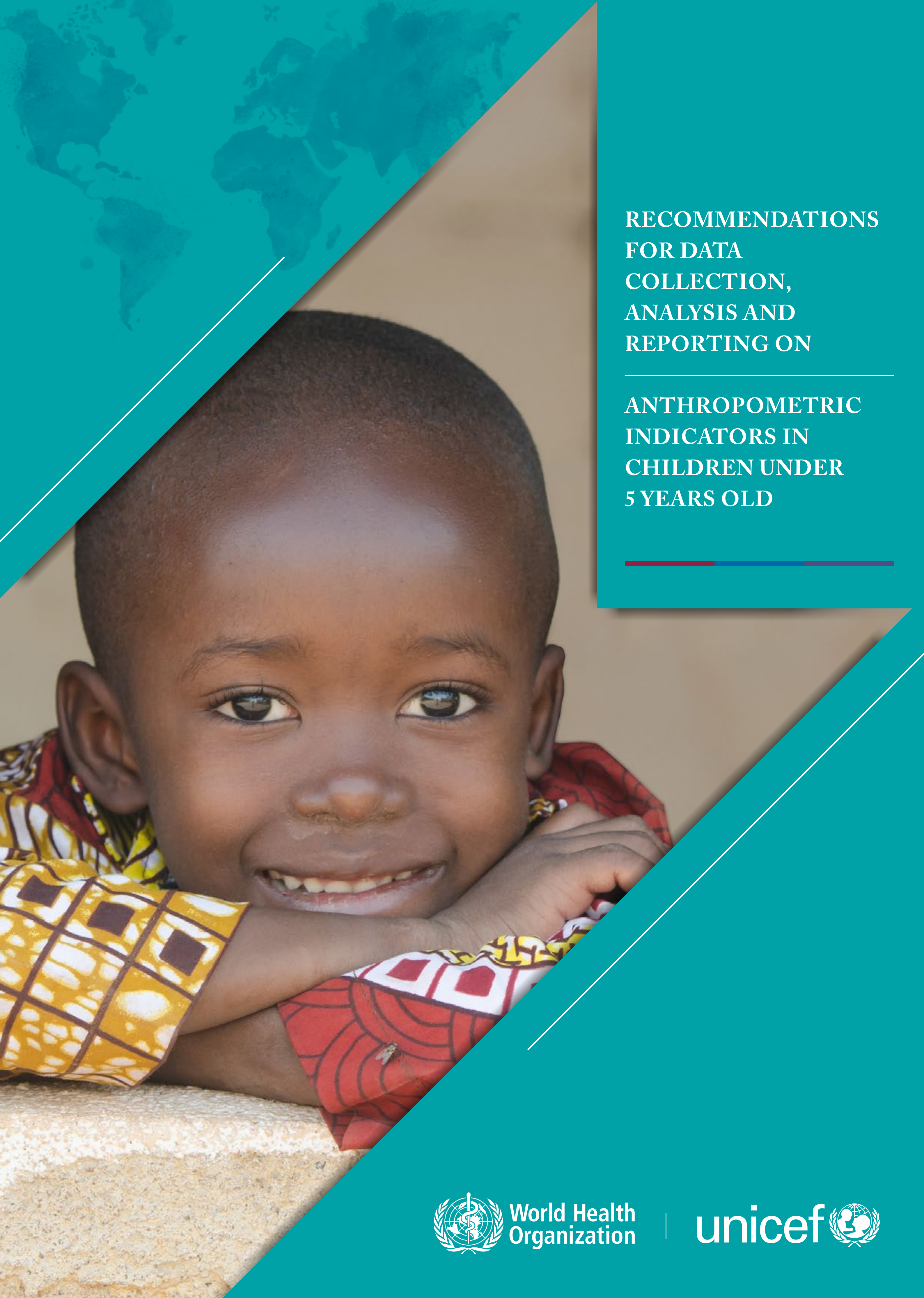

RECOMMENDATIONS FOR DATA COLLECTION, ANALYSIS AND REPORTING ON

ANTHROPOMETRIC INDICATORS IN CHILDREN UNDER 5 YEARS OLD

World Health Organization | unicef

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MAY 2019

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Recommendations for data collection, analysis and reporting on anthropometric indicators in children under 5 years old

ISBN 978-92-4-151555-9

Suggested citation. Recommendations for data collection, analysis and reporting on anthropometric indicators in children under 5 years old. Geneva: World Health Organization and the United Nations Children's Fund (UNICEF), 2019. Licence: CC BY-NC-SA 3.0 IGO.

Cataloguing-in-Publication (CIP) data. CIP data are available at http://apps.who.int/iris.

English edition: Iain Bamforth

Cover design and layout: Paprika (Annecy, France)

Printed in Switzerland

CONTENT

ACKNOWLEDGEMENTS

This technical report was prepared by the Working Group (WG) of the WHO-UNICEF Technical Expert Advisory Group on Nutrition Monitoring (TEAM) for Anthropometric Data Quality, under the joint coordination of the Growth Assessment and Surveillance Unit, Department of Nutrition for Health and Development, World Health Organization (WHO) and Data & Analytics Section, Division of Data, Research and Policy, UNICEF.

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Special appreciation goes to Elaine Borghi (WHO), Monica Kothari (PATH), Sorrel Namaste (ICF), Elisabeth Sommerfelt (FHI 360) and Monica Woldt (FHI 360) for writing several sections and reviewing the document at various stages.

The Working Group is also indebted to numerous individuals that provided valuable inputs at different stages of the project: Mary Arimond (FHI 360), Rukundo Benedict (ICF), Monika Blössner (Independent Expert), Diana Estevez (WHO Consultant), Edward Frongillo (University of South Caroline), Jonathan Gorstein (Washington University), Larry Grummer-Strawn (WHO), Louise Mwirigi (UNICEF) and Kuntal Kumar Saha (WHO). Furthermore, we are thankful to David MeGill (UNICEF), for supporting the development of the sampling section; Richard Kumapley (UNICEF), for the analyses of the JME survey datasets; and the MICS team for providing comments at different stages of the document.

This project was undertaken under the coordination of Elisa Dominguez (WHO) and Julia Krasevec (UNICEF). Overall guidance and supervision was provided by Mercedes de Onis (WHO) and Chika Hayashi (UNICEF).

ACRONYMS

ANI	Accelerating Nutrition Improvements
CAFE	Computer-assisted field editing
CAPI	Computer-assisted personal interviewing
DHS	Demographic and Health Survey
FANTA	Food and Nutrition technical Assistance project
GIS	Geographic information system
GPS	Global positioning system
HAZ	Height-for-age z-score
IT	Information technology
JME	Joint Malnutrition Estimates
MGRS	WHO Multicentre Growth Reference Study
MICS	Multiple Indicator Cluster Survey
MUAC	Mid-upper arm circumference
NCHS	National Center for Health Statistics
NHANES	National Health and Nutrition Examination Survey
NSO	National Statistics Office
PPS	Probability proportional to size
PSU	Primary Sampling Unit
SAM	Severe acute malnutrition
SD	Standard deviation
SE	Standard error
SDG	Sustainable Development Goals
SMART	Standardized Monitoring and Assessment of Relief and Transitions
TEAM	Technical Expert Advisory group on nutrition Monitoring
TEM	Technical error of measurement
TWG	Technical Working Group
UN	United Nations
USAID	United States Agency for International Development
WAZ	Weight-for-age z-score
WHA	World Health Assembly
WHZ	Weight-for-height z score
WHO	World Health Organization
WB	World Bank
UNICEF	United Nations Children's Fund

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INTRODUCTION

In the last decade, there has been an increasing awareness of the importance of nutrition for human health and well-being. This is reflected in the commitments towards the six global nutrition targets for 2025 endorsed by the Sixty-Fifth World Health Assembly in 2012 (WHO 2012), and the ambitious aim of the Sustainable Development Goals (SDGs) "to end all forms of hunger and malnutrition by 2030" *(1)*. The United Nations Decade of Action on Nutrition underscores these commitments to mobilize international efforts to end malnutrition in all its forms *(2)*. The success of these global targets requires adequate investments in nutrition programmes and surveillance.

Some of the key indicators of the nutritional status of a given population are based on anthropometric data. Accurate anthropometric data are critical to provide reliable information to policy makers, programme managers, researchers and advocates, especially in the nutrition field. The quality of anthropometric data is also important in assessing how health and nutrition interventions are implemented and in guiding subsequent planning.

In population representative surveys, anthropometric data are collected to provide a clear understanding of the magnitude and distribution of malnutrition problems in a country, and to design and monitor interventions to improve the nutritional status of the populations concerned. The type of survey used depends on the context, but all surveys should follow standard criteria for anthropometric data quality and standard methods for data collection, analysis and reporting. Comparable and accurate anthropometric data are essential if national governments and other stakeholders are to be able to monitor how nutrition-specific and -sensitive programmes have been carried out and make decisions based on their progress.

In 2015, The United States Agency for International Development (USAID) hosted a technical meeting *(3)* in Washington, DC to develop a shared understanding of the purposes, strengths and challenges of anthropometric survey methodologies and to provide recommendations for improving the comparability of anthropometric data and accuracy of population estimates. In 2017, the United Nations Children's Fund (UNICEF) and World Health Organization (WHO) co-hosted a meeting on "Strengthening and Implementing Nutrition Monitoring and Surveillance: Lessons from the Field" in Geneva to focus on lessons learned from all regions and discuss nutrition indicators and surveillance systems in place. This meeting highlighted the gaps in nutrition data for monitoring progress at national, regional and global levels. The expert group also recognized that there was a need for criteria to assess the quality of anthropometric data, and to harmonize methods for data collection, analysis and reporting *(4)*. To this end, the WHO-UNICEF Technical Expert Advisory Group on Nutrition Monitoring[1] set up a working group (WG) in 2016 to establish a set of recommendations for collecting anthropometric data that would improve data quality and standardize methods of analysis and reporting.

Purpose

The task of the TEAM WG on Anthropometric Data Quality was to define basic criteria and standards for sampling, training and standardization of anthropometrists, data collection, supervision, for data management including quality assessment and analysis, interpretation and reporting of anthropometric data. A central outcome of its deliberations is the present document the aim of which is to provide guidance to personnel involved in surveys including anthropometric measurements. It has been drawn up based on a review of currently available tools for national household surveys (DHS, MICS, SMART, etc.) and proposes a set of recommendations to enhance quality reporting for the global nutrition targets (childhood stunting, wasting and overweight) and SDG target 2.2.

Some recommendations included in this document are evidence-based while others rely more on practical experience and expert advice. When developing this technical guidance, it became clear that there is a need for further research to provide a wider range of evidence-based recommendations and to determine whether the use of technologically more advanced measuring instruments leads to the collection of more accurate data. The aim of this document is to guide survey implementers on how to improve the quality of anthropometric data for global monitoring. It should allow countries to track their progress towards the Global Nutrition Targets for 2025 and the SDGs for 2030 more effectively.

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[1] WHO-UNICEF Technical Expert Advisory Group on Nutrition Monitoring (TEAM), (https://www.who.int/nutrition/team/en/, accessed 26 February 2019)

SCOPE

This document is intended as a reference for the recommended steps in collecting, analysing and reporting malnutrition estimates based on anthropometric data in nationally representative surveys. Its objective is to set out standardized methods for generating representative malnutrition estimates based on anthropometric data relating to weight, length/height and age in children less than 5 years old (or aged 0–59 months).

Emergency settings are beyond the scope of this document. Some of its proposed recommendations and tools may be of use in emergencies but owing to the limited resources and pressing need for rapid assessments in such settings, some steps may not be feasible. A more context-bound approach may be necessary.

Recommendations focus on anthropometric indicators based on measurements of weight, length/height and age, among which the following anthropometric indices are central:

- weight-for-age;
- length-for-age or height-for-age;
- weight-for-length or weight-for-height.

Indicators such as wasting (weight-for-length/height more than 2 SD below the WHO Child Growth Standards median), stunting (length/height-for-age more than 2 SD below the WHO Child Growth Standards median) and overweight (weight-for-length/height more than 2 SD above the WHO Child Growth Standards median) in children aged 0–59 months are not only part of the Global Nutrition Monitoring Framework of the Comprehensive Implementation on Maternal, Infant and Young Child Nutrition *(5)*, they are also three of the six global nutrition target indicators as well as SDG 2.2. Mid-upper arm circumference (MUAC) is not included in this document as it is not one of the definitions of wasting used for tracking progress towards the Global Nutrition Targets set by the World Health Assembly.

Audience

This document's target audience is technical staff experienced in surveys for collecting anthropometric data, and is especially intended for:

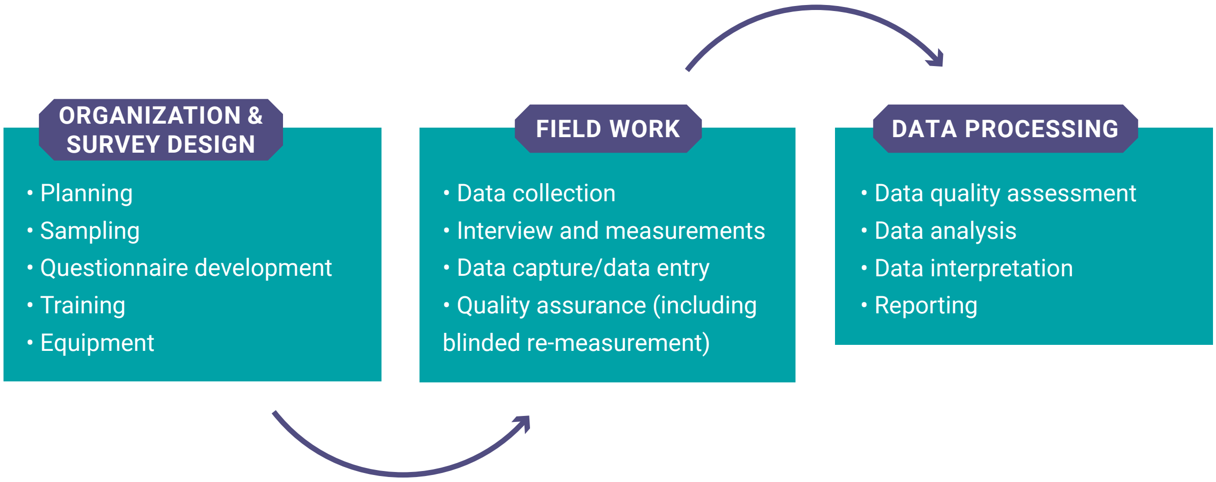
- survey managers;
- technical assistance providers for national surveys;
- national survey organizations (reporting to government on SDG and WHA, implementers of representative surveys that include child anthropometry, etc.);
- international and national organizations with interest in data quality;
- researchers;
- public health nutritionists.

Outline

This document is divided into three main chapters (Figure 1). Chapter 1 describes the organization and design of a survey including recommendations on the planning stage, sampling procedures, development of the questionnaire, training of field teams and equipment required for anthropometry. Chapter 2 provides guidance to support the collection of high quality data during field work, especially regarding data collection procedures, on conducting the interview and carrying out measurements and on the data capture/entry process and recommended in-process quality assurance checks. Chapter 3 describes the data quality assessment checks at the central office, the recommended standard approach for analysis of malnutrition estimates and their interpretation and reporting. It also provides a standard approach to producing a transparent report. Each chapter provides a rationale and proposes a number of steps for enhancing data quality. Whenever available, recommendations at each step of the process are coupled with links to useful tools. Examples of faulty practices that may affect data quality and suggestions on how to avoid them are also provided in some sections of Chapter 1 and 2.

The three chapters present material or set of recommendations of distinct nature. Chapters 1 and 2 pertain to survey steps where survey planners and implementers own the process of conducting the survey and are ultimately responsible for the survey data collected. In these chapters, potential faulty practices and how to avoid them at each stage of the planning and data collection are thus included. In turn, Chapter 3 explains how to perform data quality assessment and data analyses following a standard approach and produce a report that enhances transparency.

Figure 1. Improving data quality along the anthropometric survey process



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ORGANIZATION & SURVEY DESIGN

The organization of an anthropometric survey includes several components that are crucial for enhancing the quality of anthropometric data:

1.1. Planning
1.2. Sampling
1.3. Questionnaire development
1.4. Training and standardization
1.5. Equipment

1.1. PLANNING

Planning surveys to collect anthropometry data involves various steps to implement measures likely to generate quality data.

This section sets out the key steps in survey planning, identifies critical control points to avoid common faulty practices that may affect data quality and highlights recommendations to prevent these pitfalls.

Key steps to support the survey planning process

a) Initial planning for the survey (survey steering committee/technical working group);
b) Preparing the survey protocol (survey manager, sampling statistician);
c) Selecting the data collection method (survey manager);
d) Preparing a survey manual including an interviewer's manual (survey manager, fieldwork coordinators);
e) Signing an agreement with government for public release of datasets (survey manager);
f) Defining a timeline (survey manager, sampling statistician);
g) Obtaining ethical approval where necessary (survey manager);
h) Selecting the field team (survey manager);
i) Preparing a plan for field work (survey manager).

Brief overview of planning steps

a) Initial planning for the survey

It is recommended that an expert on anthropometry should be a member of the survey steering committee (see the survey organization chart in Annex 1). When this is not feasible, identify an expert on anthropometry in an external stakeholder group and develop a formal process to allow this expert to contribute to steering committee decisions.

Before starting, establish whether other surveys covering the same topic are being planned during the same period. This is recommended in order to enable joint work, boost efficiency and reduce duplication of efforts. If a survey with anthropometric indicators is needed, the first step is to define its **scope** (see Note 1), identify the **target population** and establish **main objectives**, while bearing in mind the context in which the survey will be carried out. Second, resources should be secured for the entire process, including the purchase of requisite equipment and logistics support, as well as to meet staffing and other financial costs. Third, the survey timeline should be developed. Identify a suitable survey manager[1] and organization experienced in undertaking surveys including anthropometric data collection to lead the survey.

[1] See a standardized model of job description in Annex 2.

NOTE 1: RECOMMENDATION ON THE SCOPE OF THE SURVEY (RELATING TO ANTHROPOMETRIC INDICATORS)

Anthropometric indicators underpinning the WHA Global Nutrition Targets 2025 and SDG 2030 (stunting, wasting, and overweight) refer to children aged from 0 to <5 years (i.e. aged 0–59 completed months). **It is very important to obtain information on children below 6 months of age and to include them in anthropometric surveys**. We recommend including in national surveys:

– all children aged 0–59 in completed months;

– indicators included in the 2025 nutrition targets: stunting, wasting and overweight.

Bilateral oedema assessment in national surveys: this assessment is not recommended as a standard protocol for all surveys as malnutrition with oedema is uncommon in many countries and, more importantly, can be easily misdiagnosed.

If assessment of bilateral pitting oedema is included in the survey, field teams should be appropriately trained with exposure to actual cases. All cases of oedema observed during data collection should be verified by a field supervisor.

When bilateral pitting oedema assessment is part of a survey, the survey report should display separate results for acute malnutrition cases with and without oedema.

TIPS

- *Identify the best period to implement the survey to allow comparison with previous surveys (seasonal factors may have an impact on anthropometric indicators);*
- *Give careful consideration when planning to cover all measurements and questions needed to estimate the prevalence of stunting, wasting and overweight in view of their importance to the Global Nutrition Targets and SDGs.*

TOOLS

- An Excel file to calculate a survey budget can be found in the MICS toolkit (Appendix A, Budget Calculation Template).

b) Preparing the survey protocol

The survey manager, working with other stakeholders, should supervise the process of preparing the survey protocol for validation by the survey steering committee. The survey manager should define the analytical plan with support from a survey statistician: this includes defining the indicators, data needed to calculate them, the target population, requisite disaggregation categories and other specifications that are required to achieve the survey objectives. The survey manager's tasks include:

– overseeing the design of the questionnaire and a local events calendar which can be used to work out the date of birth for children when this is unknown;

– pre-testing the questionnaire and drafting an interviewer's manual to provide instructions on how to complete the questionnaire and correct procedures for anthropometry measurements (see Section 1.3 on Questionnaire development for further details);

– identifying human resources required (number of teams and rotating supervision personnel required as well as mapping and listing teams during the sampling stages);

– working out specific material and equipment needs: where data collection is computer assisted, electronic weighing equipment may be able to transmit data directly to the tablet so as to avoid data entry errors (see Section 1.5 on Equipment for required specifications);

– standardizing the technical equipment.

c) Selecting the data collection method

To improve data quality and facilitate data sharing, many agencies recommend using computer-assisted data collection in the field. Experience has shown that adopting this approach instead of relying on paper-based questionnaire improves the quality of collected nutrition survey data *(6)*. Data collection using computers or smartphones as opposed to conventional paper-based systems has the following advantages:

– it is more user-friendly;
– team performance can be monitored more easily and in a more timely manner;
– collecting and digitizing data at the source makes data entry more efficient and precise, leading to more consistent data;
– no mobile internet connection is required at the time of collection;
– standardized questionnaires are readily programmable for computer-based data collection and can be reused in any setting;
– error control can be tightened with ranges and restrictions set to the needs of the survey, and data easily transferred to other software;
– results are obtained within days, rather than weeks.

TOOLS

- A model survey protocol can be found in the MICS toolkit (MICS survey plan template) along with various tools for estimating required supplies (MICS Listing and Fieldwork Duration, Staff and Supply Estimates Template);
- For more information on the advantages and disadvantages of computer-assisted interviews see DHS Survey Organization Manual 2012, p. 19.

d) Preparing a survey manual including an interviewer's manual

The manual should include a clear description of field data collection procedures adapted for use by the survey teams. It should include specific instructions for the interviewer on local customs and how to introduce the team to primary sampling unit (PSU) representatives, identify sampled households, initiate call-backs based on the protocol for full completion of the questionnaire and perform anthropometry measurement procedures correctly, etc. A chapter describing how to perform supervision tasks and conduct standardization procedures to ensure quality assurance during data collection should also be included in this manual.

e) Signing an agreement with government for public release of datasets

The team implementing the survey should reach a collective agreement with government that the raw dataset will be made publicly available for sharing and dissemination once the survey is complete. Open availability of entire and raw datasets is recommended.

f) Defining a timeline

Sufficient time should be allocated for recruiting personnel. Various factors have to be considered when making accurate predictions of the timeline required to organize an appropriate survey: these include the survey design, ethical review and approval if required, developing an appropriate recruitment process for field teams, sampling stages (including household mapping and listing operations), training including standardization exercises, procurement of equipment and other logistics and, not least, time required for field work, data processing and report writing. The survey manager is responsible for ensuring that the survey process follows the timeline and that each aspect of the survey progresses smoothly.

TOOLS

- A model survey timeline can be found in the DHS Survey Organization Manual 2012, page 8.

g) Obtaining ethical approval where necessary

UNICEF and WHO recommend that even if a country does not require ethics approval for a protocol involving a household survey that reports on malnutrition rates, survey organizers should seek ethical approval. If local ethics review boards are not available or would not require ethical approval for such a protocol, approval from an international ethics review board should be sought. The national ethics review board (or the international board) should indicate whether the survey team should refer children identified with severe wasting for treatment depending on available services in country. If referral for treatment of severe wasting is to be part of the survey protocol, the interviewer/measurer should not inform the caregiver during the household interview/measurements as they should not be aware of z-scores for any child during household interviews/measurements. The caretaker[2] of affected children should be informed about the referral for treatment by the field supervisor or other survey team member before the team leaves the PSU.

1

TOOLS

• An example of ethical standards in data collection can be found in a UNICEF procedural document[3]

h) Selecting the survey team

The roles and job profiles of all members of the field team including the data manager and data processors should be fully specified (see Annexes 1 and 2 for the organization chart and job descriptions). Determine how many team members need to be recruited to make up an adequate team and allocate sufficient time for the recruitment process, which should generally take place several weeks before survey training starts. Team members should be clearly informed about the requirements of the survey: time needed for field work and ensuring commitment, local conditions (lodgings, transportation, per diem, remuneration), security issues and the length of the working day or week in order to limit drop-outs. Consideration should also be given to specific contextual factors (cultural beliefs, gender issues) that might affect the collection of anthropometry data. Depending on the setting, gender balance within the survey teams may also be an important factor.

The recruitment process should include a test to confirm that the prospective team members can handle numbers and read measurements accurately and are also physically able to perform their tasks (e.g. able to kneel or bend down and carry the equipment) depending on the particular type of anthropometric equipment being used. If a recruitment candidate is unable to conduct anthropometric measurements correctly, he or she should be replaced.

It is good practice to record the characteristics of the individual anthropometrists (age, sex, education, professional training, employment status, past survey experience, etc.) in a database. This information can then be linked to the individual anthropometrist's identification number (or team ID) once each questionnaire has been completed for performance analysis.

An appropriate number of survey teams should be set up depending on the circumstances (weather, distance, mode of transport, working conditions, length of questionnaire, etc.). Teams must be carefully organized in such a way that a reasonable number of anthropometric assessments can be done each day while avoiding excess workload and fatigue. Team member fatigue will have a negative impact on the quality of measurements. The workload undertaken by the various anthropometrists should be monitored during the first few days of the survey.

TIPS

• It is recommended that each field team have a minimum of two trained anthropometrists to measure every child. The two anthropometrists should have defined roles, one acting as the "main measurer" and the other as the "assistant measurer";

• Remember that survey teams should not be overtaxed with an excessive workload since tired teams are likely to neglect accuracy or enter erroneous data.

TOOLS

• A model set of job descriptions is presented in Annex 2;

• DHS uses a data collection form for fieldworkers that may be helpful in assessing anthropometric performance.

[2] Mother/caretaker are used interchangeably in this report.

[3] UNICEF Procedure for ethical standards in research, evaluation, data collection and analysis, 2015: this document is a template and likely to require specific adaptation

i) Preparing a plan for field work

The survey manager should ensure that all requisite material and equipment is available on time in the field. Technical equipment should be purchased and calibrated, and any material prepared. Logistics and human resources should be ready to undertake the planned tasks as per the timeline. Having a contingency plan is advisable: this allows for the rapid replacement of a team member or item of equipment, if necessary.

Authorities at the different levels should be informed in a timely manner when the survey is going to take place. This is especially important for the PSU so that authorities can inform residents from sampled households to stay at home on the day of the survey. This part is further developed in Chapter 2 (Field work).

TIPS

- Prepare a contingency plan so that a team member or item of equipment can be replaced at short notice.

TABLE 1. FAULTY PRACTICES AND HOW TO AVOID THEM WHEN PLANNING AN ANTHROPOMETRIC SURVEY

FAULTY PRACTICES	HOW TO AVOID THEM
Unclear purpose, objective and scope	• Determine if there is a recent available survey which has already reported data for global targets (new estimates should be made for anthropometric indicators every three years so that countries can regularly update their progress towards SDG goals); • Discuss the survey with local counterparts and ask what they would like to learn from it and how its results might address priority issues in policies and programmes; • Make survey objectives are SMART (specific, measurable, achievable, relevant and time-bound); • Develop a Memorandum of Understanding (MoU) which all requisite parties sign (e.g. government, data owners, etc.,) to make data files publicly available.
Lack of resources: financial or human	• Use an established protocol and consider constraints when developing the budget; • Consider suspending the survey if there is no political commitment or financial resources to implement it.
Underestimation of the importance of language factors	• Use people thoroughly familiar with the local language when translating questions; • Commission a back-translation of the questionnaire to ensure that its questions ask precisely what the survey designers anticipated; • Ensure the data collection team includes people who speak and understand the local language.

⚠ FAULTY PRACTICES	✓ HOW TO AVOID THEM
Long process to obtain ethical approval and other authorizations	• UNICEF and WHO recommends that even if a country does not require ethics approval for a protocol involving a household survey that reports on malnutrition rates, survey organizers should seek ethical approval. If local ethics review boards are not available or would not require ethical approval for such a protocol, approval from an international ethics review board should be sought; • Identify the national or international ethics review board to whom refer to seek ethical approval and be informed about the process; • Allow sufficient time for these matters and have some flexible resources to deal with them.
Rushed or too little time for recruitment process	• Draw up a timeline of several weeks for undertaking interviews and completing contractual or administrative procedures before training starts.
Survey teams not accepted by local communities	• Contact central and local administration as well as local community leaders prior to the survey and explain its purpose and objectives and the types of measurements required.
Insufficient number of anthropometrists (survey team members drop out)	• Consider recruiting at least an additional 15% of anthropometrists above field work requirements for training in view of language needs and possible drop-outs.
Delays in arrival of equipment	• Start ordering equipment and supplies as soon as requirements are known, choose a reliable supplier and check with local counterparts about customs clearance for applicable items.

1.2. SAMPLING

All cross-sectional household surveys that are intended to be representative of a geographically-defined national and/or subnational population should employ standard methods and tools for sampling as outlined in this chapter. Statistically sound and internationally comparable data are essential for developing evidence-based policies and programmes, as well as for monitoring the progress of countries toward national goals and global commitments. Appropriate sampling procedures are a key part of the process for generating accurate estimates. Representative cross-sectional household surveys generally follow a stratified two-stage sampling design. The PSUs identified in the first stage of this design are often based on the most recent population and housing census. The second-stage sampling framework is developed by means of a mapping and listing operation which involves visiting each of the selected PSUs and drawing a location map and sketch map of structures in the PSU: this is essentially a list describing every structure along with related named household heads and other characteristics. The quality of this listing operation is one of the key factors affecting coverage of the target population. Household mapping and listing should be done as a distinct operation and while it represents a significant field cost, it is an essential procedure that guarantees the completeness of coverage of the frame and representativeness of the sample. Fortunately, existing tools can be used to help guide appropriate sampling.

The steps outlined below are recommended when implementing surveys requiring representative estimates, such as for SDG monitoring, but are not meant to apply to other research or monitoring designs.

Summary of recommended sampling steps in representative cross-sectional household surveys

a) Appoint a sampling statistician to develop and implement the sampling plan (survey manager).
b) Develop the sampling plan (sampling statistician);
c) Finalize survey objectives in terms of key indicators and geographic areas for analysis (sampling statistician supported by sector specialists and survey manager);
d) Calculate the sample size (sampling statistician);
e) Identify and review the sampling frame (sampling statistician);
f) Select the primary sampling units (PSUs) (sampling statistician);
g) Organize development of the second-stage sampling frame, i;e; planning and training for the mapping and listing operation (survey manager);
h) Carry out the household mapping and listing operation to create the second-stage sampling frame ahead of the survey (sampling statistician);
i) Select households to be interviewed (sampling statistician);
j) Define household and household members and develop the household roster part of the questionnaire and related interviewer instructions (sampling statistician and survey manager);
k) Train interviewers and other field personnel to follow the sampling plan and survey methodology (survey manager);
l) Write a detailed annex on the sample design and sample implementation (sampling statistician);
m) Calculate weights for households and individuals (sampling statistician).

Overview of steps and tools for sampling in representative cross-sectional household surveys

a) Appoint a sampling statistician to develop and implement the sampling plan

The sampling statistician should oversee all aspects of the sampling plan from its development through to implementation, calculation of sampling weights and errors, and reporting. Ideally, he or she should come from a local agency such as the National Statistics Office (NSO) if it is involved in the survey. If the NSO or comparable agency is not involved in the survey, engage a sampling statistician from a local agency or hire a consultant sampling statistician to review all sections of the sampling plan and provide oversight and technical guidance at each step of implementation and reporting; the model of terms of reference included in this guide (Annex 2) may help when drawing up a contract for this type of expert.

TIPS

- Determine whether the National Statistical Office has the capacity to reassign a sampling statistician to support this survey and if not, consider hiring an experienced international consultant.

TOOLS

- Terms of Reference for a sampling statistician (where national capacity is insufficient) are presented in Annex 2.

b) Develop the sampling plan including the sections outlined below

Note that the items below represent the basic areas which should be covered in a national-level sample, although other parameters may need to be considered depending on the scope of the survey. An experienced sampling statistician will be able to identify and address the particular requirements of a survey, e.g. oversampling of households with children under 5 years of age because of low fertility, subsampling, stratification, etc.

– Sampling frame: includes a review and evaluation of the sampling frame and outlines geographic information available for stratification;

– Survey objectives and target population: includes survey objectives in terms of key indicators, target population(s) and geographical domains of analysis (e;g; regions, urban/rural at the national level);
– Sample size: calculation of sample size based on survey objectives, target population and required level of precision for key indicators by domain;
– First-stage sampling: includes a database of PSUs with details such as the number of households in relation to the selected PSU (standard methodology generally involves selecting PSUs systematically with probability proportional to size (PPS) within each stratum);
– Preparation for second-stage sampling: includes manuals and other materials (e;g; forms or computer-assisted personal interviewing (CAPI) applications), training, organizing and performing the household listing and mapping operation;
– Household selection: includes details related to central office selection of sampled households;
– Training of field team members to follow sampling plan;
– Documentation and reporting on sampling implementation;
– Procedures for calculating sample weights for households and individuals.

TIPS

- The sampling statistician should be responsible for developing the sampling plan;
- If a MICS, DHS or other national household survey has recently been conducted, review the sample design and results for key indicators from the most recent survey; if it was aligned with section 1.2 of this report, use the same approach to allow comparability.

TOOLS

- Sample design appendices in MICS and DHS reports can serve as model sampling plans but need to be adjusted based on the specific objectives of the new survey and its expected outcome. Determine whether a MICS or DHS report exists for your country online; if not look for a survey with similar sampling needs (e.g. where similar design parameters were used for national or sub-national domains, i.e. provincial or district level, urban/rural, etc.: this can be used as a starting point for drawing up a sampling plan for the new survey.
- DHS Sampling and Household Listing Manual can be used as a model sampling plan (start at section 5.2.1).
- Other useful information can be found on the NHANES sampling design webpage.

c) Finalize survey objectives in terms of key indicators and geographic areas for analysis

Use information about specific reporting needs as well as available resources such as budget and time to define the scope of the survey: is it, for instance, going to be nationally representative or will it also allow for regional or district level estimates? A minimum sample size will need to be determined for each geographical domain that will be separately estimated in the survey tables. A larger number of geographic domains and disaggregation categories (e.g. wealth, maternal education, etc.,) will increase the sample size considerably. This will result in higher costs and longer fieldwork duration. The need for and use of information from different levels of disaggregation should therefore be carefully considered.

d) Calculate the sample size

Review outcomes, e.g. prevalence estimates, sampling errors and design effects, in all relatively recent household surveys for indicators which can be fed into the calculation of sample size. Surveys reviewed should be representative of the same population as the upcoming survey and the sampling statistician can help to determine which parameters are appropriate to use. If a MICS or DHS was recently conducted, precision measurements and design effects for key indicators can be found in the appendices of the final report. For a previous stand-alone anthropometry survey, under-5 stunting would be an effective indicator to examine. The link to the sample size calculation templates listed under "Tools" (below) may also help to generate an appropriate sample size for a survey. If an estimate of the under-5 stunting rate is not available from a previous survey, a 50% estimate would yield the largest required sample size. If the survey has multiple indicators, or if there is a need to stratify malnutrition estimates by different background characteristics, other factors or indicators may also need to be considered. The sampling statistician can provide advice on making the best decision.

Determining the sample size needed to achieve a statistically significant difference between only two time points is not recommended, unless the expected difference in prevalence is large enough not to impose a major increase in sample size requirements. The FANTA Sampling Guide has an Excel-based calculator which is able to estimate the required sample size for both surveys and time points under comparison. In most cases, progress towards a goal is best assessed using multiple time points (i.e. more than two): this is possible with the WHO Global Targets Tracking Tool or using the Child anthropometry indicators trends and targets tracking Excel spreadsheet in Annex 11.

TIPS

- MICS and DHS final reports include estimates of sampling errors, confidence intervals and design effects for key indicators which can generate an appropriate sample size;
- Determine geographic and other domains of analysis which will affect sample size requirements.

TOOLS

- MICS sample size calculation template (see sampling tools);
- DHS working paper on two-stage cluster sampling in demographic and health surveys;
- Measure evaluation spreadsheet for weight calculation example

e) Identify and review the sampling frame

The recommended source for the sampling frame is generally the latest official census of population and housing where census enumeration areas serve as PSUs. Many major household survey programmes such as MICS and DHS undertake a periodic review of the national sampling frame and corresponding reports include a description of sampling frame quality: these findings should be used when drafting the survey report to highlight any issues or shortfalls and also to make recommendations for dealing with frame problems when sampling for the survey.

A census can generally be used as the sampling frame for household surveys during the 10-year census interval period. Although first-stage sampling becomes slightly less efficient over time as the number of households in the enumeration areas change, the second-stage frame is developed for each survey through a mapping and listing operation that provides a new list of households in sample enumeration areas selected for the survey. If some parts of the country, e.g. the fringes of large urban areas, are subject to a very high growth rate, a partial frame update may be considered. If the last census was held more than 10 years beforehand, or the country has experienced a major change in population distribution due to conflict or natural disasters, other frames such as electoral registries or population registries may be considered, if thought appropriate by the sampling statistician.

It is important to ensure that the PSU frame covers the entire household-based population of the country, and that PSUs are identified on maps with well-defined boundaries. PSUs should be uniquely identified with hierarchical geographic codes, and there should be a frame database (or spreadsheet) with summary information on the number of households or population in each PSU. The relevance of including nomadic populations, if any, should also be considered. If there are parts of the country that are considered inaccessible for the period of the survey (owing to security or other issues), they should be excluded from the frame prior to sample selection; the corresponding number and proportion of households and population excluded should be documented within the survey report for the sake of transparency.

TIPS

- Most countries conduct a census of population and housing every 10 years, which is used as the sampling frame for many national household surveys with enumeration areas serving as PSUs;
- If parts of the country (e;g; fringes of large cities) have experienced very high growth since the sampling frame was developed, a partial frame update may be considered for such areas;
- If the last census is more than 10 years old, or the country has had a major change in population distribution due to conflict or natural disasters, other frames such as electoral registries, population registries, etc;, can be considered, if thought appropriate by the sampling statistician;
- Some countries use a master sample approach *(7)* to select samples for household surveys. The master sample is generally also based on the most recent census frame.

TOOLS

- Recent MICS and DHS reports may already contain a sampling frame evaluation which can be incorporated when drafting a sampling plan.

f) Select the Primary Sampling Units (PSU)

PSUs must be selected using a randomized scientific sampling method that allows all PSUs a probability of selection that is proportional to their size (probability proportional to size or PPS) within each stratum. Generally, sample PSUs in each stratum are selected using systematic PPS sampling, which also ensures representative geographical sample dispersion. There are alternative methods to PPS but they are generally less effective. The sampling statistician will suggest the optimum method depending on the specific context of the survey. Ideally, PSUs are selected by a sampling statistician at the NSO; even if this office is not involved in conducting the survey it is recommended that the NSO implement this step. If the NSO is unable to do so, the relevant person at the NSO should share the sampling frame with the survey's own sampling statistician who, in turn, should provide the final sample to the NSO for review. In most countries the NSO is also involved in generating the official sampling frame based on the most recent census and maintains maps of all PSUs in the frame. For the household listing operation, a map will be required for each sampled PSU.

All PSUs and households should be included within the frame: do not select specific groups (e.g. citizens but exclude non-citizens) if the aim is to report on progress towards SDGs and WHA global nutrition targets which aim to leave no one behind.

TIPS

- PSU selection must be based on a probability sampling procedure whereby all PSUs in the frame have a known probability of selection;
- The most effective sampling procedure is to select PSUs with a probability of selection that is proportional to their size (i;e; probability proportional to size);
- Alternative methods to PPS exist but are generally more complicated and unnecessary; The sampling statistician will suggest the method best suited to the context;
- Software such as SPSS Complex Samples or Excel applications can be used to select PSUs by PPS within each stratum.

TOOLS

- DHS Sampling and Household Listing Manual

g) Organize development of the second-stage sampling frame

Mapping and listing each structure and household in every sampled PSU using standard procedures is a **critical** operation for creating the second-stage sampling frame and is essential to allow selection of a representative sample of the current household population.

Procedures described in one of the various manuals under "Tools" below may be of assistance when developing a plan for the household mapping and listing operation based on standard protocols; they include tools, a training programme and supervision and oversight procedures. A listing coordinator should be hired to plan and oversee the listing exercise. If a computer-assisted personal interviewing device (CAPI) application is to be used for the listing operation, it will need to be developed and tested before training begins. If CAPI is not used, appropriate listing forms such as those displayed in the manuals under "Tools" should be prepared. Since mapping and listing require specialized skills, personnel with appropriate background should be hired to perform this step. Obliging one team to take on too many responsibilities may compromise the quality of some of the tasks: it is therefore recommended that mapping and listing be handled by a team working independently of the survey interview process. There may however be some overlap in personnel between teams and operations. Listers and mappers with cartographic skills should be hired. Field supervisors for the mapping and listing teams should also be hired for various tasks including planning and organizing fieldwork logistics, reviewing completed household listing forms and maps and ensuring they are safely stored at the central office, checking that each PSU has been fully covered and listed and verifying that the quality of work is acceptable.

The number of teams and field supervisors to be hired for the listing operation depends on the number of sample PSUs, and they should be hired for long enough to allow for completion of the checks and supervisory tasks outlined in step h (see MICS templates under "Tools" for help when calculating household mapping and listing needs).

Ideally, cartographic staff from the NSO, if available, should assist in the training of mapping and listing team, including on the interpretation of the census maps. The training should include a practical listing exercise in the field before the actual listing activities for the survey commence.

For MICS and DHS surveys, in some countries the listing operation in each sample PSU is conducted by a team consisting of one mapper and one lister, with a field supervisor assigned to a number of teams (e.g. one field supervisor for every 3 teams). Plans should be made for field level quality checks on mapping and listing, which will be carried out by listing team field supervisors, the listing coordinator and the survey manager. Plans should also be made for quality checks by the central office.

Note: it is not recommended to develop a second-stage sampling frame based only on households with children under five years of age: all households should be listed regardless of the household composition. The sample should then be selected from all households in the PSU and children to be measured identified during the survey interview (see Chapter 2).

TIPS

- Best practice includes mapping and listing the households in a separate operation conducted in advance of survey interview field work by specially trained teams with quality checks by field supervisors as well as in the central office;
- Mappers and listers should be thoroughly trained including practical exercises in the field;
- National Statistics Office (NSO) staff should ideally help to train listers and mappers including on interpreting census maps.

TOOLS

- MICS templates for calculating listing duration and listing staff requirements;
- DHS Sampling and Household Listing Manual;
- MICS Manual for Mapping and Household Listing (see sampling tools);
- Other useful information can be found on the NHANES sampling design webpage.

h) Carry out the household mapping and listing to develop the second-stage sampling frame

Conduct household mapping and listing with the trained teams to generate the second-stage sampling frame following the survey-specific household mapping and listing procedures developed in the manual (which should coincide with steps in DHS and/or MICS manuals under "Tools"). Be aware of challenges in listing such as gated communities and locked buildings which in some cases can be overcome by compiling a listing based on mailboxes; even such solutions may not always allow for a complete list. Ideally, listing should be conducted one to three months prior to the survey interviews, thereby allowing ample time to review completed listing forms and re-list any PSUs that fail to meet agreed standards while avoiding significant household changes. Depending on the characteristics of the population, listing may in some cases take place up to six months before survey interviews, while in other circumstances (e.g. PSUs affected by insecurity, conflict and/or high migration rates), the time frame may be shorter than a month before survey interviews. The optimal timing of the listing exercise should be determined by the sampling statistician.

There are three main checking stages:

i. by the field supervisor: all lists and maps of all PSUs held by teams are checked (paper-based checks);
ii. by the field supervisor, listing coordinator and survey manager: a random sample of 10% of all lists and maps of all PSUs held by teams are physically checked (physical checks/field visits);
iii. at the central office: all lists and maps of all PSUs held by teams are checked once forms have been returned (paper-based checks).

i) By field supervisor (paper-based checks)

Field level supervision of mapping and listing teams should occur on a daily basis during the mapping and listing operation. The field supervisor should check maps and lists of all PSUs once they are completed. When the field supervisor receives the final sketch map and listing sheets (or CAPI files) for an individual PSU from a listing team, he or she should compare the sketch map to the census base map to confirm that dwelling units near all PSU boundaries have been covered, and that there are no gaps in coverage. The field supervisor should also check that the mapper has identified the route of the listing within each PSU on the sketch map. If the listing operation is GPS-based, the field supervisor should check the GPS tracker of the mapping and listing team and retrace the path taken to ensure that the team covered all households within the boundaries of the PSU. When monitoring the quality of the mapping and listing operation, the field supervisors should be in regular communication with the listing coordinator who in turn should be regularly liaising with sampling and cartographic personnel in the central office. An important source of information for monitoring listing completeness is the sampling frame from the previous census, which includes information on the number of households enumerated in each census enumeration area. The field supervisor should check to see whether the absolute difference between the number of households listed and the corresponding number from the census frame is larger than a predetermined threshold (e.g. 20%). In cases where the threshold is exceeded, the field supervisor should first try to determine whether there is an explanation for this difference, e.g. several households moving out of an area or a new housing development. If the field supervisor concludes that the listing did not follow the correct boundaries or that many households were missed, then the PSU should be assigned for re-listing.

ii) By field supervisor, listing coordinator and survey manager (physical checks/field visits)

The field supervisors, listing coordinator and survey manager should also visit a randomly selected sample of at least 10% of all PSUs once they have been mapped and listed in order to conduct quality checks. These include a physical check of households near all PSU boundaries to make sure they have been included in the listing and any new dwelling units that have been identified. On visits to sample PSUs, the field supervisor should check the route highlighted by the mapper to ensure that it covers all the various sectors of the PSU, including the boundaries. If stickers or chalk marks on doorposts are used by the mapping and listing team to identify dwelling units, the field supervisor can also check for these marks and verify they are present in the 10% sample of PSUs where physical verification is undertaken. If any major or systematic problems are found, another random sample of 10% of PSUs should be visited and reviewed.

iii) At the central office (paper-based checks)

The central office team should perform paper-based checks on all PSUs once all maps and lists have been returned. These checks (e.g. comparing sketch map to census base map) are identical to those performed above by the field supervisor and do not require field visits. They should determine whether the listing operation needs to be repeated in any PSU or if the lists are clear for use in step i: selecting sample households.

