

Review of Nutrition and Mortality Indicators for the Integrated Food Security Phase Classification (IPC)

Reference Levels and Decision-making

by Helen Young and Susanne Jaspars

September 2009

A study commissioned by:

The SCN Task Force on Assessment, Monitoring and Evaluation, and
The Integrated Food Security Phase Classification (IPC) Global Partners

This study has been funded by the Inter-Agency Standing Committee (IASC) Nutrition Cluster and ECHO through the Global IPC Partnership.

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"There is no best indicator, best measure of an indicator, or best analysis of an indicator in a generic sense. The definition of "best" depends ultimately on what is most appropriate for the decision that must be made"

(Habicht and Pelletier, p.1519, 1990)

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Foreword

This review of nutrition and mortality indicators was carried out for the specific use by the ***Integrated Food Security Phase Classification (IPC)*** tool, applied and developed by the IPC Global Partnership programme. The UN Standing Committee on Nutrition (SCN) Task Force on Assessment, Monitoring and Evaluation (TF/AME) supervised the conduct of the review at the request of the Technical Working Group of the IPC Global Partnership. Funding was obtained through UNICEF from the Inter-Agency Standing Committee (IASC) Nutrition Cluster and from ECHO as one of the key donors of the IPC programme.

Conducted by Helen Young of the Feinstein International Centre, Tufts University, and Susan Jaspars from the Overseas Development Institution (ODI), the review benefited from a broad based two-day technical consultation in Rome in July 2009, attended by 33 experts representing 18 agencies and institutions. A draft technical paper was used as a background document for the consultation, which included health and nutrition experts, agricultural and socio-economists and practitioners of the IPC tool.

During the consultation, the properties and purpose of nutrition and mortality indicators were reviewed in the specific context of the Integrated Food Security Phase Classification, which looks at relative severity of food insecurity through a series of indicators, backed-up by an in-depth analysis of factors that influence the food security and nutrition situation. The review incorporates the outcomes of the consultation with a thorough examination of past studies and reports.

Apart from providing guidance to IPC practitioners on the significance and use of nutrition and mortality indicators for the classification of food security, the conclusions from the consultation and the study itself provide a very rich basis for further work, including in strengthening linkages between food security and nutrition analysis and revisiting the definition and interpretation of the reference levels of these indicators for the classification of the depth of food insecurity. We look forward to further research, debate and practical action in this domain of work.

Mark Smulders
Co-Chair SCN TF/AME
Senior Economist
Agricultural Development
Economics Division, FAO

Agnès Dhur
Co-Chair SCN TF/AME
Senior Food Security Analyst
Food Security Analysis Service
World Food Programme

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We are especially grateful to those that we have not even met, who responded promptly and thoughtfully to our questions, and to those who allowed time for us to interview them. We have not yet done justice to all the material that has been made available to us, and in the next phase of this work, at a consultative workshop, we hope to facilitate a more participatory process of review of the main issues, reaching consensus and consolidating practical field guidance on the use of reference levels.

At this stage, we would especially like to thank Valérie Ceylon and Mark Smulders, who have been responsible for guiding this process, with support from Agnès Dhur, Kate Ogden and Zoé Druilhe, all from FAO and WFP.

Finally, many thanks are due to our dedicated research assistant Chloe Puett who has been unerring in her support and help with this project.

Terminology

The use of terminology in relation to nutrition and mortality indicators is a little confusing, for example, the terms benchmark and threshold are often used interchangeably even within the IPC, and generally refer to the reference level of an indicator within a particular Phase. We feel the term reference level is more appropriate as it suggests a reference level to guide decision-makers, rather than a threshold which suggests a sudden change that should serve as a trigger. We have included a glossary in Annex 1 of IPC specific terms, and also more general terms.

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Summary

This report is part of a comprehensive technical review of mortality and nutrition indicators on behalf of the IPC Technical Working Group and the Standing Committee on Nutrition (SCN) Task Force on Assessment, Monitoring and Evaluation (TF-AME). The purpose of the review is to ensure that these indicators, in combination with others, help in making a single statement on the food security situation (situation analysis). Malnutrition and mortality indicators have been included in the IPC, along with those of food security, as "Key Reference Outcome Indicators" since its inception in 2004. Reference levels for each indicator (thresholds) have been attributed to each of the five phases of the classification to determine the severity of food insecurity.

Indicators reviewed in this report are: crude death rate (deaths/10,000/day), 0-5 death rate (deaths/10,000/day), low weight-for-height – indicator of wasting, and low height-for-age – indicator of stunting, which are already included in the IPC. Indicators reviewed but not yet included are under five mortality rate (deaths/1,000 live births), infant mortality rate (deaths/ 1,000/ live births), mid upper arm circumference (MUAC), underweight (low weight-for-age), and chronic undernutrition (low body mass index). Preliminary findings and recommendations from this review were discussed at a workshop in Rome on the 14-15 July with participants from a wide range of academic institutions, UN agencies and NGOs. The conclusions from the workshop are incorporated into this report (See Annex 1 and 2).

The selection of a particular indicator -- the nutritional index and cut-off point – should reflect the objectives of their use e.g. assessing risk, targeting and response decisions. Use of anthropometry for individual-based, largely curative interventions (which take place after the malnutrition has occurred) is very different from a population-based approach—aimed at improving the nutritional situation of affected populations rather than individuals. It is therefore crucial that the IPC clarify the specific purpose and role of nutrition and mortality indicators in relation to food security. Until now, very little work has been done on establishing the most useful reference levels in relation to food security.

WH is the preferred nutritional indicator for emergencies because it is indicative of severe recent or current events; for example, acute food insecurity or famine, outbreaks of disease such as diarrhoea or measles. Weight-for-height reference levels are based on recommendations from meetings and expert committees (e.g. the WHO classification), evidence from malnutrition and mortality studies in refugee and displaced contexts, and data from the WHO global database. Reference levels are used to improve accountability in decision making. In general, the WHO classification of wasting is the most widely accepted classification for determining whether a population is experiencing an “emergency”, but these reference levels are not always applied in practice.

The Sphere minimum nutrition standards reject the use of absolute reference levels in favour of more contextual analysis of trends in nutritional status, underlying causes and seasonal influences. While there is broad consensus that WH is a good indicator of recent or current nutrition, and the importance of causal analysis, there are however no standard or agreed methods or indicators to measure or assess these underlying causes, or “aggravating factors”.

Mid upper arm circumference is also an indicator of wasting, and is used without adjusting for age or height. It increases by about 2 cm between 1 and 5 years of age, however, and as a result a given cut-off of arm circumference (AC) will preferentially select younger children as they will have smaller AC measurements. There is a strong consensus that MUAC is the

best predictor of mortality. Its predictive power is in part a result of age confounding, and as such may not be a good indicator of food insecurity. The FSNAU in Somalia developed reference levels for prevalence <12.5 cm AC, which have been recommended for use as supporting evidence for severity of acute malnutrition. More recent WHO/UNICEF recommendations however suggest a cut off of 11.5 cm.

Elevated prevalence's of low height-for-age – stunting, are indicative of specific risks, including mortality, morbidity, poorer school performance, decreased work capacity and increased risk of adult morbidity and early death. The WHO have proposed reference levels (prevalence ranges) for low HA and also low weight-for-age (WA) for the purposes of classifying ranges of worldwide prevalence's. These are not based on correlations with functional outcomes and simply reflect a convenient statistical grouping of prevalence levels from different countries. In March 2006 low HA was added as an indicator to the first two phases of the IPC framework (Phase 1 Generally Food Secure - < 20% -2 HAZ; Phase 2 Chronically Food Insecure 20 – 40% < -2 HAZ).

Low HA has been closely associated with socio-economic status and poverty in the longer term, and a more recent study has shown a graded response of HA to different categories of food security among children aged 1 to 24 months. Estimates of stunting prevalence are crucial as part of an overall profile of nutritional status within the first three phases of the IPC, as they are an important indicator of sustained nutritional deficit linked with increased mortality risk and likely food insecurity. Similar stunting prevalence's can have a several-fold difference in the prevalence of severe wasting.

Low weight-for-age reflects both long term changes in nutrition (as reflected by stunting) plus the short-term more recent changes captured by weight for height. For purposes of interpretation it is more useful to consider wasting and stunting separately rather than in this combined index, although proportions of underweight have been found to be lower in food secure households. There is also some evidence that weight-for-age has been able to detect changes in nutritional status as a result of HIV/AIDS that were not apparent using WH. Weight-for-age is widely used by WHO and UNICEF in monitoring trends in the global prevalence of underweight, and is also one of the MDG indicators.

Degrees of underweight among adults (chronic energy deficiency or chronic undernutrition) have been categorized on the basis of Body Mass Index (BMI). . Low BMI is correlated with risk of long term mortality and also correlated with days in bed, sick events, physical activity, and low birth weight. Several issues affect interpretation, including the need to adjust for body shape, the decline in height with age, adaptation and seasonal fluctuations. A WHO expert committee in 1995 recommended reference levels based on the distribution of BMI found in many populations in developing countries at that time, although more data has subsequently become available as BMI is frequently measured on the 20 to 49 age group (non-pregnant women) as part of demographic surveys. Whereas child malnutrition is a composite indicator of poor health, lack of food, care etc. adult malnutrition is more intuitively a direct outcome of food insecurity.

Crude and 0-5 death rates expressed per 10,000 per day are considered key indicators to monitor and evaluate the severity of a crisis or disaster situation. In non-emergency settings, infant mortality rates (IMR/ live births) and under five mortality rates (U5MR/ live births) are more commonly reported, but these cannot detect rapid changes in mortality unless prospective surveillance systems are established. Emergency thresholds for mortality are based on the health profiles of IDPs and refugees in camp situations in the 1990's. The Sphere Project recommends context specific thresholds, justified on the basis

that the baseline rate of mortality is context specific, and a doubling of this local or regional baseline mortality is taken to define an emergency situation.

Prospective studies of the relationship between malnutrition and mortality among younger children (< 24 mo) indicate that WA, WH and AC/Height or Age are equally effective in predicting mortality associated with low anthropometric status. Among older children the situation is less clear as there is marked variation in prediction among the four indicators. Low HA (moderate stunting) tends to carry elevated risks among younger children as compared with older children. In most studies the majority of nutrition-related deaths were found to be in the mild-to-moderate category, thus presenting an argument against focussing interventions on the malnourished only.

These studies also indicate that malnutrition has its biggest impacts in populations with already high mortality levels – so the severity of malnutrition in terms of mortality risk depends on background mortality levels. This is because of the risk of dying associated with malnutrition (the anthropometric status mortality relationship) is modified by certain factors including the age range of children, morbidity, season, and breastfeeding.

Food insecurity may play a role in potentiating the risk of dying associated with wasting – as food insecurity worsens, and prevalence of wasting increases, the risk of dying increases for all children not just the malnourished. This maybe a result of a rapid decline in nutritional status of children (a shift to the left of the frequency distribution of nutritional status) without necessarily causing them to fall below the cut-off point. Although more evidence is needed, this potentially has serious implications for the interpretation of prevalence estimates of acute malnutrition and the need to advocate for community wide coverage of programmes to address food insecurity.

Population studies of prevalence data on wasting and crude mortality rates from nutritional emergencies during the eighties and nineties shows a significant log linear association between the two. This confirms that the relationship between malnutrition and mortality is exponential i.e. in the context of a worsening nutritional crisis malnutrition and mortality increase in exponents; in a curve that gradually becomes steeper, rather than increasing linearly in a straight line. This explains why a rapid deterioration is often evident in situations that are worsening.

The use of fixed reference levels for WH has been challenged on the basis of data from the Horn of Africa in particular, where studies have shown “chronically” high levels of wasting low WH, leading to the conclusion that this might be ‘normal’ in some protracted crises. At the same time it has been argued that low WH produces distorted prevalence estimates of acute malnutrition as compared with MUAC, as a result of body shape and low values of SSR. This argument is however flawed, in particular because body shape influences prevalence estimates of WH, as does age influence prevalence estimates of low AC. The suggestion of differential reference levels for different population groups was rejected by the workshop participants, due to insufficient evidence. The temporal dimension does need to be addressed within the IPC, however. There is an urgent need for the IPC to include duration, or time spent within a particular phase, as part of its analysis.

WH has generally proved to be a better indicator for monitoring nutritional status trends in response to changes in food insecurity than MUAC. As prevalence of low WH increases, as expected in the more severe phases of the IPC older children experience increasingly high prevalence’s – disproportionately more than younger children. This indicates the need to monitor trends in WH by age group. Excess mortality also shows a greater proportional increase in older children in some studies. In addition, with changes in food security, the

entire distribution shifts to the left – indicating population wide effects on nutritional status. This means that the mean nutritional status may be a more sensitive indicator of changes in the nutritional situation and that it may be an early indicator of food insecurity.

As food insecurity evolves and deepens the underlying causes of malnutrition (food, health and care) change and interacts with each other. In the non-emergency phases of the IPC, the three groups of underlying causes are on a par; food, health and care are each necessary but on their own insufficient for good nutrition. When food insecurity worsens, it influences the social and care environment (care-giving behaviours, family and wider social networks), and also access to health care and the health environment. During a humanitarian emergency food security is heavily influenced by the severe social changes – particularly where forced migration (or conversely restricted mobility and access as a result of conflict), effect the integrity of the household and their food security. At the final stage of humanitarian catastrophe all underlying causes of malnutrition are extremely elevated, as a result of the combined (multiplicative) effects of a complete failure in all three underlying causes. At each progressive stage of the IPC there is likely to be an exponential increase in malnutrition and mortality rates, because of the synergistic relationship between underlying causes.

Recommendations (guidance)

Purpose of indicators

1. Given the role of the IPC, the purpose of anthropometric indicators should be to monitor trends in food security, rather than identifying mortality risk. Given the role of the IPC the former would seem to take priority over the latter. In the emergency phases, however, anthropometric indicators that identify mortality risk will also be appropriate as these phases are characterised as more general humanitarian emergencies as well as food crises.
2. It is essential that the recommendations of the technical IPC working group are more broadly supported and endorsed by a wider group of stakeholders, who represent decision-makers across the different phases of the IPC.

Recommendations on indicators and reference levels for different IPC phases are described below, and summarised in Table 1 and 2.

Acute Malnutrition - Weight for height

3. The inclusion of WH in the IPC is appropriate, as acute food insecurity and famine are commonly associated with high levels of acute malnutrition. It is therefore appropriate to continue to use WH in all phases of the IPC and to recognize its particular relevance in phases 3-5. Based on the recommendations of the workshop, the use of GAM, i.e. low WH plus oedema, is recommended. This is consistent with the NICS classification system which uses prevalence of acute malnutrition, and WHO classification which uses wasting, but which according to WHO also includes children with oedema. Severe Acute Malnutrition (SAM) is not recommended as a key reference outcome because of the small numbers and therefore wide confidence intervals (the same argument applies to oedema).

WH Reference levels

4. There are at least three different classification systems and associated reference levels pertaining to prevalence of low WH or GAM for judging the severity of a nutritional emergency. The use of reference levels in national or local food security information systems varies even more widely. Irrespective of the institutional focus of different organizations, there is a need for the standardization of reference levels between different stakeholders and systems, based on agreement and consensus beyond the IPC institutions. This could be achieved by collaboration on the development of new reference levels for the IPC, which would make use of the WHO global database and the NICS database.
5. Reference levels need to reflect more clearly the exponential relationship between malnutrition and mortality i.e. the increase in prevalence of low WH in each of the IPC Phases should reflect the exponential increase in malnutrition that is seen with increases in background mortality and vice versa. The log linear relationship between malnutrition and mortality needs to be reflected in the actual reference levels (currently the WHO reference levels increase in increments of 5%, which explains why it is unable to differentiate between levels of severity above 15% prevalence). This could be done by analysing surveys in the NICS database. See next steps.

6. The possibility of using overlapping WH reference levels between Phases should also be considered. The actual Phase would be decided by considering the prevalence of wasting as well as other indicators; i.e. through a process of triangulation. This would be in accordance with the current IPC approach of using “convergence of evidence”.
7. Until new reference levels are established the continued use of the current WH reference levels, in combination with an analysis of trends, is recommended. The use of differential reference levels for different population groups or areas is rejected by the workshop participants and authors due to insufficient evidence about the relationship between regularly high levels of wasting and mortality. Available evidence, however, indicates a close relationship between malnutrition and mortality even in such situations (e.g. pastoralists in the Horn of Africa).
8. The use of relative reference levels, or an analysis of trends, is recommended for all phases (together with fixed reference levels in the higher phases). WH is a better indicator for monitoring trends related to food insecurity than MUAC. Prevalence should continue to be reported. The IPC should include mean WHZ where this information is available and encourage monitoring of means in food security information systems. The IPC should consider using the WHO reference levels for mean WH.

MUAC

9. There is a strong consensus that MUAC is the best predictor of short term mortality. MUAC is the preferred indicator for case definitions of wasting based on a cut-off of 115mm (as recommended by WHO/ UNICEF in 2009).
10. The prevalence of low MUAC (<115mm) is appropriate in the emergency phases of the IPC as supporting evidence to indicate mortality risk in the population in question and to identify the need for feeding programmes. Low MUAC is unlikely to be a good indicator of food insecurity.

AC Reference levels

11. The only AC reference levels that exist are those developed by FSAU in Somalia based on a 12.5cm cut-off, which obviously cannot be simply transferred to data based on a different cut-off. Prevalence's of low MUAC (<115mm) are similar (based on the new WHO child growth standards) to prevalence of severe acute malnutrition (< - 3 WHZ). At this extreme cut-off point's numbers are small and confidence intervals wide and for this reason it is difficult to develop reference levels. However it has been recommended in the past that a prevalence of 1% SAM is indicative of excess mortality. One percent and above is therefore the reference level recommended as supporting evidence to indicate mortality risk in Phases 4 and 5.

Guidance for interpretation of acute malnutrition

12. It is crucial that public health factors, disease incidence and expected seasonal patterns of disease and food insecurity are also taken into account in the interpretation of reference levels (or outcomes). The predictive power of a particular indicator is subject to modification by factors such as; morbidity, age, seasonality and very likely severity of food insecurity and this has major implications for the IPC Phases, and reference levels.

13. Mortality indicators and indicators of acute malnutrition (wasting, GAM, MUAC and possibly underweight) may fluctuate according to seasonal changes in food security, health environment and care practices. Seasonal calendars describing the usual or expected seasonal changes for different regions within a country (possibly relating to different livelihood groups where there are seasonal differences) should be developed and used to help interpret mortality and malnutrition data. Seasonal changes are often greatest in rural populations who depend on a single agricultural season. The food security, health status and caring practices of urban populations tend to be independent of seasonal agricultural production cycles, or seasonal increases in morbidity (e.g. as a result of polluted water sources). Local seasonal calendars need to be developed.
14. Monitoring trends in malnutrition by age group is crucially important for an understanding of changes in the food security situation. It is recommended therefore that IPC encourages the reporting of ratio's of older (85cm and above) and younger (< 85cm) children mean and prevalence.
15. Guidance is needed that explains how as food insecurity evolves and deepens the underlying causes of malnutrition (food, health and care) change and interact with each other and the importance of food insecurity as a cause of malnutrition increases and drives the other two groups of underlying causes(see summary, and Part IV).
16. The IPC should also consider differentiating between different levels of disease and public health crises. Phase 4 (humanitarian emergency) and Phase 5 (Famine/humanitarian catastrophe) show the disease outcome 'pandemic', which is relatively unspecific and fails to distinguish between 4 and 5. Population density, crowding and shelter might also be relevant reference outcomes needed to help differentiate public health risks that might exacerbate the contribution of malnutrition to mortality.

Height for age

17. Workshop participants concluded that the inclusion of HA in the early phases of the IPC is appropriate (particularly phases 1 and 2, but also Phase 3 as recommended by WFP) as an indicator of underlying vulnerability, rather than as a key reference outcome because there was not consensus on the latter (some argued there was insufficient evidence linking changes in HA with food security). However, some participants called strongly for the inclusion of HA as a reference outcome in the early Phases, particularly as a recent study indicated that prevalence of stunting among young children (0 – 24 months) is related to food insecurity, while other studies have shown a significant association between severe stunting and longer-term mortality risk among the same age group. Stunting is therefore likely to be of most relevance to the IPC when considered among children between 0 and 24 months.

HA Reference levels

18. There is little experience of using HA reference levels, and since the WHO reference levels were first proposed there has been an increased availability of data. Given the recent evidence of its association with food security, there is potential of HA as a reference outcome in Phases 1 to 3. The authors recommend continuing to use the HA reference levels already applied in Phases 1 and 2, and introducing the WFP recommended reference level in Phase 3. An analysis of the distribution of low HA

globally and where available in emergency contexts is urgently needed. Experience of the application of these reference levels in practice needs to be reviewed.

HA guidance for interpretation

19. It is possible that prevalence of low HA may increase, while prevalence of low WH remains fairly stable. In this situation, increasing prevalence HA may be taken as supporting evidence of deteriorating food security.

Weight for age

20. At the workshop there was a general consensus to use WA in Phases 1 to 3, but not 4 and 5, as an indicator of underlying vulnerability not as a reference outcome. One advantage is that it is widely available, although a disadvantage for the IPC is that it is a composite indicator and therefore difficult to interpret (not clear whether it reflects stunting or wasting, or both). However, given the recent evidence of its association with different categories of food security among children < 24 mo and its availability where there is often a lack of data on wasting, it is worthy of further research.

Reference levels

21. As with HA, the only available reference levels are those published by the WHO Expert Committee (1995). These clearly need reviewing and it is likely to be more helpful to consider deviations (improvements or deterioration) from regional, national and local baselines (given the greater availability of HA and WA data through NICS etc).

Guidance for interpretation

22. A deterioration in HA and WA can be used as confirmation of deteriorating food insecurity, and can also be used for monitoring long-term trends, measuring impact over time, and for advocacy purposes. The rapidity of the deterioration is important to note as indirect evidence of a worsening situation.

Body Mass Index

23. Adult BMI (non-pregnant women aged 15 to 49) was considered a promising indicator. Evidence strongly suggests that a serious decline in nutritional status of adults, as reflected by prevalence of low BMI, is associated with serious declines in food insecurity. The IPC workshop participants broadly agreed that BMI should be included in all five phases of the IPC, with an emphasis on low BMI in the upper phases. For the lower phases it has the potential to capture the double burden of over- and undernutrition. Therefore, it is recommended that low BMI (<18.5 among non pregnant women aged 15 to 49 years) are included in all phases using the widely adopted cut-off of < 18.5 to estimate prevalence was recommended (as used in the WHO reference levels adopted by WFP).

Reference levels

24. The BMI working group at the workshop recommended that the IPC should consider relative reference levels, based on national or more local figures (if there is known significant within country variation in body shape), with a multiplier of 1.5 of baseline as a guide to shift to a higher phase. The authors recommend this should only apply to those baselines that are less than 20%. It is also recommended that the prevalence of obesity is used as supporting evidence for Phase 2.

25. The reference levels recently advocated by WHO (and recently endorsed by WFP) need to be reviewed based on an analysis of the current distribution of low BMI globally, and consideration of risk of obesity in the early phases of the IPC.

Guidance for interpretation

26. Several factors other than nutritional status influence BMI, including body shape, influence of age on height decline, and seasonal fluctuations in weight. One of the most important of these is body shape, and these therefore need to be taken into account when interpreting prevalence of low BMI.

Mortality

27. Crude and 0-5 death rates are key indicators to monitor and evaluate the severity of a crisis or disaster situation and should remain indicators within the IPC. They are of particular relevance in the emergency phases to detect rapid changes in severity of crisis.
28. Excess mortality should be included if accurate baseline mortality rates are available, as they are a good indicator of the impact of an emergency in particular in protracted emergencies where the number of excess deaths increases with increased duration. Excess mortality should be reported by age, because if excess mortality is higher in older children, this has major implications for emergency response. Excess mortality is an indicator of the impact of an emergency and as it's a direct count of the dying a threshold is not needed, rather it indicates the absolute severity of a crisis.
29. IMR and U5MR are not appropriate for use in the emergency phases of the IPC as the estimates cover the past 5 years and are centred about 2.5 years in the past. Trends can however be monitored if prospective surveillance systems are present, and this should be encouraged by the IPC. Until such systems are available, it is not possible to suggest what levels of change might be detected between phases 1 and 2.

Mortality reference levels

30. The reference levels for CDR and 0-5 DR used by the IPC are widely accepted and broadly standardized among the humanitarian community i.e. for emergencies. Workshop participants concluded that CDR and 0-5DR could not distinguish between Phases 1 and 2 as Key Reference Outcomes and so have been removed.
31. Actual reference levels for the more severe phases were not discussed at the workshop. The authors recommend using the original Hakewill and Moren reference level for Phase 5 (which alters Phase 5 CDR to > 5 per 10,000/ day). Alternatively in situations where baseline mortality is relatively low, the doubling rule may be applied i.e. using doubling of the baseline CDR to identify an emergency.

Mortality Guidance

32. At Phases 4 and 5, there are likely multiple causes for increasing mortality, one of which is likely to be acute food insecurity but this is only one factor and morbidity is likely to be equally if not more important particularly in Phase 5.

Duration as an indicator

33. It is important to include a consideration of duration in the IPC to reflect situations which are extended food crises or famines and where overall mortality may be higher than in short-term situations of even higher food insecurity. There is an urgent need for the IPC to include duration, or time spent within a particular phase, as part of its analysis.
34. Situations of chronically high acute malnutrition have been reported for Southern Sudan, Somalia and more recently North Darfur. However, because the prevalence rates are based on cross-sectional data, and at different times of the year it is difficult to assess whether or not such high levels are indeed sustained over time, or alternatively if there is a degree of fluctuation and catch-up growth. This has implications for response and therefore is a priority for further research.

Further Research Needs

Several research areas have been identified below which relate to the further development of reference levels, and improvement of interpretation of nutrition and mortality indicators at the different phases of the IPC.

Revising Reference Levels

Based on this review, reference levels need to be revised based on an analysis of the distribution of estimates globally (based on national data and recommended cut-off points) and more specifically in emergencies (based on the NICS database) for the following indicators:

- Prevalence of GAM, and wasting (Low WHZ) and mean WH, for children < 5 years, and for children above and below 2 years.
- Stunting (low HAZ), including disaggregating results for children < 2 years.
- Low MUAC (< 115 mm).
- BMI of non pregnant women aged 15 to 49 years (<18.5 BMI)
- Obesity among non pregnant women aged 15 to 49 years (> 30 BMI)

Available databases that could be used for this review include the NICS database, the WHO Global Nutrition Database, and possibly the CRED database. It is uncertain whether data will be available on AC (<115mm). If this is not available the IPC should work closely with NICS and a number of operational agencies to obtain the necessary data.

Previously, there have been three approaches for determining reference levels;

- i. Arbitrary categories based on existing reference levels adapted to fit the number of scales required (e.g. the way reference levels have been determined for various food insecurity/famine scales).
- ii. A grouping of the available prevalence data for stunting and wasting in developing countries pre 1993 from the WHO database. Four categories were determined based on the grouping of available prevalence data according to quartiles (or other equal division) of observed values in the 79 countries surveyed (de Onis, Monteiro et al. 1993). Both indicators were based on height-for-age and weight-for-height below -2 SD of the values for the reference median.
- iii. The NICS categories were based on reviews of malnutrition prevalence data combined with mortality data in humanitarian emergencies, including IDP and

refugee camps, and acute food insecurity and famine crises between 1992 and 1994. These graphs clearly show an exponential increase in mortality as malnutrition increases.

A new review of globally available data in emergencies and more stable contexts is needed, because the earlier reviews were undertaken more than 15 years ago, were based on low WH (not GAM) and the data used by the RNIS/NICS covered extreme crises (prevalence's of up to 50% were common). Since that time the availability of data has increased, the quality improved, plus data is now available for GAM and not only for < -2 WHZ. It is strongly recommended that this formulation of revised reference levels is a collaborative exercise in order to achieve greater standardization of reference levels and increase the availability of data for the review.

The application of the new reference levels should be monitored in a number (minimum 5) of pilot countries, and compared with food security indicators.

Evaluating the proposed changes to the nutrition and mortality indicators

The proposed changes to the use of stunting and underweight as indirect evidence in the IPC should also be evaluated as part of the above pilots.

Reviewing the relationship between nutritional, mortality and food security indicators and the effects of age, seasonality and body shape.

Research is needed to establish the association between severity of food insecurity and nutritional indicators, and also with mortality, and how this differs between older and younger children, how this differs seasonally and according to body shape. Examples of research questions:

- What is the relationship between food security indicators and anthropometric indicators recommended for us in the IPC.
- What is the effect of age on the association between low WH (and GAM) and food insecurity?
- What is the effect of age on the mortality risk associated with low WH and GAM?
- As prevalence of low WH (and GAM) increases, how does this affect the proportion of wasted children above and below 85cm.
- What are the functional outcomes associated with low WH among older 'pastoralist children', and among older children generally.
- How does the age distribution of low WH (or GAM) change as prevalence increases and how is this influenced by the food, health and care causes of malnutrition. (This could be examined by analysing existing data sets, and developing new compound variables for each of the underlying causes).
- How does seasonality affect patterns of wasting, stunting and underweight? This should include an examination of seasonal changes in nutritional status, morbidity and mortality and in food, health and care causes of malnutrition, and the likely impact this has on risk of dying.

The changing relationship between food, health and care as food insecurity evolves and deepens

- Answers to the above questions on seasonality will help in further developing the conceptual understanding how food, health and care change over time, and how care and health are influenced by and also influence food insecurity at different Phases of the IPC.

The nature, causes and consequences of regularly high levels of wasting in chronic famines or extended food crises

Further analysis and confirmation of situations where levels of GAM appear elevated over long periods of time are needed. It is likely that approaches to nutrition surveillance as part of food security information systems tend to capture the worst scenarios, and thus cannot be used to extrapolate information for the emergency affected population overall.

Table 1 – Recommendations for key reference outcomes

Phase Classification	Key Reference Outcomes	Reference levels
1 Generally Food Secure	Stunting Acute Malnutrition – Low WH <i>and/or oedema</i> <i>Maternal Undernutrition¹</i>	< 20% (< -2 HAZ) < 3% (< -2 WHZ), <i>Mean WHZ > -0.40</i> < 10% (< 18.5 BMI among non pregnant women aged 15 – 49)
2 Moderately/ Borderline Food Insecure	Stunting Acute Malnutrition – Low WH <i>and/or oedema</i> <i>Maternal Undernutrition</i>	20 – 40% (< -2 HAZ), <i>increasing</i> > 3% but < 10% (< -2 WHZ). <i>Mean WHZ -0.40 to -0.69</i> . Usual range, stable - 10 – 19% (< 18.5 BMI among non pregnant women aged 15 – 49)
3 Acute Food and Livelihood Crisis	Crude Death Rate 0-5 Death Rate Acute Malnutrition – Low WH <i>and/or oedema</i> <i>Stunting</i> <i>Maternal Undernutrition</i>	0.5 – 1 /10,000/ day 1 - 2 /10,000/day 10 – 15% (< -2 WHZ), <i>Mean WHZ -0.70 - -0.99</i> ; > than usual, increasing. > 40% (< -2 HAZ), <i>increasing</i> - 20 – 39% (< 18.5 BMI among non pregnant women aged 15 – 49)
4 Humanitarian Emergency	Crude Death Rate 0-5 Death Rate Acute Malnutrition – Low WH <i>and/or oedema</i> <i>Maternal Undernutrition</i>	> 1 – 5 / 10,000/ day, <i>or a doubling of the baseline rate.</i> > 2 - 10/ 10,000/day > 15% (< -2 WHZ) <i>Mean WHZ < -1.00</i> ; > than usual, increasing > 40% (< 18.5 BMI among non pregnant women aged 15 – 49)
5 Famine/ Humanitarian Catastrophe	Crude Death Rate <i>0-5 Death Rate</i> Acute Malnutrition – Low WH <i>and or oedema</i>	> 5/ 10,000/ day > 10/10,000/day > 30% WHZ < -2

* No BMI threshold for Phase 5, no mean WHZ for phase 5.

¹ Maternal undernutrition reference levels are based on the 1995 WHO Expert Committee, which gives no reference levels for extreme food insecurity i.e. for the Famine/ Humanitarian Catastrophe Phase.

