Measuring Mortality, Nutritional Status and Food Security in Crisis Situations:

THE SMART PROTOCOL

Version 1

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Make everything as simple as possible but not simpler.
- Albert Einstein (1879-1955)

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Introduction

The basic indicators for assessing the *severity* of a crisis are the mortality or death rate and the nutritional status of the population. These are both estimated by conducting a survey of the affected population.

To know the *magnitude* of the problem we also need to know the population size and, if possible, the demographic characteristics of the population. A high proportion of malnourished in a small population is normally of less magnitude than a lower proportion of malnourished in a large population. The scale and type of intervention will depend upon the magnitude of the emergency rather than simply on the prevalence of malnutrition.

In order to understand the reasons for the crisis and to plan and implement appropriate relief, the "normal" situation, the evolution of the changes, and the context in which the emergency has arisen each needs to be considered. There are many sources of information that are relevant to put the crisis in context and that may affect the types of response that are appropriate. Cultural, political, economic, anthropological, medical, nutritional, topographical, climatic, seasonal and other factors can all be important. The effects of these factors on livelihoods and the ability of the affected population to cope at a household level are assessed using a food security survey.

In order to be useful, the information has to be relatively easy to collect, reliable and accurate. This manual is designed to provide agencies with the basic tools to collect those data necessary for planning direct interventions in an emergency setting[1].

The manual is divided into two sections: the assessment of nutritional status & death rates and examination of the food security situation.

These data should be collected from the same population simultaneously by conducting surveys. The data are then integrated with estimates of the population size to provide an overall picture of the scale of the crisis and the required response.

It is not difficult to conduct a survey, but there are a number of critical points that have to be correct in order for the results to be valid. It does require planning, training, supervision of staff, interaction with the community and a basic understanding of the concepts of epidemiology.

A survey should provide information that is accurate and reflects the current situation, not the situation at some time in the past. It should be relatively simple to conduct. The results should be available in time for the data to be useful for intervention. Complex surveys that attempt to answer many questions and give a complete picture are difficult to

[1] Collecting and analyzing data for advocacy, policy making and other such purposes is also necessary, though methods for collecting data for these purposes may be different from the methods advocated in this manual. Because this manual is designed for use by field staff without specialist epidemiological knowledge or experience, it is limited to the methods that yield reliable information for programming.

conduct, analyse and interpret. They also cost a lot and require special expertise. The information is often outdated by the time the survey is finished and it is not easily repeated to give an ongoing picture of changes. It is nearly always better to do a relatively simple survey that answers only the pressing, critical questions and that can be repeated as the situation evolves. Each additional piece of data that is gathered, even if it is relatively simple itself, degrades the quality and care with which the critical data are gathered and delays the survey.

This manual is designed to be used in conjunction with the accompanying software. NUTRISURVEY for SMART which is free from www.nutrisurvey.de/ena/ena.html.

Section 1: The steps in undertaking a survey

The steps that we are going to consider for mortality, nutrition and food security surveys are as follows.

- Decide whether or not to do a survey.
- Define the objectives.
- Define the geographic area and population group(s) to be surveyed.
- Gather existing and contextual information.
- Meet the community leaders and local authorities.
- Determine when the assessment is to be undertaken.
- Select the sampling method and clusters.
- Decide what additional information to collect.
- Design the questionnaires and surveyor's manual.
- Obtain and prepare equipment, supplies and survey materials.
- Field test questionnaires.
- Select the survey team.
- Train survey team members.
- Implement the survey.
- Analyse and interpret your findings.
- Write the report.
- Present your report to interested parties.
- Archive the data for future reference.

In this section of the manual those steps that are common to all the components of the survey are described. Those that differ for the different components are summarised and detailed explanations are given in the other sections.

Decide whether or not to do a survey

The decision to undertake an assessment is usually made in conjunction with the government, partner agencies and donors. It is always important to share information about when and where you plan to undertake a survey to prevent unnecessary repetition or overlap by different agencies. Surveys are usually much more informative if they are co-ordinated so that data from several agencies, geographic areas or population groups can be examined together to give a wider perspective on the situation.

Conducting an assessment is expensive and time-consuming, so before starting an assessment you should consider the following points:

- Are the results crucial for decision-making? If a population's needs are obvious, immediate programme implementation takes priority over doing a survey, and the survey should be deferred. For example, after a natural disaster, such as a flood, where it is clear that the population's food stocks have been destroyed, the current nutritional status may reflect the pre-disaster state. In dramatically changing situations, nutritional and mortality surveys are not helpful guides to current or future needs. If large numbers of malnourished children are present at a centre, implementation of relief programs should not be delayed until a survey is conducted. The Sphere minimum standards require that a nutrition assessment is conducted when a targeted feeding programme is implemented (The Sphere Project, 2004); this does not mean that the program should be delayed until after the survey is complete if the need is clear. Where such programs exist, periodic surveys should be conducted. If another agency has recently carried out a nutrition assessment in the same area then that data should be used rather than repeating the survey.
- It is anticipated that the results will lead to action. There is little point of doing a survey if you know that a response will not be possible. Where the agency cannot itself implement a program, where needed, the results must be useful to advocate for a response.
- Is the affected population accessible? Insecurity or geographical constraints may result in limited access to the population of interest. If this is extreme, a survey cannot be conducted.

Define objectives

Clear objectives make it much easier for your team, the population and donors to understand why the survey is being conducted. This should be clearly stated at the outset.

Emergency nutrition assessments are normally conducted to assess the *severity* of the situation by quantifying the acute malnutrition and mortality in a given population at a defined point in time. This is normally done by estimating the prevalence of acute malnutrition in children aged 6-59 months and the death rate of the entire population. With an estimate of population size, the proportions of malnourished and the death rate give an estimate of the absolute number of malnourished there are in the community and how many have died in the recent past. These figures indicate the *magnitude* of the problem. The estimates, together with previous surveys, food security and contextual data, also indicate the *urgency* of the situation and how it may evolve in the future.

Where the survey is undertaken during a stable period, the data can be used to establish a baseline, from which future changes can be monitored over time.

Undertaking a nutrition & mortality survey provides an opportunity to collect additional information that can be critical in deciding which interventions are most important. Immunisation and nutrition programme coverage, vitamin A or other micronutrient deficiency, disease morbidity, trauma experience, cause of death, demographic, migration and many other variables can all be important. A survey which collects all these data

would take a long time, be very costly and require a level of expertise that may not be readily available.

It is critical to understand that each additional piece of data collected degrades the accuracy of the whole dataset and prolongs and complicates the survey. Any additional information to be collected should be clearly stated and justified in the objectives and have a realistic prospect of leading to a meaningful intervention.

Nevertheless, such data are usually needed. Consideration has to be given to whether the information could be collected more efficiently in other ways (for example from health clinics, sentinel sites or a surveillance system), or whether it would be better to conduct a separate survey to collect the supplementary information. If additional information is to be included in the survey it must be quickly and reliably obtainable during a short visit to the household.

Define geographic area and population group to be surveyed

Geographic area

In designing the survey, the area and population to be surveyed should be carefully defined. The report should contain a map of the area. Many agencies do a survey confined to the area in which they intend to implement a program. They have normally chosen this area because it is thought to be most needy. This decision is usually made after a rapid assessment, interviews with key informants, migrants and refugees, by determining the origin and history of severely malnourished patients attending clinics or hospitals, and by looking for indications of increased mortality in the population. These data are used to justify the survey. The survey is often the last step before implementation and is used to persuade donors of the severity and urgency of the situation in a particular area. Data from such a survey **cannot** be extrapolated to indicate the severity of problems in other areas because the area has been chosen on the basis of an expectation that it is particularly affected.

In many cases, the area chosen will correspond to one or more administrative areas (for example, a district). The survey should be conducted in an area where the population is expected to have a similar nutritional and mortality situation. If an area is assessed which has two or more very different agro-ecological zones, the results will be an average of the two zones and will not give an appropriate perspective of either zone. Such heterogeneity can be resolved by doing separate assessments, although this usually increases the cost[2]. In general, urban and rural areas, refugee/IDP and resident populations should be assessed separately.

Frequently, there are areas which cannot be accessed because of insecurity; perhaps part of a district or other administrative zone. These areas need to be defined before the

[2] It may not increase the cost appreciably. This is because a much larger sample size is needed where there is heterogeneity. Sometimes two separate surveys can be conduced in two areas, each of which is homogeneous, with the same overall number of subjects from one large survey from a heterogeneous population. This is addressed in the section of the manual dealing with "design effects".

survey, clearly marked upon the map and reported as having been excluded from the survey. Populations living in highly insecure areas normally have a worse nutritional status and higher mortality than those living in more secure areas; nevertheless, it is unlikely that a program can be implemented successfully in areas that cannot be surveyed.

Measurements can be made on new arrivals from insecure areas. Although such data give a valuable indication of the situation in the insecure area, they do not constitute a survey and should not be reported as such. Arrivals are often better off than those who have not been able to migrate from an area of insecurity. However, this should not be assumed as they may have left the area because, unlike those remaining, they are unable to sustain themselves, or have been rejected by the rest of the population. Often, relief programs have to take account of such migration from insecure areas which have not been, and cannot be, surveyed.

Population groups

It is normal to measure children from 6-59 months of age and to assess the crude death rate (*all* deaths within a defined period of time). The 6-59 month old child is considered to be the most responsive to acute nutritional stress. This age group is chosen, therefore, to give an indication of the severity of the situation in the **whole population**. Furthermore, there are often baseline data for this age group, considerable experience in conducting surveys of their nutritional status and defined criteria for interpretation. However, in some situations it may be appropriate to include other age groups, such as less than 6 month old infants, adolescents, adults or the elderly if it is suspected that their nutritional status differs significantly from that of the 6-59 month old child. Although other age groups do not need to be surveyed, it is critically important to emphasise that limiting the survey to the 6-59 month age group cannot be used to justify confining interventions to this age group. If a survey has to be made for each age group before it receives help, the surveys themselves would become extremely cumbersome. Every malnourished individual should be eligible for relief.

Meet the community leaders and local authorities

It is absolutely essential to meet the community leaders and local authorities before starting a survey. The meetings should at least cover the following points:

- Agree with the community about the objectives of the survey. If the population does not understand why you are doing an assessment they may not co-operate during the survey.
- Obtain a map of the area in order to plan the survey. Use this map during the discussions with the local authorities and community leaders.
- Obtain detailed information on population figures (particularly at the village or camp level).
- Obtain information on security and access to the prospective survey area.

- Obtain letters of permission from the local authorities (in the local language), addressed to the district or village leaders, stating that you will be visiting. The letters should explain why you are conducting an assessment and ask for the population's co-operation.
- Agree upon the dates of the survey with the community and local authorities.
- Agree how the results will be used. In particular, realistically discuss the prospects for intervention, the steps that will be taken and types of programs that are likely to be implemented if the situation is found to be as poor as expected. Do not make promises that may not be fulfilled.

Determine timing

The exact dates of the assessment should be chosen with the help of community leaders and local authorities in order to avoid market days, local celebrations, food distribution days, vaccination campaigns, or other times when people are likely to be away from home. Roads may be impassable during the rainy season. In agricultural areas, women may be in the fields for most of the day during ground preparation, planting or harvesting. Healthy children are more likely to accompany adults to the market or the fields and are less likely to be in the home than ill or malnourished children. The survey results could be wrong if only children who were at home at the time of the survey team's visit are sampled. Where possible, the community leaders should inform in advance the villages chosen to be surveyed.

There needs to be sufficient time allocated for preparation and literature review, training, pilot testing, community mobilisation, data collection, analysis and reporting.

Select sampling methods for the nutritional and mortality components

The basic principle for selecting the households that will be visited is that every child in the whole study population should have an equal chance of being selected for the anthropometry survey and every person for the mortality survey. If, at any stage, the recommended method has to be changed for practical reasons, then those in charge have to consider whether every household and child is equally likely to be sampled.

The three commonly used methods are simple random sampling, systematic random sampling and cluster sampling.

Gather available information

Before starting the survey, it is important to learn as much about the population as possible from existing sources. These include population characteristics and figures, previous surveys and assessments, health statistics, food security information, situation reports (security and political situation), maps, and anthropological, ethnic and linguistic information. Only after these data are gathered can a judgement be made about any extra information that should be collected.

Decide what information to collect and design surveyor's manuals

The data collected must correspond to the assessment's objectives.

The mortality and nutritional data are gathered at the same time, from the same households. Food security data are not collected from the households, but by key-informant interviews with people or groups from the same community.

Children's nutritional data

To estimate the prevalence of acute malnutrition in children aged 6-59 months, the following data should always be collected:

1. age, in months (from a known date of birth or based on an estimate derived from a calendar of local events)
2. sex
3. weight in kilograms (to the nearest 100g)
4. height, in centimetres (to the nearest millimetre)
5. presence or absence of oedema.

Other child data that are often collected (depending upon specific survey objectives)

6. Mid upper arm circumference (MUAC)
7. Measles immunisation (and possibly BCG) status
8. Micronutrient supplementation status, particularly vitamin A
9. Nutrition programme coverage
10. Morbidity information

Mortality data

To estimate the Mortality rate, the following information needs to be collected:

1. The total number of people (of all ages) currently in the household
2. The number of people who were in the household at the start of the recall period
3. The number of deaths
4. The number of births
5. The number of people who have left the household during the recall period
6. The number of people who joined the household during the recall period

Other household data that are often collected

7. The age and sex of each of the household members
8. The number of deaths that were of children below 5 years old
9. Information about the causes of death

Food security

Food security data are collected at the same time from the same population, but by separate teams using different methods. Food security and other questions are not added to the nutrition/mortality survey. Food security data comes mainly from key informant interviews using the household economy approach, market assessments and observations. The training and skills required to collect these data are different from those required for nutritional and mortality assessment (see section 3 of the manual).

Obtain and prepare equipment, supplies and survey materials

Measuring material, scales and height boards should be in good condition. During the survey, the scales should be checked each day against a known ten kilogram weight (standard weight). If the measure does not match the weight, the scales should not be used. Spare equipment is needed to allow for damage or loss.

Equipment and supplies includes transport, fuel, paper & pens, per diem and recording forms. A list of materials needed for a survey is given in appendix xxx

Copies of questionnaires, absentee forms and forms for referral of moderately or severely malnourished cases to supplementary feeding and therapeutic feeding programmes (if they exist) should be prepared. (see appendix xxx for sample forms)

Select the survey teams

1) For the nutritional and mortality components, each survey team consists of a minimum of three people. Two make the nutritional measurements and one records the data and serves as the team leader. The team leader is responsible for the quality and reliability of the data collected. The same team members can sometimes take both the anthropometric and conduct the mortality interview. However, it is usually better to have a fourth team member who interviews the head of household to collect the census and mortality data.

A respected member of the community should be asked to participate in each team, in addition to the trained persons. This makes the survey much more efficient, smooth and rapid. The community member, who knows the village, introduces the survey team to the population and households, knows or can easily find out the whereabouts of any absent households, speaks the local dialect and assists in guiding the team around the location. In addition, it is sometimes necessary to have a translator on the team. The team members and their equipment should be able to comfortably fit in the available transport.

Team members do not have to be health professionals. Anyone from the community can be selected and trained. They need to be fit, as there is usually a lot of walking, and have a relatively high level of education. They must be able to read and write fluently, count accurately and if possible speak the local language. Women have more experience dealing with young children and should usually make up the majority of team members. In some cultures it is necessary to have at least one male member of the team to interview male heads of household. The most important attributes are that the team members are friendly, personable, hard working with a sense of pride in doing the job properly and eager to learn.

Two to six teams may be needed depending upon the number of households to be visited, the time allocated to complete the survey and the size and the accessibility of the area covered. Although it is faster to have more teams, the quality of the data deteriorates. It is also much more difficult to train, supervise, provide transport and equipment and to organise a large number of teams.

There should be a survey supervisor. This person should be experienced in undertaking nutrition and mortality surveys, training team members, organising logistics and managing people. The supervisor has overall responsibility for training the team members, visiting the teams in the field, ensuring that the households are selected properly and that the measurements are taken and recorded accurately. Unexpected problems nearly always arise during a survey. The supervisor is responsible for deciding how to overcome the problems. Each problem and decision that he/she makes must be recorded at the time and included in the final report. The survey team supervisor is responsible for overseeing data entry into the computer, and for the analysis and report writing.

2) There is a completely separate team for the food security component of the survey.

One team is sufficient. They have a separate training from the nutrition/ mortality survey team. They will not be selecting houses at random. The food security data is mainly collected during key-informant interviews. It is semi-quantitative. Its reliability is assessed through replication of the interviews with separate informers/groups.

Train survey team members

Adequate training of the survey team members before the survey is critical. There is no place for "on the job training" during data collection. All members should undergo the same training, whatever their former experience, to ensure standardisation of methods.

Survey management

The survey supervisor ensures that the equipment is checked and calibrated each morning during the survey.

Where possible, each evening, the survey supervisor organizes a "wrap up" session with all the teams together to discuss any problems that have arisen during the day[3].

Before leaving the field, the team leader should review and sign all the forms to make sure no pieces of data have been left out. If there were people absent from the house during the day, the team should return to the household at least once before leaving the area.

The survey supervisor should supervise survey teams in the field regularly. In particular, the supervisor should check cases of oedema. Often, there were no cases of oedema seen during the training with "normal" children. In this case, some team members may

[3] This may not be impossible if the survey area is large, so that teams are widely separated and remain in the field for several days. Communication with teams in the field is often very difficult, in these circumstances each team leader must be sufficiently trained to be able to take decisions independently.

mistake a “fat” child for one with oedema (particularly with younger children). The supervisor should look out for teams that report a lot of oedema and should actually visit some of these children to verify the data.

The team must not be overworked. When people are tired, they make mistakes or fail to select houses appropriately if a longer walk is required. Surveys can be very tiring because of all the walking involved. The supervisor must make sure the team has enough time to take appropriate rest periods and has refreshments with them.

Analysing and interpreting the data

Each evening, or during the next day whilst the teams are in the field, the supervisor should arrange for the data to be entered into the computer.

Recording errors, unlikely results and other problems with the data may become obvious at this stage. The computer program is written so that abnormal values are flagged as the data are entered. In the morning before the teams set out for the day, there should be a short feedback session. If any team is getting a large number of “flagged” results, the supervisor should accompany that team the next day. If the results are very different from those obtained by the other teams, it is sometimes necessary to repeat the cluster from the day before.

The team leaders and survey supervisor should record all important points in a notebook as soon as possible (during breaks, or at base in the evening). Include observations, ideas, problems and actions taken and the reasons for any decisions taken. Each note should be labelled with the date, location and names of relevant people.

Apart from the evening and morning meetings, the survey team members should regularly discuss their experiences and findings together. This often brings out important points and sometimes shows that the survey method has to be modified.

If possible, at each household, the team leader should calculate or look up in a table the percentage weight-for-height median score for each child and classify the child’s nutrition status. This should certainly be done for any child who appears to be malnourished. When a malnourished child is identified he or she should be referred, on the spot, to the nearest health or nutrition facility. Ideally, this will be a therapeutic or supplementary feeding programme. If these are not available, the supervisor should urge the parents to take the child to the nearest health facility. The team should have referral slips with them on which the name, height, weight, percentage weight-for-height and diagnosis is written.

The team that is collecting the food security data should attend the meetings if possible. They will have a definite input into solving any problems that may arise (because the nature of the data that they are gathering is more likely to give anthropological insights). Discussion with the survey teams that are going to different villages throughout the whole survey area will indicate whether the sites chosen to conduct the key-informant interviews are “typical” of the whole area and whether such interviews should be replicated elsewhere within the survey area.

Report writing

The final part of a survey is writing and disseminating the report. The results of the survey should be presented in a standard format so that different surveys can be compared, no important information is left out and the reader learns where to look, within the report, to find particular pieces of information.

The report must be produced as soon as possible after the data are collected. The computer program is written so that all the important data are automatically presented in the appropriate format and the headings for the sections of the report are produced. The results of an emergency survey must be released and disseminated as soon as possible to prevent any delay in the intervention. Reports for emergency nutrition and mortality surveys should be available within one week of the end of collection of the data. Baseline survey reports may not be needed so soon.

This is where the data from the nutrition & mortality components are melded with the food security data to give an overall picture of the situation within the survey area.

The quantitative nutritional and death rate results have to be put into context. Though this partly comes from background information and previous surveys, it mainly comes from the food security data gathered from the same area at the same time. These data together are used to make recommendations and to formulate plans of action for intervention.

Section 2: Nutrition and mortality survey

The Nutrition component

Children who have not taken sufficient food (whatever the cause - starvation, loss of appetite, psychological, malabsorption) do not grow. With a more severe insult they lose weight. This is judged by measuring their height and weight and comparing the results with a standard.

For an individual, these measurements are used to decide whether the person is admitted to a supplementary feeding programme, or treated for severe malnutrition. At the population level, the same measurements are used in the survey to estimate what proportion of a population is moderately or severely malnourished.

Malnutrition in this context takes three forms: 1) failure to grow results in *stunting* in height; 2) loss of the tissues of the body results in *wasting*, and 3) accumulation of fluid results in *kwashiorkor* (also called nutritional oedema, or hunger oedema). The prevalence of each of these is assessed during a nutrition survey by making "anthropometric measurements" and examining for oedema.

Other forms of malnutrition, like micronutrient deficiency, are not normally assessed during a "nutrition" survey, even though they may cause a lot of morbidity and mortality in the community. Most micronutrient deficiency diseases do not cause stunting or wasting and their prevalence cannot be determined from anthropometric measurements. An important corollary of this is that if the result of the anthropometric survey does not give rise to concern, there could still be major micronutrient deficiency in the population that is undetected, but that is an underlying cause for illness and death.

Populations for anthropometric surveys: 6-59 month old children

In emergencies, weight loss among children aged 6-59 months is used as a proxy indicator for the general health and well being of the entire community. This assumes that children aged 6-59 months are as vulnerable as other age groups to external factors (such as food shortages and illness) and the nutrition status of these children is as sensitive to change as that of other age groups. This is usually, but not always, true.

In practice, this group is much easier to measure than other population groups. Young children are generally at home, the parents are usually concerned about their children and willing for them to be measured, they are not embarrassed and there are usually fewer cultural restrictions about taking off their clothes. The equipment needed is not as cumbersome as that for older age groups.

There is a lot of experience with surveys of this age group, so that the new survey can be compared with previous surveys. Policy makers are used to seeing and acting upon such data. Furthermore, there is not yet any international agreement on anthropometric indicators and "cut-off" points used to assess acute malnutrition in adolescents, adults, pregnant and lactating mothers and older people.

It must be reiterated that surveys of children aged 6-59 months are used to indicate the situation of the whole population and not just young children. The data must not be used to justify confining relief to children within this age group just because they have been surveyed.

When to measure the nutritional status of people over 5 years of age

Surveys including other age groups are more complex and require greater technical expertise than surveys assessing only children aged 6-59 months. However, there are some situations when it may be appropriate to consider assessing the nutrition status of other age groups. These include the following:

1. There is a relative increase in the crude death rate (CDR) compared to zero to 5 death rates. The 0-5DR is generally about twice the CDR. A disproportionate increase in the CDR suggests that there is a particular problem in older age groups so that the 6-59 month age group is no longer a good indicator of the stress of the whole population.
2. There is reasonable doubt that the nutrition status of young children reflects the whole population's nutritional situation. In populations where the cultural traditions give preference to young child feeding or there is a high prevalence of HIV, older adults may be more severely affected.
3. Many adults or older children present themselves to selective feeding programmes or health facilities with malnutrition.
4. Credible anecdotal reports of frequent adult or adolescent malnutrition are received
5. The data are required as an advocacy tool to persuade policy makers to address the needs of other age groups. This should not be needed.

The methods for sampling and measuring other age groups are the same as those for the 6-59 month age group described in this manual.

Infants less than 6 months can be included, but there are particular difficulties with accuracy and precision of the measurements, as well as the quality of the reference, in this age group.

Nutrition indices and indicators

In order to determine the nutrition status of an individual, the weight, height, age and the presence of oedema is recorded. The relationship of measurements to each other is compared to international standards. The nutrition indices used in surveys are height-for-age (HFA), weight-for-height (WFH) and weight-for-age (WFA).

As a child grows, he gets taller. The height of the child in relation to a standard child of the same age gives an indication of whether the growth has been normal or not. This index of growth is called **height-for-age**. Children who have a low height-for-age are referred to as stunted. Because growth is a relatively slow process, if a child of normal height stops growing it takes a long time for that child to fall below the cut off point for stunting[4]. Because of this, height-for-age is sometimes used as an indication of long-standing or chronic malnutrition. The insult that led to stunting may be in the past so that the current growth rate may be normal, although this is unusual without a change in the family circumstances. Stunting may also be due to inter-uterine growth retardation with normal post-natal growth.

As a child gets taller he also gains weight if his body proportions are to remain normal. If he is thin then he will weigh less than a normal child of the same height. **Weight-for-height** is a measure of how thin (or fat) the child is. Because weight gain or loss is much more responsive to the present situation, weight-for-height is usually taken to reflect recent nutritional conditions. Being excessively thin is called "wasting". It is also often termed "acute malnutrition", although individual children may have been thin for a long time. An advantage of using WFH to assess the nutritional state is that it does not involve age; in many poor populations age is not known and is difficult to estimate reliably, especially in emergency situations.