TIPS

- Mapping and listing all households in selected PSUs using standard procedures in "Tools" is a critical operation: without this step a representative sample cannot be guaranteed;
- The optimal timing for the listing exercise should be worked out by the sampling statistician: it is generally about one to three months prior to survey interviewing in order to avoid significant household changes;
- Supervision in the field and checks at central level are essential for ensuring the quality of lists and maps of sampled PSUs since these will serve as the second-stage sampling frame;
- At least 10% of all sampled PSUs should be visited by field supervisors, the listing coordinator and the survey manager for physical verification after maps and lists have been completed by the mapper and lister.

TOOLS

- DHS Sampling and Household Listing Manual;
- MICS Manual for Mapping and Household Listing (see sampling tools);
- Other useful information can be found on the NHANES sampling design webpage.

i) Select households to be interviewed

Household selection must make use of a randomized scientific method to allow all households in each selected PSU to have at least a non-zero probability of selection (ideally an equal probability of selection). Once the lists and maps have been cleared by the central office, the sampling statistician should use the lists to select a random sample of households using a sampling tool such as the MICS household selection template listed under "Tools". The standard sampling procedure for selecting households from the listing is systematic random sampling. It is recommended that household selection be done in the central office, and only performed in the field in extreme cases (see Note 2).

TIPS

- Households should be selected in the central office for quality control (not in the field).

TOOLS

- DHS Sampling and Household Listing Manual;
- MICS Systematic Random Selection of Households Template (see sampling tools);
- Other useful information can be found in the NHANES sampling design webpage.

NOTE 2: HOUSEHOLD SELECTION IN SPECIAL SITUATIONS

If the situation in some PSUs does not allow for the mapping and listing exercise to be undertaken by a separate team of listers and mappers, as may be the case in some PSUs with security issues but which remain accessible (and therefore not already excluded from the frame), and the second-stage sampling frame has been developed by the survey interview team just ahead of interviewing, every effort should be made to send the second-stage frame for these PSUs to the central office for a quick review of maps and lists, followed by selection of households to be interviewed at central level. With proper planning and communication, the central office should be able to return the list of selected households to the field team on the same day.

If, however, connectivity issues preclude confirmation of household selection by the central office, then sample households can be selected in the field following a manual listing operation. In this scenario a household selection table can be used by the survey interview team supervisor to identify a systematic random sample of households based on the total number of listed households. Selection of households from the listing by the supervisor should be the exception and not the rule and applies only to a very circumscribed area and not all PSUs (e.g. a PSU with specific security issues which prevented listing during the listing operation but remains accessible for survey interviewing). In this scenario, the survey interview team supervisor should select the sample of households; the interviewers and/or anthropometrists should never be involved in this procedure.

j) Define household and household members and develop the household roster part of the questionnaire and related interviewer instructions

A household and a household member in a survey need to be clearly defined and the household roster should be part of the questionnaire (see Annex 3 for a model household questionnaire). Related interviewer instructions need to be developed on the basis of these definitions. A **household** is often defined as consisting of a person or group of persons, related or unrelated, who live together in the same dwelling unit, acknowledge one adult male or female as the head of household, share the same living arrangements and are considered as a unit[4]. In household surveys, the two main definitions of a **household member** are:

– A *de jure* household member is a usual resident of the household, regardless of whether that person stayed in the house on the night before the interview. It does not include visitors;

[4] From DHS interviewer's manual:https://www.dhsprogram.com/pubs/pdf/DHSM1/DHS7-Interviewer's-Manual-EN-12Jun2017-DHSM1.pdf#page=19

– A *de facto* household member is a person who stayed in the house on the night before the interview. This definition includes visitors who stayed the previous night but excludes usual residents who did not stay in the house on the previous night, even though they are usual residents and present at the time of the interview.

Some surveys (e.g. MICS) collect data only on the de jure population, while other surveys (e.g. DHS) collect data on both *de jure* and *de facto* populations, and then present results for either population (**but not both combined**), depending on the indicator of interest. For anthropometric indicators, for instance, the de facto sample is used. Other surveys collect data only on the de facto population. It is recommended that the NSO definition of a household be used in NSO-supported household surveys for the country where the survey is being planned. The sampling statistician and other experts working for the survey can help to identify the optimal definition of household members and should review related questionnaire forms and interviewer instructions to confirm that they are accurate and clear.

Selected definitions for household and household member need to be clearly stated in the sampling plan and survey report. The definition of household should follow criteria issued by national bodies such as NSO and a rationale provided for any deviation from the country standard. Selected definitions are also a key input for calculating correct sample weights, validating the weighted total population and providing transparent data quality reports. The household roster part of the questionnaire and related interview instructions need to allow all eligible persons in the household to be listed in accordance with the selected household member definition (see the model household questionnaire and roster in Annex 3 and "Tools" below for interviewer instructions on *de jure* and *de facto* samples). If household members are not clearly defined and instructions for completing the roster on the household questionnaire are not accurate and clear or, worse still, entirely absent, interviewers may fail to list all eligible household members: this will affect **accuracy of survey results as well as transparency of data quality reporting**.

There may be very little difference between *de facto* and *de jure* children: in most surveys, there is a greater than 90% overlap between *de jure* and *de facto* populations (i.e. > 90% of the sampled children will be the same under both definitions). **The key point is that the household member definition needs to be clearly expressed in the sampling plan and questionnaires and instructions developed in a manner that enables correct listing of all eligible members for the survey** (Note 3).

NOTE 3: WHAT CAN HAPPEN IF A HOUSEHOLD MEMBER IS NOT DEFINED?

If the situation in some PSUs does not allow for the mapping and listing exercise to be undertaken by a separate team of listers and mappers, as may be the case in some PSUs with security issues but which remain accessible (and therefore not already excluded from the frame), and the second-stage sampling frame has been developed by the survey interview team just ahead of interviewing, every effort should be made to send the second-stage frame for these PSUs to the central office for a quick review of maps and lists, followed by selection of households to be interviewed at central level. With proper planning and communication, the central office should be able to return the list of selected households to the field team on the same day.

If, however, connectivity issues preclude confirmation of household selection by the central office, then sample households can be selected in the field following a manual listing operation. In this scenario a household selection table can be used by the survey interview team supervisor to identify a systematic random sample of households based on the total number of listed households. Selection of households from the listing by the supervisor should be the exception and not the rule and applies only to a very circumscribed area and not all PSUs (e.g. a PSU with specific security issues which prevented listing during the listing operation but remains accessible for survey interviewing). In this scenario, the survey interview team supervisor should select the sample of households; the interviewers and/or anthropometrists should never be involved in this procedure.

NOTE 4: IF NON-RESPONSE IS EXPECTED TO BE HIGH.

Standard sample weighting procedures generally adjust for non-responses from households and individual children. This approach is based on the assumption that the characteristics of the non-responding households and children are similar to those interviewed. If the non-response rate is expected to be high (e.g. if it was high in a similar previous survey), a structured analytical plan for studying non-responses can be developed. This needs some forward planning before conducting the survey in order to ensure that the same data are collected in the field for non-responding households as for responding households. This allows for estimates of the non-response bias, but it requires information about the number of interview attempts. In surveys where the non-response is expected to be high at either household or individual level, it is useful to collect information for reporting on non-responder characteristics. For non-responding households, such information might entail completing only those parts of the questionnaires that do not require access to the interior of the home or a respondent (roof or wall material of dwelling and type of dwelling, e.g. condo, detached home, slum, etc.). Other environmental information can be gathered from observation of the exterior of the dwelling which ought to bear some relation to household wealth. If such information is obtained for non-responding households, it should be based on skip patterns in the regular questionnaire which allow the interviewer to complete these items based on observation. Collecting the GPS coordinates of non-responding (and responding) households, if permitted in the survey country, may be beneficial as these data can be analysed to determine factors such as the average distance of non-responding households (vs responding households) to major facilities (e.g. average distance to the closest school, closest health facility, etc.). For responding households with eligible children from whom anthropometric measurements could not be obtained, other aspects of the survey questionnaires may provide useful information for reporting on bias and should still be collected (e.g. data on mother's education, child's date of birth, etc.). More research is needed on the impact of non-responders on malnutrition estimates.

TIPS

- Clearly define household and household member in the survey sampling plan;
- Ask the sampling statistician and other experts to review the roster part of the questionnaire and related instructions for clarity and accuracy;
- Without a roster listing all eligible household members in line with the selected definition of household member for the survey, it will not be possible to calculate correct sample weights, validate the weighted total population or provide transparent reports on sample implementation and other data quality parameters;
- Where only one child aged under five years is to be randomly selected per household, ensure that the protocol is made available in the interviewer instructions and during training, and also that sample weights have been developed by the sampling statistician based on this design.

TOOLS

- A model household questionnaire including a household roster (Annex 3);
- DHS interviewer instructions (pages 27-32) (de facto and de jure collection);
- MICS supervisor instructions (pages 6-15) (de jure);
- MICS interviewer instructions (pages 16-21) (de jure).

k) Train interviewers and other field personnel to follow the sampling plan and survey methodology

Ensure that field team members are aware of and can follow the sampling plan (households should not be replaced in the field for any reason), perform call-back procedures (a recommended minimum of 2 call-backs at different times of the day if the initial visit did not provide a completed interview) and complete the household questionnaire. It is also important to stress why it is necessary to have a household questionnaire for each sampled household, whether or not the interview was completed; the cover page of the questionnaire also needs to be filled in since it contains data which are crucial for the survey database. Similarly, in all households where questionnaires were completed, a separate questionnaire must be produced for each eligible child, whether or not the interview was completed;

again, the cover page of the questionnaire needs to be filled in since it contains data which are crucial for the survey database. The model questionnaire in Annex 3 and example guides in Table 2 can be used to develop tools and used during interviewer training.

If only one randomly sampled child is being measured

Many household surveys sample all children in the age range (i.e. all under-five year olds), in which case all children from the household roster (either de jure or de facto according to the agreed household member definition) under the age of 6 years old have the questionnaire administered and those under 5 years are weighed and measured. Some surveys may opt however to select only one random child under the age of five in the household for anthropometry. In such an event, the sampling statistician should develop the protocol to enable interviewers to implement random selection at the household level and provide appropriate sample weights for analysis of results in step m. Even with this type of subsampling, all eligible children (following the selected definition of household member) need to be recorded in the household roster: this information is needed to develop sample weights and also serves as the basis for selecting a random child.

TIPS

- It is important to ensure quality of geographic and sample identification codes;
- Geographic information system (GIS) data can support accurate identification of sampled households;
- Do not permit replacement of non-responding households;
- Train field team members to complete a questionnaire for each sampled household to allow for transparent reporting on non-response bias. At minimum, the cover sheet (including information about the number and timing of call backs) needs to be completed for each sampled household. Similarly, an individual child questionnaire needs to be completed for each eligible child on the household roster for households with completed interviews.

TOOLS

- Sample household questionnaire including household roster (Annex 3);
- MICS interviewer instructions (pp; 5-7 and 16-21);
- DHS interview instructions (pp; 8-25)
- NHANES interviewer instructions (pp. 1-7 to 1-9 and 3-1 to 3-21).

l) Write a detailed annex on the sample design and sample implementation

Survey reports should include detailed information on the sample and survey characteristics in order to provide a transparent account of how well the sampling and quality control procedures were followed. Clear information should be provided on the interview status of each sample household, indicating reasons for any non-interview (see Chapter 3 sections on data quality and harmonized reporting and Annex 10 for the report checklist). A report and review should also be provided on the interview and anthropometry measurement status of all eligible children from the household roster. A section of the report should include details on sample and survey characteristics like other surveys, e.g. MICS sample plan annex and tabulation plan or Chapter 5 of DHS sampling and household listing manual. If the non-response rate was particularly high, it might be useful to develop a structured analytical plan for studying non-response (see Note 4).

TIPS

- Report on non-responses for households as a whole in addition to non-responses for anthropometric measurements: the individual response rate is multiplied by the household response rate;
- If the non-response rate was particularly high, it might be useful to develop a structured analytical plan for studying non-response;
- The harmonized reporting recommendations in Chapter 3 should be followed; see also the reporting checklist in Annex 10 to verify that sampling is reported in compliance with standards.

TOOLS

- MICS Sample Plan Annex (available in individual country survey reports) and tabulation plan for sample and survey characteristics;
- Chapter 5 of DHS Sampling and Household Listing Manual.

m) Calculate sample weights for households and individuals

It is the task of the sampling statistician to calculate sample weights. Sample weights compensate for different selected variables, adjusting for differential sampling probabilities and even for non-responses, so as to produce representative estimates of the population as a whole.

TOOLS

- MICS Sample Weight Calculation Template (see sampling tools);
- Measure Evaluation Spreadsheet for weight calculation example;
- United Nations Statistics Division: construction and use of sample weights (Chapter 6).

TABLE 2. FAULTY PRACTICES AND HOW TO AVOID THEM WHEN SAMPLING IN AN ANTHROPOMETRIC SURVEY

⚠ FAULTY PRACTICES	✔ HOW TO AVOID THEM
The survey manager develops the sampling plan	• *Hire an experienced sampling statistician to develop, implement and report on the sampling plan.*
A previous list of households more than a year old is used	• *Develop the second-stage sampling frame using the standard protocols outlined in steps g to i.*
Lists and maps are updated using key informants	• *Develop the second-stage sampling frame for selected PSUs before each survey using the standard protocols for the mapping and listing operation outlined in steps g to i.*
Household mapping and listing and/or household selection along with the survey interview is applied as the rule rather than the exception	• *Plan and implement mapping and listing as a stand-alone operation ahead of survey field work;* • *Arrange for household selection to be conducted at a central level, as outlined in steps g, h and i, noting any exceptions where these steps were not carried out separately.*
Questionnaire and/or interviewer instructions fail to provide clear household member definition	• *Articulate the definition of a household and household member in clear terms early in the planning stages. Ensure that the sampling statistician reviews the household roster and associated interview instructions to check for accuracy and clarity.*
Selected households are replaced in the field	• *Follow the sampling plan as provided by the central office and do not replace any selected households in the field.* • *Use a blank questionnaire and complete the information identifying each selected household;* • *Document the time at which call-backs are initiated, and if it proves impossible to conduct the interview in spite of the call-back protocol, select the result code signalling why the household was not interviewed, and provide additional explanation if necessary.*

1.3. QUESTIONNAIRE DEVELOPMENT

The survey questionnaire is based on a list of the key items of information required to meet survey objectives. A standard paper-printed or computer-based questionnaire helps to ensure that all sampled households are subject to the same visit and call-back procedures, a record is kept of all sampled households (whether interviews are completed or not) and respondents are asked the same questions using the same set of instructions. This enables easy and rapid tabulation of the survey responses. The questionnaire may need to be translated into local languages: it is important that translated questionnaires are back-translated into the original language by another translator and compared to the original questionnaire. Field teams need to be trained in how to use translations appropriately.

Key steps to support the survey planning process

a) Designing or customizing the household and child questionnaires;
b) Developing local event calendars;
c) Pre-testing the questionnaire;
d) Developing the interviewer's manual;
e) Training the survey team.

Brief overview of steps for developing an anthropometric questionnaire

a) Designing or customizing the household and child questionnaires

Two questionnaires—a household and a child questionnaire—are recommended when the aim is to gather data relating only to child anthropometry. The household questionnaire is required in order to establish an outcome for each sampled household (e.g. completed, refused, destroyed, etc.), and where a household interview is duly completed to produce a list of all children under 6 years of age who meet the household member definition. The child questionnaire is used to gather demographic information for children under 6 years of age, and anthropometric data for children under 5 years of age. The reason for collecting demographic information an all children under 6 is to foster inclusion of all under-5 year olds in the anthropometric measurements and assess for out transference of children nearing age 5. However, there are other means of dealing with this issue (e.g. if a survey has a target group for a different questionnaire of 5-17 year olds) and the way in which an individual household survey will deal with this issue may be different. The child questionnaire should be properly designed or adapted from a standard model to facilitate collection of all information required to calculate malnutrition estimates and assess data quality.

Customization (or adaptation) refers to the process of tailoring a standard questionnaire to the population or setting in which a survey is being conducted using established criteria and approaches, while ensuring that indicators derived from the collected data remain globally comparable. When customizing a questionnaire, it is also important that lessons learned from previous data collection activities are properly applied and tools tested whenever feasible before final decisions are made.

Some recommendations for designing or customizing a questionnaire:

1. Give due consideration to the length of the interview, including the oral information and consent process, delivering the questionnaire and time required for the anthropometric assessment. The longer the questionnaire, the higher the risk of interviewee fatigue and erroneous entries (see Note 5).
2. Encourage translation and back-translation of questions into and from the local languages of the survey country.

Recommended standard models for the household questionnaire and child anthropometry questionnaire are presented in Annexes 3 and 4. These questionnaires are based on the MICS standard questionnaires. They have been modified to include specific recommendations for improving data quality when collecting data in the field.

TOOLS

- For customizing see the MICS guidelines on customization of MICS questionnaires;
- For more information on translating and back-translating questionnaires see the DHS Survey Organization Manual 2012, p. 18;
- A model household questionnaire and child anthropometry questionnaire are presented in Annexes 3 and 4.

NOTE 5: QUESTIONNAIRE LENGTH AND INTERVIEW DURATION

A systematic literature review and meta-analysis of health studies reporting response rates and data quality in relation to questionnaire length (Rolstad et al. in 2011) concluded that, in view of the inherently problematic nature of comparing questionnaires of various lengths, it is preferable to base decisions on the use of instruments on questionnaire content rather than length per se *(8)*.

The review indicated that the response rate does not depend on the interview length, but that when participants become tired they pay less attention and respond more quickly, which can have an impact on data quality. This can be an important factor in surveys collecting anthropometry data if the caretaker has to provide information on children's dates of birth using a local events calendar.

b) Developing local events calendars

Proper determination of the child's age is essential to generate accurate and precise age-related anthropometry indicators (length/height-for-age, weight-for-age). In many countries, vital registration is not universal and documentary evidence of the date of birth may not be available in the household; the actual date of birth may be unknown. In such cases it is necessary to obtain at least the month and year of birth using a local event calendar.

This document describes the concept of using a local events calendar to estimate the child's month and year of birth rather than estimating the child's age in months.

Some key points to consider when developing a local events calendar are the following:

– Specify the calendar's timeline: if data collection lasts more than one month, adding a new month and deleting the last eligible month should be anticipated and discussed when developing the events calendar;
– Local events calendars should NOT include the age in months: they should refer only to calendar months and years, which are then to be recorded in the questionnaire;
– The local events calendar should be tested and adapted based on the outcomes of these tests prior to the survey data collection. When testing, the events calendar should include children whose date of birth is known in order to verify that it functions properly;
– In order to be able to estimate accurately each child's date of birth, field teams must be properly trained on how to use the local events calendar, during both theoretical training and the field test.

c) Testing the questionnaire

Before the questionnaire is finalized it should be tested for content and length: the different questions asked should gather the requisite information and be easily understood by both interviewers and respondents. Interviews should be carried out during testing, and the questionnaire revised based on responses and comments from the survey teams undertaking the interview.

d) Developing the interviewer's manual

It is essential that the survey manual include a guide for survey teams undertaking the interviews which provides clear instructions on their roles and responsibilities as well as information on how to identify sampled households, initiate the call-back protocol, identify eligible children, conduct and handle interviews and complete the questionnaires.

TOOLS

- For more information on how to develop a local events calendar, see the IFAD/FAO publication (2008) "Guidelines for estimating month and year of birth in young children";
- Instructions for interviewers (MICS);
- DHS Interviewer's manual.

e) Training the survey team

Training field staff is a vital step in the survey process: accurate and meaningful information can be collected only if interviewers are thoroughly familiar with all the field instructions and procedures. When all the field materials have been prepared and finalized and field staff have been hired, interviewers and supervisors should meet in a central location for joint training in survey procedures, e.g. how to identify sampled households, implement the call-back protocol, identify eligible children, collect data and complete the questionnaire. A methodology for accurate measurement of children's weight and height is an important part of the training. If the actual survey is delayed for more than three weeks following training, a refresher will be required. Further details are provided in the following section (Training).

1

1.4. TRAINING AND STANDARDIZATION

This section highlights the importance of training and standardizing anthropometrists to support the collection of high quality anthropometric data. Training should be organized and delivered by an expert trainer experienced in undertaking surveys to collect anthropometry data who also has an extensive background in training.

Training for anthropometric data surveys should include:

1. Proper interview techniques: training should include guidance on how to explain to caretakers what their role[5] is in the measurement process and how to handle a child in order to render the experience less traumatic and obtain more accurate data;
2. Practising anthropometric measurements;
3. Standardization exercises: comparing their own measurements to an expert's benchmarks (accuracy) and their own repeat readings (precision);
4. Pilot tests: putting into practice all techniques and field procedures learned during training in a field setting.

Key steps to ensure data quality during training and standardization

a) Organizing the training;
b) Determining the duration and schedule of the training
c) Identifying the content of the training;
d) Implementing the training;
e) Organizing the standardization exercises;
f) Implementing pilot tests in the field.

Brief overview of steps for training and standardization

a) Organizing the training

To assist in the collection of high quality anthropometric measurements, an acknowledged expert anthropometrist trainer should be employed to lead the training *(9)*.

To encourage the collection of accurate data regarding the child's date of birth, sufficient time should be set aside for careful review of the questionnaire and instructions, and if local event calendars are used an additional period of time for practical exercises on their use. Organizing practical demonstrations by skilled anthropometrists can help to demonstrate accurate anthropometric techniques and familiarize trainees with the equipment.

Materials, including dolls and props for practising measurements and data collection forms, etc., should be obtained well ahead of the training. Arrangements should also be made to have a sufficient number of children of different ages present for the hands-on training: the age range of these children should include a sufficient number of infants under 3 months, 3-5 months as well as 6-11 months of age.

[5] The caretaker role should be clearly explained to avoid misinterpretations such as assuming that she is to serve as assistant measurer, which is not recommended

Training sessions should be provided on how to take anthropometric measurements, fill in the household and child questionnaires, initiate the call-back protocol and other aspects of the survey programme. Fieldwork coordinators and field supervisors should also attend these trainings including on how to identify sampled households and attend separate trainings on use the anthropometry checklist, cluster control forms and other protocols which they are responsible for implementing and supervising.

TOOLS

- An additional 15%[6] of anthropometrists should be trained as a small stand-by pool in the event that team members drop out during the standardization exercises or field work.

It is recommended that anthropometry trainers be anthropometrists of demonstrated expertise based on recent experience.

b) Determining the duration and schedule of the training

Training should take place ideally as close as possible to data collection. Its duration depends on the number of trainees, length of the questionnaire, number of working hours per day, etc. The schedule should be flexible enough to allow for a few extra days should trainers decide that the field teams are not yet ready to start the data collection process and need to repeat the standardization exercises. A useful rule of thumb is to have at least one trainer for every 10 trainees. Annex 5 sets out a proposed content for an anthropometry training along with a timetable.

TIPS

- If tablets or mobile devices are to be used for the survey, sufficient time should be set aside during training to ensure field teams handle them appropriately when capturing, saving and sending data to the server, and that built-in quality checks exist (i.e. an acceptability range for a given question).

c) Identifying the content of the training agenda

Another factor that is crucial for collecting high quality anthropometric data is to standardize the training for anthropometrists in surveys using a training manual. This can be adapted from existing standard training manuals in order to serve as a standard operating procedure for the various critical steps before, during and after measurements.

Critical issues which should be considered in the training content are selecting a site in the household for measurements, preparing and positioning of the anthropometric equipment, explaining specific role of the mother, proper handling and positioning of the child during measurement, using and reading the instrument and recording measurements.

For field supervisors/fieldwork coordinators: the training content should draw attention to how the sampling plan should be followed and implemented at the field level, logistic arrangements, methods for calibrating equipment and data checks. Training should include reviews of the sampling plan and anthropometric data quality checks (using field checklists, etc).

For fieldwork coordinators, field supervisors and anthropometrists: training should include guidance on explaining to caretakers their role in the measurement process and how to handle a child in order to render the experience less traumatic and thereby obtain more accurate data. It should also include guidance on techniques for standardizing anthropometric measurements, including how to perform calibration procedures and maintain equipment and procedures for quality assurance.

d) Implementing the training

The proposed training lasts seven days for anthropometrists and eight days for fieldwork coordinators and field supervisors. The overall plan and exact timing of the may vary depending on the target audience and context: the trainer should adapt the suggested agenda to suit participants' needs. More time may be needed depending on the number of trainees.

The aim of the first day is to provide a survey overview, setting out the objectives and organization of the survey, the role of the survey team and how communities should be approached. Field procedures should be explained including

[6] See the DHS Survey Organization Manual 2012, p. 21: https://dhsprogram.com/pubs/pdf/DHSM10/DHS6_Survey_Org_Manual_7Dec2012_DHSM10.pdf/%22#page=27"

how to identify sampled households and participants and conduct the interview in the household. Information should be provided on how to record the questionnaires (household questionnaire and child anthropometry questionnaire). Time should be set aside for providing instruction on accurate determination of the date of birth and using the local events calendar when an official document is not available.

The second day should start with a few theoretical considerations, e.g. finding a spot where the equipment can be set up safely, recognizing different scenarios and settings that might be encountered and calibrating and maintaining the equipment. The theory and background of anthropometric measurements should be introduced before shifting to in-class practice of anthropometric measurements using dolls, along with other items of known dimensions such as sticks. The aim of this session is for trainees to be able to position the child's body correctly, read measurements accurately and record them properly. It is important to demonstrate examples of good practice and have trainees repeat the exercise. This also applies to data recording (paper and electronic).

Some advice should also be provided on how to avoid common field errors in anthropometric measurements, and on correct data entry.

Following this theoretical introduction, the next couple of days should be given over to hands-on anthropometric measurement exercises on children. A sufficient number of children of different ages, none of whom should be ill, should be recruited for these exercises. The duration of this section will depend on the experience of the anthropometrists. Since special attention should be paid to measuring the length of children below 2 years of age, a number of infants aged < 3 months, 3-5 months and 6-11 months should be present for anthropometric measurement. Different age groups of infants have unique challenges and need to be handled differently from older children and anthropometrists should be coached in the appropriate techniques to put them in the correct position. A sufficient amount of time should be set aside for explaining to anthropometrists how to handle children gently when taking measurements and explain the measurements to the caretaker so that their assistance can be sought to calm the child if necessary.

When the anthropometrists are ready, a first series of standardization exercises can be organized. If the anthropometrists fail this test, retraining should be organized and followed up by a second series of standardization exercises prior to pilot tests in the field.

For field supervisors and fieldwork coordinators, an extra day of training is recommended. The content of this extra day should include clear instructions on how to organize supervisory activities and perform checks in the field to ensure that procedures are being followed. Additional guidance should be provided on communication flows between the central office and survey teams. More details can be found in the section 2.4 on Quality Assurance during data collection in Chapter 2.

TIPS

- **Hands-on training for measuring length in young infants:** special attention should be given in the training for measuring length in children below 2 years of age: ideally infants under 3 months, 3-5 months as well as 6-11 months of age should be present for the practical sessions since taking measurements in each of these sub-age groups has unique challenges and all measurers should have practice on different sub age groups;
- Anthropometrists should practise on dolls before they practise on children, and before they take part in the standardization exercises. They can also do elementary practice exercises with other items such as sticks of known length.

e) Organizing the standardization exercises (days 4 and 5 in Annex 5)

All survey team members serving as "main measurer" anthropometrists during fieldwork are required to undergo and pass the standardization exercises. An "assistant measurer" cannot act as the "main measurer[7]", even if this proves necessary during field work, without passing the standardization exercise. In the standardization exercise, the main measurer needs to work with an assistant measurer, ideally someone who is going to take on the role of "assistant measurer" for the survey field work. It is recommended that no more than ten main measurers be standardized per standardization exercise *(9)*. **A minimum** of a **half-day** is required to complete each standardization exercise. Accordingly, **two half-days should be set aside for standardization in the training agenda**. This should allow enough time to carry out the first standardization exercise, retraining of those who performed poorly in the first exercise, and organization

[7] Refer to Annex 2 for job descriotions for "main measurer" and "assistant measurer"

of a second standardization exercise for those retrained to give them another chance to pass the standardization test. Depending on the number of anthropometrists required for field work, several standardization exercises will have to be performed in parallel or sequentially, thus adding extra days to the training agenda.

The standardization exercises allows a quantitative method to be applied for assessing whether teams can measure accurately and precisely under ideal situations. The exercise also serves as an opportunity for demonstrating to anthropometrists the importance and rigour they should apply to measurements in the field when conditions become more difficult. It enables the trainer to observe each trainee's performance in a systematic manner and evaluate measurement techniques.

Standardization exercises for measuring length/height are essential in view of the challenges faced in accurately taking measurements, especially in children aged under 5 years. Since survey teams often perceive measuring weight to be a straightforward measurement, whenever feasible weight can also serve as part of the standardization exercise in order to correct this misperception. One of the outcomes of training should be to make it clear to teams that errors in weight measurement can have even more impact on quality than errors in height measurement. However, since the weight of children can potentially vary during the standardization exercise and is time consuming, the use of weight measurement to evaluate anthropometrist performance is not required.

The standardization exercise should ideally take place in a calm location, preferably at the training location with subjects recruited from a nearby community. When organizing the standardization exercise, local transport and incentives should be provided (either monetary or in-kind), and practical considerations should be planned for (e.g. healthy snacks, extra diapers, water for children and their caretakers). Decisions on the type of incentives provided should be context specific.

An anthropometric measurement standardization exercise requires **a minimum of 10 children** under 5 years of age who should be measured twice by each measurer; half of these children should be under the age of 2 years[8]. It is recommended that additional children be recruited for every standardization exercise and remain for the duration of the exercise in the event that a child has to be removed from the exercise while it is ongoing. When a child has been replaced by another, all anthropometrists as well as the expert anthropometrist (who serves as the benchmark) have to measure the new child twice and discard any data recorded for the previous child. A caretaker should accompany and remain with the child during the entire exercise.

It is recommended to keep the children and their caretakers at a fixed station with their own set of anthropometric equipment and rotate the trainees from station to station. The trainees can rotate clockwise or counter clockwise. Alternatively, the trainees can move to any open station as long as they confirm they are recording the measurements for the correct child in their form. Figure 2 provides an illustrative example of how a standardization exercise can be arranged. The anthropometrist undergoing the standardizing exercise should measure at least 10 children (aided by the other person serving as "assistant measurer") and then re-measure the same children a second time without being able to consult the results of the first measurement. An expert anthropometrist (usually the trainer) should undergo the same procedure in order to serve as the benchmark or reference. A break is recommended based on judgement call or when the child and caretakers need it.

Different sets of at least 10 children should be prepared for each group of 10 main measurers in order to avoid overstressing the children (even if the standardization exercise is planned for a different group of measurers on another day).

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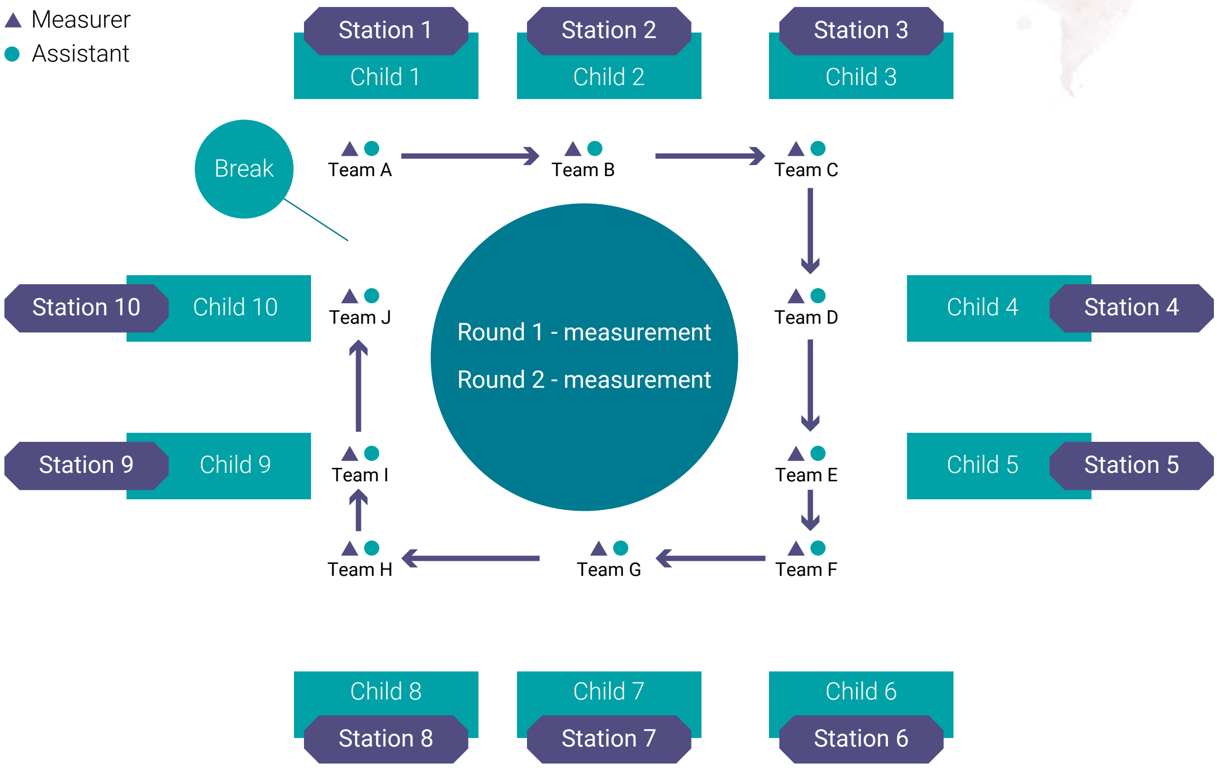
8 Half the children should be aged under two years and the other half over two years since the standardization exercises should include children at ages similar to those measured in the field and determining the technical error of measurement to define what constitutes passing a standardization exercise (as described below) is based on the average technical error of measurement for length and height derived from this source: Reliability of anthropometric measurements in the WHO Multicentre Growth Reference Study. WHO Multicentre Growth Reference Study Group. Acta Pædiatrica Suppl 450: 2006. p. 43 (http://www.who.int/childgrowth/standards/Reliability_anthro.pdf?ua=1)

Figure 2. Standardization exercise set-up (from DHS Training manual)[9]



For each anthropometrist undergoing standardization precision is calculated by comparing the difference between the first and second reading. Accuracy, by contrast, is calculated by averaging the anthropometrist's first and second readings and comparing the absolute difference between this average measurement and the benchmark measurement of the expert anthropometrist. Because the expert anthropometrist's reading serves as the reference or "gold standard" value for accuracy in the standardization exercise, the expert anthropometrist must have demonstrated the ability to obtain precise and accurate measurements in order to take on this role.

The technical error of measurement (TEM), which is defined as the square root of measurement error variance, is an indicator used to assess precision and accuracy in anthropometry.

$$TEM = \sqrt{\frac{\Sigma D^2}{2N}}$$

where D is the absolute difference between measurements from the same individual and N equals the total number of subjects being measured. D can either be the absolute difference between the first and second measurement made by the same trainee (precision) or the difference between the readings of the expert anthropometrist and trainee (accuracy).

It is recommended that acceptable TEM cut-offs for length/height be set at TEM < 0.6 cm and < 0.8 cm for precision and accuracy, respectively. These criteria applied to pass a standardization exercise for length/height measurement are based on precision and accuracy (see Note 6). If the expert anthropometrist's precision TEM is ≥ 0.4 cm during the standardization exercise, his or her measurements cannot serve as reference values. In such cases the criterion for trainee anthropometrists passing a standardization exercise must be based on precision alone. The accuracy of the individual trainee anthropometrist should not be assessed by using the mean for all anthropometrists participating in the standardization exercise because anthropometrists have been found to have consistently lower length/height values compared to benchmarks in WHO MGRS *(10)*. Further research is needed on the use of the anthropometrists' mean before this approach can be adopted.

[9] Notes to Figure 2: a) the expert anthropometrist measures each child twice; b) the "main measurer" anthropometrist measures each child twice; and c) although there may be fewer than 10 teams measuring children, there should always be 10 children in the standardization exercise along with some additional children in the event that replacements are required.

NOTE 6: HOW CUT-OFF TEMS FOR THE STANDARDIZATION EXERCISE WERE DEVELOPED

The proposed acceptable length/height TEM cut-offs of < 0.6 cm for precision and < 0.8 cm for accuracy were derived by first obtaining the average intra-observer TEM (precision) using data from all field workers' standardization exercises (initial and bimonthly) conducted at WHO Multicentre Growth Reference Study sites. Length and height TEMs were reported separately for each study site and thus had been averaged to obtain a mean TEM value combining length and height in all study sites. The resulting TEM was 0.3 cm across all MGRS study sites, equivalent to the expert TEM at the MGRS. Following MGRS procedures, intra-observer TEM was then multiplied by 2 for precision and 2.8 for accuracy to allow for a 95% margin of error when deriving acceptable TEM cut-offs *(10)*.

To substantiate whether the acceptable cut-offs for precision and accuracy as described above were feasible in the field, a review was undertaken using data from five large-scale surveys in which a total of 11 standardization exercises had been conducted[10]. An average failure rate of 25% was found for precision and accuracy, using a TEM of 0.6 and 0.8 cm, respectively. In these five surveys there was a wide variation in the failure rate between surveys: the poorest performing teams were reported to have had limited practice on children prior to the exercise. As more standardization results from surveys become available, more reliable information will be forthcoming on the anticipated number of individuals who need to undertake a re-standardization exercise. For the time being, failure rates may be expected to vary depending on the setting.

The acceptable length/height TEM cut-off for the "benchmark" or "reference" anthropometrist obtained during the standardization exercise to allow calculation of trainee anthropometrists' accuracy was also based on WHO Multicentre Growth Reference Study sites *(10)*. The value selected is the mid-pointbetween the experts' TEM and the TEM of the trained anthropometrists for precision of < 0.4 cm.

After the standardization exercise has been completed, the trainer should present the results of the standardization exercise and discuss observations with the trainees. Trainees with the most precise and accurate results should be selected as "main measurers" for survey data collection. If an insufficient number of trainees demonstrate an acceptable performance level in the standardization exercise, further training should be provided on anthropometric measurement techniques and the standardization exercise repeated before the individual anthropometrists are allowed to collect anthropometry data in the field. Outcomes for the standardization exercise should be included in survey reports to help data users have a better understanding of the quality of the anthropometry data.

TIPS

- Allocate adequate time to recruit and prepare children and their caretakers for the standardization exercises;
- It is important to consider the welfare of the children when organizing and planning the standardization procedure as it is a repetitive and tiring exercise. Small toys, games or a separate area for children to play should be provided while they wait to go to the area used for the standardization exercises.

TOOLS

- DHS Height Standardization tool (Annex 13)

f) Setting up pilot tests in the field

One-day pilot testing in the field is essential for each team. This should be arranged immediately after the training and once a sufficient number of main measurers have passed the standardization exercises. Pilot testing enables main measurer anthropometrists selected for fieldwork to put into practice all the techniques and procedures they have learned in the course of their training, and for their competency to be tested in a field setting. This is the final

[10] Personal communication with Sorrel Namaste

opportunity for the survey manager to rectify any misunderstandings about the survey procedures before actual survey data collection begins.

TABLE 3. FAULTY PRACTICES DURING THE TRAINING OR STANDARDIZATION EXERCISES FOR ANTHROPOMETRY DATA COLLECTION SURVEYS AND HOW TO AVOID THEM

⚠ FAULTY PRACTICES	✔ HOW TO AVOID THEM
Rushed or too little time for training	• Define a clear timeline which allows a set amount of time for training and review of the standardization exercise outcome (e.g. seven days for anthropometrists and eight days for fieldwork coordinators and field supervisors: see Annex 5).
Not enough training	• Do not assume that if the members of the survey team have been trained once they will remember everything; • If there is a gap in the survey for any unforeseen reason, provide refresher training for one or two days before sending the team back to collect data in the field.
No standardization exercise organized for "main measurer" anthropometrists	• Conduct a standardization exercise with at least 10 children measured twice by the main measurer trainee in order to assess the measurer ability to obrain quality of measurements; • Organize retraining and re-standardization if the trainee anthropometrists fail the test.
Rushed or too little time for the standardization exercise	• Define a clear timeline which allows a half-day for each standardization exercise; and plan for a second half-day should poor results from the first test require a further standardization exercise; • Reserve sufficient time for retraining and a second standardization exercise in the training for main measurers who fail the first standardization exercise.
Unhealthy or ill under 5-year-olds being used for the standardization exercise or insufficient number of children 0 to <2 years and 2-5 years recruited	• Provide full information to local community leaders of neighboring villages about the criteria for choosing children to participate in the standardization exercise.
Standardization test in a noisy or busy environment	• Choose a location where children will feel at ease with their caretakers with plenty of shade and adequately spaced stations.
Too many trainees participating in the standardization exercises	• Plan standardization exercises carefully if there is a large number of trainee anthropometrists (parallel or sequential sessions for groups of 10 anthropometrists) so that every anthropometrist can measure 10 children twice.
Unable to find a "lead anthropometrist trainer" for training and standardization	• Once a survey has been confirmed, start searching to find a locally experienced anthropometrist who can act as "lead anthropometrist trainer".

⚠ FAULTY PRACTICES	✓ HOW TO AVOID THEM
Not enough time spent practising anthropometric measurements	• Include at least a day for trainee anthropometrists to practise with dolls and other objects (e.g. sticks) and at least a day for hands-on training with children.
Lack of diversity in the age group of young infants present for training and standardization	• Make every effort to ensure that children attending practical training sessions include a number of children (at least two to three) aged less than 3 months, 3–5 months and 6–11 months: each age group has unique challenges and practice essential to ensure a reliable measurement.
Anthropometrists not trained because they are considered "experienced" enough	• If you are planning a survey, organize training for all anthropometrists regardless of prior experience. Include a session on how to handle children gently and explain measurements to the caretaker so that additional assistance in calming the child can be sought if needed.

1.5. EQUIPMENT

This section provides a description of the equipment recommended for anthropometric measurements (weight, length/height) that is to be of sufficient precision and accuracy. For surveys which are conducted in settings where transport by carrying is not required, or extreme conditions in transport will not be encountered, the equipment briefly described in the NHANES Anthropometry Procedures Manual would be recommended.

For field conditions requiring robust and resilient equipment, please see the minimum product requirements below. Reuse of anthropometric equipment is not recommended (see Note 7). If the equipment proves to be faulty, it should be replaced immediately.

Minimum recommended requirements[11] are:

Portable weighing scale for children 0-4 years old

The following specifications pertain to surveys where transport of weighing and measuring equipment requires transport over rough terrain and variable weather patterns, and involves individuals carrying the equipment from house to house, often walking for hours.