All recommendations for changes from the current version of the IPC Reference Table (IPC Technical Manual, IPC Global Partners, 2008) are highlighted in bold italics.

Maternal Undernutrition reference levels are based on the 1995 WHO Expert Committee, which gives no reference levels for extreme food insecurity i.e. for Phase 5 (Famine/ Humanitarian Catastrophe).

Table 2 – Recommendations for supporting or indirect evidence

Phase Classification		Supporting evidence²	
1	Generally Food Secure	Underweight < -2 WAZ Obesity (non pregnant women aged 15 - 49) > 30 BMI	
2	Moderately/ Borderline Food Insecure	Underweight < -2 WAZ Obesity (non pregnant women aged 15 - 49) > 30 BMI	
3	Acute Food and Livelihood Crisis	Underweight	
4	Humanitarian Emergency	>1% AC <11.5cm Excess mortality (i.e. more than baseline)	
5	Famine/ Humanitarian Catastrophe	Excess mortality increasing >1% AC <11.5cm)	

² The use of SAM, if available, could be considered as supporting evidence for phases 3 to 5.

Introduction

The Integrated Food Security Phase Classification (IPC) is a food security severity scale developed globally by a partnership of UN agencies, NGOs and donor agencies. It aims to provide a common technical approach to classify food security according to reference outcomes that are based on recognized international indicators of food security, nutrition and mortality, in order to facilitate comparisons between countries and over time for decision-making about appropriate policies, programmes and resource allocation. As an institutional process it aims to engage stakeholders in reaching consensus about the current and likely food security situation based on the available evidence in the form of indicators. The IPC has been introduced in several parts of Africa and Asia, and continues to gain momentum among governments, UN, NGO, donors, and academic organizations. Indicators of wasting and chronic malnutrition and mortality have been included in the IPC, along with those of food security, as "Key Reference Outcome indicators" since its inception in 2004. Reference levels for each indicator (thresholds) have been attributed to each of the 5 Phases of the classification (from generally food secure to famine/humanitarian catastrophe). The IPC reference table is shown in Annex 4.

This draft report is the first output of a comprehensive technical review of mortality and nutrition indicators, to ensure that these indicators, in combination with others, help in making a single statement on the food security situation (situation analysis), by reflecting the progressive changes in the food security situation.

Current day usage of nutrition and health indicators to gauge the severity of famine and complex emergencies originates with the early experiences of NGOs, during famine and complex emergencies in the late sixties in Biafra and India (Black 1992). By the seventies nutrition surveys in emergencies were increasingly common (Kloth, Burr et al. 1974; Seaman, Holt et al. 1978). Malnutrition classification systems have an equally long and convoluted history. The first cross-classification of wasting and stunting by Waterlow (1972) was originally intended to distinguish patterns of severe malnutrition in children admitted to hospital, but since then quantitative classification of wasting, and stunting has been used in community studies of prevalence and severity.

Waterlow's advice of 37 years ago is still relevant to the IPC today; he said a classification system needs to be simple, and ideally a classification of protein energy malnutrition would take account simultaneously three factors: quality or type of growth failure, severity, and duration. David Pelletier quantified an important fourth dimension relating to attribution; he estimated the fraction of child mortality attributable to different categories of malnutrition by analysing Population Attributable Risk³ (PAR) (Pelletier, 1993). Howe and Devereux (2004) also drew attention to magnitude as an important aspect of a classification system. For them magnitude includes both the scale and density of the phenomena, in terms of population numbers affected, geographic spread and density (Howe and Devereux 2004). Waterlow understood that a classification system must be widely accepted if it is to be useful and to make possible comparisons between results obtained by different people in different places. It therefore should only be determined by agreement, which unfortunately after 36 years has still not been achieved with the proliferation of classification systems based on different reference levels. In summary, to be useful an anthropometric

³ Population Attributable Risk (PAR) estimates the total nutrition related deaths in the population, by taking into account both the strength of the association and the prevalence of malnutrition.

classification system needs to be simple and take account of the type of growth failure, its severity, duration and magnitude and needs to be agreed upon by key stakeholders.

This introduction first considers the purpose of classification systems and the purpose of anthropometric and mortality indicators within the IPC. It then considers the selection and use of anthropometric indicators and in particular the selection of cut-off points, followed by a consideration of selection of reference levels.

Purpose of classification systems

The ultimate purpose of a classification system is to be useful for decision-making and/or advocacy, and in particular to be useful to decision-makers who influence the allocation of resources, response strategies, programming and policy formulation. Different classifications of food insecurity serve different purposes, and are used in different ways. Darcy and Hoffman (2003) were concerned with making humanitarian decision-making more accountable, which required agreement on indicators of the severity of crisis. (Darcy and Hoffman 2003) Howe and Devereux (2004) were concerned with developing a clearer classification for the purpose of diagnosing 'famine', as compared with situations of lesser food insecurity. The selective feeding decision-making frameworks apply a classification system based on prevalence estimates of low weight-for-height (WH) combined with 'aggravating factors' in order to determine the need for different types of feeding programmes i.e. they are intended to facilitate decision-making and link information to action.

In most humanitarian classification systems mortality is considered the prime indicator by which to measure the impact of a humanitarian crisis (Checchi and Roberts, 2005), although prevalence of low WH - anthropometric wasting, is frequently used as a proxy for mortality when the latter is unavailable. Similarly within the IPC mortality and malnutrition have been called the "ultimate outcome indicators" (Haan, personal communication)

Use of anthropometric indicators

Anthropometric indicators are most commonly used as proxies for 'nutritional status' and are constructed from nutritional indices. For example, the percentage of children below -2 Z scores weight-for-height (WHZ) is widely used as an indicator of anthropometric wasting. The prevalence of low WH or anthropometric wasting may then be compared with reference levels for the population to determine the severity of malnutrition in a community (reference levels are also known as thresholds, trigger thresholds, benchmarks or norm, and but all refer to a comparison to which an indicator can be examined or gauged) (Mathys 2007; Van der Heide, Brouwer et al. 2007).

The use of nutritional indices and indicators and their interpretation differ according to whether they relate to individuals or to populations. Our main concern is their use as indicators of undernutrition at the population level, which conceptually is very different from the individual diagnosis of malnutrition and has important implications for non nutritional variables collected⁴. The choice or selection of a particular indicator -- the nutritional index and cut-off point -- should reflect the objectives of their use e.g.

⁴ Undernutrition arises from the deficiency of one or more nutrients, including both macro and micronutrients, and in children can lead to growth failure, such as stunting, wasting and underweight, or combinations thereof. The term malnutrition on the other hand tends to refer to the clinical condition or nutrition disorder those results from inadequate food intake, poor absorption, altered metabolism etc.

- Identifying past and current risk, and/ or predicting future risk (an increase in wasting in a population may identify present and future risk, whereas an increase in stunting in the population identifies past risk). As well as identifying risk, the IPC is concerned with qualifying the severity of risk.
- Targeting – selecting individuals or populations for intervention
- Response decisions – predict benefit from an intervention, or measure impact.

Selection of cut-off points and reference levels

The purpose of the original classification of grades of malnutrition introduced by Gomez was to provide a guide to the prognosis of malnourished children seen in hospital (Gomez 1956), and was defined in the light of clinical experience. Only later was this system widely adopted for describing malnutrition in the community as mild, moderate and severe (Waterlow, 1984). Cut-off's focus on the lower end of the distribution, and at the extremes provide diagnoses or case-definitions for wasting (low WH) and stunting (low HA). Technically, cut-off points can be defined on the basis of either statistical, risk and or prescriptive criteria (Pelletier 2006):

1. Statistical criteria

Statistical cut-off's classify the nutritional status of individual children by comparison with a reference population, such as weight-for-height (WH), weight-for-age (WA), and height-for-age (HA) based on the NCHS/CDC population. These reference values and associated cut-off points are a tool for analyzing data and providing a common (international) basis for comparing populations. Grades of malnutrition are determined according to the probability that individuals are small because they are undernourished (Payne, 1990). A child that is 2 standard deviations below the reference median is classified as moderately malnourished; the probability of its small size being "normal" is only 2.5%. Reference values such as the NCHS/WHO population are not to be confused with standards, which imply a norm or prescriptive element with targets and associated assumptions if that norm is not achieved (see below).

2. Risk of dysfunction

Anthropometric cut-off points based on the actual risk of dysfunction (such as mortality) are less common in part because only a limited number of studies have tried to relate nutritional status to risk of death and to risk of infection, and also because these provide no clear-cut results at levels that classify above severely malnourished (see Part 3). Two exceptions are the arm circumference (AC) cut-off of 110mm and the weight-for-age cut-off of 60% (see Part 3).

3. Prescriptive criteria

The new WHO Multi-Reference Growth Standards (MRSG) is based on prescriptive criteria, which seeks to define how children should grow rather than simply describe how they do grow⁵. The use of a growth standard (as opposed to a growth reference) involves value or normative judgments. The cut-off of < -2 SD is still based on statistical probability.

Less work has been done on theorizing the selection of reference levels (thresholds or benchmarks) compared with the numerous research studies on cut-off points and the functional outcomes of malnutrition, based on different nutritional indices. Part 2 of this report describes the key characteristics of the malnutrition and mortality indicators in and

⁵ Between 1997 and 2003 WHO undertook a Multicentre Growth Reference Study in six countries, purposively designed to produce a standard by selecting healthy children living under conditions likely to favour the achievement of their full genetic growth potential. (IASC and SCN, 2009).

the origins of the reference levels in the IPC. To inform the selection of reference levels for the purposes of monitoring food security monitoring, we have reviewed the following three bodies of work:

1. The evidence base for indicators and reference levels currently in use in, or proposed for, classification systems (Part 2)
2. Prospective studies of the mortality risk of undernutrition among individuals, in order to determine which nutritional index is the best predictor of death and under what conditions (i.e. from food secure to famine/ humanitarian catastrophe) (Part 3).
3. Analysis of the association between prevalence estimates of undernutrition and mortality estimates (i.e. population data) - particularly in contexts of varying food insecurity and even famine. (Part 4 and Annex 3).
4. The practical application of indicators and reference levels in food (in-) security classification systems.

Several technical proposals have been made to the IPC for modifying the existing indicators and reference levels, during the IPC online consultation, the WFP IPC pilots in Cambodia and Indonesia, and in the minutes from the Technical consultations and Technical Working Group meetings (e.g. the WFP position paper). The main discussion to date has tended to focus on the non-acute phases of the IPC (Phases 1 and 2), particularly the inability of the current IPC indicators to distinguish between the lower levels of food insecurity i.e. the less severe phases. Specific proposals have been made relating to:

- The use of different reference mortality rates for non emergency phases (number of deaths per live births; IMR and U5MR).
- Use of stunting >40% in the acute food and livelihoods crisis.
- Inclusion of underweight in all phases, particularly for countries where wasting rates are low.

Linking indicators and decision-making: to ensure they are ‘fit-for-purpose’

The five phases of the IPC range from ‘generally food secure’ to ‘famine/humanitarian catastrophe’. Phases 1 and 2 of the IPC are meant to represent non-crisis situations--i.e., no significant shock has occurred to disrupt the system and/or the situation can best be described as stable (not deteriorating) and more of a developmental/structural nature -- which is distinct from a protracted crisis (whereby continued/intermittent shocks disrupt the system) (N. Haan, personal comm., 2009).

Purpose of anthropometric and mortality indicators within the IPC

According to the IPC manual/ user guide, “the IPC scale uses internationally accepted benchmarks in order to provide a common language and facilitate technical consensus among food security experts and practitioners” i.e. to develop a norm -- shared standards among their stakeholders that are socially enforced. The IPC Reference Table defines the five phases of food security classification (from Generally Food Secure to Famine/Humanitarian Catastrophe) by the reference levels of the main indicators. The reference levels are referred to as ‘thresholds’ and called ‘Key Reference Outcomes’, as they generally focus on actual outcomes of conditions on lives and livelihoods, such as acute malnutrition or mortality. The IPC’s use of ‘outcome’ indicators allows standardization and the ability to compare food security conditions over time and space. However, proxy or process indicators are used as “indirect” evidence and must be related to a specific reference outcome. Proxy indicators need to be interpreted in relation to the particular context and livelihood system, and usually do not have “thresholds” or reference levels.

Examples of indirect evidence includes clinic and feeding centre data (e.g. increase in attendance/admissions) as indirect evidence for the prevalence of global acute malnutrition. For access to food, indirect evidence might include rainfall data, market prices, and crop production (FAO, 2008; FAO, 2008).

The first question to ask in reviewing the role and interpretation of indicators is; *what type of decision-making is IPC trying to inform through its analysis?* The decisions to be made in emergency contexts, or in the emergency phases of the IPC, are likely to be very different from the decisions to be made in the non-emergency phases. In the non-emergency phases, issues of chronic malnutrition and underlying causes will feature more prominently, whereas in the emergency phases the emphasis will be on determining the severity of acute food insecurity. The technically best indicators are likely to vary markedly according to these different uses.

- Different anthropometric and mortality indicators will be needed, for example for: Monitoring trends related to food intake linked with acute food insecurity (monitoring response to interventions, and assessing current and future risk – classifying severity of food insecurity for early warning)
- Monitoring long-term trends in overall development/poverty reduction
- Estimating incidence of malnutrition – cases needing treatment – for response

Not only does this mean the use of different indicators for different purposes, but also for each indicator, there may be preferred ways of expressing that indicator – by prevalence below cut-off, mean or according to reference levels, that are more suited to a particular purpose.

There is a difference between uses of anthropometry for identifying malnourished individuals for curative interventions, and for interventions that aim at improving the nutritional situation of affected populations. The former requires a good case-definition with high sensitivity and low specificity for identifying children most likely to die, while the latter requires a broader population based statistic that reflects entire distribution.

A second question relates to; *are the policy makers and programmers in more stable developmental contexts drawn from the same or different stakeholders than in the more severe emergency contexts?* Indicators are only useful if agreed to and acted upon by decision-makers. Recommendations for response in the non-emergency phases in the IPC are clearly targeted at developmental decision makers, which are not always the same as those making decisions on humanitarian response in the emergency phases of the IPC. It is widely recommended that efforts should be made “to directly engage some of the end-users and stakeholders implicated in this effort, in order to reconcile some of the normative trade-offs identified” p S224. The IPC project, as it has been conceived has prioritized establishing broad institutional support for the IPC. Informing decision makers, and “triggering” a response, is widely considered to be one of the main uses of malnutrition and mortality indicators in the IPC. Broadly speaking, the IPC aims to inform three groups of responses: mitigating immediate negative outcomes, supporting livelihoods and addressing the underlying or structural causes of food insecurity. It is therefore essential that the recommendations of the technical IPC working group are more broadly supported and endorsed by a wider group of stakeholders, who represent decision-makers across the different phases of the IPC.

Part 2 - Review of Indicators and evidence base for the reference levels

Introduction

The mortality and nutrition indicators under review in this section are listed in table 3. Some were already included as part of the IPC reference table from the start, while other indicators are not yet in the IPC and are under consideration.

Table 3 Mortality and Nutrition Indicators under review by the IPC

Indicators		Definition	Currently included in the IPC reference table
Mortality indicators			
Under Five Death Rate	0-5 DR	total under five deaths per 10,000 per day	Phases 1 to 5
Crude Death Rate	CDR	number of deaths per 10,000 per day	Phases 1 to 5
Under Five Mortality Rate	U5MR (live births)	Number of deaths per 1,000 live births	Not yet included
Infant Mortality rate	IMR	Number of deaths per 1,000 live births	Not yet included
Nutrition indicators			
Prevalence of wasting	1. Low WH	Percent below minus 2 Z score weight-for-height (% < -2 WHZ)	Phases 1 to 5 <i>Also included in Nutrition Analysis Framework (FSNAU)</i>
	2. Low MUAC	Percent below MUAC cut-off's	Not yet included in the IPC framework but already included <i>Nutrition Analysis Framework (FSNAU)</i>
Global Acute Malnutrition	GAM	Percent below minus 2 Z score weight-for-height AND oedema (% < -2 WHZ)	<i>Also included in Nutrition Analysis Framework (FSNAU)</i>
Severe Acute Malnutrition	SAM	Percent below minus 3 Z score weight-for-height AND oedema (% < -3 WHZ)	<i>Also included in Nutrition Analysis Framework (FSNAU)</i>
Prevalence of stunting	Low HA	Percent below minus 2 Z score height-for-age (% < -2 HAZ)	Version 1 Phases 1 & 2 <i>Also included in Nutrition Analysis Framework (FSNAU)</i>
Prevalence of underweight	Low WA	Percent below minus 2 Z score weight-for-age (% < -2 WAZ)	Not yet included
Prevalence of chronic undernutrition in pre-pregnant women	Low BMI	Percent below cut-off's for Body Mass Index (weight/height ²)	Not yet included

This section reviews the current technical specifications for these indicators, and the origins of the reference levels in the IPC. This includes a review of the type of growth failure they reflect, a brief overview of cut-off points and reference levels, and some of the key issues in interpretation in particular in relation to food security.

Aetiology of wasting and stunting

Wasting occurs as a result of recent rapid weight loss, or a failure to gain weight within a relatively short period of time. The rapid onset of wasting, especially in emergencies, is why it is also referred to as acute malnutrition. The reduced growth rate or weight loss found in wasting, has also been referred to as Type II nutritional response (Golden 1995) and occurs as a result of deficiencies in both macro nutrients (fat, carbohydrate and protein), or low food intake, and also some micronutrients such as potassium, magnesium, sodium, phosphorus and zinc). In addition, disease (especially diarrhoea and measles) also leads to weight loss and therefore wasting⁶.

Stunting (indicating chronic restriction of a child's potential growth) implies long-term and cumulative influences of inadequate nutrition and/or repeated infections such as diarrhoea. Deficiencies of micronutrients (particularly vitamin A, iron and zinc), as well as macronutrients, play a significant role in stunting. For example, zinc deficiency contributes to poor growth in young children (Brown, Pearson et al. 1998). The causes of elevated prevalence of stunting are broadly associated with poverty; Black et al report that in most countries the poor children have about twice as much stunting as the wealthier children. Causes of a high prevalence of stunting, apart from the general socioeconomic status of the population are less easily identified than the causes of a high prevalence of wasting – which can often be attributed to a recent food shortage, disease outbreak etc (WHO Expert Committee 1995).

Wasting, stunting and mortality are all influenced by age. Wasting is more common in infants and younger children, often during the stage when complementary foods are being introduced and children are more susceptible to infectious diseases. Wasting is reversible in the short-term as children may gain weight, and often occurs on a seasonal basis as a result of a seasonal hunger gap or higher disease incidence.

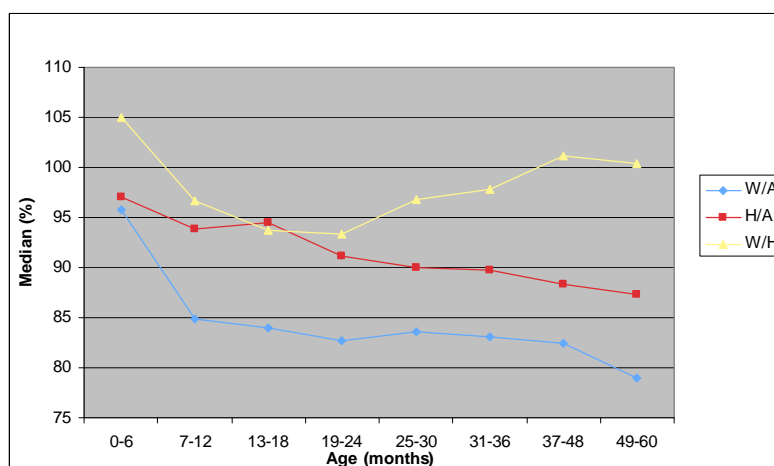
Stunting prevalence increases progressively from immediately after birth until reaching a plateau at around 24 months (Shrimpton, Victora et al. 2001), as a result of which stunting prevalence is lower among younger children compared with older children. A high prevalence of stunting among older children is reflective of their past nutrition, and also may indicate conditions currently experienced by younger children in that same community.

Because of the sharp growth faltering in the first two years of life interventions at this stage are crucially important. Similar stunting prevalence can have a several-fold difference in the prevalence of severe wasting (Black, Allen et al. 2008). Conversely, the prevalence of severe wasting is higher at younger ages and declines by 24 months (Black, Allen et al. 2008). These patterns are shown in Figure 1.

The term “chronic malnutrition” is often used to describe low height-for age, in part because height deficits occur as a result of a long-term process. WHO (1995) discourages the use of this term because it fails to differentiate between an individual's past malnutrition and a long-term continuing process of becoming malnourished.

Figure 1 Example of median weight for age, height for age and weight for height of children by age category (reference)

⁶ In contrast, a type I nutritional response occurs as a result of a deficiency in specific individual vitamins or minerals (e.g. iron, vitamin C and A) but not associated with growth failure but can represent serious public health problems.



Weight for height

WH reflects body weight relative to height. Weight-for-height reflects wasting - recent rapid weight loss. A high prevalence of low WH is indicative of severe recent or current events; e.g. starvation or outbreaks of disease such as diarrhoea or measles. WH (as well as MUAC and weight change) are good indicators to measure short term variations in nutritional status (Briend, Hasan et al. 1989) and will reflect seasonal changes in food intake and disease.

For these reasons, WH is the index of choice for all situations which involve short term actions: e.g. screening for emergency interventions, but also for early warning of impending food shortages (Waterlow 1992). An additional reason why it is preferred in emergencies is because it does not need an estimation of the child's age.

Low weight for height peaks between 12 and 24 months. Therefore in more stable settings, wasting prevalence is higher for young children (< 24 mo) as compared with older children (Figure 1). As the prevalence of low WH increases, there is a greater relative increase in wasting among older children than younger children, which implies a different causality.

Cut-off's and classification of low WH

Waterlow was the first to suggest the use of low WH as a nutrition indicator to distinguish between different types of growth failure associated with low WA (Waterlow 1972). He also suggested a qualitative distinction for severe cases: marasmus, kwashiorkor and intermediate forms, and 80% and 70% cut-off's as a guide to determine moderate and severe malnutrition. Kwashiorkor is another form of severe acute malnutrition associated with nutritional oedema. These fairly arbitrary cut-off's were later changed to cut-off's based on statistical probability (< -2 SD) as for the other anthropometric indicators. For community based studies, he proposed the use of the 50th percentile (median) as an age independent index.

Acute malnutrition includes both wasting, or low WH, and nutritional oedema. Any child with bilateral oedema has severe acute malnutrition (SAM) even if the WH is above -2 SD. If they are less than <-2 SD WH they have moderate acute wasting or moderate acute malnutrition (MAM). The term Global Acute Malnutrition (GAM) includes all children with moderate wasting, severe wasting or oedema or any combination of these conditions (SMART 2006).

As Part 3 discusses in more detail, studies of the relationship between malnutrition and mortality found that WH is the least effective predictor of mortality. However, this can be explained in part by the fact that most studies examining the relationship between malnutrition and mortality look at long term mortality risk (up to 24 months follow up periods) and WH is likely to be a better predictor of short-term risk and the low prevalence of GAM in most studies. In addition, moderate GAM (<80%WH) may be compared with severe stunting or low WA (<60%).

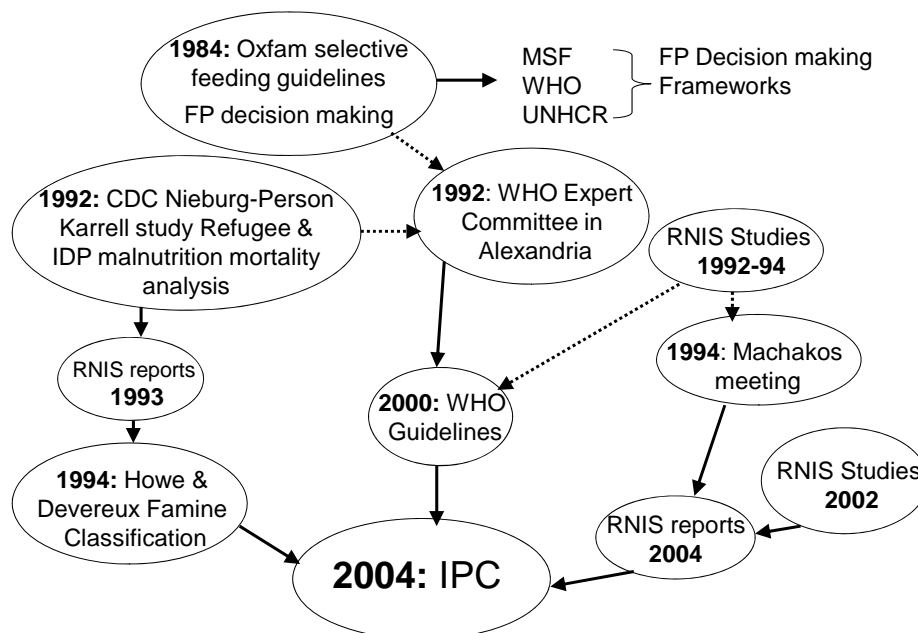
WH reference levels

There are three different sources of reference levels for WH:

1. selective feeding decision-making frameworks
2. classification of situations according to nutritional risk
3. food security and famine classification systems

The reference levels are a mixture of recommendations from expert meetings, some based on evidence from refugee and displaced contexts, and suggestions by academics to improve accountability in decision making. IPC has combined these different sources of reference levels as part of the classification of different food security phases. The origins of the different reference levels in the IPC is illustrated in Figure 2 below, and described in the following text.

Figure 2 – The Origins of WH reference levels in the IPC



1. Reference levels used in selective feeding decision-making frameworks

The first classification systems using reference levels for acute malnutrition (GAM) were used for decision making about the need for feeding programmes. In other words, they were developed by operational humanitarian agencies as a tool to determine the need for selective feeding programmes. The earliest guidelines were developed by Oxfam (in 1977

and then 1984), and similar reference levels were later adopted in MSF (1995), UNHCR and WHO (2000). . These reference levels were most likely based on experience of working in refugee camps in Sudan, Somalia and Ethiopia from the mid-80s to early 90's.

2. Classification of situations according to nutritional risk (the RNIS and WHO)

The WHO Reference Levels

The WHO reference levels for determining severity of malnutrition in the community are the most widely used reference levels within the humanitarian community, for determining whether a population is experiencing a nutritional emergency. These reference levels refer to wasting or low WH.

The WHO reference levels were developed at a WHO/EMRO (Eastern Mediterranean Regional Office) consultation on Rapid Nutrition Emergencies held in Alexandria in 1992 (WHO, 1992).. The report of the meeting gives the suggestions for reference levels for the interpretation of findings from rapid nutrition assessments in emergencies. Terms expressing value judgements were chosen to aid decision-making based on prevalence of malnutrition (given in bold in table 4 below). This classification has not subsequently been validated (de Onis, personal communication), or reviewed. In 1995, a WHO Expert Committee adopted these reference levels as a severity index for malnutrition in emergency situations based on prevalence of wasting and mean WFH Z-score for children under 5 years i.e. not for GAM (WHO Expert Committee 1995) (p213). These reference levels for low WH were then adopted in WHO guidelines (WHO 2000) and those of other agencies.

Table 4 – Reference levels for classification of severity of malnutrition in a community

	Usual Acceptable	Worrying Poor	Serious	Critical	Severe crisis
WHO 1992	<5%*	5-9%	10-15%	>15%	
SCN/RNIS 1993	5-10%		>20%		>40%
SCN/RNIS 2004		5-8%	>10%		

The RNIS classification system refers to “acute malnutrition” and the WHO classification to “wasting”⁷.

The RNIS/NICS System

In 1993, the RNIS (Refugee Nutrition Information System) was established to track the nutrition situation of refugees and internally displaced populations, in the hope that distributing information would help bring action. Like WHO, the RNIS uses reference levels for prevalence of wasting or low WH. The RNIS classifies emergencies into five categories of nutritional risk. Nutritional risk categories are determined on the basis of both prevalence of low WH (as indicated in the table above) as well the risk of becoming malnourished based on an analysis of the underlying causes of malnutrition and mortality. RNIS has been renamed NICS (Nutrition Information in Crisis Situations) to include also non-refugee or displaced populations affected by crisis.

⁷ Recent communication with WHO indicates that “an oedema case is automatically counted as severely underweight and severely wasted”, which means that both classifications include children of low WH and with oedema (Bloesner, personal communication, 14 September 2009).

The reference levels used by RNIS/NICS to classify the severity of the nutrition situation in populations have changed over time (Table x). The reference levels developed in 1993 were higher, and based on a study on the relationship between malnutrition and mortality in 42 refugee camps in Africa and Asia which showed large increases in mortality with 20 and 40% prevalence of low WH – 12 and 40 times higher than in populations with prevalence <5% (CDC 1992; Nieburg, Person-Karell et al. 1992; NICS/RNIS 1993 - 2005). This study is described in Part 3.

RNIS later changed its reference levels. The evidence base for this is not clear but is likely to have been influenced by a number of sources:

1. A conference in Machakos, Kenya, on “the improvement of nutrition of refugees and displaced people”, held in 1994. One of the papers presented states that “it is now accepted that a prevalence of severe malnutrition between 5-8% indicates a worrying situation and that prevalence greater than 10% corresponds to a serious situation” (Moren 1994).
2. Studies on the relationship between malnutrition and mortality in 298 surveys submitted to RNIS between 1992 and 1994. The review found that “Levels ranging up to 50% (low WH) are common in many of the situations - Angola, Liberia, Rwanda/Burundi, Somalia, etc. - and in Southern Sudan a number of reports have been even higher”. The analysis of low WH and mortality suggested that “situations with over 10% of wasting in young children should be taken as likely to be critical”(ACC/SCN 1994). Mason et al (2002) later re-analysed this data and confirmed that in this data set a prevalence of 10% wasting (<-2 Z scores) was equivalent to a mortality of 1/10,000/day (Mason 2002).
3. A publication on the worldwide magnitude of protein-energy malnutrition, using the WHO global database (de Onis, Monteiro, et al., 1993), which reported an initial grouping of prevalence’s of wasting according to quartiles; producing 4 categories: <2%, 2-3%, 4-7% and >8%. The first two were later pooled under one category: <4%(de Onis, Monteiro et al. 1993).

3. Food security and famine⁸ classification systems

A number of food security classification systems were developed in the early 2000’s to make decision making more accountable and to come up with an agreed definition of famine. This was prompted by the wide debates on whether famine was taking place in Sudan (1998), Malawi (2002), and Ethiopia (2000). The objective in part was to come up with an agreed definition of famine. The systems developed by Howe and Devereux (2004) and Darcy and Hoffman (2003) are the most well known, both of which use reference levels for acute malnutrition as key indicators. Whilst these appear largely based on the WHO and earlier RNIS reference levels, they both also include a Phase with much higher levels of acute malnutrition; 25 and 40% respectively.

Relative versus Absolute Reference Levels

Despite the widespread use of the WHO reference levels to estimate severity of malnutrition in a community, the Sphere minimum nutrition standards reject such absolute reference levels. “Determining whether levels of malnutrition are acceptable requires analysis of the situation in light of the reference population, morbidity and mortality rates, seasonal fluctuations, pre-emergency levels of malnutrition and the underlying causes of malnutrition” (Sphere, 2004). One of the key indicators for the general nutrition support standard is that “levels of moderate and severe malnutrition are stable at, or declining to,

⁸ In this context, famine is an extreme form of food **insecurity**/food deprivation

acceptable levels". The RNIS also highlights the need to relate thresholds to a contextual analysis. A trend analysis is also recommended, so if nutrition or mortality deteriorates over time, even if above the threshold, it indicates a serious situation.

Use in the IPC

Acute malnutrition has been a key reference outcome within the IPC Reference Table since its inception. However, the indicator used in the IPC tables is given as low WH (< - 2 Z-scores), and currently does not include oedema. The sources of the reference levels are based on a variety of different acute malnutrition classification systems, but in particular the WHO reference levels, RNIS and Howe and Devereux (2004), and have not changed since 2006. See table 5 below.