Both stunted and wasted children do not weight as much normal children of the same age. **Weight-for-age** is thus a composite index, which reflects both wasting and stunting, or any combination of both. In practice about 80% of the variation in weigh-for-age is related to stunting and about 20% to wasting. It is **not** a good indication of recent nutritional stress in the population. It is used, because it is an easy measurement to take in practice, in the community to follow individual children longitudinally.

Mid-upper arm circumference (MUAC) is also sometimes measured. It directly assesses the amount of soft tissue in the arm and is another measure of thinness (or fatness) like weight-for-height. Although it is easier to measure MUAC than weight-for-height, it is more difficult to make a precise measurement, it is not standardised for age and the cut-off points are not universally accepted. Nevertheless, MUAC is the best index to use in the community (screening) to identify individual children in need of

[4] A child who is 100% of normal who falters so that he is now growing at 70% of normal will take up to half his life to fall below the usual cut-off point and be labeled as moderately stunted. Thus, a one year old child gaining height at 70% of normal will not be designated as stunted for 6 months.

referral for further assessment or treatment. Because MUAC is used in this way in the community, it is useful to know the relationship between weight-for-height and MUAC in a particular community in order to establish a full nutrition program including screening. This is why MUAC is sometimes included in the data collected in a survey. MUAC data are often not reported or emphasised in a report and decisions are not usually based upon these data alone. It is an absolute criterion for collecting data that it is going to be used and useful for the community surveyed.

The weight-for-height, height-for-age and weight-for-age are calculated for individuals and groups using the NUTRISURVEY software[5] (See 'Using Nutrisurvey software step by step'). Users of this manual are not expected to have to calculate these values without the aid of a computer.

The reference population curves

In order to assess malnutrition as defined by WFH, WFA and HFA, individual measurements are compared to a reference value (also called a standard). At present the international reference value that is used is from surveys undertaken in USA (NCHS/WHO/CDC reference table, WHO, 1983). New reference values are being compiled at the moment. The problem with the present standards is that many of the young children used to generate the standards were bottle-fed and became heavy relative to normal breast-fed babies. As the present standards reflect the weight of heavier, non-breast-fed babies, the prevalence of malnutrition calculated using these standards will be higher than with new standards.

Although SMART will adopt these new standards whenever they become available, until many surveys have been conducted with the new standards and the humanitarian community has become used to interpreting the results, SMART will continue to report the prevalence of malnutrition using both standards. The reference values should not be considered "ideal"; they are used as a "standard" to compare the nutritional status in different regions, and in populations over time. It is a standard in the same way that the meter or the kilogram are standards used to measure length or weight in a standard way.

The NCHS references for children aged 0-59 months age given in appendix xxx. Each team should have a copy of these tables so that during the survey they can identify those children that need immediate referral to a nutrition or health facility.

Expression of nutrition indices

Anthropometric indices are usually expressed in two ways. Either as the percentage of the median value of the standard or as z-scores

[5] The software "Epiinfo" can also be used to calculate the nutritional variables.

The percentage of the median

The percentage of the median[6] weight-for-height (often written WHM[7]), compares the weight of the child to the median weight of children of the same height in the reference population. The calculation of a WHM for each child is based on:

- the child's weight
- the median weight for children of the same height (and sex) in the reference population

WHM = individual's weight divided by reference median weight × 100

Example.
In a nutritional survey, a male child who is 92 cm tall weighs 12.1kg. The median weight for boys in the reference population who are 92 cm tall is 13.7kg.
WHM = 12.1/ 13.7 × 100 = 88.3%

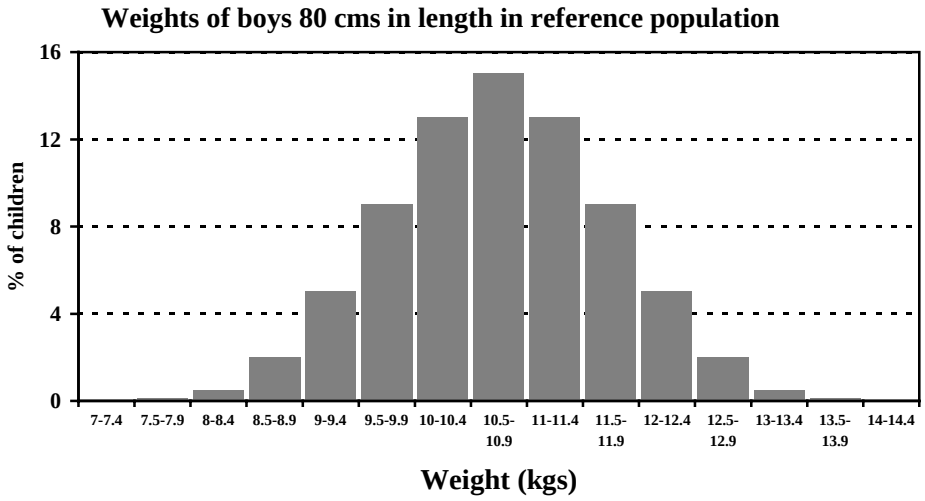
The z-score

A z-score is another measure of how far a child is from the median weight of the reference (often written WHZ). The children, from the reference population, of the same height are distributed about the median, some heavier and some lighter. For each such group of children, there is a "standard deviation" of the reference population. This standard deviation is expressed as the number of kilograms at each height. The z-score of the child being measured is the number of standard deviations (of the reference population) the child is away from the median value. This is illustrated in the diagram below.

[6] The median is a type of "average". It is used instead of the mean because the standard population is not normally distributed. This was a problem with bottle feeding making some of these children obese so that the upper half of the distribution is slightly more "spread out" than the lower half. The median is simply the middle value which has half the population above and half below the given median value.

[7] It is also sometimes written as "WHP". However, this abbreviation is also used for WFH expressed as a centile value, because of common usage of the malapropism "percentile" in place of centile. The abbreviation has been changed to WHM to avoid confusion.

Figure1. reference table for use with z-score



The WHZ is based upon:

- the child's weight
- the median weight for children of the same height and sex in the reference population
- the standard deviation of the distribution of weights in the reference population for children of the same height and sex.

WHZ = (individual's weight minus reference median weight) divided by the standard deviation of weight for the reference population

Example
In a nutrition survey, a male child of 84cm weighs 9.9kg. The reference median weight for boys of height 84cm is 11.7kg. The standard deviation for the reference distribution for boys of height 84cm is 0.908. The z-score for this child is then:.
z-score = (9.9-11.7)/ 0.908 = -1.98

These calculations will all be done by the computer, but it is useful for you to understand the basis for the calculation.

Mean weight-for-height percentage (of the median) and mean Z-score

The mean weight-for-height percentage of the median (WHM) and the mean Z-score are sometimes used to describe the nutrition status of a population. This is calculated as the mean WHM = sum of WHM (or Z-score) values in the group divided by the total number in each group.

Definitions of acute malnutrition in children aged 6-59 months

WFH is the criterion used to assess moderate and severe malnutrition, to monitor changes in the nutrition status of the population and for admission and discharge of individuals to and from feeding programmes.

Oedema

The presence of oedema should also be assessed during the survey. Pitting oedema on both feet (bilateral oedema) is the sign of kwashiorkor. In an emergency context, any person with bilateral oedema has severe malnutrition[8] and is classified as severely malnourished even if the weight-for-height z-score or percent of median is normal.

Moderate, severe and global malnutrition

Individuals are classified as being normal if they have no oedema and have a weight-for-height equal to, or above, -2 Z scores or 80% of the median. If they are less than minus 2 Z-scores or below 80% of the median and above or equal to minus 3 Z-score or 70% of the median they have moderate acute malnutrition. If they are below -3 Z-scores or 70% of the median or if they have oedema on both feet then they have severe acute malnutrition[9]. This is sometimes referred to as SAM (severe acute malnutrition). The classification is shown in the following table.

Table 1. Definitions of acute malnutrition using weight-for-height and/or oedema in children aged 6-59 months

Acute malnutrition using WFH	Percentage of the median	Z-scores	Oedema
Severe	< 70 %	<- 3 z-scores	Yes/no
	>70 %	>-3 z-scores	Yes
Moderate	< 80% to >= 70%	<- 2 z-scores to >= - 3 z-scores	No
Global	< 80%	<- 2 z-scores	Yes/no

Global acute malnutrition (GAM) is the term used to include all malnourished children whether they have moderate wasting, severe wasting or oedema or some combination of these conditions.

[8] There are other causes of bilateral oedema such as heart failure, kidney disease (nephritic syndrome), thiamine deficiency, pre-eclampsia in pregnant women. However, in an emergency context most bilateral oedema, especially in children, is due to kwashiorkor.

[9] Note that the terms “severe wasting” and “severe acute malnutrition” are not synonyms. Severe acute malnutrition is the sum of severe wasting and oedema.

In the examples above, the child who had a WHM of 88.3% is not acutely malnourished because his WHM falls above the cut-off point for acute malnutrition. The child who had a z-score of -1.98 is also above the cut-off point and is classified as not acutely malnourished

Example 1
A group of 905 children was measured in a survey. None of the children had oedema. Fifteen children had WHZ<-3 z-scores and 45 had WHZ<-2zscores and >=-3 z-scores.
Prevalence of severe acute malnutrition = number of severely malnourished children divided by total number of children multiplied by 100
= (15)/905 × 100 = 1.7%
Prevalence of moderate acute malnutrition = number of moderately malnourished children divided by the total number of children multiplied by 100
= (45)/905 × 100 = 5.0%
Prevalence of global acute malnutrition = prevalence of severe acute malnutrition plus the prevalence of moderate acute malnutrition.
= 1.7 + 5.0 = 6.7%.

Example 2
Another group of 910 children was measured in a survey. Six of the children had oedema. Of these six, one had a weight-for-height z-score < -3.0, two had weight-for-height z-scores between –3.0 and –2.0, and three had weight-for-height z-scores > -2.0. Overall, 17 children had WHZ<-3 z-scores and 55 had WHZ<-2zscores and >=-3 z-scores.
Prevalence of severe acute malnutrition = number of severely malnourished children divided by total number of children multiplied by 100
= (17+6 -1)/910 × 100 = 2.4%
One of the oedematous children was also severely wasted. The child cannot be counted twice. The oedematous are added to the severely wasted and the number reduced by the number of children who have both oedema and severe wasting.

Prevalence of moderate acute malnutrition = number of moderately malnourished children divided by the total number of children multiplied by 100
= (55-2)/910 × 100 = 5.8%
Two of the moderately wasted children had oedema: they have already been included in the severely malnourished category. The children cannot be counted in both categories. The moderately malnourished are the total with moderate wasting minus those moderately wasted children who had oedema and were therefore counted with the severely malnourished
Prevalence of global acute malnutrition = prevalence of severe acute malnutrition plus the prevalence of moderate acute malnutrition.
= 2.4 + 5.8 = 8.2%.

The user of this manual will not have to make these calculations because they are done automatically using the software.

Why have both percentage of the median and z-scores to estimate acute malnutrition?

Z-scores and percent of median produce slightly different estimates of the prevalence of wasting[10]. Therefore, if survey results present both indices, there will be two estimates of the prevalence. The Z-score is said to be more statistically valid than the percentage of the median, and has become the standard index used in nutrition surveys. Nonetheless, there are several reasons why percent of the median should also be reported.

- It is a better predictor of mortality than z-score, which is the outcome that is of dominant interest.
- It is used for the admission of patients to feeding programs because it is a better predictor of death and directs resources where they are most efficiently used[11] and is used for the admission of adolescents where WHZ cannot be used.
- It is easier for lay people to understand and for survey managers to explain because it does not require an understanding of statistical concepts.
- It is easier to calculate with a simple calculator.

Anthropometric surveys should always report the prevalence of oedema and of low weight-for-height as defined by the percentage of the median and z-scores.

Chronic malnutrition in children

The long time-scale over which height-for-age is affected makes it less useful for deciding when to intervene in an emergency. It is useful, however, for long-term planning and policy development. Although at an individual level stunting develops slowly, the degree of stunting can change within a few months when averaged over a population. Incorrect age data makes HFA information misleading and reliable age data can be difficult and time-consuming to obtain. For this reason, age data are generally gathered in an emergency survey to determine if the child is appropriately included in the sample or not (i.e., is the child probably between 6 and 59 months?), rather than to obtain accurate information about stunting.

[10] There will always be a higher prevalence of malnutrition using WHZ than WHM. The cut-off lines cross each other at the height of a normal 6 month old child.

[11] The nutritional status of adolescents can also be expressed as WHM, but not as WHZ. Using WHZ for admission leads to up to one third more admissions than WHM; the additional admissions do not require to be in therapeutic feeding programs.

The Mortality Component

Usually, public health workers at the start of an emergency have to rely on cross-sectional surveys to determine current nutrition status and death rates in the recent past. Ideally, surveys complement a functioning surveillance system to estimate acute malnutrition, verify surveillance data, and answer specific questions that the surveillance system is not providing or about areas that the surveillance system is not covering.

An elevated death rate can indicate that there is a health problem in a population, but it cannot indicate the cause.

To determine the death rates, a member of each selected household is interviewed. The data required are the number of people who live in the household and the number of deaths that have occurred during the recall period (a specified period of time in the recent past). Each day, each member of the household is at risk of death, although very few actually die on any given day. The actual deaths are expressed in relation to the number of people and the length of time they were at risk. We need to find out how many people have been at risk during the recall period and not just those who are in the house at the time of the survey. Household members who have left the household should be counted. Similarly, those who have joined the household during the recall period, have not been at risk for the whole of the recall period. During the calculations, these factors are taken into consideration.

Mortality measurements and indices

The Crude Death Rate (CDR)[12] is defined as the number of people in the total population who die over a specified period of time. It is calculated from the following formula:

$$\text{CDR} = \frac{\textbf{Number of deaths}}{\left(\dfrac{\textbf{Total Population}}{\textbf{10, 000}}\right) \times \textbf{Time interval}} = \textbf{Deaths/10,000/day}$$

In the formula, the Total Population is the population present at the mid point of the time interval. The time interval is the length of time within which the respondents are asked to state if any deaths have occurred; this is usually referred to as the "recall period". The

[12] The term Crude Mortality Rate (CMR) has been used when referring to deaths per 10,000 per day by some epidemiologists and those working in complex emergencies. Crude Death Rate (CDR) is used when referring to deaths per 1,000 per year (the units used by demographers and most epidemiologists). The terms are interchangeable. It is recommended that the term Crude Death Rate be used. This is to maintain consistency with the expression of Age Specific Death rates where there has been considerable confusion.

units for the formula are deaths per 10,000 per day[13] when the "time interval" is expressed in days.

Nomenclature: The Age-Specific Death Rate for Children Less than Five Years of Age. Under-Five-Mortality-Rate or Zero-to-Five-Death-Rate.

There is an important problem with nomenclature that has led to considerable confusion. The term "Under 5 Mortality Rate" is being used in two distinct and quite different ways.

First, demographers and epidemiologists use the term to denote the calculated probability of dying before the age of 5 years expressed per 1,000 live births. In this original sense it represents the probability of a child born during a particular year dying before that child reaches five years of age assuming that there is no change in the mortality rate. It is thus comparable to the infant mortality rate, which is the probability of a live born child dying before the age of one year. The calculations are quite complex; it is also necessary to determine the birth rate. Under 5 Mortality rate, used in this sense, cannot be calculated from the survey methods outlined in this manual.

Second, those working in complex emergencies later used the same term to refer to the rate of death of children aged from 0 to 5 years over a specific time interval. It estimates the incidence of death over a recall period. In this sense it is comparable to the CDR. Epidemiologists and demographers also calculate this rate, but they refer to it as the "Age Specific Death Rate for Children zero to 5" and use the notation "$_5M_0$". In a similar way, other Age Specific Death Rates can be estimated for other age ranges of the population.

Although, with both meanings of the term the same phenomenon is being estimated, the concepts, calculations and numerical 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).

In this manual we will restrict the term "Under 5 Mortality Rate" to the first, original definition. We will use the term "Zero to Five year Death Rate" (0-5DR) for the second definition. That is to denote the Age specific Death rate of children less than five years of age. This is simply a clarification of nomenclature introduced to avoid confusion. 0-5DR is the same as the Under 5 Mortality Rate used in the past by those working in complex emergencies. To be consistent, we will also use the term "Crude Death Rate",

[13] The CDR can also be expressed using other units such as deaths per 1,000 per month, in which case the time interval is expressed in months and 1,000 is substituted for 10,000 in the formula. 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 death/10,000/day to death/1000/month multiply by 3.04. Similarly, to express the result as deaths per 1,000 per year, the time interval is expressed in years. The conversion factor is 365/10 = 36.5. to convert death/10,000/day to death/1,000/year multiply by 36.5. The different ways of expressing the CDR are exactly equivalent; one can be readily converted to another. In this manual and reports it is recommended that ALL death rates are expressed per 10,000 per day to avoid confusing non-expert readers who become used to working with one set of units. This recommendation applies no matter the length of the recall period used.

rather than “Crude Mortality Rate”, to denote the total death rate in the population over a given time interval.

Zero to Five Death Rate

The zero to 5 death rate (0-5DR) is defined as the number of children aged from birth to 5 years of age who die over a specified period of time in relation to the total number of children below 5 years of age in the population. It is calculated from the following formula:

$$\text{0-5DR} = \frac{\textbf{Number of deaths of children 0-5 years}}{\left(\dfrac{\textbf{Population of children 0-5}}{\textbf{10, 000}}\right) \times \textbf{Time interval}} = \textbf{Deaths/10,000/day}$$

The formula is similar to that used to calculate CDR. In this case only deaths in children from birth to five years are considered and the population is the total number of children from 0 to 5 years of age present at the mid point of the time interval. The time interval is the length of time within which the respondents are asked to state if any deaths in children have occurred.

In general the 0-5DR is about twice the CDR.

Determining the recall period

The “recall period” for the mortality survey is the time interval over which you count deaths. Deaths which occurred before the recall period are not recorded as deaths even though the interviewer is often told about such deaths and will respond sympathetically.

If the recall period is three months, you will try to establish the number of deaths that occurred among your sample population during the three months prior to the day of the survey.

The number of deaths is expressed in relation to both the number of people sampled and the number of days they have been at risk; this “person-days” at risk, is the denominator in the calculation of mortality rate. The length of the recall period is thus a critical factor in determining the mortality rate.
Six thousand people at risk over three months is mathematically equivalent, in terms of the total risk of death, to three thousand people at risk over six months and to eighteen thousand people at risk for one month. There needs to be a substantial number of person-days included in order to record sufficient deaths and to determine the mortality rate with a narrow confidence interval. If the recall period is too short, a very large number of households will need to be visited and interviewed, which makes the survey unwieldy. On the other hand if the recall period is too long, then the information on the mortality rate may well be sufficiently “out of date” to be unhelpful in an emergency situation, particularly if the emergency is “evolving” rapidly.
The following factors should be considered when you choose a recall period:

- Objectives: how will the mortality information be used? How current does the information have to be? What time period is needed to address the objectives?
- Are mortality rates changing rapidly? If so, then knowing the mortality rate over the last few months is likely to be more important than knowing the average rate over six months or one year.
- Seasonality: Does the mortality change markedly with the different seasons of the year? If so then you are more likely to capture the current season if the recall period is not longer than a few months.
- Migration: over a short recall period there will be fewer household members leaving, and fewer new members joining, the household. This simplifies the interview and calculations. With mass displacement there may be very few households who have had a stable composition during a prolonged recall period.
- Accuracy: the shorter the recall period the more accurate the estimate of mortality. This is because more distant events are more likely to be forgotten by the respondent and there are likely to be more mistakes in the time of death. (Recall periods longer than one year should not be used).
- Precision: the longer the recall period the more precise the estimate of mortality (the narrower the confidence interval) with a given sample size. This is because the "sample" is actually the number of person-days considered rather than simply the number of people. With a longer recall period, a smaller number of households needs to be interviewed to achieve an acceptable confidence interval.
- Logistics: The longer the recall period the fewer persons (and households) needed in the sample. Although, a longer recall period may increase the time needed at each household, the time saved by going to fewer households more than compensates for a longer interview.

If you want to increase precision, you may increase either the length of the recall period or the sample size (i.e. the number of households[14] in the survey) or both. Logistical constraints usually limit the number of households which can be visited by survey teams.

How do decide on the length of the recall period?

- During an acute emergency, it is usually advisable to use approximately a **3 month recall period**. A 3 month recall period is a compromise; it allows an estimate of the death rate that is reasonably close to the current situation to allow for planning health and nutrition interventions, whilst usually giving a reasonable precision from about the same number of households that will need to be visited for the nutrition component of the survey. A shorter recall period may result in insufficient precision, and a longer recall period may not be sufficiently representative of the current situation and may increase recall bias.

[14] Household definitions are culturally specific and need to be decided in the field. A frequently used definition is "who slept here last night and ate from the same cooking pot".

- If the objective of the survey is to document mortality over a longer period of time, recall periods of up to 12 months are justified. For example, if major violence resulted in population displacement six months ago, you may want to document the mortality rate, for two separate periods; three or six months before, and the 6 months since, the displacement. Because this increases the complexity of the mortality survey, it should only be included if the added information is useful and if the persons interviewed can reliably place deaths into the time intervals. These are advantages and disadvantages of lengthening the recall period beyond 3 months:

Box 1. Advantages and disadvantages of a longer recall period

Advantages of a longer recall period	*Disadvantages of a longer recall period*
• Fewer households need to be interviewed to achieve the same precision. • If deaths are recorded for specific parts of the recall period, it is possible to look at sub-intervals of time (e.g. before and after major violence) or examine seasonal trends.	• Mortality rate may be less relevant to current needs than a more recent mortality rate • Important or traumatic events may be recalled as having occurred more recently than they actually did (recall bias) • Additional information, such as cause of death, becomes increasingly unreliable as the recall period lengthens

The beginning of the recall period should **always** be a date that everyone in the population remembers. For example, the start of the recall period should be a major holiday or festival (Christmas, beginning of Ramadan, Duvali, etc.), an episode of catastrophic weather, an election, coup, political decree or a similar memorable event. Some populations are aware of the phases of the moon. Care should be taken for events that may have occurred at different times in the various parts of the survey area, such as onset of the rainy season or taking in the harvest. Very local events, such as a village feast may be locally memorable, but there are likely to be some parts of the survey area that are unaware of that particular feast – their feast, with the same name, may have occurred at a different time altogether.

You then calculate the length of the recall period by counting the days between this date and the date of survey data collection. This is very rarely a nice round number of days, like 90 days. The NutriSurvey software allows you to enter any number of days for the recall period. In populations where calendar time is not closely followed, dates are not well remembered or there have been no memorable events, placing deaths in time can be very difficult. Such uncertainties should be fully documented in the report.

Box 2. Example of selecting a recall period

You need to assess mortality in a rural population because it has been predicted that next year's harvest is going to be a failure and you want a baseline measurement now. The seasonal calendar of events which have a direct impact on mortality is shown below. The population faces seasonal shortages of food from May to October, but particularly from August to October, and outbreaks of malaria occur in the season of heavy rains in January and February. The harvest is normally due in November.

	Food shortage	Malaria outbreak
Jan		**X**
Feb		**X**
Mar		
Apr		
May	**X**	
Jun	**X**	
Jul	**X**	
Aug	**XX**	
Sep	**XX**	
Oct	**XX**	
Nov		
Dec		

Imagine you undertake the mortality assessment in October:

If you use a recall period of 3 months you will obtain mortality data which is affected by the worst of this year's food shortage period.

If you use a recall period of 6 months you will obtain mortality data which is affected by the moderate food shortage as well as the more severe food shortage.

Other things being equal, your estimate of the CDR using the shorter recall period will probably give a higher CDR than the estimate using the longer recall period because recent mortality has probably been higher than mortality in the more distant past. The same would be true if you were estimating the death rate for the malaria season during an assessment in March. If you took too long a recall period, you would dilute the effect of malaria on mortality rates.

You may wish to select a recall period which covers the whole previous year in order to include all the seasonal influences on the mortality rate and establish a baseline.

Planning the survey

Sampling

The sampling method is selected based upon the way in which the households are distributed and the size of the population to be surveyed.

1. Occasionally with very small populations, every household in the population can be visited (called an exhaustive survey), but this is unusual.
2. Where the houses of the **whole population** of interest are arranged in a systematic way (such as in some refugee camps), simple or systematic random sampling is used for the entire sampling process.
3. Cluster sampling is used when households are distributed in an unstructured way that does not easily allow all the households to be listed or numbered.

The most usual method is cluster sampling.

Normally, highly insecure areas are excluded from the population under consideration before selecting the clusters. Sometimes extra clusters are chosen so that if one or more clusters cannot be visited because of sudden insecurity, not expected during the planning phase, the insecure clusters can be replaced. In this case the new areas of insecurity cannot be considered part of the sampled population; this must be reported and shown on the map.

Exhaustive surveys.

If all the households from a given population were interviewed and all the children aged 6-59 months measured, we would get a precise picture of the nutrition status and mortality rate of the population. This is called an exhaustive survey, and it is possible in small populations such as a small camp or an institution such as an orphanage. For a larger population, an exhaustive survey is long, costly, difficult and unnecessary. The results cannot be extrapolated to another camp or population.