Minimum recommended product specifications:

– Digital weighing scale (hanging spring-type or bathroom scales are not recommended since they are not accurate enough);
– A high-quality scale specifically designed for anthropometric measurements;
– Adult/child scale, weighing up to 150 kg with 100 g graduations; This scale allows child's weight to be measured while it is being held by an adult through use of a tare function;
– Battery-powered equipment; Replacement batteries should be provided with the equipment; A solar-powered scale can be used in settings where the light intensity is sufficient to operate the device and as a back-up for a battery-powered scale;
– Measuring range: 0 to no less than 150 kg;
– Graduation: 100 g minimum;

[11] UNICEF Product specifications sheet, mother-child scale, https://www.unicef.org/supply/files/UNICEF_S0141021_Mother_Child_Scale_Specification_v2.pdf, accessed on 26 February 2019

– Accuracy: better than ± 0;15% / ± 100 g;
– Portability: defined as a maximum weight of 4;0 kg (including batteries) and maximum dimensions of 360 mm length, 400 mm width and 70 mm height;
– Taring: the device should allow taring without the need to bend over (e;g; taring can be done using kick-off buttons which can be activated by foot12);
– The main on/off button should not serve any other purpose and have a feature to prevent accidental switching on or off and should be easily accessible on the top or side of the scale;
– The base of the scale should be fitted with adjustable feet so that it can be stabilized if it is set up on an uneven floor.
– Operating conditions: the scale must be hard-wearing to meet a range of operating conditions which include all kinds of climactic conditions (heat, cold, humidity, dryness, light, dust and moisture) as well as modes of transportation and terrain (e.g. vehicular or personal transport over sometimes bumpy and difficult terrain).
– Testing:
   i) The scale must be able to function with required accuracy after application of the following conditions for a minimum of 72 hours:
      - Operation temperature: minimum range 0°C to 45°C;
      - Storage temperature: minimum range -20°C to 65°C;
      - Humidity: 80% at 40°C;
      - Light: 100% illumination at 40°C;
      - Corrosion: 80% at 40°C;
      - Dust: IP5x degree of protection testing.
– The scale must comply with the following International Protection Rating (IP) and IK codes:
      - IP5x regarding degree of protection testing against dust according to IEC 60529;
      - IPx3 regarding degree of protection testing against spraying water according to IEC 60529;
      - IK09 regarding degree of protection testing against external mechanical impacts according to IEC 62262;
      - complies with the immunity requirement of EN 60601-1-2 and OIML R76-1 against electrostatic discharge (EN 61000-4-2), radiated, radio-frequency electromagnetic field (EN 61000-4-3, electrical fast transient/ burst (EN6100-4-4), surges (EN 61000-4-5), conducted disturbances, induced by radio frequency fields (EN 61000-4-6) and voltage dips, short interruptions and voltage variations.
– Warranty: the set of scales should be purchased with a warranty for a minimum period of two years dating from the time of purchase which displays contact information and local service locations (when available) for repair and recalibration.

Portable length/height measuring board for children 0-4 years old

A portable infant/child measuring board should provide accurate and reliable length/height measurements of human subjects (infants as well as children up to 5 years of age), be safe for subjects being measured, transportable over long distances by a single person and sturdy under field conditions with rough terrain and variable weather patterns.

Minimum recommended product specifications:

– A flat board with an attached metric rule in the form of a fixed and stable tape which is easy to read;
– Units of measure on the tape: centimetres, with numbering for every centimetre increment;
– Smallest graduation: 0;1 cm (i;e; showing millimetre increments): a separate line should indicate each millimetre increment with a longer line indicating the 5 mm midpoint;
– Measurement range: 0–135 cm (minimum)
– Accuracy: ± 0;2 cm (2 mm);
– Precision: ± 0;2 cm (2 mm);

[12] The reason that the specification recommends not requiring the measurer to bend over is because a measurer who is directly at the foot of the person being weighed may cause the subject discomfort especially in some settings

- Moveable measurement piece: an easily moveable measuring slide or wedge which glides smoothly over the length of the apparatus and is lockable or has a friction feature to avoid reading parallax and assure accurate and precise measurement; It should have a maximum wobble of 0;2 cm over the full length of the device, allowing repeated accurate readings;
- Able to measure length (in a horizontal position) and height (in a vertical position); For length (horizontal position), it should have an immovable headpiece at a right angle to the tape and a moveable footpiece perpendicular to the tape; For height (vertical position), it should have an immoveable footpiece at a right angle to the tape and a movable headpiece perpendicular to the tape;
- Board width: approximately 25 cm; The foot-piece needs to be wide enough to provide a stable base for the people to stand on it for height measurement, but not excessively wide so as to allow easy transportation; This is an important factor since a common weak point in portable measuring boards is a small base: this may make the apparatus unstable or prevent it being fully perpendicular to the floor;
- The base of the board should be fitted with adjustable feet so that it can be stabilized if it is set up on an uneven floor;
- Material: contact surfaces should be smooth and easy to clean using a damp cloth and non-toxic disinfectant; Equipment with a rough surface or unsealed joints and crevices cannot be cleaned and is not suitable;
- Operating conditions: the measuring board must be hard-wearing to meet diverse operating conditions which include all kinds of climactic conditions (heat, cold, humidity, dryness, dust and moisture), modes of transportation and terrain (e;g; vehicular or personal transport over sometimes bumpy and difficult terrain);
- Portability: a single adult should be able to carry the measuring board and the scale over a long distance (walking for up to an hour);
- Desirable: a numerical output (e;g; digital reader) with auto download capability. In the case of a digital device, the testing and compliance ratings noted under the weighing scale specifications would need to be included.

Calibration and maintenance

Calibration should be performed as soon as the equipment is purchased, and the procedure repeated during fieldwork (see the section 2.2 on Interview and measurements for details on the calibration and standardization of anthropometric equipment and Annex 6).

NOTE 7: RECOMMENDATION TO AVOID REUSING ANTHROPOMETRIC EQUIPMENT

Reuse of anthropometric equipment, especially if extensively used in previous large-scale surveys (e.g. DHS or MICS), is not recommended. If the purchase of new scales is not feasible, the used equipment should be recalibrated by the manufacturer before reuse. In this event, the used equipment should be dispatched to the manufacturer for recalibration before return to the country in question with a warranty that the equipment has been properly recalibrated to its original standard. Regarding length/height boards, it is sometimes difficult to notice small defects due to the wear and tear that make them unstable; it should also be borne in mind that wood expands and contracts depending on climate, and that this phenomenon may produce inconsistent variations in measurement. In this event, regular calibration exercises should be performed on the device (e.g. measuring sticks of different known lengths to test if the apparatus is reliable over its entire length). It is also very important to verify the condition of the measuring tape on the height board: it should be intact, attached over its full length to the board and display visible gradation marks, etc. These types of variations may go unnoticed especially if new and old equipment is used in tandem. *Reuse of any anthropometric equipment is therefore not recommended.*

SUMMARY OF RECOMMENDATIONS AND BEST PRACTICES

1

Section 1.1- PLANNING

Recommendations (must)

- Expert on anthropometry to be part of survey steering committee;
- Bilateral pitting oedema assessment is not recommended as a standard protocol;
- Determine whether other surveys are planned in similar timeframe to avoid duplication;
- UNICEF and WHO recommend that all national surveys undergo for ethical approval, either by national committees or international ones when national committees are not available;
- At least two trained anthropometrists (including one main measurer who passes the standardization exercise) should be planned per field team.

Good practices (optional)

- Use computer-assisted data collection technology to improve data quality and facilitate data sharing;
- A survey manual should be prepared to include clear data collection procedures;
- The team implementing the survey should sign an agreement with the government requiring release of raw datasets to the public;
- Allocate sufficient time for recruiting personnel;
- Include all children aged 0-71 months in the household questionnaire as well as the child questionnaire (to avoid losing children close to 59 months) then include only those aged 0-59 months for measurements; alternatively have a means of assessing out-transference of children close to 5 years of age.

Section 1.2 – SAMPLING

Recommendations (must)

Follow the 13 steps in section 1.2, some key points follow:

- Hire a sampling statistician to develop and oversee implementation of the sampling plan and on its reporting;
- All PSUs and households should be included within the frame: do not select specific groups (e;g; citizens but exclude non-citizens) if the aim is to report on progress towards SDGs and WHA targets which aim to leave no one behind;
- Select PSUs using a randomized scientific sampling method that allows all PSUs a probability of selection that is proportional to their size (probability proportional to size or PPS) within each stratum;
- Employ the National Statistic Office to select PSUs through systematic PPS sampling using the national frame recognized (e;g; census frame) for first stage;
- Conduct the listing and mapping operation using a specially trained team that works independently of the survey interview process using standard protocols for planning, training, implementation and field and central checks;
- Draw the sample of households to be interviewed at central office (only at field level in extreme cases in select PSUs);
- Never replace sampled PSUs or households at field level as this can have implications in the sampling representativeness;
- Use the National Statistics Office definition of "household" and clearly define household member and included related details in the survey report;
- Include detailed information on the sample and survey characteristics in the survey report using MICS and DHS sampling annexes as an example.

Good practices (optional)

- If the National Statistic Office is not able to do it, then the sampling statistician should select PSUs through systematic PPS sampling using the national frame recognized (e.g. census frame) for first stage;

– Determining the sample size needed to achieve a statistically significant difference between only two-time points is not recommended, unless the expected difference in prevalence is large enough not to impose a major increase in sample size requirements.

Section 1.3 – QUESTIONNAIRE

Recommendations (must)

– Use a separate questionnaire for each sampled household (household questionnaire) and each eligible child (anthropometry questionnaire);

– One household questionnaire must be filled for each sampled household and include a full list of household members, following the definition agreed on "household member";

– Record the time and date or all call-backs on the household questionnaire for the requisite 2 call backs;

– Use one questionnaire for anthropometry for each child under 6 years of age but undertake weight and length/height measurements only for children under 5 years of age;

– The date of birth should be determined using an official certificate; Only when this is not available, an event calendar should be used to identify at least the month and year of birth;

– Do not record the age in months on the questionnaire.

Good practices (optional)

– Follow the model questionnaire for anthropometry in Annex 4 which includes instructions to prompt correct measurement position and space to record the reason if the measurement is taken in alternate position. Also includes space to record if the child is not undressed to the minimum

Section 1.4 – TRAINING AND STANDARDIZATION

Recommendations (must)

– The trainer for anthropometry must have demonstrated expertise based on recent experience;

– Special attention should be given in the training for measuring length in children below 2 years of age: infants under 3 months, 3 to 5 months as well as 6 to 11 months of age should be present for the practical sessions since taking measurements in each of these sub-age groups requires different techniques

– The standardization exercises is recommended for height/length measurement only;

– Ten children (half under 2 years of age and half 2-5 years of age) are required for the standardization exercise per 10 main measurers; a new set of children is needed per standardization exercise;

– Use TEM cut offs of <0;6 cm for precision and < 0;8 cm for accuracy to pass the standardization exercise when assessing anthropometrist performance;

– If the expert anthropometrist's precision TEM ≥ 0;4 cm, he/she cannot serve as reference and can only assess main measurers against precision;

– If an insufficient number of trainees demonstrate an acceptable performance level in the standardization exercise, further training should be provided on anthropometric measurement techniques and the standardization exercise repeated;

– One-day pilot testing in the field is essential for each team, immediately after the training and standardization;

– Budget half a day to standardize a group of up to 10 measurers plus extra half day in case of need to standardize (with time to provide re-training between the exercises);

– Results of the standardization exercise should be provided in the survey report.

Good practices (optional):

– Training should take place ideally as close as possible to data collection;

– Have at least one trainer for every 10 trainees for anthropometry;

– Anthropometrists should practise on dolls before they practise on children, and before they take part in the standardization exercises; They can also do elementary practice exercises with other items such as sticks of known length;

– For field supervisors and fieldwork coordinators, an extra day of training is recommended. In addition to other training topics for supervisors and fieldwork coordinators, training on use of the anthropometry checklist should be provided.

For the standardization exercises:

– recruit additional children in case any have to stop during the test;
– keep child and caretaker at one station with measurers rotating

Section 1.5 – EQUIPMENT

Recommendations (must)

For weight:

– Portable with taring function;
– "hard wearing" with specifications related to dust and moisture permeability;
– Precision better than ± 0.15 % / ± 100 g across entire 0-150 kg load range Base fitted with adjustable feet;
– The scale must comply with the required International Protection Rating (IP) and IK codes.

For length/height:

– Accuracy: 2 mm; Precision: 2 mm; Graduation with demarcations at every 1 and 5 mm and numbers at every 1 cm

Good practices (optional):

– Desirable: auto data download;
– Warranty: the set of scales should be purchased with a warranty for a minimum period of two years dating from the time of purchase which displays contact information and local service locations (when available) for repair and recalibration.

2

FIELD WORK PROCEDURES

The fieldwork procedures include several components that are crucial for enhancing the quality of anthropometric data:

2.1. Data collection
2.2. Interview and measurements
2.3. Data capture/entry
2.4. Quality assurance methods and field supervision

2.1. DATA COLLECTION

The survey manager should ensure, with support from the fieldwork coordinators and field supervisors, that all procedures required for data collection are fully understood and correctly implemented.

These procedures include:

– how to identify the sampled households, follow call-back protocols and identify eligible respondents and children for anthropometric survey in the households;
– how to follow a standardized protocol when faced with special cases in the field (e.g. missing survey subject, empty houses, individuals with disabilities, polygamic families, etc.).

Key steps to enhance anthropometric data quality during the data collection process

a) Ensuring survey teams have received the survey package (survey manager, fieldwork coordinators, field supervisors);
b) Making logistical arrangements (survey manager, fieldwork coordinators);
c) Coordinating with local authorities on arrival in the sampled PSU (field supervisors);
d) Identifying sampled households and eligible respondents (field supervisors);
e) Preparing to collect data (interviewer/anthropometrist);
f) Collecting data (anthropometrists including the interviewer);
g) Following up after data collection (anthropometrists, field supervisors).

Brief overview of steps during data collection

a) Ensuring survey teams have received the survey package

Survey teams should have received the survey package with all the relevant information including a list of the sampled households: the package should include equipment as well as a survey manual with guidelines on how to identify respondents and specific instructions on taking measurements and completing the questionnaire properly: these topics should have been developed during the planning process and explained in depth during the training. Anthropometrists and field supervisors should refer to this manual should there be any queries during the data collection process.

Before going into the field, each survey team will receive a list with the sampled households assigned to that team for the day. When organizing the daily work roster, fieldwork coordinators should consider where the assessment is going to be done, and how much time is required to reach the PSU where the measurements will be made. Teams should be carefully organized so that a reasonable number of households can be visited on a daily basis while avoiding an excessive workload and field team fatigue.

b) Making logistical arrangements

Once logistical arrangements are made, teams should be monitored to see whether they are well prepared for each working day. Fieldwork should be organized in such a way as to allow field teams to move between households over the course of the day. An adequate supply of materials (e.g. a sufficient stock of questionnaires, weighing scales, etc.) should be at hand.

Fieldwork coordinators should report any problems accessing PSUs to the survey manager. Primary sampling units should under no circumstances be replaced at field level.

c) Coordinating with local authorities on arrival in the sampled PSU

Meet with the area representative to explain the objectives of the survey and what is expected of each participating household. Provide the list of households selected on the basis of the sampling plan and advise local authorities in the PSU on how to explain to household heads why anthropometry data are being collected. Explain the exact nature of the data to be collected and how the survey will proceed.

d) Identifying sampled households and eligible respondents

The PSUs will have been assigned to specific survey teams ahead of fieldwork, and field supervisors are responsible for assigning individual households from the list of sample household provided by central office, to the individual interviewers on each data collection day. The survey team will receive a list with sampled households and they are responsible for filling in a "household questionnaire" for each planned household whether an interview can be completed or not. A model of the household questionnaire can be consulted in Annex 3.

For each household questionnaire, fill in first the name of the head of household, then the other members. The names of those currently not at home but who usually live in the household or of those who stayed the previous night should also be recorded, based on the agreed definition of "household member" for the survey. The questionnaire should list all children under 6 years of age, indicating those eligible for the child questionnaire and those not.

On the list of household members, check the names of the children under 6 years of age. Issue a separate child questionnaire for each child aged under 6 years of age who is eligible for the survey (see model "Questionnaire for child anthropometry" in Annex 4).

Even if not recommended as standard protocol, if a survey protocol states that only a single child needs to be measured in each household, **all children** in that household should be included in the household member list in the household questionnaire before the child questionnaire is administered for each of these children under 6 years of age. Only children under age 5 will be measured. Among the children under 5 years old in the child questionnaire (based on date of birth information), one child is selected for measurement. The importance of including all children under 6 years of age in the household questionnaire is to ensure that random selection can be properly applied: this is essential for calculating sample weighting and helps later to estimate the "percentage of missing data" and evaluate survey quality.

If there are no children under6 years of age in the sampled household, i.e. making it impossible to complete an individual child questionnaire for that household, thank the respondent and move on to the next household assigned by the field supervisor.

If the household is empty, destroyed, not found or the caretaker refuses to take part in the survey, enter this information in the corresponding section (this is question UF10 in the model child questionnaire) and move on to the next household assigned by the field supervisor.

The household and child questionnaires will serve as a record of non-response, which means that incomplete questionnaires need to be retained and submitted: they are an integral part of the sample and a record of them should exist within the public datasets. Non-response rates will be used to calculate the **sampling weights** applied in the final data analysis.

Call-backs should be conducted following the terms of the protocol. The recommendation is to make an initial visit and then return at least twice if required.

e) Preparing to collect data

The survey team should explain to the head of household the various procedures to be undertaken, all of which should be compliant with local and international ethical norms. A clear, general explanation should be provided of the purpose and nature of the survey and the kinds of data to be collected. The caretaker or head of household should be given the opportunity to ask questions and to decide, as the case may be, not to take part.

The survey team should correctly identify the respondents eligible to take part in the survey. Verbal permission from the caretaker or head of household is necessary before proceeding with a survey questionnaire or undertaking any kind of measurement. It is essential that verbal permission be sought, and an explanation provided to the respondent or caretaker about how the information will be used and by whom. An assurance must be given that any information collected will remain confidential.

f) Collecting data

Taking measurements of individuals can be intrusive and time-consuming. It is the task of the survey team to minimize discomfort and inconvenience during anthropometric measurements. The anthropometrist's confidence and stance are important to reassure both mother and child: this includes instructing the mother/caretaker to stay close to and maintain eye contact with the child while talking to them in a calm and reassuring tone of voice. The mother or caretaker should always be present when measurements are taken.

It is recommended that the measurements be made away from direct sunlight since it can hamper reading displays on scales and other equipment; it is also more comfortable for anthropometrist and child. The chosen area for measurement should however be well enough lit to allow the measuring board ruler and weighing scale to be read without difficulty (see section 2.2 on Measurements for further information).

g) Following up after data collection

Household call-backs should be conducted in line with the protocol. If a child is not present, the caretaker should be asked when the child is likely to be present so that the anthropometrist can return to perform the measurements at a suitable time.

It is recommended that two call-backs be made: this means an **initial visit plus two more call-back visits** before leaving the PSU. The call-back protocol developed for the survey suggests making attempts at different times of the day (e.g. call-backs should not be made in the morning within 30 minutes of the previous attempt but spread out between morning, afternoon and evening).

The field supervisor should review all questionnaires to check that they have been completed properly before leaving the PSU. If digital data collection is being used, the field supervisor should also check that the equipment is functioning properly and follow the various steps to upload data to the server.

The survey team should make sure that all equipment is securely placed in the vehicle and thank the representative of the PSU for their collaboration before leaving.

2.2. INTERVIEW AND MEASUREMENTS

This section describes best practice for procedures to collect anthropometry data. It does not include specific instructions on measurement techniques or training but provides links to specific documents including instructions on how to calibrate the equipment at the beginning of the survey and then maintain it accurately and regularly.

There are many anthropometric variables that have a legitimate place in the assessment of the nutritional status of children under 5 years of age; this document will concentrate however solely on measurement and interpretation of:

– weight-for-age – WFA;
– length-for-age (for children < 24 months) or height-for-age (for children ≥ 24 months) – HFA;
– weight-for-length (for children< 24 months) or weight-for-height (for children ≥24 months) – WFH.

Appropriate anthropometric equipment is required to perform weight and length/height measurements in order to calculate these indices There is a pressing need for high quality and "user friendly" equipment wherever feasible. Recommended product specifications for the devices used to take anthropometric measurements can be found in Chapter 1, in the section on equipment.

Key steps to take into consideration while taking measurements

a) Recording the date of birth and date of interview;
b) Observing general recommendations when taking anthropometric measurements;
c) Preparing to measure the child;
d) Measuring weight;
e) Measuring length (in children under 2 years old);
f) Measuring height (in children 2 years old and above);
g) Recording measurements;
h) Calibrating equipment.

Brief overview of steps for collecting anthropometric data in the field

a) Recording the date of birth and date of interview

Ensure all questions related to the date of interview and date of birth are properly completed in the questionnaire (see model questionnaire for child anthropometry in Annex 4). Where vital registration is not a universal practice, a local events calendar should have been developed during the planning stage.

Start by asking for documentary evidence of the date of birth (e.g. birth certificate, baptismal certificate, clinic card, etc.). Record the day, month and year of birth as noted on the documentary evidence, if available, and indicate what type of documentary evidence is acting as the data source for the questionnaire. The ideal source is a written document, so even if the mother says she knows the date of birth by heart request politely to see a copy of the documentary evidence and record the information directly from it.

If no document is available, ask the mother or caretaker for the date of birth as they recall it and indicate the source on the questionnaire as "mother/caretaker's report" (following the model for child questionnaire in Annex 4). If the mother/caretaker does not know the date of birth, then at minimum the month and year of birth should be obtained using a local events calendar. The local events calendar will have been prepared and tested prior to finalization of the questionnaire and completion of training, and all anthropometrists should have been trained on how to use it during data collection. If using documentary evidence or the mother/caretaker's report, the anthropometric team should record the actual day of birth (assuming it is specified). If using the local events calendar, it is very probable that it will be impossible to identify the exact day of birth. In this case, anthropometrists have to enter 98 (unknown) for the day of birth and enter the birth month and year as determined by the local events calendar. The source of the information should always be recorded in the questionnaire. Refer to the instructions for more details on how to use the local events calendar when filling in the questionnaire (see Chapter 1, section 1.3 on Questionnaire development).

TIPS

- **Always record the date of birth** and **date of visit** on the questionnaire;
- The questionnaire should have two distinct spaces for the day, two for the month and 4 for the year (e;g; DD/MM/YYYY) and their order should follow national convention;
- When filling in the questionnaire, never leave a blank space for DD or MM or YYYY (i;e; 14 June 2018 is 14/06/2018 and if day is unknown then it is 98/06/2018);
- Never make up a value if the caretaker does not know the information you have requested, and use standard codes for unknown items such as 98 for DD;
- Avoid recording the age in months on the questionnaire (see the model questionnaire in Annex 4).

TOOLS

- For more information, see Annex 4 (model anthropometry questionnaire);
- For more information on how to develop and use an event calendar see Section 1.3 on Questionnaire development in Chapter 1.

b) Observing general recommendations when taking anthropometric measurements

Anthropometrists' preparation: anthropometrists should not have long fingernails and their hands should be clean before approaching children who are about to be measured. Anthropometrists should remove any object from their hands and wrists such as clunky watches or bracelets so as prevent them getting in the way and hampering the measurement or even harming the child. No member of the field team should smoke while working.

Placement of the equipment: a careful choice should be made about where to place the measuring board and scale. Be sure that there is a sturdy, flat surface for the measuring board and digital weighing scale, and sufficient light for the measurements to be read with precision. If the floor is not flat, consider bringing a wooden board in order to stabilize the scale. If the scale is solar-powered, there must be adequate light to operate the mechanism.

Individuals with disabilities: It is recommended to measure individuals with disabilities. However, it can be a challenge to acquire accurate and safe measurements in individuals with impairments that affect their ability to stand, straighten their arms, legs or back or hold themselves steady. In these circumstances, it may be necessary to adapt the measurement protocols or provide additional assistance to the child being measured. Child safety takes priority.

c) Preparing to measure the child

When a child is brought into contact with any measuring equipment (length/height board or weighing scale), the child must be held carefully so that he or she does not trip or fall. Children should never be left alone with a piece of equipment; physical contact with the child, except for the few seconds while taking his or her weight, should always be maintained. Remember that the caretaker should not assist in the measurement process but can and should talk to and soothe the child while measurements are being carried out.

Handle the child carefully. When you are taking weight and length/height measurements, the child needs to be as calm as possible. A child who is excited or scared can make it very difficult to get an accurate measurement. Infants and young children should be held by their mother to foster a sense of security. This can be done right up to the point of measurement, but not during measurement for length.

If a child shows distress this can have a big emotional impact on the other children who are waiting to be measured. It is better to leave the distressed child to calm down and come back later to weigh and measure this particular child. In some cases, it may be possible to weigh and measure a distressed child after he or she has seen other children—especially siblings—going through the measurement process.

d) Measuring weight

Specific instructions on how to weigh children under 5 years old are provided in different manuals. Refer, for instance, to FANTA Anthropometry Guide 2018 for instructions on weighing infants and children under 5 years old with standing electronic scales (pp. 174-177).

Tared weight: Children under 2 years of age or who cannot stand still are best weighed with the mother holding them ("tared weight"). In this case, weigh first the mother, then switch the scale to the tared mode and weigh the mother together with the baby: the scale will display the baby's weight. If the child is not able or willing to stand on the scale, use the tared weight. The tared weight can be used for a child of any age provided the child is held properly by the mother.

Children two years of age or older can be weighed alone, provided the child stands still or does not jump while standing on the scale. If the child is fidgety it is better to adopt the tared weighing procedure instead.

It is recommended that children be weighed undressed to the minimum. Owing to cultural preferences or climate, some parents or caretakers may not allow the child to be weighed without clothes. To accommodate this preference and maintain accuracy, children may be wrapped in a blanket.

Using blankets and the taring scale: First ask the adult to stand on the scale with the blanket and tare the scale so that the weight of the blanket used to cover the child while weighing will not be included when measuring the child's weight. The adult should then wrap the child in the blanket and stand on the scale while holding the child for measurement.

If it is not possible to weigh the child with minimal clothing, it should be noted in the questionnaire that the child was not undressed to the minimum[1].

If the child has braids or hair ornaments that are likely to interfere with length/height measurements, **remove them before weighing** to avoid any delay between the measurements. If the child is not undressed with minimal clothing or hair ornaments cannot be removed, these factors must be recorded in the questionnaire.

e) Measuring length (in children under 2 years old)

Refer, for instance, to FANTA Anthropometry Guide 2018 for instructions on measuring length in children under 2 years of age (pp. 181-183).

Be prepared to measure length immediately after weighing, while the child is minimally clothed, and shoes are off. Ensure that the board is in the right position and placed on level ground. If the anthropometrist is unable to get the child to put both legs outstretched in the correct position, make sure at least one leg is straight with the foot flexed against the footpiece. Allowing the child to adopt a position with only one straight leg should be regarded as an exception and

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[1] Best practice on weighing children with clothes cannot be provided at this stage. Further research is required.

permitted only when extremely difficult children are being measured. It is important to proceed quickly when measuring length to avoid locking of the legs.

In every case, the actual position adopted (lying down/recumbent length) should be systematically recorded in the questionnaire (see model questionnaire for child anthropometry in Annex 4).

Digital readers are optimal, but if a measuring board with tape measure is used the anthropometrist must make sure, in order to obtain a correct measurement, that his or her eye is parallel with the footpiece so that the board placement is read on the appropriate plane.

f) Measuring height (2 years old and above)

Refer, for instance, to FANTA Anthropometry Guide 2018 for instructions on measuring height in children 2 years of age and older (pp. 184-187).

When measuring a child, ask the parent/caretaker to place the child on the board and kneel in front of the child. The measurer should kneel on the left side of the child, with the trained assistant kneeling on the child's right (or the parent/caretaker moving to that position).

In every case, the actual position adopted (standing) should be systematically recorded in the questionnaire.

Digital readers are optimal, but if a measuring board with tape measure is used the anthropometrist must make sure, in order to obtain a correct measurement, that his or her eye is parallel with the footpiece so that the board placement is read on the appropriate plane.

TIPS

- Pay special attention when measuring recumbent length in children under 2 years old due to the difficulty of measuring children in this age group when in this position; measurement error tends to be an issue[2].

TOOLS

- FANTA Anthropometry Guide:
  weighing infant and children under 5 years of age with a standing electronic scale (pp. 174-177);
  measuring length in children under2 years of age (pp. 181-183);
  measuring height in children 2 years of age and older (pp. 184-187).

g) Recording measurements

Complete questions and measurements for one child at a time. This avoids potential problems with mix-ups that might occur when several children are waiting to be measured. If an error is made when completing the questionnaire, measurements should be crossed through and the corrected measurement written alongside so that any change is clearly visible. For computer-based surveys, see the section on Data capture/entry in Chapter 2.

Always **record carefully whether recumbent length or standing height** was measured. If a child is 2 years old or older and cannot stand, measure the child's recumbent length and note this in the questionnaire (in the question about measurement position); equally, if a child is less than 2 years old and is measured standing, this should also be noted in the questionnaire. In both cases, explain why this child was not measured in the appropriate position for his or her age. In such cases, an adjustment will be required in the data analysis phase prior to calculating the z-scores based on the WHO Child Growth Standards (0.7 cm should be added to the standing height to convert it to recumbent length for children below 2 years old old, and 0.7 cm subtracted from the recumbent length to convert it to standing height for children 2 years or older). This adjustment is made automatically by the software program in the standard analysis approach (see Chapter 3 on Data Analysis).

If the child is measured in the non-standard measurement position for his or her age, the event and the reason for this discrepancy must be recorded in the questionnaire.

[2] Length measurement in younger children is less precise than in older children. Reliability of anthropometric measurements in the WHO Multicentre Growth Reference Study. WHO Multicentre Growth Reference Study Group. Acta Pædiatrica Suppl 450: 2006. Page 43 (http://www.who.int/childgrowth/standards/Reliability_anthro.pdf?ua=1)

TIPS

- In the questionnaire, the row for recording weight should have three distinct spaces, including one space for the decimal value (e.g. 12.4kg);
- In the questionnaire, the row for recording length/height should have four spaces, including one space for the decimal value (e.g. 108.3 cm);
- To avoid any transcription errors, is recommended that the anthropometrist reading the measurement repeat it out loud twice to the person completing the questionnaire. Once it has been recorded, the anthropometrist should then check the questionnaire to confirm that the measurement has been correctly entered.

h) Calibrating equipment

In this document, the term "calibration" refers to the notion of confirming that an anthropometric device functions accurately when weighing or measuring an object of known weight or length.

Calibration should be done whenever an item of equipment is purchased and then routinely repeated at specific intervals. Measurements performed during the calibration process should be recorded and checked for accuracy on each occasion. This also helps to ensure that faulty equipment is quickly identified and replaced.

Routinely calibrating anthropometry equipment ensures that it continues to provide accurate measurements. Both the digital weighing scale and measuring board should be routinely calibrated during an anthropometric survey.

These checks should be carried out before starting fieldwork, and regularly thereafter, although not necessarily every day. It may be feasible to carry out daily checks depending on equipment available to the anthropometry team during their survey (e.g. weights and sticks of known values).

The following regular checks should be carried out.

– Each scale should be tested with a standard weight of at least 5 kg: a daily check is strongly recommended to ensure accuracy.
– A measuring board can be calibrated using piping of a known length, e.g. 110 cm. If different measuring boards are checked using the same calibrating rod or pipe, discrepancies between these various items of equipment will become readily apparent. A daily check is recommended.

Calibration log tools for anthropometric equipment are presented in Annex 6.

The survey office should have back-up equipment in readiness for use during fieldwork. Fieldwork coordinators should be informed immediately if equipment is defective and request replacement devices. Length/height and weight measurements should not be performed until replacement equipment is provided.

TIPS

- Do not use faulty equipment;
- If readings prove to be inaccurate during the data collection process in the field and the equipment cannot be calibrated, the device should be replaced immediately; The team should wait until a new device arrives and revisit the PSU when the new equipment has been tested for accuracy;
- Equipment needs to be protected from extreme weather conditions throughout the survey, e.g. extreme heat or cold, rain, etc.

TOOLS

- For details on calibration procedures and equipment care see section 5.0 "Care for measurement equipment" in the WHO Training Course on Child Growth Assessment (p. 25).

TABLE 4. FAULTY PRACTICES WHEN TAKING ANTHROPOMETRIC MEASUREMENTS AND HOW TO AVOID THEM

⚠ FAULTY PRACTICES	✓ HOW TO AVOID THEM
Non-calibrated equipment is used (e.g. a malfunctioning electronic scale, a wooden height board with poor quality metre tapes)	• Weighing should be postponed if the equipment has not been recently calibrated; • Check the equipment is calibrated at the start of the survey and regularly throughout (using standard weights) on a daily basis; • Ensure spare or backup equipment is available in case faulty or broken items need replacing during the survey.
Poor positioning of the scale or the measuring board	• Make sure the scale is flat on the ground and the child correctly positioned before taking the measurement (if necessary use the adjustable feet on the scale to achieve a level position).
Poor positioning of the measurers	• The "main measurer" anthropometrist should read the measurement facing the metre scale and not upside down.
The measurer is holding a pen when taking measurements	• When measuring children avoid holding a pen or other device. Anthropometrists should avoid wearing rings or clunky watches while doing the measurements.
Measuring a child standing up when the measurement should be taken lying down (child aged < 24 months	• The child's age in years should be determined before commencing measurement in order to make sure the measuring position corresponds to the position recommended for their age group.
The child is measured wearing shoes or with braids or ornaments in the hair (footwear or headgear not removed) or not undressed to the minimum	• Ask the mother to remove the child's shoes and any other ornament or object on their head (hair clips, extensions, braids, etc.). If a hair feature cannot be removed, this should be noted in the questionnaire; • Note on the questionnaire whenever a child is not undressed to the minimum.
The child is not properly positioned on the board, e.g. head is badly positioned or not in the correct plane, knees are bent, heels are not flush against the back of the board and soles not flat on the base of the board, sliding piece is not firmly against head or heels because child is "pointing toes"	• Ensure that the child's head or feet are correctly positioned, ask the child standing up in the height board to look straight up perpendicularly to the board, and check the position of the child's body on the board before taking the measurement; • Do not read length/height measurements if the child's position is incorrect, e.g. if the child is leaning to one side, heels are not touching the board and/or hands are not positioned at sides (height).
The child not lying straight along the length of the board	• The child's heels should be flush against the back of the board with the soles of the feet flat on its base (height) or flat against the footpiece (length).
Length/height measurements are rounded off to the nearest 0.0 or 0.5 cm rather than being read off and recorded in 0.1 cm increments	• Do not round off numbers when reading or recording measurements. Record length/height to the exact mm.

2.3. DATA CAPTURE/ENTRY

Accurate capture of anthropometric measurements is a key step in collecting and processing anthropometric data. Several approaches are widely used for capture of anthropometry data, including:

1. paper forms for collecting data, with subsequent data entry in a central office (see Annex 3 for a model questionnaire);
2. paper forms for collecting data, with same-day data entry in the field (sometimes known as computer assisted field editing or CAFE);
3. computer-assisted data collection (otherwise known as computer-assisted personal interviewing or CAPI) or mobile data collection).

All three approaches have been used successfully, but it is now most common to use either the second or third option, with electronic capture of anthropometric measurements in the field. The key element in the whole process is the accurate capture of anthropometric data and minimizing the transcription of measurements in this process is therefore critical to ensure quality. Using paper forms prior to entering data in a tablet or computer requires measurement data to be recorded at least twice, once on paper and once in the tablet or computer, both of which offer a margin for error. With computer-assisted data collection, only a single transcription of the measurements is required, provided measurements are recorded directly using the tablet or computer and not via an intermediate step, e.g. writing the measurements first on a notepad. Recording measurements in an intermediate step increases the risk of error and defeats part of the purpose of direct measurement capture although this must be counterbalanced by the added complication of having to manipulate a tablet or computer while conducting anthropometric measurements. If an intermediate step needs to be used owing to such a complication, it should be in a form specifically designed for recording measurements, not simply a measurement written down in a notebook.

Many types of transcription errors can occur when anthropometric measurements are recorded. They include misreading written digits from the paper copy, mistyping digits, transposing digits or omitting digits. The data capture system, whether relying on registration of data on paper forms or direct entry at the time of measurement, should always be checked twice in order to detect data capture errors.

When used in the field, either with paper forms undergoing same-day data entry or computer-assisted data collection, the data capture system should include a double check of captured measurements with immediate verification of recorded values.

When paper forms undergo data entry in the central office, entry is usually performed by two separate data-entry operators: the resulting datasets are compared in order to detect any discrepancy in data entry, and any correction that needs to be made is based on the measurements recorded on paper. When data is collected on paper forms for entry in the office, it is standard practice that all data should undergo double-entry in order to detect data entry errors.

If a centralized data entry system is used instead of data capture in the field, data entry should commence as soon as forms and questionnaires from a PSU arrive back in the central office. Data entry should be carried out in small batches (e.g. a single PSU at a time). Double entry of data is required to eliminate keying errors. Once data recorded on a batch of forms and questionnaires has been individually processed feedback should be provided to the interviewing team based on any issues relating to the data. Additionally, it is recommended that checks be performed on the consistency of data collected, both when data are captured in the field and when entered in the office. See section 2.4 on quality assurance methods for information on the types of checks that should be reviewed during data collection.

The data capture or entry system must be carefully designed to facilitate the capture of anthropometric measurements with an emphasis on ensuring the quality of the data measured. Data capture or entry staff must be well trained and aware of the importance of accurately recording measurements and related data. Software programs for data capture or entry, as well as data checking, should be set up, tested and verified using data from the pilot or pre-test survey before the main field work phase begins. Any problems affecting the data capture or entry programs must be resolved, and the programs modified as necessary, before beginning data collection for the survey itself.

2.4. QUALITY ASSURANCE METHODS DURING DATA COLLECTION

2

Adequate and consistent field supervision during data collection is critical and should occur in the field as well as at the central level. Gaps in supervision can lead to significant delays in the scheduled timeline and most importantly to preventable mistakes in the collecting or recording of data.

Different checks can be performed to support quality assurance during data collection.

1. **Field supervision:** checks by the fieldwork coordinators and field supervisors via PSU control form and other forms, review of questionnaire data and direct observation and use of an anthropometry checklist;
2. **Re-measurement:** re-measure a random selection of children to assess precision and accuracy and re-measure children with flagged anthropometry data to reduce the volume of incorrect data included in the final dataset;
3. **Central level checks:** results from field check tables processed in the central office and reported back to the teams.

Field supervisors, fieldwork coordinators and data processors all play an important role in performing checks (see Annexes 1 and 2 for roles and responsibilities). The role of field supervisors is critical since it is impossible for the survey manager and fieldwork coordinators to be with each survey team on a daily basis during data collection. Field supervisors should accompany teams every day during data collection and oversee their work. The role of the fieldwork coordinators is to rotate between teams and provide higher-level supervision. It is recommended, at the very least, that a subset of fieldwork coordinators experienced in anthropometric measurements be available to monitor field work. In the first few weeks of field work it is especially important to have more intensive supervision so that any major problems can be identified and addressed early on. For surveys with a longer period of field work, intensive supervision towards the end of data collection is also recommended to ensure that the quality of teamwork does not fall off with time.

A minimum requirement is for fieldwork coordinators experienced in anthropometric measurements to visit every team within the first few weeks of data collection. Data processors can then start reviewing data as it begins to accumulate at the central level.

Most of these checks should be performed in the field. Consistency can be checked in the central office by comparing data with tables checked in the field. Some checks however should only be performed at the central level (e.g. to measure anthropometrist performance, etc.).

Key checks to support collection of high quality anthropometric data during supervision at field level

a) Using PSU control forms;
b) Reviewing data in questionnaires;
c) Applying the anthropometry checklist;
d) Taking re-measurements in the field;
e) Other forms and checks.

a) Using cluster control forms

It is the task of the field supervisors to fill in the cluster control forms[3] which set out the outcomes of each planned interview. Cluster control forms should be discussed daily with the teams to provide feedback on how closely they are following the call-back protocols and progressing with their work, as well as to address any outstanding issues. Fieldwork coordinators should also review the cluster control forms from the field supervisors when they visit different PSUs to monitor the progress of the survey.

The cluster control forms help to monitor the following aspects of data collection:

– **overall team progress** so that, if necessary, corrective action can be taken, e.g. by detecting issues such as high refusal or non-response rates. Information of this kind can indicate a problem in how respondents are being approached or data are being collected, and trigger corrective actions;

[3] also referred as “interviewer assignment sheets” in some surveys.

– **the percentage of interviews and measurements completed according to plan**, revealing whether interviews were implemented or not following the planned timeline, and reasons for non-measurement (e.g. refusal, absence, etc.);
– **completion of the assigned PSU before the team moves on to the next**, thereby verifying that all eligible respondents have been interviewed and/or call-backs initiated in line with the protocol for all sampled households.

A model cluster control form can be found in Annex 7.

b) Reviewing data in questionnaires

Paper-based questionnaire: field supervisors should examine the paper-based questionnaires being completed by all team members on a daily basis and flag any anomalies when performing the checks below.

1. Check for missing or duplicate data, identifying the person and date of visit; length/height; weight; date of birth; standing/lying position for length/height measurement; and sex;
2. Check the source of the date of birth and whether it was confirmed by an official document, reported by the parent or caretaker, or estimated using the event calendar;
3. Check for consistency between the date of birth/age when the information has more than one source (e.g. household roster and anthropometry questionnaire);
4. Check for consistency between the date of birth/age and whether the child was measured standing up (for children aged 24 months and older) or lying down (for children aged under 24 months), while being aware that in some cases there may be a reason (which has to be recorded in the questionnaire) for a non-standard measurement position;
5. Check for consistency between the length/height and weight data; For example, the length/height value in cm should always be numerically greater than the weight value in kg; If the weight value exceeds the length/height value, this may indicate that length/height and weight values have been swapped

Electronic-based questionnaire: skip patterns or a restricted range of possible responses should be pre-programmed into an electronic device when it is used: this will reduce data capture errors when the data is recorded by the anthropometrist.

The following automatic checks should be programmed into the software program:

1. Missing data should not be permitted for personal identification and date of visit; length/height; weight; date of birth; standing/laying position for length/height measurement; and sex;
2. A built-in range should be applied for all variables including date of birth, age (in years 0–5, typically collected from the household roster), length/height and weight. For length/height and weight, DHS suggests the maximum ranges for children under 5 years old should be as follows:
   i) Length/height: 35.0–140.0;
   ii) Weight: 0.5–40.0.

Once the data has been entered by the anthropometrist it is the task of the field supervisor to run programs to check data structure. The program should be set to run automatically whenever an anthropometrist sends a data file to the field supervisor, but also able to function manually at any time. The best strategy is for the supervisor to provide immediate feedback by going over the report together with the anthropometrist and identifying households at which problems were encountered. Data can be considered "finalized" only when the structure check has been successfully completed by each household in the PSU: the team is then free to move to the next PSU. If the field supervisor waits until the scheduled last day in the PSU to receive data, he or she may find that there are several data issues that require the team's stay in the PSU to be extended in order for the issues to be resolved, e.g. the structure check may reveal that an eligible respondent has yet to be measured.

The structure checks below should be performed by the field supervisor for each team member and any anomalies flagged.

1. Check for duplicate entries, identifying the person and date of visit; length/height; weight; date of birth; standing/lying position for length/height measurement; and sex.
2. Check the source of the date of birth and whether it was confirmed by an official document, reported by the parent or caretaker, or estimated using the event calendar;
3. Check for consistency between the date of birth/age when the information has more than one source (e.g. household roster and anthropometry questionnaire);

4. Check for consistency between date of birth/age and whether the child was measured standing up (for children aged 24 months and older) or lying down (for children aged under 24 months), while bearing in mind that in some cases there may be a reason (which has to be recorded on the questionnaire) for a non-standard measurement position;[4]
5. Flag unusual high or low z-score values for height-for-age, weight-for-age, and weight-for-height for re-measurement, and randomly select additional cases for re-measurement. A z-score is the deviation of an individual's value from the median value of a reference population, divided by the standard deviation of the reference population. Z-scores should be calculated in accordance with WHO Child Growth Standards. The procedure for flagging outlying values for re-measurement and selecting random cases for re-measurement is described below: see the section on "Anthropometry re-measurements in the field". The program should be able to issue a prompt for re-measurement of random and flagged cases while the team is still in the field. The reason for re-measurement should be blinded to the interviewer and supervisor.

2

c) Applying the anthropometry checklist

An anthropometry checklist can be a useful aid for measuring field team performance. The checklist includes a core set of essential tasks which should be performed when taking anthropometry measurements. Each task is a crucial step that, if omitted or done incorrectly, can result in poor quality data. Recording and monitoring whether the checklist has been completed is a factor that increases accountability when supervising team members.

The checklist can be used during household observations and completed either in a paper-based format or electronically. The person completing the checklist should inform the members of the household that his or her role is simply to observe data collection in a supervisory role. Feedback on the checklist results should be provided to the survey team after leaving the household.

The checklist can be used by field supervisors and fieldwork coordinators, although the person completing the checklist must be trained to use it correctly. The training should include instruction on how correct anthropometry measurements are obtained, how to use the checklist, and how to provide feedback and discuss results constructively and effectively with the anthropometrist.

In addition to the checklist, job aids and handbooks should be provided for the anthropometrists. All these documents should be included in the survey manual (see section 1.1 on Planning).

An example of an anthropometry checklist can be found in Annex 8.

d) Anthropometry re-measurements in the field

It is recommended that two types of re-measurement be performed while the survey team is in the field. The first, blinded re-measurement, involves randomly sampling a subset of the survey population and taking repeat measurements of height, weight, date of birth and sex on this random sample. The second, flagged re-measurement, involves performing repeat measurements of height, weight, date of birth and sex for children with unusual measurements.