Table 5 – WH reference levels in the IPC

Generally food secure	Moderately food insecure	Acute food and livelihood crisis	Humanitarian emergency	Famine/Humanitarian Catastrophe
<3%	>3 but <10%, usual range, stable	10-15%, usual, increasing	>15%, > usual, increasing	>30%

The reference values within the IPC are largely based on the WHO classification (although an RNIS/NICS 2004 report is also given as a reference), with the exception of the higher level for famine and humanitarian catastrophe. The IPC manual explains the higher reference value of 30% as being between "famine" and "severe famine" in the Howe and Devereux classification. (Note that the 40% in Howe and Devereux is based on the old RNIS classification and thus the refugee and IDP studies of the late 80's).

Recommendations from the Sphere minimum standards have also been incorporated into the IPC; in that a greater than usual or an increasing prevalence of malnutrition is also an indicator for the acute food and livelihoods crisis and humanitarian emergency phases. This highlights the importance of monitoring trends and comparison with pre-emergency levels of malnutrition.

Issues of interpretation

There is broad consensus that WH is a good indicator of recent or current nutrition, and for this reason it is the most widely used indicator in emergencies. There is also consensus on the need to interpret any particular prevalence in relation to its underlying causes (food insecurity, poor health environment and/or poor social and caring behaviours). There are however no standard or agreed methods or indicators to measure these underlying causes, plus the range of indicators or "aggravating factors" measured varies between surveys. It is also generally accepted that the prevalence of acute malnutrition has to be interpreted in relation to normal seasonal patterns.

In conclusion, WH is widely accepted as an indicator to be used in emergency situations as it reflects rapid weight loss, due to decreased food intake or disease and high prevalence's of acute malnutrition can therefore be used to trigger emergency response. The inclusion of WH in the IPC is appropriate, as acute food insecurity and famine are commonly associated with high levels of acute malnutrition. It is particularly responsive to rapid changes in nutrition, food security or health and therefore will be most useful as an indicator in the emergency phases (3-5).

The WHO classification is the most widely accepted classification for determining whether a population is experiencing an “emergency”. This classification system uses both children of low WH (< -2 Z-scores) and oedema cases to estimate the prevalence of wasting or acute malnutrition. Oedema cases should be included in the classification of acute malnutrition within the IPC table. There has also been considerable debate, over whether to use fixed or relative reference levels in populations suffering “emergency” levels of acute malnutrition over long periods of time (see Part 4).

There is an urgent need to develop standardized acute malnutrition reference levels as part of nutrition or food security classification. A higher reference level as part of these classification systems should be considered but this needs to be based on actual evidence from famine situations on the relationship between malnutrition and mortality, and in the case of the IPC, the relationship between food insecurity, malnutrition and mortality. Both these objectives could be achieved by collaboration between IPC, WHO and SCN/NICS on the development of new reference levels. In the meantime, it is recommended that the IPC continues to use the WHO reference levels. Issues of causality and classification are also discussed in Part 4.

MUAC as an indicator of acute malnutrition

Arm circumference is also an indicator of wasting and in particular lean body mass. MUAC uses the measurement itself (or unadjusted measurement) to classify children as malnourished or not, rather than comparing it with a reference value. Prospective mortality studies show that low MUAC is the best indicator of mortality (see Part 3), and for this reason it is now recommended as an independent indicator of admission to therapeutic feeding programmes⁹.

MUAC and age

MUAC was first proposed as a measure of wasting in the 1960's based on observations that for normal well-fed Polish children MUAC increased by just 1 cm between 1 and 4 years of age, and varied little between boys and girls (Jelliffe, 1966; Jelliffe and Jelliffe, 1969). However, later studies showed that MUAC did in fact increase over this age range, by about 2 cm (WHO 1995). This means that younger children are preferentially selected as malnourished and MUAC misses some older children who might be classified as malnourished according to low weight-for-height.

A WHO committee has concluded that the assumption of age independence was not valid and recommended the use of age specific reference data. Such a AC-for-age reference was developed in 1997 (de Onis, Yip et al. 1997) and WHO recommends this both for screening

⁹ When higher cut-off's are used (e.g. 14 cm) to ensure that the majority of low WH children are correctly screened, one study found that almost half the children had to be measured, thus not saving much time Bern, C. and L. Nathanail (1995). "Is mid-upper-arm circumference a useful tool for screening in emergency settings?" *Lancet* **345**(8950): 631-3.. This can also mean after time, parents will no longer bring their children for screening if children have been rejected following WH measurement in the past Myatt, M., T. Khara, et al. (2006). "A review of methods to detect cases of severely malnourished children in the community for their admission into community-based therapeutic care programs" *Food and Nutrition Bulletin* **27**(3 (Supplement)): S7-S23.. MUAC is now used directly to admit children to feeding centres.

and assessment purposes (WHO, 2000). As for other anthropometric indicators, children are classified as malnourished if <-2 Z scores and severely malnourished when between -2 Z scores. MUAC for age is rarely used in practice, despite being recommended by WHO (2000). AC for height was used in emergencies during the Biafra famine when the Quakers developed the QUAC stick as a screening tool for wasting. The QUAC stick measure uses MUAC for height; 85% of the standard MUAC for height was found to correspond roughly to 80% WA (Arnhold 1969).

MUAC cut-off's and use

The advantages of MUAC are thought to be its simplicity, particularly for screening children in emergency situations, as only a single measurement is required which need not be related to a reference population. Unadjusted AC measurements are used as cut-off points (see Table 6 below), to identify moderately or severely wasted children. These cut-off's have changed over time, in part because of a change in the use of MUAC measurements. Broadly speaking, its use has changed from being mainly a screening tool for identifying children of low WH for feeding programmes, to being the key indicator for admission to therapeutic feeding programmes. The use of AC as a screening tool for low WH is now largely rejected because when using a cut-off of 13 cm or lower the sensitivity is low, whereas with a higher cut-off (e.g. 14 cm) almost half the children had to be measured, thus not saving much time (Bern and Nathanail 1995). More recently, it has also been recommended for use in surveys to estimate the prevalence of acute malnutrition.

Table 6 - Cut-off's proposed for MUAC

	Normal	Mild	At risk	Moderate	Severe
Oxfam/UNHCR (1982/84)	>13.5 cm			12.0-13.5 cm	<12.0 cm
Waterlow (1992)	>14 cm			14-12.5 cm	<12.5 cm
MSF (1995)				<13.5 cm	<11 cm
ACF (2002)	>13.5 cm	12.5-13.5 cm	12-12.5 cm	>11-12.cm	<11 cm
Sphere (2004)				<12.5 cm	<11 cm
WHO/UNICEF (2009)					<11.5 cm

MUAC for case definition of severe acute malnutrition

A MUAC of <11 cm is used for admission to therapeutic feeding programmes as an indicator of severe malnutrition and because of the associated mortality risks. Recent guidelines, such as those by MSF and ACF use this cut-off point (MSF 1995; Prudhon 2002).

The origin of the 11 cm cut-off point is a study by Briend and Zimicki (1986), on "the validation of arm circumference as an indicator of risk of death in one to four year old children". This study found that the risk of dying greatly increased if children had a MUAC below 11 cm. They also found that if a cut-off point of 11 cm is chosen, it identified only 4% of the population as at risk, but about 34% of the total number of deaths occurred in this group (Briend and Zimicki 1986).

A recent WHO/UNICEF statement on the new WHO growth standards recommends 11.5 cm as the new cut-off for severe malnutrition. This is based on the following criteria:

- associated risk below the cut-off (sensitivity)
- high specificity
- response to treatment with therapeutic products (WHO and UNICEF 2009).

More recent practice is the treatment of severely malnourished children at home, which reduces the risks associated with treatment and it is acceptable to have a more sensitive indicator (with lower specificity). In the past, a very specific indicator was needed (i.e. one that was good at correctly identifying children that were not malnourished), to reduce the risk that well-nourished children experienced the risk of cross-infection in feeding centres (Briend, personal communication). The cut-off of <11.5 cm is more sensitive, but still highly specific (WHO 2009). The prevalence of severe acute malnutrition using an AC cut-off of 11.5 cm, was similar to the prevalence when using < -3 WHZ. However, the issue that different children are identified when using MUAC as an indicator of malnutrition and when using WH remains. WHO therefore recommends the use of both low MUAC and low WH for admission to feeding programmes.

MUAC has been recommended for case definition of severely malnourished children, not only because it is a better predictor of short term mortality than other anthropometric indicators, but according to other properties for case detection methods. This includes: age independence, precision, accuracy, sensitivity, as well as simplicity, and cost (Myatt, Khara et al. 2006). However, whilst Myatt et al (2006) argue that the measure is simple and precise, other studies have not shown that compared with other body measurements (in particular weight and height) MUAC shows higher inter and intra observer measurement error (Ulijaszek and Kerr 1999). Given this measurement error it is also more difficult to detect significant changes over time (Ulijaszek and Kerr 1999).

One explanation as to why MUAC is such a good predictor of mortality is because it selects younger children (see above). Another explanation is the “muscle mass hypothesis”. In a study in rural Senegal, it was found that children who died and who survived differed more in different measures directly relating to muscle mass (weight, height or arm circumference) than by nutritional indices obtained by comparison with growth standards. The muscle mass hypothesis explains this by survival being related to the ratio between muscle mass and energy demanding organs such as the brain (Briend, Garenne et al. 1989).

MUAC for use in surveys

MUAC was widely used as a screening tool in the 1980's, and at the time, numerous studies were done to compare the prevalence of acute malnutrition according to MUAC and WFH, and on the sensitivity and specificity of MUAC as an indicator of acute malnutrition compared with weight for height. These studies found that the prevalence of malnutrition was usually higher than according to WH – using the recommended cut-off at the time of 13.5 cm (e.g. (Gayle, Binkin et al. 1988; Ross, Taylor et al. 1990). Also, as a result of the measurement error described above, it was recommended that MUAC should not be used in nutrition surveys.

The Sphere Handbook (The Sphere Project 2004) does not recommend the use of MUAC alone to estimate the prevalence of acute malnutrition, but its use as a good predictor of mortality (see below) has meant that it has now been recommended both for use in surveys and for admission to feeding programmes (<12.5 cm for moderate malnutrition and <11 cm for severe malnutrition). More recently, Myatt has argued for the use of MUAC in surveys, not only because it is a good indicator of mortality, but also because switching from

prevalence of low WH based on NCHS standards to prevalence of low WH based on the new WHO growth standards will produce much greater differences in prevalence, than if changing from prevalence of low WH using NCHS to prevalence of low MUAC (Myatt 2007). This was not a general finding, however, in some populations, the use of AC leads to substantially lower prevalence's in particular those with short trunks and long limbs.

Use in the IPC

The prevalence of acute malnutrition using AC is not currently used as a reference outcome within the IPC, but the manual suggests that it could be a “supporting method” for estimating levels of acute malnutrition. The User Guide also states that it can be a very useful indicator of acute malnutrition, but cannot be directly compared to WH.

There are no internationally agreed reference levels for the prevalence of malnutrition using AC, but the FSNAU in Somalia has developed reference levels by using the data from a meta-analysis from surveys over the past four years, and divided the overall distribution into quartiles which were then allocated between the phases. The reference levels developed in this way are shown in Table 7 below:

Table 7 – AC reference levels used in Somalia

	Acceptable	Alert	Serious	Critical	Very critical
AC < 12.5 cm	<5%	<5% with increase from seasonally adjusted previous rapid assessments	5-9.9%	10-14% or where there has been a significant increase from seasonally adjusted rapid assessments	>15% or where there is a significant increase from seasonally adjusted rapid assessments

Issues in interpretation

There is a strong consensus that MUAC is the best predictor of mortality and that it therefore is a good indicator to use for case definition of children eligible for feeding programmes. There was consensus around a cut-off point of 11 cm for admission to feeding programmes and it is likely that the new WHO/UNICEF statement on the use of an 11.5 cm cut-off point will be widely adopted.

There is still considerable controversy, however, over whether MUAC or WH is the best indicator of wasting and in particular which is the best indicator to use in surveys. Recent studies comparing prevalence of malnutrition according to MUAC and WH have shown large differences particularly in pastoral populations (Myatt, Duffield et al. 2009). This is discussed further in Part 4. As low MUAC preferentially selects younger children, low MUAC may not be a good indicator of food insecurity, which has obvious implications for a food security classification system.

In conclusion, the prevalence of low MUAC (<115mm) is appropriate in the emergency phases of the IPC as supporting evidence to indicate mortality risk in the population in question and to identify the need for feeding programmes. However, it should also be noted that a nutritional intervention aimed only at the most severely malnourished children will only prevent a fraction of all deaths (further discussed in Part 3). The reference levels currently used by the FSNAU cannot be used as these are based on a cut-off of 12.5 cm. Since the prevalence of SAM using cut off of 11.5 cm was similar to the prevalence using <- 3

WHZ with the new WHO growth standards, it is recommended to use a reference level of 1% as indicative of excess mortality. This reference level was recommended in a recent review of lessons on nutrition of displaced people, where it was found that any severe wasting was indicative of a mortality rate above normal (Mason 2002). New reference levels for prevalence of malnutrition using the <11.5 cm AC cut off will have to be established by working closely with operational agencies. As this is a new cut off, prevalence data may not be available within existing databases.

Stunting – chronic malnutrition – low HA

The consequences of stunting are reflected in the short term in greater child mortality and also over the medium and long term in poorer school performance, decreased work capacity and increased risk of adult morbidity and early death (Shrimpton, Victora et al. 2001). More recent studies looking at the consequences of child undernutrition for adult health, found that height-for-age at 2 years was the best predictor of human capital (height, school achievement, economic productivity, and birthweight of the off' spring). Consequently the effects of undernutrition span at least three generations (Victora, Adair et al. 2008), and prevention of stunting requires population wide interventions preferably before birth. This pattern of stunting may explain why HA is a stronger predictor of mortality in children less than 3 years of age (see Part x) but less so among older children (Part 2).

HA cut-off points and classification of nutritional status

The HA cut-off's based on Z scores (< -2 and < -3 Z scores HA) reflect statements of statistical probability. Percentage of the median cut-off's have been selected in the past based on studies of functional outcomes of low anthropometric status (for example, the Gomez classification of first, second, and third degree malnutrition (76-90% WA, 61-75% WA, <60% WA). These were determined on the basis of clinical picture and risk of dying (Gomez, 1956), but are generally not in use today.

WHO have proposed reference levels (prevalence ranges) for low HA and WA for the purposes of classifying worldwide prevalence ranges (see Table 8)(WHO Expert Committee 1995; de Onis and Blössner 2003). It should be noted however that "this classification was not based on correlations with functional outcomes and simply reflects a convenient statistical grouping of prevalence levels from different countries. Moreover, the designations of prevalence as "low" and "medium" should be interpreted cautiously and not be taken as grounds for complacency"(WHO Expert Committee 1995) p 209. These reference levels can also be used to make statements such as 'the low reference level height-for-age would include communities with up to eightfold excess or expected prevalence', although this assumes comparison with a growth standard. These reference levels are useful for visual presentations or 'mapping' of prevalence levels which allow visual inspection of geographical distribution of stunting.

Table 8 Proposed classification of worldwide prevalence ranges of low height-for-age and low weight for age among children under 5 years (WHO Expert Committee 1995) p209

Prevalence group	Prevalence ranges (% of children < -2 Z Scores)	
	Low height-for-age (stunting)	Low weight-for-age (underweight)
Low	< 20	< 10
Medium	20 – 29	10 - 19

High	30 – 39	20 -29
Very High	>=40	>= 30

Stunting prevalence's are also used to determine the risk of zinc deficiency; countries at high risk of zinc deficiency are those with a stunting prevalence of more than 20% and estimated prevalence of inadequate zinc intake of more than 25%; countries at low risk of zinc deficiency are those with stunting prevalence of less than 10% and inadequate zinc intake of less than 15% (IZiNCG 2007; Black, Allen et al. 2008)

Reference levels for IPC Phases

Low HA was first added to the IPC framework in March 2006. The main rationale for including stunting was because the IPC Technical manual was being written at that time(FSAU 2006) which would be considered for use in other country contexts, and thus would need a stronger basis for making the distinction between Phase 1 and 2. The reference levels used were:

- Phase 1 Generally Food Secure < 20% HA <- 2 Z scores
- Phase 2 Chronically Food Insecure 20 – 40% HA <- 2 Z scores

Version 1.1 of the IPC manual has since changed the nomenclature for Phase 2 from Chronically Food Insecure to Moderately/ Borderline Food Insecure, thus removing the reference to the temporal or time dimension implied by 'chronic'.

Earlier, stunting was not considered as a defining characteristic of Phase 3 or higher. Phases 3 to 5 represent crisis situations where a clear shock has occurred, which is straining livelihoods and possibly leading to death. This is important and probably reflects a widely held misperception that stunting is not necessarily associated with increased mortality risk.

WFP have recommended that "Stunting rates between 20-40% should be classified as "moderately food insecure" and everything above 40% as Phase 3 "acute food and livelihood crisis". This would follow the WHO guidance and interpretation which classifies a prevalence exceeding 40% as "very high"." (P 1, recommendation 4, (WFP 2007) and introduced stunting as a reference outcome indicator in Phase 3).

Importantly, the Nutritional Surveillance Project of the FSNAU have adopted the reference levels for HA loosely based on the WHO reference levels (WHO Expert Committee 1995), although it is not entirely clear why there are two categories for the one lower WHO category, while the WHO medium to high category have been merged. This requires further discussion and clarification.

Table 9 - Prevalence ranges of low height for age used by WHO and FSAU/NS (% of children < -2 Z Scores)

WHO, 1995		FSAU/NS	
Prevalence group	Low height-for-age (stunting)		Chronic Malnutrition/ Stunting (low HAZ)
		Acceptable	<10%
Low	< 20	Alert	10 - <20%
Medium	20 – 29	Serious	20 - <40%
High	30 – 39	Critical	> 40%
Very High	>=40	Very critical	

The IPC User Guide emphasizes that direct evidence of stunting must be representative of the population, i.e. “data from properly conducted nutrition surveys using a standardized methodology” p 1-9. It is suggested that time series analysis of stunting data might be useful, although what this means is not clarified.

The User Guide also states that although stunting is not used to classify the more severe phases, it may be important to know this information as it indicates an underlying level of “chronic food insecurity”.

Use of HA by the IPC in practice

In Indonesia, the national average for stunting and U5MR was adopted as a threshold which can affect comparability with IPC results elsewhere (p6 Lessons learned IPC pilot Indonesia). The reason for this was because the national average for stunting was around 40%, with some provinces reporting as high as 60% stunting. On the basis of this indicator alone, the entire country would have been classified in Phase 2 with no differentiation between districts or severity of stunting.

Interpretation and response to low HA

There is a strong consensus that the prevention of stunting requires population wide interventions preferably before birth. This means there are no short-term remedies for stunting, and rather it is an indicator of long-term development and poverty.

Interpretation of low height for age of an individual child depends crucially on the age range of the children; for younger children low HA reflects a continuing process of failing to grow, while for older children it reflects past nutrition and a state of “having failed to grow”. The method for determining age should always be included when reporting population based data on stunting or underweight. Ideally age should be obtained from a written birth record or similar document, and “as a last resort” age reported by the carer.

The causes of stunting are more difficult to identify than the causes of wasting because stunting results from long-term and cumulative influences. While low HA has been closely associated with socio-economic status and poverty in the longer term, there is less evidence of its use as an indicator of food insecurity. A recent study in Bangladesh found that among children from birth to 24 months household food security was significantly ($P < 0.001$) associated with higher gain in all anthropometric indices (WAZ, LAZ, WLZ and BMIZ)(Saha, Frongillo et al. 2009). For stunting and underweight there was a gradient in the four categories of household food security from extremely food insecure to food secure among children 1 to 24 months (ibid).

In conclusion, levels of low HA are indicative of specific risks, including mortality, morbidity, poorer school performance, decreased work capacity and increased risk of adult morbidity and early death. As part of an overall nutritional profile of a population, estimates of stunting prevalence are an important indicator of sustained nutritional deficit, which as some studies indicate are associated with food insecurity in young children (0 – 24 months).

Whilst the workshop participants suggested the inclusion of HA as an indicator of underlying vulnerability, the authors recommend that the inclusion of HA as a reference outcome is appropriate in the early phases, because levels of stunting are inevitably related to poverty, given the stronger association between HA and longer-term mortality risk, especially among

younger children, and the recent study in Bangladesh linking food insecurity with stunting. It is recommended to continue to use the reference levels currently used in phases 1 and 2 of the IPC, and to include the WFP recommended reference level for phase 3. In the longer term a review of the distribution of HA globally is needed.

Two major gaps in the User Guide and the Manual are reference to the cross-classification of wasting and stunting proposed by Waterlow, and the use of weight for age as an indirect indicator of underweight and therefore a composite indicator of wasting and stunting.

There is an urgent need for harmonization between the IPC framework and the reference levels proposed by WHO, which have been adopted by the FSNAU.

Underweight - a composite index

Underweight is the term used to describe low weight-for-age (WA), with cut-off's of minus 3 Z scores for severe underweight and minus 2 Z scores for moderate and severe underweight. Low weight-for-age can indicate either wasting (low WH), or more commonly, stunting (low HA). For this reason weight-for-age is known as a composite index and its interpretation at both the individual and population level is not as clear-cut as wasting and stunting, because it reflects both long term changes in nutrition of the individual or population, plus the short-term more recent changes captured by weight for height.

Low weight-for-age (gaining insufficient weight relative to age, or losing weight) implies recent or continuing current severe weight loss. The aetiology of low weight-for-age is the same as the combined causes of wasting and stunting. As explained above, these two conditions can have different determinants and respond to different interventions and for this reason "consideration of wasting and stunting is more useful than consideration of underweight"(Black, Allen et al. 2008).

Cut-off's and classification of low WA

In recent years increasing attention has been paid to the health risks associated with underweight and undernutrition among infants and young children more broadly¹⁰, in terms of premature deaths and vulnerability to infection and disease (Black, Allen et al. 2008). Low WA is a good predictor of mortality. With the exception of one study from Bangladesh (Chen et al., 1980), Pelletier found a consistent increase in child mortality with decreasing WA, which is more marked from 60% to 69% to less than 60% of the median.

WA reference levels

Weight-for-age is widely used by WHO and UNICEF in monitoring trends in the global prevalence of underweight¹¹. Prevalence of severely underweight children (< -3 WAZ) is

¹⁰ This section is focused on underweight or stunting as an important risk factor for increased prevalence and severity of infection and high mortality rates, but it should be noted that there is increasing evidence for an independent role for micronutrient deficiency. Tomkins, A. (2000). "Malnutrition, morbidity and mortality in children and their mothers." Proceedings of the Nutrition Society **59**(1): 135-146.

¹¹ Unicef State of the Worlds Children <http://www.unicef.org/sowc09/index.php>

the indicator used to monitor progress towards the first stated Millennium Development Goal “to halve between 1990 and 2015 the proportion of people who suffer from hunger”.

Weight-for-age is often chosen simply because it is the most widely used and therefore available indicator of child nutritional status in developing countries, as well as in the studies available for analysis. Unlike wasting¹², prevalence of underweight is often higher (averaging about 30%) and therefore changes in underweight may be more readily detected. In a study of AIDS, drought, and child malnutrition in southern Africa, Mason et al selected underweight as their primary indicator of nutritional status (Mason and al 2005).

Reference levels for classification of WA prevalence have been proposed by WHO (Table 10) although are in less frequent use than the HA reference levels. This might be because the MDG target of halving underweight puts the focus on actual prevalence levels and progress within individual countries or regions over time, rather than grouping regions by reference levels.

Table 10 - Classification of worldwide prevalence ranges of low height-for-age and low weight for age among children under 5 years (WHO Expert Committee 1995) p208

Prevalence group	Prevalence ranges (% of children < -2 Z Scores)	
	Low height-for-age (stunting)	Low weight-for-age (underweight)
Low	< 20	< 10
Medium	20 – 29	10 - 19
High	30 – 39	20 -29
Very High	>= 40	>= 30

There is no mention of underweight or weight-for-age in the IPC User Guide, nor in the two manuals. The review of lessons learned from the IPC pilot in Indonesia and Cambodia both recommended that discussions and future pilots should look into a grading system within the Chronically Food Insecurity Phase (now called the Moderately/Borderline Food Insecure Phase 2), and that additional key indicators are included in the IPC reference table, such as underweight, IMR and micronutrients.

The use of regional or national baselines (national averages) was also raised as an important issue for the IPC, and guidance was requested. In Cambodia the use of underweight was recommended because it is closely linked to stunting, in some provinces it is higher than stunting, while wasting is not very prevalent. Additional reasons included the importance of underweight as an MDG indicator and because of its availability because of growth monitoring. Suggested reference levels from the Cambodia pilot are in table 11 below.

Table 11 – Suggested reference levels in Cambodia from WFP pilot

	Wasting	Underweight	Stunting
Low Chronic Food Insecurity	3-5.9%	10-29.9%	20-39.9%
High Chronic Food Insecurity	6-9.9%	>=30%	> 40%

- The WHO Global Database on Child Growth and Malnutrition: de Onis, M. and M. Blössner (2003). "The World Health Organization Global Database on Child Growth and Malnutrition: methodology and applications." International Journal of Epidemiology 32: 518-26.

¹² Wasting prevalence's are often low for many regions (less than 10% in southern Africa).

Issues in interpretation

In a population, a given level of underweight may reflect varying combinations of low WH and low HA, as a result underweight is unable to reflect the precise nature of undernutrition – i.e. there will be different degrees of overlap between each indicator (WA, HA, and WH).

Comparisons of prevalence levels of wasting, stunting and underweight by Nandy and Jaime Miranda (2008) suggest that underweight “clearly misses numbers of undernourished children” p 1964, (Nandy and Miranda 2008) and sometimes even indicates an improving nutritional situation when in fact the reverse is true. An alternative indicator, that is a summary index which ‘identifies children who experience either stunting, wasting or underweight, or any combination of these’ has been proposed, known as the CIAF. As this allows the calculation of an overall composite index plus an index of different combinations of underweight, wasting and stunting it may be a practical tool for comparing the complete nutritional profile of different regions, countries etc.

In conclusion, classification of underweight according to reference levels is a convenient way of grouping prevalence levels from different countries, or regions, according to levels of excess underweight.

Reasons to include WA in Phases 1-3 of the IPC are that it is widely available, and has been found to be sensitive to changes in HIV/AIDS which were undetected through wasting. More recent studies have also shown a significant association between prevalence of underweight and food insecurity in young children. Workshop participants recommended that the prevalence of underweight is used as an indicator of underlying vulnerability. The WHO reference levels can be used, but these need to be reviewed, so that reference levels can be developed based on deviations from regional baselines.

Adult nutritional status – Body Mass Index – energy deficiency

Cases of frank starvation among adults are one of the most visible characteristics of acute famine, observations of which have been widely recorded¹³. It is only since the early 90s that there have been advances in the screening and selection of admissions of adults into therapeutic feeding centres (Collins 1995; Collins 2000).

Deficiencies of energy, protein and several micronutrients (e.g. zinc) can lead to a fall in body weight, which reflect changes in lean body mass and or fat mass. The cause of these deficiencies are inadequate food energy, impaired tissue growth, anorexia from trace element deficiency, intestinal parasites or general chronic infection (James 1994). Subsequent authors have emphasized the importance of protein catabolism and also deficiencies of vitamins and minerals in the aetiology of adult acute undernutrition (Collins, et al, 2000).

¹³ The public records of local officials in 19th century India record the extreme emaciation of adult famine victims. Whitcombe, E. (1993). "Famine mortality." Economic and Political Weekly, Bombay India **28**(23): 169-79. Released inmates from concentration camps in the second world war were so malnourished many could hardly stand Lipscomb, F. M. (1945). "Medical aspects of Belsen concentration camp." The Lancet. Descriptions of famine victims in the 1985 famine camps describe adult malnutrition Fleischer Michaelsen, K. and T. Clausen (1987). "Inadequate supplies of potassium and magnesium in relief food - implications and counter-measures." The Lancet: 1421-1423..

The most useful measure of malnutrition in adults is body mass index ($\text{BMI} = (\text{weight in kg})/(\text{height in metres})^2$), an indicator of weight deficit in relation to height. BMI is also used to define grades of obesity¹⁴ - overweight. BMI is a measure of central body mass and it reflects stores of both fat and protein. Other measurements have been used including mid upper arm circumference (Collins et al., 2000). Among women BMI is assessed only among non pregnant and non lactating women of reproductive age (15 – 49 years).

In nutritional emergencies and in general, nutrition surveys of adults are less common than surveys among infants and young children. Surveys of adults have been used in helping to determine the degree to which a whole population has been affected by undernutrition. If young children appear to be more affected than adults, the causes are more likely to be related to feeding practices or to common infections among children than to overall food shortage (WHO 2000).

Average BMI in most adult groups in developing countries falls in the range from 19 to 21 BMI. There are many studies that have shown that adults with a BMI less than 18 or 18.5 have more frequent illness, less capacity for physical labour and in women poorer birth outcomes (James and Ralph (eds) 1994).

One of the risks associated with severe thinness is nutritional oedema, which increases weight, producing a biased BMI result (distorting measurements by up to 10% of body weight) (Collins et al, 2000). Famine oedema is also associated with poor prognosis (Collins, 1995).

Cut-off's and classification of low BMI

Degrees of underweight categorized on the basis of BMI have been defined as Chronic Energy Deficiency (CED) (James et al, 1988 and Ferro Luzzi et al., 1992, quoted in WHO Expert Committee 1995) or alternatively chronic undernutrition (Collins 2000). The 1995 WHO technical committee defined three grades of low BMI or "thinness":

Mild thinness	(grade 1)	BMI 17.0-18.49
Moderate thinness	(grade 2)	BMI 16.0-16.99
Severe thinness	(grade 3)	< 16.0

The same cut-off points apply to both sexes and the elderly. The choice of these three cut-off's was adapted by a working group of the international Dietary Energy Consultative Group (James, Ferro-Luzzi et al. 1988; 1992). FAO have subsequently adopted these cut-off's and have used them in estimating worldwide prevalence's of malnutrition¹⁵, as did Collins et al (2000).

¹⁴ WHO 1995 defined three degrees of overweight with the BMI cut-offs 25, 30 and 40. This classification is based principally on the association between BMI and mortality. Overweight is associated with an increased prevalence of cardiovascular risk factors such as hypertension, unfavourable blood lipid concentrations and diabetes mellitus.

¹⁵ FAO supported a major research initiative at the Rowett Research Institute to assess the usefulness of BMI as an index of CED, in their efforts to improve its methods for assessing malnutrition and moving beyond the food balance sheet. James, W. (1994). "Introduction: The challenge of adult chronic energy deficiency. Presented at The functional significance of low body mass index. Proceedings of an International Dietary Energy Consultative Group Workshop, Rome." European Journal of Clinical Nutrition 48 (Suppl)(3): s1 - S9.

Table 12 WHO BMI Classification

Type and level of nutritional problem	BMI range (kg/m ²)
Obese	>30.0
Overweight	25.0 – 29.9
Normal	18.5 – 24.9
Mild thinness	17.0 – 18.49
Moderate thinness	16.0 – 16.99
Severe thinness	< 16.0

The lower limit of normality is based on the BMI of patients with anorexia nervosa and a large sample of healthy young British soldiers. BMI alone is now accepted as the anthropometric indicator of choice for chronic undernutrition in the adult and is closely related to food consumption and the prevalence of inadequacy of food in the community (Shetty 2002).

BMI data may be used to assess the presence of overnutrition in individuals and the community, which is now recognized as an equally important problem particularly among countries in transition. Rapid urbanization and rural to urban migration may lead to nutritional deprivation among segments of society. Based on studies in China, even in food secure households some members may be undernourished while others may be overweight, suggesting that with the process of nutritional transition with economic development, both features may be seen within the same household (Doak, Adair et al. 2002).

An ACC/SCN publication on the Assessment of Nutritional Status in Emergency Affected Populations emphasized the importance of taking into account the Cormic Index when comparing the BMI of different populations, in order to account for differences in body shape (Collins et al., 2000). For screening severely malnourished adults they suggested a number of interim techniques based on MUAC cut-off's, in combination with clinical signs of oedema and additional relevant social factors¹⁶. BMI was ruled out because it is affected by oedema and body shape. Importantly Collins and co-authors point out that the cut-off's intended for the purposes of estimating prevalence of underweight, may be inappropriate for the purposes of screening adult admissions to feeding centres. This point in fact applies to all nutritional indicators.