> Example. An organisation wants to know the rate of malnutrition in a refugee camp for which it is responsible. There are between 2,000-3,000 people in the camp. It is estimated that 20% of the population is less than 5 years of age; therefore, there are about 400-600 children less than five years of age. All the children were measured and households interviewed.

Exhaustive surveys will not be considered further in this manual

Representative sampling.

Instead of interviewing all the households and measuring all the children, a sample is taken which “represents” the whole population. It is important that the sample is chosen so that it does indeed represent the whole population. This is done by choosing households at random from the population. The critical point is that each household and

child in the population must have an exactly equal chance[15] of being selected into the sample.

Convenience sampling.

Series of children measured in health centres, market places or other places where people gather are not representative. The children that come to health centres are not the same as those that do not need to attend; similarly, well children can go to the market, run around the village and follow the assessment team; sick children are more likely to be in the house. The results of measuring such groups should never be called a "survey" – it can be called a "series" – but no decisions should ever be based upon such a "grab" sample. Similarly, clusters can never be selected on the basis of convenience. If we were only to select households in villages that are near to the road again we will not get a representative sample. Villages near roads have better access to transport and may be wealthier than more remote villages. In all of these examples, all the households and children in the community do not have an equal chance of being selected. Because they go to a clinic, are running around the village, live near a road or in the centre of a village should not lead to them being more likely to be selected.

If it is likely that malnutrition in a particular area or one group of people is much higher than in another, it is necessary to do two separate surveys. This is particularly true if different programs are likely to be implemented for the different groups or areas. For example, a resident population is likely to be different from refugees/IDPs in the same area and should not be mixed together in the same sample.

If there are more than two distinct population groups in the same area, you might need to do more than two surveys in that area. Surveys cost time and money, however, and you should only conduct more than one survey if there is a real reason to suspect that there is a difference in the rate of malnutrition, and that you will be able to respond to the different groups differently.

Precision and sampling error

Most surveys which estimate the prevalence of malnutrition or death rates make these estimates from randomly sampled households selected from the population of concern. There will always be some differences between the results obtained from the sample, regardless of how big it is, and the entire population from which the sample was selected. For example, if a room contains 10 men and 10 women, random samples of 6 persons from this room will sometimes contain 3 men and 3 women, sometimes 4 men and 2 women, 2 men and 4 women, or, more uncommonly, 1 man and 5 women or 5 men and 1 woman; very rarely the sample would have six men or six women. The frequency with which any of these samples are likely to be chosen can easily be calculated mathematically using standard statistical theory; the same theory has been applied to samples from a population.

[15] Or, if the chances are not exactly equal, the relative chances of being selected must be known beforehand. However, this makes the calculations very complicated, so for practical purposes each child must have an equal chance of being selected.

Samples which are very different from the entire population are much less likely to be randomly selected than samples for which the results are similar to the entire population. The difference between the measurement in a sample and the true value in the entire population is called the "sampling error".

The size of the sampling error can be estimated. The way the sampling error of a survey is presented is as the "confidence intervals"[16]. If a survey were repeated many times with the same sample size and method, 95% of the calculated death or malnutrition prevalence rates would fall within the 95% confidence interval. The 95% confidence interval is an expression of how certain we are that the actual result in the population is similar to that we have obtained from the survey. For example, if a survey estimates the prevalence of malnutrition to be 8.7% with a 95% confidence interval of 7.1% – 9.5%. We are 95% sure that the actual malnutrition prevalence in the population in which the survey was done lies between 7.1 and 9.5%.

Sampling error is an estimate of "precision", that is, how similar the results are if a survey is repeated over and over. If the confidence interval is wide, sampling error may be responsible for a substantial difference between the estimate of the death rate calculated from the survey and the true value in the population. Precision is increased, and the confidence interval narrowed, with larger sample sizes. This means that the larger the sample size, the narrower the confidence interval and, if there is no bias, the more certain we are that the survey result is close to the actual population value. For mortality surveys the sample is "person-days" so that the sample size can be increased by either increasing the number of subjects or the recall period. Statistically, a large sample size is preferable. However, it takes more time, money, personnel, and other resources to measure more children or ask more households about mortality. During planning we decide the precision needed (how much uncertainty we will tolerate) and then calculate exactly how many children or households are needed in the survey to achieve this precision. Including additional children or households wastes resources, prolongs the survey, delays the report and gives a result that is unnecessarily precise. Nutrisurvey software calculates the sample size needed to achieve a given degree of sampling error in the results of the survey; this software should be used routinely to calculate the sample size instead of using a fixed sample size or survey design. The factors entered into Nutrisurvey for both nutrition and mortality calculations must always be included in the report.

Bias

Sampling error is not the only source of difference between a survey's result and the actual population value. Sampling error is due to the random selection of households from the population; it cannot be eliminated, but it can be minimized by selecting a larger sample. The degree of uncertainty is calculated by the software and presented in the report.

[16] Other ways of expressing the sampling error, such as the "standard error", are used in other contexts.

Bias is anything, other than sampling error, which causes the results of the survey to be different from the actual population prevalence or rate. Bias cannot be calculated and its effect upon the result assessed. It is the main reason why surveys may not give an accurate answer. The fact that the results are biased is usually not appreciated by those doing the survey; it is usually not apparent from the results and its extent cannot be judged by those reading standard reports.

Readers may distrust the results of a survey if the level of malnutrition or the death rates differ from those expected. The reader will examine a survey particularly closely if the results do not "triangulate". For example, if the food security and mortality data do not indicate that there is a crisis when the nutritional status is reported to be very poor, the reader will suspect that the nutritional data is incorrect because of bias. This uncertainty can lead to relief being delayed or even denied by donors when it is urgently needed. Alternatively, it can lead to waste of supplies and resources if a relief operation is mounted when the situation is thought to be much worse than it actually is. The reader must be able to rely on the results of a survey for there is a great deal at stake. A careful and full description of the methods and precautions taken to minimise bias is essential to give the reader sufficient confidence in the results to lead to action. If precautions to minimise bias are not taken, and fully described in the report, a sceptical reader will assume that a mistake has been made and that the results can be discounted.

Bias is minimised by using good technique. This is the main reason why the supervisor has to be experienced, why adequate training is critical and why the report has to document all the steps taken to eliminate or minimise bias.

Examples of bias include:

1. Because the foot piece of a length-board was loose, one team systematically measured the height of each child to be 1 centimeter taller than they really were. Even if weight was accurately measured, each child's weight-for-height z-score would be lower than it should be and the prevalence of wasting exaggerated. Any inaccuracy in the equipment or measurement technique will lead to a systematic bias.

2. Inaccurately taken weight and height, even when the inaccuracy is random and evenly distributed between over-measurement and under-measurement, results in systematic overestimation of the prevalence of wasting. This overestimate is greater for severe malnutrition than for moderate malnutrition, and relatively greater when the true prevalence is low than when it is high. The effect of inaccurate measurements is to widen the distribution curve. Because we are counting the number of children in the tails of the distribution below the cut-off point of minus 2 Z-scores, any artificial widening of the distribution curve will increase the number of children in the tails and thus increase the apparent malnutrition rate. Analysis of many surveys has shown that this is a common and major cause of error. Its extent can be estimated from examination of the standard deviation of the weight-for-height, which should always be between 0.8

and 1.2 Z-scores. If the SD is outside these limits then the prevalence of malnutrition should be calculated from the mean value assuming a normal distribution and an SD of one Z-score unit (these calculations are performed by Nutrisurvey); this is the result that should be reported. The report should make it clear that the calculated prevalence is presented, instead of the prevalence obtained from the count of children below the cut-off point, because of probable measurement errors.

3. Shortcuts" are likely to be taken if the survey teams are required to work too hard, if there is inadequate time allocated to rest periods and refreshments, or if the time that can be spent in a particular household, to administer the mortality questionnaire and measure the children properly, is not sufficient. These "shortcuts" can take many forms. The team members are usually aware that they have deviated from the standard method, but through solidarity will not inform the supervisor. For example:
    1) The team may "rush" the interview or the measurements. They should be able to spend sufficient time in each house to complete their tasks properly and complete a cluster within one day. Most teams try to complete at least one cluster each day. The data may be much more accurate if the sample size is sufficiently low to have 20 or 25 households in each cluster instead of 30 households. By provoking "shortcuts" increasing the sample size may introduce substantial bias, leading to an inaccurate result, in an effort to achieve a higher precision.
    2) A team may not select the households at random when they reach a cluster site. They may go to the village and take a "convenience" sample of some sort because of tiredness, heat, hunger, and harassment or because they have insufficient time to select the sample correctly. This tends to be more common in rough terrain of when there is a long distance to walk to the edge of the cluster.

4. Survey respondents misunderstand questions about mortality in their households and tell survey interviewers, for example, that persons who left the household are dead. This would lead to an overestimate of the death rate, thus increasing the difference between the death rates calculated from the survey results and the actual population death rates.

5. The following are some of the sources of non-sampling error that occur particularly during the interview.

    a. ***Recall error**:* Respondents often fail to recall all deaths during a given recall period. Infant deaths, in particular those within a short time of birth, are particularly under-reported. Respondents may also report ages, dates, and salient events wrongly.

    b. ***"Calendar" error:*** Respondents may report events as happening within the recall period when they did not (or vice versa) due to lack of clarity about dates.

c. ***"Age heaping"/digit preference**:* Respondents may round ages to a number ending in a 0 or 5. This can be a problem with 0-5DR or other age-specific death rates.

d. ***Sensitivity/taboos about death:*** In general, the death of a household member is not a subject discussed readily with a stranger. In some cultures, taboos about death may hinder discussion if the subject is not broached with tact and understanding.

e. ***Deliberate misleading**:* In some populations, with experience of relief operations, some of the respondents may deliberately give incorrect answers in the expectation of continuing or increased aid. This can even be orchestrated by local people with authority.

f. ***Mistranslation**:* Questionnaires may contain mistranslated key terms and concepts (a common example is what constitutes a family vs. household). Interpreters may misunderstand questions or mistranslate answers.

g. ***Interviewer error:*** Enumerators may ask questions and/or write down answers incorrectly, skip questions, or rush respondents in an effort to get done quickly.

h. ***Data-entry error:*** In the process of data entry, answers can be miscoded or entered incorrectly.

i. ***Analytic error:*** In the manipulation of any data, especially quantitative data requiring statistical analysis, mathematical and conceptual errors can generate faulty results or explanations

Because bias cannot usually be calculated or corrected by the computer after data collection is finished it is critical to avoid bias during sampling and data collection.

However, we can examine the quantitative data to see if there is likely to be some form of systematic bias. The teams should be aware that such techniques will be applied during the analysis in order to avoid succumbing to any temptation to take shortcuts. We examining the results using the following tests (calculated automatically by Nutrisurvey).

1. Compare the data (weight-for-height, oedema prevalence, CDR and 0-5DR) collected by the different teams. If any particular team has obtained data that is statistically different from the other teams it is likely that this team's technique has created a systematic bias. The team differences are tested by a statistical technique called "analysis of variance" that is built into Nutrisurvey. The software will warn the analyst if any team's data are suspect. If this happens then if there is time, the aberrant team's clusters should be re-sampled using a different team and the new data substituted for the aberrant data[17]; if re-sampling is not

[17] If the second team gets data that is similar to the original team's data then there is probably a real difference between the particular clusters assigned to that team and the remainder of the clusters. If this is the case then the original data should be retained. The design effect will be

feasible within a reasonable time, then the data should be analysed with and without the aberrant clusters and both results reported, with a recommendation from the survey supervisor indicating which result is likely to be more reliable. There has to be a full report of such occurrences and how they are resolved. Perhaps that team's equipment is faulty or their training has been inadequate; certainly, the checking of the equipment and supervision has not been adequate.

2. Examining the distribution of weight-for-height for each team separately. If the standard deviation of weight for height for any particular team is outside the range 0.8 to 1.2 Z-scores then their data should be replaced by a calculated prevalence of malnutrition based upon the their mean value.

3. Examining the quantitative data for "digit preference". That is the data having an excess of particular digits as the last digit in the measurements of height or weight. This is done overall and for each individual team. Such "rounding" by the measurer of the team usually results in an excess of "0" or "5" as the last digit. The data obtained during training should also be examined for evidence of digit preference.

4. It is frequent for teams to get tired during the day. The measurements taken in the morning are often taken more carefully than those in the late afternoon. The data collected from the first and second half of each of the clusters is compared. If for example, there are 30 children in each cluster and one cluster was done by each team each day then all children with cluster numbers 1-15 are compared to those with cluster numbers 16 - 30. The data that are compared are not only the final results for death rates, weight-for-height, and oedema cases, but also the counts of members of households, children, in- and out-migrants deaths and births.

These tests can indicate the presence of some types of systematic bias and help to resolve the problem. Bias is particularly difficult to detect if all the teams have been trained to make the same mistake. Further, bias is more likely to go unnoticed in the interview than with the quantitative measurements. It is far better to take great care to avoid bias and to demonstrate to the teams, during training, the disastrous effects bias. Bias is minimised by:

- careful standardisation of measurement techniques,
- using standard weights and length-sticks to check the accuracy of equipment,
- training survey workers well,
- writing clear questions to be asked of survey respondents,
- back-translation of all questionnaires,
- using more than one translator and comparing their results when interviewing the same households,
- careful choice of the start of a recall period,

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unusually high. If the second team's data are very different from the original data this confirms that there was a systematic bias in the work of the first team.

- using local calendars,
- using the minimum sample size that gives adequate results so that the teams are not stressed
- providing comfortable transport and clothes for the staff
- ensuring adequate rest and refreshment periods
- making sure that the payment to the teams is adequate and agreed.
- having motivated cohesive teams that participate fully in the daily meetings and report any difficulties promptly and faithfully. The teams must be trusted by the supervisor.
- And applying the other techniques mentioned in this manual.

Sampling methods

There are three main methods used for nutrition and mortality surveys: 1) simple random, 2) systematic random and 3) cluster sampling. Each uses a standard method of selecting the subjects designed to eliminate bias and get a representative sample.

First, there has to be a clearly defined population for which you need to estimate the prevalence of malnutrition. This might be the children living in a refugee camp, several villages, a district, a region or even a whole country.

Second, it is critical to obtain available population data.

The best place to obtain population data for a district is usually from district Government offices or other agencies working in the area. Similarly, regional level population data usually are available from regional Government offices. In refugee camps, you should be able to get population data from United Nations High Commission for Refugees (UNHCR) or NGOs working in the camp. If no population data are available, for example for newly displaced people or refugees, a rough population estimate can be made by estimating the number of dwellings and the number of people in each dwelling.

The next step is to choose the most appropriate sampling method to used.

Simple random sampling: When a list of every household or individual (and if possible the location) is available, individuals are randomly chosen from the list using a random number table. This is an uncommon situation and so is rarely used.

Systematic random sampling: Systematic random samplingis used either when there is a list of the households or where the population is geographically concentrated and all the dwellings are arranged in a regular geometric pattern. Such a situation may occur in a camp where tents are pitched row after row, in blocks of flats, where streets are laid out in a grid or where the houses are all along the edge of a river, coast, road or other major feature. The first household is chosen at random. The subsequent households are visited systematically using a “sampling interval”; this is determined by dividing the total number of households by the number needed to give an adequate sample.

Every house has an equal chance of being chosen before the first house is selected. This method is usually used for small scale surveys of limited areas. This method is also

frequently used to select the households to sample within a "cluster", used in the next method.

Cluster sampling: This is the most common form of sampling. The sampling is in two stages. First, the whole population is divided, on paper, into smaller discrete geographical areas, such as villages[18]. For each village, the population size is known or can be estimated. Clusters are then randomly selected from these villages with the chance of any village being selected being proportional to the size of the village. This means that each person in the whole area has an equal chance of being selected[19]. This is called sampling with "probability proportional to population size". In the second stage, the individuals are chosen at random from within each cluster area or village.

Population data

The population data may be very inaccurate or out of date particularly if there has been population movement because of the emergency. As many sources of information as possible should be used to list all the known villages in the area to be surveys. If the population figures are unavailable, use local knowledge to assign a relative size to each village. A starting village, A, is used and the other villages described in terms of their relative size (x is half the size of A, y is twice as large as A etc); these factors are then used to give the villages weights. Sometimes only vague descriptions are available, very big, big, medium, small, very small, for example. These descriptions can also be used to give the villages weights[20] to allow sampling proportional to population size.

Inaccessible areas

A common problem occurs when there are parts of the population within the sample area that are not or cannot be sampled. In some countries, surveys can only be conducted within a radius from an airstrip or road. In others there are areas that cannot be accessed because of insecurity, impassable roads and rivers or mountains. The results are often presented as representative of the whole area. This is incorrect; a map showing the accessible areas that are included in the survey should always be presented with the report and it should be made clear what areas are excluded.

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[18] The term "village" is used throughout the manual for convenience. It is used here to denote any area, where people live, that has been given a separate name by the local authorities or population. This may be a traditional village, part of a town or city, subdistrict or even a rural area bounded by geographical features such a stream or river. When the area is named, the population knows the boundaries of the area and the authorities either know or can estimate the population of the area.

[19] Although larger villages are more likely to be selected to contain a cluster than smaller villages, the individual households within the larger village are less likely to be sampled than a household from a small village. These effects balance each other so that each household in the whole population has an equal chance of being selected.

[20] It is unclear what relative sizes should be given to these descriptions; for example very big = 2,500, big = 1,600 medium = 900 small = 400 very small =100; or very big = 500, big=400, medium=300, small=200, very small=100. or some other estimated size. It is normally better to take one typical village that everyone knows and then describe the other villages in terms of fractions or multiples of the index village.

Nobody expects surveys to be done in inaccessible areas and the surveyors will not be criticised for omitting such areas. They will be criticised for pretending that they have included areas that are, in reality, inaccessible. The report can legitimately discuss whether inaccessible areas are likely to be better or worse than the surveyed areas.

Calculating sample size

With any particular study design, the calculation of the sample size depends on making the following decisions.

1. How wide a confidence interval can be tolerated? This determines the minimum precision around the estimate of malnutrition or death rate that will result in a useful result.
2. What are the expected malnutrition prevalence and death rate?
3. What is the likely design effect (if the survey is to use cluster sampling)?

How do you make these decisions?

1) The first consideration is the minimum precision needed to meet the objectives of the survey. If a survey is done to determine whether one third or more of the population is malnourished or there is a gross elevation of death rate, for example, then much less precision is needed than for a survey designed to estimate whether there has been a change since a similar survey conducted three months previously. The desirable precision and expected prevalence/death rate are interconnected. If there is a very high prevalence of acute malnutrition – say 40% - then the precision does not need to be high to enable agencies to make appropriate decisions. At a prevalence of over 35% or so, services will be overwhelmed and urgent and substantial intervention is needed; if this is true whether the actual malnutrition rate is 25% or 45% then plus or minus 10% for the confidence interval is perfectly acceptable. In general, the lower the prevalence the greater the precision needed. A survey that gives a prevalence of malnutrition of 7.5%, but with a confidence interval of 0 – 15% is not sufficiently precise to decide whether or not intervene; the confidence interval varies from no malnutrition at all to a substantial proportion of the population; such a result is useless for making program decisions.

2) The higher the malnutrition prevalence or death rate, the lower the precision obtained with a fixed sample size. However, as we have seen, with a high rate of malnutrition a lower precision is perfectly acceptable. There are ways you can guess the ranges within which the malnutrition prevalence and death rate are likely to lie. When making this assessment always decide upon a plausible range of values rather than a single value. “Given the situation the malnutrition prevalence is unlikely to be above 20% or below 10%” would be a reasonable statement in many situations. There may be surveillance data which include proportions of children presenting to clinics with malnutrition; a prior survey or one in an adjacent area of the country may have estimated these outcomes;

persons who have worked with the population since a previous survey may have a sense of whether malnutrition or mortality has become more or less common. A more general impression can be also obtained by asking health workers if they see many thin children. Religious leaders should be asked how many funerals they have conducted recently and the approximate size of their congregations as well as whether the number of funerals has increased or decreased recently.

3) Using cluster sampling requires a larger sample size than for simple or systematic random sampling. This is because the subjects within the same cluster are generally more similar to each other than to members of different clusters. This results in a decreased precision. The imprecision of cluster sampling is compensated by multiplying the sample size calculated for a simple random sample by a factor called the "design effect".

Design effects can vary from 1 (if population is homogeneous so that all the clusters are similar to one another) to 4 or higher where some clusters are not affected and others are severely affected. For example, if you think that malnutrition is more or less the same throughout the population, then the design effect is probably low. In most emergencies, the design effect for malnutrition is about 1.5 increasing to about 2 in more heterogeneous or large scale surveys[21].

If you anticipate that crude death rate or malnutrition prevalence is quite different in different parts of the population, then the design effect may be high and a value of at least 2 should be used in the calculation. If the design effect is thought to be much greater than 2 then the population is probably sufficiently heterogeneous that two separate surveys should be conducted each focused upon more homogeneous sections of the population. Two surveys, each with a design effect of 1.5, can be conducted with the same effort as one survey with a design effect of 3.

In emergencies where violence causes a large proportion of deaths, the violence is very rarely evenly distributed; the design effect can be up to 10. Such high design effects result in very large sample sizes if meaningful data are to be produced; for this reason it is often not efficient to include cause-specific mortality data in a combined nutrition/ mortality survey.

Probably the best sources for estimates for the design effect are prior surveys done in the same, adjacent of similar populations. Design effects from prior surveys should not be used directly to calculate sample size for a survey if there are very different numbers or

[21] The decision about severe malnutrition is more complicated because the design effect for oedema is normally greater than for moderate or severe wasting. There is insufficient analysis at the moment to make recommendations about the design effect for oedematous malnutrition (kwashiorkor).

sizes of clusters or if there is a reason to think that the heterogeneity of malnutrition or death has changed due to the present crisis.

Table 2 gives an indication of the sort of minimum precision that it is reasonable to achieve at various levels of malnutrition

Table 2.

Prevalence %	Precision %	Sample size Design = 1	sample size design = 1.5	sample size design = 2.0
5	2	456	684	912
10	2.5	553	830	1106
15	3	544	816	1088
20	5	246	369	492
30	7.5	143	169	287
40	10	92	138	184

Table 2 shows the minimum sample size calculated for various prevalence of wasting and the level of precision that is commonly asked for in conjunction with the anticipated prevalence. The column showing a design effect of 1 is for use with simple random or systematic random samples and those showing a design effect of 1.5 or 2 are for cluster sampling.

It is usually not feasible to achieve a precision greater than 2%. It has become common practice to use a sample size of 900 for cluster samples (30x30). In practice more than 900 children are very rarely needed in a survey. If a much larger sample size is generated by the calculations then perhaps you are aiming for an unrealistically precise result. It is usually possible to use fewer than 900 children which, in turn makes the logistics of the survey much simpler and may reduce bias. Thus, we strongly recommend that the survey supervisor uses Nutrisurvey to calculate the number of children needed for each survey that is conducted.

It is clear that when there is a major catastrophe with a very high level of malnutrition so that a high precision is not required to decide whether or not to intervene, a relatively small survey is sufficient. In this case, the survey can be conducted and reported much more rapidly.

At the levels of malnutrition and mortality generally found in emergencies, the decision about precision has a much greater effect on the sample size than the suspected prevalence of malnutrition or death rate. This is illustrated in table 3. If the malnutrition rate is thought to be about 10%[22] then to achieve confidence interval of 8-12% will

[22] 10% prevalence has been used by some agencies as an action level to intervene. If this is the case then a relatively high precision is needed if the prevalence is thought to be around this cut-

require up to 1729 children, whereas to achieve a confidence interval of 7-13% will require less than half that number: 768 children. This illustrates the dramatic effect attempting to increase the prevalence slightly can have on the sample require in the survey.

Table 3.

Prevalence %	precision %	Sample size design = 1	sample size Design 1.5	sample size design 2.0
10	2	864	1297	1729
10	2.5	553	830	1106
10	3	384	576	768

There is no "standard" precision, this is a judgement derived directly from the objectives of the survey. The supervisor must consider the likely results and whether wide are tolerable or whether narrow confidence intervals will be necessary in order to make program decisions. Another consideration is whether the survey results will be used in the future to determine whether the prevalence of malnutrition or death rates are increasing or decreasing. In the latter case a higher precision is desirable, although a lower precision may be adequate for the immediate planning requirements.

All the figures in the tables give a false impression of accuracy because the formula give results to the nearest one child. Given the uncertainty of the estimated ranges of prevalence and the design effects that are entered into the formula, the numbers produced by the formula are equally uncertain. They are definitely not "accurate" to the nearest child.

The advice to anticipate a range of likely values for the prevalence and for the design effect, within which you anticipate the results will fall is important. In the formula you should enter:

- the **widest** confidence interval that is acceptable
- the **highest** prevalence that is anticipated
- the **largest** design effect that is likely to be encountered.

The first choice will minimise the sample size whereas the two latter choices will each increase the calculated sample size. This is likely to result in a higher number of children being surveyed than will be found to have been absolutely necessary after the results are obtained. Nevertheless, it is much better to include a few extra children in the survey than to have to repeat the whole survey because there were insufficient children chosen during the planning stage, or to make critical program decisions on insufficiently precise

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off point. For various reasons, we do not recommend that 10% should be used in this way as an "action" point.

data. When there is a prior survey the anticipated prevalence and design effects can be chosen with narrower ranges so that subsequent surveys should be more efficient than the first one that is attempted in an unsurveyed population.