Selecting cases for re-measurement, either owing to unusual measurements or as members of the random subset, is a task that should be performed by the field supervisor using a data capture or entry system designed for this purpose. Random selection of cases is straightforward with an electronic data system where blinded cases for re-measurement can be selected after completion of interviews. If data cannot be electronically captured in the field, random selection should be carried out by the field supervisor using pre-specified selection criteria. Flagging of cases for re-measurement is an electronic procedure and feasible only when electronic data capture is used in the field. The anthropometrist must be kept uninformed about the reason a child is selected for re-measurement i.e. whether it is because of an unusual measurement or as a member of the blinded random subset. Flagging of cases for re-measurement should not be performed in the absence of random re-measurement in order to avoid over-editing of data in the field: this could result in the suppression of genuine variation and introduce bias.

Blinded random re-measurement procedures

There are two approaches to blinded random re-measurement. Both require that a second measurement be taken on a child who has already been measured as part of the survey sample. The aim of the first approach is to assess **precision**: it requires the anthropometrist who took the original measurement to return in order to obtain a second measurement. The aim of the second approach is to assess **accuracy**: an expert anthropometrist therefore has

[4] A measuring position recorded as "standing" for a child who is younger than 9 months should be considered an entry error and flagged as such during data analysis. Refer to section on Data quality assessment and data analysis for more details.

to obtain the second measurement (for definitions of precision and accuracy see the section 1.4 on Training and Standardization). It is preferable to assess both precision and accuracy, but where this is not feasible precision alone should be assessed on a random subsample.

Re-measurements should be performed using the same type of calibrated equipment and standard measurement methods used for the initial measurement. Anthropometrists should remain unaware of the subsample of randomly selected households until they are instructed to undertake the second measurement. The field supervisor should take every precaution to ensure that the anthropometrist does not have access to the first measurement. Where the same anthropometrist is requested to take two measurements on the same subject an adequate period of time should have lapsed between measurements in order to minimize the chances of the anthropometrist recalling the original measurement. In spite of this consideration, the two measurements must be obtained within a certain window of time for them to be comparable: the weight of a child can change owing to different factors, so re-measurement should be done while the team is still within the PSU (i.e. at most 3–4 days after the first measurement).

Blinded anthropometric re-measurement data are used to determine if any teams are in need of retraining during field work and to assess data quality after the survey. When used for field supervision purposes, feedback on discrepancies regarding date of birth, sex, weight and length/height should be shared with the anthropometrists[5]. A standard maximum acceptable difference for length/height measurements has not been established. The WHO Multicentre Growth Reference Study defined a maximum acceptable difference as 0.7 cm or less *(11)* while others have defined it as 1.0 cm or less *(12)*.

Since this approach is being used only for quality assurance purposes, a third measurement is not recommended and only the first measurement should be used in the generation of prevalence and other estimates. However, for reasons of transparency, the second measurement should be retained in the dataset and carefully labelled so that users understand the meaning of this quality assurance variable.

Flagged case re-measurement procedures

Re-measurement of children with flagged data can reduce the amount of incorrect data included in the final dataset. Flagged data are defined using anthropometry z-score ranges for each anthropometric indicator. These should be based, as a minimum, on the WHO Child Growth Standard flag ranges[6] and, as a maximum, on the range £ -3 SD or > 3 SD with a mean of zero based the WHO Child Growth Standards reference population. While it may be preferable from a data quality standpoint to use the maximum flag range, this approach can lead to a heavy workload in some settings. Use of survey data from a similar setting (e.g. previous surveys from the same country) can therefore be used to predict heuristically the number of re-measurements that will be required using different flag ranges: the decision about which particular range to adopt can be made based on grounds of feasibility. Further research is required to identify a balanced set of flag ranges that could be used in different settings to prompt re-measurement.

As noted above, outliers must not be identified by hand in the field and to avoid over-editing survey teams should not be provided with reference sheets for child growth (e.g. weight-for-height reference sheets). Z-score flagging should be done automatically using a software program that is able to generate anthropometry z-scores. While it is logistically easier to flag cases while the team is still in the household and re-measure children on the spot this is not recommended because the anthropometrist will no longer be blinded about the reason for re-measurement (i.e. blinded vs flagged).

Contrary to the blinded re-measurement procedure, the second measurement for flagged cases should be used for calculating prevalence and other estimates, although the original measurement should be retained in the dataset under a different variable name for reasons of transparency. All relevant information (date of birth, sex) and measurements (length or height, weight) should be re-measured.

e) Other forms and checks

Field supervisors should check the calibration log (see section 1.5 on Equipment in Chapter 1 and Annex 6) of their teams on a daily basis to determine if the equipment for measuring height and weight is being tested to confirm its proper functioning before teams leave for the field each day. Fieldwork coordinators should also review the calibration log when they visit different PSUs and provide feedback as required to the field supervisor who, in turn, will provide feedback to the team concerned.

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[5] Natural variation of weight measurements collected on different days is unknown, so calculation of a maximum acceptable difference for weight requires research before it can be adopted. However, weight should still be measured and the anthropometrist remain blinded as to why a particular child is selected for re-measurement (blinded vs flagged).

[6] Height-for-age <-6 or >6 z-scores, weight-for-age <-6 or >5 z-scores, weight-for-height <-5 or >5 z-scores

It is possible to create paper forms in order to provide summary information on the team's performance.

Key checks to support collection of high quality anthropometric data during supervision at central level

a) Household completion rate;
b) Completeness of age;
c) Completeness of height measurement;
d) Completeness of weight measurement;
e) Source of age;
f) Data heaping;
g) Position of measurement;
h) Cases out of range.

Aggregated data quality checks, as data begins accumulating, should be performed by a data processor at the central level. This information provides an objective and continuous measure of each anthropometrist's performance and can also highlight issues relating to data collection. Relevant information obtained from the data quality checks needs to be provided to the field supervisors to help improve team performance.

Field check tables are one way of monitoring data quality while the fieldwork is still in progress. They are tabulations of data which are produced periodically in order to monitor the performance of each separate survey team. Each table focuses on an important aspect of data quality and is presented by team. Use of these tabulations is crucial during the entire fieldwork period when there is still time to arrange for field team members to be re-trained or problem PSUs to be re-measured. If the data from a particular team reveal problems, it may be useful to have each individual anthropometrist review the field check tables in order to see whether the problems are team-wide or restricted to one or two team members. The central office should be able to provide feedback to the survey teams on how they can improve their work and avoid repeating the same errors, based on field and central office checks.

Checks at central level which are included in the field check tables:

a) **Household completion rate:** percentage of households completed; no household member at home or no competent respondent; entire household absent for extended period of time; refused; dwelling vacant or address not a dwelling; dwelling destroyed; dwelling not found; and other reason, out of total number of eligible households;
b) **Completeness of age:** percentage of date of births completely defined as day, month and year of birth; year and month of birth; and year of birth only, out of total number of eligible children;
c) **Completeness of height measurement:** percentage of children measured; children not present; refused; other reason; and missing, out of total number of eligible children;
d) **Completeness of weight measurement:** percentage of children measured; children not present; refused; and missing, out of total number of eligible children;
e) **Source of age:** percentage of date of birth information obtained from birth certificate; vaccination card; caretaker's recall; and other source, out of the total number of eligible children;
f) **Data heaping:** height and weight digit preference for any digit (see section on digit preference in Chapter 3 on Data quality);
g) **Position of measurement (standing):** percentage of children recorded who were measured in the lying position who should have been measured in the standing position out of total number of children measured; and measured in the standing position who should have been measured in the lying position out of total number of children measured;[7]
h) **Cases out of range:** percentage of invalid HAZ, WAZ, WHZ based on WHO flags (see section 3.1 on Implausible values in Chapter 3 on Data quality).

If data based on blinded and flagged re-measurement related to anthropometry are available, this information can also be included in field check tables. These could also be tabulated using each anthropometrist's unique identifier.

[7] Defined as children under two years of age measured standing up and children over two years of age measured lying down. Alternatively, or in addition, defined as children under 9 months of age measured standing up as this is likely to be biologically implausible (child unable to stand).

Re-training and standardization

A survey team should undergo re-training if observation or field check results, either at field level or in the central office, indicate poor performance during data collection. Re-training should be provided by an expert anthropometrist to ensure that the correct measuring techniques are being taught. If several teams are performing poorly, centralized retraining and re-standardization exercises is recommended. It is also preferable for all anthropometrists, in large surveys requiring more than 4 months' data collection, to undergo re-standardization halfway through the data collection process.

TOOLS

- A model calibration log tool for anthropometric equipment is shown in Annex 6;
- A model cluster control form in shown in Annex 7;
- A model anthropometry checklist is shown in Annex 8[8].Standard field check tables are currently being developed to comply with the guidelines in this report.

[8] The model anthropometry checklist provided in Annex 8 was developed by the DHS Program and is based on use of a Seca® scale (model no. SECA 878U) and Shorr board. The checklist should be adapted accordingly if other equipment is used.

SUMMARY OF RECOMMENDATIONS AND BEST PRACTICES

2

Section 2.1- DATA COLLECTION PROCEDURES

Recommendations (must)

– List all children under 6 years old, before selecting children under 5 years old for measurement;
– Implement a minimum of 2 call backs per household at different times of the day and establishing optimal time for revisit of eligible children not present;
– Undertake checks of the scale with test weight of at least 5 kg daily.

Good practices (optional)

– Organize field work according to the timing set up with the PSU authorities

Section 2.2- INTERVIEW AND MEASUREMENTS

Recommendations (must)

– Always record the date of birth and date of visit on the questionnaire;
– Do not recording the age in months on the questionnaire;
– Weigh the child undressed to the minimum and if not possible, record it on the questionnaire;
– Request for braids or hair ornaments to be removed before length/height measurement;
– Position the child in lying or standing position for length/height based in the child's age group;
– The main measurers should read the measurement out loud twice to the person completing the questionnaire. Once it has been recorded, the main measurer should then check the questionnaire to confirm that the measurement has been correctly entered;
– Always record whether recumbent length or standing height was measured;
– Do not use faulty equipment;
– It is recommended to measure individuals with disabilities. However, it can be a challenge to acquire accurate and safe measurements in individuals with impairments that affect their ability to stand, straighten their arms, legs or back or hold themselves steady.

Section 2.3- DATA CAPTURE/ENTRY

Recommendations (must)

– If using a centralized data entry system, double entry of data is required to eliminate keying errors.

Good practices (optional)

– If a centralized data entry system is used instead of data capture in the field, data entry should be carried out in small batches;
– Software programs for data capture or entry, as well as data checking, should be set up, tested and verified using data from the pilot survey.

Section 2.4- QUALITY ASSURANCE DURING DATA COLLECTION

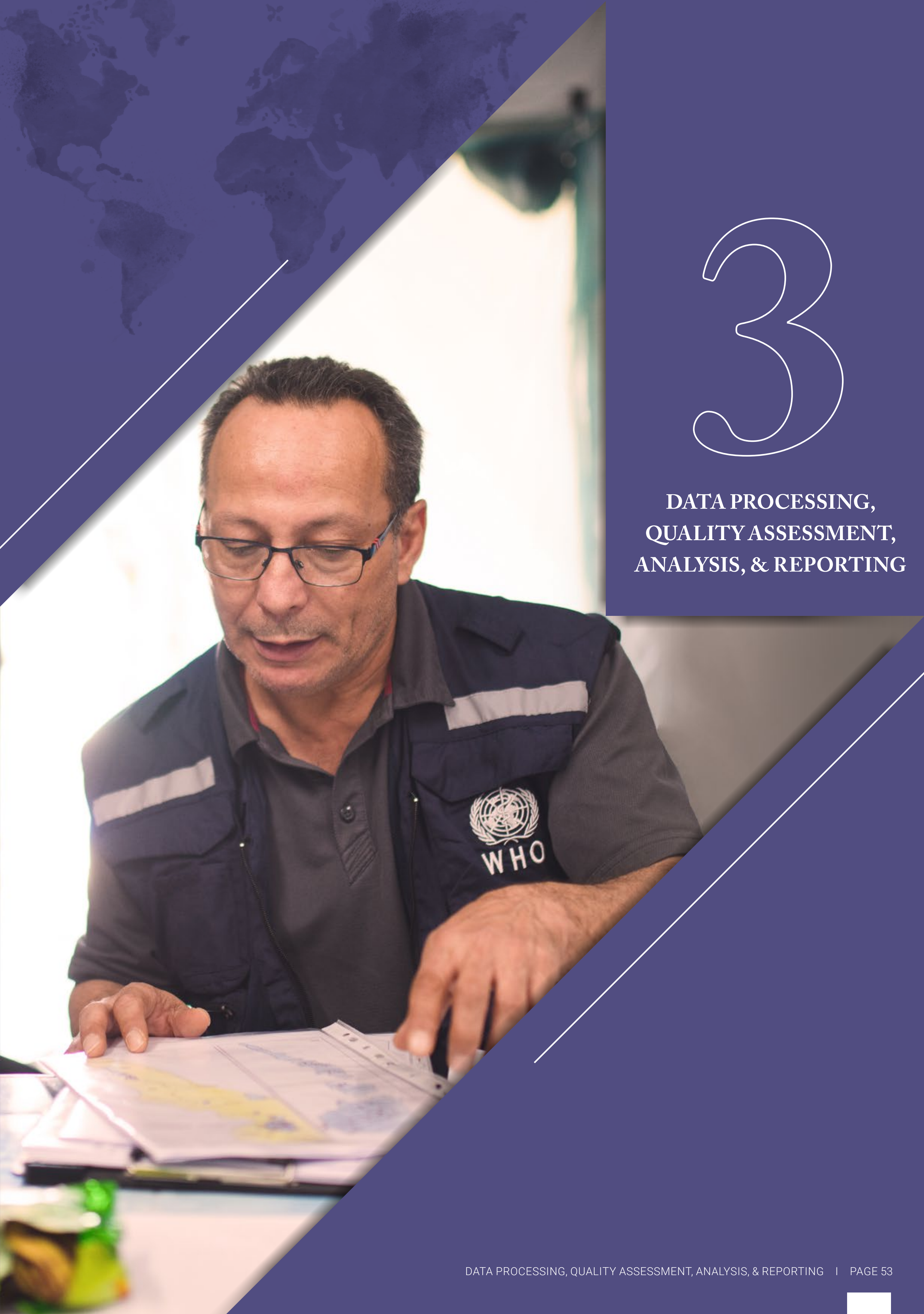
Recommendations (must)

– It is recommended that a subset of fieldwork coordinators experienced in anthropometric measurements be available to monitor field work;

– In the first few weeks of field work it is especially important to have more intensive supervision so that any major problems can be identified and addressed early on;
– For surveys with a longer period of field work, intensive supervision towards the end of data collection is also recommended to ensure that the quality of teamwork does not fall off with time;
– It is recommended two types of re-measurement be performed while the survey team is in the field. The first, blinded re-measurement (randomly sampling a subset of the survey population and taking repeat measurements of height, weight, date of birth and sex), the second, flagged re-measurement.
– Re-measuring children on the spot is not recommended because the anthropometrist will no longer be blinded about the reason for re-measurement (i.e. blinded vs flagged) or the original values;
– outliers must not be identified by hand in the field and to avoid over-editing survey teams should not be provided with reference sheets for child growth.

Good practices (optional)

– If survey teams are performing poorly, a centralized retraining and re-standardization is recommended.



3

DATA PROCESSING, QUALITY ASSESSMENT, ANALYSIS, & REPORTING

The previous two chapters laid out guidelines and checklists for the collection of high quality anthropometric data. For thorough and transparent reporting on survey quality, reporting on actions taken in its various stages including the planning, designing, field work, data entry and analysis are required as are thorough reports on data quality and estimates.

The present chapter provides guidance for best practices in data processing and reporting. It has four sections:

3.1. Data quality assessment;

3.2. Data analysis;

3.3. Data interpretation;

3.4. Harmonized reporting and recommended release of data.

A variety of software is available, some allowing a full range of activities from data entry to analyses and reports. For data analyses, the standard approach adopted for the WHO Global Database on Child Growth and Malnutrition *(13)* and the UNICEF-WHO-WB Joint Child Malnutrition Estimates (JME) *(14)* to ensure comparability across countries and years can be achieved using currently available Anthro software or macros (SAS, SPSS, STATA and R). WHO recently developed an online tool for anthropometric data analyses that updates Anthro methodology to provide more accurate estimates of standard errors and confidence intervals for prevalence and mean z-scores. The WHO Anthro Survey Analyser is a tool based on the R and R Shiny package that provides interactive graphics for data quality assessment and a summary report template offering key outputs, e.g. z-score distribution graphics in terms of various grouping factors and nutrition status tables with accompanying prevalence and z-score statistics.

3.1. DATA QUALITY ASSESSMENT

It is recommended that data quality be assessed to determine whether there are any issues that might lead to biased estimates, have an impact on interpretability or limit the potential use of findings. In general, data quality assessment aims to pinpoint two main types of bias: selection bias and measurement bias. Selection bias is related to the representativeness of sampled households and children. Measurement bias is generally a consequence of inaccurate measurements of weight, height and date of birth. These biases may be due to either random or systematic errors.

High quality measurement of all information needed (length/height, weight and date of birth of children under five years of age) to generate the anthropometric indicators as well as sampling and field procedures are essential for generating accurate child malnutrition estimates. The following sections describe the checks recommended for assessing the quality of anthropometric survey data.

The checks described in this section address the following topics:

3.1.1. Completeness;

3.1.2. Sex ratio;

3.1.3. Age heaping;

3.1.4. Digit preferences of heights and weights;

3.1.5. Implausible z score values;

3.1.6. Standard deviation of z scores;

3.1.7. Normality (skewness and kurtosis) of z scores.

For each of these checks, text under bold headings explain **what** it is, **why** it is recommended to use it, **how** it should be used or calculated, and then describe how to **interpret and report** it.

Applied in combination, these checks can provide insight into the quality of the anthropometric data that serves to support the interpretation of malnutrition estimates. It is generally recommended that data quality be appraised not on the basis of isolated checks but by considering all of them conjointly. One limitation to current assessments of data quality is that no consensus exists about cut-offs for data quality checks that indicate a definitive problem. Further research is needed to determine appropriate cut-offs for data quality measures and whether other data quality checks might be helpful.

Data quality checks should be conducted for the entire sample population and separately for each main measurer or team. If potential data quality issues are detected at the national level, data quality checks may also be carried out for subpopulations within the sample, assuming the sample size is sufficient for the test/assessment for the specific disaggregation categories in question. Subpopulations should be disaggregated for sex and age, and if feasible for region, mother's education and wealth quintile. Disaggregation categories can provide valuable information to support the interpretation of data quality, although it is not always apparent whether differences are due to sample heterogeneity or quality issues.

Some data quality checks are made before excluding implausible values whereas other checks are made after exclusions: this is indicated below for each check. Prior exclusion of implausible values is only done for data quality checks relating to distribution.

Some data quality checks are made using unweighted and others using weighted samples, as indicated below for each check described. Weighted analyses are recommended where a comparison is being made to an external reference population. Conversely, unweighted analyses are recommended where measurement error is being evaluated, ensuring that each individual measurement has an equal sample weight.

It is recommended that data quality assessment findings be included in all survey reports that provide estimates for child anthropometric indicators. At the time of this publication, the WHO Anthro Survey Analyser includes most of the data quality checks described below, and follows the recommendations included in the present document (see sample report in Annex 9). Several other software packages are available that include some but not all the recommended checks. It is not known whether all these packages follow recommended calculation methods; some include formal tests, cut-offs or scoring systems not recommended in this report.

Errors in measurement and selection are important since they can lead to inaccuracies in prevalence estimates. Insight into data quality in every survey helps to interpret results especially when investigating trends over time. While it is not always possible to distinguish between them, there are two main types of measurement error, systematic and random error. In many other fields, random errors may have less of an influence on estimates and systematic error is the main concern, as reported indicators are based on the mean, median or estimated coverage. However, since the malnutrition indicators discussed in this report relate to prevalence at the tail ends of the distribution, both random and systematic measurement error are of concern and need to be minimized. In fact, for malnutrition estimates based on prevalence at the distribution tails, three major sources can threaten the accuracy of prevalence estimates: (a) selection errors (e.g. errors in identifying sampled households or eligible children in these households to be measured); (b) systematic measurement error; and (c) random measurement error. A number of different variables can be responsible for introducing systematic and/or random errors including date of birth (used to calculate age), length/height and weight. That is why transparent and thorough reporting on data quality and survey methodology is of such great importance for estimates related to malnutrition prevalence.

3.1.1 Completeness

What

When undertaking survey data collection in sampled households, it is necessary to ensure that the data collected are complete. In anthropometric surveys, this means ensuring not just that all eligible children are accounted for but includes checking the structural integrity of all aspects of the data. The following topics should be checked for structural integrity.

- **PSUs:** all selected PSUs are visited, although this may not be possible on some occasions, e.g. due to civil strife, flooding or other similar reason;
- **Households:** all selected households in the PSUs are interviewed or recorded as not interviewed (specifying why);
- **Household members:** all household rosters are complete, with all household members listed and information provided about their key characteristics, e.g. age, sex and residency;
- **Children:** all eligible children are interviewed and measured or recorded as not interviewed or measured (specifying why), with no duplicate cases;
- **Dates of birth:** dates of birth for all eligible children are complete.

Why

Assessing the completeness of collected data is an important aspect of verifying data quality. Errors during data collection and lack of data completeness in a survey can lead to non-representative or biased results. Being able to check data completeness provides confidence in the survey and how it has been implemented.

How to calculate

For each of the items listed above, the sampled proportion successfully interviewed should be reported, generally disaggregated by survey strata or sampling domain.

Usually it is possible to visit all PSUs, but in those surveys in which some PSUs are not visited the number of non-visited PSUs in each stratum should be stated. If selected PSUs are not visited, then it is generally necessary to make an adjustment in the analysis, e.g. sample weights to correct for under-sampling within a stratum. We recommend as a best practice that PSUs which cannot be visited, should not be replaced by other PSUs since this may introduce bias into the sample.

For households, the response rate (based on all contactable households) should be provided along with the completion rate (based on all selected households).

$$\textit{Household completion rate} = \frac{\textit{Number of households with completed interviews}}{\textit{Total number of households selected}}$$

$$\textit{Household response rate} = \frac{\textit{Number of households with completed interviews}}{\textit{Total number of households contactable}}$$

The *total number of households contactable* includes households completed (code 01), partially completed (code 02), with no household member at home or no competent respondent at home at the time of visit (code 03), refused (code 05), and dwelling not found (code 08), and excludes those where the entire household was absent for an extended period of time (code 04), dwelling vacant or address not a dwelling (code 06), dwelling destroyed (code 07) and other (code 96).

For household members, an assessment of the completeness of the household roster should be reported, comparing average household size and average number of children aged under five years by stratum or sampling domain with estimates of average household size and number of children from other sources.

$$\textit{Average household size} = \frac{\textit{Number of household members}}{\textit{Number of households completed}}$$

$$\textit{Average number of children per household} = \frac{\textit{Number of children under five}}{\textit{Number of households completed}}$$

Note: if the survey is using a de facto sample, the average number of children per household should be presented for de facto children, i.e. those who stayed in the household the previous night, rather than de jure children (usually resident).

For eligible children, typically all eligible children under 5 years should be reported unless a subsampling method is applied, showing the percentage of eligible children who had completed interviews.

$$\textit{Children completion rate} = \frac{\textit{Number of children under five with completed interviews}}{\textit{Number of eligible children under five}}$$

Information on completeness of re-measurements should be presented for all eligible children, including random and flagged re-measurements.

$$\textit{Random remeasurement completion rate} = \frac{\textit{Number of children with completed random remeasurements}}{\textit{Total number of children selected for random remeasurements}}$$

$$\text{Flagged remeasurement completion rate} = \frac{\text{Number of children with completed flagged remeasurements}}{\text{Total number of children with flagged measurements}}$$

In addition, present the percentage of children with a complete date of birth, including day of birth, and those with month and year of birth (but not day).

$$\text{Children with complete date of birth} = \frac{\text{Number of children with day, month and year of birth recorded}}{\text{Number of children with complete interviews}}$$

$$\text{Children with partially complete date of birth} = \frac{\text{Number of children with month and year of birth recorded, but not day}}{\text{Number of children with complete interviews}}$$

$$\text{Children with incomplete date of birth} = \frac{\text{Number of children with month or year of birth missing}}{\text{Number of children with complete interviews}}$$

Note: the second ratio related to children's date of birth refers to the percentage of children with an imputed day of birth (i.e. where DD was imputed to 15 but MM and YYYY available to calculate age in months), and the third to the percentage of children with insufficient information to calculate an age in months (i.e. MM and/or YYYY are missing and these cannot be imputed for anthropometry z scores. The sum of the preceding three ratios—expressed as percentages—equals 100.

Completeness of measurement for length/height and weight should be presented by showing the proportion measured, the proportion absent, the proportion refused, and the proportion not measured owing to other reasons, for all eligible children.

For length/height, and for weight:

$$\text{Children measured / absent/ refused / other reason} = \frac{\text{Number of children measured / absent / refused / other reason}}{\text{Number of children with complete interviews}}$$

Furthermore, the proportion of missing data for age, sex, residency based on the household questionnaire, whether measured lying or standing in the anthropometry module or for other variables used in the calculation of anthropometric z-scores should also be presented.

How to present

When presenting these results, numerators and denominators as well as resulting ratios should be displayed in the data quality survey report.

3.1.2 Sex ratio

What

The sex ratio is the proportion of males to females in a given population, usually expressed as the number of males per 100 females for a specific age group. It should be assessed for the survey dataset and compared to an expected sex ratio for the same age group. Because the sex ratio is generally not 100 boys to 100 girls in most countries, it is important to compare the survey sex ratio to a reference. A potential reference is the United Nations Population Division World Population Prospects (UNPD-WPP)[1], which provides sex ratios estimated using smoothed distributions based

[1] Check for the most recent version of the World Population Prospects at: https://esa.un.org/unpd/wpp/Dataquery/

on expected sex ratios at birth and mortality levels by country and year for different age groups[2]. The median sex ratio for all countries between 1995 and 2015 in the UNPD WPP is 104 boys per 100 girls with 5th and 95th percentiles of 101 and 108 respectively. It is therefore unlikely that a nationally representative survey would have a sex ratio outside this range. The only country that had a male-to-female ratio for children aged 0 to 4 years of 95 boys or lower per 100 girls was Rwanda in 1995, 1996 and 1997. At the other end of the spectrum, only a handful of countries such as Armenia, Azerbaijan and China have, over several consecutive years, shown sex ratios for children aged 0 to 4 years of 115 boys or more per 100 girls.

Why

The sex ratio of the survey population, when compared to an expected sex ratio, can be used to identify selection bias. This may result from problems of sampling (e.g. populations where members of one sex are more likely to be excluded from the household listing) or differences in response rates (e.g. higher absentee rates for one sex compared to the other).

How to calculate

The sex ratio should be calculated for *all* sampled children eligible for anthropometry from the household roster, whether or not measurements were made, or information is missing, and whether or not they are flagged as outliers on an anthropometry z-score. The sex ratio should be calculated using sampled weights in order to be comparable to the reference population. It is calculated as follows:

$$\frac{\textit{Weighted number of boys in survey under age 5 eligible for anthropometry}}{\textit{Weighted number of girls in survey under age 5 eligible for anthropometry}} \times 100$$

How to present and interpret

It is recommended that the sex ratio for the survey be compared against a country-specific expected sex ratio. Expected sex ratios can be obtained from UNPD-WPP[3] or other national sources such as the latest censuses or other nationally representative survey reports for the same time period as the survey. If the survey sex ratio does not resemble the expected sex ratio for that country, sex ratio patterns should be examined by team and possibly by other disaggregation categories, but only if there is a sufficient sample size for this assessment for the disaggregation categories in question. The survey team should seek explanations for the unexpected sex ratio and include them in the survey report, including any problems with the reference used.

3.1.3 Age heaping

What

Age heaping refers to an unexpected distribution of observations for specific ages and/or months of birth. Three common age heaping patterns may occur, and various checks should be conducted to spot them as defined below:

- **Unequal distributions between single year age groups**

  The expected distribution for each single-year age group among children aged 0–4 years is about 20%. As confirmed by UNPD-WPP data between 1995 and 2015, the median ratio of children in each one-year age group between 0 and 4 years was 0.20 for all countries in the world. In other words, each single year interval (i.e. 0–11, 12–23, 24–35, 36–47 and 48–59 months old) contains 20% of all children aged 0–59 months. A survey team might see more 5 year olds than 4 year olds, for instance, if an unequal distribution existed between single-year age groups;

- **Distributions with peaks at single or multiple month age groups**

  In this scenario, peaks and troughs have a frequency distribution for age corresponding to specific months in the dataset. Common patterns include peaks at full years 0, 12, 24, 36, 48 and 60 months or at half and full years (0, 6, 12, 18, 24, 30, 36, 42, 48, 54 and 60 months). However, in some surveys peaks may also occur at other ages; peaks for any single-month age group would be unexpected and a potential cause for concern. Unequal distributions may

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[2] Check for the most recent version of the World Population Prospects at: https://esa.un.org/unpd/wpp/Dataquery/
[3] Check for the most recent version of the World Population Prospects at: https://esa.un.org/unpd/wpp/Dataquery/

also occur among multiple-month age groups, for example too few 0–3 month olds compared to 4–7 month olds in the dataset when a near equal distribution would be expected;

– **Distributions with peaks at specific months of birth**

Estimates of age in months are calculated using the date of birth and date of interview and include the month of birth as obtained during data collection. Although there is evidence that the month of birth is not uniformly distributed in different countries, owing to various seasonal and climate factors *(15)*, large peaks or troughs would not be expected.

3

Why

Unequal distributions between single-year age groups or too few children in a specific age group may be related to selection bias (e.g. aging out children who are just under five years) and/or measurement bias (e.g. misreporting of date of birth). It may be helpful, in the event of unequal distribution, to review the survey methodology and sampling design since they can shed some light on the type of bias. Distributions with peaks at a single month of age or peaks at specific months of birth are likely to indicate measurement bias.

Selection bias can occur if the household roster is filled incorrectly. Selection bias can also result from problems during interviews, e.g. where the interviewer records children close to the age of 5 as having already turned 5 in the household roster or there are different response rates, e.g. higher refusal rates for younger children or higher absenteeism for older children who may be attending school.

Measurement bias can occur where vital registration is not universal and information on the exact date of birth is not available. In this situation the interviewer is obliged to estimate the year and month of birth from incomplete records, maternal recall or by means of local events calendars. Misreporting can be due to the respondent genuinely not knowing a child's date of birth, faulty date-of-birth records, incorrect handling of the local events calendar by the field team or data fabrication. Data heaping is more commonly observed for older (36–48 months) than younger children (12–24 months), most probably due to the fact that caretakers are less good at recalling the birthdates of older children. In some settings, children are issued with vital registration documents, but in populations where an application is not lodged for the child at the time of birth but instead sought some months or years following birth, a specific but arbitrary month—often "January"—is assigned as the month of birth on birth certificates, vaccination cards and other documentation when the true month of birth is unknown. Major data heaping on the month of birth can also be seen when local events calendars are not used according to the recommendations set out in this report (see Questionnaire development section in Chapter 1).

How to calculate

Age heaping should be investigated using histograms. These histograms should include *all* sampled children eligible for the child questionnaire for anthropometry from the household roster, whether or not measurements were made, or information is missing, and whether or not they are flagged as outliers on an anthropometry z-score. Information for children under 6 years old can be included as may show age displacement.

The following three histograms should be plotted.

– **Histogram 1**

Calculated with sample weights[4] and binned by year of age, i.e. six bars representing ages from 0 to 5 years (if data are collected only for children under 5 years, then five bars representing each year of age from 0 to 4);

– **Histogram 2**

Calculated without sample weights and binned by month of age, i.e. 72 bars representing ages from 0 to 71 months (if data are collected only for children aged 0-4 years, there would be 60 bars representing each month of age from 0 to 59);

– **Histogram 3**

Calculated without sample weights and binned by calendar month of birth, i.e. with 12 bars for the months January to December.

[4] A histogram can also be plotted without sample weights when investigating misreporting but will probably not differ in a significant manner from the weighted histogram.

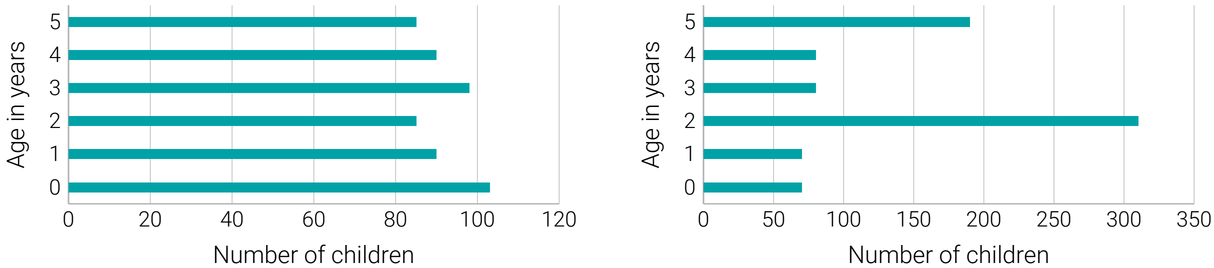
There are several methods to calculate age heaping numerically [e.g. index of dissimilarity (also known as Myers' unblended index), Myers' blended index, MONICA, Whipple's index)]. More research is needed to determine how different values for such indices influence estimates of malnutrition prevalence in order to develop cut-offs that might indicate poor data quality.

How to present and interpret

Plot all three histograms for the national sample as well as by team and examine them for unexpected distributions.

Histogram 1 – by age in completed years: Check to determine whether each of the 5 one-year age groups for children aged 0 to 4 years has an approximately 20% share of the entire under-five population (and/or each of the 6 one-year groups has an approximately 17% share of the entire under-six population if data for children aged under six years are available). If the proportion of any one-year age group for the 0 to 4 year olds deviates much from 20%, the country-specific expected age distribution from UNPD-WPP or other reliable sources (latest censuses or other nationally representative sources for the same time period as the survey) should be consulted. If an unexpected distribution is present at the national level, histograms should also be examined by other disaggregation categories. In some circumstances, for instance where child mortality is extremely high, or fertility rates have markedly changed in the previous five years, expected ratios may not follow a uniform distribution. A variation between the expected and survey age distributions may however also be due to a problem with the reference used. The team should seek explanations for unexpected age distributions and include them in the survey report. Examples of age distributions in years are shown in Figure 3.

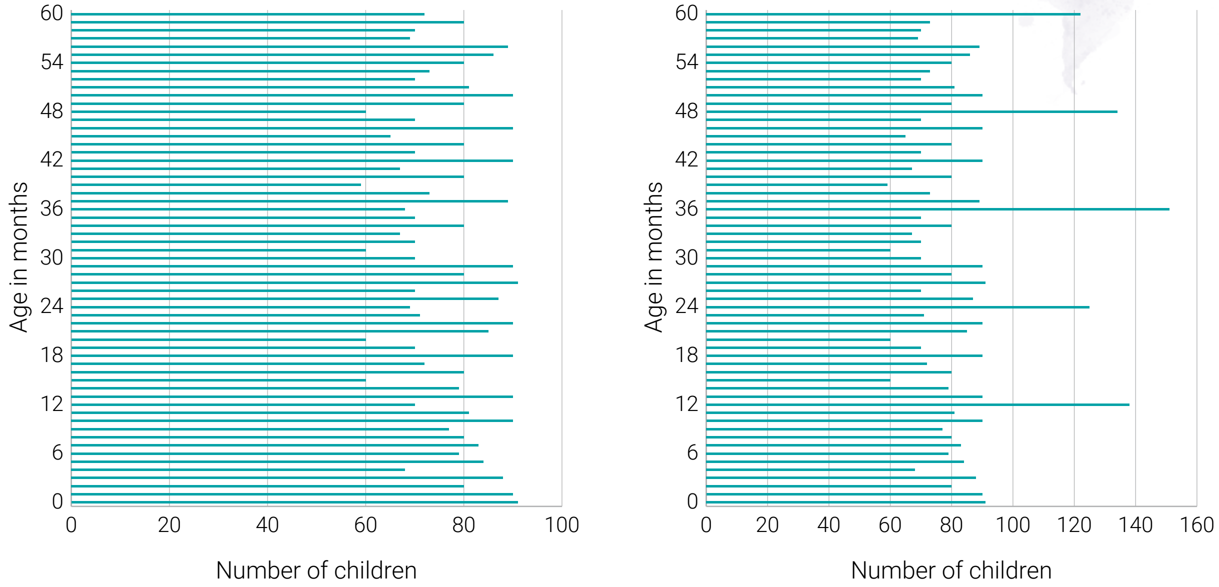
Figure 3. Examples of age distribution (in years) in different surveys



(left) approximately equally distributed; (right) heaping in years 2 and 5;

Histogram 2 – by age in completed months: Check to see whether the length of each bar is approximately the same (see examples in Figure 4). Look for the common patterns noted above (e.g. peaks at 12, 24, 36, 48, and 60 months or 6, 12, 18, 24, 30, 36, 42, 48, 50 and 66 months). Obvious troughs or peaks at either end of the distribution should also be assessed to determine whether they represent a potential selection bias. If peaks and troughs are apparent in areas other than the beginning or end of the histogram, they may indicate a misreporting of the birth date, especially if they are observed at 6- or 12-month intervals. If an unexpected distribution is present at the national level, histograms should also be examined by other disaggregation categories but only if there is a sufficient sample size for this assessment for the disaggregation categories in question. Explanations should be sought for data heaping in months and included in the survey report.

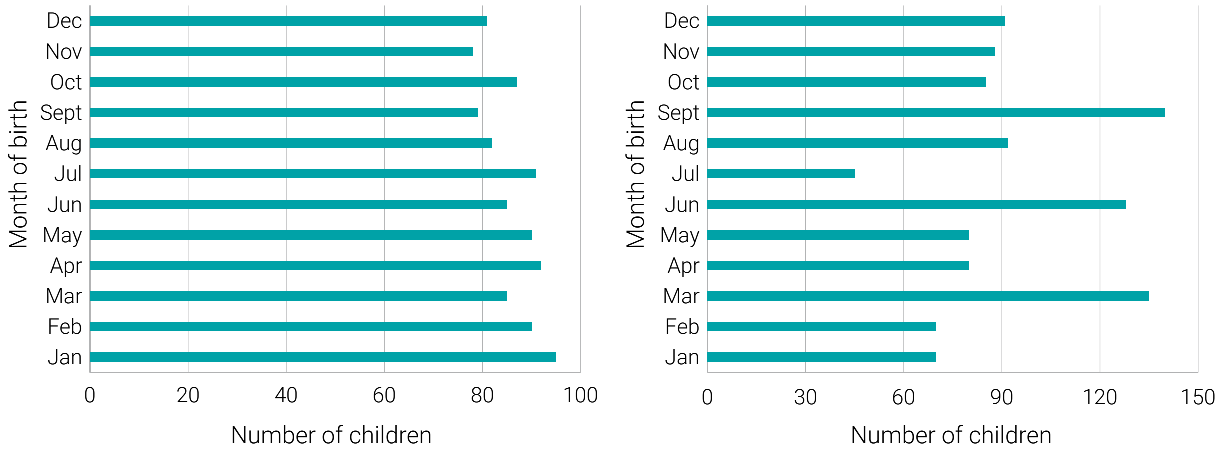
Figure 4. Examples of age distribution (in months) in different surveys



(left) approximately equally distributed; (right) heaping in months 12, 24, 36, 48 and 60;

Histogram 3 – by calendar month of birth: Check to see whether the length of each bar is approximately the same. It should be borne in mind that perfect distribution is not expected in any country since age distribution occurs as a function of monthly patterns of fertility (Figure 5). What is not expected is to find a large peak for a specific month, a finding which has typically been associated in some countries with the month of January. If an unexpected distribution is present at the national level, histograms should also be examined for other disaggregation categories but only if there is a sufficient sample size for this assessment for the disaggregation categories in question. Explanations should be sought for data heaping in the month of birth and included in the survey report.

Figure 5. Examples of age distribution (month of birth) in different surveys



(left) approximately equally distributed; (right) heaping in March, June and September

3.1.4 Digit preferences for length/height and weight

What

Digit preference refers to an unexpected distribution of digits in weight and length/height measurements. Digit preference may affect the terminal digit or, less often, the integer part of the number. If survey teams use the equipment recommended in Chapter 1, each weight and length/height measurement in the survey should display one terminal digit:

this represents one tenth of a kilogram for weight and millimeters for length/height[5]. There are 10 possible terminal digits ranging from 0 to 9. In a survey where the length/height and weight of each child has been measured and recorded correctly on properly functioning equipment, the expected distribution of each digit should be approximately 10%. Whole number preference refers to the process whereby data heaping occurs because the integer part of the number has been rounded off, e.g. 10 kg or 75 cm.

Common digit preference patterns include:

– a preference for the terminal digits 0 and 5;
– a preference for a terminal digit(s) other than 0 and 5;
– whole number digit preferences for height or weight (e.g. multiples of 5 or 10 cm for height or 2 or 5 kg for weight).

Why

Digit preference may be a tell-tale sign of data fabrication or inadequate care and attention during data collection and recording. Identifying which particular digits are overrepresented may provide insight into the type of error. For instance, if the frequency distribution indicates significant terminal digit entries for 0 and/or 5, this may indicate that measurers were rounding off. If there is a preference for digits other than 0 and 5, then it may be possible that data have been fictitiously constructed. A whole number digit preference is indicative of rounding of the integer part of the number or fictitious data.

If survey teams are using the currently recommended anthropometry equipment (digital weighing scale and height board with printed measuring tape) a digit preference for length/height is more likely to occur since the board needs to be read by counting lines and the 0 and 5 marks stand out from other markings on the board which represent the terminal digits. Since the recommended equipment for weight is a digital scale, the display provides easily readable numerical values. Rounding off is therefore less likely to occur for weights.

How to calculate

Digit preference in weight and length/height measurement should be investigated using histograms computed, without sample weights for *all* children measured and weighed in the entire sample, whether or not they are flagged as outliers on an anthropometry z-score.

– Histogram 1: binned by each terminal digit for weight (i.e. 10 bars from 0 to 9);
– Histogram 2: binned by each terminal digit for length/height (i.e. 10 bars from 0 to 9);
– Histogram 3: full range of weights in the dataset in whole numbers (i.e. approx. 25 bars from 0 to 25);
– Histogram 4: full range of lengths/heights in the dataset in whole numbers (i.e. approx. 90 bars from 35 to 125).

Terminal digit preference should also be calculated numerically, using the index of dissimilarity. computed, without sample weights for *all* children measured and weighed in the entire sample, whether or not they are flagged as outliers on an anthropometry z-score. See Annex 12 for the index of dissimilarity calculator for terminal digits. The index of dissimilarity is expressed by the following formula:

$$\text{Index of dissimilarity} = \frac{\sum_{i=1}^{10} \left| \text{actual percentage}_{is} - \text{expected percentage}_{ie} \right|}{2}$$

where

actual percentage$_{is}$= percentages for terminal digits in the survey (e.g. number of height measurements with a terminal digit of zero/all height measurements), and

expected percentage$_{ie}$ = expected distribution percentages (i.e. 10% for each terminal digit).

[5] Digit preference can only be assessed if length/height or weight values have not been rounded off at the data cleaning stage. For instance, in some DHS surveys, at the time of this publication, weight is recorded to the hundredth decimal place as either 0 or 5 and to the tenth place in the recode microdata (based on publicly available data).

How to present and interpret

Present the four histograms and examine them for unexpected distributions based on the overall sample as well as disaggregated by team. If an unexpected distribution is observed at the national level, histograms should also be examined by other disaggregation categories.

Histogram 1: Check to determine whether each of the 10 terminal digits for weight has an approximately 10% share of the entire sample as well as for each team or main measurer. If the proportion for any digit deviates much from 10% this suggests a terminal digit preference for weight.

Histogram 2: Check to determine whether each of the 10 terminal digits for length/height has an approximately 10% share of the entire sample as well as for each team or main measurer. If the proportion for any digit deviates much from 10% this suggests a terminal digit preference for length/height.

Histogram 3: Check to determine whether there are visible peaks for any particular weights. A roughly uniform distribution is not expected for weights at whole integers, but extreme peaks should not be strikingly visible.

Histogram 4: Check to determine whether there are visible peaks for any heights/lengths. A roughly uniform distribution is not expected for heights at whole integers, but extreme peaks should not be strikingly visible.

These histograms can provide information about the reasons for digit preference. For instance, in Figure 6, which presents terminal digit patterns, the digit preference for 0 and 5 suggests numbers have been rounded off; the preference for 3 and 7 in the adjoining histogram is more probably the result of fictitious data. Any noticeable peaks in whole number distributions (e.g. noticeable peaks at 70, 80 and 90 cm) would be indicative of severe problems with equipment or fictitious data. These are merely illustrative examples and scrutiny of actual survey data may bring to light more or less extreme cases. Prominent peaks on whole numbers give rise to inaccurate prevalence estimates since children in the peak value range are likely to have heights and/or weights which deviate substantially from their true values.