Reference levels

Reference levels for prevalence of low BMI (< 18.5) recommended by the 1995 WHO Expert Committee are shown in Table 12.

Table 12 – BMI reference levels recommended by WHO

Low prevalence (warning sign, monitoring required):	5- 9% of population with BMI < 18.5
Medium prevalence (poor situation):	10 - 19% < 18.5

¹⁶ Examples of social factors included access to food, distance from centres, presence/absence of carers, shelter, dependents and availability of cooking utensils.

High prevalence (serious situation):	20 - 39% < 18.5
Very high prevalence (critical situation)	>=40% with BMI < 18.5

Note that pregnant women or adults with oedema are excluded from surveys to assess BMI because of the bias introduced by weight gain not related to nutritional status.

WFP have subsequently adopted these reference levels, referring to them as benchmarks of public health significance, which includes for women, increased risk of low birthweight babies, and for all adults: increased risk of mortality with very low BMI(WFP 2009) p59-60.

This classification reflected the distribution of BMI found in many populations in developing countries at that time. Worldwide the committee concluded that "About 3 - 5% of a healthy adult population have a BMI below 18.5cm, based on BMI distributions worldwide" (WHO, 1995). More recent data indicates higher prevalence levels than reviewed by the WHO Expert Committee (and upon which their reference levels are set). In their analysis of 388 national surveys from 139 countries in 2005 Black et al (2008) reported that maternal undernutrition (BMI < 18.5 kg/m²) ranges from 10% to 19% in most countries (Annex 4). However, higher prevalence levels of 20% or more are found in sub-Saharan Africa, south-central and south-eastern Asia, and in Yemen, while India, Bangladesh, and Eritrea have a more critical problem still with a prevalence of low BMI around 40% in women (Black, Allen et al. 2008).

Fewer data are available on the nutritional status of adults falling below the lower cut-off of 16 BMI. Data from Congo, Ghana, Mali, Morocco and Tanzania identified a range of between 0.3 and 2.8% of adults falling below the cut-off of 16 BMI (Bailey and Ferro-Luzzi 1995). These data sets were presumably from stable non-emergency populations. In Somalia in 1992-93, the relief agency Concern found that most adults had a BMI of less than 16.0(Collins 1995), indicating the dramatic increase in undernutrition at the height of this crisis.

Issues in interpretation

Food insecurity or the presence of widespread infectious diseases such as HIV/AIDS and TB could result in a high proportion of adults with low BMI. A detailed analysis of two nationally representative nutritional surveys conducted in Brazil found that an adult's BMI was closely correlated with their families/households energy adequacy. Similar good correspondence was found between BMI categories and a range of socio-economic variables such as family total expenditure (Monteiro, Conde et al. 2002). Whereas child malnutrition is a composite indicator of poor health, lack of food, care etc. adult malnutrition is more intuitively a direct outcome of food insecurity.

Despite this association, there is an apparent lack of agreement in the estimated numbers of undernourished in different countries based on food energy inadequacy and estimates based on anthropometry (Svedberg 2000; Nube 2001). For example, for similar levels of energy inadequacy, the prevalence of a low BMI (< 18.5cm) in adult women was much more marked in countries in the Asian region than in countries in Sub-Saharan Africa. Nube argues that the lack of agreement between the estimates could be attributable to either the poor quality of data, or because there is a fundamental difference between countries or regions with regard to factors that affect the relationship between food consumption and anthropometric outcomes in both children and adults(Nube 2001).

Several factors other than nutritional status influence BMI, including body shape, influence of age on height decline, and seasonal fluctuations in weight. One of the most important of these is body shape, which varies between different ethnic groups, and reflects the length of an individual's trunk or sitting height in relation to their overall height. This ratio was originally described by Norgon as the Cormic Index (Norgon 1994), and more frequently as the Sitting Height to Standing Height Ratio or SSR (Myatt, Duffield et al. 2009).

Where individuals have long legs relative to their trunk the SSR ratio is smaller. Ratios for different groups are shown below:

- 0.47: in Aborigines
- 0.48: in pastoral groups in East Africa
- 0.52: European reference
- 0.55 in Japanese

This SSR ratio has been shown to affect BMI, for example, as the ratio of sitting height/standing height increases i.e. legs become shorter, then Cormic index and BMI increases (Japanese 0.55). Conversely, as the ratio of sitting height/ height decreases i.e. legs become longer, BMI decreases (pastoralists 0.48).

The use of the Cormic index is an additional time consuming and not altogether easy calculation, which makes it less suitable for routine use in emergencies. Collins et al (2000) recommend that if BMI survey data are used to compare between populations, estimates should be corrected by standardization to a SH/S ratio of 0.52 (the European reference) using the mean SH/S ratio for the specific populations studied. Such adjustments have been made, for example, in Ethiopia in 2000 where 22.7% of adults were below an adjusted BMI of 18.5 (Salama, Assefa et al. 2001).

A further issue influencing BMI is the effect of age on height; height decline occurs with age at a rate of 1-2 cm per decade & increases with age.

Changes in food intake and health influence body weight and thus seasonal changes in diet or disease patterns, or physical activity produce fluctuations in adult weight, which means that BMI is potentially useful for assessing food security (or alternatively unusually heavy workloads or the impact of illness).

Note that for adults who are already of low body weight, any weight loss would mean they would lose proportionally more lean tissue and "are therefore compromised to a greater extent in their general health and work capacity" by seasonal fluctuations in food availability. This could be particularly significant for those groups with a lower SSR (e.g. pastoralists), who tend to show higher levels of thinness and who experience on a regular basis seasonal fluctuations in food security and health.

In summary, the advantages of BMI as a nutritional indicator for adults is that it reflects fat and protein stores; and for women, low BMI is correlated with increased risk of low birthweight babies, and for all adults: increased risk of mortality with very low BMI.

Its disadvantages are that it is difficult to measure, particularly among the stooping elderly and that it is prone to age related changes and modified by body shape.

Nevertheless, evidence strongly suggests that a serious decline in nutritional status of adults as reflected by mean and prevalence of low BMI is almost certainly associated with serious declines in food insecurity.

The existing BMI reference levels which originate with the 1995 WHO Expert Committee are somewhat arbitrary and they reflect the distribution of BMI in many populations in developing countries at that time. Subsequent analysis by Black et al (2004) has shown prevalence levels to be somewhat higher.

The IPC workshop participants broadly agreed that BMI should be included in all five phases of the IPC, with an emphasis on low BMI (< 18.5 BMI) in the upper phases and the risk of obesity as supporting evidence (< 30) in the lower phases. The widely adopted cut-off of < 18.5 to estimate prevalence was recommended (as used in the reference levels adopted by WFP). It was suggested that the IPC should consider relative reference levels, based on national figures, with a multiplier of 1.5 of baseline as a guide to shift to a higher phase. This would necessitate developing tables of national and regional estimates of maternal undernutrition (non pregnant women aged 15 – 49 years).

As an interim measure we recommend the use of the WHO reference levels adapted to the IPC phases as shown below:

- Ph 1 <10%
- Ph 2 10-19%
- Ph 3 20 – 39
- Ph 4 40 and above
- Ph 5

Prevalence of obesity (> 30 BMI) may be used as indirect evidence of undernutrition for classifying severity between Phases 1 and 2.

Mortality

Crude and under five mortality rates are considered key indicators to monitor and evaluate the severity of a crisis or disaster situation.

“Mortality rates are the most specific indicators of the health status of emergency affected populations” (CDC 1992)

“The daily CMR is the most specific and useful health indicator to monitor in a disaster situation”(The Sphere Project 2004).

“Mortality is the prime indicator by which to measure the impact of a crisis, the magnitude of needs and the adequacy of humanitarian response” (Checchi and Roberts 2005)).

Both CMR and under five mortality rates (or 0-5 age specific death rates) are assessed in emergencies. In acute emergencies, these rates are usually expressed as deaths/10,000/day as mortality may change quickly over time. Mortality is sometimes also referred to as deaths/1000/month (particularly in articles from the 80's and 90's)¹⁷.

In non-emergency settings, infant mortality rates (IMR) and under five mortality rates (U5MR) are more commonly reported. This is defined as the number of deaths per live births and indicates the probability of dying between birth and 1 or 5 years of age. These indicators are used in DHS and MICS surveys and for MDG monitoring. It has been proposed to use these in the IPC to distinguish the non-emergency phases.

¹⁷ The conversion factor is $30.4/10 = 3.04$ (there are an average of 30.4 days in one month) to convert a result expressed as deaths/ 10,000/day to deaths/1000/month multiply by 3.04. To convert death/10,000/day to death/1,000/year multiply by 36.5.

The Under Five Mortality Rate which refers to deaths per live births before the age of 5 is different from the age specific death rate for 0-5 year olds over a specific time interval. Although both estimate mortality in under five year olds, the calculations and results are quite different. The numerical result using the first definition is (very roughly) five times higher than the second, although one cannot be calculated from the other. It has been recommended that the term “0–5 year death rate” (0–5DR) denoting the age-specific death rate of children less than 5 years of age is used for the IPC manual, which is the same as the under-5 mortality rate used in the past by those working in complex emergencies. The term “crude death rate” (CDR), rather than “crude mortality rate” (CMR), was also recommended to denote the total death rate in the population over a given time interval¹⁸.

Mortality thresholds and benchmarks¹⁹

A benchmark for emergencies of a CDR >1/10,000/day was first suggested in 1990 by Toole and Waldman (Toole and Waldman 1990). This was based on a review of health profiles of refugee and IDP populations during emergency and post emergency phases (Toole and Waldman 1990). They concluded that the emergency Phase can last from 1-12 months following displacement, and it can be considered over when the CDR drops to less than 1/10,000/day. A CDR of 1/10,000/day is essentially a doubling of what was the normal CDR for Sub-Saharan Africa at the time; 0.44/10,000/day, and has subsequently been used as the threshold for declaring an emergency (Checchi and Roberts 2005). This threshold has been adopted in different agency guidelines. In 1991, Hakewell and Moren provided a number of benchmarks to classify emergencies according to their severity:

0.5/10,000/day: normal rate in developing countries
<1/10,000/day: relief programme; under control
>1/10,000/day: relief programme: very serious situation
>2/10,000/day: emergency: out of control
>5/10,000/day: famine: major catastrophe

They also suggested that benchmarks for children less than five years are approximately double those of the crude mortality, thus it assumes that the baseline for under 5 mortality is about 1/10,000/day. Anything above 2/10,000/day is considered very serious, above 4 is out of control (Hakewill and Moren 1991). The baseline mortality for under five year olds in developing countries is about 1/10,000/day (Davis 1996).

Relative versus fixed thresholds

As described above, these thresholds are based on the health profiles of IDPs and refugees in camp situations during a period when extremely high prevalence's and death rates were found. Some argue that these same thresholds may be less helpful in prolonged emergencies affecting large populations and large rural areas where many of the increases in mortality occur. In more recent emergencies, camp mortality has rarely been found above the emergency threshold of 1/10,000/day (Salama, Spiegel et al. 2004).

Comparing mortality rates with baselines has been suggested as an alternative to using fixed thresholds; in this case it has been recommended to double the baseline rates to create context specific thresholds (Salama, Spiegel et al. 2004; The Sphere Project 2004). It might

¹⁸ This text was taken from the e-mail communication on the technical proposals for the IPC. This contribution was made by Francesco del Re.

¹⁹ Although we have chosen to use the term “reference levels” for nutrition indicators, this is not appropriate for mortality indicators. We will use the term threshold for mortality indicators.

still be necessary to use a fixed threshold if the baseline rate is unknown, but this is unlikely to be appropriate for contexts outside of Sub-Saharan Africa as baseline levels of mortality are so much lower.

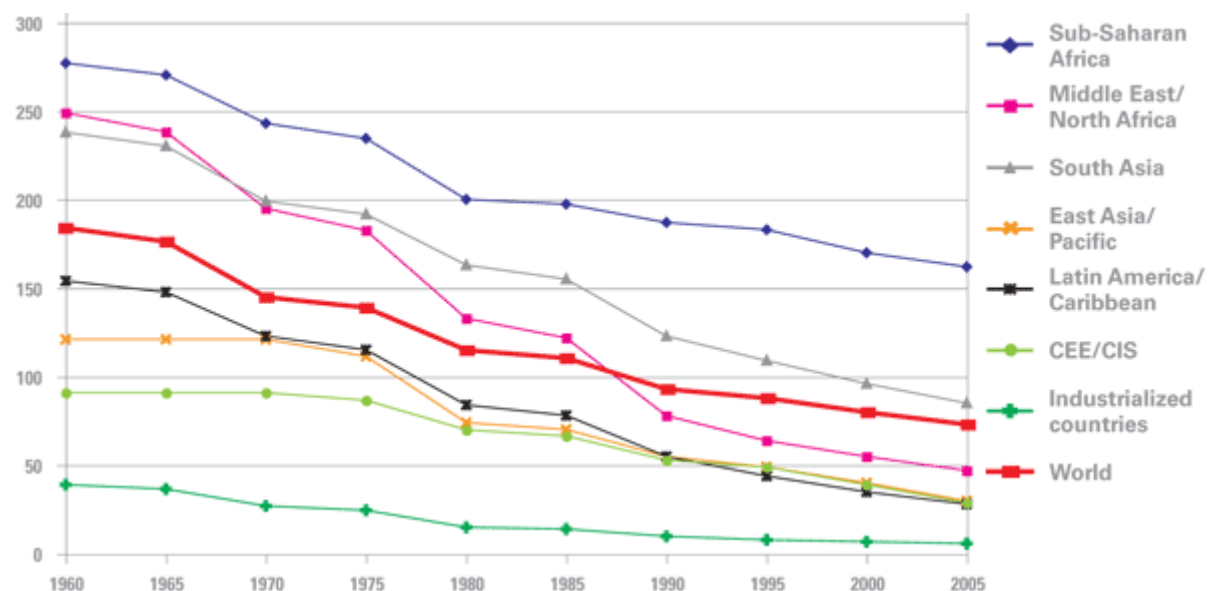
The Sphere handbook gives baseline mortality rates by region, which were calculated from annual crude and under five deaths in 2001, given in UNICEF's State of the World's Children publication from 2003.

The use of context specific thresholds raises a number of ethical issues, however, as it means the thresholds for populations with high levels of baseline mortality are higher than for those with low baseline mortality. For example, CDR in Darfur must be 5-6 times higher than in Europe before an emergency response is organised (Checchi and Roberts 2005). The HIV/AIDS epidemic may also cause baseline rates and therefore threshold levels to increase. Using different thresholds for different population groups in some ways contradicts humanitarian principles, as humanitarianism should seek to reduce absolute, not relative suffering (Checchi and Roberts 2005).

There have also been suggestions that thresholds will need to be revised in light of the global reduction in mortality in the past 15-20 years (Roberts, personal communication). Although this reduction has not taken place everywhere. In much of Sub-Saharan Africa, and in Afghanistan, mortality has remained the same or increased over the past decade. In this case, the use of relative thresholds would create even bigger differences in emergency thresholds used for SSA and elsewhere in the world. Figure 3 below shows the decrease in under five mortality over the past 5 decades.

Figure 3 Trends in child mortality

Under-five mortality rate (per 1,000 live births), by region (1960–2005)



Source: UNICEF

Excess mortality

Excess mortality is an important indicator of the impact of emergency, which is the difference between observed crisis and expected non-crisis context specific mortality rates. It therefore describes the gap to be filled by humanitarian agencies, when the ultimate aim of humanitarian assistance is to reduce excess mortality. This means that even if a context

specific threshold is not used as a threshold, it can still be used to work out excess mortality as an important indicator of humanitarian crisis. Excess mortality is greater the longer a crisis lasts, and thus duration of an emergency becomes a key factor (Checchi and Roberts, 2005). This indicates the need for the IPC to include temporal dimension not only for malnutrition, but also for mortality. In reality, excess mortality may be difficult to measure because of a lack of a population specific baseline.

Reference levels for IPC Phases

The IPC classification uses a similar mortality classification as that developed by Hakewell and Moren (1991). The main difference is that the IPC does not use the rate of 5/10,000/day to classify a famine or major catastrophe, but rather uses 2/10,000/day for this level of crisis. According to the IPC manual, this was recommended by CDC²⁰.

Famines in the 80's and 90's have however shown much higher mortality rates. The manual also refers to the thresholds used by the RNIS/NICS system of the SCN, which in 2004 set the trigger for alert is a CMR or 1/10,000/day and for a severe situation is: 2/10,000/day. See Table 13 below:

Table 13 – Mortality thresholds and the IPC classification

Threshold	Emergency classification	IPC classification
0.5/10,000/day	Normal for developing countries	Generally food secure Chronically food insecure/ moderately food insecure
0.5-1/10,000/day	Under control	Acute food and livelihoods crisis
1-2/10,000/day	Very serious	Humanitarian Emergency
>2/10,000/day	Emergency out of control	Famine/humanitarian catastrophe
>5/10,000/day	Famine: major catastrophe	NA

IPC also uses the Sphere minimum standards by using “greater than 2 x reference rate” (or baseline) in Phase 4 (humanitarian emergency) and also “greater than usual” and “increasing” for the same phase.

Use of infant and child mortality in the IPC

The use of mortality rates to distinguish the non-emergency phases of IPC has been an area of concern for users, particularly in Asia. In these countries, CDR and 0-5 year death rates are generally unavailable. However, national surveys, such as NHS and MICS surveys do make projections about under five and infant mortality rates (deaths per 1000 live births). As explained above, it is not possible to convert these mortality rates into deaths/10,000/day. No internationally agreed thresholds exist for these mortality rates, so some countries adopting the IPC have developed different thresholds for generally food secure and moderately food insecure.

Examples include:

²⁰ The reference is given as: Brennan and Bilukha, 2006, April, but the source is not given in the reference list.

- In a Sri Lanka pilot, a threshold for IMR of 13 was used which is national MDG for 2015. However, the IMR was already very low, with a level of 13 reached in 2000. For U5MR used 1 and 1-2/10,000/day.
- In Indonesia, the analysis team used IMR and U5MR instead of CMR and used the national average as threshold. These indicators were used as indirect evidence.

The MDG goal of reducing U5MR by two thirds is used as a target rather than a threshold. However, even if the IPC decided to use the MDG's in the non-emergency phases, this would not provide different thresholds for different phases. A further problem is that whilst IMR or U5MR is closely related to poverty, there is no evidence of an association with food insecurity despite the obvious theoretical association between food insecurity, starvation and death.

IMR and U5MR could not be used in the emergency phases of the IPC, as the estimates cover the past 5 years and are centred about 2.5 years in the past. The confidence intervals are very broad if data for just one year are presented and the smallest recall period is one year (Checchi, personal communication). In addition, results of surveys measuring IMR and U5MR usually take much longer to work out than those of emergency mortality surveys. Myatt (Myatt, Taylor et al. 2002) developed a method to measure U5MR for short periods using previous birth history, but this is currently not widely used. Although this method is simple and could potentially give more reliable mortality estimates, it has yet to be validated.

Issues in interpretation

There is strong consensus that mortality is a key indicator of severity of crisis. There is also consensus that both CDR and 0-5 DR should be monitored in emergencies. There is some debate around the use of either fixed or relative thresholds (similar to the arguments relating to low WH), and the use of excess mortality as an indicator versus the use of thresholds.

There are also issues of interpretation relating to excess mortality and age and seasonality. Some studies of mortality in emergencies, have found that older children and adults have a greater proportional increase in mortality than younger children. This has obvious implications for emergency response. If over fives are progressively more susceptible to emergency risk this has implications for targeting and resource allocation. Targeting under five year olds would be misguided and most excess mortality would be unaffected (Davis 1996). Mortality also shows seasonal patterns, for example in Sudan with lowest mortality post harvest (de Waal 1989). Although seasonal mortality risk is unacceptable, for determining the severity of emergencies mortality in rural populations needs to be interpreted in relation to expected seasonal patterns.

There are also a number of methodological issues with collecting mortality data in emergencies. The best way of monitoring mortality is to set up a prospective surveillance system, but these appear to be very limited in emergency settings as there are no guidelines on how to do this in emergencies. On-going monitoring would be able to detect unusual patterns much more quickly than the cross-sectional surveys normally done in emergencies. Cross-sectional surveys take time to carry out and analyse, results reflect mortality in the past (estimating very recent mortality would require very large sample sizes), and confidence intervals are often very wide because of the low number of deaths found in the sample. Such surveys might therefore be a good tool for advocacy and documentation, but less so for determining current severity, or for planning and monitoring the effectiveness of emergency response (Checchi and Roberts 2008). When mortality surveys are done as part

of nutritional surveys, there may be under-reporting because mothers may feel judged and report fewer deaths.

In conclusion, mortality rates are key indicators to monitor and evaluate the severity of crisis. The inclusion of CDR and 0-5DR for the emergency phases of the IPC (3-5) is therefore appropriate. Actual reference levels for the more severe phases were not discussed at the workshop. The authors recommend using the original Hakewill and Moren reference level for Phase 5 (which alters Phase 5 CDR to > 5 per 10,000/ day). Alternatively in situations where baseline mortality is relatively low, the doubling rule may be applied i.e. using doubling of the baseline CDR to identify an emergency.

In the lower phases of IPC, IMR and U5MR may be more appropriate as indicators of poverty and thus underlying vulnerability, but not as reference outcomes. IMR and U5MR are calculated over long time periods and therefore only appropriate for planning of long term food security and poverty reduction programmes. Prospective surveillance systems could, however, detect small changes quickly which could assist with identifying a shift from Phase 2 to 3. Until such systems are available it is not possible to give recommendations about the change that indicates a shift between these phases.

Excess mortality is an important indicator of the impact of an emergency in particular in protracted emergencies and the number of excess deaths increases with increased duration. Protracted crises in large dispersed populations could lead to more deaths than higher mortality rates for short duration during an acute crisis. Calculation of excess mortality, using baseline rates, should be considered by IPC even if fixed thresholds are used to determine the phases. Excess mortality is an indicator of absolute severity of crisis and as such does not need a threshold. This can be considered as indirect evidence to classify a humanitarian emergency. Also, reporting by age group needs to be considered, as increases in excess mortality in older children has implications for targeting emergency response. IPC should therefore also consider reporting of excess mortality by age group particularly in the highest phases (4-5).

Part 3 - Evidence-Base of the Relationship between malnutrition and mortality

Introduction

The simplicity of counting the malnourished, with the assumption they are most likely to die, is politically a very powerful advocacy tool for eliciting a response by decision-makers, in part because it is easily understood but more importantly because of the strong evidence of the link with risk of dying. Risk of dying is one of the many serious consequences of undernutrition, which also includes impaired immunocompetence, learning difficulties, reduced work capacity, increased risk of chronic disease in later life and the long-term inter-generational nutritional effects. The risk of death associated with malnutrition is important to understand, as food insecurity is underlying cause of malnutrition, and therefore by implication an indirect cause of death.

Here we review two bodies of literature, first, the prospective studies of malnutrition and mortality among individuals, and second, the much smaller literature that reviews prevalence of malnutrition and mortality rates in population based surveys.

In the eighties and early nineties, a considerable body of research was directed at analyzing the mortality risks associated with low anthropometric status among individuals (community based prospective or longitudinal studies), which have helped determine the most appropriate nutritional indicators for identifying risk of dying.

Key findings from prospective studies on malnutrition and mortality

The purpose of our study is to review the evidence of the relationship between malnutrition and mortality and consider the implications for the application of nutrition indicators and reference thresholds in the IPC. This section briefly reviews the prospective studies on malnutrition and mortality, and considers their methods of analysis, points of consensus, and the issues they raise for interpretation of nutritional indices in relation to food security²¹.

²¹ From our literature review, we culled data from 24 discrete longitudinal studies focusing on the relationship between anthropometric status and mortality, and only those studies collecting data on both explicitly were included in this analysis (Table x). Articles re-analyzing existing data were not included in this table. Articles included in the meta-analyses conducted by Pelletier (1994) and Caulfield (2004) contributed the bulk of the studies in this analysis. Only 3 studies were found that were conducted since the meta-analysis of David Pelletier. These included; a study in Northern Sudan Fawzi, W. W., M. G. Herrera, et al. (1997). "A prospective study of malnutrition in relation to child mortality in the Sudan." *American Journal of Clinical Nutrition* **65**: 1062-9.; a study examining the effect of vitamin A supplementation on vitamin A status and anthropometric status at age 12 months in India, Ghana and Peru WHO/CHD Immunisation-linked vitamin A supplementation study group (1998). "Randomised trial to assess benefits and safety of vitamin A supplementation linked to immunization in early infancy." *Lancet* **352**: 1257-1263. and another vitamin A supplementation trial in Nepal West, K. P., R. Pokhrel, et al. (1991). "Efficacy of Vitamin A in reducing preschool child mortality in Nepal." *Lancet* **338**(8759): 67-71. There have been subsequent re-analyses of older longitudinal datasets, including the study by Garenne et al. (2009) who estimated the case fatality of severe wasting episodes, among children in DRC and Senegal Garenne, M., D. Willie, et al. (2009).

In 1991 Pelletier (1991) identified and reviewed 15 community based prospective studies. He compared the predictive ability of different anthropometric indicators and estimated the percent of child deaths attributable to anthropometric deficits were somewhere between 20% and 75% (Pelletier 1991). This work was expanded in 1994 to include 21 separate studies (Pelletier 1994). His work has been crucially important in informing the health policy debates that most child deaths result from disease aggravated by malnutrition (Pelletier, 1991). The importance of malnutrition in contributing to disease burdens has been re-emphasized by the recent studies that review and statistically quantify underweight as an underlying cause of child deaths associated with diarrhoea, pneumonia, malaria, and measles (Ezzati, Lopez et al. 2002; Caulfield, De Onis et al. 2004; Fishman, Caulfield et al. 2004).

The prospective studies on malnutrition and mortality have mostly been concerned with:

- Comparing the predictive power of different anthropometric indices i.e. predictive of mortality risk over the long and short-term,
- Determining the 'best cut-off' for diagnosing categories of low anthropometric status that have an increased risk of mortality (for the purpose of identifying individuals in need of treatment)
- Determining the best indicators for detecting a change in the prevalence of malnutrition (which is the most 'responsive' indicator).

Note that these prospective studies were investigating statistically attributable associations between anthropometric status and mortality, which cannot by themselves provide evidence of causality between child mortality and underweight, wasting and stunting.

Most studies were conducted in relatively stable developmental contexts. At least six studies have been conducted in the vicinity of the field research station at Matlab, Bangladesh. Several other studies covered locations benefitting from development programmes, where the research formed part of programme evaluation or to assist in programme planning (for example, UNICEF Uganda (Yambi, Latham et al. 1991), the evaluation of improved water supply in rural Malawi, (Lindskog, Lindskog et al. 1988) and as part of a health impact assessment of a 5-year water and sanitation intervention project in Teknaf, Bangladesh (Alam, Wojtyniak et al. 1989)..

Studies varied in terms of their length of follow-up, the age ranges of children included in the studies, and the statistical methods for examining this relationship (Annex 6).

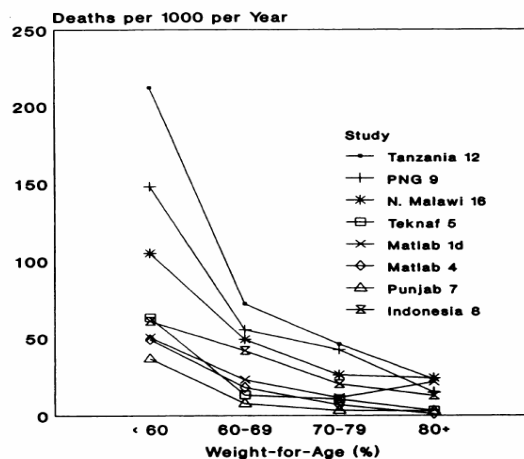
Comparison of different anthropometric indicators and mortality risk

The prospective studies of individuals in Africa and the Indian Sub-Continent show that mortality risk increases as anthropometric status declines. This occurs over the range of decreasing nutritional status, with mortality risk increasing exponentially with decreasing levels of anthropometric status, and some risk being associated with mild to moderate malnutrition.

"Incidence and duration of severe wasting in two African populations." Public Health Nutrition.. These re-analyses were not included but they are noted in the table.

Figure 4 Relationship between child mortality and weight for age (from Pelletier, 1994)

Graph a.



Graph b.

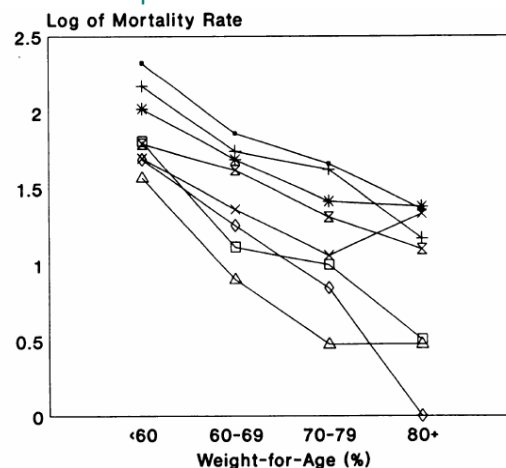
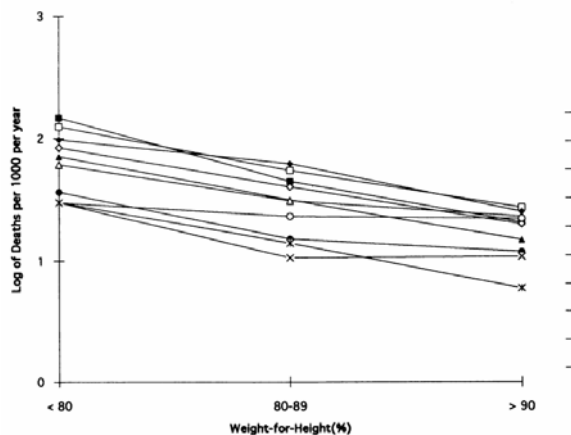


Figure 5 Relationship between child mortality and weight for height (from Pelletier, 1994)



The slope of the association between mortality and malnutrition in graph b is positively associated with the baseline mortality rates among the well nourished. This accounts for the parallel lines. Populations with high levels of baseline mortality experience a quantitatively larger increase in mortality for a given prevalence of malnutrition

The strength of the association between child mortality and malnutrition varies according to different nutritional indices (including indicators of wasting (WH and AC); stunting (HA) and underweight (WA). Since the eighties a consensus has grown that AC (at extreme cut-off's – high specificities), is the best predictor of short-term nutrition associated mortality risk (Alam, Wojtyniak et al. 1989; Briend, Hasan et al. 1989; Vella, Tomkins et al. 1993; Pelletier 1994; Myatt, Khara et al. 2006). Standardizing AC by age or height weakens its predictive power.

Pelletier's 1994 landmark meta-analysis based on ROC curves, which is more reliable than relative risk (see Annex 5), shows that WA appears superior to HA according to all performance criteria. WH has a much lower sensitivity for a given specificity compared with other indicators. The reasons why WH has a lower predictive power include:

1. The long follow-up periods in *most* studies (up to 24 mo), which means most studies are concerned with long-term mortality risk, rather than short-term risk which could affect the discriminating power of indices of wasting.

2. The relatively low prevalence of low WH in most prospective studies and therefore relatively small number of deaths in the low WH categories, which increases the confidence interval around relative risk.
3. The comparison between nutritional indices of differing categories of growth failure. For example in a study in Bangladesh, the mortality discriminating power was lowest for WH, but the cut-off point used for WH was < 80% (moderate wasting), while for HA it was < 85% and for WA it as < 60% (Alam, Wojtyniak et al. 1989). This is a particular problem of comparing relative risk of different indices – unless the cut-off's are comparing similar grades of growth failure, then the relative risk is not comparable.
4. The age confounding effects of MUAC (see previous section)
5. The changing patterns of nutritional status with age
6. The distribution of wasting among younger (<85cm) and older (>85 cm) shifts as the overall population prevalence of wasting increases. In other words the ratio between wasted younger children compared with wasted older children decreases – older children are increasingly likely to become wasted as the prevalence of wasting increases. This is illustrated in Figure 6. At low levels of wasting, most wasting affects younger children, but as prevalence levels increase the percent of wasting among older children increases proportionately more than younger children. The question arises as to what causes this shift.