After the sample size has been calculated, using Nutrisurvey, the number should be increased slightly and rounded up to a convenient number that is a multiple of the number of clusters. This is to allow for contingencies such as being unable to measure all the children in selected households, having to exclude data during the "cleaning" process where implausible results are discarded and visiting households where there is no reliable respondent for the mortality questionnaire. In general the sample size is normally increased by 5% to 10% to allow for these and other unforeseen contingencies.

When the combined survey is designed the sample size to estimate the prevalence of malnutrition and the number of households that need to be interviewed to estimate the mortality rate are both calculated; the greater number should then be chosen for the combined survey.

Calculating sample size to estimate death rates

There are additional considerations when calculating the sample size needed for the mortality section of the survey.

The same underlying formula is used to calculate the sample size needed to estimate the death rate[23]. The calculation is not as straight forward as with the prevalence of wasting and it is recommended that Nutrisurvey be used for the calculation.

There are two additional factors that need to be considered in making the calculation.

- Recall period: the longer the recall period the fewer subjects need to be considered.
- The household size: the larger the average household size the fewer households need to be visited.

The following tables give examples of the number of households that will need to be interviewed with various CDR and levels of precision (assuming an average household size of 5). As with wasting, the higher the CDR the less precision that is generally required. Table 4 shows the sort of precision that is sought at different levels of CDR.

Table 4.

CDR /10,000/d	precision /10,000/d	recall period day	household Size		households design = 1.5	design = 2
0.5	0.3	90	5	472	708	944

[23] Details of the formula and examples of making the calculations from the basic formula instead of by the computer program are given in appendix xx

1	0.4	90	5	529	793	1058
1.5	0.5	90	5	505	758	1011
2	0.75	90	5	298	447	596
3	1	90	5	249	374	498

A CDR of 1/10,000/d is important because it is the level that is often used to declare an emergency. Table 5 below shows the numbers of households that would need to be interviewed with various levels of precision and a recall period of 90 days (3 months). It is generally not possible to achieve a precision much greater than 0.4 deaths/10,000/d with a survey of a reasonable size and a 3 month recall period. If a higher precision is required, then the recall period would need to be lengthened.

Table 5.

CDR /10,000/d	precision /10,000/d	recall period Day	household size Number	households design = 1	households design = 1.5	households design = 2
1	0.3	90	5	940	1410	1880
1	0.4	90	5	529	793	1058
1	0.5	90	5	338	508	677

Table 6 below shows the effect of changing the recall period. At a mortality rate of 1/10,000/d increasing the recall period to from 90 to 120 days has an dramatic effect upon the possible survey designs that are open to the supervisor; an unwieldy survey may become feasible with a reasonable effort. At this death rate a recall period of 60 days is insufficient to produce a reasonable precision and a straightforward survey.

Table 6 also shows that when the mortality rate is very high indeed (3 and above), then not only are wide confidence interval acceptable, but the recall period can be shortened considerably while still having a reasonable sample size. If there is a very high mortality that lasts for a long time, a large proportion of the population dies. Such a situation is usually clear. Generally, an acute emergency with a very high mortality is relatively short lived and it is appropriate to have a short recall period that covers the time of the acute emergency.

Table 6.

CDR	precision	recall period	household size	Households	households	households
/10,000/d	/10,000/d	Day	Number	design = 1	design = 1.5	design = 2
1	0.4	60	5	796	1193	1591

1	0.4	90	5	529	793	1058
1	0.4	120	5	395	593	791
3	1	45	5	505	758	1011
3	1	60	5	377	566	754
3	1	90	5	249	374	498
5	2	30	5	315	473	631
5	2	45	5	209	313	417
5	2	60	5	155	233	311

These examples show the importance of calculating sample size for each survey. With the mortality survey the variables that need to be entered into Nutrisurvey are:

- Anticipated CDR: deaths/10,000/d
- Desired precision: deaths/10,000/d
- Recall period: days
- Household size: number of people
- The design effect for cluster samples.

Sample size calculations for 0-5DR.

Data are normally collected for the less than 5 year old children in the camp and the 0-5 DR calculated and presented in the report. However, because the zero to 5 year olds form between 15% and 20% of most populations, the sample size for these children obtained from the household interviews will be about one fifth of the sample size for the CDR. The precision around the estimate is correspondingly poor. If a similar precision is required for the 0-5DR as for the CDR, then it is necessary to undertake a separate mortality survey to obtain these data specifically. The precision of the 0-5DR is not normally considered when designing a combined nutrition/mortality survey.

Methods for choosing households to be surveyed in the anthropometric and mortality surveys:

In statistical terms, all sampling methods are equivalent, as long as they result in a representative sample. The sampling scheme that should be chosen is determined mainly by the size of the population and the physical area and organisation of the households.

Simple random sampling

Simple random sampling is used where there is an up-to-date list of all individuals or households in the population, with enough information to allow them to be located. It is generally only used for small populations. It is the most straightforward method. Households (individuals) are randomly chosen by using the random number procedure in the planning sheet of the software.

In practice, a reliable population list is rarely available. In a very small population all the houses can sometimes be enumerated and given numbers by the survey team. The sample is then chosen from these houses using the software.

Steps for choosing households using Simple random sampling

Determine the number of households that need to be visited from the estimated sample sizes.

For the nutritional survey, we either know or calculate the average number of children per household (say 0.9 children per household). If we need to sample 344 children for the survey, 382 households (344/0.9) will need to be visited to complete the nutritional sample.

For the mortality survey we either know or calculate the average number of household members (say 4.55). If we need to sample 2105 people for the survey we need to visit 463 households (2105/4.55) for the mortality component.

The number of households to be visited is the greater of the two components of the surveys – this normally results in a greater number of subjects than necessary in one or other component of the survey.

Determine which households will be visited. Enter into Nutrisurvey the total number of households in the population and the number required for the sample. Nutrisurvey will select the required house numbers at random. It will then sort them into a list in ascending order to simplify visiting each house.

Measure all the children in each selected house and record their measurements on the data-sheet. Complete the mortality questionnaire for each household, even if the household has no children.

Systematic sampling

This method is used in relatively small geographic areas where there is an orderly layout of the houses that make it possible to go systematically from one house to another in order without omitting any of the houses. Usually the houses are mapped and can be numbered. Accurate population data are not needed for systematic sampling.

Figure 2. Example of a community where systematic sampling is possible (source MSF, in press).

Steps for choosing households using systematic sampling

1. Determine the number of households that need to be visited for the mortality, and children required for the nutritional survey using the Nutrisurvey software.
2. On the map of the site, trace a continuous route that passes in front of every household[24].
3. Determine the number of inhabitants and the number of households in the population (let us assume 50,000 people and 11,000 households as an example).
4. Estimate the number of children aged 6-59 months in the population. This can be estimated either from knowledge of the average number of children per household or the proportion of children in the population[25] (example 10,000 children).

[24] If the households are in neat rows, such as tents in a refugee camp, then it is not necessary to draw a map.

[25] In the least developed countries, characterised by high baseline mortality and birth rates, about 20% of the population are less than 5 years. In more developed countries the proportion is less

5. Calculate the number of households required.
    a. For the nutritional survey, we either know or calculate the average number of children per household (example 10,000/11,000 = 0.9). If we need to sample 344 children for the survey, 382 households (344/0.9) will need to be visited to complete the nutritional sample.
    b. For the mortality survey we either know or calculate the average number of household members (example 50,000/11,000 = 4.55). If we need to sample 2105 people for the survey we need to visit 463 households (2105/4.55) for the mortality component.
    c. The number of households to be visited is the greater of the two components of the surveys – this normally results in a greater number of subjects than necessary in one or other component of the survey.
6. Determine the "sampling interval" by dividing the total number of households by the number that must be visited. In our example, if the total number of households is 11,000, the sample interval = 11,000/643 = 23.7. You should round down to the nearest whole number - one household in every twenty-three should be visited.
7. Select the first household to be visited. The first household is randomly selected within the sampling interval (1-23) by drawing a random number which is smaller than the sampling interval using the Nutrisurvey software. For example, if the random number drawn is "5", start with the fifth house.
8. The next household to be visited is found by adding the sampling interval to the first household selected (or counting the number of households along the prescribed route). In the example, 5+23 = 28. Continue in this way so that you visit houses number 5, 28, 51, 74, 97, etc) until all the households selected have been visited. Theoretically, both the mortality and nutrition survey should be completed in all the pre-selected households even if this means that more children/subjects are included than are needed from the calculations of sample size.[26].
9. Measure all the children in each selected house and record their measurements on the data-sheet. Complete the mortality questionnaire for each household, even if the household has no children.

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than this. Useful data can be obtained from MICS or DHS survey reports or other surveys which have collected household census data.

[26] If the survey is halted as soon as sufficient subjects are included, then the people in the households at the "end" of the village are less likely to be sampled than those sampled at the beginning. However, if the sampling is halted as soon as there are sufficient children/subjects, it is unlikely to introduce a major bias provided that the sampling interval has been correctly chosen and the team is "close" to the end of the area when the survey is halted.

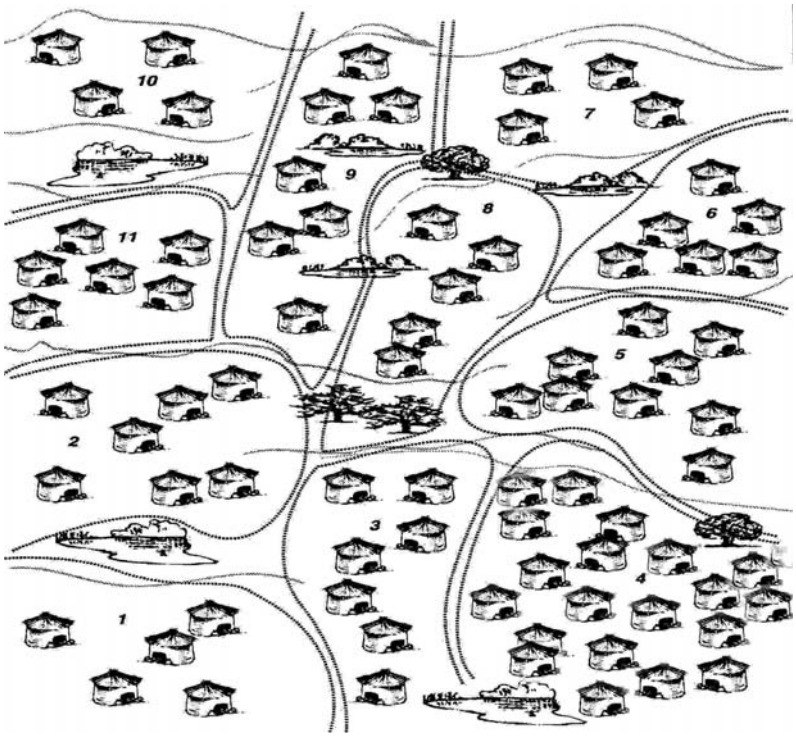
Cluster sampling

Two-stage cluster sampling is used in large populations, where no accurate population register is available and households cannot be visited systematically. This is the most common situation in most populations. Cluster sampling is more convenient than simple random sampling because a cluster design reduces the distance the survey team has to walk. However, the sample size is always greater so that more households need to be visited.

The sampling is split into two stages:

- Stage one: The villages with the clusters, or sampling sites, within the total population are selected randomly according to their size
- Stage two: The required number of houses within each cluster are selected and visited.

Figure 3. Example of a community where two-stage cluster sampling is needed



Stage one: selecting the cluster

Cluster sampling requires the grouping of the population into smaller geographical units like villages. The smallest available geographical unit is always chosen, as long as population data are available, and the geographical unit has a name. So if village data are available, use these localities as the geographical unit. If village data are not available, use districts. If there are no population data, draw a map of the area and with someone who is familiar with the area, roughly divide the area into sections of about equal size, following as far as possible existing geographic or administrative boundaries. Each area should have a local name, so that the inhabitants are familiar with the boundaries of the

area when the local name for the area is used. Each section should have at least the number of households required to form a complete cluster. If there are insufficient houses in a village then two adjacent villages should be combined at the planning stage.

The selection of the sections, from which a cluster will be chosen, is arranged so that the chance of any particular section being selected is proportional to the population of the section. Thus, if one section has a population of 5000 and another 1000, then the first section has five times the chance of being chosen to contain a cluster. This is the main reason why (approximate) population data are required.

Steps in choosing the clusters

1) Determine the sample size using Nutrisurvey.

2) Obtain the best available census data for each village, district, or section on the map. This is usually obtained from the local Government offices. In a stable population, such as a drought-affected region with little in- and out-migration, a census that is several years old may still be acceptable as a base for population proportionate sampling. However, in refugee situations where influx continues, reliable up-to-date counts are important for a valid sample. Alternatively, if no population data are available, you can estimate the relative size of the population living in each section of the map with a key informant.

3) On the planning page of Nutrisurvey (right hand side of pane) there is a table. Enter the names of all the villages (districts or sections on map) into the left column and their population size into the right hand column. The order in which you enter the villages is not important. What is important is that they must **all** be included.

The Software will automatically do the selection of the villages that should contain a cluster.

You will not be able to change a cluster site once it is selected. If the survey is to be unbiased, the selected site must be visited. Thus, it is important to define your geographical area in the planning stage, very realistically taking travel, security, and any other factor that could influence your ability to get to the cluster site into account before listing the sites in the planning table. An appendix of the report will give the list of villages included in the “draw” which will contain the whole population that constitute the people to which the results can be applied.

Large villages or sections of towns may be selected for more than one cluster. If this happens then the village should be divided in two equal sections geographically (say North and South) and one cluster taken at random from each division.

How many clusters should be selected?

The number of children in a cluster should generally be chosen so that one team can complete one cluster per day. If it is anticipated that the teams can only measure, say, 20 children per day, then the best strategy is to increase the number of clusters. The design effect is smaller with larger numbers of clusters. So although there are more clusters fewer total numbers of children are likely to be needed. Thus, 40 or 45 clusters of 20 children is more efficient than 30 clusters of 30 children.

If the teams leave base at 8 am and take one hour to reach the cluster site and a further hour to introduce themselves and select the first house, then measurements will start at 10am. The team will need two refreshment breaks of 15 min, one hour at lunch and will need to leave in order to get back to base before dark[27] – say about 4pm. This means that the team will have 4.5 hours to measure the children and interview the head of the household for the mortality survey. If thirty households are to be visited then there will be about seven minutes for each child and interview, with two minutes to reach the next house and introduce the team to the new house. Thus, all the data that is to be gathered from a family should be able to be collected in about seven minutes. If there are 20 visits to be made in the same time then the team can spend 11.5 minuets at each house, with only 15 visits per cluster the team could spend sixteen minuets at each house. These practical points should be considered when designing the survey. If the distances are not great, there is no insecurity and there is little walking from house to house, then more children can be included in a cluster. This is one reason why sample size should always be calculated to have the minimum number of visits that is compatible with the desired survey precision.

In household where the mother is not the respondent for the mortality interview, it is possible to conduct the interview and make the measurements on the children simultaneously (if there are separate team members for interviewing and measuring). However, in most households the mother will need to be interviewed. She should also be with her children when they are measured if they are not to be frightened by the team (of strangers). Thus, the two components of the survey will often need to take place consecutively even if there are additional team members. The interview should always take place before the anthropometric measurements. During the interview, the children will "settle down", see that the mother interacts with the team harmoniously and be more amenable to being measured.

Some of the houses will have to be revisited at the end of the day to measure children that were missing during the first visit. Time is short in practice and the team can get tired (in which case the quality of the measurements will deteriorate). These are the reasons why the amount of data collected from each house should be very simple and kept to the essential minimum. If this time scale cannot be kept, there are two choices. Either the team can take two days to measure one cluster, which will double the time taken to collect the data and is undesirable; or the number of children in each cluster can be reduced (so that there is more time to take careful data) and the total number of clusters increased. This is the better method for not overstressing the team.

For example, if data from 30 children cannot be collected in one day during the Field Test at the end of the training session, the number of clusters should be increased and the number of children in each cluster reduced.

The importance of calculating the sample size is that the fewer children that are needed the more likely that the team will be able to complete the sample in one day without

[27] Before leaving the teams will need to attend the briefing meeting, check their equipment, obtain their refreshment, fuel the vehicle, etc. Adequate rest and refreshment are essential and time must be allocated. In emergency situations it is inadvisable to travel after dark.

taking “shortcuts”. The common 30 by 30 cluster survey design is calculated to cover nearly every situation and give a relatively high precision when there is a high prevalence of malnutrition – it is a “worst case” situation, designed to be simple for inexperienced surveyors to follow and ensuring that nearly all surveys will have sufficient children. In general it is found that most surveys could have been adequately conducted, more cheaply and rapidly, with fewer children. To avoid bias, it is better to measure fewer children accurately than overstress the team so that the measurements are not made accurately, particularly at the end of the day when the team is tired and ready to travel back to base.

You should always plan to have at least 30 clusters. As the number of clusters decreases the design effect increases rapidly, so that below about 26 clusters the results become unreliable.

Therefore, the size of each cluster is chosen on the basis of how many households it is reasonable for the team to measure and interview in one day comfortably, without cutting corners and sampling each cluster appropriately and having time to return to households where the child was absent during the initial visit. This number is divided into the overall sample size to give the total number of clusters that should be used. Even under very difficult conditions, nearly every team can manage at least 15 households per day. So that if the total sample size is 450 or less there should be 30 clusters chosen. With a larger number of clusters you are more confident that a design effect of about 1.5 will be adequate rather than having to use a design effect of 2.

> Example:
> The team is working in very difficult terrain and can visit about 18 households per day. The total sample size is calculated to be 720 children. Then you should plan to have 40 clusters of 18 children in each cluster rather than 30 clusters of 24 children each, with the team having to spend two days at each cluster site.
> In fact, during the sample size calculation a design effect of 2.0 was used; if the number of clusters is to be increased we decide to reduce the design effect to 1.8. This reduces the desired sample size from 720 to 648. We can now design the survey to have 36 clusters of 18 children in each cluster. Four teams should complete the data collection in 9 days in comfort without being harassed. If we had insisted upon 30 clusters, each team having to spend two days at each cluster, the team would spend the first day measuring 18 children and the second day 6 children; the survey would take 15 days for the 4 teams to complete, and the survey would probably be of lower quality. This illustrates the importance of both doing a sample size calculation for each survey, having a cluster size that the team can easily complete in one day and the effect of choosing a realistic design effect upon the efficiency of the survey.

Stage two: selection of households to form the clusters

There are several methods of choosing the households from the cluster-area. The best way is to treat each cluster-area as if it is a “small population” and to select the houses using the simple or systematic random sampling methods described above. If the cluster is to be taken from a larger population, the first step of stage two is to subdivide the population into segments of roughly the same number of people. One of these segments is then chosen from the random number table. In this way the “village” is reduced to an area containing up to 250 households. These households are then listed and the required households selected from the list by simple or, if they are arranged in some logical order, systematic random sampling.

If it is not possible to select the households in this way then the "EPI" method can be used. Although, this method is simple, widely known easy to train, and rapid, it results in a somewhat biased sample[28]. However, the time taken to select the sample and move from house to house is far less when the EPI method is used[29].

Steps in using the EPI method

When the team arrives at the village that will contain the cluster, the following procedure should be followed after discussions with the village leaders:

1) Go to the centre of the selected locality (ask local people to assist).

2) Randomly choose a direction by spinning a bottle, pencil or pen on the ground and noting the direction in which it points when it stops.

3) Walk in the direction indicated by the pen, from the centre to the edge of the village. At the edge of the village spin the bottle again, until it points into the village. Walk along this second line counting each house on the way[30].

4) Select the first house[31] to be visited by drawing a random number, using a random numbers list, between one and the number of households counted when walking. For example, if the number of households counted was 27, then select a random number between one and 27. The team will not have a computer in the field, so each day[32],

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[28] . First, the households closer to the centre more likely to be selected. Consider a village with houses arranged in concentric circles around the centre. If each house occupies the same area, the number of houses in each circle will have about 6 times as many as in the previous one. If a direction is selected then a particular house on the periphery has a much lower chance of being selected than one near the centre. Second, because "proximity" sampling is used all the households selected for the cluster are more likely to resemble each other than more remote houses in the village. Because of this inherent bias, this method is not recommended. However, there are situations where using random sampling methods is not feasible.

[29] There have not been sufficient studies where the two sampling methods have been compared at "cluster" level for either nutritional or mortality surveys, to determine the extent to which this bias influences the results of the survey and the "design effect". Because the EPI method is much simpler and quicker to conduct, research to determine the extent of the bias introduced into nutritional and mortality surveys is urgently needed. When the results of such research become available the recommendations of this section may change.

[30] As the houses closer to the centre are more likely to be on the walking-line from the centre this modification of the standard EPI method is suggested to reduce bias when the walk is started from the centre of the village.

[31] It is important to carefully define a household. It is usually defined as a group of people who regularly eat together from the same cooking pot – but those that contribute to a common economy or sleep in the same compound may be more appropriate. The definition has to be decided at the planning stage and the same definition applied by all the teams consistently. Polygamous families may constitute one or more households.

[32] These can be generated and printed when planning the survey – one list is printed for each cluster and numbered one to 30 (or whatever the total number of clusters) – the team then takes the random sheet with them when they visit the village.

before setting out, the supervisor should print out a list of random numbers. One number for each range from 1 to 100. If the number five was chosen, then go back to the fifth household counted from the centre along the walking line. This is the first house you should visit.

5) Go to the first household and examine **all** children aged 6-59 months in the household for the nutritional survey and complete the mortality questionnaire.

6) The subsequent households are chosen by proximity. In a village where the houses are closely packed together, choose the next house on the right[33]. Continue to go in this direction until the required number of children have been measured and subjects enumerated for the mortality survey. The same method should be used for all the clusters. If the village is spread-out, then choose the house with the door closest to the last house surveyed whether it is on the right or left; this saves a lot of time in an area where the dwellings are very spread out. Continue the process until the required number of children has been measured.

When the house is selected

Too many children

In cluster sampling when the last house is visited to get the last child in the cluster and there are several children in the household, they should all be measured and included in the sample. Thus, if the planned cluster size is 25, some of the clusters will end up having one or two more children in the cluster. This is normal and expected.

In systematic sampling, the plan for selecting houses should be followed and all the children in the houses measured, even if this means that more children are measured than calculated by the sample size.

Not enough children

In cluster sampling, if the team runs out of houses to measure in a village (they can go to all the houses in a village) without identifying sufficient children, it is necessary to go to the next nearest village to complete the survey. When you arrive at the next village, repeat the process of selecting a house to start using the same method as for the first village. Proceed from house to house until sufficient children have been measured.

In systematic sampling, if the team has finished going to all the houses planned, and there is not sufficient children, the whole sampling procedure need to be repeated to select the remaining children. This is done by finding a new sampling interval and a new starting point. In the example given above, if another 40 children are needed then the new sampling interval (11,000/40) will be 275. They also need a new random starting point – say 193. They now need to visit every 275th household starting at house 193, to find the remaining children. This is a tiresome occurrence and doubles the work to find a few extra households. It is important not to overestimate either the proportion of children aged 6-59 months or the average household size when calculating the sampling interval. If the sampling interval is too large the total number of children measured will not be

[33] Or left, but the same rule should be used by all the teams – decided during the planning stage. It is more convenient to always go to the right for every survey.

enough. The sampling should not finish when the predetermined number of children is found; it should continue until all the houses that were selected are visited even if there are additional children and subjects for the morality survey; they form part of the sample.

No substitution

In each of the methods of selecting houses, whenever a house is selected according to the rules, there should not be a substitution for this house for any reason. Possible reasons for not including a house include refusal by the occupants to be measured, because the staff fear dogs, local people direct the team to include particular houses and omit others, the house is deserted or it is physically difficult to reach (up a steep hill for example). If the selected house is not included then the team makes a note and goes on to the next house according to the rules; another house is not substituted for the properly selected house. This is not usually a problem with the EPI method because the rules say that the nearest house to the right should be the next selected, but it does mean that a house to the left should not be substituted.

In the house

With all sampling methods, the house is the unit that is selected – it is not known how many children are in the house, or whether there are no children in that house before it is visited.

Measure all the children

ALL the children living in the house in the correct age range should be included in the sample and measured. If two eligible children are found in a household, both are included. This is important. It is one of the basic principles that every child should have the same chance of being selected at the outset of the survey. If there was one child in a house, that child would be selected. However if there are two children in one house and only one of them is selected, each of those children has half the chance of being selected as the child who is the only child less than 5 years of age in another house. If there are three children in the house then each has one third of the chances of being selected as the single child. It is clear that all the children in the community would then not have an equal chance of being selected. Some agencies used to select one child because they reasoned that the children within a house would have a similar nutritional status. Surprisingly, detailed analysis has shown that there is little correlation between the nutritional status of children living in the same household. Individuals seem to become malnourished rather than households.