Figure 6. Different possible patterns of terminal digit distribution (Histograms 1 and 2)

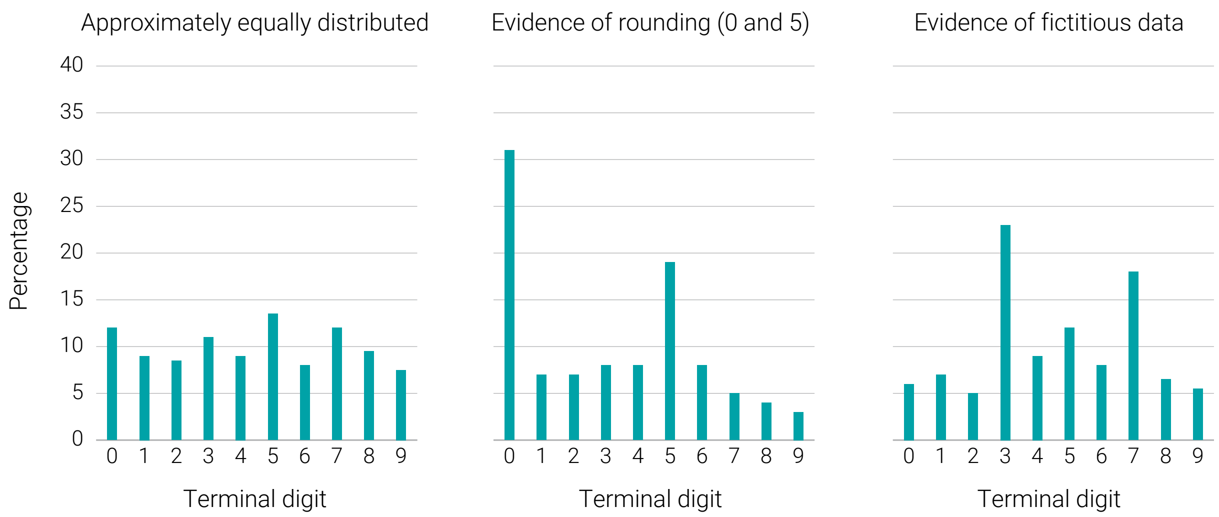


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Figure 7. Different possible patterns of whole number distribution of heights/lengths (Histogram 3)

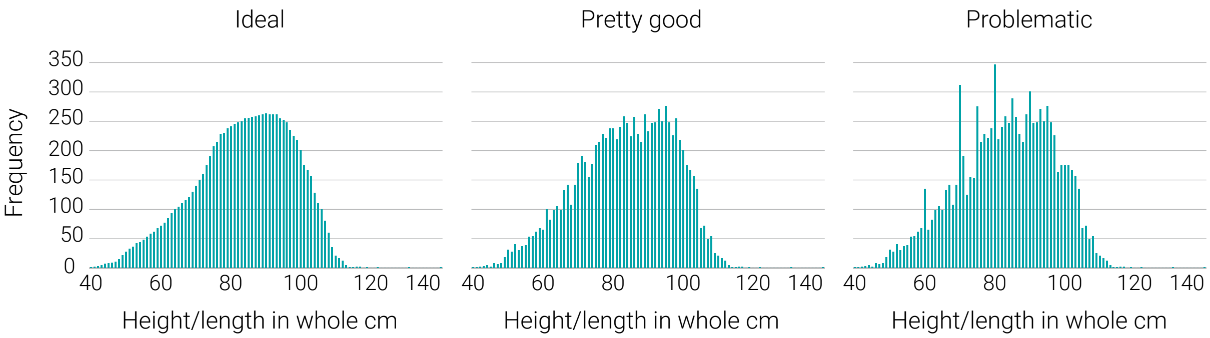

Figure 8. Different possible patterns of whole number distribution of weights (Histogram 4)

It is recommended that the index of dissimilarity for terminal digits of weight and length/height be summarized for the entire sample as well as for individual teams. If an unexpected distribution is present at the national level, histograms should also be examined by other disaggregation categories. Index of dissimilarity outputs for terminal digits of height and weight range from 0 to 90 and represent the percentage of observations that would need to shift from overreported to underreported digits in order to achieve a uniform distribution. The ideal value of the index is 0 (0% needs to be redistributed) and the maximum score is 90 (all terminal digits are heaped on one value and 90% of all terminal digits in the dataset would need to be redistributed to achieve a uniform distribution).

A digit preference for terminal digits of weight will result in greater inaccuracies when estimating prevalence for WAZ and WHZ than a digit preference for terminal digits of length/height would have on HAZ or WHZ. Nevertheless, every digit preference is a data quality indicator and should be noted in the report.

3.1.5 Implausible z-score values

What

Implausible values are z-score values that fall outside a specified range. The currently recommended flagging system to detect implausible z-score values was defined in 2006 on the release of the WHO Child Growth Standards, replacing the NCHS/WHO reference for child growth[6] (see discussion on flagging in section 3.2 on Data analysis). System cut-offs were defined on the basis of what is biologically implausible, in other words incompatible with life. These flagging cut-offs have been challenged based on observations of living children whose z-scores are beyond currently defined implausible values *(16)*, although true z-score values beyond the implausible value cut-offs recommended by the WHO rarely occur in any population. Nonetheless, this is a topic for future research.

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[6] The WHO macro excludes children if their length is outside of the ranges of 45 to 110 cm or if their height is outside of the ranges of 65 to 120 cm when calculating weight-for-height z-scores. This exclusion is done prior to flagging values outside of the plausible weight-for-height z-score ranges. Thus, when calculating the percentage of implausible weight-for-height the out-of-range length/height values need to be identified (not using the WHO macro) and added into the numerator and denominator." WHO Anthro Manual, https://www.who.int/childgrowth/software/anthro_pc_manual_v322.pdf?ua=1

Why

The percentage of implausible z-score values derived from the WHO Child Growth Standards is an important indication of data quality. Values outside the plausible range are usually due to poor measurement, inaccurate date of birth or data recording errors. As WHO flagging ranges are quite broad, they likely do not detect all values due to measurement errors because they fall within the plausible range.

How to calculate

The percentage of implausible z-score values should be calculated using unweighted sample weights for *all* children measured in the entire sample. For the currently recommended fixed exclusions approach, z-score values outside the following intervals are considered implausible: HAZ (-6, +6), WHZ (-5, +5), WAZ (-6, +5). These values should be flagged independently for each type of anthropometry z-score (HAZ, WAZ, WHZ), which means that some children may be flagged for one anthropometry z-score but not another. Statistical packages and software are available which calculate anthropometry z-scores and flag cases outside the predefined intervals for each anthropometry z-score[7] *(17)*.

$$\text{Percentage implausible HAZ} = \frac{\text{number children with HAZ} < -6 \text{ or } > 6}{\text{Total number children with height and DOB}}$$

$$\text{Percentage implausible WHZ} = \frac{\text{number children with WHZ} < -5 \text{ or } > 5}{\text{Total number children with height and weight}}$$

$$\text{Percentage implausible WAZ} = \frac{\text{number children with WAZ} < -6 \text{ or } > 5}{\text{Total number children with weight and DOB}}$$

Note: DOB=date of birth, requiring at least the month and year of birth

How to present and interpret

Present the percentage of implausible values for each index separately, HAZ, WHZ and WAZ, for national sample as well as for each team. A percentage of implausible values exceeding 1% is indicative of poor data quality *(18)*. This data quality threshold of 1% was based on the NCHS/WHO reference for child growth ranges for implausible values in use at that time as well as the deliberations of the WHO Expert Committee in 1995. The same threshold is expected to hold when based on the WHO Child Growth Standards ranges for implausible values, as the latter were developed to match the implications of the previously recommended. Examine the percentage of implausible values by other disaggregation categories if the percentage of implausible values is greater than 1%. While a high percentage of flagged values reliably indicates poor data quality, a low percentage does not necessarily imply adequate data quality since values that are inaccurate may still occur within the WHO flag range.

3.1.6 Standard deviation of z-scores

What

The standard deviation (SD) is a statistical measure that quantifies the amount of variability in a dataset. The smaller the SD, the closer the data points tend towards the mean. The higher the SD, the greater the spread of data points. Standard deviation cannot be negative; the lowest possible value for SD is zero, which would indicate that all data points are equal to the mean or that only one value exists in the entire dataset, e.g. if every child were to have exactly the same WHZ value.

The reference sample for the 2006 WHO Child Growth Standards displays, by definition, a standard normal distribution with zero mean and SD of 1 for each of the anthropometric indices including WAZ, WHZ and HAZ. The WHO Child

[7] The WHO macro excludes children if their length is outside of the ranges of 45 to 110 cm or if their height is outside of the ranges of 65 to 120 cm when calculating weight-for-height z-scores. This exclusion is done prior to flagging values outside of the plausible weight-for-height z-score ranges. Thus, when calculating the percentage of implausible weight-for-height the out-of-range length/height values need to be identified (not using the WHO macro) and added into the numerator and denominator.

Growth Standards are based on a sample of healthy children from six different countries on five different continents (Brazil, Ghana, India, Norway, Oman and the United States) with varying ethnic groups living in an environment that did not constrain optimal growth. The sample was purposively selected to be homogeneous with respect to variables that can affect optimal growth, e.g. economic status of the family, mother's smoking behaviour, term delivery, feeding practices and absence of significant morbidity

Less is known about expected SD in disadvantaged populations or those living in environments that do not support optimal growth. The 1995 WHO Technical Report on Anthropometry recommended using SD as a data quality criterion: it was stated that studies with a SD outside the following ranges would require closer examination for possible problems related to age assessment and anthropometric measurements: 1.1 to 1.3 for HAZ, 1.0 to 1.2 for WAZ and 0.85 to 1.1 for WHZ. These cut-offs for determining data quality need to be revised however, for various reasons:

- they were developed using a set of surveys not all of which were nationally representative and included several rapid nutrition surveys conducted in emergency situations, where the populations concerned were probably more homogeneous with respect to nutrition status and its determinants;
- they were based on the distribution of z-scores calculated using the NCHS/WHO reference for child growth which was replaced in 2006 with the WHO Child Growth Standards in use today; and
- the flagging system applied to exclude extreme values was more conservative (i.e., the ranges for exclusion were narrower) than the currently recommended flagging system (see Table 5), which would have resulted in narrower SD ranges.

TABLE 5. EXCLUSION CRITERIA PREVIOUSLY AND CURRENTLY USED FOR DIFFERENT APPLICATIONS[8]

Purpose of ranges	Previously used for exclusion when generating SD ranges for data quality assessment but not recommended for any purpose at present		Previously used for exclusion before calculating prevalence estimates but not recommended for any purpose at present	Currently recommended for exclusion before calculating prevalence estimates and for generating SDs for data quality assessment
Reference	Technical Report Series 854, 1995 *(18)*		NCHS/WHO reference *(19) (20)*	WHO Child Growth Standards *(17)*
Flag type	Fixed	Flexible*	Fixed	Fixed
HAZ	<-5 or >3	<-4 or >4	<-6 or >6	<-6 or >6
WHZ	<-4 or >5	<-4 or >4	<-4 or >6	<-6 or >5
WAZ	<-5 or >5	<-4 or >4	<-6 or >6	<-5 or >5

*around the observed survey mean

The Joint Malnutrition Estimates (JME) country dataset[9] lists, as of January 2019, estimates after re-analysis for 474 nationally representative household surveys from 112 countries. Standard deviations were estimated for HAZ, WHZ and WAZ for these 474 surveys after applying the exclusions discussed under "how to calculate" below. It contains surveys with a wide range of SD values for HAZ, WAZ and WHZ. Their median (and 5^{th} and 95^{th} percentiles) were 1.54 (1.21 and 2.03) for HAZ, 1.27 (1.04 and 1.72) for WHZ and 1.22 (1.06 and 1.52) for WAZ. The wide range of SDs derived from these surveys may be due to a combination of varying degrees of data quality and heterogeneity in the survey populations with regard to nutrition status and its determinants. Nevertheless, the 95^{th} percentiles from the

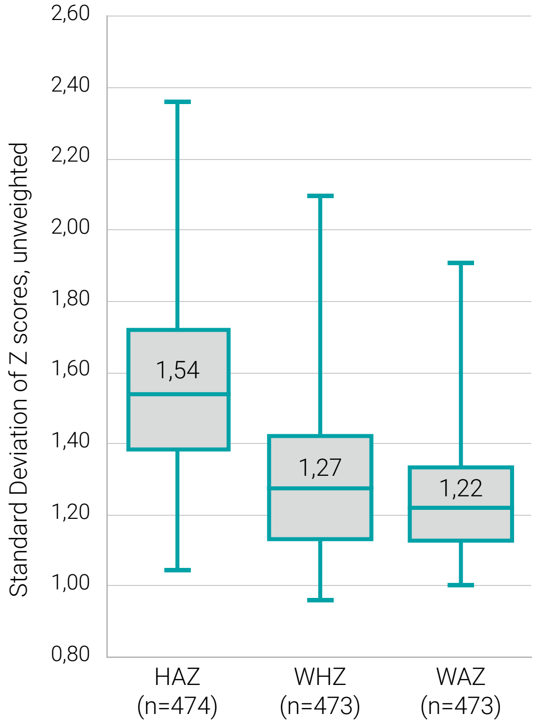
[8] Even though the cut-offs are different in the last two columns, differences are small in terms of actual kg or cm values in the two international references (WHO Child Growth Standards and NCHS/WHO reference). This is because the WHO flags for exclusion criteria were identified to maintain inferences similar to those already in use with the NCHS/WHO reference.

[9] https://data.unicef.org/topic/nutrition/malnutrition/; http://www.who.int/nutgrowthdb/estimates/en/

re-analysed surveys in the global database reflect very large SD values for both HAZ and WHZ; some of the SDs in the dataset are larger than would be reasonably explained by population heterogeneity and are thus more likely to reflect poor data quality. It can be confidently stated that as SDs for anthropometric indices become larger, they can more reasonably be attributed to poor data quality rather than population heterogeneity. Although data quality assessment based on z-score SDs is therefore fully justified, further research is required to develop recommended SD ranges for acceptable HAZ, WHZ and WAZ.

3

Figure 9. Box plots of Z scores for 474 nationally representative surveys included in the Joint Malnutrition Estimates database



Note: Middle line and value label represent the medians, edges of box represent first and third quartiles and whiskers represent minimum and manximum SD values by z score in the JME country dataset.

Why

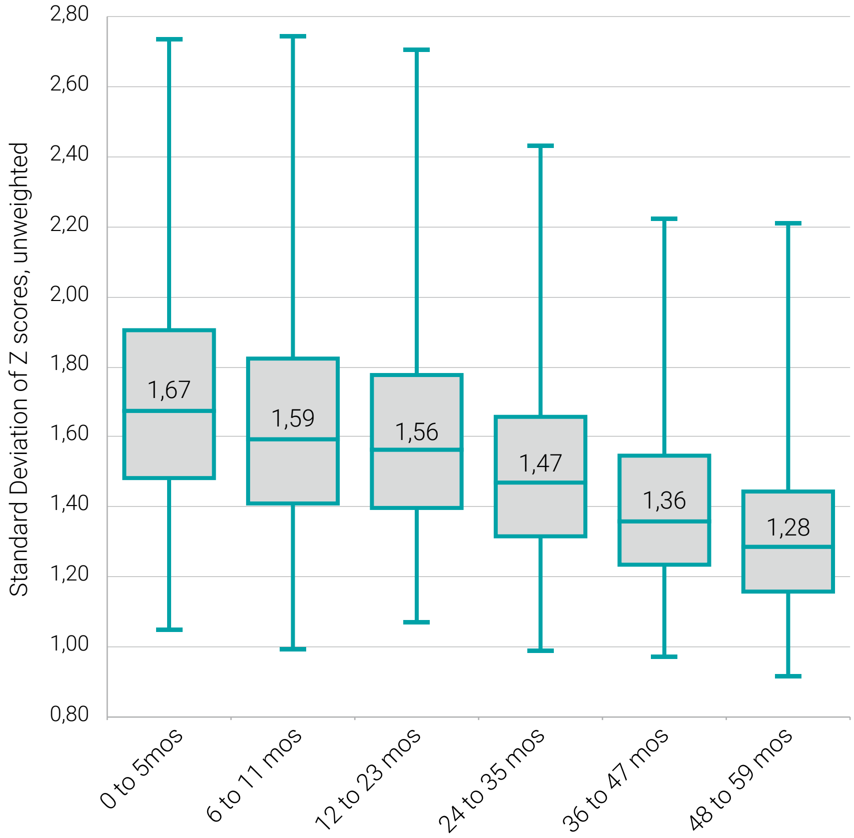
Reporting on and identifying the causes of large SDs are important tasks in data quality assessment. Prevalence estimates of stunting, wasting and overweight are dichotomous variables which measure the percentage of children with z-score values beyond a specified cut-off (e.g. <-2 SD for wasting or stunting, >+2 SD for overweight). If the SD is artificially inflated as a result of poor quality data, prevalence estimates are therefore likely to be overestimated. The relative overestimation of prevalence will be even greater for estimates of severe categories of malnutrition (e.g. <-3 and >+3).

The higher the SD, the greater the likelihood that poor data quality is contributing to the wide SDs observed. Quantifying in definitive terms how much of the dispersion in z-scores can be attributed to heterogeneity in relation to environments prejudicial to optimal growth and how much to measurement error is a challenging research question. The following statements can be made about SDs for HAZ, WAZ and WHZ:

– The 1995 WHO Technical Report on Anthropometry suggested a set of SD ranges, beyond which data quality was of possible concern: these cut-offs need to be revised however, so that they reflect nationally representative surveys among populations with varying degrees of malnutrition and the currently used WHO Child Growth Standards. SDs are typically larger for HAZ than they are for WAZ or WHZ. Some of this difference in SDs is probably due to measurement error since height is more difficult to measure reliably than weight with currently available equipment; obtaining a reliable date of birth problematic in populations with substandard vital registration systems. Furthermore, the dispersion of z-scores which represent linear growth is likely to differ from that of z-scores which represent acute malnutrition, especially in malnourished populations. Also, length- or height-for-age z-scores can present wider degrees of dispersion in malnourished than in well-nourished populations because deficits in length or height are cumulative; varying levels of substantial malnutrition in a country may be reflected in wider SDs for z-scores where data represent cumulative (i.e. HAZ) rather than non-cumulative deficits (i.e. WHZ);

– SDs for HAZ tend to decrease from youngest to the oldest group of children, as indicated in Figure 10 below, based on 571 surveys for which stratification by age is available and are included in the Joint Child Malnutrition Estimates database. Some of this SD spread is due to measurement error since length is more difficult to measure than height. It may, on the other hand, be easier to determine the date of birth in younger infants born just a few months before a survey, resulting in tighter SDs in this age group. However, smaller errors in age can impact z-scores for younger children more than for older children where there is the same degree of error (i.e. 15 days' inaccuracy in age for a 1-month-old child would generally result in a different HAZ whereas 15 days' inaccuracy in age for a 4-year-old would generally yield a similar HAZ). Furthermore, the WHO Child Growth Standards SDs for HAZ steadily increase with month of age from birth reflecting the divergent growth trajectories of full-term, well-nourished children when growth is viewed cross-sectionally at specific ages. In other samples of children that include pre-term births, the SDs may be larger at and just after birth.

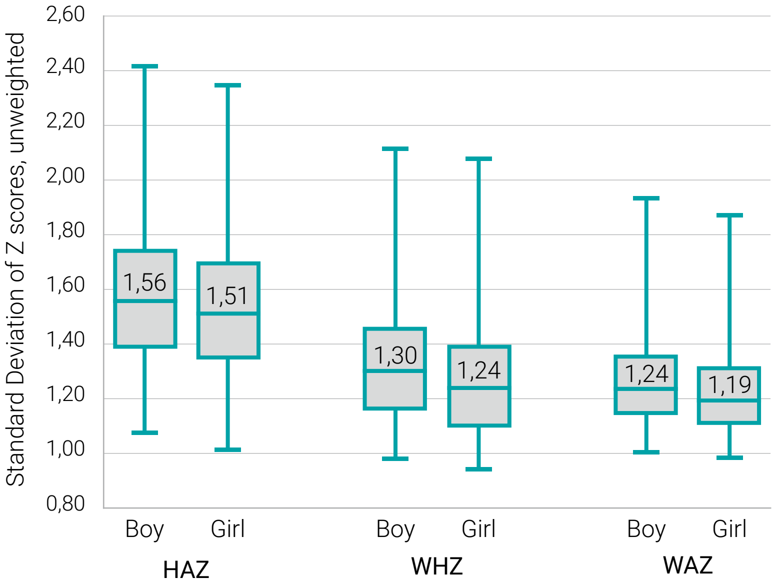
Figure 10. SD for HAZ by age groups in 422 surveys included in the Joint Malnutrition Estimates database



Note: Middle line and value label represent the medians, edges of box represent first and third quartiles and whiskers represent minimum and manximum HAZ SD values by age group for surveys with SD estimates for each age group in the JME country dataset.

There is no expected substantial difference in SDs when comparing boys and girls, apart from slightly higher for boys which may be due to their higher rate of preterm births. Figure 11 shows these expected patterns between sexes based on 513 surveys for which stratification by sex is available and are included in the Joint Child Malnutrition Estimates database.

Figure 11. SD for HAZ, WFH and WFA by sex in 473 surveys included in the Joint Malnutrition Estimates database



Note: Middle line and value label represent the medians, edges of box represent first and third quartiles and whiskers represent minimum and manximum z score SD values by sex for surveys with SD estimates for boys and girls in the JME country dataset.

How to calculate

SD should be calculated using unweighted sample weights for *all* children measured and weighed in the entire sample and after WHO fixed flags (see section 3.2 on Data analysis for WHO fixed flag values) have been removed from the dataset. The formula is:

$$SD = \sqrt{\frac{\sum_{i=1}^{n}(Y_i - Y)^2}{n-1}}$$

where n=total number of data points, Y = mean of Y_i and Y_i = each value in the dataset.

How to present and interpret

It is recommended that the SD for each indicator (HAZ, WHZ, and WAZ) be presented separately, at the national level, and for teams and other disaggregation categories. Strata specific SDs that are greater than the SD for the national estimate, as well as large differences between groups where they would not be expected (e.g. large differences in SDs between girls and boys or large fluctuations between neighbouring age groups) should be examined and explained in the survey report.

Further investigations are needed to develop guidance on how to tease out the relative contribution of measurement error from expected population-associated spread in any given survey, and to establish cut-offs at which SDs for each anthropometric index might be more conclusively related to poor data quality.

3.1.7 Normality (skewness and kurtosis) of z-scores

What

Distribution of HAZ, WAZ and WHZ is a description of the relative number of times each z-score occurs in the survey population. A standard normal distribution is a symmetrical bell-shaped curve with a mean of zero and standard deviation of 1. Patterns of deviation from normal distribution include asymmetric, peaked or flat distribution curves. Skewness is a measure of asymmetry: a normal distribution curve which is perfectly symmetrical will have a skewness value of zero with equal distribution on both right and left halves. When the skewness coefficient is positive, distribution is skewed to the right: this indicates that there are more cases on the right side of the distribution curve than on the left, usually an indication of extreme values in the right side or tail of the distribution curve. In turn, when the skewness coefficient is negative, the distribution curve is skewed to the left (see Figure 12). Like skewness, kurtosis is a description of deviation from the normal shape of a probability distribution (see Figure 13). Kurtosis is a measure of tailedness which also describes the sharpness or flatness of the frequency distribution peak: a kurtosis coefficient of 3 represents a population following normal distribution. When the kurtosis value is greater than 3, the curve is flat and peakedness reduced: this indicates that there are many extreme values in the tails than the expected normal distribution. Conversely, when kurtosis is less than 3, the peak is high, and tails are therefore relatively short.

Figure 12. Different possible patterns of skewness

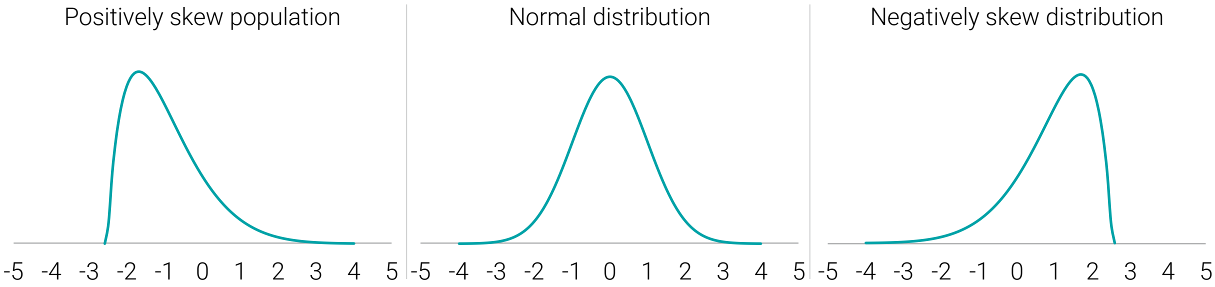
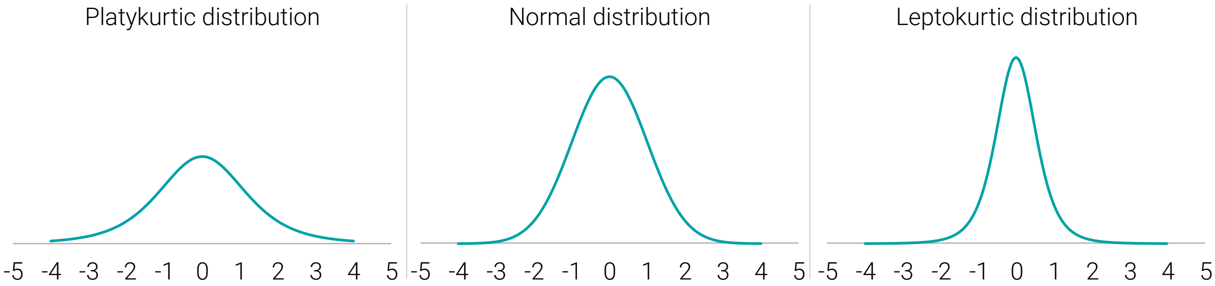


Figure 13. Different possible patterns of kurtosis



Why

Understanding the shape of the frequency distribution can provide insights into the survey population and data quality. The WHO Child Growth Standards based on a sample of healthy children living in environment that did not constrain growth showed normal distribution for each of the anthropometry z-scores. It is sometimes assumed that survey populations will have a normal distribution and that distribution will shift depending on the degree of malnutrition affecting the population. However, probability distributions among malnourished populations can deviate from normal distribution especially when there are many inequities or severe forms of malnutrition are prevalent (e.g. severe stunting is high, or overweight is a significant problem in specific subpopulations) without necessarily indicating data quality issues.

Conclusions about data quality cannot be drawn solely on the grounds of skewness or kurtosis values. On the other hand, deviations from the normal, when combined with other issues identified by data quality checks, should raise concern. Further research is required to understand distribution patterns in populations with different forms of malnutrition and also how skewness and kurtosis values suggesting departure from normality might indicate problems with data quality.

How to calculate

The shape of the distribution curves for HAZ, WHZ and WAZ can be visualized using kernel density plots. These plots should be developed based on the entire sample of children that were measured and weighed, without sample weights, and after flagged z-scores (see section 3.2 on Data analysis for WHO fixed flag values) have been removed from the dataset.

– Kernel density plot 1: HAZ;
– Kernel density plot 2: WHZ;
– Kernel density plot 3: WAZ.

Checks for normality of z-score distributions help to assess departures from a normal distribution, based on measures of skewness and kurtosis. Skewness and kurtosis coefficients should also be calculated for HAZ, WAZ and WHZ without sample weights after flagged z-scores have been removed.

There are various formulas for determining skewness and kurtosis coefficients: those proposed below are based on the Fisher-Pearson coefficient, although others may be applied.

Formula to assess skewness using the Fisher-Pearson coefficient:

$$\frac{\sum_{i=1}^{n}(Y_i - \overline{Y})^3/n}{s^3}$$

Formula to assess kurtosis using the Fisher-Pearson coefficient:

$$\frac{\sum_{i=1}^{n}(Y_i - \overline{Y})^4/n}{s^4}$$

where

$\overline{Y}$ = mean, s = standard deviation (calculated with n in the denominator rather than n-1) and n = sample size.

How to present and interpret

Present the distribution curve graphics for the national sample as well as by team and examine them for unexpected distribution patterns. Deviations from the normal for HAZ, WHZ or WAZ are difficult to interpret, as it may genuinely represent malnourished populations with high levels of inequity and/or severe forms of malnutrition, as well as be due to poor data quality, or a combination of these. Further research needs to be carried out before practical guidance on interpreting the shape of the distribution curve in any given survey can be provided. Nevertheless, comparisons of distributions between groups can provide hints that can help interpretation.

Kernel density plots 1, 2 and 3: Check to see if the tails of the HAZ, WHZ, and WAZ distribution curve end smoothly rather than abruptly. If distribution ends abruptly, it may be indicative of data quality issues.

It is recommended that skewness and kurtosis coefficients for HAZ, WHZ and WAZ be summarized for the entire survey sample[10]. While there is no defined cut-off, it is an accepted rule of thumb that a coefficient of <-0.5 or >+0.5 indicates skewness. Similarly, while there is no defined cut-off, in general a coefficient of <2 or >4 indicates kurtosis. Moreover, since the kurtosis coefficient for standard normal distribution is 3, some formulas and most statistical software subtract 3 from the value obtained using the formula above to obtain a kurtosis value of 0 for standard normal distribution: these formulas therefore represent "excess kurtosis". When these formulas are used, a kurtosis coefficient of <-1 or >1 indicates kurtosis. Should skewness or kurtosis coefficients fall outside these ranges, the coefficients should be examined by other disaggregation categories.

3.2. DATA ANALYSIS – THE STANDARD ANALYSIS APPROACH

The previous chapters and section described steps to enhance data quality during fieldwork and assess data quality. The present section sets out various considerations to bear in mind when conducting an analysis of anthropometric measurements, from early preparation of the dataset to actual calculation of the prevalence estimates.

[10] A small adjustment to produce an unbiased estimate with respect to sample size is automatically included in standard software packages.

The calculation of child malnutrition prevalence involves two stages: comparing the anthropometric measurements of sampled children against reference data (z-score calculation) and then calculating the proportion of children whose z-scores are below or above the specified cut-offs for each of the nutrition indicators in question (e.g. prevalence estimates for stunting or wasting).

For these analyses, the recommended standard approach below adopts as its reference data the WHO Child Growth Standards (see Note 8) and can be performed using standard software such as the WHO Anthro Survey Analyser. Macros for the main statistical programs (complete procedures available in Stata, R, SAS and SPSS) are also available to analyse data based on the reference data for children's z-scores and survey sampling design for prevalence estimates[11]. Other tools such as the MICS6 and DHS7 syntax/programs which adhere closely to the recommended standard approach are available[12]. Epi Info/ENA software can also be adapted to the standard approach if selecting the WHO flag system.

3.2.1 Why a "standard analysis" approach?

Data analysis is an important step and it deserves proper attention to ensure that country-specific results are accurate and comparable between countries or over time. Using different methods when preparing the data analysis file (e.g. imputing a missing date of birth, selecting children in the household for inclusion in the analysis) and applying different reference data to calculate individual z-scores or different exclusion criteria for implausible values may generate inconsistencies between estimates made at a different point in time. Such methodological differences are commonly observed even when surveys are carried out very close together in time, sometimes during overlapping time periods, consequently making it difficult to monitor country trends.

Since the launch of the WHO Child Growth Standards in 2006 (see Note 8), WHO, key partners and data collection programs (e.g. national nutrition surveys, DHS, MICS, SMART and others) have collaborated in an attempt to standardize analyses of anthropometric data emerging from national surveys or other non-emergency settings as fully as possible.

Based on these collaboration efforts, WHO and key partners have developed software and macros for survey analysis based on a standard approach[13, 14], which is referred to hereafter as the "standard analysis". The main steps of this standard analysis are shown in Table 6. Most surveys have a complex sampling design (e.g. two-level sampling) since use of the appropriate methodology enhances estimates of accuracy around prevalence and mean z-score. This is a significant improvement in data reporting and is a precondition for adhering to the Guidelines for Accurate and Transparent Health Estimates Reporting[15], which aim to define and promote best practices in reporting health estimates. Recently, WHO and UNICEF have updated the R and Stata macros to include methodology that takes into account complex survey sampling design, and syntax files from programs such as MICS and DHS have also adopted this approach.

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11 Macros available at http://www.who.int/childgrowth/software. UNICEF Stata Macro available upon request via email to data@unicef.org. Note SAS and SPSS macros do not calculate confidence intervals for estimates to take into account complex sample designs; update under development at time of publication.

12 For MICS access SPSS syntax files online at: http://mics.unicef.org/tools#analysis. For DHS a request can be sent for syntax files

13 WHO Anthro Survey Analyser available at https://whonutrition.shinyapps.io/anthro.

14 Macros available at http://www.who.int/childgrowth/software. UNICEF Stata Macro available upon request via email to data@unicef.org. Note SAS and SPSS macros do not calculate confidence intervals for estimates to take into account complex sample designs; update under development at time of publication.

15 Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER), http://gather-statement.org/

3

NOTE 8: THE WHO GROWTH STANDARDS 2006

In 2006, WHO published its Child Growth Standards for children from birth to 5 years *(21)*. They were constructed based on data from the WHO Multicentre Growth Reference Study (MGRS), which established the full-term breastfed infant with absence of significant morbidity born from a non-smoking mother e as the normative growth model *(21)*. The wealth of data collected made it possible to replace the international NCHS/WHO reference for attained growth (weight-for-age, length/height-for-age, and weight-for-length/height) and develop new standards for body mass index (BMI)-for-age, head circumference-for-age, arm circumference-for-age, triceps skinfold-for-age and subscapular skinfold-for-age. Detailed descriptions of how the MGRS was conducted and WHO Child Growth Standards were constructed are available elsewhere *(21) (22)*. The standards are sex-specific, in the recognition that boys and girls have different growth patterns.

WHO Child Growth Standards were devised for children from birth to 60 completed months of age. For each anthropometric index, available standards cover the following ranges:

– weight-for-length: length from 45 to 110 cm;

– weight-for-height: height from 65 to 120 cm;

– weight-for-age: age from 0 to 60 completed months;

– length/height-for-age: age from 0 to 60 completed months;

– BMI-for-age: age from 0 to 60 completed months;

– arm circumference-for-age: age from 0 to 60 completed months.

WHA Resolution 63.23 recommended the implementation of WHO standards *(23)*. Adherence to WHO Child Growth Standards ought to ensure optimal levels of health globally. At the time of publication, standards had been adopted by more than 160 countries and provide a tool for identifying countries where child malnutrition is a significant burden.

TABLE 6. SUGGESTED COMPONENTS AND KEY CONSIDERATIONS FOR STANDARDIZING THE ANALYSIS OF ANTHROPOMETRIC DATA

COMPONENT	KEY CONSIDERATIONS
1. Reference data for z-score calculation	• Use the WHO Child Growth Standards for child malnutrition monitoring.
2. Missing data	• Any recode of missing values (depending on the software or code used for the analysis, e.g. 9998, 9999, 99 recode to blank cells) or imputation should be made by creating a new variable. The original variables should always be retained since their presence in the file guarantees data reproducibility and transparency; • It is important that all records, including those with missing measurements or sampling weights, are available for analysis, since they are important for data quality assessment (e.g. non-response); • Imputation of missing day of birth: if only the month and year of birth are provided, it is recommended that the missing information for the day of birth be imputed. This can be done in different ways but using the 15^{th} of the month for all missing days of birth is recommended in standard analysis. The approach used for imputing the date of birth and the number or proportion of cases falling on the imputed day should be mentioned in the report for reasons of data quality assessment. • If the month or year of birth is missing, then the date of birth and consequently the child's age should be considered as missing. In such cases, indicators related to age as stunting or underweight will not be calculated, while indicators not age-related as wasting will be calculated; • Some surveys use a code number for missing values such as 9999, 9998, 98, etc. Such numbers should always be treated as missing data and not as extreme values, since it is important to differentiate between implausible z-score values and missing measurements when assessing data quality.
3. Age calculation	• Age should be calculated based on the date of visit and date of birth and both variables kept in the analysis file; • If exact date of birth is unknown, the month and year of birth should be estimated using a local events calendar. In such cases, age should be calculated after imputing the day of birth as the 15^{th} of the month.
4. Oedema (Although assessment of oedema is not recommended for systematic inclusion in all surveys except in settings where collecting this information is appropriate)	• Oedema measurement is only appropriate in surveys where local experts, specifically clinicians or individuals from the Ministry of Health working at a local level, can clearly indicate if they have seen recent cases where nutritional oedema was present (see Note 1 in Section 1.1 in Chapter 1 for more details); • If information on oedema is collected following the above recommendation, it should be included in each child's dataset and used in the analysis. In this event: – all children, even those with oedema, should be weighed to reduce the likelihood of biased decisions in the field; – children with oedema should automatically be classified with "severe acute malnutrition" (<-3 SD for weight-related indexes) when calculating prevalence estimates; – weight-related indices z-scores will not be calculated for children with oedema (i.e. set to missing); – the number of cases of oedema should be included in the survey report; – prevalence levels based on analyses both including and excluding oedema-related data should be included in the survey report.

COMPONENT	KEY CONSIDERATIONS
5. Conversion of recumbent length to standing height or vice versa	Recumbent length or standing height • Verify that the child's measurement position (standing height or recumbent, i.e. supine or lying length) was recorded in the questionnaire during measurement to allow for age-linked adjustments in length/height depending on whether they were lying or standing; • Based on the recorded measurement position, software performing the standard analysis will need to make automatic adjustments when calculating z-scores, adding 0.7 cm if the standing height was measured for children aged < 24 months and subtracting 0.7 cm if the recumbent (lying) length was measured for children aged ≥ 24 months; • If data on the measurement position are missing, recumbent length is assumed to have been adopted for children aged <731 days (<24 months) and standing height for those with aged ³ 731 days (³ 24 months); • For children under 9 months of age, data which suggests that the infant was "standing" rather than the expected "lying" should be disregarded in the analysis, i.e. set to missing, since this is deemed to be an error. This is done to avoid the wrong automatic adjustment in such cases (adding 0.7 cm), which would result in an overestimation of wasting and underestimation of stunting.
6. Handling re-measurement data	• Re-measurements (height, weight, date of birth, and sex) of children randomly selected or flagged should be retained in the datafile (see section 2.4, where this operation is described). Use height, weight, date of birth and sex from the first measurement for children randomly selected for re-measurement when calculating z-scores. Use height, weight, date of birth and sex from the second measurement for children flagged for re-measurement when calculating z-scores.
7. Exclusion of flagged z-scores (WHO flag system)	• The recommended flags for z-score values follow the WHO flag system[16] (see section 3.2.1 below for a discussion of flagging systems): – height-for-age: < -6 or > +6; – weight-for-length/height: < -5 or > +5; – weight-for-age: < -6 or > +5; – body mass index-for-age: < -5 or > +5. • The number and percentage of values excluded should be reported; • Exclusions should be made based on the indicator (rather than child), e.g. measurements for a child with a HAZ of -6.5 and a WHZ of -4.5 would be included in an analysis of wasting (WHZ) but not of stunting (HAZ); • All measurements should be retained in the dataset for transparency; • Flagged z-scores are excluded before calculating prevalence estimates and other z-score summary statistics.

[16] WHO Anthro 2005 for personal computers manual. page 41: http://www.who.int/childgrowth/software/WHOAnthro2005_PC_Manual.pdf

COMPONENT	KEY CONSIDERATIONS
8. Sampling design	Strata and cluster/PSU • The purpose of stratification is to ensure that the sample is representative of the population of interest and divides the population into groups (typically geographic groups) before sampling. Stratification in the sampling design helps to reduce sampling errors when introduced at the initial stage of sampling (its effect on the sampling error is minor when introduced at the second or later stages); • Strata should not be confused with survey domains, i.e. a population subgroup for which separate survey estimates are desirable (e.g. urban/rural areas, see bullet point 9 below)[17]. Both categories may be the same, but do not need to be. A cluster/PSU is a group of neighbouring households which usually serves as the Primary Sampling Unit (PSU) for efficient field work; • Each child/household should be assigned to a cluster/PSU and strata and analyses should take that information into account in order to boost the stability of estimated variance. Sampling weights • A sampling statistician should create the weights; • A sampling weight must be assigned to each individual in the sample to compensate for unequal probabilities of case selection in a sample, usually owing to the design. In a self-weighted sample, the weight is the same for each child (usually equals to 1 for simplicity); • To derive anthropometric indicator estimates, appropriate sampling weights should be applied in each survey while taking into consideration sample stratification. This is done to make sure that the sample population is fully representative; • Sampling weights can also be adjusted for non-responses; • All individuals not assigned a sampling weight should be excluded from analyses for generating malnutrition estimates but remain in the dataset for reporting purposes.
9. Stratified analysis for population sub-groups (when available)	• The most common population disaggregation categories are age (different age groups), sex (male or female), type of residence (urban or rural) and sub-national geographic areas (e.g. region, district). For age groups, standard analysis relies on the exact age in days (where available) to define age groups in months (e.g. <6, 6 to <12, 12 to <24, 24 to < 36, 36 to <48 and 48 to <60). One month equals 30.4375 days;. • Monitoring equity is of increasing importance for health and development. Disaggregated analysis is also recommended in order to derive estimates by wealth quintiles (1=lowest, 2, 3, 4, 5=highest) and mother's education (no education, primary school and secondary school or higher), whenever this is possible.

3.2.2 Exclusion of extreme values before calculating malnutrition estimates

it is recommended that extreme values be excluded from estimations of mean z-scores and malnutrition prevalence since exclusion makes it more likely that true population estimates will be accurately represented.

Before the WHO Child Growth Standards were developed, in 1995 the WHO Expert Committee provided two exclusion approaches *(18)*.

– **Fixed exclusions**

Fixed exclusions are centred on a reference mean z-score**.** Fixed exclusion values in 1995 were based on the NCHS/WHO reference for child growth but now refer to WHO Child Growth Standards. Fixed exclusions were intended to remove biologically implausible observations;

[17] DHS Sampling manual, page 4: https://dhsprogram.com/pubs/pdf/DHSM4/DHS6_Sampling_Manual_Sept2012_DHSM4.pdf.

- **Flexible exclusions**

  Exclusion values are centred on the observed survey mean z-score. Flexible exclusions are based on statistical probability and premised on the statistical phenomenon that > 99.99% of values fall within ± 4 standard deviations of the mean in standard normal distribution.

A description of the fixed and flexible exclusion approaches recommended by the WHO Expert Committee in 1995 is provided in Table 7. Where there are few extreme values, e.g. in a population with very low prevalence for any form of malnutrition, the use of either fixed or flexible exclusion has very little or no impact on prevalence estimates. However, in surveys with a greater number of extreme values there can be significant differences in prevalence estimates depending on the exclusion approach adopted *(24)*.

Excluding extreme z-score values requires a balance to be found between the risk of two events: excluding a child with a genuinely very extreme z-score and including a mistake that has given rise to an improbably extreme z-score. Extreme z-scores values defined by fixed exclusions are almost certainly the result of measurement error, but in surveys with substantial measurement error, fixed exclusions may not capture a large portion of incorrect values. In this situation, fixed exclusions will probably lead to an overestimation of malnutrition prevalence in surveys. This can be problematic because even a 1–3 percentage point increase in the prevalence of severe wasting can have profound programmatic implications. By contrast, the prevalence of moderate categories of stunting and wasting (e.g. z-scores between -2 and -3) may be less affected by the exclusion criteria. A flexible exclusion approach that has been applied in some surveys is to use standard deviation units (by assuming a normal distribution with a standard deviation of 1) and a narrower exclusion range. This is likely to give rise to lower prevalence estimates, and while they may address concerns about measurement error they may also truncate true values representing extremely undernourished children (in the negative tail of the distribution curve) or children who are extremely obese or very tall (in the positive tail of the distribution curve). Further research is needed on the use of existing and potentially new flexible exclusion approaches, especially in situations where anthropometry measurements are of poor quality.

TABLE 7. CHARACTERISTICS OF FIXED AND FLEXIBLE EXCLUSION APPROACHES *(18)*

	FIXED	FLEXIBLE
Exclusions applied (range of z scores included and removed)	Apply the same exclusion ranges to all surveys (without taking into consideration the survey-specific population distribution).	Exclusion ranges shift depending on distribution within the survey population, i.e. a positive shift in the population will result in a positive shift in the exclusion ranges and vice versa.
Source of reference statistical distribution	Statistical distribution aligned with international growth standards.	Individual survey population statistical distribution is used to obtain the mean while assuming a standard normal distribution with SD of 1.