The predictive power of a particular indicator is subject to modification by factors such as; age, seasonality, severity of food insecurity etc (see section on confounders and modifying effects below)

Potentiating effect of malnutrition on mortality

A synergism exists between nutrition and infection, whereby malnutrition has a potentiating (multiplicative) effect on mortality within populations (Pelletier, Frongillo et al. 1993; Pelletier 1994). This means that where levels of morbidity and mortality are already high, children who are malnourished are likely to have an even greater risk of dying. It also helps to explain the inconsistent results among prospective studies, for example in Tanzania attributable risk at 60% WA or less is 189, while it is only 34 in India. *Pelletier observed that over the entire range of WA, mortality in the three African studies appeared higher as compared to the South Asian studies, which is consistent with trans-national comparisons of data (Pelletier 1994).* This has implications for the IPC Phases, and reference levels, and makes it crucial that public health factors, disease incidence and expected seasonal patterns of disease are also taken into account in the interpretation of reference levels (or outcomes).

The synergistic relationship between malnutrition and mortality is also influenced by the mix of prevalent diseases, particularly diarrheal disease, measles, malaria and ARI. Measles for example may act as a confounder in this relationship. There was a measles outbreak at the same time as the Guinea Bissau study and measles may be fatal among children with varied nutritional status (Smedman, Sterky et al. 1987).

More recently studies have been undertaken analyzing childhood underweight status as a risk factor for mortality due to diarrheal disease, measles, malaria and pneumonia (Fishman, Caulfield et al., 2004). The statistically attributable fractions of mortality associated with WAZ < -1 were 44.8% for measles, 57.3% for malaria, 52.3% for pneumonia and 60.7% for diarrhoea (Fishman, Caulfield et al. 2004).

Confounders and effect modifiers

The relationship between malnutrition and mortality varies as a result of other factors (effect modifiers) or are actually accounted for by other factors (confounders) (Pelletier 1991). Examples of 'effect modifiers' include age, morbidity, seasonality, and they either potentiate (strengthen) the relationship between malnutrition and mortality or they attenuate or weaken it. For example, a high incidence of disease or epidemic is associated with higher levels of background mortality, and a stronger relationship between anthropometric deficits and death. Other effect modifiers that have not generally been taken into account include breastfeeding²², body shape and HIV/AIDS. All effect modifiers are important and their analysis must be incorporated within the IPC

i. Morbidity

Other important modifying effects include morbidity (patterns and incidence of disease) breastfeeding, and possibly body shape and maternal nutritional status. Malnutrition has differential effects on mortality according to cause of death. For example, two early studies in Bangladesh and Uganda showed that deaths from diarrhoea had an elevated risk of death associated with malnutrition (Fauveau, Briend et al. 1990; Van den Broeck, Eeckels et al. 1993). Importantly the effect of diarrhoea on growth is transient and after non-bloody diarrhoeas children catch up and deficits in weight gain and linear growth were no longer apparent weeks later (Briend, Hasan et al. 1989)

More recently Caulfield et al calculated the relative risk for low underweight categories by different cause of death based on data from 10 cohort studies (Table 14). Diarrhoea clearly showed a higher relative risk, with measles showing a somewhat lower risk. The authors urge caution in the interpretation of the relative risks for measles and malaria, in part because fewer studies were available on these diseases (3 for malaria, 6 for measles) and because of their equivocal results(Caulfield, De Onis et al. 2004).

Table 14 - Relative risk (95% CI) of mortality overall and by cause associated with low weight-for-age estimated from weighted random effects regression analysis (data from Caulfield et al., 2004).

Cause of death	-3 Z scores	1 -2 to -3 Z scores	-1 to -2 Z scores	_-1 Z scores
Diarrhoea	12.50 (7.19, 21.73)	5.39 (3.73, 7.79)	2.32 (1.93, 2.79)	1.0
Pneumonia	8.09 (4.36, 15.01)	4.03 (2.67, 6.08)	2.01 (1.63, 2.47)	1.0
Malaria	9.49 (3.25, 27.66)	4.48 (2.20, 9.15)	2.12 (1.48, 3.02)	1.0
Measles	5.22 (2.29, 11.88)	3.01 (1.74, 5.21)	1.73 (1.32, 2.28)	1.0
All causes	8.72 (5.55, 13.72)	4.24 (3.13, 5.53)	2.06 (1.77, 2.39)	1.0

Since many of these studies were done more than 20 years ago, disease profiles may have changed thus affecting mortality risk. For example with expanding programmes of immunization, even or especially in humanitarian contexts, prevalence of measles has declined. Meanwhile HIV/AIDS has emerged, and probably led to an increase in the

²² Breastfeeding is an important effect modifier; in the absence of breastfeeding the effect of severe malnutrition on mortality is made substantially worse Briend, A. and A. Bari (1989). "Breastfeeding improves survival, but not nutritional status, of 12-35 months old children in rural Bangladesh." European Journal of Clinical Nutrition **43**: 603-8. Briend et al., 1987 found that even in the third year of life breastfeeding reduces the risk of mortality among the severely malnourished Briend, A., B. Wojtyniak, et al. (1987). "Arm circumference and other factors in children at high risk of death in rural Bangladesh." The Lancet **26**: 725-727.. A more recent study in Sudan found that wasted children were at a much higher risk of dying if they were also not being breastfed Fawzi, W. W., M. G. Herrera, et al. (1997). "A prospective study of malnutrition in relation to child mortality in the Sudan." American Journal of Clinical Nutrition **65**: 1062-9..

prevalence of wasting in many countries which may influence the relationship between anthropometric deficits and death (Garenne, Willie et al. 2009).

A six country study in Southern Africa found that areas nearer to large towns with higher HIV/AIDS showed more deterioration in child nutrition during the drought period, than they did before the drought. In contrast rural areas (which were preferentially targeted with food aid) showed stability or improvement. Prevalence of underweight was associated with prevalence of HIV - child underweight increased in higher HIV areas more than in lower prevalence areas. Although the occurrence of drought statistically interacted with prevalence of HIV/AIDS i.e. drought significantly worsens the effect of HIV on population nutritional status, and HIV significantly worsens the effect of drought at the level of the population. (Mason, Bailes et al. 2005). HIV/AIDS impacts on nutrition directly and indirectly through multiple pathways, destroying livelihoods and undermining governance, social and human capital.

ii. Age – a confounding or modifying effect and implications for targeting

Previous reviews of the effect of age on malnutrition and mortality relationships suggest the possibility that various anthropometric indicators may have a higher risk of dying at certain ages. This is of programming and policy importance to the IPC – in relation to identifying which age groups might have a higher risk of death for a specific grade of malnutrition.

Several malnutrition mortality studies have tried to control for this age effect by entering the age variable into the logistic regression equation before examining the anthropometric indicators. While this eliminates the age effect in the regression analysis it does not take into account whether or not the mortality risk of anthropometric indicators might vary with age.

Annex 7 summarises the findings from various studies that have analysed the predictive ability of different indicators by age group. The results show that mortality prediction is significantly affected by child's age, but the strength and direction of this effect modification varies across the commonly used four indicators (WA, HA, WH and ACA) are not entirely conclusive (Pelletier, Low et al. 1994) particularly for older age groups (Pelletier 1994). Key points relevant to this review are summarized below:

- Low HA tends to be associated with a higher risk among younger children (< 36 mo) as compared with older children (Smedman, Sterky et al. 1987; Katz, West et al. 1989; Vella 1994). One exception to this is the study by Pelletier in Malawi that found HA performed well among older children as a predictor of death.
- Severe underweight was associated with a peak in relative risk of mortality between 6 and 12 months of age as compared to other groups up to 80 mo (Kielman and McCord 1978).
- Mild deficits in WA are not associated with increased risk of dying among older children, probably because much of the weight deficit in older children is a result of height deficits accumulated earlier (Kielman, Taylor et al. 1978).
- Wasting (< -2 WHZ or <80%WH) among children older than 24 months is associated with a marked elevation in risk of dying as compared to younger children. This has been confirmed by three studies (Katz, West et al. 1989; Vella 1994; Fawzi, Herrera et al. 1997).
- Low AC (unadjusted for age or height) tends to show a higher relative risk among older children – which is not surprising as AC increases with age, so if an older child's

measurement falls below the cut-off their nutritional status is relatively worse compared with a younger child with same measurement (Vella 1994).

- When AC is adjusted for height the pattern changes. The relative risk of dying associated with low AC/height for children aged above 36 months and less than 48 months is almost double that of younger children (12 – 36 mo) (Sommer and Loewenstein 1975). Results for low WH vary between studies.

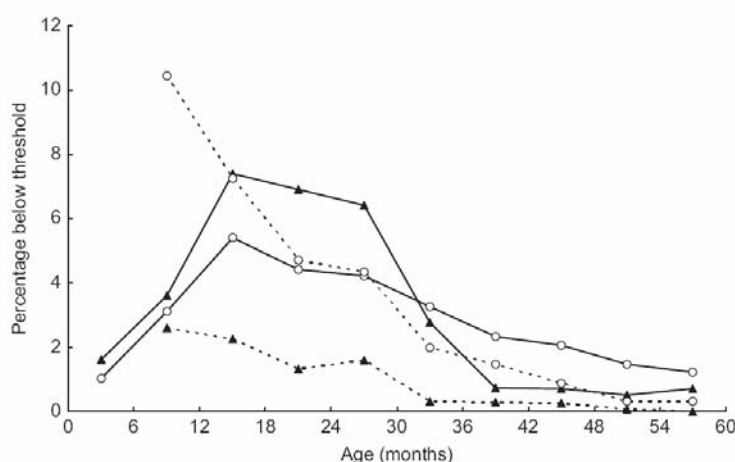
In summary, among young children, WA, WH and AC/Height or Age are equally effective in predicting mortality associated with low anthropometric status. Among older children the situation is less clear as there is marked variation in prediction among the four indicators. Wasting appears to be more strongly associated with mortality among older children than younger children. Low HA (moderate stunting) tends to carry elevated risks among younger children as compared with older children.

A difficulty in assessing the predictive power of WH among older children in the available prospective studies is the extremely low prevalence of wasting found in this group – sometimes limited to only 3 children – in the study locations. Numbers of deaths among older children are also far fewer than among younger children. This situation often does not apply in emergency contexts where excess mortality tends to be higher among older children (see Part 2). This review of age effects suggests that the categorization of anthropometric status by age group is important for predicting mortality.

Age effects also partly account for the better mortality predictive power of MUAC as compared to low WH. Figure 6 shows how WH prevalence is initially low at age 3 months and increases to a peak by age 12 months, plateaus up to 30 months and decreases thereafter. AC tracks a path that is not dissimilar to mortality; tending to be higher among younger children and decreasing with age, while the WH curve looks very different from the mortality curve, which partly explains why its predictive power is less than AC.

Figure 6 Prevalence of severe wasting by age (population estimates) according to weight-for-height Z-score (WHZ) and mid upper arm circumference (MUAC):

Niakhar (Senegal; —▲—, WHZ; —▲—, MUAC) and Bwamanda (Democratic Republic of Congo; —○—, WHZ; —○—, MUAC). Thresholds: WHZ ≤ -3 and MUAC < 110 mm ((Garenne, Willie et al. 2009) Z-score was calculated using the Centers for Disease Control and Prevention 2000 child growth charts (CDC-2000).



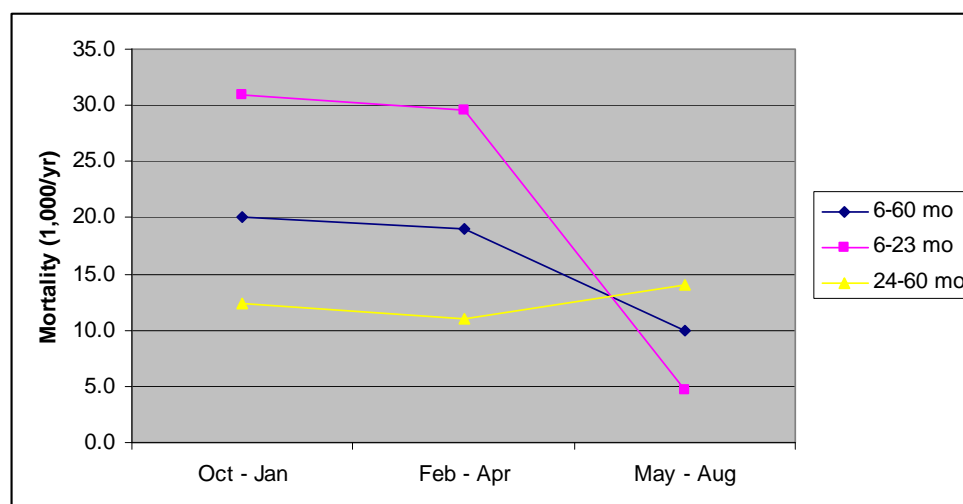
iii. Seasonality

Underweight, wasting, morbidity and mortality all demonstrate seasonal patterns. Indicators of acute malnutrition, such as WH and MUAC show more variation by season than other indicators (WA, HA), as they reflect short term variations in nutritional status (Briend et al, 1989). In de Waal's mortality study in Darfur, most of the excess deaths occurred during the dry season and the rains of 1985. There were also seasonal variations in mortality in normal times, with fewest deaths occurring during the harvest and most at the end of the dry season (de Waal 1989).

Similarly, among rural populations with a single rainy season, the prevalence of acute malnutrition will often be highest during the hungry season before the harvest and lowest just after the harvest. Kielman and McCord (1978) found that the risk of dying associated with low nutritional status was considerably higher if children were malnourished during the first half of the year, when food stores are exhausted, temperatures increase and diarrhoeal disease is more prevalent and often complicated by dehydration (Kielman, Taylor et al. 1978).

In the Malawi study, there was marked seasonality in production, labor demands, morbidity and child nutritional status. November to April is the preharvest rainy season characterized by food shortage in many households, high agricultural labor input, high morbidity and reduced levels of child nutritional status. Figure 7 shows that mortality decreases for all children during May to August, but that most of this effect was among children 6 to 23 months, while older children actually experienced an increase in mortality. This might suggest that causes of mortality are different between the two groups at this time, although no data or discussion of this point is made in the paper.

Figure 7 Seasonal differences in mortality (1,000/ year) among different age categories (Malawi, (Pelletier, Low et al. 1994)



Given the pervasiveness of seasonal changes in nutritional status, morbidity and mortality and in food, health and care causes of causes of malnutrition, and the likely impact this has on risk of dying, this is an area in need of urgent systematic review. From a policy perspective it has implications for identifying the time period when malnourished children suffer greatest mortality risk, and from a programming perspective it is crucially important for determining the seasonal determinants of malnutrition and mortality.

Season of measurements modified the relationship between wasting and mortality in the Sudan study by Fawzi et al., (1997). Relative mortality among those with severe acute malnutrition compared with those > -2 WHZ was highest when overall mortality and morbidity levels were lower (May/ June and July/August). The relative mortality increased during periods of lower mortality i.e. the difference in mortality rates between well-nourished and malnourished was less when rates were high. This also indicates that in areas where undernutrition, mortality and morbidity rates are high, children who are not classified as malnourished are likely to be at risk (Fawzi, Herrera et al. 1997). Targeting strategies therefore need to be broadened to include all groups during seasons associated with increased mortality, morbidity and undernutrition.

Table 15 - Relative mortality (RM) in relation to weight-for-height as modified by seasonality (from Fawzi et al., 1997)

Seasonality	No of deaths (Rate/ 1000 child mo)	Relative Mortality within anthropometric sub- groups		
		> -2 WHZ	-2 to -3 WHZ	< -3 WHZ
January- February	42 (0.54)	1.0	2.1	51.3
March-April	17 (0.37)	1.0	6.1	12.0
May-June	52 (0.64)	1.0	1.1	7.9
July-August	51 (0.74)	1.0	1.4	10.7
September- October	25 (0.32)	1.0	3.3	23.6
November- December	22 (0.25)	1.0	1.8	27.1

In summary, the prospective malnutrition and mortality studies have been crucially important in informing the health policy debates that most child deaths result from disease aggravated by malnutrition, caused by a combination of food, health and care. Significantly, Pelletier found that “in most studies 46-80% of all nutrition-related deaths were found to be in the mild-to-moderate category” (p. 2047s), and cautioned against policies and programs focusing primarily or exclusively on the severely malnourished, as these would miss the majority of nutrition related deaths.

In contrast, little attention has been paid to the role of food insecurity in malnutrition mortality relationships, or even in reviewing the underlying causes of anthropometric deficits, which may be related to food, health and care.

Given that the predictive power of a particular indicator is subject to modification by factors such as, morbidity, age and seasonality, has major implications for the IPC Phases, and reference levels. It is crucial that public health factors, disease incidence and expected seasonal patterns of disease and food insecurity are also taken into account in the interpretation of reference levels (or outcomes).

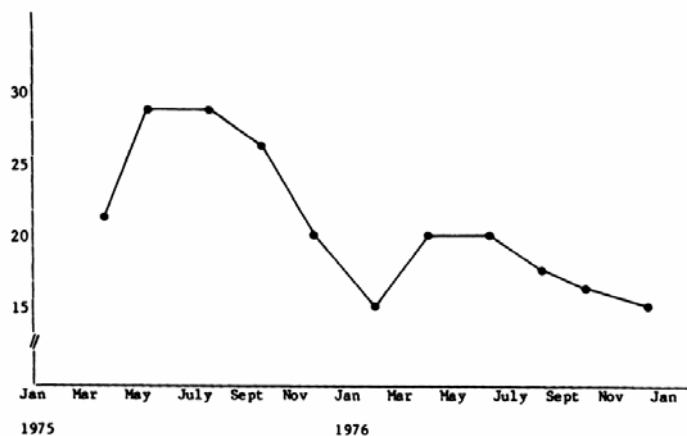
Food security, nutritional status and mortality

While much is known about the relative risks of dying from different infectious diseases associated with malnutrition, very little attention has been paid to the risk of dying associated with worsening food insecurity, and how that changes with increasing prevalence of acute malnutrition. The prospective studies do not provide many insights into how food insecurity might affect the risk of dying among the malnourished.

We found three studies that shed light on how food insecurity affects the risk of dying associated with anthropometric deficits. All three suggest that the relationship between low weight-for-height and mortality risk is stronger during periods of food insecurity and famine than at more stable times, meaning that for a given nutritional status mortality risk is higher during periods of food insecurity as compared to more stable food secure periods.

1. A study from 1975 to 1976 in Matlab, Bangladesh began at the tail end of the Bangladesh famine of 1974. At the time, this famine was considered as the worst in recent years, and was characterized by a period of mass starvation, and high mortality, following cereal price hikes in March 1974, which were exacerbated by massive flooding. From June to August 1975, the rate of underweight (< 60% WA) reached its highest levels of approximately 25 - 30% WFA, almost certainly a result of the famine. The figure below shows these elevated seasonal increases in 1975 as compared with 1976. Normally, November through February is the good season as the result of the harvest of the main crop. The authors reported that the mortality risks associated with a given level of nutritional status appeared greater during the famine than outside the famine (Bairagi, Chowdhury et al. 1985).

Figure 8 Prevalence of underweight children (< 60% WA) from 1975 to 1976 From: (Bairagi, Chowdhury et al. 1985)



2. Following the Ethiopian famine of the mid eighties, populations in southern Ethiopia living in relief shelters suffered an elevated risk of dying associated with a given nutritional status as compared to the same ethnic group living in traditional pastoralist and agro-pastoralist communities (Lindtjorn 1985).
3. Over the course of three years, a nutritional surveillance programme in Ethiopia reported a rapid decline in nutritional status with mortality increasing about threefold in the first and third year, but not in the second year (Table 16). The decline in nutritional status was associated with harvest failure and food insecurity (Lawrence, Yimer et al. 1994). Relative risks i.e. risk of dying among malnourished compared with well-nourished were slightly higher during the more food insecure year. The major difference

was in the baseline mortality. Much of the increase in mortality in these years resulted from a general increase in mortality risk, rather than from changes in WFL per se. The authors hypothesize that rapid declines in nutritional status could carry their own mortality risk, as many children experienced rapid declines in mortality risk in the first 6 mo of years 1 and 3. (Lawrence, Yimer et al. 1994).

Table 16 Food security, mean WH and mortality over three years in Wollayta, Ethiopia (Lawrence, Yimer et al. 1994)

Year	Harvest Failure	Mean WFL (%)	Mortality (1,000/60days)	Relative Risk
1988-89	Yes	92	9.1	4.9
1989-90	No	94	2.9	5.6
1990-91	Yes	90	8.9	4.6

In summary, these findings are few but they do corroborate the conclusions of the prospective studies that the risks of dying associated with acute malnutrition vary according to baseline levels of mortality. Most importantly, these studies suggest that as food insecurity may play a role in potentiating the risk of dying associated with wasting – as food insecurity worsens, and prevalence of wasting increases, the risk of dying increases for all children not just the malnourished. This maybe a result of a population wide decline in nutritional status i.e. a rapid fall in the mean rather than simply a result of the increased prevalence. Although more evidence is needed, this potentially has serious implications for the interpretation of prevalence estimates of acute malnutrition and the need to advocate for community wide coverage of programmes to address food insecurity.

Malnutrition and Mortality in Humanitarian Crises: A Population Based Perspective

In emergency contexts high death rates have long been associated with high prevalence's of acute malnutrition (low WH) (Toole and Waldman 1990). The use of prevalence of wasting as an index for mortality has been recommended for emergency affected populations where it is not practical to estimate mortality rates directly (Person-Karell 1989; Nieburg, Person-Karell et al. 1992; ACC/SCN 1994; Mason 2002).

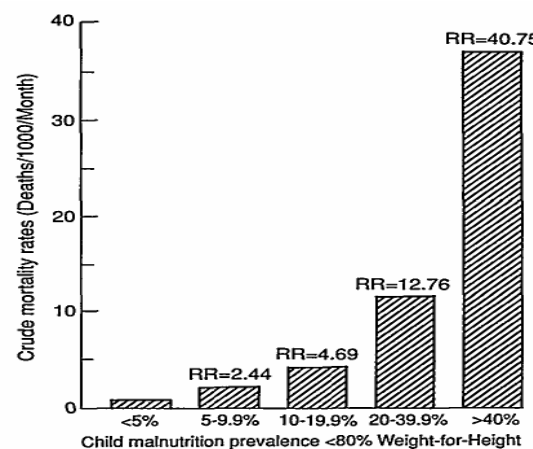
Data on acute malnutrition and crude mortality rates in 42 refugee camps in Africa and Asia was examined in the late eighties by Person-Karell. In many of the camp populations at that time measles and diarrheal disease were more common and were associated with highly elevated mortality rates and malnutrition prevalence²³ For example, the three camps

²³ For example, in five of the 42 refugee camp populations where measles was reported as a major cause of death, the mean prevalence was 21% < 80% WH and the mean CMR was 11/1000/ month. The five camps with diarrheal disease as a major cause of death had a mean prevalence of 30% < 80% WHZ and a mean CMR of 20/1000/month. The three camps reporting both measles and diarrhea as a major causes of death had a mean PEM prevalence of 43% and a mean CMR of 25/1000/ month (Person-Karell, 1989)

reporting both measles and diarrhoea as a major causes of death had a mean PEM prevalence of 43% and a mean CMR of 25/1000/ month. This indicates the importance of diarrheal disease and measles as significant risk factors for both mortality and acute malnutrition.

Nieburg et al, (1992) also reported on this data. They grouped survey populations into five categories according to their WH prevalence, and using weighted averages for mortality for each category they calculated the Relative Risk for each, using the category < 5% WH% as the comparison group (Figure 9). They suggested that “mortality rates in refugee camps could be roughly predicted - or assumed – based on their prevailing malnutrition rates” p 251.

Figure 9 – Malnutrition prevalence and mortality in 42 refugee camps



\RR = rate ratios – the rate in the prevalence category as compared with the category < 5% below 80% WH%.

In 1994, the former Refugee Nutrition Information System (RNIS) reviewed 298 surveys submitted between 1992 and 1994. The review found that “levels ranging up to 50% are common in many of the situations - Angola, Liberia, Rwanda/Burundi, Somalia, etc. - and in Southern Sudan a number of reports have been even higher”. For both of these reviews, there were likely to be issues with data quality and the methods used. Even so, it appears that prevalence levels of GAM were considerably higher than recent years. This period coincided with the Rwandan genocide and refugee crises, a complex emergency in Somalia, and also in southern Sudan.

Figure 10 - Wasting versus mortality in refugee and displaced populations in Africa (ACC/SCN 1994)

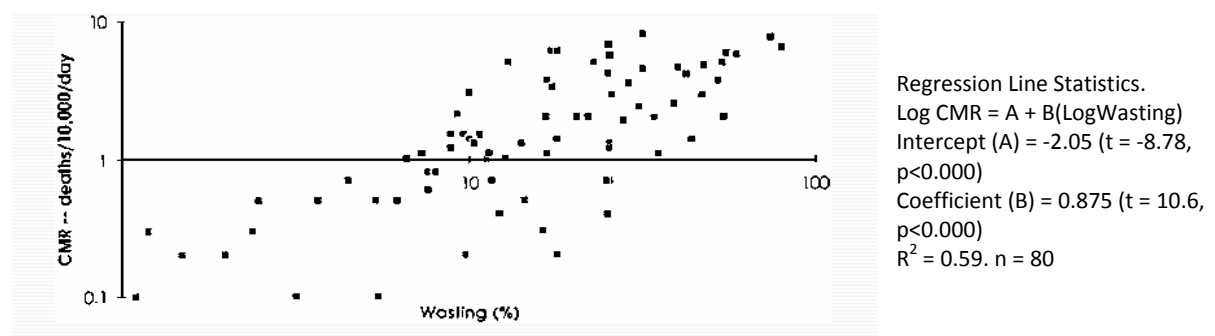
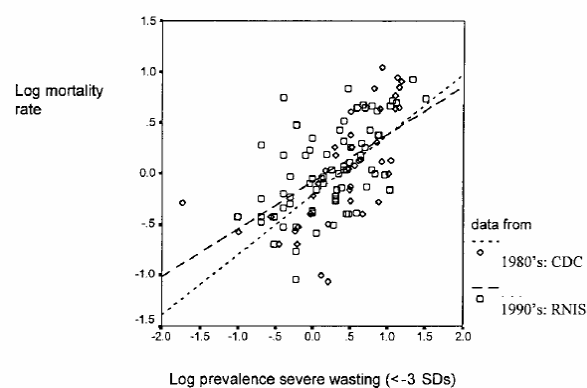


Figure 10 uses log scales for wasting and for CMR, and shows the reference level for CMR of 1/ 10,000/ day. The report notes that “few situations with wasting levels of less than 10% show a crisis level of mortality by this definition” (ACC/SCN 1994), which again is a justification for this reference level and concludes that ‘a good degree of prediction of mortality exceeding 1 or 2/10,000/day can be obtained using cut-offs of wasting of 10 to 20% (optimum around 15%)... .. and that situations with over 10% of wasting in young children should be taken as likely to be critical” (ACC/SCN 1994).

A significant association was found between the two indicators, after log scales were applied (R2 value= 0.59, n = 80). That strongly suggests a synergism underlying this relationship, as would be expected from the data on prospective studies.

Mason (2002) re-analysed the data from the surveys in eighties, and the survey data from the nineties, which included a large number of extreme nutritional crises (Figure 11). In support of the two earlier recommendations, the paper concludes that “the relationship is close enough to lead to a possible use of wasting prevalence’s to predict mortality rates” (Mason 2002).

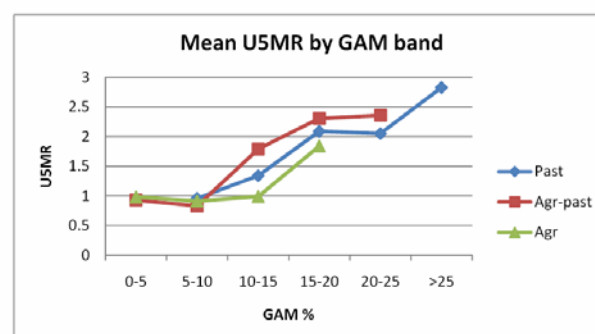
Figure 11 Relation between mortality and prevalence of severe wasting (< -3 WHZ)



A more recent compilation of epidemiological data on WHZ in the Greater Horn region during 2000-2006, drew from 900 small scale surveys, which were classified according to their predominant livelihood group; pastoral, agricultural, mixed, migrants. Wasting prevalence’s were found to be 17% for pastoral children overall, compared to 10% overall for agriculturalists. Above 10% GAM, mortality rates among pastoralists were found to increase to significantly more elevated levels than among agriculturalists for a given level of GAM (Figure 12).

Figure 12

Mean U5MRs (deaths/10,000/day) by band of GAM, by livelihood group.



In summary, the analysis of the prevalence data on wasting and crude mortality rates from nutritional emergencies during the eighties and nineties shows a significant log linear association between the two. This indicates that the relationship between malnutrition and mortality is exponential i.e. in the context of a worsening nutritional crisis malnutrition and mortality increase in exponents; in a curve that gradually becomes steeper, rather than increasing linearly in a straight line. This explains why a rapid deterioration is often evident in situations that are worsening.

Part 4 - Issues for Interpretation of Indicators in Relation to the Phases of the IPC

Validity of conclusions as important as reliability of data

Population based nutrition data must be both reliable and valid. Valid conclusions require that anthropometric indicators are interpreted in the context of their underlying causes, taking account of modifying factors including age, morbidity, seasonality, breastfeeding etc. While considerable attention has been paid to issues of data quality and reliability within the IPC, far less consideration has been given to issues of interpretation and needs of decision-makers. Generally this reflects a wider gap in the practical guidance given to support nutritional surveys and surveillance. In an earlier publication (Young and Jaspars 2006), we recommended that to properly understand and interpret nutritional data, it should be reviewed from the following inter-related perspectives:

1. Reference levels of anthropometric indicators
2. Trends over time and seasonality
3. Underlying causes
4. Implications for risk of mortality (malnutrition and mortality relationships)

Here we consider the implications of this review of different indicators, for each of these areas in relation to the interpretation of nutrition data within the different Phases of the IPC.

Reference levels

Fixed reference levels for determining the severity of acute malnutrition (usually low WH, not including oedema) have been in use since the early nineties, although the scales of reference levels vary. The reference levels recommended by the WHO Technical Committee in 1995 have been used extensively in survey reports and for advocacy. In more recent years, the use of relative reference levels based on local baselines and trends have been advocated. Despite their importance for decision-making the practical use and application of these reference levels has not been evaluated.

Practical application of reference levels

Nutrition surveillance as part of food security information or early warning systems dates back to the eighties, and since then have been applied in a range of contexts. Nutrition surveillance was considered useful for early warning, only if there were; rapid fluctuations in household food availability, resources and response capacities to prevent these, and a lack of timely information to trigger or target these interventions (Mason, Habicht et al. 1984). Table 17 reviews examples of recent local or national nutritional surveillance systems from Kenya, Somalia, Ethiopia, Sudan (Darfur), Malawi and Afghanistan, describing their purpose, indicators, reference levels and methods.

The purpose of these surveillance systems is to monitor trends, provide early warning and/or avert deterioration in the nutritional situation. Four important findings from this brief review are that:

1. The nutritional indicators used vary between information systems (nutrition indices and cut-off points).

2. Malnutrition reference levels vary, and do not always correspond to the WHO reference levels despite the general widespread acceptance²⁴.
3. Many systems use mean nutritional status rather than prevalence
4. A number of systems monitor nutritional status over time in sentinel sites.

Mortality is rarely monitored as part of nutrition surveillance systems or EWS, but more commonly as part of health information systems. These systems either obtain data from existing registers of births and deaths, surveillance systems may be specifically set up in emergency contexts, or a hoc surveys are done to estimate mortality. Some of the technical issues associated with mortality surveillance and surveys are discussed in Part 2.