No children

For all the sampling methods, if there are no children under-five in a household then this house is still part of the “sample” that contributes zero children to the nutritional part of the survey. However, it is very important to include this house for the mortality survey. Collect the data on mortality and any other data which forms part of the survey, record the household on the nutritional data sheet as having no eligible children, and proceed to the next house according to the rules. On the data-sheet, there is normally one line for each child. In cluster sampling, this goes up to more than 30 because the last house that is visited may have more than one child in it, so that a cluster can have up to about 33 children in it. The next lines on the data sheet should be used to record households with no children in them and the household is given a “household survey number”. With

systematic sampling go to the next selected house according to the plan (in the example, if there are no children in house 23, then collect the mortality data and go to house 41 – NOT to house 22 or 24). It is important that the households have the same identifying number on the nutritional data collection forms and the household census/ mortality forms.

Empty houses

If the house is empty, the neighbours should be asked about the family that lives in that house. On the data collection form, record why the house is empty (if this can be determined). If the residents are likely to return before the team leaves that cluster, the team should return to the house to include the residents in the survey. If they house is permanently empty or the residents will not return before the team must leave, this house can be skipped and a note made. Neighbours should be interviewed to determine the fate of the residents. It the house is empty because all the members are dead then the neighbour should be interviewed and all the residents recoded as having died. Do not substitute a house which is not in the original sample for the empty house.

Absent children

If a child lives in the house but is not present at the time of the survey then this child is recorded on the data-sheet when the house is visited. Of course the weight and height cannot be entered. Tell the mother that you will come back to the house later in the day, after you have been to all the other houses in the cluster or systematic sample. Then go back to the house to find the child. The team should continue to look for the missing children until it leaves the survey area. There are always some children who cannot be weighed or measured. This needs to be recorded and reported. The team should not simply take another child and forget about the child that is missing. If more than 5% of the children in a survey are not found, the teams should revisit the area at another time to see if they can complete the sample.

Child in a centre

If a child has been admitted to a hospital or feeding centre, the team must go to the centre and measure him or her there. This is critical as such a child is very likely to be severely malnourished. If it is impossible to visit the centre (it may be in a local town many miles away) then the child should be included in the data-sheet and a note added that the child was in a feeding centre and probably severely malnourished. They may or may not be severely malnourished in reality. If there are a large number of such children, and the centres cannot be visited to complete the measurements, then two rates of severe malnutrition can be calculated, one assuming that these children were severely malnourished and the excluding the children from the survey.

Problems often encountered

Population scattered over a large area

This is common in pastoral areas. The population numbers are usually very inaccurate and it takes more time for travelling between sites and finding the subjects. It is better to have more clusters with fewer children per cluster to make sure that there will be sufficient children at each site.

In some situations where the population is very spread out, you may deliberately choose to undertake a survey without sampling certain sections of the population. You might chose to sample only the population that lives together in larger settlements, which would save you the time and money needed to get into the bush to the more scattered population. This would mean that you would not include the population estimates from the scattered area when you are originally selecting your sample. As a result, you would have no accurate data about the nutritional status of children or the mortality rate in the population excluded from the survey. It is critical that the reader of the report is not misled – there has to be a clear description of the exclusion in the report. The decision to exclude or include sections of the population, such as small groups of scattered nomads, whose current whereabouts is unclear, will depend upon anecdotal reports of whether these groups are more or less affected than those that are more easily accessible.

Population is very mobile

If you are attempting to undertake a survey in an area of nomads where the population frequently moves large distances, it likely that you may travel to an area to find that there is no-one there and no-one nearby. If you suspect that this might happen, you should select some extra clusters before you start the survey. This way, if one cluster is deserted you can replace it with another one.

With nomads it is sometimes more appropriate to list the names of the groups, clans or extended families themselves instead of villages or other such fixed settlements. The clans to be sampled are then selected proportional to population size as normal, and the teams set out to find the clans within their normal migratory range.

However, sampling in nomads is a highly specialised topic and either the advice of an experienced epidemiologist should be sought or nomadism should be a cited as a reason for exclusion.

Occasionally in nomadic areas with a very sparse population it is not possible to do a representative survey. The total population of these areas is generally low.

Training the teams

Training the teams is one of the most important aspects of doing a survey. This aspect should not be rushed or assumed. It has been recently found from analysis of several hundred surveys that inaccurate measurements can have a very large effect upon the prevalence of malnutrition reported by the survey. The software has certain checks built into it to examine the internal structure of the data to make sure that each team is consistent with the other teams, that the measurers are not rounding the values inappropriately and that there are not large numbers of unlikely values. This examination of the data after it is collected is important and the team must understand that it will be looked at in this way by the software. However, there is no substitution for having a well trained, confident team that makes accurate and precise measurements. The software may recognise poorly conducted surveys, but it cannot correct them adequately.

The team members have to understand the principles of doing a survey, the reasons why this survey is being done and the likely interventions that could result depending upon the results. They have to be comfortable with this knowledge and not confused. They have to be able to explain and answer questions from community leaders, fathers and mothers. They have to be sufficiently well trained to be confident when they go into the community.

They must also learn to select the houses, talk to the mothers, make the specific measurements and record the results. This has to be done with practice. At the end of the practice they have to show that they can take the measurements accurately in a standardisation exercise.

The survey members will be formed into teams. It is important that the team members get on well together. The team leader and other responsibilities will be assigned at the end of the training. However, each team member should be able to perform each other's roles.

The training usually takes at least three days and should include the following.

1. A clear explanation of the objectives of the assessment.
2. Clear explanation of the roles and responsibilities of each of the team members, team leader, and survey supervisor (they should also be given a written "job description").
3. An explanation of the sampling method. This should stress the reasons and importance of each child and household member having an equal chance of being selected (including households without children for the mortality survey). The idea of random selection is sometimes difficult to grasp. Games, such as taking counters from a bag, should be used to illustrate the principles.
4. A demonstration of weight and height measurements.
5. Practice taking height and weight measurements and assessing the presence of oedema. After the team members have practiced taking measurements, they are formally tested to determine how well they have learned how to take the

measurements. For the tests, ten to twenty children of different ages between 6 and 59 months are recruited. Each team measures each child in rotation. The teams go round two times so that each child is measured twice times by each team. The data are entered into the computer during the training course. The software calculates how precise (ability to get the same result on the same child each time) and how accurate (how close the team is to true value, which this is taken to be either the average or the supervisor's values) each team is in taking the measurements. After training and practice, any team member who is unable to measure and record the anthropometry of the children within the limits set by the computer program should be replaced.

6. The teams should visit a therapeutic feeding centre, hospital or clinic to see cases with oedema and practice checking for oedema with actual cases. Note that most cases encountered during a survey will have mild oedema – do not train the teams only on cases with gross oedema. It is very common for teams to make errors in assessing oedema if they have only practiced on normal children, none of whom have oedema.
7. An explanation of any additional data that need to be taken.
8. Instruction and practice administering the mortality questionnaire. Both male and female headed households should be visited. There should be at least twice the number households as teams. Each team visits each household and administers the mortality questionnaire. As there is likely to be a "learning" effect by the respondent, each team should be the first to visit two of the practice households. The teams should get identical results.
9. A full-scale pilot test in the field. During the last day of the training, the team visits a village that is not part of the real survey, but is similar and convenient to the training location. The teams go through all the steps in conducting the survey under supervision in that village. Of course, data collected during the pilot test should not be used for the results.

During the pilot test the teams will demonstrate:

1. that they understand and can follow the sampling procedure. This means that the team will practice selecting the first house, the respondent(s) and children of the right age.
2. that they can take and record measurements correctly under field conditions. This means that the team members will practice working as a team, each with his or her allotted tasks.
3. that they can administer the mortality questionnaire
4. how they interact with the respondents.
5. their ability to organise the transport and care of the equipment.

At the end of the pilot test, the team members, leader and supervisor should be confident that each team can undertake the survey accurately and know how long it takes to

complete the survey of each household[34]. This information allows the supervisor to calculate how many households and children can be expected to be completed each day during the real survey. If this is excessive, any additional information being collected will need to be re-considered.

Standardisation of the measurements

The standardisation test consists of all the members of the teams measuring 10 different children twice, with a time interval between measures by one team on an individual child. The size of the variation between these repeated measures is calculated to assess how precisely each person measures the children (repeatability of measurements), and also each persons measurements are compared to the mean of the whole group to assess how accurately the measurements are made. Each team member is then be given a score of competence in performing measures. Any misunderstandings or errors in technique are corrected during the training. If any team member is unable to make the measurements sufficiently well, then they should be replaced or given a different job in the survey that does not require them to make the primary measurements.

The exercise is performed with a group of ten children whose ages fall within the range for the study (6-59 months). Before carrying out the standardisation exercise, the supervisor carefully weighs and measures each child and records the results without any of the trainees seeing the results. The supervisor is automatically given the ID number 0. The supervisor should start by filling in a form like that shown in Figure xx. It is important that the supervisor undertakes the exercise as well as the team members. The supervisor's data will be assumed to be of higher quality than the trainees, but the actual values should relate closely to the mean value for all the teams[35].

Each team member is also given a team-ID. So if you have 12 trainees they should be numbered 1-12. Each child that will be measured is also be given an child-ID starting from 1.

For the exercise, each child, with his/her mother, remains at a fixed location with the ID number clearly marked. The distance between each child should be far enough to prevent the trainees seeing or hearing each other's results.

At the beginning of an exercise, each a pair of trainees starts with a different child. The supervisor instructs the measurers to begin the measurements. The trainees should carefully conduct the measurements and clearly record the results on the second and third columns of the standardisation form next to the child's identification number. Each pair of measurers should have their own form to complete and each should take turns at taking the measurement. When each member of the pair has done the measurement they should move on to the next child. At the end the whole process the sheets are handed in and a

[34] The teams normally take longer during the pilot test than after they become used to working as a team.

[35] The supervisor's results can be taken as a "gold standard" or the mean of all the measurements can be taken as the gold standard. If there is a difference between the supervisor's data and the mean of the trainee's data then the exercise should be discussed and repeated.

second sheet is taken. The teams then take a break (lunch). The whole process is repeated after the break so that each enumerator has measured each child twice, but they have not been able to see the previous measurements that they made when they make the second measurements.

At the end of the exercise the data forms should look like those below:

Enumerator name……. ID ### 1st measure		
Child	Weight (Kg)	Height (cm)
1	14.6	96.0
2	10.3	89.8
3	13.8	105.1
4	11.1	84.5
5	10.8	89.3
6	9.4	76.3
7	10.3	87.6
8	14.3	101.1
9	8.0	74.3
10	15.6	97.0

Enumerator name……. ID ### 2nd measure		
Child	Weight (Kg)	Height (cm)
1	14.8	96.1
2	10.4	89.5
3	13.8	105.3
4	11.0	84.7
5	10.7	89.0
6	9.4	76.4
7	10.3	87.6
8	14.1	101.2
9	8.1	74.1
10	15.4	97.5

The same equipment is used to measure each child's weight and height that is going to be used in the survey itself. The team members rotate, but the equipment remains with each

child so that each child is always measured with the same equipment (the team is being tested not the equipment). Only one pair of measurers should be with a child at any one time. Talking between pairs of trainee measurers during this exercise should not be allowed.

The supervisor observes each trainee's performance. She should check the positioning of the equipment, the adjustment to zero, positioning of the child, child's clothing and angle at which the reading is taken. The supervisor should make notes on any errors to discuss with the team later.

The results of the training exercise are analysed by entering the data into the Nutrisurvey software and asking for the training-report.

If the results are poor then the whole exercise should be repeated, perhaps with different people matched together to make a team.

Field training

The training is practical, not confined to the classroom. Field training takes place after the teams are able to make accurate and precise measurements have "passed" the test and have formed teams that have practiced working together. For field testing the teams go to a convenient, local village that has **not** been chosen to contain a cluster. They practice selecting the houses that will form the cluster, practice approaching mothers and explaining the purpose of the survey, making the measurements and conducting the mortality interview. This is essential so that the team are confident when they arrive at the first "real" cluster during the actual survey.

The data from each of the teams is entered into Nutrisurvey and analysed. The teams should each have selected different households from the village (otherwise the selection it is likely that the selection was not random). Each team's results will be slightly different; this is used as a practical demonstration for the teams of the effect of sampling error and the importance of taking a random sample,

Taking the measurements

Nutritional measurements

Weighing equipment

The scale has to be light and robust. A suitable instrument for weighing children aged 6-59 months is a 25kg hanging spring scale marked out in steps of 0.1kg. Weighing pants should be provided with this scale. An electronic scale such as the Uniscale can also be used. Bathroom scales are not sufficiently accurate.

Equipment for measuring height and length

The measuring board should be at least 130cm long and made of hardwood with a hard water-resistant finish. Choice of wood is important[36]; the boards should be light enough to easily carry from house to house and should not warp in the rainy season. The board should have two tape-measures attached to it, one on each side, which should be marked out in 0.1cm steps. The foot-piece must be smoothly movable[37], remaining perpendicular to the board. The board should be easily set upright to measure height; the head piece of the length board becomes the base when the board is set upright. It must be large enough for a child to stand on it and to stabilise the whole board when it is set upright. The board or tape should not be of metal as this can get sufficiently hot in the sun to burn the child being measured. Height boards are usually made by local carpenters; there should be at least one commercial board. This is used as a template for the local carpenter to copy and is also used to standardise the locally made boards. A height arch can be used for selecting children shorter than 110cm. This can be constructed simply and should consist of a horizontal bar fixed at 110cm above the ground at right angles to a vertical pole (or between two vertical poles). Any child who can walk under this horizontal bar without hitting it, and without stooping, should be included in the sample for further measuring.

All the boards are standardised with a brush-handle that has been cut to measure exactly 100 cm.

Estimating age

Emergency nutrition surveys normally measure the weight and height of children aged 6-59 months. However, in many rural areas of the developing world, the age of children is not known. In general, the younger the child is, the more accurately you can estimate the month of birth.

The following methods may be helpful if the mother does not know the birthday.

---

[36] Aluminum should NOT be used; this is because it can get very hot in the sun and aluminum has a sufficiently high specific heat that it can burn the children. Wood is most comfortable for the child being measured. Rigid plastic boards are acceptable.

[37] It is best lubricated with by rubbing with a candle.

The mother may have the child's immunisation card, road-to-health card, or other written document with the child's age or date of birth written on it; always ask to see the child's immunisation card.

If the age of a neighbour's child is known, then you can ask whether or not their child was born before or after the selected child.

Use a local-events calendar. A local-events calendar shows dates on which important events took place during the past 5 years. It can show local holidays, hailstorms, the opening of a nearby school or clinic and political elections, etc. You ask the mother whether or not the child was born before or after a certain event. In addition, the local calendar can include agricultural events which occur at the same time each year. These events can help identify which month the child was born in. Although use of such a calendar can be quite time consuming.

Estimating age from height

Where the age is not available and a local events calendar cannot be used to estimate the age of the children, then it may be useful to use a height cut-off for selecting children instead of age.

The height of normal children of 6 and 59 months is approximately 65cm and 110cm respectively. Where age is not known then height could be used as a proxy measure. However, most populations where age is not known suffer from chronic malnutrition and the children are stunted. The less educated members of the community are more likely to have a stunted child and not to know that child's age. This can result in a bias in the selection of children into the sample.

To partially address this problem WHO recommends that in countries where the prevalence of stunting is known to be high the height range should be changed to 65 to 100 cm. However, this will always lead to a biased sample; height selection will include older stunted children and exclude younger but taller children. These inclusions and exclusions are unlikely to be representative of the children that would have been included/excluded if the age was known.

Of course, children selected using height (instead of age) criteria cannot be included in the height-for-age or weight-for-age information. During data entry the age fields are left empty so that the software can automatically exclude such children when assessing height-for-age and weight-for-age. The percent of children in the sample selected upon height instead of age criteria should be given in the report.

Unfortunately, there is no simple answer to the problem of "age unknown". It is likely that the estimates of stunting in many populations are inaccurate because of the problem of ascertaining age accurately. One particular difficulty is that different surveys, even ones in different regions of the same country or different population groups in the same area, will have a variable proportion of children selected to be included in the sample with an unknown age. This makes it difficult to properly compare surveys, although this problem is usually overlooked when such comparisons are made.

One solution would be to select **all** the children that are to be included in a sample on the basis of their height. So that instead of having a survey of children 6 to 59 months the

survey would be of children 65 to 110 cm. In stunted populations this would result in having a different group of children included in the survey. However, the results from different surveys would then be comparable, the selection criteria would be consistent, clear and unequivocal and the team would not necessarily spend a lot of time trying to determine the age of the child. This solution has not been accepted internationally.

Weight

Weight should be measured to the nearest 100g

The scales should be checked for accuracy before and after, each day's measurements, using the same known weights. Each team must use the same standard weights at the base. Standard weights do not need to be carried in the field, but the scale should measure the same in the morning and evening when the team returns from the field.

The scales should first be set at zero, with the weighing pants, basket or basin[38] attached. Suitable standard weights include a commercial standard, a stone, a perfectly sealed container filled with sand, some agencies use the tins of oil distributed as relief. The standard weight should have the true weight clearly written on it and the same weight is used all the time. It is important NOT to use weights made from materials that will absorb water, dry out or change weight in any other way (collect dirt or spill any of the contents); this is why the containers should be sealed. Sacks of food should not be used; the nominal weight given on the bag is not sufficiently accurate.

The figure shows the correct way to weigh child with a hanging spring balance and pants.

1) Explain what you are going to do to the child's mother.

2) Hang the scale from a suitable point (hooked on a tree or a door frame) or from a stick held on the shoulders of two people (local men can be enlisted to come with the team to hold the scale). The dial on the scale has to be at eye level.

3) Hang the weighing pants from the hook of the scale and check that the needle reads zero

4) Remove the child's clothes and any jewellery and place him or her in the weighing pants

5) hang the weighing pants, with the child in them, from the hook on the scale

6) Check that nothing is touching the child or the pants.

7) Read the scale at eye level to the nearest 100g

[38] A plastic basin with 4 ropes attached to the rim is sometimes used. Some mothers do not like their child put into pants that have been on other children (there is a chance of faecal contamination and the spread of disease). The children are much more comfortable being weighted in such a basin, weighting is faster than with pants and the basin can be washed easily. However, it is very inconvenient for the team to carry from house to house and so is very rarely used..

8) Say the number out loud.

9) The assistant repeats the weight out loud so that everyone can hear and writes the weight on the data-sheet.

Always weigh the child before taking the height.

If there are two children in a household, ask the mother which child will be less fussy and weight than children first (children in a family copy each other's behaviour, particularly if one is frightened).

If a lot of the children struggle, so that the needle does not stabilise, there is often faulty technique. Involve the mother and have her close to the child at all times, get the mother to put the pants onto the child, be gentle, be respectful, speak softly and do not shout or order the mother around, make sure that the team is wearing clothes with which the child is familiar; it is usually better to have a female team.

For the few children who may struggle, estimate the weight by taking the value situated at the midpoint of the range of oscillations. Make a note that the weight may be inaccurate because of instability. This is normally done by putting a circle around the weight on the data sheet.

Older children may hold on to a bar attached to the balance and lift themselves off the ground.

In some societies and in cold climates it may not be appropriate or acceptable to take the children's clothes off. In this situation careful preparation before the survey should be conducted so that children can be weighed already clothed. This involves preparing:

- A reference sheet of the weights and descriptions of popular children's clothing items based on the child's age and the season when the survey is being conducted.
- An album with photographs of different items of clothing with a description of the item, its principle fabric, the age of the children wearing it and its weight.
- Careful training of the team to recognise the items accurately is needed. If this process is well done then in the analysis the weight of each child's clothing should be subtracted from the weight measured. This can result in an accurate estimate of the child's weight.
- If the clothes worn are fairly standard (such as a pair of pants to cover the genitalia) then a sample of the items can be weighted and that weight taken from each child weighed in pants. Such items are usually weight less than 30g. This is less than the divisions of the scale, nevertheless, such weight is subtracted from each weight during analysis because the "rounding" to the nearest whole scale division may have been affected by the pants.

The mother should always be with the child during the measurement. She should not be interviewed for the mortality part of the survey whilst the measurements are being taken. If this is attempted then it will be much more difficult to measure the children and the mother will be distracted by the manipulation of her children, even if they do not cry, and will give less attention to providing full and accurate answers to the mortality

questionnaire. Furthermore, if the team is too large, the mother and children are more likely to be intimidated or distracted.

Figure 4. How to take weight of a child using hanging scales

Fig. A3.1 Use of the hanging spring balance for weighing infants[1]

[1] Adapted, with permission, from *Assessing the nutritional status of young children: preliminary version*. New York, United Nations Department of Technical Co-operation for Development and Statistical Office, 1990.

Height and length

Every effort should be made to measure children's height accurately, to the nearest 0.1cm if possible.

Children up to 85cm in height are measured lying down on a horizontal measuring board. Children above 85cm are measured standing up[39].

The figure shows how to measure a child less than 85 cm.

1) Explain the procedure to the child's mother or carer.

2) Remove the child's shoes and any hair ornament or top knot on the top of the child's head.

3) Place the child gently onto the board on his back, with head against the fixed vertical part, and the soles of the feet near the cursor or moving part. The child should lie straight in the middle of the board, looking directly up.

4) The assistant should hold the child's head firmly against the base of the board

5) The measurer places one hand on the knees (to keep the legs straight), places the child's feet flat against the cursor with the other hand, pushes the cursor against the feet firmly but gently.

6) The measurer reads and announces the length to the nearest 0.1cm.

7) The assistant repeats the measurement out loud and then records it on the datasheet.

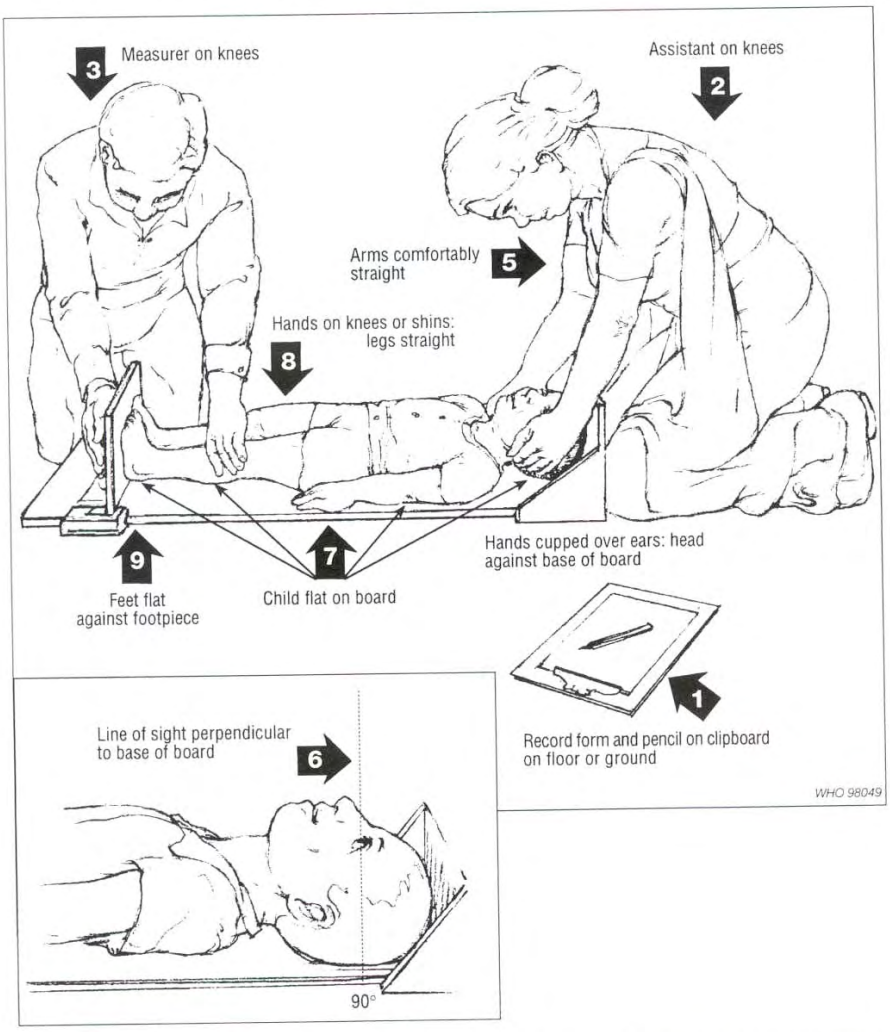
There are a few cultures where the parents are unhappy about measuring a child lying down. This is where such measurement is used to measure bodies for a coffin, and even if there is not misunderstanding then it is considered to be bad luck. Where this occurs it is particularly important to have local people from the same culture as the main people on the team and to make sure that the community leaders, religious authorities and other influential people understand why the measurements are being made and give explicit authority for length measurements to be made. The mother needs to be warned and give her permission specifically. In these circumstances, children who can stand can have their height measured instead of length, and a correction made to the measurement.

[39] Some manuals suggest an age cut-off for taking length or height. This should never be used in an emergency survey – the cut-off is only based upon whether the child is above or below 85cm, no matter the age of the child.

How to measure length in a child less than or equal to 85 cm.

Figure 5. measuring a child's length

Fig. A3.2 Measuring a child's length[1]



[1] Adapted, with permission, from *Assessing the nutritional status of young children: preliminary version*. New York, United Nations Department of Technical Co-operation for Development and Statistical Office, 1990.