The use of fixed exclusions based on the WHO Child Growth Standards is currently recommended (Table 8). Fixed exclusions, conventionally used in national surveys, are accepted worldwide and allow comparability between surveys and countries. Software packages have been developed to flag z-score values automatically based on the recommended fixed exclusion values (HAZ (-6, +6), WHZ (-5, +5), WAZ (-6, +5)[18]. Exclusions should be applied by indicator (rather than child), e.g. measurements for a child with a HAZ of -6.5 and WHZ of -4.5 would be included in the analysis of wasting (WHZ) but not of stunting (HAZ). All measurements should be retained in the dataset for transparency, although z-scores which are considered extreme on the basis of the fixed exclusion approach do not contribute to prevalence estimates. The number and percentage of values excluded should be reported.

[18] WHO Anthro 2005 for personal computers manual. page 41: http://www.who.int/childgrowth/software/WHOAnthro2005_PC_Manual.pdf

TABLE 8. EXCLUSION CRITERIA PREVIOUSLY AND CURRENTLY USED[19]

Purpose of ranges	Previously used for exclusion before calculating prevalence estimates but **not recommended for any purpose at present**	**Currently recommended** for exclusion before calculating prevalence estimates and for generating SDs for data quality assessment
Reference	NCHS/WHO reference *(19)(20)*	WHO Child Growth Standards *(17)*
Flag type	Fixed	Fixed
HAZ	<-6 or >6	<-6 or >6
WHZ	<-4 or >6	<-6 or >5
WAZ	<-6 or >6	<-5 or >5

3.2.3 Reporting the results of analysis

Once standard analysis has been performed, it is recommended that reporting of its results include measures of precision around prevalence estimates, as well for z-score means. At the very least, the report should include the following parameters.

1. Height-for-age: weighted and unweighted sample sizes, % < -3 SD (95% CI), % < -2 SD (95% CI), z-score mean (95% CI), z-score SD;
2. Weight-for-age: weighted and unweighted sample sizes, % < -3 SD (95% CI), % < -2 SD (95% CI), z-score mean (95% CI), z-score SD;
3. Weight-for-height: weighted and unweighted sample sizes, % < -3 SD (95% CI), % < -2 SD (95% CI), % > +2 SD (95% CI), % > +3 SD (95% CI), z-score mean (95% CI), z-score SD.

It should be noted that deriving estimates of standard errors from confidence intervals of prevalence estimates may not be straightforward since they are often not symmetrical; ideally, standard errors should also be reported. Standard errors are useful for feeding into modelling exercises to account for data variance.

As an example of the standard analysis application, Table 9 sets out the requisite variables and procedures for treating input variables when calculating individual z-scores for each child and prevalence estimates with tool developed by WHO, the WHO Anthro Survey Analyser. More detailed comments on the methodology for deriving the various anthropometric z-scores are described elsewhere *(25)*.

[19] Even though the cut-offs are different in the two columns, differences are small in terms of actual kg or cm values in the two international references (WHO Child Growth Standards and NCHS/WHO reference). This is because the WHO flags for exclusion criteria were identified to maintain inferences similar to those already in use with the NCHS/WHO reference.

TABLE 9. ACCEPTED VALUES FOR VARIABLES AND METODOLOGICAL ASPECTS AROUND THEM WHEN APPLYING THE STANDARD ANALYSIS USING THE WHO ANTHRO SURVEY ANALYSER

VARIABLE	ACCEPTED VALUES	METHODOLOGICAL ASPECTS
Date of birth and date of visit	Accepted date formats: DD/MM/YYYY or MM/DD/YYYY	Both variables, date of birth and date of visit, should be provided to calculate age in days (date of visit minus date of birth). If DAY is missing for the date of birth, a new variable should be created by imputing the missing day by 15 (e.g. ??/05/2014 should be set as 15/05/2014) in the analysis file before importing the dataset. In turn, if the month or year is missing, the date value should be set to missing/blank (see analysis data file preparation in the tool WHO Anthro Analyser Quick Guide). When date of birth and date of visit are missing, the variable age (in days or months) can be used (see below). When month or year of birth and age are missing, results will only be computed for weight-for-height. Invalid date of birth or date of visit or a negative value resulting from date of visit minus (-) date of birth entails a missing age.
Age	Accepted values for variable age: • age in days (integer) or • age in months (float value with decimals) Indicator estimates (e.g. stunting)	It is recommended that age be calculated based on the date of visit and date of birth. Mapping of the variable age is available only when the user selects this option instead of the (default) recommended calculation based on date of visit and date of birth. This should be done only if the latter is not available. Age in months should be derived by dividing age in days by 30.4375 and not by rounding it off). Age in months should be provided with a precision of at least two decimal points for accurate estimation of age-related malnutrition.
Sex	Male (1, M or m) and Female (2, F or f)	If this variable (sex) is missing, z-scores will not be calculated for any index because the WHO Child Growth Standards are sex-specific.
Weight	Numerical, float value (in kilograms with one decimal point precision)	If missing, estimates for weight-related indices will not be calculated.
Length or height	Numerical, float value (in centimetres with at least one decimal point precision)	If missing, estimates for length- or height-related indices will not be calculated.

VARIABLE	ACCEPTED VALUES	METHODOLOGICAL ASPECTS
Standing (height) or recumbent (length) position	Usually: recumbent length (L or l) or standing height (H or h).	Depending on information provided about the measurement position, standard analysis software should make adjustments automatically when calculating z-scores, adding 0.7 cm if standing height is measured for children aged < 24 months, and subtracting 0.7 cm if recumbent (lying) length is measured for children aged ≥ 24 months. If this information is missing, the code will assume recumbent length for children aged < 731 days (< 24 months) and standing height for those aged ^{3} 731 days (^{3} 24 months). If this information is missing and the child's age is also missing, the code will assume that the measurement was recumbent length if the length/height value is below 87 cm (mean value from the Multicentre Growth Reference Study sample[20] in boys and girls, for height-for-age and length-for-age at 24 months) and otherwise assume that the measurement was standing height. For children under 9 months of age, where the information indicates that standing height was measured, the code will assume this was an error and register the case as missing. This is done to avoid the wrong automatic adjustment in such cases (adding 0.7 cm) which can lead to overestimation of wasting and underestimation of stunting.
Oedema (assessment not recommended systematically except for settings where collecting this information is appropriate)	Usually: No (2, N or n) or Yes (1, Y or y)	If not provided as a variable, all values will be assumed to be missing. Missing values are treated as no oedema and z-score calculation is not affected. Z-scores for all weight-related indices will be set to "missing" when oedema is present. The report includes the number of children with bilateral oedema. For prevalence calculation purposes, children with oedema are classified as having severe malnutrition (i.e. weight-for-length/height < -3 SD, weight-for-age < -3 SD and BMI-for-age < -3 SD). It is recommended that prevalence levels based on both analyses (including or excluding information on oedema) are included in the survey report. This should be performed by a separate analysis, one including the variable "oedema" and another excluding (or not mapping) it.
Sampling weight	Numeric, float value	If sampling weights are not provided, the sample will be assumed to be self-weighted, i.e. the sampling weight equals one (unweighted analyses will be carried out). If provided, all children with missing sampling weights will be excluded from the analysis.
Cluster	Numeric integer	If not provided, it will be assumed that all children belong to the same unique cluster/PSU. If provided, all children with missing cluster/PSU data will be excluded from the analysis.

[20] The cut-off point of 87 cm reflects the standards' median for boys and girls height-for-age z-score (HAZ) at 24 months. The WHO standards' median height is 87.1 cm for boys and 85.7 cm for girls, and median length is 87.8 cm for boys and 86.4 cm for girls. The mean of these four values is 86.75 cm which was rounded to 87 cm in order to obtain the cut-off point for shifting from length to height in case age and the type of measurement are unknown (https://www.who.int/childgrowth/mgrs/en/)

VARIABLE	ACCEPTED VALUES	METHODOLOGICAL ASPECTS
Strata	Numeric integer	If not provided, it will be assumed that all children belong to the same unique stratum. If provided, all children with missing strata data will be excluded from the analysis.

3

3.3. DATA INTERPRETATION

3.3.1 Reporting nutritional status

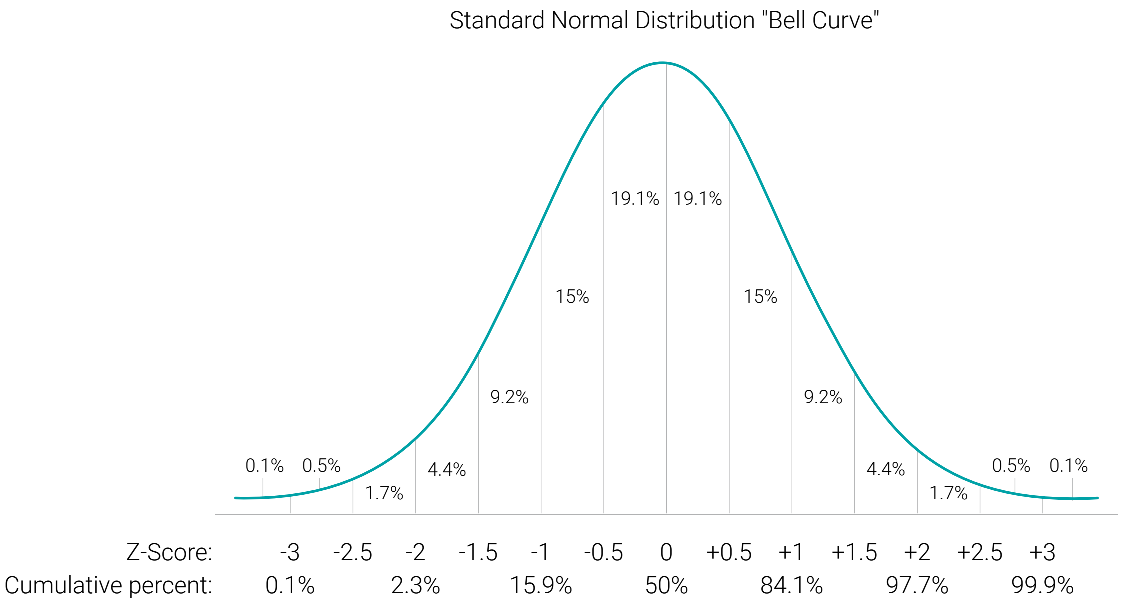
Prevalence-based data for children aged 0–59 months are commonly reported using cut-off points, usually < -2 SD and > +2 SD. The rationale for doing so is that statistically 95% of the international reference population can be found within this central range. The reference population recommended globally for calculating prevalence is the Multi Reference Growth Study (MRGS) Population *(22)*.

The WHO Global Database on Child Growth and Malnutrition uses a z-score cut-off point of < -2 SD to classify low weight-for-age (underweight), low length/height-for-age (stunting) and low weight-for-length/height (wasting) as moderate and severe, and < -3 SD as severe undernutrition. The cut-off points of > +2 SD classifies high weight-for-height in children as moderate and severe overweight and of > +3 SD as severe overweight.

The assessment of nutritional indices among children at the population level is interpreted on the basis of the assumption that in a well-nourished population they normally follow the distribution of the bell curve shown below (Figure 14).

Use of -2 SD and +2 SD as cut-offs implies that 2.3% of the reference population at both tails or ends of the population curve will be classified as malnourished even if they are apparently "healthy" individuals with no growth impairment. Accordingly, 2.3% can be regarded as the baseline or expected prevalence at both ends of the spectrum of nutritional status calculations. Reported values in surveys would need to subtract this baseline value in order to calculate prevalence above normal if they seek to be precise. It is important to note however, that the 2.3% figure is customarily not subtracted from observed values.

Figure 14. Standard normal distribution of a model population



3.3.2 Interpreting prevalence estimates

Prevalence ranges have conventionally been used since the early 1990s to classify levels of malnutrition in global monitoring.

In 2018, the WHO-UNICEF Technical Expert Advisory Group on Nutrition Monitoring (TEAM), an independent technical expert group created to provide advice on nutrition monitoring, revised prevalence ranges used to classify levels of stunting and wasting, and established prevalence ranges to classify levels of overweight (based on weight-for-length/height) *(26)*.

Table 10 presents the new prevalence thresholds, labels and country groupings for wasting, overweight and stunting. Labels have been harmonized across indicators as "very low", "low", "medium", "high", and "very high". TEAM described these classifications as "prevalence thresholds", a term more in line with its intended population-based application, as opposed to "cut-offs", which is a term mainly used for interpreting measurements of individual children. Prevalence levels were set depending on their degree of deviation from normality as defined by the WHO Child Growth Standards.

TABLE 10. POPULATION LEVEL PREVALENCE THRESHOLDS, CORRESPONDING LABELS AND NUMBER OF COUNTRIES IN DIFFERENT PREVALENCE THRESHOLD CATEGORIES FOR WASTING, OVERWEIGHT AND STUNTING USING A "NOVEL APPROACH"

WASTING			OVERWEIGHT			STUNTING		
Prevalence thresholds (%)	Labels	# of countries	Prevalence thresholds (%)	Labels	# of countries	Prevalence thresholds (%)	Labels	# of countries
< 2.5	Very low	28	< 2.5	Very low	16	< 2.5	Very low	4
2.5 - < 5	Low	41	2.5 - < 5	Low	35	2.5 - < 10	Low	26
5 - < 10	Medium	39	5 - < 10	Medium	50	10 - < 20	Medium	30
10 - < 15	High	14	10 - < 15	High	18	20 - < 30	High	30
≥ 15	Very high	10	≥ 15	Very high	9	≥ 30%	Very high	44

[a] Wasting = weight-for-length/height <-2 SD; Overweight = weight-for-length/height >+2 SD; Stunting = Length/height-for-age <-2 SD

The revised prevalence thresholds presented here can be interpreted and exploited by the international nutrition community for various purposes: classifying and mapping countries according to levels of malnutrition severity *(27)*; by donors and global actors to identify priority countries for action *(28)*; and most importantly, by governments for monitoring and triggering action and target programmes aimed at achieving "low" or "very low" levels.

3.3.3 Interpreting mean z-scores

The mean z-score, though less commonly used, provides a direct description of the average nutritional status of the entire population without the need to refer to a subset of individuals below a given cut-off. A mean z-score significantly lower than zero, which is the value for distribution in the reference population (in this event the MGRS study population), means that overall distribution has shifted downwards, implying that most if not all individuals have been affected. More research is needed to understand the circumstances in which the mean z- score can most effectively be used.

3.3.4 Checking denominators

Attention needs to be paid to the denominators used when reporting on stunting, wasting, underweight and overweight in children aged under five years. While not recommended for global reporting, some surveys do not routinely include children aged 0–5 months in their anthropometry measurements. Using denominators that are not aligned with global indicators for children under 5 years of age may confuse the interpretation of estimations if reports are being compared across populations or examined for trends and even data quality. Denominators should always be clearly documented when reporting on the nutritional status of children, especially when observing trends.

3.3.5 Tracking trends

WHO, in collaboration with UNICEF and the EC, has developed a tracking tool to help countries set their national targets and monitor progress towards WHA targets, three of which are stunting, overweight and wasting. This tool allows users to explore different scenarios while taking into account different rates of progress to meet the targets and time left to 2025. Information and tools related to the tool can be accessed by users at the following link on the WHO website of the Global Targets Tracking Tool.

This tracking tool has been used to review trends in current data included and validated in the UNICEF-WHO-WB Joint Child Malnutrition review. Tools for estimating trends include stunting and overweight as indicators. While wasting is part of the tracking tool it is not included in the calculation of trends owing to high short-term variability. Countries are encouraged to use the Excel template provided with this guidance document (Annex 11), which follows a similar methodology to that of the tracking tool, to enter their own data for assessing trends.

3

3.4. HARMONIZED REPORTING AND RECOMMENDED RELEASE OF DATA

A harmonized method of reporting is essential if survey teams wish to develop a comprehensive set of indicators and ensure comparability between surveys. In addition, qualitative information about contextual factors, e.g. shocks and crises, can help survey managers and statisticians to gain a better understanding of anthropometric data from various types of survey and to use it more effectively. Providing systematic notes on seasonal and other relevant contextual factors and how to use these meta-data is recommended.

This section presents a harmonized scheme for reporting anthropometric data as well as contextual information gathered in various nutrition surveys.

Survey results must be reported at the national level. Data at the subnational level can also be presented where they exist. Results should be presented in a standardized manner, e.g. percentage of children with z-scores below or above standard cut-offs using WHO flags and age groups (< 6, 6 to < 12, 12 to < 24, 24 to < 36, 36 to < 48 and 48 to < 60 months).

The inclusion of the following information when presenting anthropometry data is recommended:

a) Cover page

Survey title, dates of the survey, author.

b) Executive summary

c) Introduction

- Survey title and details: geographic area surveyed (areas excluded if any and why), description of the population: total population, population surveyed, type of population surveyed (residents, immigrants, refugees, displaced, etc.).
- Contextual information: food security, nutrition, health situation or any other information likely to have an impact on the nutrition status of the population;
- Objectives: population including age group surveyed;

d) Methodology

- Sample size determination;
- Sample frame details including whether any region, district, PSU or other area or population has been excluded from the first stage sample (and why);
- Sampling design and procedure: full details about all sampling stages, especially the initial stage (i.e. selection criteria for PSUs), second stage (i.e. mapping and listing procedures) and last stage (i.e. selection of households and participants, etc.) and any additional step or stage applied in the survey (e.g. subsampling, etc). Include a definition of household and household member;
- Questionnaire: procedures for developing the questionnaire and interviewer instructions, development and instructions for using the local events calendar, pre-testing if any, procedures for translation and back-translation, etc;
- Measurement procedures;

- Case definitions and inclusion criteria;
- Training of field staff: content, number of days, number of trainees, description of standardization exercises implemented and results of the standardization exercise, pilot test in the field, etc;
- Field work procedures: data collection procedures, number and composition of teams, period of data collection, procedures for call-backs when children absent or for re-measuring children, etc;
- Equipment used and calibration procedures;
- Coordination and supervision process: checks for procedures in the field;
- Data entry procedure;
- Data analysis plan: software (name, version and link if available), data cleaning process, imputation factors (e.g. WHO Anthro Analyser imputes day 15 when day of birth is missing);
- Type of flags used.

e) Results

- Total number of PSUs sampled versus number of PSUs completed (and reason for non-completions);
- Total number of sampled households;
- Breakdown of survey outcomes for all sampled households: completed, refused, including random and flagged re-measurements;
- Total number of children under 5 years in sampled household (indicating if all children were eligible); if data are collected in a subsample, present the total number of eligible children in this subsample;
- Total number of eligible children under 5 years with weight measurement, length/height measurement and at least the month and year of birth;
- Total number of eligible children under 5 years selected for random re-measurements with weight measurement; length/height measurement; and at least month and year of birth;
- Prevalence of anthropometric indicators based on recommended cut-offs for each indicator together with confidence intervals (for stunting, wasting, overweight and underweight). Information should be presented as tables and/or plots;
- Design effects observed;
- Mean z-scores for each index;
- Z-score standard deviations;
- Standard errors (SE) for prevalence and mean z-score estimates;
- 95% confidence intervals for prevalence and mean z-score estimates;
- Frequency distribution plots versus reference population;
- Results presented by disaggregation categories for results where available**:** sex, age group, urban, rural and subnational regions, wealth quintiles and mother's educational level;
- Weighted and unweighted total sample (n) for each indicator.

f) Reporting on indicators for data quality

The recommendation in section 3.1 is to include a data quality report similar to the model in Annex 9 using the WHO Anthro Analyser output. Since this may be too extensive for multitopic household surveys, it could be limited to a summary presentation following the bullet list below provided the raw data are publicly available.

- Number and percentage of cases excluded when applying the fixed exclusion criteria based on WHO Child Growth Standards for each anthropometric index: this should include the overall number and percentage of cases as well as for the best and worst performing teams;
- Missing data disaggregated by age group and other reporting categories. Number and percentage of children missing for height, weight and age expressed at least as month and year of birth;
- Digit heaping charts including for length, height, weight and age;
- Distribution issues: z-score distributions by age group, sex and geographical region;
- Percentage of date-of-birth information obtained from birth certificate, vaccination card, caretaker's recall or other source out of the total number of eligible children. Children lying down/standing up for measurement by age: % of children below 9 months standing, % of children over 30 months lying down, % mismatches for position measured versus recommended position;

– Mean, SD, median, min, max, absolute difference between the first and second measurement for the random cases;
– Percentage of random remeasurements within the maximum acceptable difference;
– Indicate other eventual data quality pitfalls and survey limitations.

g) Discussion

Interpretation of the nutritional status of the children concerned including contextual factors which might have some bearing on the results. Limitations of the survey.

h) Conclusion

The conclusion should summarize the main findings of the survey, briefly mention any interpretative issues raised in the discussion and make recommendations (often as a list) that are logically related to points already made. It should not contain any new material and may merge with the executive summary.

i) Appendices

– Sample design details;[21]
– Questionnaire;
– Local events calendars;
– Map of the area surveyed;
– Results of standardization exercises;
– Field check tables used.

TOOLS

• The online application WHO Anthro Survey Analyser generates a summary report template with the principal graphic outputs and tables of summary statistics as well as a data quality report (Annex 9). A completeness checklist is provided in Annex 10.

Public release of datasets from surveys collecting anthropometric data

As mentioned at the beginning of this document, it is recommended that an agreement be signed with central or local government in the very first stages of the survey for public release of its report and dataset once the data have been validated. Releasing survey datasets for public use ensures transparency and also allows for secondary analysis which can lead to a better understanding of the data and the context in which they were collected, thus enabling the data to be used for the benefit of the population from which they were collected. Raw datasets should be made available for public use including the quality assurance measures that were included in the dataset for both random and flagged re-measurement.

Datasets should still be made public even where a survey produces poor quality results, and problems with data quality explicitly addressed in the report, even when report does not include nutritional status findings.

In some cases, government is responsible for endorsing and releasing survey results and must be consulted for authorization to release datasets to specific individuals or to make them accessible on the internet.

Whatever the case, there is a need to strengthen commitment and advocacy to ensure public access to raw data and develop a database (e.g. registry or repository) containing survey datasets and protocols. Datasets should be released with minimally cleaned data, showing pre- and post-application of flags, so that researchers are subsequently able to apply uniform flags to datasets.

Datasets should include records for all sampled households even if interviews were not completed, and all children who ought to have been measured (even if they were not), actual measurements recorded (i.e. length/height and weight), their date of birth and date of measurement (date of visit), sampling weights, and all other variables. These datasets should be accompanied by clear documentation.

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[21] See an example of a Sampling annex of a MICS report here: http://mics.unicef.org/surveys

The TEAM working group, which is composed of experts from different international organizations (CDC, DHS, SMART, UNICEF, WHO, etc.) recommends that raw datasets from national household surveys including anthropometry be released for public use as a way of strengthening the use of anthropometry data for public health purposes.

TOOLS

- On data anonymisation, consult a Guide to data protection;
- Archiving and dissemination tool;
- USAID open data policy 2014.

RECOMMENDATIONS AND BEST PRACTICES

3

Section 3.1- DATA QUALITY ASSESSMENT

Recommendations (must)

– Report on the following using specifics outlined in the report regarding how to calculate and present:

- Completeness;
- Sex ratio;
- Age distribution;
- Digit preference for height and weight;
- Implausible z score values;
- Standard deviation;
- Normality.

– Appraise data quality by considering the indicators conjointly and not in isolation;

– Do not undertake formal tests or scoring.

Good practices (optional):

– Use WHO Anthro Survey Analyser data quality report.

Section 3.2- DATA ANALYSIS

Recommendations (must):

– Use the standard approach as outlined in the report for analysis, including:

- Use of WHO Child Growth Standards and WHO flags;
- It is important that all records, including those with missing measurements or sampling weights, are available for analysis, since they are important for data quality assessment (e.g. non-response);
- Oedema measurement is only appropriate in surveys where local experts, specifically clinicians or individuals from the Ministry of Health working at a local level, can clearly indicate if they have seen recent cases where nutritional oedema was present;
- Calculate age using date of birth and date of visit and imputation of day 15 if no day available;
- Imputation of missing day of birth: if only the month and year of birth are provided, it is recommended that the missing information for the day of birth be imputed. This can be done in different ways but using the 15th of the month for all missing days of birth is recommended in standard analysis;
- Child's measurement position (standing height or recumbent, i.e. supine or lying length) should be recorded in the questionnaire to allow for age-linked adjustments in length/height depending on whether they were lying or standing;
- Ignore conversion of standing to lying position for children <9 months;
- Re-measurements (height, weight, date of birth, and sex) of children randomly selected or flagged should be retained in the datafile;
- Use height, weight, date of birth and sex from the first measurement for children randomly selected for re-measurement when calculating z-scores. Use height, weight, date of birth and sex from the second measurement for children flagged for re-measurement when calculating z-scores;
- The number and percentage of values excluded should be reported;
- All measurements should be retained in the dataset for transparency;
- A sampling weight must be assigned to each individual in the sample to compensate for unequal probabilities of case selection in a sample, usually owing to the design.

Good practices (optional):

– Use WHO Anthro Survey Analyser or standard STATA and R syntax from JME;

– Monitoring equity is of increasing importance for health and development. Disaggregated analysis is also recommended in order to derive estimates by wealth quintiles (1=lowest, 2, 3, 4, 5=highest) and mother's education (no education, primary school and secondary school or higher), whenever this is possible;

Section 3.4- DATA INTERPRETATION AND REPORTING

Recommendations (must):

– Include measures of precision around prevalence estimates, as well for z-score means in the report.

– Include the prevalence of moderate and severe forms of malnutrition as well as mean and SD for HAZ, WHZ and WAZ in the report.

– Include data quality assessment findings as per section 3.1 in all survey reports that provide estimates for child anthropometric indicators.

– Release complete and clearly labelled datasets to the public including initial measurements and re-measurements

– Include a detailed annex on sampling (to the level of detail in MICS and DHS reports)

Good practices (optional):

– Include the Anthro Analyzer data quality report in annex of the survey report

4

ANNEXES

LIST OF ANNEXES

ANNEX 1. STANDARDIZED DEFINITION OF SOME KEY ACTORS IN SURVEYS INCLUDING ANTHROPOMETRY

1. National implementing organization

Generally, the overall responsibility for organizing a household survey lies with a single implementing agency. This agency may be a governmental, non-governmental or private-sector organization, a university or government research group, or a private research firm.

2. Survey steering committee

It is recommended that the national implementing organization set up a survey steering committee or a technical working group (TWG) to provide advice and support for the survey. Generally, the committee examines the goals and objectives of the survey, policy issues and technical matters such as questionnaire content. The committee can assist in providing broad support to the survey team, ensuring that survey results are accepted and used by national institutions and advocating for raw data to be made available to the public for transparency. The steering committee or TWG should be made up of stakeholders and partners with the technical expertise to provide input on aspects of survey design and implementation such as sampling, questionnaire design, field team member recruitment and training, fieldwork logistics, anthropometry equipment, procurement and training and relevant data quality checks.

3. Survey manager

The survey manager must have experience working in nutrition surveys and is responsible for coordinating and supervising the survey team. He or she should have an overview of the entire process: gathering available information on the survey context and planning, selecting and hiring survey team members, organizing and managing training as well as supervising field work and intervening, if necessary, to enhance the accuracy and precision of data collected. The latter task includes field visits during data collection to verify that survey methodology and procedures are being correctly followed. The survey manager also has a supervisory role in the organization of data entry, data quality checks, monitoring data analysis and assisting in the interpretation of its initial results for later validation at the survey steering committee level.

4. Fieldwork coordinator

The fieldwork coordinator is in charge of several teams. He or she is responsible for supervising fieldwork and field activities.

5. Field Supervisor

The field supervisor is in charge of a single field team. He or she checks that the field team is following the survey protocols and procedures endorsed by the steering committee, including the sampling plan from the central office, as well as correctly using and calibrating equipment and taking measurements.

6. Anthropometrists

Anthropometrists are survey personnel trained to collect the anthropometric data required for generating malnutrition estimates (height, weight) using standardized equipment. Anthropometrists are responsible for the proper care and calibration of their equipment and for taking and recording measurements following standard protocols based on globally accepted criteria and endorsed by the steering committee.

7. Lead anthropometrist trainer

The lead trainer is responsible for organizing and implementing training on anthropometric measurement including standardization exercises to evaluate the performance of individual anthropometrists following training.

8. Data manager

The data manager is responsible for ensuring that data collected are accurately captured and entered in a database. His or her responsibilities include supporting the quality and availability of the datasets as well as training other staff on data entry and how to use software systems.

9. Data processors

The task of data processors is to develop and maintain software systems for data entry, editing, imputation and analysis in surveys.

10. Survey statistician

The survey statistician must be experienced in managing and analysing data in household surveys involving anthropometry, and familiar with the specific statistical package that will be used in the survey.

11. Sampling statistician

The sampling statistician is responsible for developing and implementing the sampling plan, working with the Listing and mapping teams as well as for determining sampling weights for analysis.

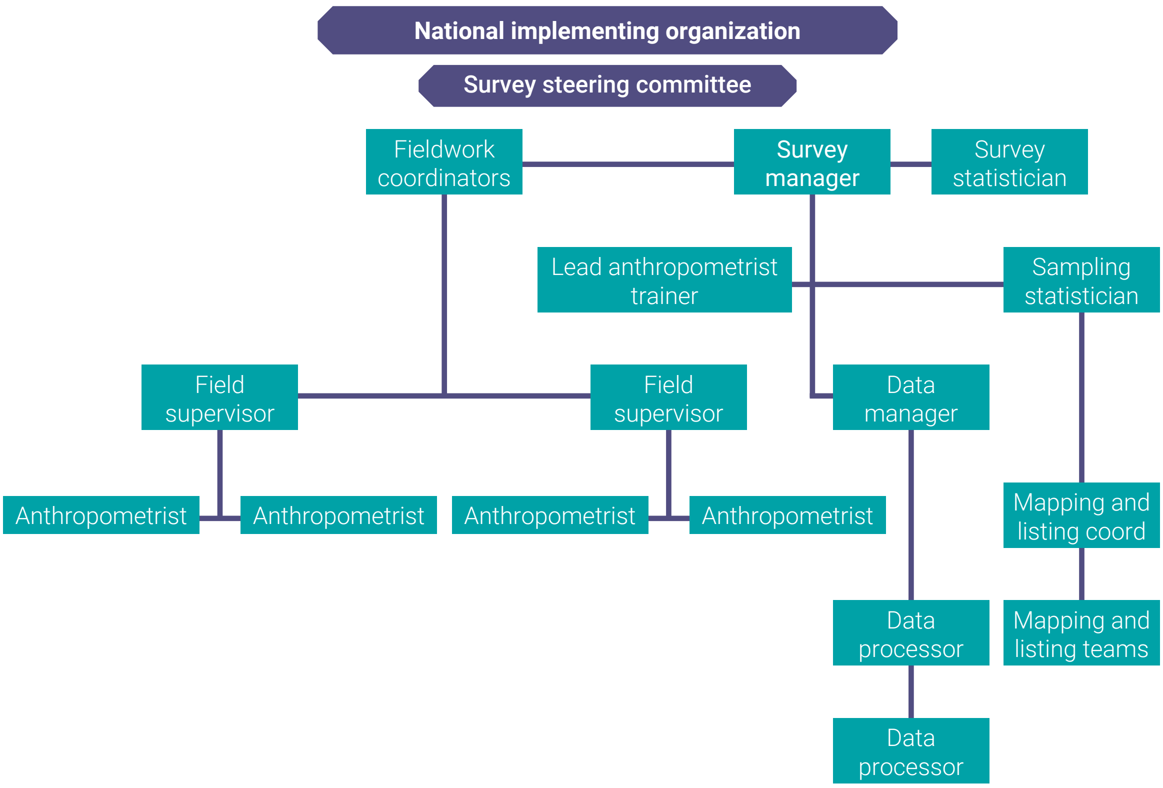
12. Mapping and listing teams

The task of the mapping and listing teams is to collate and geographically define households during the sampling stage. The team is led by the listing coordinator and comprise of listers, mappers and field supervisors.

An example of an organization chart is presented below displaying the human resources required for anthropometry data surveys.

Example of organization chart for surveys that collect anthropometric data

Example of organogram for surveys that collect anthropometric data



ANNEX 2. DETAILED JOB DESCRIPTIONS FOR ANTHROPOMETRY SURVEY TEAM MEMBERS

Each survey team should be composed of at least two people who are involved in anthropometric measurements who are termed hereafter the "anthropometrists". One of the team anthropometrists should be a main measurer and is the person who leads the process of taking correct measurements. The other(s) act as assistant measurer and support the process. To act as main measurer the anthropometrist must have passed the standardization test during the training. To act as assistant measurer the anthropometrist should have attended training for the survey but does not necessarily have to have passed the standardization test.

The composition of team members should be sensitive to the local setting in terms of gender, ethnicity and language skills. Some team members should ideally have a local knowledge of the survey area. It is good practice to include at least one woman on each team, but this will depend on the setting.

All team members must have the following qualifications:

– they should be able to read and write the main language used for the survey and speak the local languages of areas in which the survey will be conducted;
– they should have an appropriate level of education, which allows them to read and write fluently and to count accurately;
– they should be fit enough to walk long distances and carry the measuring equipment;
– they should have good eyesight and/or prescription glasses; but
– they do not necessarily have to be health professionals.

Detailed job descriptions are presented below for the most important roles in a survey team. These job descriptions are general and should be adapted to the setting of each survey.

Survey Manager

Skills and required abilities

– A university degree or equivalent. Documented expertise on managing surveys that collect anthropometry data;
– Significant experience in undertaking anthropometric household surveys (design and methodologies, staff recruitment and training, field supervision and data analysis and reporting) and knowledge of the nutrition field;
– Fluency in the language required for the specific setting where the survey will be conducted, with excellent writing and presentation skills *[insert any other language requirements]*;
– If data are to be collected using digital devices:
  - working knowledge of IT and ability to adapt to new technologies with ease;
  - familiarity with digital devices before data collection begins (additional time may be required for familiarization during the preparatory phase).

Tasks

The survey manager guarantees the integrity of the survey methodology. He or she is responsible for:

1. coordinating the whole process although expert support should be provided as required (experts to help with survey design sampling, protocol development, data analysis procedures, etc.);
2. gathering available information on the survey setting and planning;
3. supervising survey protocol development for validation by the survey steering committee;
4. preparing all survey-related logistical aspects: material and equipment, ethical approval, engaging national and local partners, etc.;
5. selecting team members;
6. coordinating and managing the training for all survey team members, which includes organizing standardization and field tests;
7. supervising fieldwork and intervening, if necessary, to enhance the accuracy of data collected, which includes:

- visiting teams in the field and making sure that before leaving the field each **field supervisor** reviews and signs all forms to confirm that all items of data have been recorded, and that the team follows the call-back protocol (i.e. each sampled household is visited at least twice after an initial attempt has failed) before leaving the area;
- overseeing the work of field supervisors to ensure that households sampled at the central level are interviewed without replacements in accordance with the sampling plan drawn up by the sampling statistician, verifying that equipment is checked and calibrated every day during the field work period, and that measurements are taken and recorded accurately;
- deciding how to overcome the specific problems encountered during the survey (problems encountered, and decisions made must be promptly recorded and included in the final report if they lead to a change in the planned methodology);
- organizing field checks to support the field supervisors and verifying any suspicious data before the team leaves the PSU;
- ensuring that teams take refreshments with them and have enough time for appropriate rest periods (teams should not be overworked since there is a lot of walking involved in a survey, and tired field teams make mistakes or fail to include more distant houses selected for the survey).

8. coordinating data analysis with the specific person in charge of this task;
9. reviewing the draft report for submission and validation by the survey steering committee;
10. organizing, if required, a final workshop to publicize results and stimulate discussion on use of the data obtained;
11. ensuring raw datasets are made publicly available.

Fieldwork coordinator/ field supervisor

The fieldwork coordinator and field supervisor have very similar roles: the fieldwork coordinator oversees several teams while the field supervisor is in charge of a single team.

Skills and required abilities

– Minimum education: high school graduate with superior reading, writing and mathematics skills;

– Good knowledge of the survey area. A reliable, friendly person who is able to coordinate and supervise a team. Previous experience on anthropometric survey required. Leadership skills essential;

– If data are to be collected using digital devices:

- able to use a digital device and adapt rapidly to new approaches and technologies (additional time may be required for familiarization in the preparatory phrase);
- able to multitask, e.g. manage the phone while making sure other team members are conducting good quality measurements and collecting data correctly.

Tasks

The field supervisor should lead, supervise and provide support and guidance to all members of the assigned field team(s), including the anthropometrists. He or she is responsible for ensuring that every team member follows the survey protocols and procedures endorsed by the steering committee and should seek backup from the survey manager as required. The specific responsibilities of the field supervisor include:

1. checking all team members have a sufficient number of questionnaires and all other required forms at the start of each day;
2. ensuring all teams have cleaned and calibrated their equipment, troubleshooting any identified equipment problems and providing replacement equipment if needed;
3. verifying all logistical aspects are organized at the start of each day, and protecting the security of team members;
4. organizing a briefing with the survey team before starting data collection every day;
5. meeting the local representatives head to explain the survey and its objectives;
6. ensuring all field team members (anthropometrists, interviewers, etc.) have a map of the area and list of sampled households that have been selected to be part of the sample provided by the central office, know which households have been assigned to them for that day, and follow the sample plan provided by the central office;

7. supervising anthropometric measurements in the field, carrying out quality assurance checks during data collection, identifying deviations from standard anthropometric procedures and retraining or referring anthropometrists for retraining;
8. verifying that houses with missing data have been revisited before leaving the PSU, and that team members have adhered to the call-back protocols;
9. if oedema is part of the survey, the field supervisor should visit the household to verify the case has been properly diagnosed.

Interviewer

Skills and required abilities:

– To be able to read, write and count; know the area to survey; be reliable and friendly.
– If data collection will be using computer-based questionnaires: capable of using a digital device and able to quickly adapt to new approaches and technologies.

Tasks:

Is responsible for filling out the household questionnaires and the anthropometry questionnaire

Anthropometrists

Skills and required abilities

Minimum education: A middle school graduate with good reading, writing and mathematics skills, who has a good knowledge of the survey area. He or she should be reliable, friendly and speak the local language.

Tasks

1. Following the sample plan provided by the central office and visiting the households assigned by the field supervisor;
2. Explaining clearly the anthropometry procedures and measurements to be taken, the role of the caretaker and what is expected of the caretaker and child(ren);
3. Measuring length/height and weight;
4. Assessing the presence of bilateral pitting oedema (if being included in the survey, although not generally recommended);
5. Completing the required questionnaires and forms as set out in the interviewer instructions, including how to determine the date of birth of the child properly;
6. Observing the timetable established for measurements, breaks and meals;
7. Maintaining and calibrating the equipment and reporting any issues immediately to the field supervisor;
8. Following security measures.

Survey statistician

Skills and required abilities

The survey statistician must be experienced in managing and analysing data in household surveys that include anthropometry. Statisticians should be detail-orientated people who like working with large amounts of data.

Minimum education: A master's degree in statistics or mathematics is typically required.

Statisticians are required to have the following skills:

– **Statistical programming:** the ability to apply statistical formulas and methods to solve practical problems is a key element of this role;
– **Data analysis:** creating relevant data sets, tables and figures;
– **Mathematical skills:** statisticians use advanced mathematics;
– **Project management:** statisticians often work independently and must be able to manage multiple assignments and meet project deadlines with efficiency and accuracy;

– **Interpersonal skills:** since the statistician liaises with the survey manager he or she must be able to explain ideas clearly so that they are understood and adopted;
– **Critical thinking:** statisticians must use logic and critical thinking to overcome challenges in data collection and the interpretation process.

Tasks

1. **Design surveys and questionnaires**

   In order to collect the requisite data, statisticians create statistically accurate surveys and questionnaires. They often train personnel or write instructions on how best to manage and organize survey data, providing suggestions on enhancing the design of surveys, including sampling stages.

2. **Data cleaning**

   Data editing, cleaning and undertaking thorough checks for overall quality are key aspects of a statistician's work. Data management is essential to separate files and make thorough checks for overall quality. Data management is essential for producing accurate conclusions and results, and statisticians are required to maintain and update precise databases.

3. **Statistical analysis**

   Statisticians analyse data with specific statistical software. Their primary responsibility is to spot trends and detect relationships within data sets. They commonly conduct tests to determine the reliability and soundness of their data. They should implement analysis in line with the recommendations of this report (see Chapter 3).

4. **Presentation of statistical findings**

   Survey statisticians compile their findings from survey data. They create reports, charts, or graphs that describe and interpret their conclusions, and may be called upon to present written reports to other team members. They should follow the recommendations of this report (see Chapter 3).

Sampling Statistician

Statistically sound and internationally comparable data are essential for developing evidence-based policies and programmes, as well as for monitoring countries' progress toward national goals and global commitments, including the Sustainable Development Goals (SDGs). A sampling statistician is thus an integral part of a household survey team.

Skills and required abilities

– At least 10 years' experience in designing samples for household surveys in the region (experience in countries without recent census information is an asset);
– Must have experience in conducting national surveys and be familiar with the sampling methodology for surveys that collect anthropometry data;
– Demonstrated training experience;
– Experience in the region concerned;
– Excellent communication and interpersonal skills;
– Fluency in the national language is an asset;
– Demonstrated ability to work in a multicultural environment

Qualifications of Successful Candidate

Education

– At least a master's degree or equivalent in survey sampling or statistics with special expertise in survey sampling.

Tasks/Expected deliverables

1. Designing or reviewing sampling plans developed by the National Statistics Office;
2. Working with the mapping and listing teams;

3. Reviewing, advising and calculating sample weights for countries after data collection is completed and before proceeding with data analyses;
4. Discussing sampling plans and sample weights with the survey manager and the National Statistics Office;
5. Writing or reviewing the relevant chapters of the survey report.

Deliverables:

– Templates, guidelines, programmes, presentations and manual as indicated above;
– Reports on reviews of sampling plans, sample weight calculations and sampling chapters in the survey report.

The sampling statistician should uphold the confidentiality of any data collected in the survey as well as any country-specific documents produced during the same period. Documentation and datasets should be used solely for tasks related to his or her terms of reference.

Data manager and data processor[1]

The data manager will overview the tasks of the data processors.

Skills and required abilities

– Bachelor's degree in computer science, demography or public health-related fields;
– Strong programming skills in accepted programming language such as C#, C++, Java, etc;
– Experience in public health or demographic research;
– Familiarity with SPSS, SAS, Stata or other statistical software package;
– Fluency in specific local language required.

Tasks

1. Developing and maintaining software systems for data entry, editing, imputation and analysis for paper-based population surveys;
2. Developing and supporting computer-based interviewing systems in developing countries;
3. Building capacity through workshops and seminars on data use and survey processing;
4. Producing data analysis to support country report production;
5. Conducting data archiving and providing technical support for data users;
6. Developing programs for computer;
7. -based data collection.

Lead Anthropometrist Trainer

Skills and required abilities

The lead trainer should be an individual with the technical ability and experience to conduct anthropometric surveys and a full set of skills for training anthropometrists.

The skills of the lead trainer can be confirmed by an existing lead anthropometrist from the same or a related institution.

Tasks

1. Organizing the theoretical and hands-on training for anthropometrists, using dolls and in children;
2. Preparing the standardization exercises to assess the performance of anthropometrists;
3. Organizing the field test.

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1 If the survey is paper-based, the survey team should include data entry operators.

Listing and mapping survey staff

The household listing operation is carried out in each sampled PSU by a household listing and mapping team prior to the main survey. The quality of the listing operation is one of the key factors in terms of target population coverage: it is therefore essential for each team member to understand his or her roles and responsibilities. **Mappers** and **listers** are responsible for creating maps and lists of sampled PSUs. They work together as a team, one person essentially working as the **mapper** while the other operates as the **lister**. **Field supervisors** supervise teams of mappers and listers for the listing and mapping operation while the overall household listing operation is planned and monitored by a **listing coordinator**.

Tasks of the listing coordinator

- Planning and supervising the mapping and listing operation;
- Developing the mapping and listing manual;
- Hiring the field teams (mappers, listers and field supervisors);
- Organizing training for the field teams and arranging for local experts to provide input as needed (e.g. arranging for NSO cartographic staff to take part in training for listing and mapping staff and to interpret census data or other records used as base maps);
- Remaining in regular communication with field supervisors and central office during the mapping and listing operation;
- Taking part in field visits to verify completed maps and lists for random PSUs.

Tasks of the field supervisors during the sampling stage

- Obtaining base maps for all PSUs selected for the survey. If base maps are not available, any available documentation on the location of the PSU should be used by the mapper before creating a base map;
- Assigning PSUs to teams;
- Ensuring that all listing materials (manual for mapping and household listing, adequate number of base and sketch map forms, household listing forms, segmentation forms) are provided before teams go to the field;
- Planning and organizing fieldwork logistics (e.g. arranging for transport, identifying and contacting local officials and village elders in each PSU to inform them about the listing operation and obtain their cooperation);
- Receiving and reviewing properly completed household listing forms and maps and ensuring they are safely stored at the central office;
- Checking that each PSU has been fully covered and listed;
- Monitoring and verifying that the quality of work is acceptable and conducting field visits to a sample (e.g. 10%) of all PSUs to carry out physical checks;
- After receiving completed forms and maps from the listing teams, making a copy of the materials and ensuring that original forms and maps are kept in the central office to support and monitor the data collection operation when needed.