Table 17 – Nutritional surveillance as part of food security information systems

<i>Country</i>	<i>Purpose</i>	<i>Indicator</i>	<i>Reference level</i>	<i>Method</i>
Ethiopia - 70's to 2002. (SC-UK) (Watson and Dolan 2006)	Trend analysis, EW, advocacy	Mean WFL (% of median).	Intervention recommended when mean < 90%.	Sentinel sites of 50 children in 12 randomly selected villages in (purposively?) selected survey areas. Also twice yearly cluster surveys?
Ethiopia 02-05 (Government) (Disaster Prevention and Preparedness Commission 2002)	EW, identify deterioration	Prevalence of low WFH; GAM and SAM, oedema	2-9% = typical 10-14% or 5-9% +AF = poor 15-19% or 10-14% +AF = serious GAM>20% or SAM>5% or 15-19%+AF = critical	Ad hoc nutrition surveys as needed when food security indicators show a deterioration
Kenya (Government)(Arid Lands Resource Management Project?; Oxfam GB?)	Trends, identify deterioration	Prevalence of MUAC <13.5 cm	Comparison with 5 year average (relative reference level)	Sentinel sites. 10-22 per district in "typical" communities.
Somalia (FAO)	Trends, identify nutrition responses	Prevalence of low WFH; GAM and SAM MUAC <12.5 cm	Reference levels recommended by WHO, but for WH >20% is critical. Also monitoring of trends.	Sentinel sites by livelihood zone (?). Ad hoc surveys.
Sudan- Darfur (UNICEF) (UNICEF 2006; Holland	Monitor trends, avert deterioration	Mean WHZ	Trends	Sentinel sites selected on basis of vulnerability (to

²⁴ In both Somalia and Ethiopia, information systems use a reference level higher than the 15% to indicate a critical situation. In Somalia, the higher level (> 20% GAM) for a critical situation takes account of the frequency with which these higher levels occur in practice. In Ethiopia, the new system uses a framework very similar to the feeding programme decision making frameworks of the 70's and 80's, but in this case uses levels of prevalence of malnutrition with "aggravating factors" to determine stages of alert (typical, poor, serious, critical). The aggravating factors are similar to those previously used in feeding programme decision making frameworks.

2007)				<i>what?</i>) as well as geographical areas and livelihood zones
Malawi (ACF/Government) (Heide 2008)	Trends, EW	Prevalence of low WFH by age group, low WFA, low HFA, MUAC <12 and <11.5 cm	NA	Sentinel sites randomly selected from clinics and health posts. Geographic diversity. 5 sites per district.
Afghanistan (Government?) (Johncheck and Holland 2007)	Trends for EW	Prevalence of low WFH, or <13.5 cm	>10% = serious	Twice yearly emergency needs assessments in sentinel sites?

Issues in the use of fixed reference levels

The use of reference levels raises different issues for the lower and higher end of the IPC scale. At the lower end of the scale, discussion on indicators has centred around reference levels for low HA (stunting) and low WA (underweight), as prevalence of low WH is unable to distinguish between Phase 1 and 2. The lack of reference levels for IMR and U5MR has also been an issue for these Phases, as CMR is rarely available.

At the higher end of the IPC scale (3 to 5), discussion has centred on the general applicability of fixed reference levels to all populations. This debate centres around two issues, and two related bodies of research:

1. Whether somewhat higher prevalence's of acute malnutrition in some populations are 'normal'? There has been extensive re-analysis of cross-sectional population survey data from the Horn of Africa, which compared the prevalence of wasting and associated mortality rates among children in different areas and livelihood groups (Chotard, Mason et al. 2006; Mason, Cercone et al. 2008; Mason, Chotard et al. 2008). Agro-pastoralists and pastoralists were found to have higher prevalence of low WH compared with other groups, and the authors of these studies are proposing differential reference levels – with higher levels for pastoralist groups.
2. Whether WH prevalence estimates of low WH are distorted by differences in body shape. Studies comparing prevalence of acute malnutrition according to low WH and MUAC in Somalia and Ethiopia showed higher levels of wasting among pastoralists as compared with agrarian groups according to WH, but similar prevalence's according to MUAC (<12.5 cm). These differences were attributed to the influence of body shape on WH prevalence (Myatt 2005; Myatt, Duffield et al. 2009).

These two issues have serious implications – obviously for reference levels but also for the well-being of pastoralist populations, and could unwittingly feed into and reinforce the ongoing discrimination against pastoralists. Almost universally government policies favour sedentarized groups over mobile groups, with the result that provision of basic services of any description to pastoralists is inferior, and on all human development indicators they come out lower. To 'normalize' the effects of this harsh reality is a failure to recognize their human rights. The use of different reference levels for different populations was rejected by the workshop participants.

While this debate specifically concern pastoralists versus agriculturalists, the same arguments apply more broadly as the mortality rates across the range of nutritional status vary according to context (as shown in the prospective studies of malnutrition and the reviews of population based data – Part 3).

‘Normalizing’ high prevalence of GAM

Mason et al. compiled epidemiological data on GAM and mortality in the Greater Horn region (Eritrea, Ethiopia, Kenya, Somalia, S Sudan, and Uganda) for the period 2000-2006, drawn from 900 nutrition surveys of children less than 110cm. Surveys were classified according to their predominant livelihood group; pastoral, agricultural, mixed, migrants. On average, wasting prevalence’s for pastoral children were 17% (< -2 WHZ) compared to 10% for agriculturalists or mixed livelihoods. In bad years, the prevalence of acute malnutrition often rose to 25% or higher, but for agriculturalists rarely rose above 15%. Mason et al., conclude that fixed or invariant reference levels for low WH should be ‘avoided’ and that populations should be judged by population-specific criteria, for example, “roughly, exceeding 25% wasting in pastoralists and 15% in agriculturalists (taking account of timing) are warnings of unusual malnutrition levels” (Mason, Chotard et al. 2008). The authors make two important additional observations about this data;

- Prevalence of low HA also varies between these populations, with pastoralists experiencing less stunting.
- Patterns of growth from birth also differ significantly related to different diets. For example, Ugandan babies were not thin at 6-12 months, but fell rapidly below standards in terms of linear growth and by 12-24 months, 50% were stunted. A Somali child is thinner and taller by 12-24 months, with half the stunting prevalence and 15% “thinness” (Chotard et al, 2006).

The effect of body shape on prevalence of low WH and low AC

Body shape influences prevalence estimates of low WH; children with long limbs (lower SSR) tend to be taller and have a lower WH than children with higher SSR values. Studies in Somalia and Ethiopia, found that older pastoralist children (85 to 110cm) tended to have longer limbs (lower SSRs), as compared with agrarian children, which generated higher prevalence estimates of low WH among pastoralists as compared with agrarian children. They compared prevalence estimates of low WH and low AC among children from 85cm to 110 cm, from 6 surveys in Ethiopia. Low WH and low AC produced similar estimates among agrarian groups but among pastoralists the WH estimate was significantly higher than the AC. For both groups, those children who were below the WH cut-off also tended to have a lower SSR – thus supporting the assumption that low WH overestimates acute malnutrition compared with low AC in older children (85cm to 110cm) (Myatt, Duffield et al. 2009). This is an important finding and as the authors propose has serious implications for case-diagnosis of severe malnutrition for treatment. In relation to reference levels a number of clarifications are needed:

- The difference in SSR between mean agrarian and pastoral child populations is not large, 0.5698 and 0.5585 respectively, as compared to adult populations (0.48: in pastoral groups in East Africa; and a reference of 0.52 based on a European population). Both groups were considerably lower than the reference.
- The analysis in Ethiopia was restricted to older children, among whom differences in SSR would be expected to be larger than younger children i.e. if data were pooled for all ages, the effect of SSR on prevalence would be less. The earlier Somalia survey showed that the difference was particularly in older children but that in younger children the prevalence was similar according to MUAC and WFH (Myatt 2005).
- ‘Body shape’ acts as an “effect modifier” on prevalence estimates of WH, similar to ‘age’ on prevalence estimates of low AC (see Part 3). While SSR is a predictor of WH, age and

height are significant predictors of MUAC; younger children have lower AC measurements as compared to older children. The authors did not adjust WH for body shape among for pastoralists, nor did they adjust the AC measurements for age. It is therefore not possible from this paper to compare prevalence rates among these two groups adjusted for these effect modifiers.

- High prevalence of acute malnutrition using WH is not consistently found in pastoral populations, nor is differences in prevalence of acute malnutrition according to MUAC and WH. A recent review of nutritional survey data from Somalia between 2001 and 2007, shows that over this period pastoral populations had a lower median wasting prevalence than riverine, agro pastoral or IDP populations (FSAU 2008). Also in contrast to Myatt's findings in Somalia, early studies comparing WH and MUAC as indicators of malnutrition show a similar difference in prevalence of malnutrition in pastoral and agrarian populations (Ross, Taylor et al. 1990)²⁵. As the cut-off points used in the late 80's were different from now, a rough recalculation of the data shows that the differences in the "nomadic" group were smaller than would be expected from Myatt's studies in Ethiopia²⁶.

	GAM by WH	GAM by MUAC
S. Sedentary	11.9%	7.6%
N. Sedentary	24.7%	15.5%
Nomadic	15.0%	11.5%

Possible explanations for this include that the sedentary and nomadic communities are closely related and share in common aspects of each others livelihoods, including their diet. Another possible reason is that the causes of malnutrition are largely related to food insecurity (in both groups) resulting in higher prevalence's of malnutrition in older children.

From this analysis of body shape, and differences between populations, three outstanding questions remain:

- *What are the functional outcomes associated with low WH among older 'pastoralist children', and among older children generally?* Unless this is answered properly we cannot validate the use of higher reference groups for this group.
- *What were the prevailing underlying causes of malnutrition, how did patterns of morbidity, food insecurity and care differ for these groups?* Given the very particular livelihood and distinctive way of life of pastoralists it seems reasonable to propose that the higher prevalence is linked to food insecurity, rather than disease, and that access to milk and animal products protects linear growth over the long-term.
- *What are the long-term trends in nutritional status?* Many of these studies have been affected by repeated disasters over the past one or two decades (for example Ethiopia, Kenya) and others have in addition experienced conflict (Somalia, Uganda). Somalia in particular has been affected by the most brutal civil conflict and crisis since 1992. In such contexts, it is essential to look beyond short-term trends of 5 years or less. For example, when reviewing surveys done in the pre-conflict era, and non-drought years in

²⁵ May-June 1985:

	<70%%	<12 cm	70-80%	> 12-13.5	
Southern Sedentary		1.2	3%	10.7%	15.7%
Northern Sedentary		3.1%	6.9%	21.6%	31.3%
Nomadic	1.6%	3%	13.4%	24.5%	

²⁶ Myatt used a factor of 2.46 to change the MUAC prevalence from using a cut-off of 13.5 to 12.5 cm. This was based on data from his database of 450,000 kids.

Somalia, the prevalence of acute malnutrition dropped as low as 4% in rural areas (Cambrezy, 1997), so the current situation could well be indicative of a severe and protracted food crisis (see below). This issue is considered in the next section.

Temporal and severity dimensions of food insecurity

The examples from the Horn of Africa show that for populations who suffer protracted crisis or repeated emergencies levels of malnutrition considered critical according to the WHO classification occur on a regular basis and therefore could be considered “normal”.

Two famine classification systems developed in the early 2000’s (see Part 2), both include a Phase for those situations where elevated prevalence of acute malnutrition is maintained for long periods of time i.e. different from those situations where malnutrition suddenly deteriorates. Howe and Devereux suggest such situations should be called “chronic famine” for populations which are persistently between food crisis and famine (for e.g. 3 years), and a “chronic food crisis” as a population which is persistently between food insecurity and food crisis (Howe and Devereux 2004). Darcy and Hoffman (2003) would call a similar situation an “extended food crisis”(Darcy and Hoffman 2003).

The issue of “chronic food insecurity” as a Phase within the IPC classification system comes up numerous times in discussions and reviews of the IPC. The key issue being that the earlier IPC scale “confounds the duration and severity of food insecurity in one scale” (Lawrence and Maunder, 2007) i.e. the Phase between “food secure” and “acute food and livelihoods crisis” conflates the severity and duration of food insecurity. There is an implicit and rather confusing assumption that in Phase 2, “chronic” equates to “mild” food insecurity. Devereux has highlighted the importance of distinguishing between the temporal and severity dimensions of food insecurity as shown in Figure 13 (Devereux 2006).

Figure 13 Temporal and severity dimensions of food insecurity combined (Devereux 2006)

		Severity of food insecurity	
Duration of food insecurity		Moderate	Severe
	Chronic	Moderate chronic food insecurity (<i>chronic hunger</i>)	Severe chronic food insecurity (<i>high infant mortality rate and crude mortality rate</i>)
	Transitory	Moderate transitory food insecurity (<i>e.g. seasonality</i>)	Severe transitory food insecurity (<i>emergencies</i>)

This model clarifies that chronic and transitory refer to the duration of food insecurity, not the severity of food insecurity. This still does not quite capture situations described above in Somalia, where regularly high levels of acute malnutrition are found. Devereux associates “severe chronic food insecurity”, with high IMR and CMR, and not regularly high levels of acute malnutrition. To address this, Lawrence and Maunder recommend an analysis of duration in addition to an analysis of the current situation and of trends (Lawrence and Maunder 2007). This was proposed at the IPC technical forum in Rome in 2007, but has not yet been adopted.

More recently Phase 2 “Chronically Food Insecure” has been renamed “Moderately/Borderline Food Insecure”, in order to remove the reference to the temporal dimension

implied by chronic. While this corrects the nomenclature of phases, it does not address the lack of temporal dimension in the analysis of phases. There is an urgent need for the IPC to include an analysis of the time spent in a particular phase. Another possibility is to work on a dedicated “chronic” IPC scale, with possibly a set of different indicators and explicit time- and trend analysis. Including duration within the IPC is important not only for malnutrition, but also for mortality. Absolute excess mortality increases with duration of crisis. For example, a protracted crisis, even if associated with somewhat lower mortality rates, might be associated with higher excess mortality than some short but more severe acute crises.

There is also a need for further analysis and confirmation of situations where levels of wasting appear elevated over long periods of time. Nutritional surveillance as part of food security information systems is usually done through sentinel sites or ad hoc cluster surveys to confirm severity of food insecurity (see Table X above). Sentinel sites are selected either to be representative of populations vulnerable to food insecurity or malnutrition of different geographical areas or livelihood zones. Ad hoc surveys to confirm deterioration in food security indicators are by their nature done in areas or population groups which are worst affected. It is likely that both approaches tend to capture the worst scenarios, and thus neither can be used to extrapolate information for the emergency affected population overall. The ad hoc surveys cannot strictly be used to monitor trends.

Relative reference levels and the issue of baselines

The Sphere Handbook recommends comparison of current levels of malnutrition with pre-emergency levels and other factors; “determining whether levels of malnutrition are acceptable requires an analysis of the situation in light of the reference population, morbidity and mortality rates, seasonal fluctuations, pre-emergency levels of malnutrition and the underlying causes of malnutrition”.

Comparison with pre-emergency levels requires a context specific baseline, which can be difficult to determine. The case of chronic or extended food crisis is one issue; should malnutrition levels be compared with a baseline about 5 years ago, in which case nutritional status might be considered “normal” for the population, or 20 years ago, in which case it would be considered a humanitarian crisis or critical nutritional situation.

The development of baselines is also problematic because of the challenges associated with determining the characteristics of a baseline year; should the baseline reflect an “average” year, a normal year, or a good year? In the Kenya ALRMP, an early warning system which incorporates nutritional surveillance, a decision was made to use an average year based on an analysis of the past five years. Taking a good year was considered problematic as it could cause alarm earlier than it should, whereas taking a bad year was risky as warnings were likely to be late.

In Ethiopia, SC-UK has developed acute malnutrition (WFH) thresholds for each season and District for this purpose (Duffield and Myatt, 2004). They used the following definition for a baseline year: *“The baseline year is selected as the year with the lowest annual prevalence of malnutrition among the years where the population received below average amounts of relief.”*, thus effectively deciding on a good year over the time period investigated. Historically, however, this was not necessarily a good year, as the analysis of acute malnutrition prevalence in other parts of the Horn of Africa also shows. In the development of baselines for Ethiopia, the reference years selected was either 1996 or 1997.

Establishing baselines is also difficult for mortality. The calculation of excess mortality requires a baseline rate of mortality that would have occurred in the absence of a crisis. Since this is immeasurable, pre-emergency levels are usually taken, or alternatively, the mortality rate in a neighbouring “control” population with similar demographic and

epidemiological characteristics but which is not experiencing a crisis. However, no two populations are ever truly alike and pre-emergency data often cannot be disaggregated to lower administrative levels or out of date (Checchi and Roberts 2008).

Comparison with baseline years may be more appropriate for those indicators for which no reference value is available (IMR and U5MR) and/or at the non-emergency scale of the IPC. For example, the prevalence of low WH is unable to distinguish between Phase 1 and 2. In the non-emergency phases of the IPC (1 – 2) it is preferable to monitor or track local trends in IMR and U5MR, in order to detect changes. It is difficult to say what change might be significant (i.e. a doubling) as at this level of food insecurity a substantive change in mortality would not necessarily be expected in contrast to later phases.

Similarly it is not clear how HA or WA might be expected to change in relation to moderate changes in food insecurity. It would be helpful to monitor local trends and use this as background vulnerability (rather than key reference outcomes – unless a clear association can be shown between food insecurity and stunting).

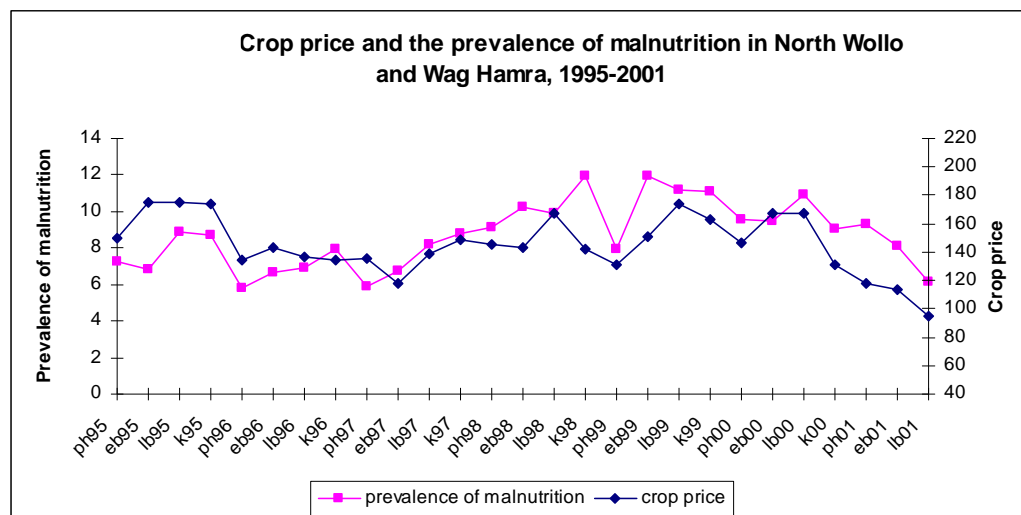
Monitoring trends and seasonality

Seasonal changes and trends in food security

In many populations, nutritional status and mortality shows marked changes according to season (see Part 3). These seasonal changes have been found at a population as well as individual level. A recent study in the Horn of Africa, showed seasonal changes of between 2-4% compared to the best season (Chotard, Mason et al. 2006). In Ethiopia, when looking at changes in particular districts, baseline levels could increase by as much as four fold from one season to another (Duffield and Myatt 2004). Similarly, when smaller homogeneous population groups are monitored, changes of as much as 20 percentage points can be seen over a period of 3 months (Young and Jaspars 1995). It is important therefore to interpret a prevalence of malnutrition in relation to expected seasonal patterns.

Seasonal changes can be explained as a result of seasonal changes in underlying causes. Several studies have shown that changes in WFH closely mirror seasonal changes in food security indicators. In North Darfur, changes in prevalence of low WFH (<-2 Z scores) were closely related to grain (millet) prices both seasonally and during a drought year when millet prices became much higher than the normal seasonal variations (Young and Jaspars 1995). Devereux showed the same in Northern Ghana in 1988/89, where rates of malnutrition followed the same seasonal pattern as millet prices (Devereux, Vaitla et al. 2008). In Ethiopia mean WH% began to decrease when food security was threatened and continued to decrease until the harvest was gathered, showing that WH can in fact be an early indicator of food insecurity (Kelly 1992). Later studies in Ethiopia, found that the relationship between food security indicators and nutritional status varies between different locations/population groups (Duffield and Myatt 2004). The graph below shows the close relationship between the prevalence of acute malnutrition and crop price in one area, Wag Hamra. The prevalence of malnutrition rises when crop price rises, particularly in 1998 and 1999 when rains were poor. However, not all other areas showed such a clear relationship, indicating perhaps that the relationship between malnutrition and household food security depends on the characteristics of the livelihoods systems affected and also the homogeneity of the livelihoods being monitored.

Figure 14



Source: (Duffield and Myatt 2004)

Monitoring trends: changing age profile of wasting with increasing prevalence

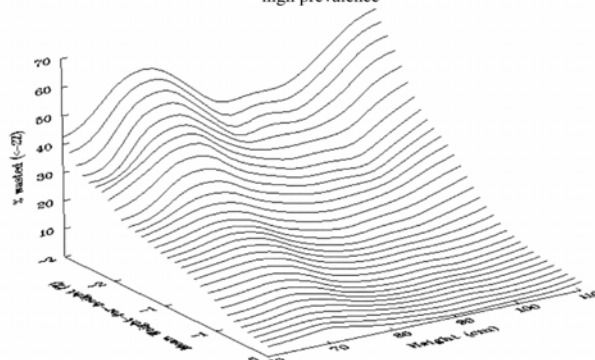
As the prevalence of low WH increases, there is a greater relative increase in wasting among older children than younger children, which implies a different causality. Low WH in older children is more likely to be a result of increasing food insecurity, as an increase in disease levels would effect young children more than older children.

It is important therefore for IPC to consider the prevalence of low WH for younger and older children.

The fact that MUAC preferentially selects younger children and that prevalence of low WH increases in older children when the overall prevalence of wasting increases, suggests that MUAC may be a better indicator of mortality, but WH a better indicator of food insecurity.

Figure 15 – Wasting by height group as the population nutritional status deteriorates

Wasting by height group as the population nutritional state deteriorates:
All groups are affected – as the situation becomes desperate older children have a high prevalence



This graph is taken from a presentation by Michael Golden – available at http://www.smartindicators.org/workshop/SMART_Expert_panel_meeting/SMART_Expert_Panel_Meeting

Further research is needed to better understand the risks associated with low WH (in terms of mortality) and on WH as an indicator of food insecurity particularly among older children

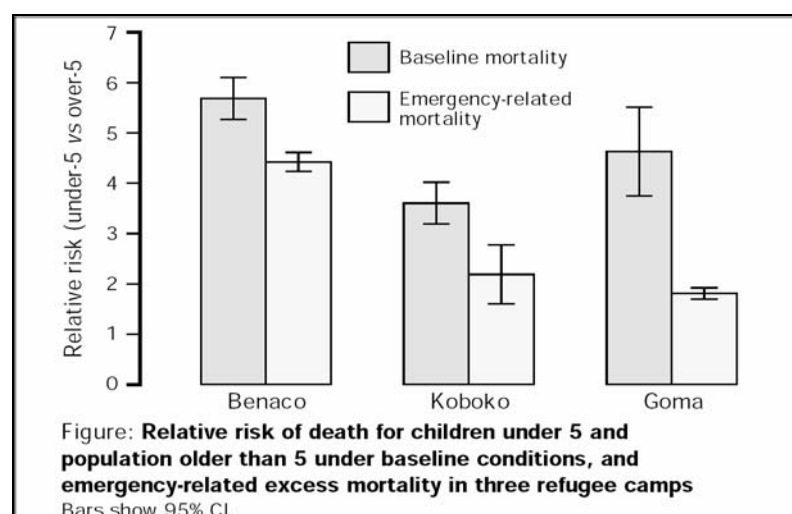
(> 85 cm or 2 years). There are also few prospective studies where the relationship between low WH and short term mortality (6-12 months) has been investigated. At the population level, the prevalence of malnutrition in emergencies appears closely related to mortality, but the analyses discussed above also show that there are situations with high levels of acute malnutrition and low mortality and vice versa.

The fact that older children show a greater relative increase in low WH when the overall prevalence of malnutrition increases, suggests that food insecurity rather than disease is the cause. It also means that acute malnutrition in older children could potentially be a good indicator of food insecurity. It is important therefore for IPC to look at the prevalence of low WH for younger and older children.

Monitoring trends: age and excess mortality

Similar trends are seen for mortality; in emergencies it is sometimes the older children that show a greater proportional increase in mortality during emergencies than younger children (some studies say this for children under 1, others for children under 5). This has been observed in camp and non-camp emergency contexts. In Darfur in 1984-85, mortality in infants was close to normal, and most of the excess mortality was found in children aged 1-4 (de Waal 1989). In refugee camps in Tanzania, Uganda and Zaire in the early 90's, excess mortality was often higher in over 5's than under 5's and the relative risk of dying for under five year olds compared to over fives varied over time in the same context and between different contexts (Davis 1996). Figure 16 below shows that in all camps studied the relative risk of dying for under five year olds versus over fives was lower in emergency contexts (i.e. mortality in over fives has increased proportionately more. Earlier studies in camps in Somalia, Thailand and Sudan had similar findings (Toole and Waldman 1988; Toole and Waldman 1990). The relationship between age and excess mortality in these studies is described in more detail in Annex 8

Figure 16 – The relative risk of dying for under five year olds versus over fives in camp populations in Tanzania and DRC



If excess mortality is higher in older children, this has major implications both for monitoring and for emergency response. If over fives are progressively more susceptible to emergency risk this has implications for targeting and resource allocation. Targeting under fives would be misguided and most excess mortality will be unaffected (Davis 1996). IPC should

therefore also consider reporting of excess mortality by age group particularly in the highest phases (4-5).

Monitoring trends – why mean anthropometric status may be more useful than prevalence

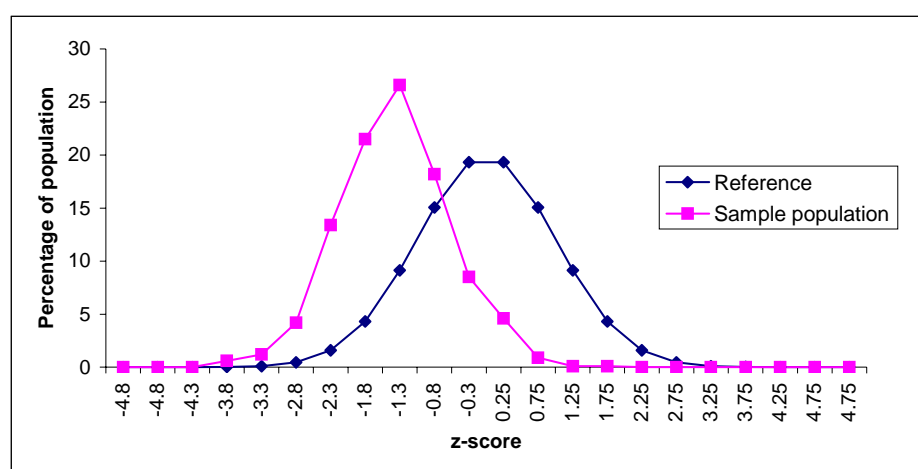
Prevalence of low anthropometric status is most useful in identifying the malnourished and those with increased risk of dying and other undesirable functional outcomes associated with malnutrition. At best these cut-off's "represent a purely statistical separation of malnourished from normal" (WHO 1986). "At worst, they ignore the growth failure that is found among children whose nutritional status is above the cut-off in a population where there is a high prevalence of either wasting or stunting, and the entire height or weight distribution has shifted downwards" (p181 WHO , 1995). The mean and associated standard deviation is statistically more powerful than prevalence rates because they are based on all the population data, not just the small number below the cut-off. A small change in the population as a whole is easier to detect statistically, and may be more revealing than a change in the prevalence of the malnourished. It also allows direct comparisons of different populations (Waterlow 1992).

There are a number of examples where "during periods of starvation or infectious disease, the increased prevalence of low WFH is associated with a downward shift of the weight for height distribution" (WHO 1995). Young and Jaspars (1995) showed that in Darfur during a period of food insecurity, the entire frequency distribution for vulnerable communities shifted to the left, and that the distribution shifted back to the right in a relatively short time as food security improved. Golden and Grellety similarly found that during periods of famine or food insecurity all children lost weight and the entire distribution curve shifted (based on analysis of data from 228 nutritional surveys). They reported that:

- The spread of a survey does not change when a population becomes more malnourished
- The population remains normally distributed as wasting increases
- The SD does not change as the population becomes more malnourished

So on average, exactly the same absolute quantity of weight is lost by a child in the upper, as in the lower, portions of the distribution (Golden and Grellety n.d.).

Figure 17- Example of a frequency distribution of WHZ



This is evidence that factors which cause changes in nutritional status tend to affect all children in the population, not just those at the lower end of the distribution. It also means that "changes in WH can be an early indicator of changes in food security and is a sensitive indicator of stress within a population" (Golden presentation for SMART).

The explanations for this uniform change are that:

- there are altruistic or other cohesive social networks whereby members of the community assist each other in times of stress so as to maintain their relative positions as the whole population deteriorates (Golden and Grellety n.d.),
- similar coping strategies are adopted by different wealth groups, such as reduction in food intake, or that the nature of some people's wealth is not necessarily easily accessible (Jaspars and Young 1995).
- That socio-economic status and food insecurity are relatively homogenous within these quite small survey populations i.e. they are all relatively poor, food insecure etc, and therefore a deterioration in food insecurity has a community wide effect.

This is especially relevant to the IPC, where concern is with the food security of the population, and how this affects all children in the population, not just those near the lower end of the distribution.

A brief review of local or national nutritional surveillance systems as part of food security information systems also shows that in practice the most common purpose is to monitor trends, provide early warning and/or avert deterioration in the nutritional situation (See table 17). In this case, monitoring mean nutritional status would be preferable to monitoring prevalence. If the nutritional status of the whole population changes in response to food insecurity, this also has implications for targeting, as population based food security interventions aim to improve the nutrition of all children in the "worst off" communities, rather than targeting only those below the cut-off.

The importance of community wide interventions in response to changes in mean nutritional status related to food insecurity is clearly evident, but not current practice. The nutrition sector is pre-occupied with the use of nutritional indicators for case detection for selective feeding programmes e.g. (Myatt, Khara et al. 2006). Similarly, the response in nutritional surveillance programmes is increasingly focussed on the treatment of the severely and moderately malnourished. For example, the Somalia nutrition cluster has detailed scenario planning on the basis of not only prevalence of acute malnutrition, but also insecurity, population density and partner capacity. The response options appear to be limited to different types of selective (and blanket) feeding programmes, and the use of different nutritional products (Nutrition Cluster 2008). Similarly, a recent review of WFP emergency nutrition and food security assessments also found that out of 23 reports, 21 recommended some form of food aid (Frize 2007).

WH has generally proved to be a better indicator for monitoring trends than MUAC. For example, the Kenya Arid Lands Drought Monitoring System found that MUAC was not a very sensitive nutritional indicator and showed some lag when monitoring prevalence <13.5 cm (Oxfam GB?). This was also shown by a study looking into measurement error when measuring MUAC; i.e. significant change could only be detected for 6-17 mm because of measurement error (Ulijaszek and Kerr 1999). WFH was the most commonly used indicator in the local surveillance systems reviewed for this project, with MUAC being included as an indicator in some but not all systems although the cut-offs varied between surveillance systems.

A further reason why MUAC is not recommended for monitoring trends in food security is because if prevalence below a fixed cut-off is used, the age confounding effects of MUAC will mask changes in nutritional status among older children (i.e. older children tend to have higher AC measurements than younger children, and so a fixed AC cut-off will be less sensitive among older children). Means cannot be used, as they will reflect the age

composition of the sample. Monitoring trends in WH by age group (prevalence and mean), and the ratio between them, is also likely to be a sensitive indicator of change over time. As explained earlier as levels of malnutrition increase so does the relative proportion of older children who are malnourished.

Earlier sections in this report have shown that MUAC is a good indicator of risk of dying and therefore for case detection for feeding programmes or individuals in need of special nutrition products. If the aim of nutritional surveillance is to identify the need for feeding programmes and case detection of malnourished children, MUAC might be the best indicator. However, if the aim is to monitor food insecurity, then WFH might be a better indicator. The appropriateness of an indicator therefore depends on the purpose for which it is used.