Figure 5 shows how to measure a child less than 85 cm.

1) Explain the procedure to the child’s mother or carer.

2) Place the measuring board upright in a location where there is room for movement around the board. Be sure it is stable and will not tip over.

3) Remove the child’s shoes and any hair ornament or top knot on the top of the child's head and stand her or him on the middle of the measuring board.

4) An assistant should firmly press the child’s ankles and knees against the board.

5) Make sure that the child’s head, shoulders, buttocks, knees and heals touch the board.

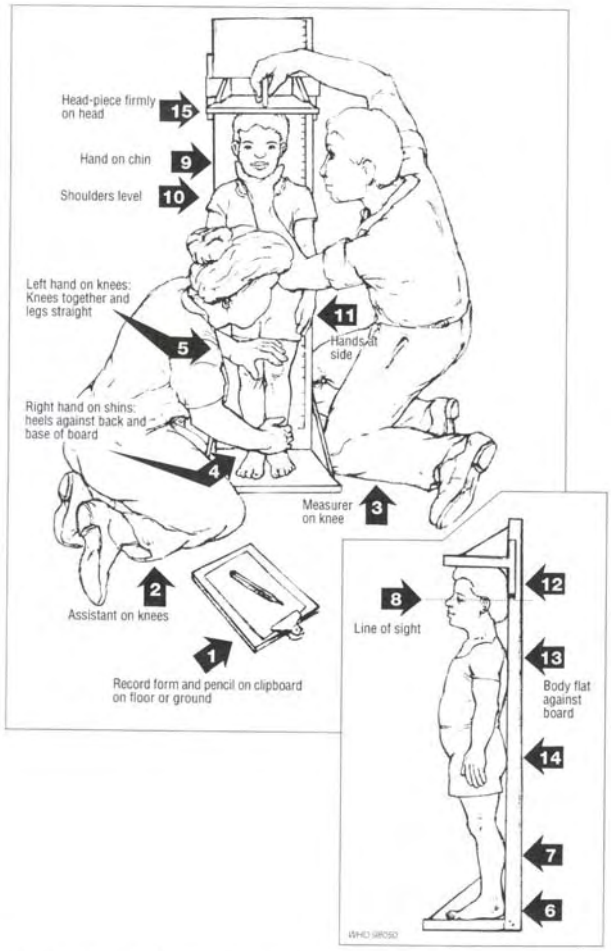
6) The measurer should position the head and the cursor at right angles — the mid-ear and eye socket should be in line and hair should be compressed by the cursor.

7) The measurer reads and announces the height to the nearest 0.1cm.

8) The assistant repeats the measurement out loud and then records it.

Figure 6. How to measure height in a child of more than 85cm

Fig. A3.3 Measuring a child's height[1]



[1] Adapted, with permission, from *Assessing the nutritional status of young children: preliminary version*. New York, United Nations Department of Technical Co-operation for Development and Statistical Office, 1990.

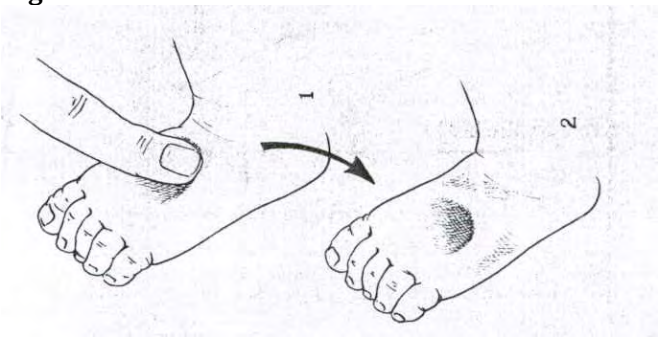
Oedema

Oedema is the retention of water in the tissues of the body. To diagnose oedema, moderate thumb pressure is applied just above the ankle on the inside of the leg were the shin bone is below the skin or on the tops of the feet. The pressure is kept for about three seconds (if you count "one thousand and one, one thousand and two, one thousand and three" in English, pronouncing the words carefully, this takes about three seconds). If there is oedema, an impression remains for some time (at least a few seconds) where the oedema fluid has been pressed out of the tissue. The child should only be recorded as oedematous if both his feet clearly have oedema.

It can be quite painful if the team presses hard on the skin. Hard pressure is NOT required to test for oedema. The team should practice on each other and if anyone finds it

painful or uncomfortable then the team member is pressing excessively. Oedema should be tested for after weight and height/length are measured.

Figure 7. How to check for oedema



Most people, including doctors, overestimate the amount of oedema in the body. Measurements of several thousand children loosing weight during treatment for oedematous malnutrition show that the average amount of oedema is 3.6% of body weight.

The Nutrisurvey software can automatically make an adjustment of 3.6% of body weight for any child that is recorded as having oedema (set in “options”).

A further refinement can be made. Oedema can be graded as absent, one plus (mild), two pluses (moderate) or three pluses (severe). These are defined as follows:

+	mild: both feet/ankles
+ +	moderate: both feet, plus lower legs, hands, or lower arms
+ + +	severe: generalized oedema including both feet, legs, hands, arms and face

If the degree of oedema is recorded then different adjustments are made by the software according to the table below.

Table 7. Percent of body weight that is accounted for by nutritional oedema

Marasmus	0.00 %	weight * 1.0000
Kwash +	2.68 %	weight * 0.9732
Kwash ++	4.31 %	weight * 0.9569
Kwash +++	8.38 %	weight * 0.9162
Kwashiorkor mean	3.6%	weight * 0.964

These values can be changed in the options screen.

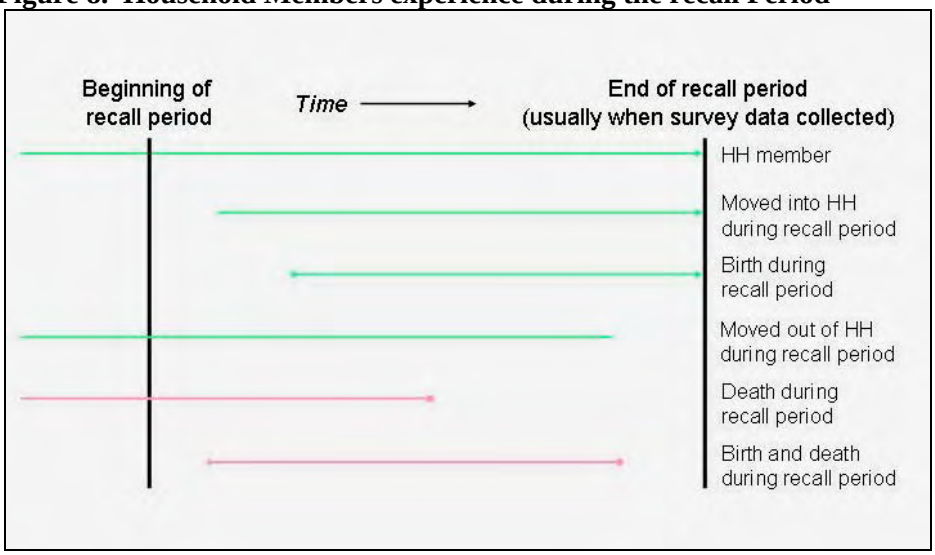
Mortality Interview

To estimate a mortality rate from a survey we need to know the number of people at risk and the length of time over which they were at risk. This will form the denominator of the calculation to which the number of recorded deaths is related. However, the composition of some of the households will have changed during the recall period (death, birth, migration into and out of the household); thus the number of people within each of the households is will not have been constant during the recall period.

In the diagram, at the beginning of the recall period, the household had three members and at the end of the recall period, the household also had three members but only one person was in the household during the entire interval. At one time, the household had six members. In calculating a denominator for this household two main methods have been used "past household census" and "current household census" methods. In both a household census is taken, at the beginning of the recall period or at the present time respectively, and the changes that have occurred during the recall period explored[40]. In this manual we recommend a modification of the current household census method[41].

It is likely that people will both leave and join household at an increased rate during a disaster. If this in-migration and out-migration is significant then they both have to be accounted for in the calculation. If the in-migration and out-migration are significantly different from each other, this will have an effect upon the calculated death rates.

Figure 8. Household Members experience during the recall Period



[40] The past household census method counts births and deaths and includes out-migrants but misses in-migrants who were not members of the household at the beginning of the recall period.
[41] The classical current household census method counts births and deaths and includes in-migrants but misses out-migrants who were not members of the household at the end of the recall period. The modification used in this manual corrects this deficit by allowing for out-migrants.

In order to calculate the denominator you need to ask the respondent:

1. to list all the present household members at the time of the survey.[42]
2. whether each of these household members were present at the start of the recall period.
3. to add to the end of the list all the members of the household that were present at the start of the recall period but are not part of the household at the time of the survey[43].
4. Whether the individual is above or below the age of 5 (in order to derive 0-5DR).
5. whether young children were born during the recall period
6. to list all deaths that occurred in the household during the recall period.

Two additional questions are usually asked:

7. the age of each member. These data confirm if an individual is above or below 5 years of age and allow a demographic pyramid of the population to be constructed.
8. the sex of each member. These data are only necessary if sex-specific death rates are required.

Three additional optional questions are sometimes asked:

9. The date of any death (this is usually very unreliable data)
10. The cause of death (this is usually unreliable and normally requires a much larger sample size to produce data that has a reasonable precision because of large design effects[44])
11. the current status of each household member (not relevant in terms of those household members who have left the household in calculation of death rates).

These data are collected on a form, using a separate sheet for each household. An example of the form is given in figure xx. An example of a more complete form which contains the additional information is given in appendix xx.

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[42] Sometimes the respondent is simply asked to state how many people are in the household. Although this is quicker, it is much more inaccurate than asking the respondent to list all the household members. We therefore strongly recommend that the household members are enumerated.

[43] This is not part of the classical Current Household method, but is added here to account for out-migration.

[44] One of the survey objectives may be to determine if deaths have been due to war related violence. Such violence normally affects only particular areas within the whole survey area; the design effects are therefore usually between 4 and 10. Such large design effects mean either that the result has a very low precision or that the sample size needs to be increased to levels far exceeding those needed to determine malnutrition prevalence and CDR adequately. Nevertheless, advocates are generally interested to compile such data even if it is relatively imprecise.

Under normal circumstances it is not necessary to obtain the additional information.

The CDR is then calculated by Nutrisurvey using the death rate formula:

$$\text{CDR} = \frac{\textbf{Number of deaths}}{\left(\dfrac{\textbf{Total Population}}{\textbf{10, 000}}\right) \times \textbf{Time interval}} = \textbf{Deaths/10,000/day}$$

It is assumed that those who were not present in the household for the whole of the recall period were present on average for half the recall period[45].

Thus, the "Total Population" used in the equation is the sum of:

+ **all** the persons that were in the household at the time of the survey
+ *add:* **half** the deaths
+ *add:* **half** the people who were present at the beginning of the recall period but had left the household by the time of the survey
− *subtract:* **half** of the people who were present at the time of the survey but who had joined the household during the recall period [46].
− *subtract:* **half** the births

Infants that were born and died within the recall period are counted as deaths but are not included in the denominator.

The calculations are done automatically by Nutrisurvey. An example of the calculation is given in appendix xxx

[45] Note that the denominator is actually *person x days.* It is mathematically equivalent to count half a person as it is to count half the recall period for that person.

[46] Note that if in-migration and out-migration are exactly balanced then counting half a person for each migrant is the same mathematically as counting all in-migrants as whole persons and ignoring out-migrants in the current-household method. It is also the same as counting out-migrants as whole people and ignoring in-migrants in the past-household method. It is because both in-migration and out-migration are frequently major coping strategies in a disaster situation, and one is usually far greater than the other so that it dominates migration (both occur but in different security and disaster situations) and will influence the final result, that we suggest attempting to enumerate both in- and out-migration in a disaster survey. This is a bit like combining the current and past household census methods together. Furthermore, such information is often of interest to planners; in- and out-migration rates can usefully be included in the survey report.

Persons who leave the household

There is a question raised by some epidemiologists; how should those people who have left the household but whose status is unknown be handled. This depends upon the objective of the survey[47]. If, for example, the objective is to measure the mortality **in** a refugee camp, and the person whose status is unknown has physically left the refugee camp, it does not matter whether they are alive or dead; if they are dead, they did not die in the refugee camp, should not be added to the deaths for that camp and are irrelevant to the camp's death rate. On the other hand, if they have moved to another household within the camp, then their new household had an equal chance of being selected at the outset of the survey, in which case their death would have been part of the sample. If their new household is in fact selected as part of the sample as well as the household they have left, then their death would be counted twice if it were recorded in the household that is being interviewed. Thus, deaths after leaving the household should not be counted or contribute to the calculation.

Mass migration

In an emergency situation whole families migrate. There are likely to be whole families that arrive in the survey area during the recall period, part of their experience has taken place in the study area and part of their experience in the area from which they have migrated. In the case of a forming refugee/IDP camp this can apply to a large proportion of the study population. The mortality experience in the camp itself is likely to be very different from that experienced before they departed from a stricken area or on the journey, which is usually particularly hazardous. The various households will have arrived at different times. Under these circumstances, if we take a fixed recall period, some of the respondent households will have been in the camp for the whole of the period and some will be new arrivals who have spent most of the recall period elsewhere or on the journey.

In a camp situation, it is desirable to derive separate death rates for the time that the population are in the camp and for the time before the displaced households reached the camp. As the denominator for the death rate is person-days at risk, if we know how long each household has been in the camp then we can calculate a death rate, but in this case the "recall period" or "period considered at risk" is different for each household. The date of arrival can often be determined from a registration card given to new arrivals. It is also a definite time that most migrating households remember. In this case, the date of arrival is recorded for each household and the time period used in the equation is the average number of days each household has spent in the camp.

[47] It is only relevant to determine what happened to out-migrating persons when it is intended to examine a selected cohort of the population. This is rarely an objective of an emergency survey where the objective is usually to determine the death rate of a population within a defined geographical area. It is of interest to some demographers who follow cohorts of people longitudinally.

To derive the separate mortality rate for the time before arrival, the fixed recall period is used, as in the standard method, and the average time spent in the camp subtracted from this time. Deaths are recorded as occurring in the camp or before arrival but after the start of the recall period. The "before arrival" mortality rate is much more susceptible to serious sampling error because the households are self-selected in terms of those that have the means, opportunity and composition that enable them to migrate and the households may have arrived from a wide variety of different geographical areas. The rate thus only applies to the migrants who have reached the camp and should not be extrapolated to the area of origin.

It is much more difficult to calculate the sample size needed to separate CDR into two components – before and after arrival. There is an added variable in the calculation – the average length of time households have spent in the camp. In effect it is like doing two separate surveys using the same households, one for the time in the camp and one for the time before arrival. If the average length of time in the camp can be obtained from the camp's administrators then this is used as one of the "recall periods" in the calculation.

Figure 9. Example of Household enumeration data collection form

Survey district:_Ambo_____Village:_Limbo_____Cluster number:_4_____
HH number:____23_____
Date:__12- Aug - 04_____Team number:__2_____

	1	2	3	4	5	6	7
ID	HH member	Present now	Present at beginning of recall (include those not present now and indicate which members were not present at the start of the recall period)	Sex	Date of birth/or age in years	Born during recall period?	Died during the recall period
1	Mother (respondent)	√	√	F	Adult		
2	Father	√	√	M	Adlt		
3	Uncle 1	√	√	M	Adutl		
4	Aunt 1	√	√	F	Ad		
5	Aunt 2	√	x	F	Ad		
6	Child 2	√	√	F	12		
7	Child 3	√	√	M	8		
8	Child 4	√	birth	M	2/12	√	
9	Child 1 aunt 1	√	√	F	4		
10	Child 2 aunt 1	√	√	M	1		
11	Child 1 aunt 2	√	x	M	3		
12	Grandmother	Dead	√	F	A		√
13	Grandfather	x	√	M	A		
14	Child 1	x	√	M	over 5		
15	Uncle 2	x	√	M	A		
16							
17							
18							
19							
20							

Tally (these data are entered into Nutrisurvey for each household):

Current HH members – total	11	Ticks col 2
Current HH members - < 5	4	
Current HH members who arrived during recall (exclude births)	2	X's col 3
Current HH members who arrived during recall - <5	1	
Past HH members who left during recall (exclude deaths)	3	X's col 2
Past HH members who left during recall - < 5	0	
Births during recall	1	birth col 3 and 6
Total deaths	1	Dead col 2 and 7
Deaths < 5	0	

Determining cause of death

Inquiry into cause of death should be limited to causes that are clearly defined by local terms, familiar to the local population, and characteristic. These include measles, neonatal tetanus, and diarrhoea.

If local terms do not exist, enquiry should be limited to deaths due to violence and all other causes. Violent deaths can be due to war injuries and atrocities, or accidents not related directly to conflict. In this case two questions are sufficient:

1) "Did (the person) die from some sort of violence such as being assaulted, shot or violated, a car accident, fall, drowning, poisoning, burn, bite or sting?"

If YES, Go to next question
If NO, record death not related to injury or violence

2) "Was this injury caused by someone fighting the war such as from a bullet, bomb, mine, machete or assault?"

If NO, record non-war-related injury or violence as cause of death
If YES, record war-related injury or violence as cause of death

As with other parts of the household questionnaire, questions about cause of death need to be translated into the local language, back translated to the original language to ensure accurate translation, and pre-tested in the local setting. Usually the head of household is interviewed; however, there may be a potential need to interview multiple respondents if the current head is a child or a relative who has lived only part of the recall period in the household.

Analysis of results

The report should always be presented in a standard way and contain all the information that allows the reader to understand why the survey was conducted, the methods that were used, the population to which the results apply, the results themselves, any additional information that is relevant and any problems that were encountered. The report can also contain recommendations, but the recommendations should not be simply general recommendations, but should be directly supported and justified by the data that is contained within the report. The presentation of the information in a standard way makes sure that no important information is omitted, it also allows the reader, familiar with the format, to quickly find the particular information that they need to know.

The Nutrisurvey software takes the data that have been entered during the survey, does the analysis and then presents the data in a standard format. It also gives headings of all the paragraphs that need to be completed by the person responsible for the report.

The report

(This section is not yet complete)

Description of the sample

The report is to include a TABLE which lists all the critical data:

Country,

Region/Area,

Selection within population (IDP, farmers etc).

Date of survey

Agency

Total population

Type of survey

Size of sample

Cut off points for selection (age/ height)

Number of clusters/ subjects per cluster

Method of selection of houses

Number of children chosen per house

Using Nutrisurvey software step by step

A SMART survey is designed to be analysed by computer using the Nutrisurvey software. It can be downloaded free from either www.smartindicators.com or from www.nutrisurvey.de/ena; the software is free. The food security component is analysed using a separate Excel spreadsheet and is not included in the Nutrisurvey software.

The analysis can also be done using other programs or by hand, although this is not recommended for non-epidemiologists. The formulae used are given in the appendices and in the help files of the program.

When the program first opens the data entry anthropometry screen is presented.

The various sheets on the front-end are used in order[48]. The steps where Nutrisurvey is used are as follows:

1. Planning the survey.
2. Training the teams.
3. Entering the nutritional (anthropometric) data.
4. Entering the mortality data.
5. Checking the data for errors and plausibility[49]
    a. Highlighting implausible values
    b. Analysis for digit preference
    c. Analysis by team
    d. Comparison of the prevalence of severe malnutrition calculated from the mean and Standard Deviation with the prevalence from counting the subjects below the cut-off points.
6. Generating the results
7. Writing the report in a standard format.

[48] As the software is under continuous development, the version downloaded may not be exactly the same as that shown in this section of the manual. The "update" notes that are downloaded with the software should be consulted for a full description of the current version.
[49] In future versions, the distribution of the data will also be examined.

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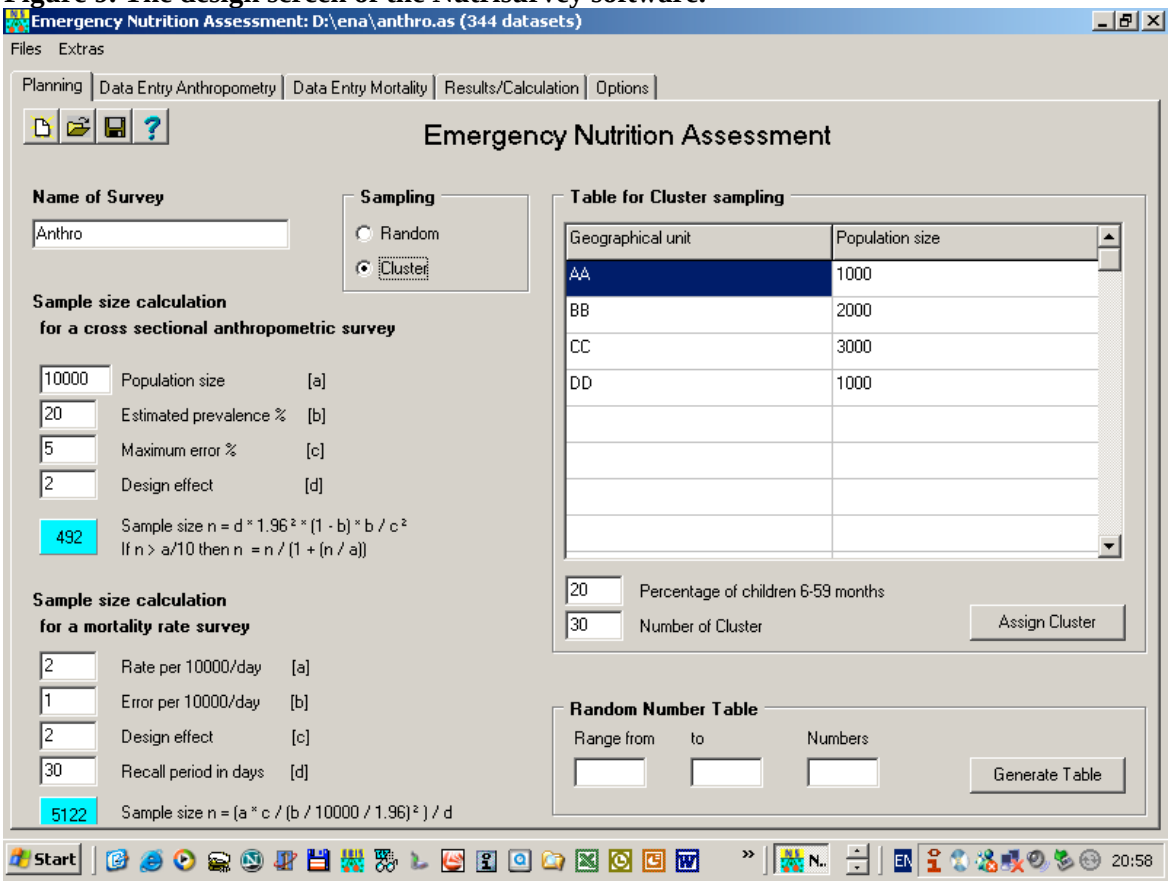
Figure 9. The design screen of the Nutrisurvey software.



Planning the survey

The survey must be given a name.

The software cannot help decide what type of sampling will be conducted.

1. The survey will either be a random sample (simple random or systematic random) or a cluster survey: tick the appropriate box.
2. Enter an estimate of the total population that is targeted by the survey (not the population of children only). For example, if you survey a district of 60,000 people, enter this number. It does not have to be accurate unless the total number is less than ten times the expected sample number; If the population is unknown but large enter any number which is more than 10 times the expected sample size. The software will do an automatic correction based on this number.
3. Enter the estimated prevalence. If you are uncertain, you will have selected a range of likely values – enter the higher (maximum) prevalence that you expect. However, if you are particularly interested in a particular prevalence (for

example, the level would trigger an emergency response), and you suspect the actual prevalence is below this threshold, enter the threshold number.

4. Enter the largest error rate you can tolerate in the estimate (normally 5% or more at high rates of prevalence falling to about 2.5% for lower rates). This figure has a substantial effect upon the number needed for the sample.
5. Enter the design effect. The default design effect for sample size calculations for malnutrition is 2.0. However, a design effect of 1.5 for malnutrition in children is often sufficient. The decision should be made individually for each emergency context.

The results of Steps 1-5 yield the total number of children required for the sample (the sample size). This figure is given in the blue box. In cluster surveys, this number needs to be divided by the number of clusters.

For the mortality component of the survey

1. Enter the expected mortality rate per (per 10,000/day)
2. Enter the required precision (per 10,000/d) For example, if your expected mortality rate is 2.0 /10000/day and you want a confidence interval of 1.4-2.4, enter an error of 0.6. The precision chosen has a substantial effect upon the sample size needed.
3. Enter the design effect. The default design effect for sample size calculations for mortality is 2.0. If violence-related-mortality is limited, a design effect of 1.5 for crude death rate may also be sufficient.
4. Enter the chosen recall period in days. In most situations, a recall period of approximately 90 days (30 to 120) days will be used. However, the decision should be made individually for each emergency context. The recall period also has a substantial effect upon the number of households that will need to be interviewed.
5. Divide the sample number by the average household size. This will give the number of households that will need to be visited to achieve the sample size.

Choosing the clusters

Enter the number of clusters.