Tasks of the listing and mapping team

- Identifying the boundaries of each sample PSU from the base map, ensuring that the location of the PSU is clearly identified on the base map and updating the information if necessary;
- Completing a PSU segmentation form for a large PSU that needs to be subdivided into segments;
- Contacting the field supervisor immediately in the event of a small PSU with less than the target number of sample households listed (e.g. 20). (Note that a census enumeration area typically has at least 50 households, and that any smaller enumeration area selected from the census frame will generally have been merged with an adjacent PSU prior to the listing operation. People may have moved away for a number of reasons, including natural phenomena such as permanent flooding or because local employment opportunities have become scarce. The field supervisor together with the sampling statistician should assign a neighbouring PSU which should **also** be mapped and listed;
- Drawing a detailed sketch map displaying the location of the PSU and all the structures it contains;
- Systematically listing all the structures and households in the PSU using the household listing form;
- When no address system exists, marking the structure number on the doorframe of each structure in the sample PSU, or using stickers for identification purposes. (This may not be appropriate in all countries or regions for cultural and/or safety reasons.)
- Completing all household listing forms and maps;

– Transferring all completed forms and maps to the field supervisor;
– Informing the field supervisor about any problems encountered in the field and following his or her instructions for the same area.

Method: mapper and lister should first identify the PSU boundaries together: then the mapper prepares the base and sketch maps while the lister fills in the appropriate information in the household listing forms. The following materials should be present at all times for the household listing operation:

– Mapping and household listing manual;
– If there is no address system, a felt-tipped marker or chalk should be used to number structures. Stickers placed on doors are used in some surveys. Whichever system is selected, it is very important that the identifying mark remains in place until the interviewing teams arrive. (Cultural and/or security concerns may render this approach difficult is some regions or countries.);
– A notebook;
– Pencils and erasers;
– Base maps of the selected PSUs;
– Sketch map forms;
– Household listing forms;
– PSU Segmentation Forms.

ANNEX 3. MODEL HOUSEHOLD QUESTIONNAIRE FOR ANTHROPOMETRY SURVEY

NAME AND YEAR OF SURVEY

HOUSEHOLD INFORMATION PANEL		**HH**			
HH1. *PSU number:* ___ ___ ___		**HH2**. *Household number:* ___ ___			
HH3. *Supervisor's name and number:* NAME ___ ___ ___		**HH5**. *Region:* REGION 1 .... 1 REGION 2 .... 2 REGION 3 .... 3 REGION 4 .... 4 REGION 5 5			
HH4. *Type of place of residence:*	URBAN .... 1 RURAL 2				
INTERVIEWER VISITS					
	1	2	3	Final visit and Result	
HH6. *Date of visit*	__ __/__ __/__ __ __ __	__ __/__ __/__ __ __ __	__ __/__ __/__ __ __ __	__ __/__ __/__ __ __ __	
HH7. *Interviewer's name and number*	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	
HH8. *Result**	___ ___	___ ___	___ ___	___ ___	
HH9. *Next visit: Date and time*	__ __/__ __/__ __ __ __ __ __:__ __	__ __/__ __/__ __ __ __ __ __:__ __		**HH10**. Total number of visits ___ ___	

**Result of Household Questionnaire interview:* *Discuss any result not completed with supervisor.*	COMPLETED .... 01 PARTIALLY COMPLETED .... 02 NO HOUSEHOLD MEMBER AT HOME OR NO COMPETENT RESPONDENT AT HOME AT TIME OF VISIT .... 03 ENTIRE HOUSEHOLD ABSENT FOR EXTENDED PERIOD OF TIME .... 04 REFUSED .... 05 DWELLING VACANT OR ADDRESS NOT A DWELLING .... 06 DWELLING DESTROYED .... 07 DWELLING NOT FOUND .... 08 OTHER (*speciFY*) ______________________ 96

Check that the respondent is a knowledgeable member of the household and at least 18 years old before proceeding. You may only interview a child age 15-17 if there is no adult member of the household or all adult members are incapacitated. You may not interview a child under age 15.	**HH11**. Record the time.	
	Hours	: Minutes
	__ __	: __ __

HH12. Hello, my name is (**your name**). We are from ***(Implementing organization)***. We are conducting a survey about the nutritional situation of children. I would like to talk to you about the members of your household. This interview usually takes about **number** minutes. Following this, I may ask to conduct additional interviews with you or other individual members of your household. All the information we obtain will remain strictly confidential and anonymous. If you do not wish to answer a question or stop the interview, please let me know. May I start now?	
YES .... 1 No / NOT ASKED 2	1⇨List of Household Members 2⇨HH8

HH17. *Name and line number of the respondent to Household Questionnaire interview:* NAME________________ __ __	To be filled in after the Household Questionnaire is completed		*To be filled in after all the questionnaires are completed*	
	TOTAL NUMBER		COMPLETED NUMBER	
HOUSEHOLD MEMBERS	**HH18**	__ __		
CHILDREN AGED 0–5 YEARS	**HH19**	__ __	**HH20**	__ __

LIST OF HOUSEHOLD MEMBERS — HL

First complete HL2-HL4 vertically for all household members, starting with the head of household. Once HL2–HL4 are complete for all members, make sure to probe for additional members: those not currently at home, any infants or small children, any others who may not be family (such as servants, friends) but who usually live in the household and anyone who stayed in the household the previous night. Then ask questions HL5-HL12 for each member one at a time. If additional questionnaires are used, indicate by ticking this box:

HL1. Line number	**HL2**. First, please tell me the name of each person who usually lives here, or stayed here last night, starting with the head of household. Probe for additional household members.	**HL3**. What is the relationship of (name) to (name of the head of household)?	**HL4**. Is (name) male or female? 1 Male 2 Female	**HL5**. How old is (name)? Record in completed years. If age is 95 or above, record '95'.	**HL6**. Does (name) usually live here? 1 Yes 2 No	**HL7**. Did (name) stay here last night? 1 Yes 2 No	**HL8**. Record line number if aged 0–5.	**HL9**. For children aged 0–5, record the line number of the mother or caretaker and go to NEXT LINE.
Line	Name	Relation*	M F	Age	y n	y n	0-5	Mother
01		0 1	1 2	__ __	1 2	1 2	01	__ __
02		__ __	1 2	__ __	1 2	1 2	02	__ __
03		__ __	1 2	__ __	1 2	1 2	03	__ __
04		__ __	1 2	__ __	1 2	1 2	04	__ __
05		__ __	1 2	__ __	1 2	1 2	05	__ __
06		__ __	1 2	__ __	1 2	1 2	06	__ __
07		__ __	1 2	__ __	1 2	1 2	07	__ __
08		__ __	1 2	__ __	1 2	1 2	08	__ __
09		__ __	1 2	__ __	1 2	1 2	09	__ __
10		__ __	1 2	__ __	1 2	1 2	10	__ __
11		__ __	1 2	__ __	1 2	1 2	11	__ __
12		__ __	1 2	__ __	1 2	1 2	12	__ __
13		__ __	1 2	__ __	1 2	1 2	13	__ __
14		__ __	1 2	__ __	1 2	1 2	14	__ __
15		__ __	1 2	__ __	1 2	1 2	15	__ __

* Codes for HL3: Relationship to head of household:				
	01 Head	05 Grandchild	09 Brother-in-law / Sister-In-Law	13 Adopted / Foster / Stepchild
	02 Spouse / Partner	06 Parent	10 Uncle/Aunt	14 Servant (Live-in)
	03 Son / Daughter	07 Parent-In-Law	11 Niece / Nephew	96 Other (Not related)
	04 Son-in-law / Daughter-In-Law	08 Brother / Sister	12 Other relative	98 DON'T KNOW

HH13. Record the time.	HoursS and minutes ....__ __ : __ __	
HH14. Check HL8 in the List of Household Members: Are there any children aged 0–5 years?	Yes, at least one..1 No 2	2⇨*HH16*
HH15. Issue a separate QUESTIONNAIRE FOR CHILDREN 0-5 for each child aged 0-5 years.		
HH16. Now return to the HOUSEHOLD INFORMATION PANEL and, • Record '01' in question HH8 (result of the Household Questionnaire interview), • Record the name and the line number (from the List of Household Members) of the respondent to the Household Questionnaire interview in HH17, • Fill in questions HH18 and HH19, • Thank the respondent for his/her cooperation and then • Proceed with the administration of the remaining individual questionnaire(s) in this household. If there is no individual questionnaire to be completed in this household thank the respondent for his/her cooperation and move on to the next household assigned by your supervisor.		

INTERVIEWER'S OBSERVATIONS

SUPERVISOR'S OBSERVATIONS

ANNEX 4. MODEL QUESTIONNAIRE FOR ANTHROPOMETRY IN CHILDREN

NAME AND YEAR OF SURVEY

CHILD INFORMATION PANEL			**UF**
UF1. PSU number: ___ ___ ___	**UF2**. Household number: ___ ___		
UF3. Child's name and line number: Name_______________ ___ ___	**UF4**. Mother's/caretaker's name and line number: Name_______________ ___ ___		
UF5. Interviewer/measurer's name and number: Name_______________ ___ ___	**UF6**. Supervisor's name and number: Name_______________ ___ ___		
UF7. Day/month/year of interview: ___ ___ /___ ___ / 2 0 ___ ___	**UF8**. Record the time:	Hours : Minutes __ __ : __ __	

UF9. Hello, my name is (**your name**). We are from **(Implementing organization)**. We are conducting a survey about the nutritional situation of children. I would like to talk to you about **(child's name from UF3)**. This interview will take about **number** minutes. All the information we obtain will remain strictly confidential and anonymous. If you wish not to answer a question or wish to stop the interview, please let me know. May I start now?	
Yes........ 1 No / NOT ASKED 2	1⇨ Under six's Background Module 2⇨UF10

UF10. *Result of interview for children aged 0–5 years* *Codes refer to mother/caretaker.* *Discuss any result not completed with supervisor.*	Completed........ 01 Not at home........ 02 Refused .... 03 Partly completed .... 04 Incapacitated ....(specify) .... 05 No adult consent .... 06 Other (specify)........ 96

UNDER-SIX'S BACKGROUND		UB
UB0. *Before I begin the interview, could you please bring (**name**)'s birth certificate, **national child immunization record and any immunization record** from a private health provider, or any other document where the date of birth is officially registered? We will need to refer to those documents.* *If the mother/caretaker says she knows the exact date of birth and can give it to you without getting the document, ask the respondent to bring the document in any case.*		
UB1. On what day, month and year was (**name**) born? Probe: What is (his/her) birthday? If the mother/caretaker knows the exact date of birth, also record the day; otherwise, record '98' for day.	Date of birth Day..__ __ Don't know day...98 Month..__ __ Don't know month ....98 Year .... 2 0 __ __ Don't know YEAR 9998	
UB2. Source of information for date of birth Several options are possible	BIRTH CERTIFICATE ....A BIRTH REGISTRATION RECORD ....B NATIONAL CHILD IMMUNIzATION RECORD .... C PRIVATE HEALTH PROVIDER IMMUNIzATION RECORD D MOTHER'S REPORT ....E ESTIMATE USING CALENDAR OF EVENTS................F Other (specify)...K	
UB3. How old is (**name**)? Probe: How old was (**name**) at (his/her) last birthday? Record age in completed years. Record '0' if less than 1 year. If responses to UB1 and UB3 are inconsistent, probe further and correct.	Age (in completed years) .... __	
UB4. Check UB3: Child's age?	Age 0–4 ....1 Age 5 OR OLDER...2	2⇨AN13
UB5. Tell the respondent that you will need to measure the weight and height of the child before you leave the household and a colleague will come to lead the measurement.		

ANTHROPOMETRY		AN
AN1. *Measurer's name and number:*	Name .... ___ ___ ___	
AN2. *Record the result of weight measurement as read out by the measurer:* *Read the record back to the measurer and also ensure that he/she verifies your record.*	Kilograms (kg) .... ___ ___ . ___ Child not present ....99.3 Child refused ....99.4 Respondent refused.....................................99.5 Other (specify).....................................99.6	 99.3⇨AN12 99.4⇨AN12 99.5⇨AN12 99.6⇨AN12
AN3. *Was the child undressed to the minimum?*	Yes..................................... 1 No, the child could not be undressed to the minimum 2 2	
AN4. *Check UB3: Child's age?*	Age 0 or 1 .... 1 Age 2, 3 or 4..................................... 2	 2⇨AN8
CHILDREN UNDER 2 YEARS OF AGE		
AN5. *The child is less than 2 years old and should be measured lying down. Record the result of length measurement as read out by the measurer:* *Read the record back to the measurer and also ensure that he/she verifies your record.*	Length (cm) .... ___ ___ ___ . ___ Child refused .... 999.4 Respondent refused..................................... 999.5 Other (specify)..................................... 999.6	 999.4⇨AN12 999.5⇨AN12 999.6⇨AN12
AN6. *How was the child actually measured? Lying down or standing up?*	Lying down..................................... 1 Standing up..................................... 2	1⇨AN11
AN7. *Record the reason that the child was measured standing up.*	REASON MEASURED STANDING UP	⇨AN11
CHILDREN 2 YEARS OF AGE OR OLDER		
AN8. *The child is at least 2 years old and should be measured standing up. Record the result of height measurement as read out by the measurer:* *Read the record back to the measurer and also ensure that he/she verifies your record.*	Height (cm)..................................... ___ ___ ___ . ___ Child refused .... 999.4 Respondent refused..................................... 999.5 Other (specify)..................................... 999.6	 999.4⇨AN12 999.5⇨AN12 999.6⇨AN12
AN9. *How was the child actually measured? Lying down or standing up?*	Lying down..................................... 1 Standing up..................................... 2	 2⇨AN11
AN10. *Record the reason that the child was measured standing up.*	REASON MEASURED lying down _______________________________	
AN11. *Was the child's hair braided or the child wearing hair ornaments that interfered with measurement?*	Yes, CHILD'S HAIR BRAIDED OR CHILD WORE HAIR ORNAMENTS THAT INTERFERED WITH MEASUREMENT 1 No 2	
AN12. *Today's date: Day / Month / Year:*	Date of measurement: ___ ___ /___ ___ / 2 0 ___ ___	

AN13. *Record the time:*	Hours and minutes.. __ __ : __ __	
AN14. *Thank the respondent for her/his cooperation. Go to UF10 on the CHILD Information Panel and record '01'.*		
AN15. *Is there another child under 6 years old in the household who has not yet had the child questionnaire administered?*	Yes.. 1 No 2	1⇨ Next Child
AN16. *Inform your supervisor that the measurer and you have completed all the measurements in this household.*		

INTERVIEWER'S OBSERVATIONS FOR ANTHROPOMETRY MODULE

MEASURER'S OBSERVATIONS FOR ANTHROPOMETRY MODULE

SUPERVISOR'S OBSERVATIONS FOR ANTHROPOMETRY MODULE

ANNEX 5. SUGGESTED DURATION AND AGENDA FOR ANTHROPOMETRIC TRAINING

Anthropometric training duration

	ANTHROPOMETRISTS	FIELD SUPERVISORS
Classroom training on identifying households and participants, and completing questionnaires (including proper identification of date of birth)	1 day	1 day
Classroom training on using and maintaining equipment, and taking anthropometric measurements with dolls and other objects	1 day	1 day
Practical exercises on measurements with children	2 days*	2 days*
Standardization exercises, re-training and re-standardization	2 days	2 days
Field supervisor training	------	1 day
Field testing	1 day	1 day
Total length of training	**7 days****	**8 days****

*May be reduced to one day if pool of experienced anthropometrists; ** More time may be needed depending on the number of trainees

Suggested training agenda

DAY	MORNING	AFTERNOON
Day 1 **Survey overview and training on completing questionnaires**	Opening session Introductions Overview of malnutrition and its public health significance Objectives of the survey, brief overview of country profile, consent form, survey description, general organization, period of survey implementation, role of interviewers and supervisors, importance of interviews Administrative matters, rate and timing of payment, survey regulations Introduction to the survey manual: fieldwork procedures (identification of sampled households, introduction to the family, identification of eligible children and completing the questionnaire including proper use of local events calendars)	Description of the sample and eligibility criteria Interviewing techniques Explanation of questionnaire Proper identification of the date of birth Exercises If required: use of electronic devices
Day 2 **Training on use of the equipment plus anthropometric measurements (in class)**	Instructions on where to place the equipment safely, and how to calibrate and maintain it Theory and background information about anthropometric measurements Instructions on measuring length/height and weight Practice with dolls and other objects (e.g. sticks) Feedback after practice with dolls (30–60 min)	Idem
Days 3 **Hands-on measurement exercises**	Hands-on practice with children of different age-groups in pairs (preferably one more experienced and one less experienced trainee together), with all trainers and supervisors observing and assisting Practice feedback in class in the afternoon (30–60 min)	
Day 4 **First standardization exercises**	Standardization exercises (half day required for one group of 10 measurers)	
Day 5 **Practice and second standardization exercises**	If required or any measurers fail the standardization test, conduct an additional hands-on practice session with children in the morning (retraining) and then a second standardization exercise in the afternoon	
Day 6 **Field supervisors**	Organization of supervision, checks to be done at field level, instruction on how to communicate with anthropometrists	Exercises

DAY	MORNING	AFTERNOON
Day 7 **Field testing**	Field test	Discussion of field test Review problems, errors, and observations made during field practice Catching errors in completed questionnaires Discussion of methods of data quality monitoring: field editing, spot-checking and field-check tables
End of training	Trainees informed of final team composition Finalization of logistics	

ANNEX 6. MODEL CALIBRATION LOG FOR ANTHROPOMETRIC EQUIPMENT

CALIBRATION LOG – WEIGHING SCALES

Month and year:						
Equipment ID	**Day of Month**	**PSU Number**	**Measurement in kg**	**Condition/Remarks**	**Not in use (check)**	**Technician ID**
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
	24					
	25					
	26					
	27					
	28					
	29					
	30					
	31					

CALIBRATION LOG – MEASURING BOARDS

Month and year:						
Equipment ID	**Day of Month**	**PSU Number**	**Measurement in cm**	**Condition/Remarks**	**Not in use (check)**	**Technician ID**
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
	24					
	25					
	26					
	27					
	28					
	29					
	30					
	31					

ANNEX 7. MODEL PSU CONTROL FORM

CLUSTER CONTROL FORM - EXAMPLE

Superisor name: _________ Supervisor Number: ______ District No. ______________ Cluster No. ___________

Codes for outcome of interview

1=COMPLETED
2=PARTIALLY COMPLETED
3=NO HOUSEHOLD MEMBER AT HOME OR NO COMPETENT RESPONDENT
4=ENTIRE HOUSEHOLD ABSENT FOR EXTENDED PERIOD OF TIME
5=REFUSED
6=DWELLING VACANT OR ADDRESS NOT A DWELLING
7=DWELLING DESTROYED
8=DWELLING NOT FOUND
98=OTHER (SPECIFY __________)

Interviewer number	HH#	Head of HH name	date assigned	Date and time if first visit		date and time of second visit		date and time of third visit		date and time of fourth visit		Total eligible children	Total children measured	Interview final oucome	Comments
			dd/mm/yy	dd/mm/yy	HR:MN	dd/mm/yy	HR:MN	dd/mm/yy	HR:MN	dd/mm/yy	HR:MN			codes above	

ANNEX 8. MODEL ANTHROPOMETRY CHECKLIST

[YEAR] [COUNTRY] SURVEY - ANTHROPOMETRY CHECKLIST

CLUSTER NUMBER					ANTHROPOMETRIST ID ...				
HOUSEHOLD NUMBER					FIELD SUPERVISOR ID				

INSTRUCTIONS: FILL IN THIS FORM DURING FIELD OBSERVATIONS FOR ONE CHILD PER HOUSEHOLD. PROVIDE FEEDBACK TO THE ANTHROPOMETRIST AFTER HE/SHE LEAVES THE HOUSEHOLD.

	PREPARATION				
101	Line number, name, DOB, lying/standing filled. CHECK QUESTIONNAIRE.	1	2	3	4
102	Anthropometris and assistant performing measurement.	1	2	3	4
103	Asked to unbraid or remove child's hair ornaments that will interfere with measurement. Refusals noted on questionnaire.	1	2	3	4
104	Asked to remove child's shoes and outer clothing. Refusals noted on questionnaire.	1	2	3	4
	WEIGHT MEASUREMENT				
200	OBSERVE IF THE CHILD IS MEASURED STANDING OR WEIGHED BEING HELD BY AN ADULT. STANDING ☐ ↓ HELD ☐ → 301				
201	Measurer positioned in front of scale.	1	2	3	4
202	Air bubble in center of circle.	1	2	3	4
203	Scale displays numbers «0.00» before child steps on scale.	1	2	3	4
204	Child looking straight ahead.	1	2	3	4
205	Short press on «hold» key after numbers stabilize.	1	2	3	4
206	Read outloud, reading repeated, checked.	1	2	3	4
207	Correctly recorded weight. CHECK QUESTIONNAIRE.	1	2	3	4

ANNEX 9. WHO ANTHRO SURVEY ANALYSER DATA QUALITY AND OUTPUT REPORTS[2]

DATA QUALITY REPORT

SURVEY TITLE:

ADD SURVEY DETAILS: field work period, context Information, Information on training, limitations on access to selected households, etc.

AUTHOR:

Table of Contents

Recommended citation:

Data quality assessment report template with results from WHO Anthro Survey Analyser

Analysis date: 2019-03-14 16:40:14

Link: https://whonutrition.shinyapps.io/anthro/

This report is a template that includes key data quality checks that can help to identify issues with the data and considerations when interpreting results. Other outputs that can be relevant to your analyses can be saved directly from the tool interactive dashboards and added to the report.

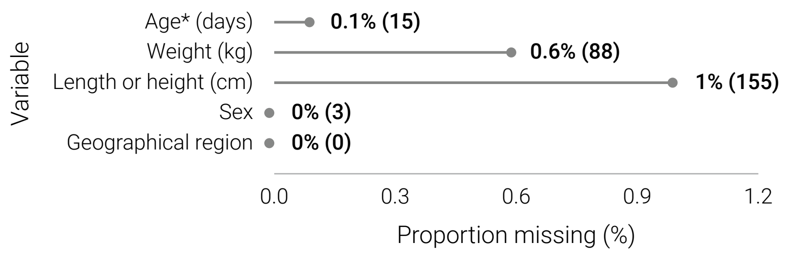
[2] The following outputs and data quality checks enclosed are those produced by the WHO Anthro Survey Analyser at the time the report was released. Not all recommended tests were included but the aim is to harmonize the outputs with those recommended in this guidance document over time.

For guidance on how to interpret the results, user should refer to the document "Recommendations for improving the quality of anthropometric data and its analysis and reporting" by the Working Group on Anthropometric Data Quality, for the WHO-UNICEF Technical Expert Advisory Group on Nutrition Monitoring (TEAM). The document is available at www.who.int/nutrition/team, under "Technical reports and papers".

1. Missing data

1.1. Percentage (number of cases) of children missing information on variables used in the analysis

Total number of children: 15735.



* *The percentage of missing values are based on dates that have either or both month and year of birth missing.*

1.2. Missing data by Geographical Region

GEOGRAPHICAL REGION	N	AGE* (DAYS)	WEIGHT (KG)	LENGTH OR HEIGHT (CM)	SEX
1	812	4 (0.5%)	5 (0.6%)	5 (0.6%)	3 (0.4%)
2	918	4 (0.4%)	25 (2.7%)	34 (3.7%)	0 (0%)
3	946	1 (0.1%)	8 (0.8%)	16 (1.7%)	0 (0%)
4	950	0 (0%)	3 (0.3%)	5 (0.5%)	0 (0%)
5	974	0 (0%)	0 (0%)	0 (0%)	0 (0%)
6	933	0 (0%)	5 (0.5%)	5 (0.5%)	0 (0%)

* The percentage of missing values are based on dates that have either or both month and year of birth missing.

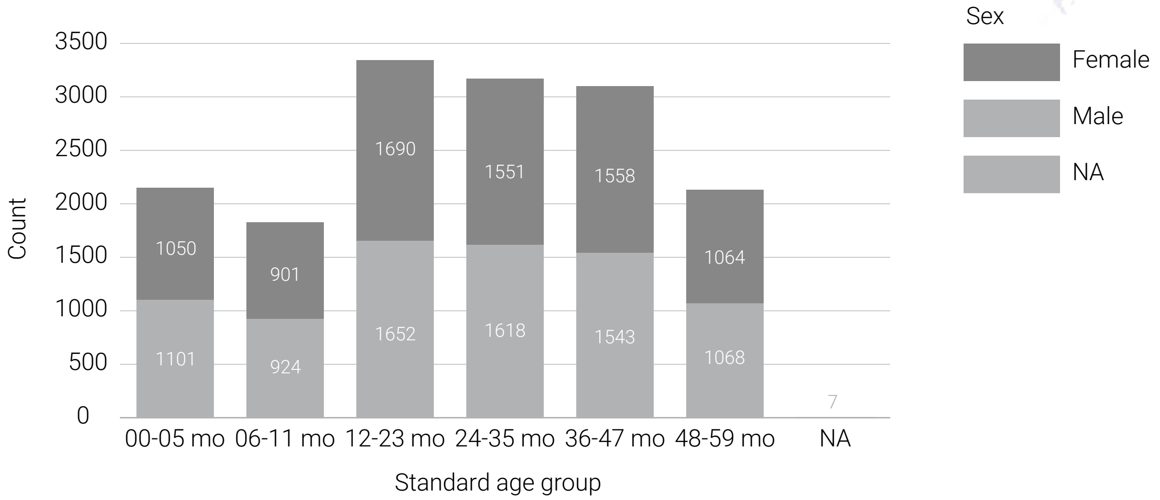
1.3. Missing data by Team

TEAM	N	AGE* (DAYS)	WEIGHT (KG)	LENGTH OR HEIGHT (CM)	SEX	GEOGRAPHICAL REGION
1	1059	4 (0.4%)	5 (0.5%)	5 (0.5%)	3 (0.3%)	0 (0%)
2	919	0 (0%)	0 (0%)	1 (0.1%)	0 (0%)	0 (0%)
3	1060	0 (0%)	3 (0.3%)	16 (1.5%)	0 (0%)	0 (0%)
4	887	1 (0.1%)	9 (1%)	20 (2.3%)	0 (0%)	0 (0%)
5	1016	2 (0.2%)	1 (0.1%)	8 (0.8%)	0 (0%)	0 (0%)
6	1052	0 (0%)	8 (0.8%)	15 (1.4%)	0 (0%)	0 (0%)
7	1181	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
8	1075	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

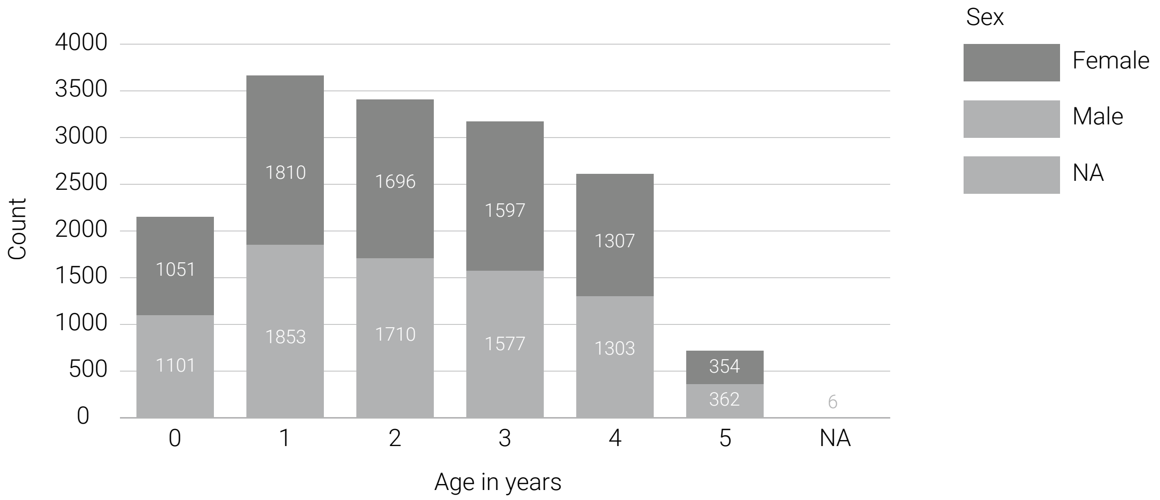
* The percentage of missing values are based on dates that have either or both month and year of birth missing.

2. Data Distribution

2.1. Distribution by standard age grouping and sex



2.2. Distribution by age in years and sex



3. Number of cases and proportions of mismatches between length/height measurement position and recommended position, by age group.

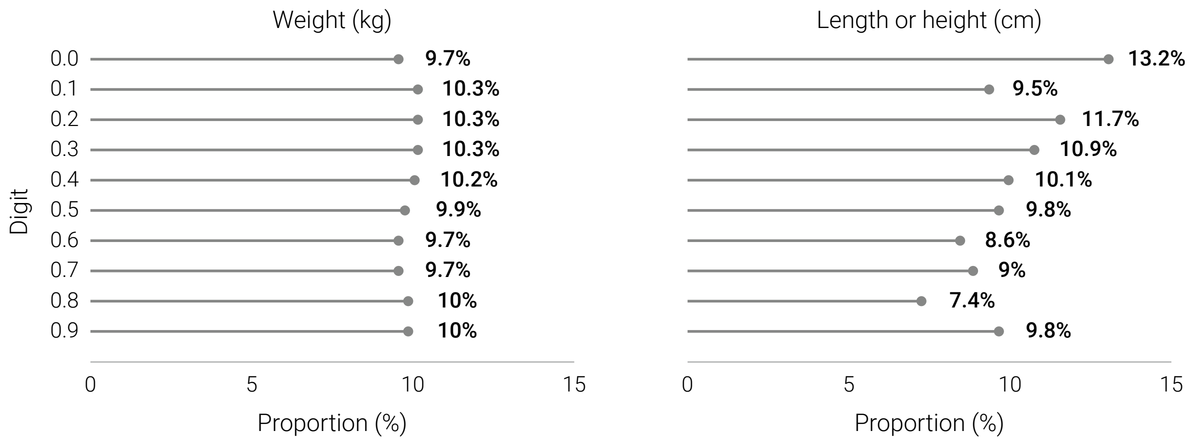
AGE GROUP	EXPECTED POSITION	TOTAL	OBSERVED MISMATCH*	% MISMATCH*
00-11 mo	lying	3504	515	14.7%
00-08 mo	lying	2780	405	14.6%
12-23 mo	lying	2980	515	17.3%
24-35 mo	standing	2797	1861	66.5%
36-47 mo	standing	2753	1009	36.7%
48-59 mo	standing	1871	548	29.3%
Total		13905	4448	32.0%

Number of children with missing information on measurement position: 1825

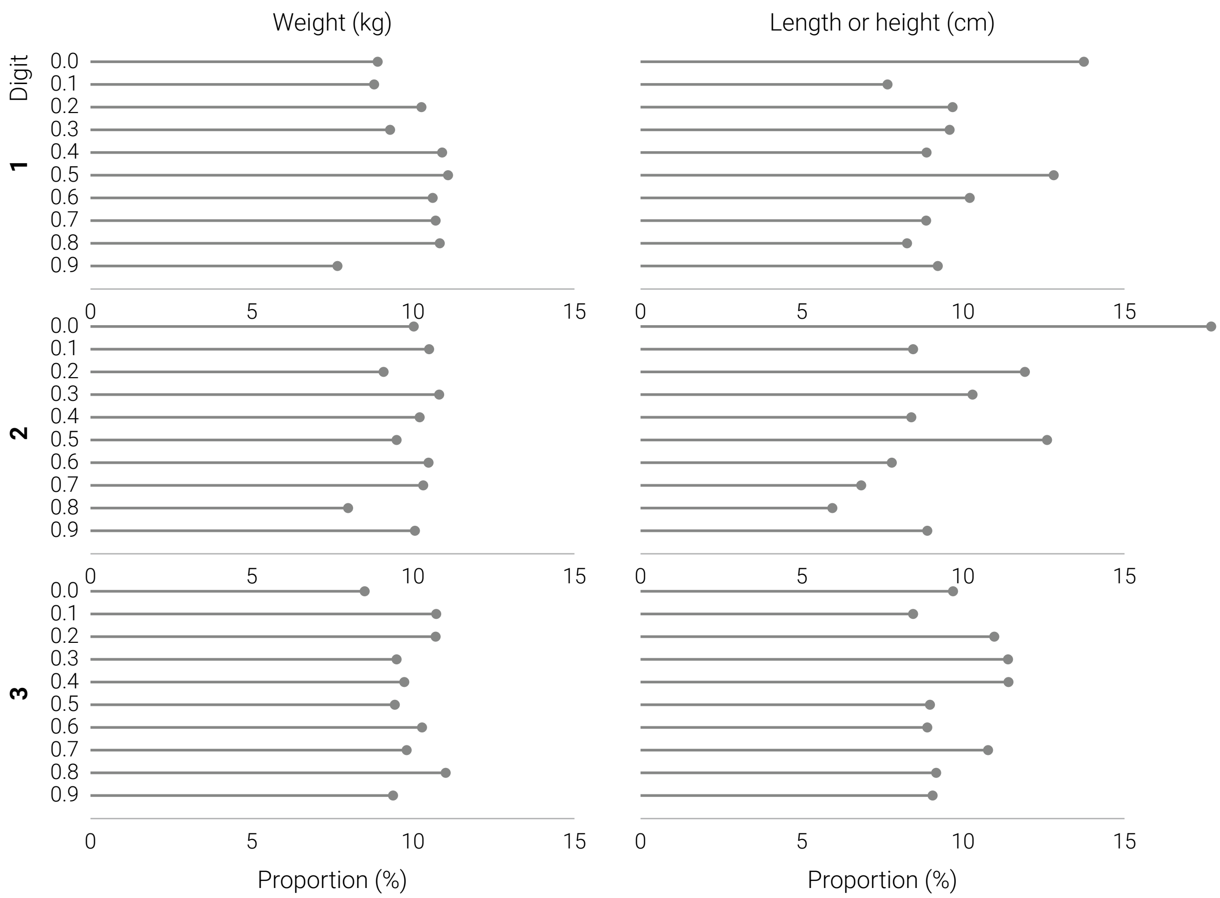
Mismatch means children under 24 months were measured standing (height) or children 24 months or older were measured laying down (recumbent length), as opposed to the recommendation.

4. Digit preference charts

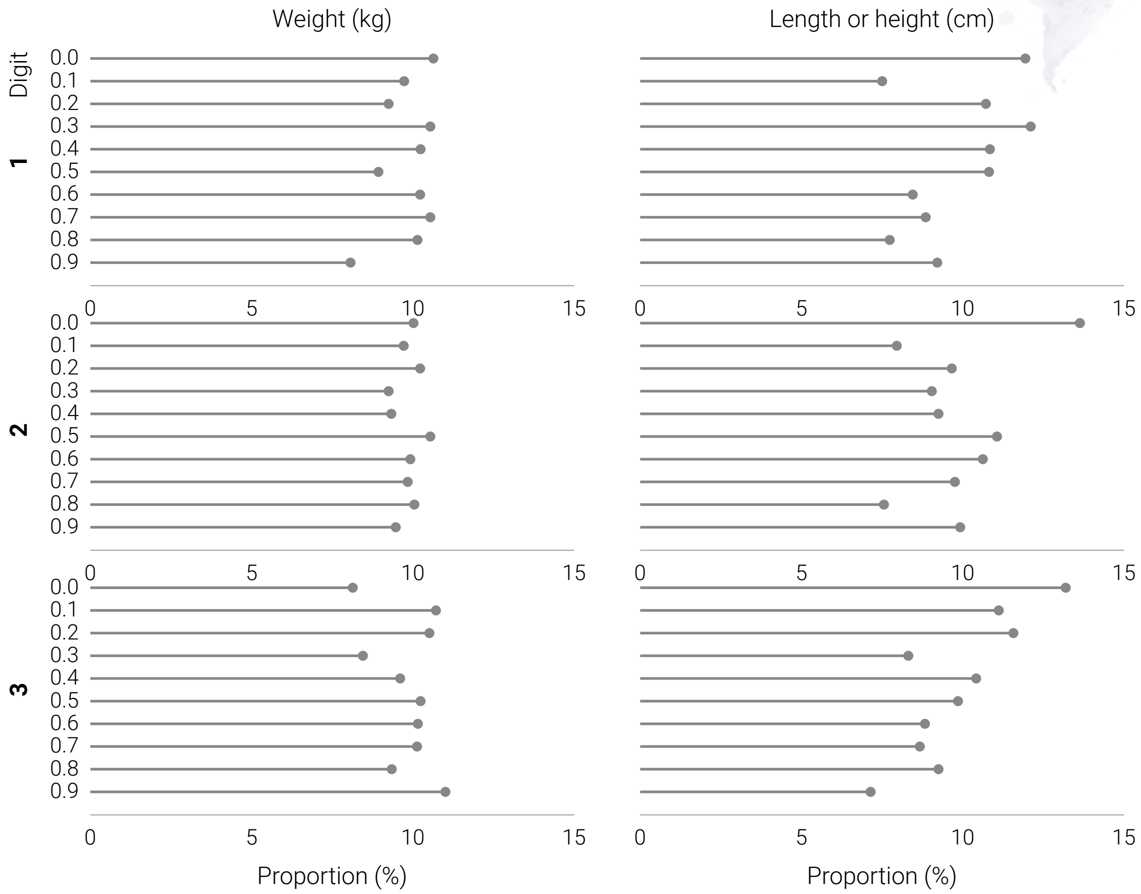
4.1. Decimal digit preference for weight and length/height



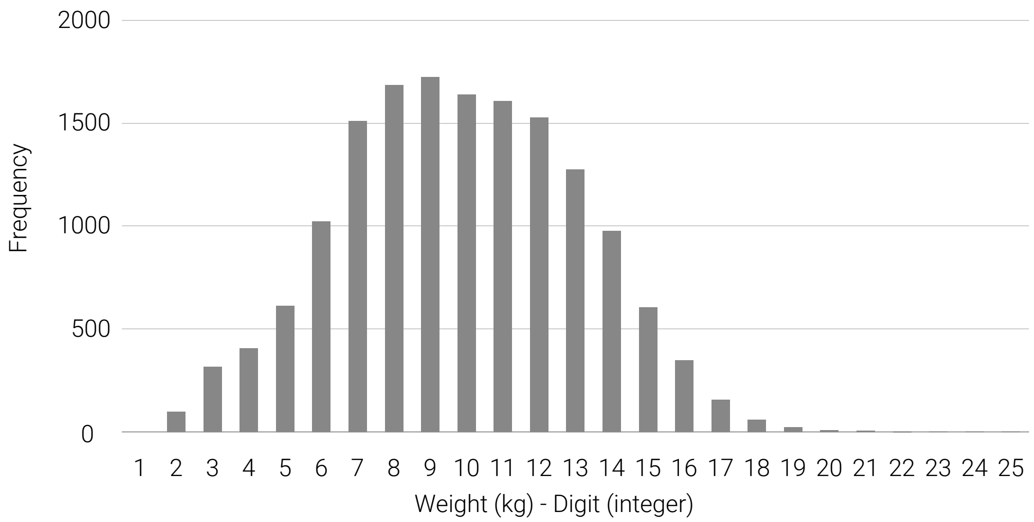
4.2. Decimal digit preference by Geographical Region



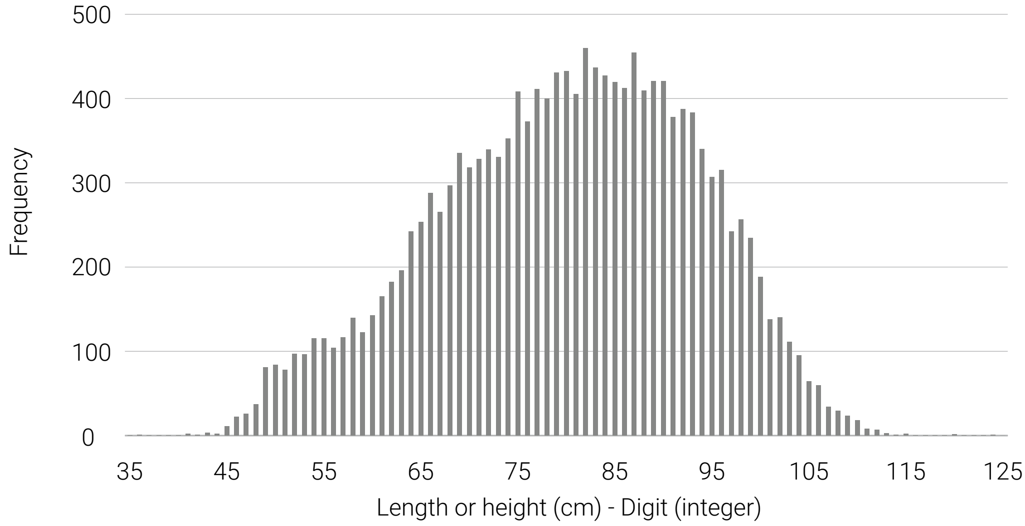
4.3. Decimal digit preference by Team



4.4. Whole number digit preference for weight

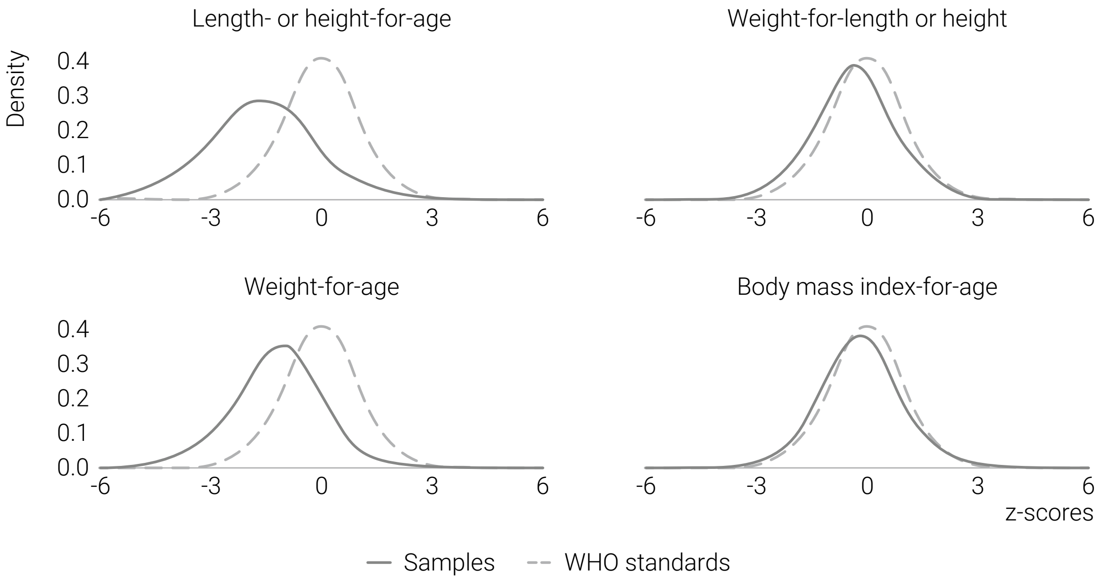


4.5. Whole number digit preference for length/height

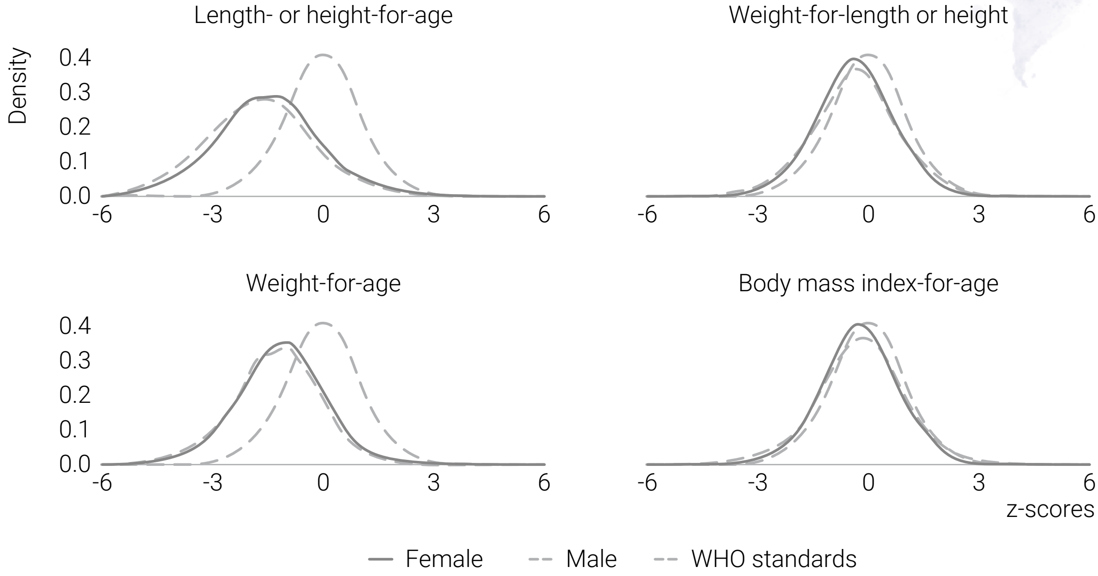


5. Z-score distribution of indicators

5.1. Z-score distribution by index

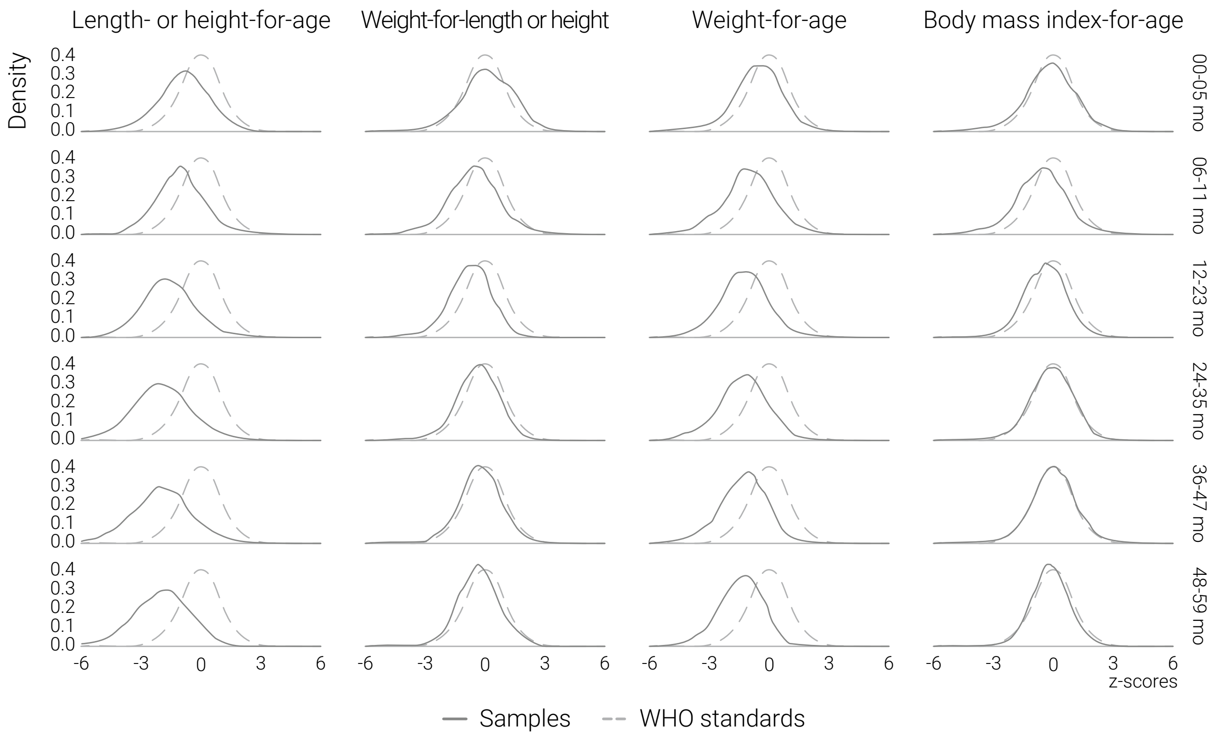


5.2. Z-score distribution by index and sex

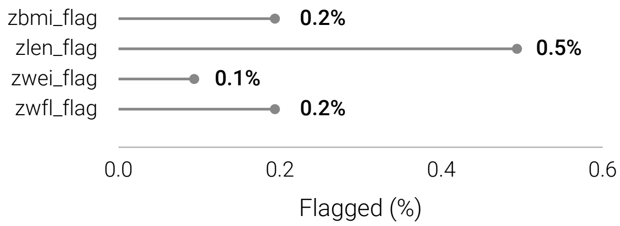


The standard normal density distribution curve is overlaid as a dashed-and-dotted line to provide a visuel reference.