Causality

Food security is one of three underlying causes of malnutrition, and this is one pathway through which food insecurity leads to excess mortality in situations of humanitarian emergency and famine i.e. food insecurity is an underlying cause of malnutrition, and extreme food insecurity is associated with hunger, starvation and ultimately increased risk of dying. Despite the conceptual link between malnutrition and food insecurity, evidence of the statistical association between nutritional status of children and household food insecurity is limited. Recent efforts to improve measures of food security, and develop food security scales (Coates, Webb et al. 2003), have made it possible to examine this relationship. A recent study in Bangladesh found that among children from birth to 24 months household food security was significantly ($P < 0.001$) associated with higher gain in all anthropometric indices (WAZ, LAZ, WLZ and BMIZ) (Saha, Frongillo et al. 2009). The four categories of household food security from extremely food insecure to food secure were associated with a gradient in stunting and underweight among children 1 to 24 months. Although for wasting, differences among the food security categories were statistically significant during the second year of life.

While considerable efforts have been made to fully integrate nutrition and food security within the IPC, by including both types of indicators, it is not clear conceptually how the relationship between food security and malnutrition might evolve as food insecurity worsens. This impedes interpretation of malnutrition and mortality indicators in the different IPC Phases.

Conceptual clarification is needed within all phases of the IPC framework, as the relationship between food, health and care varies between more stable developmental contexts, and humanitarian catastrophes. The more specific aim here is to illustrate how the underlying causes change and interact as food insecurity evolves and deepens.

Malnutrition causal pathways are complex. Most child deaths result from disease made worse or aggravated by malnutrition, which in turn could be a result of food, health or care factors or worst case scenario a combination of all three (Phase 5).

Disease remains the proximal cause of death, which is exacerbated by malnutrition, but the way this evolves, who it affects and the role of food insecurity changes in different contexts. Most 'excess' deaths in emergencies result directly from disease which is made worse by *increased exposure* to infectious disease, combined with *increased susceptibility* to disease as a result of malnutrition. The two factors, exposure and susceptibility work in tandem; if only one set of factors is present the resulting mortality will be significantly reduced. Increased exposure to infectious disease depends on disease transmission which is

influenced by living conditions, crowding, access to health care, clean water and sanitation (this may be summarized as the 'health environment' or as "poor health" as in Figure 18).

Susceptibility to disease associated with malnutrition is influenced by all three groups of underlying causes - food insecurity, the health environment, and inadequate care. The prevailing social, economic and political conditions during food crises are the most important determinants of food security, but these same conditions are also influencing the health environment (access to clean water, sanitation, exposure to other vectors of disease and access to health care), and the care clusters of underlying causes of malnutrition.

The IPC clearly recognizes the importance of both disease and inadequate food intake as immediate causes of malnutrition (IPC Global Partners 2008). At a conceptual level the relationship *between* each of the three groups of underlying causes (food, health and care), malnutrition and excess mortality has not been clarified, and this is crucial for valid analysis, interpretation and ultimately for determining the most appropriate policy and programmatic responses in the different phases. A proposed conceptual framework for the different IPC Phases is given in Figure 18 below:

Phase 1 -2 Generally Food Secure / Moderately Borderline Food Insecure

These two phases are the less severe phases of the IPC, and the UNICEF conceptual framework of underlying causes generally applies, with each of three underlying causes contributing indirectly to malnutrition. For the majority of the population food insecurity will not be adversely affecting either their "caring and household behaviours", nor the "public health environment and access to health services". This is best represented by the UNICEF framework whereby food insecurity, health and care are on a par with each other, and each is necessary, but on their own insufficient, for addressing malnutrition (Figure 18a).

Phase 3 Acute and Livelihood Crisis

This is the first of the more severe food insecure phases, with indicators showing acute food insecurity. The relative importance of food insecurity is heightened and as a result food insecurity influences the social and care environment (care-giving behaviours, family and wider social networks), and also access to health care and the health environment. For example, as HH must prioritize their food security, coping strategies place severe constraints on care-giving behaviours - breastfeeding is curtailed, infants and young children are left with secondary carers or sent to stay with relatives, HH members migrate in search of work reducing family support, there is less time/ resources available to prepare adequate complementary foods, for appropriate childcare etc. Similarly, health seeking and hygiene behaviours are restricted because of a loss of income as a result of food insecurity (inability to pay for services), and less time on health/hygiene behaviours as more is needed for food security/ coping strategies. As an underlying cause of malnutrition food insecurity is no longer on a par with care and health, rather it is a driving force increasingly influencing these other two underlying causes (Figure 18b). As the food insecurity worsens, malnutrition of children is no longer an issue of prevention linked with disease, but is a population wide phenomenon linked to food insecurity. The impact on mortality depends on what the usual background levels of mortality and morbidity are for the population group in question. It might be that acute malnutrition as a result of food insecurity at this level is not associated with the same functional consequences of malnutrition caused by disease (this might explain the higher prevalence's of acute malnutrition corresponding to the CMR threshold of 2 among pastoralists – see discussion below).

Phase 4 Humanitarian Emergency is characterized by "a severe lack of food access with excess mortality, very high and increasing malnutrition, and irreversible asset stripping" (p19 IPC Global Partners, 2008). The overriding characteristics of a humanitarian emergency are

the severe social disruption, including increasing migration and displacement, civil unrest and general insecurity, and even conflict. That it is classified as a humanitarian emergency often means that it exceeds the capacities of local institutions to cope, and requires external emergency intervention. Food security is heavily influenced by the severe social changes associated with the above – particularly where forced migration (or conversely restricted mobility and access as a result of conflict), effect the integrity of the household and their food security (Figure c). At this stage, both acute malnutrition and mortality are likely to be high.

Phase 5 Famine/ Humanitarian Catastrophe is one stage beyond humanitarian emergency, and represents “extreme social upheaval with complete lack of food access/ and or other basic needs where mass starvation, death and displacement are evident” (p19 IPC Global Partners, 2008). At this stage ALL underlying causes of malnutrition are extremely elevated, and the combined effects of a complete failure in all three underlying causes generates the unprecedented levels of malnutrition and mortality as were witnessed in Southern Sudan, Somalia, Ethiopia etc.

Therefore at each of the IPC Phases the relationship between food insecurity, health and care shifts in relation to each other. At each progressive stage of the IPC there is (or should be) an exponential increase in malnutrition and mortality rates, because of the synergistic relationship between underlying causes.

Note that, it is possible for disease to lead to increased mortality without influencing anthropometric status, yet it is less likely that food security would lead to excess mortality without changes in anthropometric status, or disease patterns becoming exaggerated. What is not widely recognized however are the health implications of food insecurity, particularly in terms of influencing the health environment (by prompting migration, over-crowding, pressure on water and sanitation etc) and also care-giving behaviours (displacement, separation or break-up of families, pressures on infant feeding).

Each Phase of the IPC above Phase 1 and 2, is not simply a linear exaggeration of the previous phase, but rather represents a re-alignment in the relationship between indicators and their relative importance. For example, the importance of food insecurity in influencing nutritional status and disease does not probably occur until Phase 3 and above. A comprehensive food security classification system therefore has to review and monitor mortality and morbidity trends, as well as malnutrition, and their expected seasonal patterns.

Figure 18 – The changing relationship between food, health and care as food security deteriorates

Figure 18a Phase 1 -2

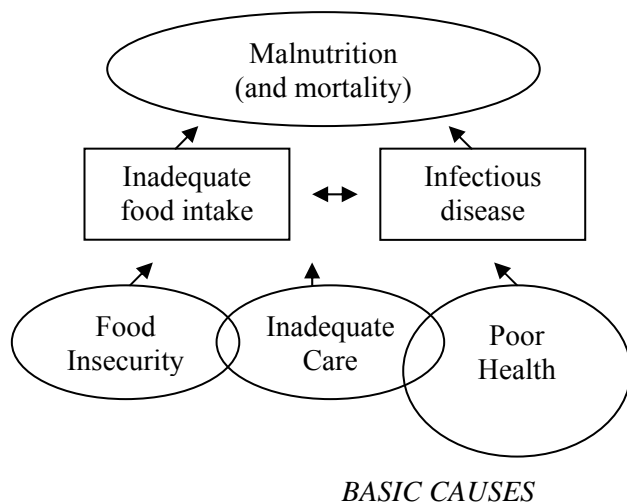


Figure 18b Phase 3 Acute Food & Livelihood Crisis

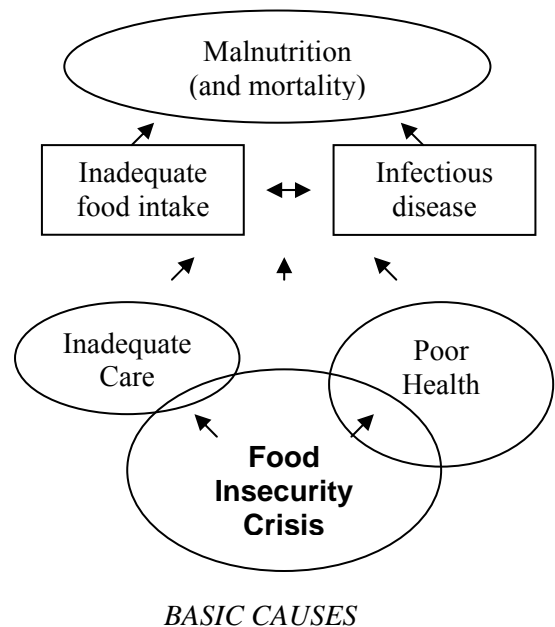


Figure 18c - Phase 4 Humanitarian Emergency

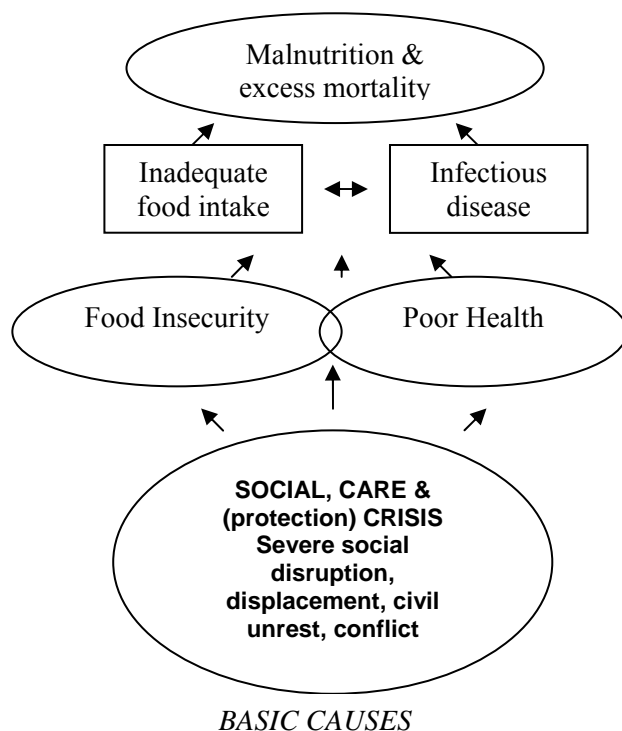
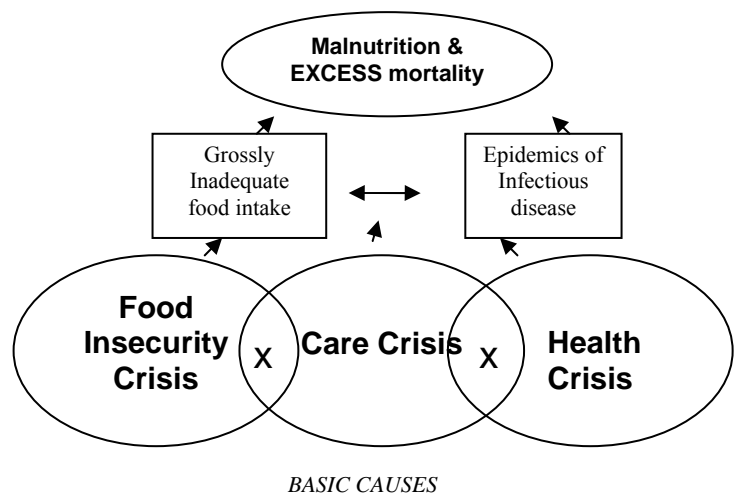


Figure 18d - Phase 5 Famine/ Humanitarian catastrophe



X denotes the synergism that operates between health, care and food insecurity. The combined effects of a failure in all three are much greater than the sum of their parts.

Malnutrition and Mortality

Both the review of prospective studies and the review of nutrition surveys in emergencies in Part 3 of this report, clearly show that the association between malnutrition and mortality is exponential – not linear. Malnutrition has its greatest impacts in populations with already high mortality levels, which could mean that it has its greatest impacts in situations of heightened food insecurity.

Because the increase in malnutrition and mortality is multiplicative, not additive, each Phase of the IPC above Phase 1 and 2 represents a synergistic increase in the mortality risk of reducing nutritional status and also a re-alignment in the relationship between indicators and their relative importance. It is not simply a linear exaggeration of the previous Phase as explained in the previous section.

Importantly this exponential increase in mortality risk in the emergency phases of the IPC does not only occur among the malnourished. As background mortality levels and the severity of food insecurity increases so does the risk of dying for all children, not just the malnourished. The Bairagi (1985) prospective study indicated that the mortality risks associated with a given level of nutritional status appeared greater during the 1973 Bangladesh famine than compared with after the famine. Two others studies also indicated the relative risk of dying among malnourished children as compared with well nourished children was lower during periods of harvest failure compared with food secure years food insecurity (Lawrence, Yimer et al. 1994) or alternatively was lower during periods of seasonal increases of acute malnutrition (Fawzi, Herrera et al. 1997). This is likely to be because the well-nourished group (> -2 WHZ) in a context of high prevalence of malnutrition have recently suffered a decline in nutritional status i.e. their nutritional status may be above the -2 WHZ cut-off but nevertheless they have suffered a recent decline in their nutritional status, as a result of which their risk of dying increases proportionally more as compared with the malnourished.

There is no way of accurately (quantitatively) apportioning the relative importance of food, disease and malnutrition in contributing to death because of the complex pathways through which this takes place and the synergy between them. The more important question is what is the relative mix of interventions to most effectively bring down levels? In the light of this, it is helpful to reconsider Pelletier's point in 1993, that 'significant reductions in child mortality can be expected through reductions in morbidity or malnutrition - although the greatest impacts can be achieved by addressing both simultaneously' and the greatest impacts can be expected when attention is paid to all grades of malnutrition and in those populations having the highest baseline levels of morbidity and malnutrition" (Pelletier et al., 1993), which is an argument for prioritizing pastoralists not changing reference levels. Since Pelletier's work, the exponential relationship between malnutrition and mortality has been confirmed and the programme interventions available to address malnutrition and mortality have improved dramatically. However, the very practical problems of implementing programmes in more inaccessible regions remain.

These issues are relevant to program decision-makers in emergency contexts who are concerned with addressing risks. Frequently the question arises as to the relative importance of food and disease as causes of malnutrition and mortality? This question is all but impossible to answer, as the relative contribution of malnutrition to mortality depends on morbidity rates and types of disease present, and the contribution of morbidity varies according to the prevalence of malnutrition.' i.e. malnutrition's contribution to mortality varies depending on disease exposure rates.

As well as reviewing reference levels of malnutrition, the IPC should also consider differentiating between different levels of disease and public health crises. Phase 4 (humanitarian emergency) and Phase 5 (Famine/ humanitarian catastrophe) show the disease outcome 'pandemic', which is relatively unspecific and fails to distinguish between 4 and 5. Population density, crowding and shelter might also be relevant reference outcomes needed to help differentiate public health risks that might exacerbate the contribution of malnutrition to mortality.

The risk of dying associated with malnutrition (the anthropometric status mortality relationship) is likely to be modified by additional confounding factors including the age of the child (or age range of children), season, and breastfeeding. These factors should be explicitly taken into account in the analysis of anthropometric data – simple guidance is needed for each factor.

The effect of confounding factors such as age and seasonality is likely to depend on the underlying causes of malnutrition. For example, inadequate public health will exacerbate morbidity and this is likely to affect infants and younger children, more than older children. In contrast, there is some evidence to suggest that as food insecurity worsens older children are disproportionately affected.

Finally, this review has highlighted the importance of food security as an underlying cause of malnutrition and indirectly as a cause of death. Hitherto, the reviews of population surveys of malnutrition and mortality have focused solely on the use of wasting prevalence to predict crude mortality and thereby to enable wasting prevalence to serve as a criterion for intervention (i.e. prior to intervention taking place). This is an extremely limited perspective, focusing on one outcome – death, and one relatively small target group – the malnourished. The severity of the situation might be understood based on the predicted mortality, yet it provides no indication as to the mix of interventions required. Rather it fosters an approach designed to tackle only the tip of the iceberg of the problem, and not to address the community wide effects of food insecurity and famine on nutrition more broadly.

It is hoped that through a more nuanced understanding of food insecurity, nutritional status and mortality throughout all the phases of the IPC, this will generate a more comprehensive and community wide programming strategy that addresses increased risk and vulnerability throughout the affected populations.

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ANNEXES

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Annex 1 - Technical Consultation and Review of IPC Nutrition and Mortality Indicators: *Summary of Workshop Proceedings*

Objectives of workshop

The Integrated Food Security Phase Classification (IPC) is a food security severity scale developed by a global partnership of NGOs, UN agencies and donors. It provides a situation and response analysis to facilitate timely identification of priorities for intervention.

A two-day workshop was held on July 14th and 15th, 2009 by the Food and Agriculture Organization (FAO) in Rome, Italy, with the dual aim of reviewing and clarifying the purpose of the nutrition and mortality indicators within the IPC, and reviewing draft recommendations on current and proposed indicators in order to develop clear guidance on their use within the IPC. Further, as the IPC is a food security classification system, the workshop focused on understanding key nutrition and mortality reference outcomes with regard to how well they indicate food security.

Participants in the workshop (33 total) included representatives from several UN agencies and fora (including FAO, SCN, WFP, WHO, UNHCR and UNICEF); academic institutions (Columbia University and Tufts University in the US, University College and the Overseas Development Institute in London and Vrije Universiteit, Amsterdam); research and technical groups (, ENN, FANTA, IRD, NutritionWorks, ODI); NGOs (ACF, Oxfam, World Vision International); and government groups (EC-JRC, CDC). Participants represented a balance between head office and regional personnel. It is noteworthy that representatives were present from many of the major nutrition information systems and standard-setting groups (HNTS, NICS, WHO Global Database on Child Growth and Malnutrition, as well as the Sphere Project and SMART).

Helen Young (Feinstein International Centre) and Susanne Jaspars (Overseas Development Institute), who have conducted similar reviews in the past, were commissioned to conduct a comprehensive technical review of the evidence for the selection of reference levels for the range of nutrition and mortality indicators and their practical application. This technical review was used as the background and basis for the two-day workshop. Presentations from workshop organizers were geared towards informing participants on the purpose of the exercises and equipping them with the technical details necessary to provide the most informed and specific guidance possible. These presentations were kept to a minimum in order to allow maximum time for group deliberation on the relevance of and guidance on use of specific indicators.

The workshop was conducted using a participatory approach, and was divided into two main working group sessions. The objective of the first session was to review the indicator properties required for each of different IPC phases, including severity or short term mortality risk, responsiveness to short term changes in food security, long term risk, acceptability and availability. The next step was to select the most appropriate indicators which met these properties, and score them, and to provide guidance on age, morbidity, and seasonality. In the second session, four working groups covered one group of indicators: Acute malnutrition (AC and WH), underweight and stunting (HA and WA), adult malnutrition (BMI), and mortality (CDR, 0-5DR, IMR and U5MR), and reviewed reference levels, and guidance on effect modifiers (morbidity, seasonality, breastfeeding), body shape and causality.

Summary of Working Group Sessions

Relevance of indicators by IPC Phase

During plenary discussion, it was emphasized that inclusion of an indicator in the reference table should not be influenced by its availability, because the reference indicators should represent the ideal indicators to be collected. Further, while an indicator may not be specifically selected as a reference outcome for a particular phase, it may still be used as indirect or supporting evidence for phase classification. The working groups came to consensus on the importance of several indicators in specific phases. However, differing opinions were also expressed. There was some debate as to whether different indicators should be used for different phases. Participants agreed that certain indicators were more or less appropriate at different phases.

In the emergency phases of the IPC (Phase 3-5), wasting (weight-for-height) was considered very important. It was given less importance in the non-emergency phases of the IPC (Phase 1-2). MUAC got mixed results due to lack of association with food security but importance in emergency phases as an indicator of mortality. However its use was suggested for indirect evidence in the emergency phases. Stunting (height-for-age) and underweight (weight-for-age) were recognized as useful in the non-emergency phases, with underweight given less preference due to its composite nature and resulting difficulties in its interpretation. It was noted that mortality, wasting, MUAC and underweight are most affected by seasonality, so the interpretation of these indicators would need to refer to the seasonal calendar for the specific location and context at the time of data collection.

Body mass index (BMI) for measuring adult nutrition status was supported especially in the lower phases, due to its ability to capture both over- and underweight. This is an important quality of the indicator in the lower phases of the IPC, as more countries enter the “nutrition transition” with double burdens of over- and undernutrition.

In terms of mortality indicators, the crude death rate (deaths/10,000/day) and 0-5 death rate (deaths/10,000/day) were assigned great importance in the emergency phases of the IPC. The infant mortality rate and under-five mortality rate (deaths/1,000 live births) were considered more useful for development situations, and a key constraint is their infrequent availability via national surveys.

Reference levels of specific indicators by IPC Phase

In sum, the interim guidance for each indicator is as follows:

Mortality: The guidance for mortality indicators included a reminder to take seasonality into consideration, and to report by cause of mortality when possible. While it would be preferable to disaggregate mortality data by age group, it may not be possible as sample sizes are generally too small for data to be statistically significant by age group.

For infant/under-five mortality rate per 1,000 live births, participants felt a need for guidance on their interpretation and use in the absence of thresholds, especially in terms of classifying the severity of food security. These indicators were felt to be more relevant for classifying the underlying health status of a population, rather than an outcome of a specific crisis event. They are known to be associated with poverty, but the link with food insecurity is not clear. As such they could be used as indicators of underlying vulnerability. Excess mortality is a good indicator of the magnitude of impact of a humanitarian crisis, but is often not possible to calculate because of the difficulties in determining accurate baselines.

The Mortality Working Group recommended to retain the IPC’s fixed reference levels for CDR and 0-5DR as reference outcomes, but to allow relative reference levels (using regional

baselines) to reflect trends and changes. These indicators should factor prominently in the emergency phases of the IPC. These indicators were however not considered very useful in distinguishing between the non-emergency phases of the IPC.

Stunting and underweight: This Working Group concluded that stunting and underweight should not be included as reference outcomes for the IPC, as it was considered more an indicator of poverty and vulnerability in general rather than food insecurity. Research is needed to elucidate the links between severity of food insecurity and stunting/underweight, and the modifying effect of factors other than morbidity. Research is also needed to determine evidence-based reference levels. Neither indicator should be dismissed completely, however, and both could be used as indirect evidence within the IPC and for triangulation. WA was considered to be useful potentially because of its sensitivity to HIV/AIDS. Prevalence of >40% low HA was also considered a risk factor. Some suggested that severe stunting could be used as a reference outcome. Participants suggested guidance for the application as indirect evidence and to pilot it.

Adult malnutrition (low BMI): BMI of non-pregnant adult women aged 20 - 49²⁷ was considered a promising indicator. Especially for the lower phases of the IPC, it has the potential to capture the double burden of over- and undernutrition. This Working Group suggested that BMI could be a better indicator of food insecurity than growth failure in children, since child malnutrition is a composite indicator of poor health, lack of food, care etc. whereas adult malnutrition is more intuitively a direct outcome of food insecurity. There is currently a lack of research in this area. When using BMI, several issues should be taken into consideration. Seasonality and morbidity can affect the indicator, and must be taken into account. Body shape also affects results, but guidance is needed on whether using the Cormic Index would be helpful or too complex. They concluded with a recommendation to use BMI as a reference outcome for all five phases of the IPC. MUAC was not recommended for measuring adult malnutrition due to lack of evidence. For reference levels, it was recommended to compare prevalences of low BMI with national or regional baselines, and rough guidance was suggested to use 1.5 times the baseline to move to a higher phase.

Acute malnutrition: Acute malnutrition can be defined using many WH, AC and oedema, in severe and moderate categories. In addition, the terms acute malnutrition, wasting and low WH are sometimes used inter-changeably. This Working Group recommended that the IPC clarify the key reference outcome and recommended global acute malnutrition (GAM). and this should be disaggregated by age because of the possibility that GAM in older children is closely related to food insecurity. This needs further research. Severe acute malnutrition (SAM) was not recommended as there can be methodological issues involved with getting accurate prevalence levels of SAM based on small sample sizes. MUAC was recommended only as indirect evidence, as there is no available evidence on using fixed reference levels for decision-making. The development of local MUAC baselines was encouraged. It was suggested to use overlapping reference levels instead of discrete cut-offs, with phases decided through triangulation with other data points. Trend analysis was encouraged, using in particular mean nutritional status. The use of differential reference levels for different population groups, based on differences in body shape or baseline based on a number of years, was rejected. Further research is needed on this in particular in relation to outcomes. Further research is also needed to review the exponential increase in acute malnutrition with each phase. There is a need to raise the level for Phase 5.

²⁷ In the workshop this was the age group referred to by the working group, however 15 to 49 is the more usual age group monitored by WHO and others.

Workshop Conclusion

The outputs of this workshop are interim guidance and draft recommendations on the use of proposed indicators with a view to developing clear guidance and final recommendations on the use of nutrition and mortality indicators within the IPC. A final report will combine conclusions from the working groups with technical inputs generated by Young and Jaspars, to produce provisional recommendations on mortality and nutritional status indicators and thresholds. During the concluding plenary session, there was discussion on the best way forward with this information. Participants emphasized the need to make guidance user-friendly, with attention to the use and interpretation of indicators. Potential involvement of each of the nutrition information systems with representation at the workshop was proposed, as well as opportunities for linkages between them in providing the technical guidance needed to move forward. This would be particularly helpful for ensuring reliability of the data used in the IPC.

Areas for future research

Several areas for future research were highlighted from this workshop. First, there was a defined need to elucidate the links between food insecurity and many of the anthropometric indicators under consideration, including AC, HA, WA, BMI, and mortality indicators. The relationship between GAM in different age groups and food insecurity was also considered a priority area for research. Further, there is a need to pilot the use of stunting and underweight as indirect evidence in the IPC, as well as the possible use of severe stunting as a reference outcome. Second, a need was highlighted to develop new reference levels; for example for AC, but also to explore the implications of an exponential increase between phases, and in using and interpreting fixed versus overlapping reference levels. Third, a need for additional research on the relationship between food, health and care and how this changes with increasing food insecurity. A need for guidance on how to interpret reference levels in relation to these factors as well as others was also expressed.

Annex 2 – Workshop Participants

Name	Organization	Email
Agnes Dhur	WFP	agnes.dhur@wfp.org
Andy Seal	ICH, London	A.Seal@ich.ucl.ac.uk
Carmel Dolan	NutritionWorks	Cmadolan@aol.com
Caroline Wilkinson	UNHCR	WILKINSO@unhcr.org
Chloe Puett	Tufts University	chloe.puett@tufts.edu
Chris Leather	Oxfam International	chris.leather@oxfaminternational.org
Cristina Lopriore	FAO	clopriore@hotmail.com
Ferima Coulibaly Zerbo	WHO	zcferima@yahoo.fr
Fiona Watson	NutritionWorks	Fiona.watson6@btopenworld.com
Franscesco Del Re	FAO	Franscesco.DelRe@Fao.org
Grainne Maloney	FAO/FSNAU	Grainne.Moloney@fsnau.org
Hedwige Deconnick	FANTA	deconinck@aed.org
Helen Young	Tufts University	Helen.Young@tufts.edu
Jennifer Coates	Tufts University	jennifer.coates@tufts.edu
Jeremy Shoham	ENN	jshoham@easynet.co.uk
Jose Manuel Veiga	EC-JRC	manuel.veiga@jrc.it
Leisel E Talley	CDC	lre0@cdc.gov
Les Roberts	Columbia University	lfr2102@columbia.edu
Marie Claude Dop	FAO	marieclaudedop@fao.org
Mark Smulders	FAO	mark.smulders@fao.org
Marteen Nube	SNC TF AME	'mnube@sow.vu.nl'
Marzella Wustefeld	WHO	wustefeldm@who.int
Mesfin Teklu	World Vision/Sphere	mesfin_teklu@wvi.org
Monika Bloessner	WHO	bloessnerm@who.int
Nitesh Patel	WFP	Nitesh.patel@wfp.org
Noreen Prendiville	UNICEF	nprendiville@unicef.org
Santiago Alba-Corral	ACF/SMART	salbaco@gmail.com
Susanne Jaspars	ODI	s.jaspars@odi.org.uk
Thierry Negre	EC-JRC	thierry.negre@ec.europa.eu
Tina van den Briel	WFP	Tina.vandenBriel@wfp.org
Valerie Ceylon	WFP	Valerie.Ceylon@wfp.org
Yves Martin Prevel	IRD & WHO/HNTS	Yves.Martin-Prevel@ird.bf

Annex 3 - Acronyms & Glossary

BMI	Body Mass Index
CED	Chronic Energy Deficiency
CIAF	Composite Index of Anthropometric Failure
FSNAU	Food Security and Nutrition Assessment Unit
HA	Height-for-Age
IPC	Integrated Phase Classification
MDG	Millennium Development Goal
MGRS	Multicentre Growth Reference Study
PAR	Population Attributable Risk
RR	Relative risk
SCN	Standing Committee on Nutrition
SSR	Sitting Height to Standing Height Ratio or Cormic Index
TF-AME	Task Force on Assessment, Monitoring and Evaluation
WA	Weight-for-Age
WFP	World Food Programme of the United Nations
WH	Weight-for-Height
WHO	World Health Organization of the United Nations
FAO	Food and Agriculture Organization of the United Nations

Glossary

Anthropometric indices are combinations of measurements e.g. measurements of weight and height may be combined to produce Body Mass Index (weight/ height²) or weight may be related to height through the use of reference data.

Benchmark -- “is measuring or judging other persons or ‘things’ by comparing them with a benchmark; i.e. a point of reference or standard” van der Heide

Chronic undernutrition - a term used by Collins et al., to refer to a condition diagnosed by low BMI, or chronic energy deficiency as defined by James et al., 1988

Effect modifiers and confounders (HH economic status, concurrent morbidity, and feeding practices) Pelletier 1991, distinguishes between an 'effect modifier' (relationships vary according to other factors; morbidity, breastfeeding, seasonality) and a 'confounder' (relationship accounted for by other factors/ influences mortality and anthropometry simultaneously; socio-economic status) of the anthropometry relationship.

Norm

“In sociology, a norm, or social norm, is a rule that is socially enforced. As such, it is closely associated with behaviour. After all, social norms are shared standards about what is appropriate or acceptable behaviour in a specific context and at a particular time. Here, however, we consider a norm as a value considered appropriate for a certain indicator. A norm affirms how things should or ought to be”. Van der Heide, et al, 2007

Indicator: “A value that can be used to evaluate or assess different types of impact. Indicators are in SEAMLESS values that have been assessed to be relevant for a specific context, a specific policy, or user group” Van der Heide

Index - Indices are constructs from measurements. Usually relating an observed measurement to its counterpart in the reference population. Some indices are however single ratios, such as chest circumference/head circumference and BMI (Waterlow, 1992). An index has biological meaning; an indicator only has meaning in relation to some application or value judgement. An indicator represents the use of an index, often in conjunction with a cut-off point, for making a judgement or assessment (Waterlow, 1992).

Undernutrition is the outcome of insufficient food of whatever kind caused primarily by an inadequate intake of dietary or food energy, whether or not any specific nutrition deficiency is present.

Malnutrition refers to all deviations from adequate nutrition, including undernutrition (and overnutrition) resulting from inadequacy of food (or excess food) relative to need and/or disease. Malnutrition also encompasses specific deficiencies (or excesses) of essential nutrients such as vitamins and minerals.

Percentile – the rank position of an individual on a given reference distribution, stated in terms of what percentage of the group the individual equals or exceeds.