There should be at least 30 clusters. Twenty-six clusters is the minimum for the survey to be valid.

The best way to obtain the number of clusters is to decide realistically how many households a team can visit on one day and both measure the children and conduct the mortality interview. The higher of the two values, a) the total sample size of children, and b) the total households needed for the mortality survey, is then divided by the number of households that can be visited in one day. This is the number of clusters that should be chosen, unless the result is less than 30 (when 30 should be used). If there is a choice, it is better to increase the number of clusters and reduce the numbers of children in each cluster.

Choose the clusters

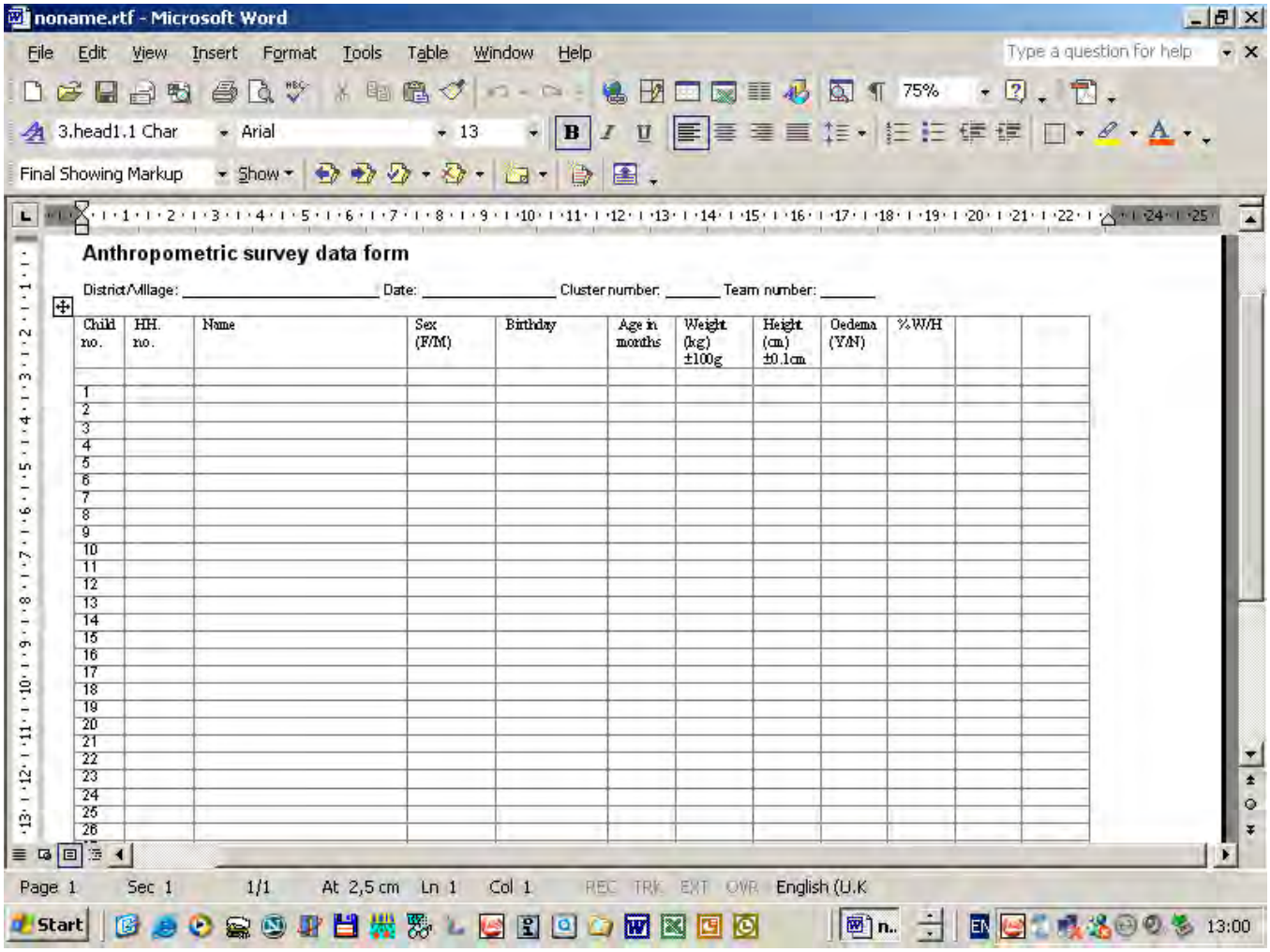
Enter the names of all the villages, towns, sub-districts or other areas that will potentially be chosen to contain a cluster. All the areas in the whole population have to be entered. It does not matter what order the areas are entered. If they are omitted at this step, then they are not part of the surveyed population. Enter the population size for each "village".

The computer will then select the areas where there will be clusters. This is done by the computer at random with the chance of any village being chosen being proportional to its population size. This should only be done one time. Once the cluster sites have been chosen this is fixed. It will potentially introduce a bias if they are re-selected. Under no circumstances should the program be re-run until particular villages are included or excluded.

Field recording

The anthropometric data are entered on data-sheets as they are taken (see figure 10). These sheets are generated by the software and converted into Microsoft Word format for printing. One data sheet is used for each cluster. In many surveys it is not necessary to enter the child's name if the child is at home and the measurements are complete. This only takes additional time for the team to record. Eligible children that are absent from the house when it is visited are entered in the sheet; names are entered for these children. This is so the team can ask for the specific child when they return to the house at the end of the day. A household number has to be assigned to each house that has no eligible children. They are recorded at the end of the sheet and given consecutive household numbers starting with 31 and recorded as having no children. The same number is entered on the mortality data form. The WHM (%weight-for-height) is **not** calculated for each child on the data-sheet in the field. The reason for having this column is for children that are going to be referred to a feeding centre or other facility. The last columns are used for notes or other data that is to be collected.

Figure 10. Anthropometric survey data form



noname.rtf - Microsoft Word

Anthropometric survey data form

District/Village: _____ Date: _____ Cluster number: _____ Team number: _____

Child no.	HH. no.	Name	Sex (F/M)	Birthday	Age in months	Weight (kg) ±100g	Height (cm) ±0.1cm	Oedema (Y/N)	%W/H		
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
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17											
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19											
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21											
22											
23											
24											
25											
26											

Data entry

The data is entered into the computer using the Nutrisurvey software. The entry panel is shown in figure 11.

The survey date, cluster number and team are entered in the first row (the village that has been chosen for the cluster is already in the database in the planning stage – the same cluster number should be used in this panel). As the data are entered these fields will default to the last entered information so that the data do not have to be entered for each subject.

The ID number will increment automatically by one for each new record that is entered.

The Household number will not be incremented, as there is often more than one child in the same house. The household number needs to be entered. These are the same household numbers that are included in the mortality data.

Either the age in months or the birth date can be entered into the age fields. If birth date is entered the age is automatically calculated. If age is entered the birthday field is left

blank. It is not necessary to enter an age to proceed. If age is not entered it is assumed that the child was selected on the basis of height and the age is not known with sufficient accuracy to be recorded. In this case, weight-for-age and height-for-age will not be calculated or entered into the database.

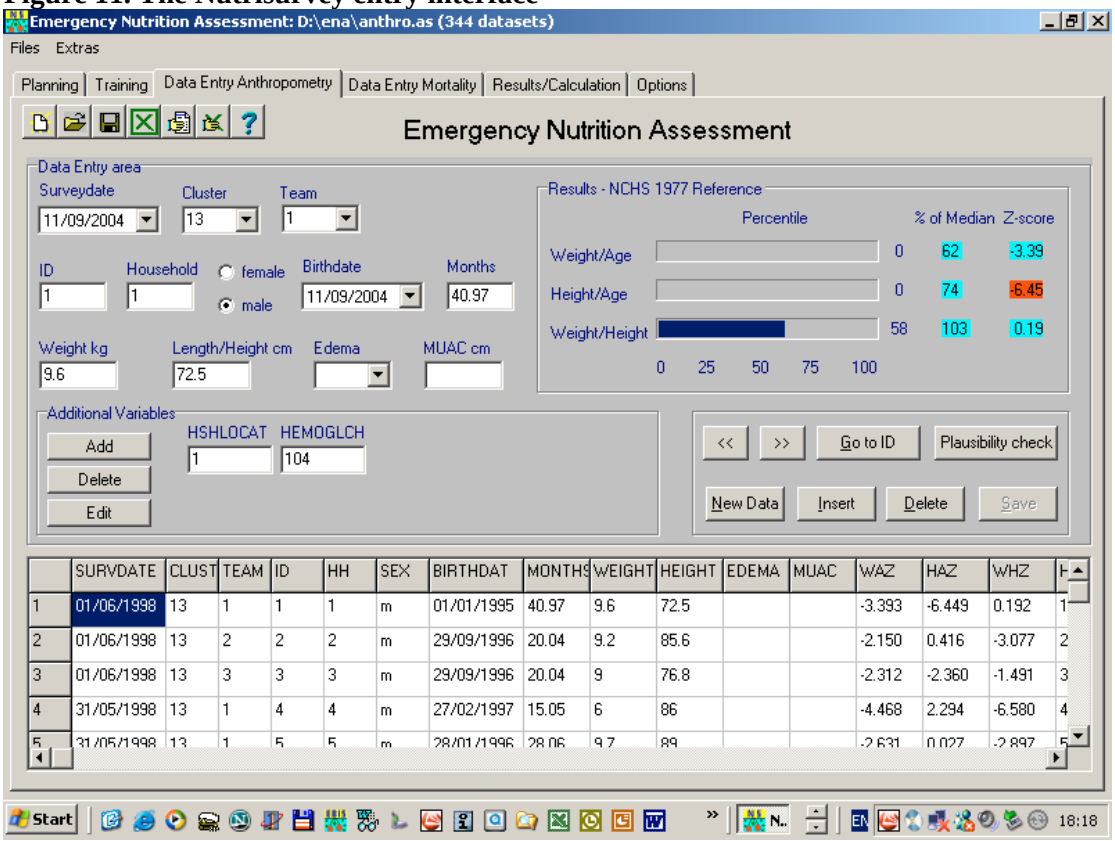
The anthropometric variables are automatically calculated as the data is entered. If there appears to be an error in the data then the field will turn red and make a noise. The cut-off points to alert the person entering the data can be set in the options screen.

During analysis, the program will list and query any value that is outside the mean value of the survey plus or minus three standard deviations of the survey-mean. After one or two clusters have been entered or if there has been a previous survey then it is useful to enter the limits as the mean plus and minus three standard deviations (or 3 Z-scores) during data entry, so that potential errors can be picked up during data early.

It is useful to enter the data into the computer when the team gets back to base; in this way, if there are query values it is possible to return to the area and retake the measurements.

Oedema defaults to absent.

Figure 11. The Nutrisurvey entry interface



Naming of files

It is important to be consistent in the naming of files and directories and to give all files names that can be recognised later by any member of the team.

All the files relating to a particular survey should be put into a separate directory.

The name of the file should start with a three letter code for the country (eg SUD for Sudan, ZAM for Zambia, ANG for Angola, etc), then the file-name should have the date of the survey in YYMM format (year, year, month, month). Then there is a code for the type of file. REP for report, DAT for the data file, etc. This naming convention means that if the files in the directory are sorted they will automatically be listed in a clear order and all the files will be together. In certain circumstances the region, type of subject (refugee, IDP, resident) or the agency involved can be usefully included in the name of all the files. All files related to one survey should be kept in a unique directory, The directory should also be named by the country and date, and any other information that makes the directory unique for a particular survey. It is important that everyone in an agency uses the same convention for naming files.

Thus, a file names <LIB_0408_rep.doc> would be the report of a survey taken in August 2004 in Liberia. There may be several simultaneous surveys conducted in Liberia around that time, <LIB_0409_IDP_buch_dat.xls> would be the data file for a survey with IDPs in Buchanan, Liberia in September 2004. Under no circumstances should the report-file be called “report.doc”.

Data preparation and cleaning

Before doing the definitive analysis, any errors in the data need to be identified and if possible corrected.

This is done partly during data entry. An implausible or “out-of-range” value is coloured red during data entry and an audible bleep sounds. The ranges should be set in the “options” panel before data entry.

The data cleaning is also done using Nutrisurvey’s “plausibility” check. The computer automatically examines the data to see if there are any values that are outside the usual or expected range and lists them in Microsoft Word. These values should be gone through and checked against the original written data collection sheets. Where an error is found in the data entry it should be corrected.

Missing data

If your survey records of a child are missing certain pieces of information then it will not be possible to include him in some of the analyses of the anthropometric data.

Age: if the child’s information on age is missing you can still include him in assessment of wasting because the index does not require age. However, you would need to be sure that he is eligible to be in the survey (is the child in the required height range).

Sex: if the child’s information on sex is missing you may or may not include him/her in the assessment of wasting. The reference population information on height and weight is sex specific so strictly they should be excluded; however, the difference between the sexes is small. If there are only a few children with their sex missing then there is an option in Nutrisurvey to assign a sex to the individual with missing gender data entirely at random. In other words, about half the missing cases will be assumed to be male and the other half female.

Height: if the child's information on height is missing you cannot include him in the assessment of wasting. He can, of course, still be included in an analysis of oedema because any child with oedema is severely malnourished.

Weight: if the child's information on weight is missing you cannot include him in the assessment of wasting. He can, of course, still be included in an analysis of oedema because any child with oedema is severely malnourished.

Data out of the required range

In most nutrition surveys we are measuring children aged 6-59 months, or children who are 65-110 cm tall. Children outside these ranges should not be included in our results. These values depend upon the defaults that have been set in the "options" panel of the software. The default is to accept any child who is in the correct AGE range, even if the height is out of range. Any child outside the AGE range will be rejected by the program and not included in the analysis. If there are no age data then a child who is below 65cm or above 110 cm will be rejected from the analysis. These defaults can be changed in the options so that the HEIGHT range is given priority (65 to 110 cm), any child within the height range will then be accepted even if the age is out of range. If height data are missing then the anthropometric indices of interest cannot be calculated, however if the age is within range then the child can be included if there is oedema. The accepted height range can be altered in the options panel, for example to change the range to 60 of 100 cm if the population is very stunted. These choices must be included in the report.

Thus, by default, if a child is 55 months old and is 112cm he will be included but if the child was 65 months old he would be rejected.

Extreme weight for height data

As well as excluding children who have information missing, or who are out of the required range, we also want to exclude children who have a Weight-for-height that is more likely to be the result of an error than a true measurement. There are various ways of doing this. Clearly data that are biologically unlikely are very likely to be the result of a measurement or recording error. Thus, it is very unusual in an emergency context to find any child with a WHZ<-5.00 or a WHZ > +3.00.

However, most children with wrongly measured or recorded data give values that are within the plausible range. Inclusion of such errors can be surmised from examination of the standard deviation, and other statistical checks on the data. The standard deviation should be between 0.8 and 1.2 Z-score units for weight-for-height in all well conducted surveys, and in 80% of surveys the standard deviation is between 0.9 and 1.1 Z-score units. The standard deviation increases as the proportion of erroneous results in the dataset increases; this has a very dramatic effect upon the computed prevalence of wasting. For this reason if a value is more likely to be an error than a real measurement it should be removed from the analysis. We do this by taking the mean of the weight-for-height data as the fixed point for describing the status of the population that we are surveying. If the children "properly belongs" to the population being surveyed then about 2.5 children out of 900 will lie outside the limits of plus or minus 3 z-score units of the mean. Less than 5 out of 10,000 will lie outside plus or minus 3.5 z-score units from

the mean. This forms the basis for deciding if a value is more likely to be an error or a real measurement. The software will list children with these extreme values in the plausibility check list, it will also omit all children more than 3 z-scores from the mean of the population from the analysis unless the default is changed on the options panel.

Checking for measurement bias

Measurement bias occurs when the team have not been adequately trained or supervised or when measuring equipment is faulty. The best way to avoid measurement bias is to be rigorous in training and supervision and put in place careful checks for the quality of the equipment. Supervisors should check data collection forms at the end of each day to see if WHZ are feasible and to see if oedema is being realistically reported.

There are several useful methods to check the quality of the anthropometric data collected during a nutrition assessment after the data has been collected.

First, the distribution of the final decimal for height and weight. This will tell you if the survey workers are rounding weights and height to the nearest kilogram or centimetre, respectively. It is called "digit preference". Nutrisurvey automatically examines the data for digit preference. Furthermore, it examines the digit preference for each of the teams. There may be one team that is "cutting corners" or has been improperly trained or supervised. The data can then be examined to see if there is a substantial difference if the data from that team is omitted.

Second, the standard deviation of the z-scores for weight-for-height and height-for-age should be examined. As explained in the section on extreme values, this tells you if there has been substantial random error in the measurements. If the standard deviation is high (over 1.2) then it is also likely that there are a lot of extreme values and values more than plus or minus 3 z-scores of the mean. Nutrisurvey not only examines the standard deviation for the whole survey, but it also calculates the SD for each of the teams' measurements and the number of extreme values for each team. The SD and prevalence of malnutrition can then be examined omitting the data from one team, Comparison of the data with and without that particular teams results should be looked at to see if there is a substantial difference. Such problems should be reported.

There are other statistical measures that are computed on the data and for each team's results. First, "skewness" which measures the extent to which the results are symmetrical. The "moment of skewness" should lie between plus and minus one. Similarly, "kurtosis" measures whether the tails are very long (Mexican hat) or very short (pudding shaped) with too many values in the shoulders of the distribution. The "moment of Kurtosis" should also be between plus and minus one. These variables can also be computed for each team, and with one team omitted. It is extremely difficult to fabricate data for weight and height that "pass" all these checks for data distribution; in particular, the kurtosis checks whether values that might be considered to be in error by the team have been removed (sometimes referred to as "over-cleaning"). If any of the distribution checks are abnormal it is likely that the survey is biased and the results unreliable.

There is a further check that can be made with a cluster survey. If the numbers of individuals with wasting in each cluster is calculated, then there will be one number for

each cluster. These numbers should properly follow a statistical distribution called a Poisson distribution. It is possible to test whether the numbers do follow this distribution or deviates from the distribution statistically. If there is a problem so that the distribution is not a Poisson distribution then it indicates that the population that has formed the sample is heterogeneous. This is often caused by a problem with the design of the survey, with non-random selection of the villages to contain the clusters, or with a biased selection of houses from the village so that the houses chosen do not properly represent the villages. The Nutrisurvey software automatically calculates the Poisson distribution for wasting and compares this with the expected distribution. If the data do not follow a Poisson distribution then there will be a larger than usual design effect calculated. These two measurements give complementary information.

When we examine many surveys we find that the clusters with oedema do not follow a Poisson distribution, which they should if the whole population were equally vulnerable. In fact oedema follows what is called a “negative binomial” distribution, this means that there are some villages where lots of children get oedema and others which are relatively protected. This means that the design effect for oedema is larger than for wasting. This complicates calculation of the confidence intervals of severe malnutrition.

If there is no substantial digit preference, an SD between 0.8 and 1.2, the moments of skewness and kurtosis are within the range given, and the distribution of wasting follows a Poisson distribution, then one can be reasonably confident that the survey has been properly conducted, that the sampling method is a fair representation of the population and the results can be relied upon.

Even if you are not interested in stunting, calculating the height-for-age z-scores and their standard distribution should also be examined. The normal reason for a problem with height-for-age is determination of age. This statistic gives an indication of how accurately age was determined.

Once the data has been cleaned and examined to ensure that the data are plausible then we proceed to the final analysis.

Analysis and reporting.

The graphs of the distribution of the variables combined and by gender should be examined.

The data are automatically analysed and reported as a Microsoft Word file. The headings are generated. The Survey Supervisor should go through each heading and enter the relevant information. The quantitative data are presented in the tables.

To put the illustrations into the report, the graphs are transferred to the clipboard within Nutrisurvey and pasted into the report at the appropriate place.

Section 3: Food Security

Introduction: interpreting nutrition surveys – the 'food security story'

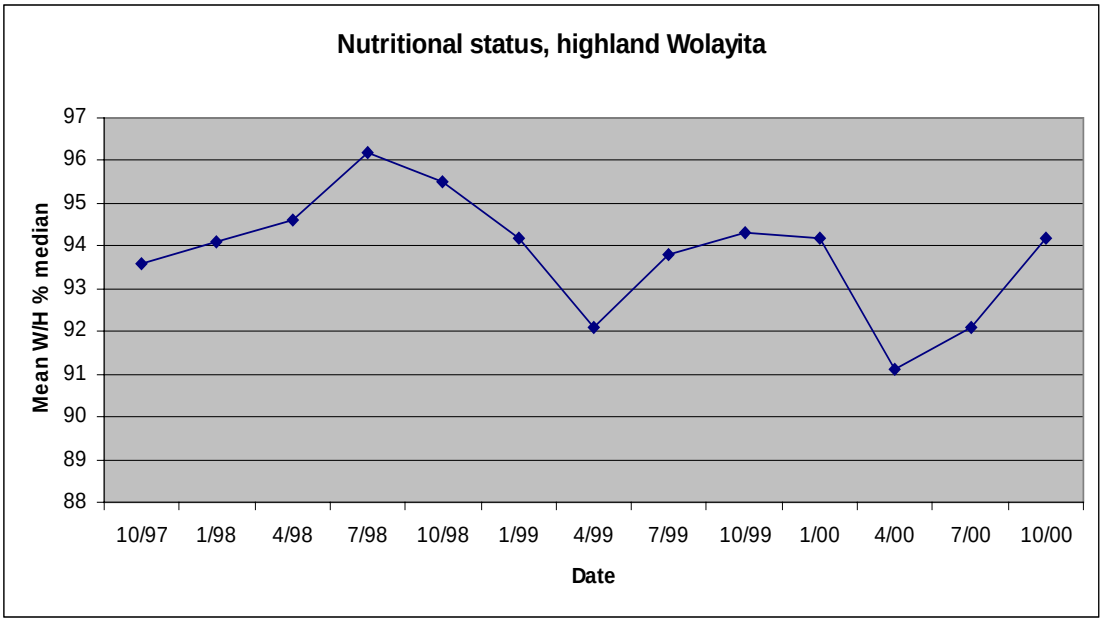
What are we trying to do, and why?

Anthropometric surveys give an estimate of the prevalence of malnutrition at the time when the survey was done, but give no indication if the findings are abnormal, or how the rate of malnutrition is likely to evolve in future, without which it is impossible to plan a response. The purpose of this chapter is to provide the basic conceptual and practical guidelines necessary to conduct a simple food security assessment in order to help interpret nutritional data, from a food access perspective. Most nutrition surveys use 'weight – for – height' ('thinness') as a proxy indicator of people's recent food intake. In analysing nutrition survey findings, the task is to develop a logical argument about what we think has happened to people's food access and by implication their food intake.

The problem of interpreting nutrition survey findings

Figure 12 shows how nutritional status varies between different years and within years at different seasons, even in relatively normal, or non-crisis times in one part of Ethiopia. It can be seen that there is substantial seasonal variation in nutrition status within each year, and variation between years, even at the same season.

Figure 12. Seasonal variation in nutrition, Ethiopia



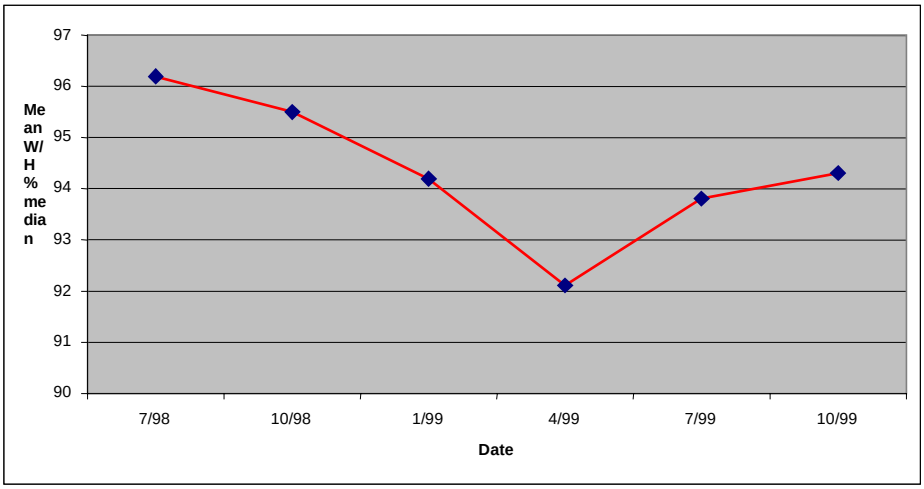
This variation leads to a difficulty in interpreting nutritional status data. Nutrition survey information can be clearly interpreted only:

- By comparing current survey results with equivalent results from the same season of an earlier non-crisis year. In practice comparable seasonal nutritional status information is only rarely available.
- If the nutrition findings are so extreme as to be clearly abnormal e.g. a malnutrition prevalence of 50%.

In practice, nutrition findings can be interpreted only by setting them in a 'food security' context. The aim is to find out what has happened to people's access to food, and to use this to:

- 'Explain' the observed nutrition findings i.e. to say if these are likely to be normal or abnormal.
- Predict how nutritional status is likely to evolve

Figure 13. Actual and 'Expected' Nutritional Trend



It is useful to think about a food security assessment as a narrative that sets out to answer four questions:

1. How did people live before the event/shock?
2. What has affected or disrupted their way of life?
3. How are they currently coping?
4. What might reasonably be expected to occur in the near future?