Percent of median – the ratio of a measured value in the individual, to the median value of the reference data for the same age or height, expressed as a percentage {WHO Expert Committee, 1995 #1}

Reference level “A general term for a level to which the indicator is referred. Reference levels come in a wide variety of names, such as benchmark, standard, threshold, norm, but all refer to a comparison to which an indicator can be examined or gauged”.

In general, a reference level has a generic meaning, namely a level to which the indicator is referred. However, in a more specific meaning, a reference level relates to the level of ecological, social or economic ‘quality’, based on scientific evidence. Above the reference level, there are demonstrated effects on the ecological, social or economic system. Reference levels provide a basis for establishing goals for management and policy making. Following the evaluation and selection of the applicable scientific literature, integration of knowledge, and characterisation of exposure and risk, the reference level is determined. Van der Heide, et al, 2007.

Relative reference value A reference level (see above) that has a relation to or connection with or necessary dependence on another value.

Reference value “Concept that includes several types of values, namely thresholds, critical values, critical ranges, and target values. These values can be used to define the context for an indicator as well as the basis of reference to which the indicator should be compared” Van der Heide

Sensitivity and specificity

The performance of any given indicator is reflected by its sensitivity and specificity (sensitivity is the proportion testing positive (i.e. malnourished), while specificity is the proportion testing negative i.e. adequately nourished), both of which change with their cut-off point. Thus for any cut-off point there will be children classified as malnourished who are healthy, and vice versa healthy children classified as malnourished. Sensitivity and specificity are inversely related – by reducing the cut-off point sensitivity is increased (the proportion testing positive that are malnourished is increased – fewer false positives) and at the same time specificity is decreased (more false negatives). Sensitivity and specificity may

be calculated over a range of cut-offs to show how the performance changes at different cut-offs.

The positive predictive value, defined as the percent of indicator positives who are true positives.

Indicator results	True Malnutrition		
	Positive	Negative	
Positive	(A) True Positive	(B) False Positive	(A + B)
Negative	(C) False	(D) True	(C + D)
Total	(A + C)	(B + D)	

Sensitivity, $A / (A + C)$;

Specificity, $D / (B + D)$;

Positive predictive value, $A / (A + B)$.

Temporal or time aspect of food security: "Chronic and transitory food insecurity refer to the time dimension of food insecurity: chronic food insecurity is a long-term or persistent inability to meet minimum food consumption requirements, while transitory food insecurity is a short-term or temporary food deficit". (Devereux, 2006)

Threshold; in relation to anthropometric indices the threshold implies the individuals anthropometric status below which there is a significant increase in risk of mortality, "The threshold below which nutritional status is associated with excess mortality is likely to vary with different environments, although the relationship is unclear (Seaman and Rivers, 1988, Dowler 1982).

Trigger indicator:

"Indicator used to determine the threshold at which Multi-year Assistance programs (MYAPs) need to shift activities and/or require additional resources for new activities in response to a slow-onset shock. Such an indicator helps direct program priorities in dynamic and often unpredictable operating environments" (Matthys, 2007).

Trigger threshold:

"The level of a trigger indicator that, when seen, signals the need for certain actions to be taken (such as needs assessment, contingency and response planning, request for emergency resources for MYAP)." (Matthys, 2007)

Undernutrition arises from the deficiency of one or more nutrients, including both macro and micronutrients, and in children is assessed anthropometrically by measuring growth failure which encompasses stunting,, wasting, and underweight, or combinations thereof, and among adults is measured by weight loss.

Wasting as a clinical sign means visible loss of subcutaneous fat and skeletal muscles. Anthropometric wasting as in the Waterlow classification, on the other hand refers strictly to low W/H, which is usually observed in cases of clinical wasting. Low W/H, anthropometric wasting may not be observed in cases of kwashiorkor where wasting is masked.

Z score (or standard deviation score) – the deviation of the value for an individual from the median value of the reference value, divided by the standard deviation for the reference population (WHO, 1995){WHO Expert Committee, 1995 #1}

IPC TERMS:

Counter Evidence - "Where some evidence contradicts other evidence" (p1.5 User Guide)

Direct evidence is "data that directly measures the outcome reference indicator, and can therefore be compared to a given threshold". (p 1.4 User Guide)"

Direct evidence is often not available or is of low reliability" (Box 1 P 1.5 User Guide)

Indirect evidence on the other hand, is evidence that does not directly measure the reference outcome, and cannot be compared to a threshold. (p 1.4 User Guide)

Magnitude – absolute number of people experiencing a condition at a given intensity (IPC Technical Working Group Meeting, EC-JRC Ispra, 29-30th April 2009).from IPC discussion – magnitude at population level (i.e. nutrition and mortality indicators) (The IPC has agreed to explore, in the longer term, the development of depth thresholds (i.e. prevalence) for all outcome indicators (currently only the nutrition and mortality indicators have prevalences), the others being based on the situation at household level).

Reference Table presents the overarching framework for the IPC analysis. As its name suggests, it is purely for reference: it provides users with a quick but complete picture of the different phases

of food insecurity and how they relate to the main indicators and strategic response options. (p 0-6 User Guide)

Reliability Score - "a rather subjective score from 1 = very reliable; 2 = somewhat reliable; to 3 = unconfirmed. The two main things to keep in mind are: a) the quality of the data in terms of source; method of collection; whether it is supported by other data or contradicted by it; and b) the validity of the data especially in terms of how old it is."

Severity - The IPC approach provides a severity scale, with severity defined as a combination of intensity and depth (see above definitions of terms).

Severity: Devereux and Howe in the Famine Scale define severity as a combination of intensity, depth and magnitude. However, in the context of the IPC, the TWG agreed to define severity as a combination of intensity and depth only". (IPC Technical Working Group Meeting, EC-JRC Ispra, 29-30th April 2009).

Reference Table presents the overarching framework for the IPC analysis

Proxy Indicator: The term proxy is used in different ways in the manual. It is used in the sense that nutritional status of children is a proxy for the nutritional status of the wider population.... not sure this is valid, and also in terms of proxy indicators for key reference outcomes ("Proxy indicators should be treated separately and also aligned to the same pillars" For the future the intention is to develop guidance on proxy indicators' threshold(IPC Technical Working Group Meeting, EC-JRC Ispra, 29-30th April 2009).

Annex 4 - IPC Reference Table

Phase Classification		Key Reference Outcomes <i>Current or imminent outcomes on lives and livelihoods. Based on convergence of direct and indirect evidence rather than absolute thresholds. Not all indicators must be present for classification..</i>	Strategic Response Framework <i>Objectives: (1) mitigate immediate outcomes, (2) support livelihoods, and (3) address underlying causes</i>
1A	Generally Food Secure	Crude Mortality Rate <0.5 / 10,000 / day Acute Malnutrition <3 % (w/h <-2 z-scores) Stunting <20% (h/lage <-2 z-scores) Food Access / Availability usually adequate (> 2,100 kcal ppp day), stable Dietary Diversity consistent quality and quantity of diversity Water Access / Avail. usually adequate (> 15 litres ppp day), stable Hazards moderate to low probability and vulnerability Civil Security prevailing and structural peace Livelihood Assets generally sustainable utilization (of 6 capitals)	Strategic assistance to pockets of food insecure groups Investment in food and economic production systems Enable development of livelihood systems based on principles of sustainability, justice, and equity Prevent emergence of structural hindrances to food security Advocacy
1B	Generally Food Secure		
2	Moderately / Borderline Food Insecure	Crude Mortality Rate <0.5 / 10,000 / day; U5MR<1 / 10,000 / day Acute Malnutrition >3% but <10 % (w/h <-2 z-score), usual range, stable Stunting >20% (h/lage <-2 z-scores) Food Access / Availability borderline adequate (2,100 kcal ppp day); unstable Dietary Diversity chronic dietary diversity deficit Water Access / Avail. borderline adequate (15 litres ppp day); unstable Hazards recurrent, with high livelihood vulnerability Civil Security Unstable; disruptive tension Coping "insurance strategies" Livelihood Assets stressed and unsustainable utilization (of 6 capitals) Structural Pronounced underlying hindrances to food security	Design & implement strategies to increase stability, resistance and resilience of livelihood systems, thus reducing risk Provision of "safety nets" to high risk groups Interventions for optimal and sustainable use of livelihood assets Create contingency plan Redress structural hindrances to food security Close monitoring of relevant outcome and process indicators Advocacy
3	Acute Food and Livelihood Crisis	Crude Mortality Rate 0.5-1 / 10,000 / day, U5MR 1-2 / 10,000 / dy Acute Malnutrition 10-15 % (w/h <-2 z-score), > than usual, increasing Disease epidemic; increasing Food Access / Availability lack of entitlement, 2,100 kcal ppp day via asset stripping Dietary Diversity acute dietary diversity deficit Water Access / Avail. 7.5-15 litres ppp day, accessed via asset stripping Destitution / Displacement emerging; diffuse Civil Security limited spread, low intensity conflict Coping "crisis strategies"; CSI > than reference; increasing Livelihood Assets accelerated and critical depletion or loss of access	Support livelihoods and protect vulnerable groups Strategic and complimentary interventions to immediately food access / availability AND support livelihoods Selected provision of complimentary sectoral support (e.g., water, shelter, sanitation, health, etc.) Strategic interventions at community to national levels to create, stabilize, rehabilitate, or protect priority livelihood assets Create or implement contingency plan Close monitoring of relevant outcome and process indicators Use "crisis as opportunity" to redress underlying structural causes Advocacy
4	Humanitarian Emergency	Crude Mortality Rate 1-2 / 10,000 / day, >2x reference rate, increasing; U5MR > 2 / 10,000 / day Acute Malnutrition >15 % (w/h <-2 z-score), > than usual, increasing Disease Pandemic Food Access / Availability severe entitlement gap; unable to meet 2,100 kcal ppp day Dietary Diversity Regularly 3 or fewer main food groups consumed Water Access / Avail. <7.5 litres ppp day (human usage only) Destitution / Displacement concentrated; increasing Civil Security widespread, high intensity conflict Coping "distress strategies"; CSI significantly > than reference Livelihood Assets near complete & irreversible depletion or loss of access	Urgent protection of vulnerable groups Urgently food access through complimentary interventions Selected provision of complimentary sectoral support (e.g., water, shelter, sanitation, health, etc.) Protection against complete livelihood asset loss and / or advocacy for access Close monitoring of relevant outcome and process indicators Use "crisis as opportunity" to redress underlying structural causes Advocacy
5	Famine / Humanitarian Catastrophe	Crude Mortality Rate > 2 / 10,000 / day (example: 6,000 / 1,000,000 / 30 days) Acute Malnutrition > 30 % (w/h <-2 z-score) Disease Pandemic Food Access / Availability extreme entitlement gap; much below 2,100 kcal ppp day Water Access / Avail. < 4 litres ppp day (human usage only) Destitution / Displacement large scale, concentrated Civil Security widespread, high intensity conflict Livelihood Assets effectively complete loss; collapse	Critically urgent protection of human lives and vulnerable groups Comprehensive assistance with basic needs (e.g. food, water, shelter, sanitation, health, etc.) Immediate policy / legal revisions where necessary Negotiations with varied political-economic interests Use "crisis as opportunity" to redress underlying structural causes Advocacy

Annex 5 - National estimates for percent women 15-49 years old with low BMI and low height by United Nations regions and countries
(from Black et al., 2008)

Anthropometric indicators for women

Region and country	Source	Year of survey	Low BMI (% <18.5)	Short stature (% <145 cm)
Africa				
Eritrea	DHS	2002	38.1	2.3
Ethiopia	DHS	2000	26.0	2.1
Chad	DHS	2004	22.6	0.3
Madagascar	DHS	2003-04	20.9	6.4
Niger	DHS	1998	20.7	0.4
Burkina Faso	DHS	2003	18.5	0.2
Mali	DHS	1995-96	16.2	0.4
Central African Republic	DHS	1994-95	15.3	2.4
Senegal	DHS	1992-93	14.9	0.1
Nigeria	DHS	2003	14.4	1.3
Namibia	DHS	1992	13.7	1.1
Zambia	DHS	2001-02	13.0	1.7
Guinea	DHS	1999	11.8	1.2
Kenya	DHS	2003	11.8	0.7
Togo	DHS	1998	10.9	1.0
Benin	DHS	2001	10.5	1.0
Comoros	DHS	1996	10.3	3.8
Uganda	DHS	2000-01	9.4	1.8
Ghana	DHS	2003	9.0	0.9
Mauritania	DHS	2000-01	8.6	0.6
Mozambique	DHS	2003	8.4	5.0
Tanzania	DHS	2004	7.8	2.6
Cote d'Ivoire	DHS	1998-99	7.4	0.8
Gabon	DHS	2000	6.6	1.3
Malawi	DHS	2000	6.5	2.4
Cameroon	DHS	2004	6.4	0.5
Rwanda	DHS	2000	5.9	1.3
Tunisia	WHO	1996-97	5.9	
Lesotho	WHO	2004-05	5.7	
SouthAfrica	WHO	1998	5.6	
Zimbabwe	DHS	1999	4.5	1.8
Morocco	DHS	2003-2004	4.4	0.7
Egypt	DHS	2000	0.6	1.2
Asia				
India	DHS	1998/99	41.2	13.2
Bangladesh	DHS	2004	38.1	16.1
Pakistan	WHO	1990-94	31.6	

Nepal	DHS	2001	26.7	14.8
Yemen	DHS	1997	25.2	8.7
Cambodia	DHS	2000	21.2	4.5
Philippines	WHO	1993	16.1	
LaoPeople'sDem.Rep.	WHO	1994	14.8	
Malaysia	WHO	1996	13.7	
Turkmenistan	DHS	2000	10.0	0.5
China	WHO	1992	9.9	
Uzbekistan	DHS	1996	9.9	1.3
Kazakhstan	DHS	1999	9.8	0.7
Kyrgyz Republic	DHS	1997	6.2	0.5
Republic of Korea	WHO	1998	5.6	
Armenia	DHS	2000	5.0	1.2
Turkey	DHS	1998	2.5	2.1
Kuwait	WHO	1998-00	2.3	
Jordan	DHS	2002	2.2	1.0
Latin America & Caribbean				
Cuba	WHO	1982	9.0	
Haiti	DHS	2000	8.5	2.2
Brazil	DHS	1996	6.3	3.6
DominicanRepublic	DHS	1996	6.2	2.5
Colombia	DHS	2005	4.8	3.5
Nicaragua	DHS	2001	3.1	6.4
Guatemala	DHS	1998-99	2.0	31.8
Mexico	WHO	1998-99	1.7	
Bolivia	DHS	2003	1.3	12.0
Peru	DHS	2000	0.7	14.8
Europe				
Estonia	WHO	1997	7.3	
Spain	WHO	1993	3.9	
CzechRepublic	WHO	2002	3.7	
Lithuania	WHO	1997	3.7	
Latvia	WHO	1997	2.7	
Ireland	WHO	1997-99	1.1	
Croatia	WHO	1995-97	0.2	
North America				
Canada	WHO	2000-01	4.2	
USA	WHO	1999-02	3.3	

*Demographic and Health Survey

Annex 6 - Statistical methods for examining the relationship between anthropometric status and mortality

Anthropometric data may be analysed as either as a continuous variable, or as multiple categorical variables according to cutoff points such as moderate and severe wasting, or as a dichotomous variable (< -2 WHZ and > -2 WHZ as the reference category). However, it is usually statistically less powerful than using a continuous indicator of nutritional status (Habicht and Pelletier 1990). For monitoring changes in prevalence, the "best" indicator is defined in relation to the statistical power to identify a change in population anthropometric status (linked to food security), which is quite different from choosing a cut-off point to count the malnourished in a population (Habicht and Pelletier, 1990). Categorical variables are used to analyse the sensitivity and specificity of an indicator, and also the relative risk i.e. risk of dying associated with different categories of low anthropometric status. Continuous variables can be used in regression analysis to explore the relationship between mortality and a range of different variables.

Comparing the predictive ability of different indicators

The performance of an indicator depends of its sensitivity and specificity properties over a range of cutoffs. Brownie et al., (1986) recommend that the single best comparative criterion is the normalized distance statistic (da), followed by the maximum sum of sensitivity and specificity (MSS). In general indicators and cutoff points with higher values of MSS (maximum sum of Se and Sp) are considered more efficient than those with lower values.

The use of 'receiver operating characteristic' curves (ROC) is also highly recommended (ibid). The sensitivity (Se) and specificity (Sp) of each indicator is calculated using 2x2 tables based on 30 - 40 cut-off points. The cut-off points are based on the distribution of anthropometric Z scores, e.g. generally in units of 0.1 Z units. The exact values of the cutoff points are relatively arbitrary, the chief criterion being that a smooth Se/Sp distribution is produced in the form of ROC curves, which are a plot of true positive ratio (true positive=1-sensitivity), against false positive ratio (false positive= 1-specificity). Indices most suitable for recognizing high risk children have the highest true positive ratio for any given false positive ratio. In other words, a good indicator is one which, with high probability, discriminates correctly between those children who will die and those who will not (for fixed specificity, sensitivity is high). ROC curves may be inspected visually; the further above the main diagonal the better the indicator. For anthropometric indices with parallel ROC curves, the difference in normalized distance can be tested with Zda statistic. The normalised distance statistic (da) is based on the values of the slope (b) and the intercept of the ROC curves. The Zda statistic assesses the ability of an anthropometric indicator to differentiate between children who died and children who survived. The distance represents the difference between children who survived and died for each indicator in terms of SD units. ROC analysis has been used by (Brownie, Habicht et al. 1986; Pelletier 1991; Sachdev and Satyanarayana 1992; Pelletier, Frongillo et al. 1993)

Relative risk is probably the most common method for comparing risk between two groups of people, such as the risk of dying among the malnourished, as compared with those who are adequately nourished. The adequately nourished or reference group has a relative risk of one. Relative risk obviously changes depending on the cutoffs used to define cases, and the reference group, and for this reason comparisons should only be made within studies and of the same indicator, and not between studies or indicators. The relative risk of dying also

varies for different diseases, which means that low anthropometric status does not interact equally with all common forms of morbidity (Van den Broeck, Eeckels et al. 1993).

The odds ratio is different from relative risk in that it describes the ratio of the odds of dying among the malnourished compared with the odds of dying among the adequately nourished. Each category of malnutrition, and is a measure of effect size. Odds ratio is used in logistic regression to generalize the odds ratio beyond two binary variables.

Population Attributable Risk (PAR) estimates the total nutrition related deaths in the population, by taking into account both the strength of the association and the prevalence of malnutrition. In population terms, a low prevalence of malnutrition with a high relative risk is of lesser policy relevance than a very high prevalence of malnutrition with a lower associated relative risk. PAR is used by Pelletier (1994) to assess the extent to which malnutrition related deaths are to be found in different categories of malnutrition. This statistic can only be used for individual indicators, because its magnitude is influenced by prevalence and therefore the cut-off point. He calculated PAR for severe, and mild to moderate underweight prevalence.

Logistic regression analysis describes the relationship between one or more risk factors (e.g., nutritional status, age, sex, etc.) and mortality as the outcome variable. It is therefore useful to test for possible confounding and effect modification. Vella et al, 1994, used a combined index of socio-economic status formed by a multivariate discriminant analysis of 19 individual variables, as one of the dependent variables in a logistic regression (Vella, Tomkins et al. 1993).

Annex 7 - Summary of the studies that examine the effect of age on malnutrition mortality relationships

1. **Katz et al., (1989), West Java, Indonesia.** Their sample included 3461 children from 0 to 59 months, who were followed-up over a period of 18 months. They stratified the sample into age groups and calculated OR for each. Only 2% were less than 80% WH, and 10% were less than 85% HA. They found that stunting (low HA) is a better predictor of mortality for children younger than 24 months; while wasting is a better predictor for older children (more than 24 months) (Table x). Note that when the risk of wasting was highest (among children aged 36 - 60mo) the prevalence was lower, and similarly for stunting when risk was highest i.e. among younger children the prevalence was lower.

Relative risk of mortality within 18 months according to child's age, and low weight for height and height for age. (from Katz et al., 1989)

Age (years)	prevalence	Deaths	Mortality rate*	Odds ratio
Weight for height <80% median				
0 - 11 mo	2.6%	2	70.2	2.4
12 - 23	4.0	3	74.1	1.9
24 - 35	2.3	4	177.8	9.6
36 - 60	1.0	3	142.9	16.9
Height for age < 85% median				
0 - 11 mo	0.4	1	222.2**	11.1
12 - 23	4.6	6	129	11.5
24 - 35	9.9	7	72.9	8.8
36 - 60	17.5	6	16.2	1.3

* Mortality/ 1,000/ year

** Note the extremely low prevalence and subsequently only 1 death.

2. **Kielmann and McCord (1978) Punjab, India** stratified their cohort of 2808 children into age groups (1-5.9 mo, 6-11.9 mo, 12-35.9). All children who died were classified according to age and nutritional status category 2 months preceding death. For each group the average mortality risk for the year was determined, which is not strictly speaking relative risk, rather it is probability of death/child/year. Prevalence of underweight was relatively low (less than 4.0% were < 60% WA overall). In the two most underweight groups (<60% WA and 60 - 69% WA) the relative risk of mortality peaks between 6 and 12 months of age.

Prevalence of low WA and risk of death among different age and WA categories (from Kielmann and McCord, 1978)

	< 60		Risk*	60-69		Risk*	70 -79		80+		
	N	%		n	%		n	%	n	%	
1-5.9	48	3.09%	0.001	109	7.02%	0.092	258	16.61%	1138	73.28%	1553
6-11.9	62	4.25%	0.177	212	14.53%	0.080	437	29.95%	748	51.27%	1459
12 - 35.9	218	4.24%	0.037	1025	19.92%	0.008	2126	41.32%	1776	34.52%	5145
Total	328	4.02%	0.120	1346	16.50%		2821	34.58%	3662	44.89%	8157

* Probability of death/ child/
year

3. **Sommer and Lowenstein (1975)** designed a prospective analysis of the QUAC stick, and followed 8292 Bangladeshi children between 1 & 9 years prospectively for 18 months after nutritional assessment of their height and arm circumference. Standards were constructed, and the 9th percentile was found to correspond to 75% of western standards (moderate to severe malnutrition). Only 4 deaths occurred in the 5 – 9 yr age group which precludes meaningful analysis. All age groups up to five years have an elevated mortality in the moderate to severe nutrition category, but the mortality of children aged between 3 and less than 4 years is almost double that of younger children (< 3 years). The authors concluded that “The narrower range of relative risks among older children is likely a reflection of the limited importance of malnutrition as a direct or contributory cause of death in this age group”(Sommer and Loewenstein 1975).

Low AC/ height, deaths, mortality and relative risk by age group

	Nutrition category: Moderate/Severe < 9 th percentile ACH			
		Deaths	% Mortality	Relative Risk*
1 year	6.2	7	11.9	3.9
2 yr	6.5	9	13.6	3.6
3 yr	6.3	11	17.7	7.0
4 yr	8.2	4	6.1	3.2
1-4	6.7	31	12.3	4.5
5-9	9.2	4	1.0	2.0
1-9	8.1	35	5.5	3.4

* Relative risk = mortality rate among malnourished category divided by mortality rate in nourished category (> 50% AC/H)

4. **Pelletier (1994), Malawi**, analysed the age modification effects on anthropometry mortality relationships among two age groups of children 6 -23 mo and 24-60 mo as part of a three year longitudinal study of maternal and child nutrition. Elevated mortality rates were found among the 6-23 mo group. The study found no statistically significant differences in prediction across these four indicators when applied to young children (6-23 mo) and employing a 1 yr follow-up. Among older children there is marked variation in prediction among the four indicators; HA appears to be the best predictor, followed by ACA. WA appears to be only a weak predictor among older children. WH actually has an inverse relationship below SP of 80% (i.e. thinner children appear to survive better). Although the mean WH Z score for children aged 24 – 60 mo were 0.06, 0.10 and 0.26 for the three study sites, thus indicating very low prevalence of wasting among this age group. Overall, prevalence of wasting was relatively low; 5.3% of all children under five were < 80% WH, and most of whom would have been less than 2 years, which might help explain this odd result.

5. **Fawzi et al. (1997) (five regions in North Sudan)**, prospectively followed 28,573 children (aged from 6 months to 6 years) in a vitamin A supplementation trial every 6 months for 18 months. . In the group receiving vitamin A, prevalence of stunting was 38.3%; wasting 6.3%; and stunted and wasted: 6.3%, while the placebo group was similar {Herrera, 1992 #213}. There was a stronger relation between WH and mortality for children aged between 2 and 4 years as compared with both younger children, suggesting this was a more vulnerable age group (however a formal test of interaction showed that was not significant) (see table below). Age did not modify the relation between HA and mortality. This table also shows how relative risk of dying changes with age – children from 12 to 23 months are 4.4 times more likely to die than children aged five years and over.

All-cause relative mortality (RM) in relation to WA as modified by age, breast-feeding and seasonality (data taken from Fawzi et al., 1997)

Characteristic	No of Deaths*	Characteristic – RM relation**	RM within subgroups		
			> -2 Z	-2 to -3 Z	< -3 Z
Age (y)					
>= 5	27 (0.14)	1.0	1.0	1.3	6.7
4	24 (0.19)	1.7	1.0	0.6	18.3
3	53 (0.62)	2.5	1.0	2.1	32.3
2	85 (1.35)	4.4	1.0	2.5	15.8
<1	15 (1.56)	6.2	1.0	1.1	5.1

* rate/1000 child-months among all children

** relation among children with a Z score > -2

6. Vella et al (1992) in North West Uganda, investigated the determinants of child nutrition and mortality. They undertook a cluster survey of 1178 children aged 0- 59 months, and followed up who died over 12 months. The survey found a high prevalence of stunting 18% < -2 HAZ), and low level of wasting (3.0% < -2 WHZ). They calculated percentage mortality for categories of anthropometric status and age which clearly showed higher mortality among younger children and lower anthropometric cutoffs. However, based on the data provided, we calculated relative risk of dying for different age groups (see below) which children aged 12 to 23 months experienced a higher risk. The relative risk by WH for children from 24 to 60 mo was extremely high (33.3) but only 3 children fell below the -2 WHZ cutoff, and of them 1 died. This again illustrates the caution that is needed when reviewing relative risk.

Percentage mortality levels, by anthropometric intervals, according to age group {Vella, 1992 #10}

Nutrition indicator	Percentage mortality levels*				Relative risk			
	0-11 mo	12-23 mo	> 23	Total	0-11 mo	12-23 mo	> 23	Total
WAZ								
< -3	17.6	11.1	6.5	10.7	2.1	7.4	5.9	4
-3 to -2.01	15.6	0	0	2.6	1.8	0	0	1
> -2.01	8.5	1.5	1.1	3	1	1	1	1
HAZ								
< -3 Z	23.1	4.3	0.8	3.1	2.2	4.8	0.4	1
-3 to -2.01	10.5	2.9	0	2.3	1.2	3.2	0	1
> -2.01	9	0.9	2	4.1	1	1	1	1
WHZ								
< -2.0	9.1	11.1	33.3	12.5	0.9	7.9	33.3	4
> -2.01	10	1.4	1	3.2	1	1	1	1

7. Van der Broeck et al (1993) In the Bwamanda, Zaire study, marasmus and kwashiorkor were the most common cause of death in children older than 3 years; 39% of deaths (13 of 33) among those aged 36 – 72 months were from marasmus or kwashiorkor compared with 10% of deaths (2 out of 21 deaths) among children aged 18 – 23 months. However, death was possibly underreported in this study as mortality rates are unaccountably low. Malaria was the most frequent primary cause of death followed by

severe anaemia, ARI and then diarrhoea. The authors suggested that malaria and severe anaemia may have comparable case fatality rates across all categories of nutritional status (Van den Broeck, Eeckels et al. 1993).

Mortality rates per 1000 child-periods by arm circumference and weight-for-height anthropometric indices (adapted from Alam et al., 1989)

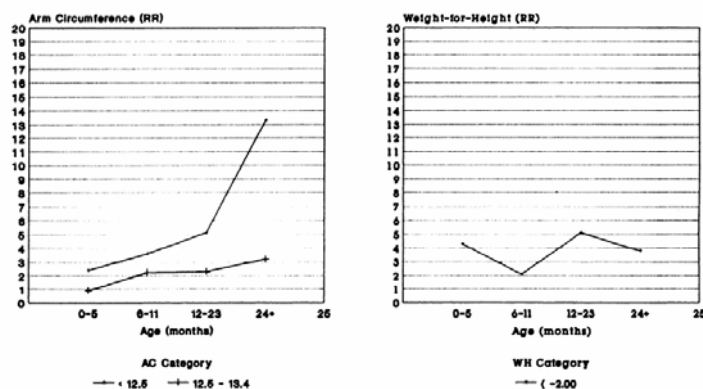
Indices	Number of measurements	Number of deaths in 6 mo	Mortality rate			Relative risk ^a		
			1-3 mo	4-6 mo	Total	1-3 mo	4-6 mo	Total
Arm circumference (mm)								
<121	599	22	23.4	13.4	36.7	16.7	7.9	11.8
121-130	1729	12	2.9	4.0	6.9	2.1	2.4	2.2
131-140	3317	13	1.5	2.4	3.9	1.1	1.4	1.3
141+	4216	13	1.4	1.7	3.1	1.0	1.0	1.0
Percent of median weight for height								
<80	733	11	13.6	1.4	15.0	5.4	0.5	2.8
80-89	3983	21	1.8	3.5	5.3	0.7	1.2	1.0
90+	5145	28	2.5	2.9	5.4	1.0	1.0	1.0

^a Relative risk = mortality rate divided by that of the highest category. ..

8. Vella et al., 1994, South West Uganda

In this study in South West Uganda, low AC (unadjusted for age or height) tends to show a higher relative risk among older children

Relative risk of mortality for AC and WH by age categories



Annex 8 - Age and Excess Mortality

In Darfur in 1984-85, De Waal found that whilst infant mortality was not much higher than normal, most of the excess mortality was found among children between the ages of 1-4. Their annual age specific death rate jumped from 15.7 to 79.5/1000 during the two years from June 1984 to June 1986. It was also group for which mortality rose the earliest (during rains of 1984) whereas for others did not rise until 6 months later and remained high for longer. Adolescents and adults were marginally more at risk than in normal times, but older people more at risk than before. The pattern of excess mortality was therefore closely related to age (de Waal 1989).

Davis (1996) similarly found that excess mortality was often higher in the over 5's than under fives, when examining increases in mortality rates for under fives and over fives in 3 emergency settings: Benaco camp in Tanzania, Koboko in Uganda and Katale in Zaire, and found that children over 5 were disproportionately affected. He also found that the relative risk of dying for under fives compared to over fives varied over time in the same context and between different contexts. In Koboko, CMR and U5MR peaked at different times with the U5MR peak occurring earlier, suggesting that older children and adults suffered similar risks but adults were more resilient and suffered later. Similar findings have been reported from Somalia and Angola. In Katale camp in Zaire, in contrast, mortality in older children and adults peaked first. Mortality in the elderly was particularly high, due to their susceptibility to diarrhoeal disease. Only Benaco camp showed the expected doubling of CMR for U5MR (Davis 1996).

These findings are also supported by the earlier work of Toole and Waldman (Toole and Waldman 1990) in refugee contexts, where age specific mortality in a range of refugee contexts showed that the ratio of mortality rate in younger children compared to older children and adults decreases in emergencies. For example, in Eastern Sudan, the mortality rate for children under 5 was 2.6 times the mortality rate for children aged 5-14 and 7.6 times the mortality rate for people 15-44. During non-famine periods in Sudan, under five mortality was usually 36 and 24 times higher than in 5-14 and 15-44 year age groups respectively. Normally the ratio of under 1 deaths to deaths in the 1-4 year age group is about 5:1, but in refugee contexts it has been 3:2 (Thailand), and 2:1 (Somalia). In other words, excess mortality is higher in 1-4 and 5-14 year olds. In the post-emergency phase, age specific mortality and proportional distribution of mortality by age group resemble non-refugee patterns. More recently in Gode, Ethiopia, a relatively large proportion of deaths occurred amongst children aged 5-14 year olds, highlighting the importance of considering relative increases in age specific mortality (Salama, Assefa et al. 2001)