Repeated nutrition surveys can be used to monitor the way in which the nutritional status actually changes.

An example from Salima Malawi – telling the story and making a prediction

The Facts / Current Situation.

- The 2001 maize harvest was reduced by 20-30%, chiefly due to water logging. From July 2001, the maize price steadily increased, largely due to other factors, and by February 2002 reached 4-5 times the usual seasonal price.
- In December 2001, a nutrition survey showed a malnutrition rate of 9.3%. This is a fairly typical rate for the time of year.

The Operational Questions.

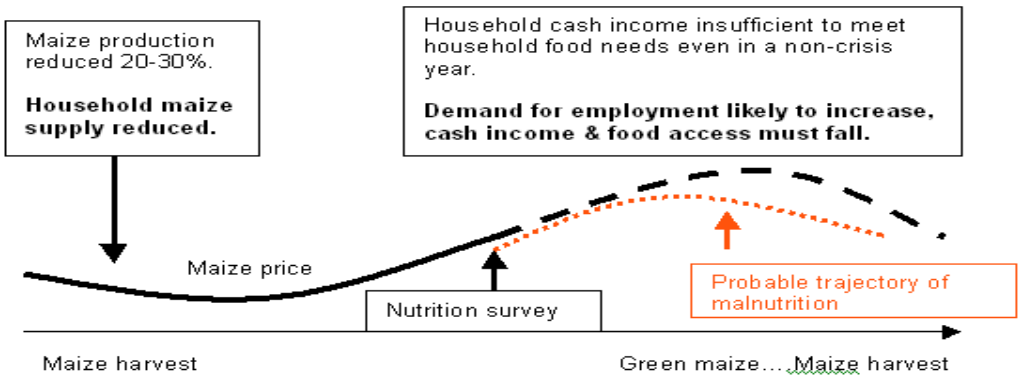
- is the observed rate of malnutrition seasonally 'normal'?
- how is the rate of malnutrition likely to evolve? Bringing food into Malawi was a major problem, as the only available food stocks were in south Africa and the regional price of food and transport was high.

The food security story:

- The poor group, make up approximately 40 % of the population.
- The main maize harvest is in March/ April although some green maize is consumed from February.
- The poor produce only a small part of their own consumption needs and from October - harvest they depend heavily on income from day labour, to get cash to purchase food. Work is difficult to find, even under non-crisis conditions.
- The reserves of the poorest groups are small. At most, household assets include 1 - 2 goats and household contents i.e. virtually no value in terms of food at the increased maize prices

What is the probable significance of nutrition findings?

Figure 14.



The best estimate was that nutrition status was likely to continue to deteriorate until the first green maize was available when it would start to improve. It was estimated that the maize harvest would be reduced because of the looting of green maize, and that food would be required into the following year.

This prediction was based on the following information:

- Reasonable knowledge of the livelihood pattern of the population:
  - i.e. that the poorest 40% of the population rely heavily on labour for cash income, and rely on the purchasing food from the market for food access, from about October to March/April.
  - that the population group of concern have few assets with a low value, when converted to maize at the current prices, and no other access to food (e.g. wild foods).
- An understanding of the basic seasonality of agriculture and its associated activities.
- An estimation of the shock – the fall in maize production and increase in maize prices – which had occurred.

Doing a food security assessment

The time and skill and cost required to conduct a food security assessment depends largely on the purpose of the assessment, and the size and complexity of the area to be assessed. Fully quantified assessments are demanding (Annexe gives more details). Smaller local assessments, sufficient to build up a good picture of an economy and what has happened to it, with less emphasis on quantification can be done with much less time and effort.

The keys to an assessment are to:

- take a structured approach to information collection. This ensures that all critical information is collected.
- obtain information from several sources, to triangulate the findings.
- The use of good interview techniques – culturally sensitive and also probing or challenging (skills common to Rapid and Participatory Rural Appraisal (R/PRA) methods)

On a rapid survey, most information will be obtained from key informants

Key informants are people who, by virtue of their position or experience, are capable of answering critical questions about the area, village or wealth group. These may be the staff of the NGOs/PVOs on the ground, local government staff, local leaders, farmers and traders. Ultimately a good key informant could be almost

anyone from the area that has had an interest and the experience to build up a good picture of some aspect of how people live.

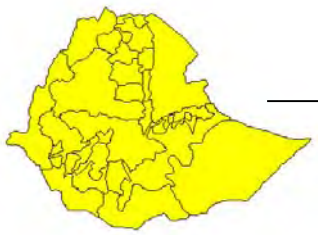
The main steps in conducting an assessment are to:

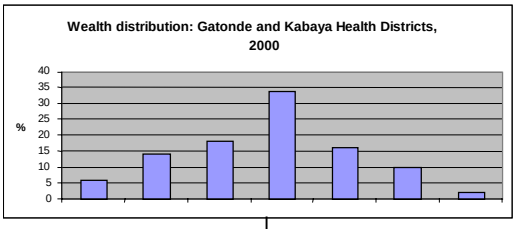
1. *Define the population or populations to be assessed*. Populations are defined as 'Livelihood groups' i.e. in terms of the way in which people usually get their income. For instance, a sedentary population whose income is from agriculture and paid work (as in the Malawi example above) and a pastoral population who live from livestock products and the sale of livestock, would be different livelihood groups.
2. *Describe the wealth structure of the population* i.e. the differences between poorer and better off people. The people themselves define the wealth structure and there are often vernacular terms for different wealth groups.
3. *Build up a baseline or reference picture of the economy* and how this varies between different wealth groups. The aim is to find out how people in different wealth groups obtain their income in a defined reference year – particularly the relative importance of different income sources. The reference year is ideally a recent non-crisis year, but may be any year in which conditions are known.

Figure 15.

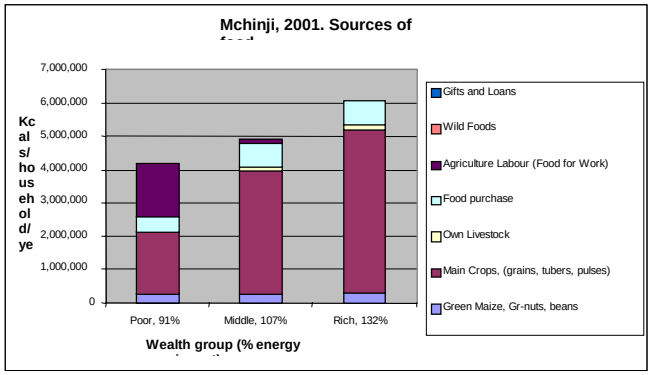
Populations are defined by economy

Wealth groups & a wealth distribution are defined for each population





Household data (a household budget + assets) is obtained for a 'typical' household for each (or at least 3) wealth groups + contextural information (availability of wild foods etc).



Practical guidelines: obtaining the information for each step

Defining Livelihood Groups

The reasoning behind it

Livelihood grouping serves to separate geographic areas or populations in to more manageable and understandable groups, each of which can then be analysed separately. On a small-scale assessment, only one group may be found, although in some cases, even when there is only one livelihood group, it may be useful to subdivide this. For example the population of a camp may be one livelihood group, getting much of its food from rations and by selling rations to buy other goods. If it is thought that there may be differences within the camp e.g. some areas have better access to rations it may be useful to subdivide the population by camp area each of which can then be analysed separately.

Livelihood zones i.e. an area in which a livelihood group lives, do not usually follow traditional administrative boundaries. Once livelihood groups have been agreed and any analysis undertaken it is straightforward to re-convert that analysis to administrative zones. Note that people in a livelihood group may move outside the area (e.g. seeking seasonal work) and still be part of the group.

How to do it

Livelihood groups can usually be defined geographically, in terms of topography, climate, ecology, and above all, agriculture, as in most poor rural areas people's economy is still often largely determined by land use. A good starting point is an agro-ecological map of the country. Better yet is an agro-economic map that goes one step further, taking into consideration common use of resources or access to markets. Further layers of analysis might include soil maps and topography maps.

Often maps are not available. Whether they are or not the common features of different areas must also be developed by talking to key informants, around maps if possible (hand-drawn if necessary), and according to crops, livestock and other local characteristics such as employment opportunities, migration patterns, ethnic groups etc. Pastoral groups may vary according to livestock type and marketing patterns.

Where an analysis is being conducted to interpret a nutrition survey, the livelihood boundary will usually be set by the limits of the nutrition survey.

Sources of Information

- Agro-ecological and agro-economic maps and other secondary resource materials
- Key informants

Tools to Use

- Informal discussions with a variety of key informants, ideally who know a reasonably wide area
- Official maps and hand-drawn maps depending on availability

Socio-economic or wealth structure

The reasoning behind it

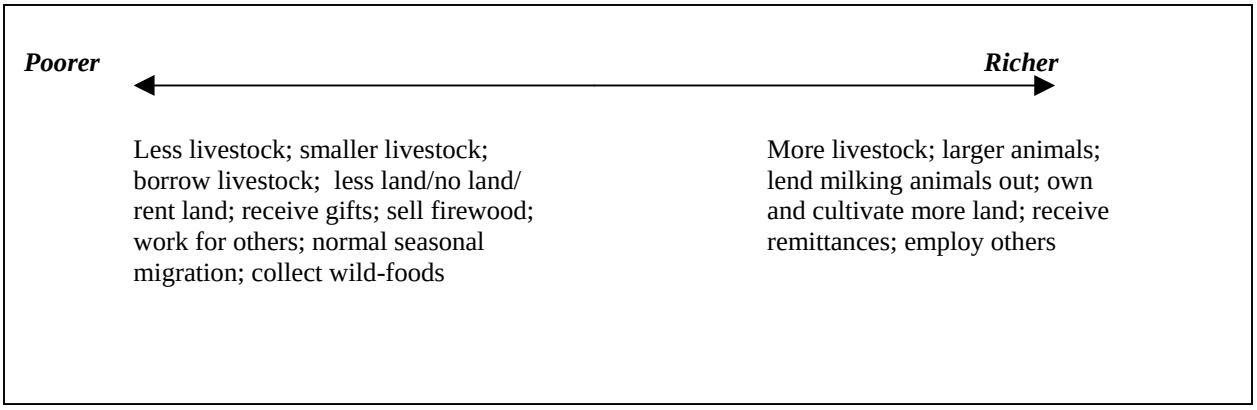
Just as the same external shock will have a different effect on two separate livelihood groups, it will also have a varied impact on families in different wealth groups. Thus even within one food economy zone it is necessary to make distinctions about the ways in which families live.

Households with different levels of assets tend to do different things to get food and income. Poor households with little land may work for richer households to get money to buy food; rich families may use profits from agriculture as capital to engage in trade. In the event of a crisis, poor and rich households will be affected differently and therefore warrant separate examination.

Table 8

Characteristics	**Poor**	**Middle**	**Better-off**
% of Total population	50-60%	25-35%	10-15%
Land cultivated	1-3 acres	5-7 acres	8-10 acres
Livestock	0-2 cattle < 5 goats 10-15 chicken	5-10 cattle (1-2 milking) 10-15 goats <5 sheep 15-20 chicken	15-25 cattle (2-3 milking) 20-30 goats 10-15 sheep 15-25 chicken
HH size	6 (1 wife)	6 (1 wife)	11 (2 wives)
Main activities	Ag labour, Brewing, selling thatch, construction, sell veg & wild fruits, crafts	Sell livestock, brewing, sell thatch, sell veg, wage employment outside district, fishing	Sell livestock, sell cotton, brewing, sell veg, wage employment outside district

Figure 16



Wealth groups can be established by interviews with local key informants, at the village level and at the local administrative level. 'Poor' and 'rich' are thus relative to local standards for the local area. Often these standards are predictable along general livelihood lines: 'richness' is almost always defined by the productive assets held by a household. For instance in pastoral areas, this may be the number of livestock; in

agricultural areas, the amount or quality of land or where employment is available the amount and quality of labour available.

At this stage it is also useful to obtain an estimate of the reserves and *other tradable assets* available to each wealth group, as these often represent a large part of the household's ability to withstand shocks. Tradable assets include:

- Livestock holdings, which are a major investment and reserve in agricultural and pastoral economies.
- Food stocks
- Cash savings

How to do it

Proportional piling i.e. asking a key informant to group counters (100 stones, or beans) where each group represents the proportion of people falling into each wealth group can be a useful technique.

Discussions with key informants should centre on what makes people different from each other, and how some people are better-off or worse-off than others. Exploring local terminology for different types of households is often useful.

Information Sources

- Useful secondary sources are limited on this topic: NGO/PVO reports.
- Key informants

Tools to Use

- Discussions with key informants.
- Proportional piling exercises.

Wealth groups are not necessarily the same as vulnerable groups. Defining 'wealth' is not automatically defining vulnerability. It is not possible to talk about 'vulnerable' groups without giving a context (cattle disease, drought, market closure), as different livelihood groups, wealth groups and households are vulnerable to different things. A poor household, with goats but no cattle, is not very vulnerable to a cattle disease epidemic, but may be very vulnerable to a food price rise, as he buys a lot of his food from the market.

Timeline and Reference Year

The reasoning behind it

Understanding the ups and downs and characteristics of an area's recent history will help to reveal past difficulties and how people managed, which may be relevant to today's situation. Knowing that a population has faced several consecutive difficult years will have very different implications than if the current year is the first difficult year following many normal or good years.

Table 9: North Wollo Highland Belg Zone, Amhara Region, Ethiopia

Year	Ranking	Description
2004/2005	1	Very poor rains. No crop development. Deteriorating livestock conditions. Return of borrowed sheep from poor to rich. Similar to 1999/00.
2003/2004	5	Good rains. Best harvest in past 10 years. Excellent livestock conditions and production.
2002/2003	3	Average rains and harvest. Fairly typical year.
2001/2002	2	Poor rains and year. Food aid distributions.
2000/2001	1	Severe drought. Large food aid distributions. Excess livestock sales.

Developing a timeline will also help to identify the characteristics of different past years, which may be useful to explore in more depth, for example to compare with the current year.

A timeline is also useful in identifying a reference or baseline year about which you will be gathering the more detailed information, on production and exchange options. A reference year is a year that reflects the **usual** conditions: the way in which people **normally or typically** live. If we develop a picture of how people live in a good year only, which does not actually occur frequently, then most other years are going to look relatively bad in comparison. Similarly if we develop a picture of people's livelihoods in a bad year, we will not have a good reference for how people's livelihoods have changed as a result of a problem.

How to do it

Timelines are typically developed through interviews with key informants. By identifying the appropriate local calendar or a production year (from one harvest to the next), and working backwards following a simple checklist of key criteria, a basic history of an area can be revealed.

A simple ranking exercise can be used to compare year types for their overall quality, which is then useful to identify a reference year. It is usually easiest to discuss agricultural years i.e. harvest to harvest. Results can be correlated with the Julian calendar (January – December) later.

Sources of Information

- Government (e.g. agriculture) and NGO/PVO reports may give a history of the area.
- Key informants.

Tools to Use

- Semi-structured interview format
- Proportional piling

Describing the economy

The ways in which people survive and meet their basic needs, and their success in doing so, depends on the opportunities available to them. There are only so many potential ways in which people can get money, income and food. By systematically working through these it is possible to build up a picture of household (food and cash) income. The important thing to remember is that we are interested in tracing *how households gain access to food* (rather than documenting exactly what they eat) because knowing how households get food indicates what will affect that access. Put simply, we are detailing *access* patterns, not *consumption* patterns.

Sources of income can be divided into production and exchange options.

Production options

the alternatives that households employ for gaining access to food that involve a direct relationship between production and consumption. In other words, food produced for the family for consumption purposes.

There are three categories of production options:

- Crops produced by the household.
- Livestock and livestock products (milk, meat, eggs, blood) produced by the household
- Wild foods / hunting (gathered by the household).

Exchange options

These consist of

- Flows of food from outside the household to inside in exchange for something the household has (e.g. livestock) or does (e.g. labor) through trade on non-reciprocal, i.e. commercial terms.
- Flows of food, money (and occasionally other goods) as 'gifts'. 'Gifts' may be non-reciprocal (e.g. relief food) or involve some return from the recipient (e.g some token work, or the expectation that the gift will be returned at some future time when the giver is in need).

The complete set of exchange options is:

- Crop sales (which may include 'cash crops' such as cotton, but will also sometimes include the sale of food crops)
- The sale of livestock and livestock products.
- Wild food sales
- Labor sales (including remittance income)
- Non-food product sales ('self-employment': firewood, charcoal, handicrafts, etc.)
- Other trade (transport and resale of goods/petty trade)

- Gifts (of food or cash) and gift sales (e.g. of relief food).

Some categories, e.g. fishing, might fall under different headings. Sea or river fish might be included under hunting; fish farming under livestock. The important thing is to follow the headings to ensure that all sources of income are classified.

Quantities or proportions?

The emphasis in this analysis is on the proportion of the income obtained from each income source by each wealth group e.g. that maize makes up about 50% of a 'poor' groups crops. In practice it is often possible to discuss income with key informants in these terms ('about half'), although the information can also be obtained as quantities ('4 bags consumed', '6-7 goats sold'). An analysis is easier using proportions, but if this is done, note that it is useful to have some idea of what the *actual income and standard of living of different wealth groups is.*

How to find out about them

The task here is to identify for each wealth group what are the production and exchange options and what is the relative importance of each. This type of information is rarely available from secondary sources and will have to be gathered from key informants at the local and village levels.

A logical order in which to get the information is:

1. Before conducting more detailed interviews obtain a *qualitative* description of the main features of the economy. The agricultural cycle –what is produced and when - will be fairly constant and known to anyone engaged in it. Following the headings above, obtain information on the main crops which are produced, harvest times, types of paid employment and self employment, the wild foods which are gathered and when these are available and what is done with them, and the way in which the prices of the chief traded goods vary through the year. It is much easier to conduct subsequent discussions if you are already broadly familiar with the economy.
2. In discussion with key informants 1. Ensure that it is clear which wealth group is under discussion and that this refers to the reference year. 2. Establish the size of the household which is under discussion e.g. an adult man, an adult woman, two children. 3. Work though each source of income (and food?) systematically to establish its relative importance to that wealth group.
3. Lastly some information will be required on the cost to a household of maintaining a basic standard of living. Typically this would include the cost of clothing, soap (personal and clothes washing), fuel (often a small amount of kerosene or diesel used for lighting), cooking utensils, education costs (even if no direct charge is made for school there are costs for books, examination fees etc), and a provision for health.

The number of interviews necessary is not fixed. By conducting several interviews in representative sites and cross-checking these for consistency, a final estimate can be obtained. Gross inconsistencies include:

- Estimates of income which do not ‘add up’. Income should broadly balance expenditure i.e. the amount of food eaten in a reference year should be within the range of biological possibility and leave enough cash over to meet claimed non-food costs. (proportions versus actual)
- Inconsistencies between wealth groups e.g. if poor people work as agricultural labourers for the better off, this should be recorded as an income/ expense for each group respectively.

The energy content of foods can be checked using the tables in annexe xxx

Sources of Information

Mainly from key informants. If possible speak to key informants drawn from each wealth group e.g. heads of households (men and women).

Secondary sources for reference information

Tools to Use

- Semi-structure interviews
- Detailed quantification based interviews
- Calorie conversion sheets

‘Coping’

Households usually have a variety of options, sometimes known as ‘coping’ strategies that they can use to sustain their food supply when times become more difficult. These include:

- Reducing non-essential expenditure.
- Reducing food consumption.
- Consuming food stocks.
- Using cash savings to purchase food.
- Selling livestock and other assets to purchase food.
- Falling back on wild foods, hunting etc.
- Intensifying an existing source of income e.g. to look for paid work at a distance.

In practice the options may be very restricted e.g. wild foods are scarcely available in many places and the poor lack food stocks, or the options may involve high costs to the household. For example a household may be able to survive a shock but only by selling livestock and other assets, eating unsuitable foods or engaging in prostitution or other dangerous occupations. In extreme cases a household may survive in the short-term, but only at the cost of long-term destitution

Information on coping strategies is best gathered when collecting the baseline information. In many places people will have recent experience of ‘coping’, and in any year some households will have to resort to using such methods to survive.

It is important, and sometimes difficult, to differentiate between normal seasonal activities (for obtaining food and income), a change or intensification of those (coping) activities in more difficult times and unsustainable or distress (coping) strategies. Distress strategies might include movement of whole families to towns, and desperate acts such as eating maize cobs or grass. Through discussions with key informants identify and list the activities that people are currently adopting to meet their needs, for the different livelihood groups and socio-economic groups.

Analysis: putting nutritional survey results in context

The steps are:

- To define the shock which has occurred
- To combine this with the economic information to reach a conclusion about how the shock has affected people's access to food.

Translating hazards into economic effects on households

Describing the shock

Just knowing that a hazard or shock has occurred is insufficient. As illustrated in the example below, we need to be able to work out the way in which a shock has affected food supply and information should be compiled, organised and analysed with this goal in mind.

Hazard	Economic effects
Drought	- reduced crop production (e.g. crop production 30-40% of normal)
	- reduced livestock production (e.g. milk yields half of normal)
	- loss of income from cash crop sales, livestock sales, or loss of employment on local farms (e.g. daily wages 50-70% of normal)
	- change in availability of wild foods (one quarter % of normal)
	- change in availability of fish (130-150% of normal)
War	- market closure (e.g. staple food prices doubled)
	- loss in crops/livestock/inputs from looting (e.g. crop production 30% of normal)
	- reduced access to critical land for planting or grazing (e.g. milk yields 20-30% of normal)
	- disruption of trade and transport (e.g. effective 75% reduction in livestock prices)
	- reduced access to outside assistance (e.g. food aid 0% of normal)
	- displacement (total loss of food and cash income for displaced & increased demands on host population)

In understanding food security, it is necessary to define the shock that has occurred in terms of its relationship to people's sources of food and income. For instance, maize production may fail for a wide variety of reasons: drought, flood, stem-borer; the important step is to estimate the actual impact this has had on production and/or prices.

The scale of a shock can be estimated by comparing the current shock with historical trends – prices of major commodities and labour rates and cereal production for example. It is often the case that some factors, such as changes in the availability of wild foods or milk yields or loss of access to land, or even crop failure, may have to be estimated through discussions with key informants, where official sources do not exist or are considered unreliable.

Putting the shock information and the economic description together

The effect of a shock on household's ability to acquire food depends on

- The usual pattern of livelihood
- The specific shock which has occurred

The impact of a shock can be estimated in two stages:

1. The direct impact of the shock on the income of each wealth group.
2. The extent to which each wealth group may be able to compensate or 'cope' for the shock and what the impact will be for the food security and standard of living in the household

Step 1. Estimating the direct impact

The direct impact can be estimated by combining the 'shock' with the description of the economy of each wealth group. For example, if the 'poor' wealth group gets approximately 50% of its food income from maize in the reference year, and the 'shock' is estimated to have reduced maize production by 20%, it can be estimated that food income will fall by (50*20/100) about 10% *from the reference value*.

Poorer households often have diverse income sources (i.e several main crops, such as millet, sorghum and groundnuts, and some paid or other employment) and will tend to be less vulnerable to a shock affecting one food or income source. A richer farmer who mainly grows maize for his consumption and to sell will, in terms of the *proportion* of current income lost be more seriously affected (but is then likely to be better able to cope after the direct impact if he/she has tradeable assets – see coping section).

The same logic applies to any source of income e.g. a cattle disease epidemic would be expected to have a greater direct effect on wealthier cattle owners/ agro-pastoralists than poorer ones, who mainly keep sheep and goats (e.g. 50% cattle deaths against poor and rich income from livestock).

A rise in the price of food may affect poorer households, which are more dependent on food purchase, more than wealthier ones who grow more of their own (Figure).

Step 2. Estimating the ability of the household to compensate for the direct impact on income … how are they currently coping

Do households have assets, reserves or savings, employment or other strategies they can draw upon to maintain their income, given any deficit in step 1?

For example, if a poor wealth group has no food stocks, and on average 1-2 goats, and 1 goat can usually buy 2 sacks of sorghum, we start to have an idea of the value of household assets in terms of food:

> Example
>
> If a rich wealth group of on average 6 people has approximately 2 bags or 200Kg maize held as food stocks and a deficit of 2 months of food, it is likely the deficit can be met through using the stocks:

Putting the food security story together

The aim is to draw the analysis together into a narrative which can be used to help explain the observed nutritional status and make a projection into the future. The following example

How did people live before the crisis

One-year timeline, showing harvests etc.

histograms or pies of the pattern of income of each wealth group.

The shock:

How the current year has developed?

Repeat first two figures with changes showing step 1 analysis.

Coping

How people should be living now (i.e. at the time of the nutrition survey)

Confirming the analysis by observation

What strategies are different wealth groups currently adopting? I.e. should be consistent with the analysis.

Projecting the analysis into the future

Whether food security conditions have already been at their worst or are likely to worsen further will help us to use the nutritional data as a basis for further predictions.

Section 4: Analysis, Interpretation and Recommendations (not yet available)

Interpreting The results of combined nutritional status, mortality and food security findings

(Not yet available)

Formulating the recommendations

(Not yet available)

Presenting the report

(Not yet available)

Appendicies (not yet available)