5.3. Z-score distribution by index and age group



5.4. Percentage of flagged z-scores based on WHO flagging system by index



6. Z-score summary table

6.1. Z-score distribution unweighted summary statistics by index

GROUP	UNWEIGHTED N	MEAN (ZLEN)	STANDARD DEVIATION (ZLEN)	SKEWNESS (ZLEN)	KURTOSIS (ZLEN)	MEAN (ZWEI)	STANDARD DEVIATION (ZWEI)	SKEWNESS (ZWEI)	KURTOSIS (ZWEI)
All	15735	-1.62	1.50	0.26	3.94	-1.20	1.23	-0.17	3.43
Age group: 00-05 mo	2151	-0.83	1.42	0.15	4.23	-0.60	1.25	-0.40	4.20
Age group: 06-11 mo	1825	-0.99	1.47	0.65	5.36	-1.02	1.29	-0.16	3.54
Age group: 12-23 mo	3342	-1.57	1.46	0.57	4.75	-1.30	1.22	-0.06	3.53
Age group: 24-35 mo	3169	-1.94	1.45	0.22	3.42	-1.34	1.22	-0.26	3.11
Age group: 36-47 mo	3101	-1.96	1.44	0.09	3.24	-1.31	1.14	-0.30	3.23
Age group: 48-59 mo	2132	-2.00	1.38	-0.17	2.85	-1.45	1.09	-0.38	3.29
Sex: Male	7911	-1.72	1.53	0.35	4.14	-1.26	1.26	-0.12	3.39
Sex: Female	7821	-1.52	1.47	0.19	3.77	-1.14	1.20	-0.21	3.50
Team: 1	1059	-1.46	1.43	0.10	3.42	-1.21	1.19	-0.30	3.58
Team: 2	919	-1.33	1.51	0.37	4.27	-1.08	1.17	-0.09	3.41
Team: 3	1060	-1.55	1.63	0.46	3.86	-1.16	1.26	-0.10	3.55
Team: 4	887	-1.61	1.54	0.45	4.38	-1.17	1.23	-0.19	3.36
Team: 5	1016	-1.95	1.53	0.35	3.81	-1.45	1.29	-0.25	3.48
Team: 6	1052	-2.15	1.53	0.13	3.20	-1.48	1.27	-0.10	3.27
Team: 7	1181	-1.85	1.33	0.04	3.38	-1.38	1.16	-0.05	3.38
Team: 8	1075	-2.01	1.49	0.43	4.12	-1.46	1.24	0.05	3.42
Geographical region: 2	918	-1.12	1.51	0.19	4.06	-1.00	1.23	-0.32	3.78
Geographical region: 3	946	-1.87	1.59	0.46	4.46	-1.40	1.24	-0.21	3.36
Geographical region: 4	950	-1.32	1.49	0.56	4.42	-0.90	1.17	0.01	3.22
Geographical region: 5	974	-1.20	1.30	0.06	3.99	-0.69	1.08	-0.11	3.51

GROUP	UNWEIGHTED N	MEAN (ZLEN)	STANDARD DEVIATION (ZLEN)	SKEWNESS (ZLEN)	KURTOSIS (ZLEN)	MEAN (ZWEI)	STANDARD DEVIATION (ZWEI)	SKEWNESS (ZWEI)	KURTOSIS (ZWEI)
Geographical region: 6	933	-1.70	1.30	0.07	3.73	-1.34	1.19	-0.37	3.58

6.2. Z-score distribution unweighted summary statistics by index (continued)

GROUP	UNWEIGHTED N	MEAN (ZBMI)	STANDARD DEVIATION (ZBMI)	SKEWNESS (ZBMI)	KURTOSIS (ZBMI)	MEAN (ZWFL)	STANDARD DEVIATION (ZWFL)	SKEWNESS (ZWFL)	KURTOSIS (ZWFL)
All	15735	-0.23	1.13	-0.20	3.84	-0.36	1.15	-0.03	3.82
Age group: 00-05 mo	2151	-0.15	1.23	-0.11	3.72	0.14	1.29	-0.11	3.48
Age group: 06-11 mo	1825	-0.60	1.24	-0.15	3.58	-0.55	1.24	-0.01	3.88
Age group: 12-23 mo	3342	-0.46	1.12	-0.13	3.98	-0.71	1.10	-0.06	3.82
Age group: 24-35 mo	3169	-0.11	1.08	-0.29	3.72	-0.37	1.07	-0.17	3.93
Age group: 36-47 mo	3101	0.01	1.06	-0.17	3.86	-0.21	1.04	-0.05	3.77
Age group: 48-59 mo	2132	-0.16	1.00	-0.03	4.14	-0.32	1.02	-0.06	3.91
Sex: Male	7911	-0.22	1.19	-0.27	3.78	-0.38	1.20	-0.09	3.60
Sex: Female	7821	-0.24	1.08	-0.10	3.86	-0.33	1.10	0.05	4.05
Team: 1	1059	-0.42	1.14	-0.07	4.21	-0.54	1.13	-0.07	3.78
Team: 2	919	-0.32	1.08	-0.01	3.57	-0.44	1.09	0.06	3.48
Team: 3	1060	-0.22	1.18	-0.26	3.92	-0.36	1.18	-0.13	4.15
Team: 4	887	-0.18	1.16	-0.16	3.67	-0.28	1.20	0.20	3.77
Team: 5	1016	-0.27	1.15	-0.33	3.96	-0.43	1.18	-0.10	3.81
Team: 6	1052	-0.07	1.10	-0.24	4.03	-0.26	1.09	-0.21	3.59
Geographical region: 1	812	-0.43	1.07	0.17	4.65	-0.53	1.07	0.25	4.12
Geographical region: 2	918	-0.43	1.11	-0.11	3.86	-0.52	1.12	-0.08	3.76
Geographical region: 3	946	-0.24	1.15	-0.28	4.06	-0.40	1.15	-0.12	3.77
Geographical region: 4	950	-0.09	1.13	-0.23	3.88	-0.18	1.17	0.01	4.13
Geographical region: 5	974	0.09	1.10	-0.07	3.37	0.01	1.11	0.03	3.66
Geographical region: 6	933	-0.39	1.21	-0.49	4.08	-0.50	1.21	-0.30	3.80

Annex: Summary of recommended data quality checks

The Working Group (WG) on Anthropometry Data Quality recommendation is that data quality be assessed and reported based on assessment on the following 7 parameters: (i) Completeness; (ii) Sex ratio; (iii) Age distribution; (iv) Digit preference of heights and weights; (v) Implausible z score values; (vi) Standard deviation of z scores; and (vii) Normality of z scores.

The WG recommends that (i) data quality checks should not be considered in isolation; (ii) formal tests or scoring should not be conducted; (iii) the checks should be used to help users identify issues with the data quality to improve interpretation of the malnutrition estimates from the survey. Although not exhaustive, a summary of details on the various checks is provided below to help their use. Full details and more comprehensive guidance, including on how to calculate, can be found at the full report on the WG's recommendations[3].

(i) Completeness: although not all statistics are included in the WHO Anthro Survey Analyser, report on structural integrity of the aspects listed below should be included in the final report:

– PSUs: % of selected PSUs that were visited;

– Households: % of selected households in the PSUs interviewed or recorded as not interviewed (specifying why);

– Household members: % of household rosters that were completed;

– Children: % of all eligible children are interviewed and measured, or recorded as not interviewed or measured (specifying why), with no duplicate cases;

– Dates of birth: % of dates of birth for all eligible children that were complete.

(ii) Sex ratio:

– What - ratio of girls to boys in the survey and compare to expected for country. The observed ratios should be compared to the expect patterns based on reliable sources;

– Why – to identify potential selection biases.

(iii) Age distribution:

– What – age distributions by age in completed years (6 bars weighted), months (72 bars) and calendar month of birth (12 bars), as histograms;

– Why – to identify potential selection biases or misreporting.

(iv) Height and weight digit preference:

– What –terminal digits as well as whole number integer distributions through histograms;

– Why – Digit preference may be a tell-tale sign of data fabrication or inadequate care and attention during data collection and recording. When possible, it should be presented by team or other relevant disaggregation categories.

(v) Implausible z score values:

– What – the % of cases outside of WHO flags[4] for each HAZ, WHZ and WAZ;

– Why – a percent above 1% can be indicative of potential data quality issues in measurements or age determination It should be presented by team or other relevant disaggregation categories.

(vi) Standard deviations:

– What –SD for each HAZ, WHZ and WAZ;

– Why – large SDs may be a sign of data quality problems and/or population heterogeneity. It is unclear what causes SD's size and more research is needed to determine appropriate interpretation. It should be noted that SDs are typically wider for HAZ than WHZ or WAZ, and that HAZ SD is typically widest in youngest (0-5 mo) and increases as children age through to 5 years. No substantial difference should be observed between boys and girls. It should be presented by team or other relevant disaggregation categories.

(vii) Checks of normality:

– What – measures of asymmetry (skew) and tailedness (kurtosis) of HAZ, WHZ and WAZ, as well as density plots;

3 Working Group on Anthropometric Data Quality, for the WHO-UNICEF Technical Expert Advisory Group on Nutrition Monitoring (TEAM). Recommendations for improving the quality of anthropometric data and its analysis and reporting. Available at www.who.int/nutrition/team (under "Technical reports and papers").

4 WHO Anthro Software for personal computers - Manual (2011). Available at www.who.int/childgrowth/software/anthro_pc_manual_v322.pdf?ua=1.

– Why – general assumption that 3 indices are normally distributed but unclear if applicable to populations with varying patterns of malnutrition. One can use the rule of thumb ranges of <-0.5 or >+0.5 for skewness to indicate asymmetry and <2 or >4 for kurtosis to indicate heavy or light tails. Further research needed to understand patterns in different contexts. Anyhow the comparisons amongst the distribution by disaggregation categories might help with the interpretation of results.

SURVEY OUTPUTS REPORT (RESULTS FROM WHO ANTHRO SURVEY ANALYSER)

SURVEY TITLE:

ADD SURVEY DETAILS: field work period, context Information, Information on training, limitations on access to selected households, etc.

AUTHOR:

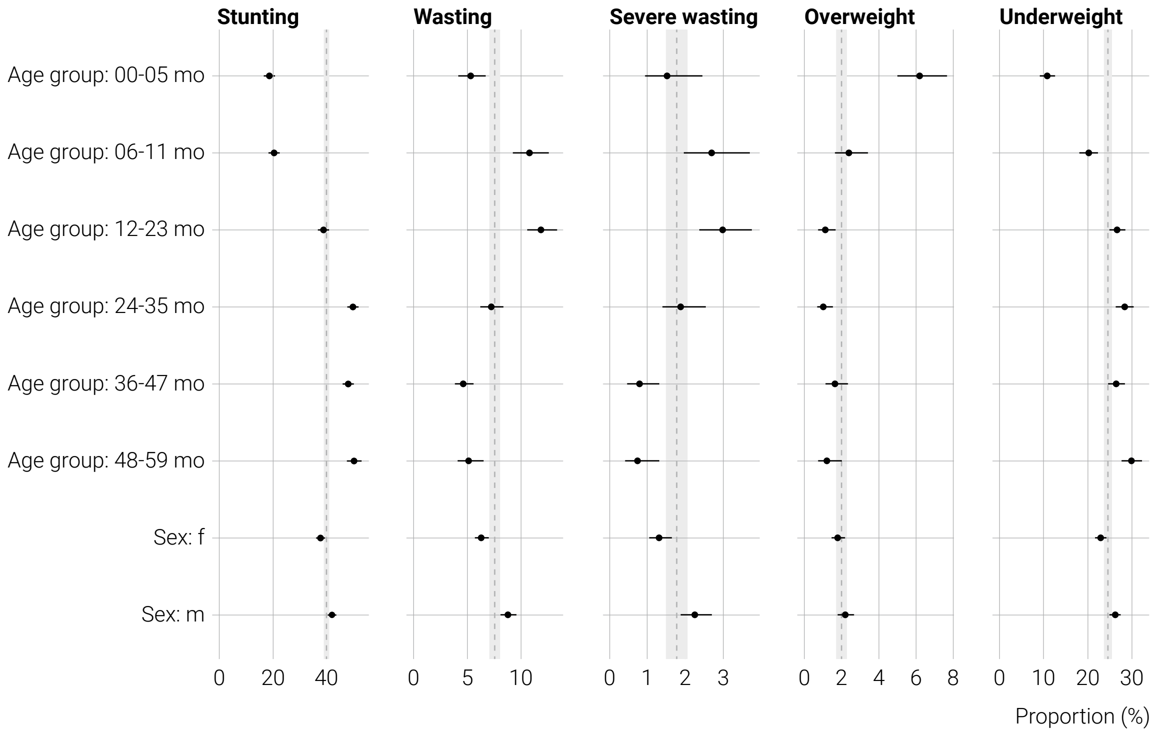
Recommended citation: "Report template with results from WHO Anthro Survey Analyser". Analysis date:

Link: https://whonutrition.shinyapps.io/anthro/)

Overall survey results summary

i) Outcome plots

Figure 1: Nutritional status by stratification variable



ii) Summary on survey description

2.1 Sample size: The original sample was of 15741 children. There were 15735 children retained after filtering for **[INSERT DETAILS OF ANY FILTERING APPLIED]**; height measurements were obtained for 15580 (99%) children and weight measurements were obtained for 15647 (99.4%). There were 3 (0%) children with missing information on sex and there were 13 (0.1%) children with missing age and 2 (0%) children with negative values for age. There were 6 (0%) children aged greater than sixty months who were excluded from the analysis. There were 39 cases of oedema reported.

2.2 Sample design:

2.3 Household listing (source or how was it done to update existing information):

2.4 Training of field staff: How many, how many teams, how many measurements per team per day:

2.5 Standardization:

2.6 Equipment and calibration:

2.7 Data collection period:

2.8 Data collection: Start: **[enter month and year the survey started MM/YYYY]**; End: **[enter month and year the survey ended MM/YYYY]**

2.9 Data entry:

2.10 Supervision:

Other survey context important for the interpretation of results: seasonality (e.g. harvest and malaria), climate conditions (e.g. monsoon, drought, natural catastrophes), epidemics, high mortality, security issues, civil unrest, population groups not covered (e.g. slums, refugees), etc:

iii) Summary of survey analysis

3.1 Data processing: Software;

3.2 Data cleaning;

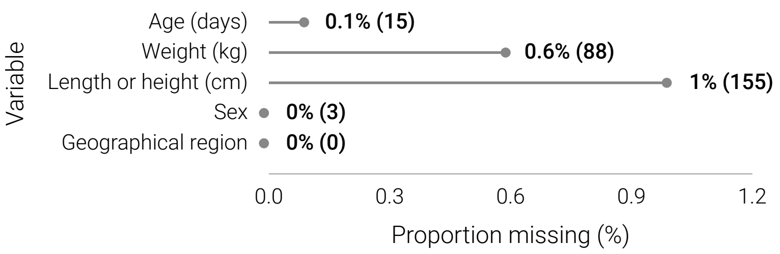
3.3 Imputations.

iv)Data quality indicators and assessment:

4.1 Flags: Flags were calculated as follows: There were 78 (0.5%) flags for length- or height-for-age, 11 (0.1%) flags for weight-for-age, 31 (0.2%) flags for body mass index-for-age, 26 (0.2%) flags for weight-for-length or height.

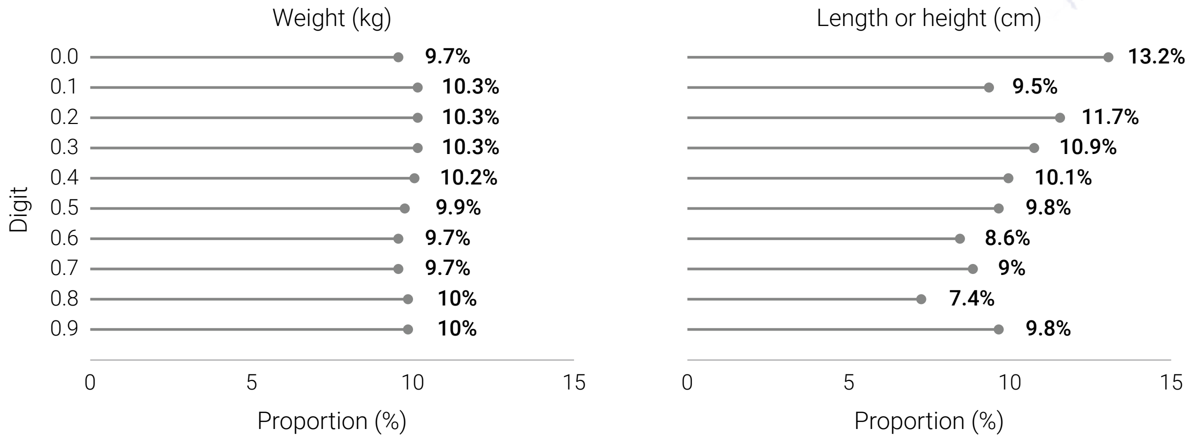
4.2 Missing data

Figure 2: Missing data



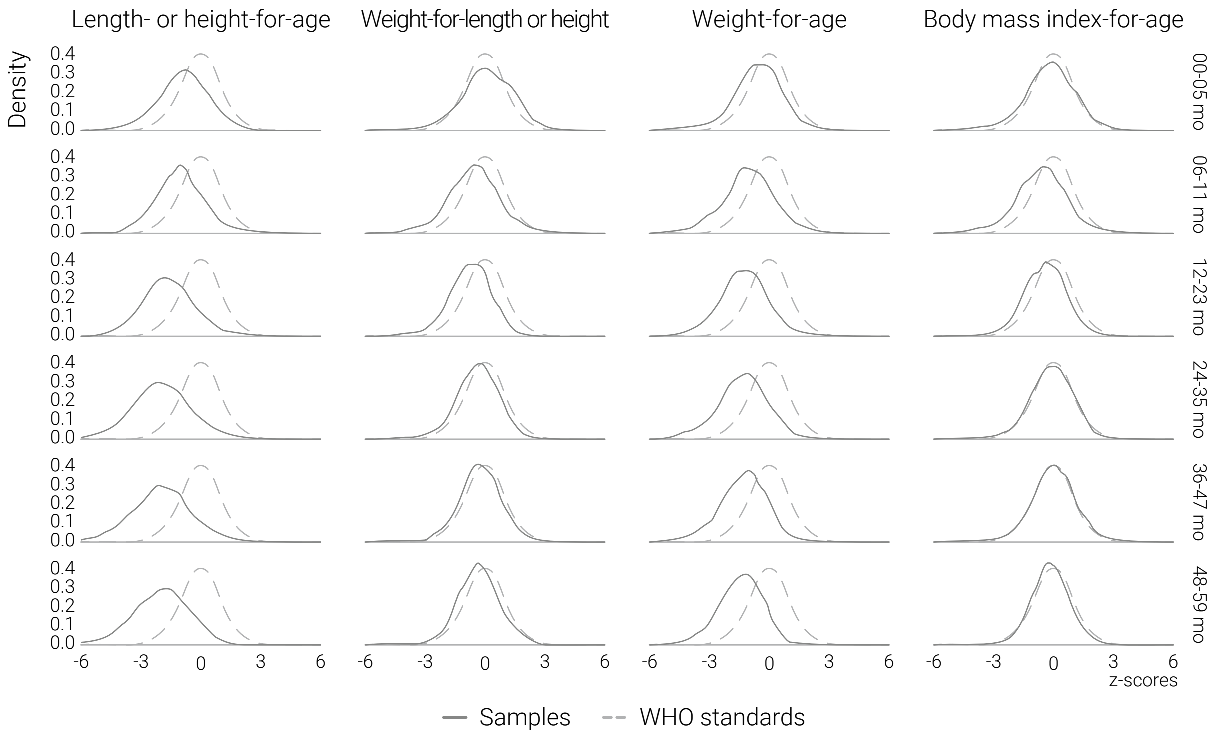
4.3 Digit heaping charts (with mapping variable labels)

Figure 3: Digit preference for weight & height measurements



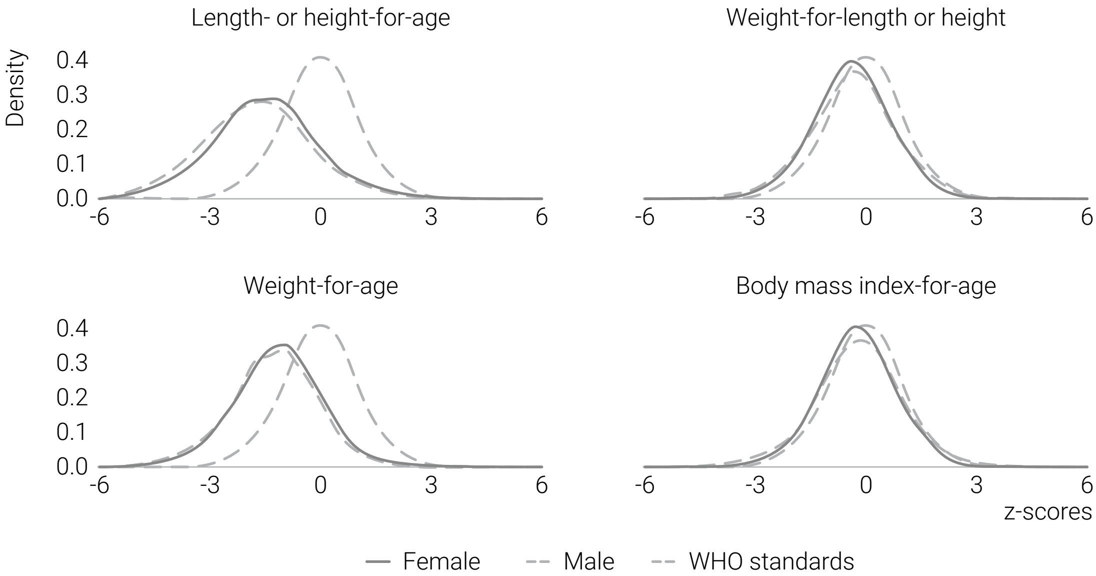
4.4 Distribution issues:

Figure 4: Z-score distributions by age group



The standard normal density distribution curve is overlaid as a dashed-and-dotted line to provide a visuel reference.

Figure 5: Z-score distributions by sex



The standard normal density distribution curve is overlaid as a dashed-and-dotted line to provide a visuel reference.

Figure 6: Z-score distributions by geographical region

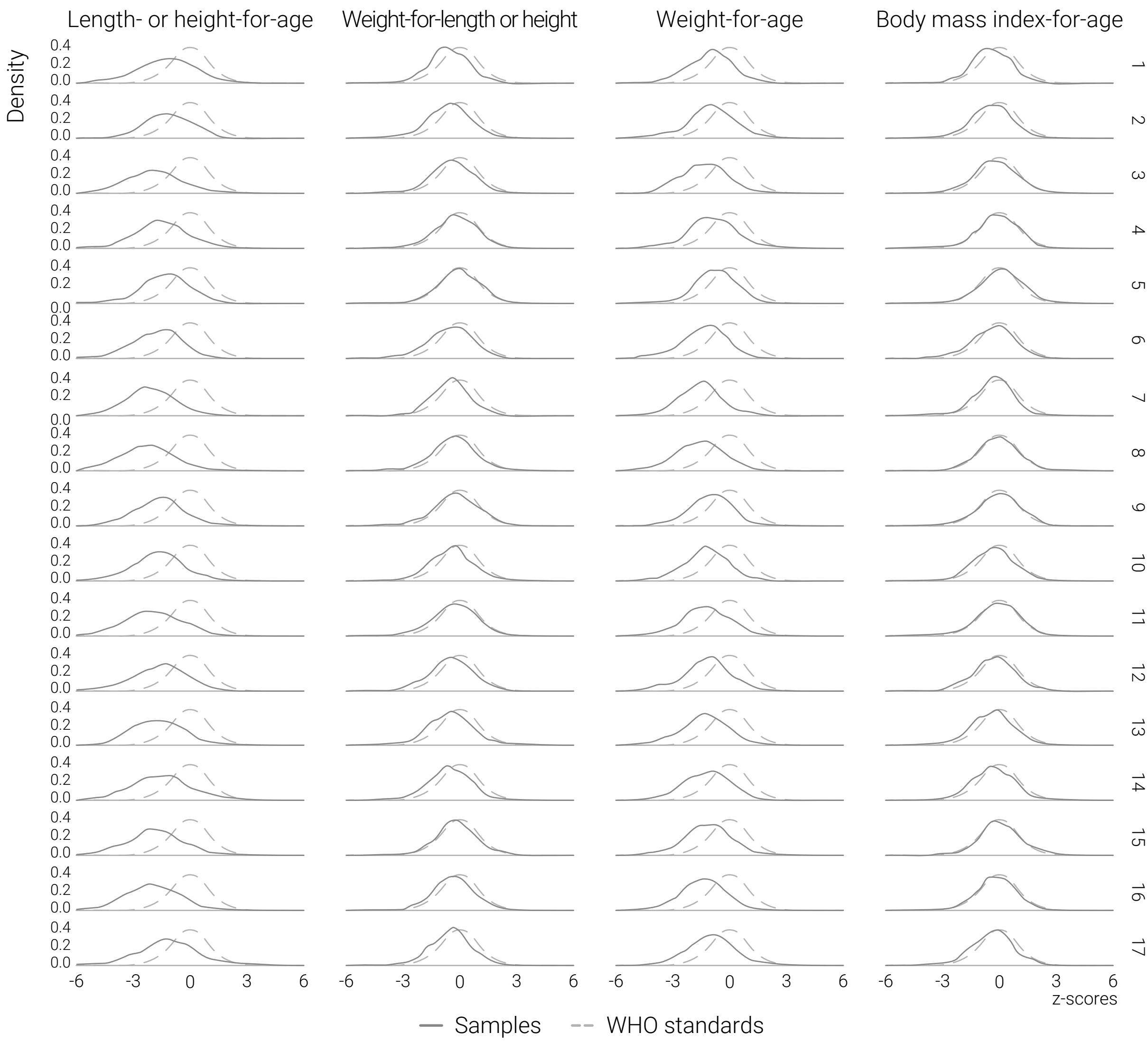


Figure 7: z-score distribution violin plot by age group

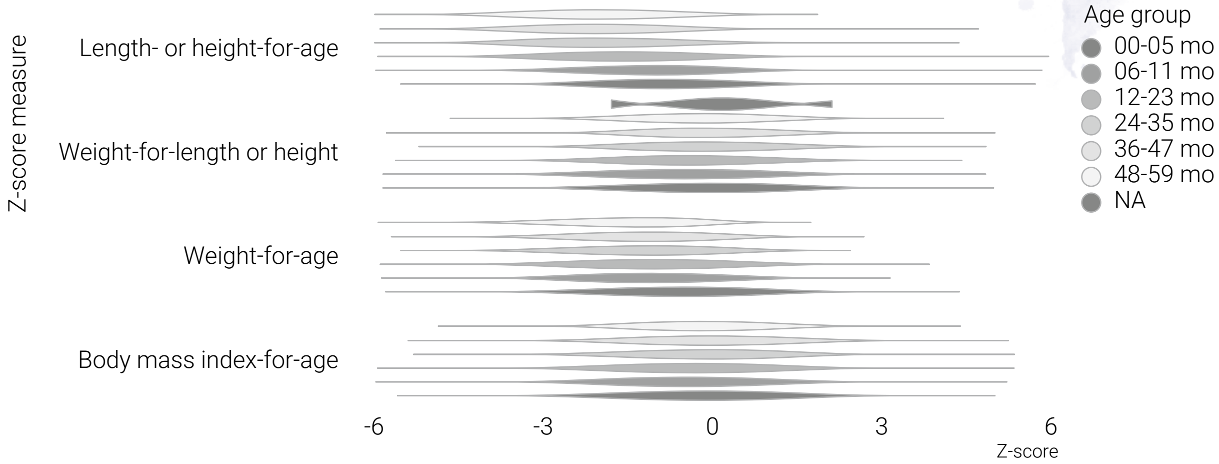
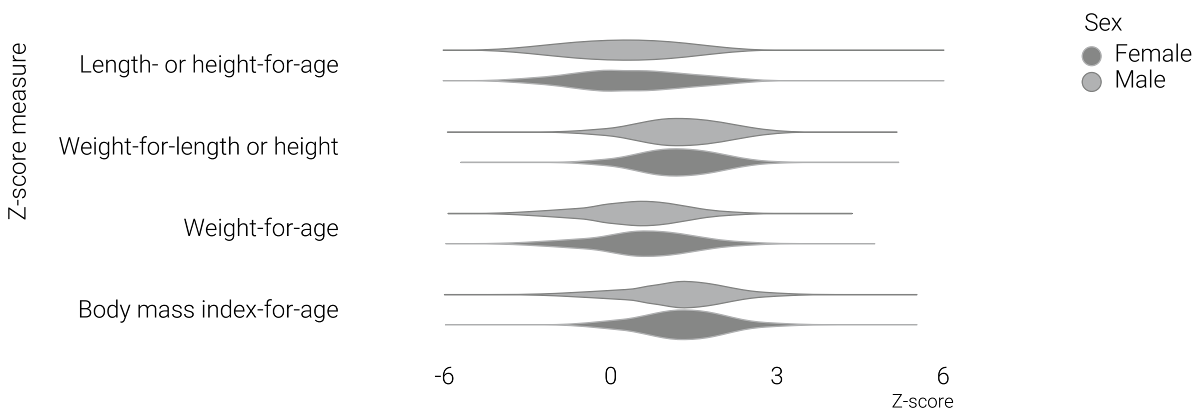


Figure 8: z-score distribution violin plot by sex



v) Appendix: Nutritional status tables

5.1 Height-for-age

GROUP	WEIGHTED N	UNWEIGHTED N	-3SD (95% CI)	-2SD (95% CI)	Z-SCORE SD
All	15272.0	15496	17.1 (16.2; 18.1)	39.7 (38.4; 41.0)	1.54
Age group: 00-05 mo	1930.4	2058	5.7 (4.6; 7.1)	18.6 (16.6; 20.8)	1.45
Age group: 06-11 mo	1765.1	1812	5.8 (4.7; 7.1)	20.3 (18.1; 22.7)	1.46
Age group: 12-23 mo	3196.3	3313	14.7 (13.2; 16.3)	38.7 (36.5; 41.0)	1.50
Age group: 24-35 mo	3178.6	3136	22.2 (20.4; 24.1)	49.6 (47.3; 51.9)	1.48
Age group: 36-47 mo	3058.9	3068	23.0 (21.2; 25.0)	47.8 (45.5; 50.2)	1.48

GROUP	WEIGHTED N	UNWEIGHTED N	-3SD (95% CI)	-2SD (95% CI)	Z-SCORE SD
Age group: 48-59 mo	2142.7	2109	24.2 (22.0; 26.6)	50.0 (47.2; 52.8)	1.40
Sex: f	7605.5	7720	14.9 (13.8; 16.0)	37.6 (36.0; 39.2)	1.51
Sex: m	7666.4	7776	19.3 (18.1; 20.5)	41.8 (40.3; 43.4)	1.56
Age + sex: 00-05 mo.f	963.5	1006	3.8 (2.7; 5.4)	15.2 (12.7; 18.2)	1.44
Age + sex: 06-11 mo.f	878.7	896	3.3 (2.2; 4.9)	16.5 (13.9; 19.4)	1.40
Age + sex: 12-23 mo.f	1593.8	1677	12.1 (10.2; 14.2)	36.3 (33.3; 39.4)	1.40
Age + sex: 24-35 mo.f	1559.4	1542	19.2 (17.0; 21.5)	47.0 (43.8; 50.2)	1.45
Age + sex: 36-47 mo.f	1548.8	1545	21.4 (18.9; 24.0)	45.6 (42.6; 48.7)	1.45
Age + sex: 48-59 mo.f	1061.3	1054	22.9 (20.1; 26.1)	51.8 (47.9; 55.6)	1.37
Age + sex: 00-05 mo.m	966.9	1052	7.7 (5.9; 9.9)	21.9 (19.0; 25.1)	1.45
Age + sex: 06-11 mo.m	886.3	916	8.2 (6.4; 10.5)	24.2 (21.0; 27.7)	1.50
Age + sex: 12-23 mo.m	1602.5	1636	17.3 (15.1; 19.7)	41.1 (38.0; 44.3)	1.59
Age + sex: 24-35 mo.m	1619.2	1594	25.1 (22.7; 27.7)	52.2 (49.2; 55.1)	1.50
Age + sex: 36-47 mo.m	1510.2	1523	24.8 (22.1; 27.6)	50.0 (46.7; 53.4)	1.51
Age + sex: 48-59 mo.m	1081.4	1055	25.4 (22.3; 28.8)	48.3 (44.6; 52.1)	1.42
Geographical region: 1	171.3	806	10.3 (8.3; 12.7)	27.3 (24.4; 30.4)	1.53
Geographical region: 2	2501.9	880	9.3 (6.8; 12.7)	26.1 (21.7; 31.1)	1.51
Geographical region: 3	964.8	921	24.0 (20.7; 27.7)	47.8 (43.2; 52.4)	1.59
Geographical region: 4	357.3	945	11.2 (8.9; 14.0)	31.6 (28.2; 35.3)	1.49
Geographical region: 5	228.6	972	7.2 (5.7; 9.0)	25.8 (22.1; 29.9)	1.30
Geographical region: 6	467.5	926	15.6 (12.6; 19.1)	40.2 (35.5; 45.1)	1.30

4.2 Weight-for-age

GROUP	WEIGHTED N	UNWEIGHTED N	-3SD (95% CI)	-2SD (95% CI)	Z-SCORE SD	OEDEMA_ CASES
All	15457.8	15630	8.3 (7.7; 9.0)	24.6 (23.6; 25.6)	1.24	39
Age group: 00-05 mo	2023.6	2114	4.0 (3.0; 5.2)	10.8 (9.2; 12.6)	1.26	0
Age group: 06-11 mo	1772.5	1818	7.1 (5.8; 8.6)	20.2 (18.1; 22.4)	1.29	3
Age group: 12-23 mo	3219.0	3330	8.9 (7.7; 10.2)	26.6 (24.8; 28.6)	1.25	14
Age group: 24-35 mo	3198.5	3155	10.4 (9.1; 11.8)	28.3 (26.4; 30.4)	1.22	15
Age group: 36-47 mo	3083.1	3088	8.7 (7.5; 10.0)	26.4 (24.6; 28.4)	1.17	5
Age group: 48-59 mo	2161.1	2125	9.0 (7.7; 10.6)	29.9 (27.6; 32.3)	1.09	2
Sex: f	7676.5	7771	7.2 (6.5; 8.0)	22.9 (21.6; 24.3)	1.21	18
Sex: m	7781.3	7859	9.4 (8.5; 10.4)	26.2 (25.0; 27.5)	1.27	21
Age + sex: 00-05 mo.f	1006.7	1033	3.6 (2.5; 5.3)	9.0 (6.9; 11.6)	1.23	0
Age + sex: 06-11 mo.f	881.8	899	4.6 (3.2; 6.6)	17.7 (14.9; 20.8)	1.23	1
Age + sex: 12-23 mo.f	1600.3	1682	6.3 (5.0; 8.0)	24.9 (22.4; 27.7)	1.19	6
Age + sex: 24-35 mo.f	1562.9	1546	9.4 (7.8; 11.3)	26.2 (23.6; 29.0)	1.21	8
Age + sex: 36-47 mo.f	1557.0	1551	8.2 (6.7; 10.0)	25.1 (22.6; 27.8)	1.15	2
Age + sex: 48-59 mo.f	1067.8	1060	9.4 (7.5; 11.7)	29.4 (26.2; 32.9)	1.07	1
Age + sex: 00-05 mo.m	1016.9	1081	4.3 (3.0; 6.1)	12.6 (10.4; 15.3)	1.28	0
Age + sex: 06-11 mo.m	890.7	919	9.5 (7.5; 12.1)	22.7 (19.6; 26.2)	1.35	2
Age + sex: 12-23 mo.m	1618.8	1648	11.4 (9.7; 13.4)	28.3 (25.8; 30.9)	1.30	8
Age + sex: 24-35 mo.m	1635.6	1609	11.3 (9.6; 13.2)	30.3 (27.6; 33.2)	1.23	7
Age + sex: 36-47 mo.m	1526.1	1537	9.1 (7.4; 11.1)	27.8 (25.1; 30.7)	1.19	3
Age + sex: 48-59 mo.m	1093.3	1065	8.7 (6.9; 10.8)	30.4 (27.2; 33.7)	1.11	1
Geographical region: 1	171.5	807	5.7 (4.2; 7.7)	20.3 (17.3; 23.8)	1.20	0

GROUP	WEIGHTED N	UNWEIGHTED N	-3SD (95% CI)	-2SD (95% CI)	Z-SCORE SD	OEDEMA_CASES
Geographical region: 2	2536.1	892	7.0 (4.7; 10.1)	17.8 (14.9; 21.2)	1.23	2
Geographical region: 3	981.6	937	10.5 (8.7; 12.6)	29.5 (25.7; 33.5)	1.24	4
Geographical region: 4	358.1	947	4.3 (3.2; 5.8)	15.0 (12.4; 18.0)	1.17	0
Geographical region: 5	228.9	973	2.0 (1.2; 3.1)	9.2 (7.1; 12.0)	1.08	1
Geographical region: 6	468.0	927	9.5 (7.4; 12.1)	26.5 (23.3; 30.1)	1.19	4

There were 39 cases of bilateral oedema, for which weight-for-age and weight-for-height z-scores were considered as below -3 for prevalence calculation purposes.

4.3 Weight-for-height

GROUP	WEIGHTED N	UNWEIGHTED N	-3SD (95% CI)	-2SD (95% CI)	Z-SCORE SD	OEDEMA_CASES	Z-SCORE SD	OEDEMA_CASES
All	15324.5	15541	1.8 (1.5; 2.1)	7.5 (7.0; 8.1)	2.0 (1.7; 2.3)	0.4 (0.3; 0.5)	1.15	39
Age group: 00-05 mo	1917.9	2049	1.5 (0.9; 2.5)	5.3 (4.1; 6.7)	6.2 (5.0; 7.7)	1.5 (0.9; 2.3)	1.30	0
Age group: 06-11 mo	1769.9	1815	2.7 (2.0; 3.7)	10.8 (9.2; 12.6)	2.4 (1.7; 3.4)	0.5 (0.2; 1.1)	1.23	3
Age group: 12-23 mo	3207.9	3321	3.0 (2.3; 3.7)	11.9 (10.5; 13.4)	1.1 (0.7; 1.7)	0.2 (0.1; 0.5)	1.12	14
Age group: 24-35 mo	3192.6	3149	1.9 (1.4; 2.5)	7.2 (6.2; 8.4)	1.0 (0.7; 1.5)	0.2 (0.1; 0.5)	1.08	15
Age group: 36-47 mo	3069.5	3078	0.8 (0.5; 1.3)	4.6 (3.8; 5.6)	1.6 (1.1; 2.3)	0.2 (0.1; 0.5)	1.04	5
Age group: 48-59 mo	2158.8	2123	0.7 (0.4; 1.3)	5.1 (4.0; 6.5)	1.2 (0.7; 2.0)	0.1 (0.0; 0.5)	1.02	2
Sex: f	7622.1	7732	1.3 (1.0; 1.6)	6.3 (5.7; 7.0)	1.8 (1.5; 2.2)	0.4 (0.3; 0.6)	1.11	18
Sex: m	7702.3	7809	2.2 (1.9; 2.7)	8.8 (8.0; 9.6)	2.2 (1.8; 2.7)	0.3 (0.2; 0.5)	1.19	21
Age + sex: 00-05 mo.f	956.7	999	1.0 (0.5; 2.2)	4.5 (3.1; 6.4)	4.8 (3.4; 6.7)	1.1 (0.5; 2.3)	1.23	0
Age + sex: 06-11 mo.f	880.0	898	2.4 (1.4; 4.0)	9.4 (7.3; 12.0)	2.6 (1.6; 4.3)	0.7 (0.3; 1.7)	1.20	1

GROUP	WEIGHTED N	UNWEIGHTED N	-3SD (95% CI)	-2SD (95% CI)	Z-SCORE SD	OEDEMA_CASES	Z-SCORE SD	OEDEMA_CASES
Age + sex: 12-23 mo.f	1596.9	1678	1.7 (1.1; 2.5)	9.1 (7.4; 11.1)	1.2 (0.7; 2.1)	0.2 (0.0; 0.5)	1.06	6
Age + sex: 24-35 mo.f	1561.6	1544	1.7 (1.1; 2.7)	6.0 (4.7; 7.7)	0.9 (0.5; 1.7)	0.4 (0.2; 1.0)	1.06	8
Age + sex: 36-47 mo.f	1554.1	1549	0.6 (0.3; 1.4)	4.1 (3.1; 5.5)	1.5 (0.9; 2.4)	0.3 (0.1; 0.8)	1.02	2
Age + sex: 48-59 mo.f	1067.8	1060	0.5 (0.1; 1.6)	4.7 (3.4; 6.6)	1.0 (0.5; 2.0)	0.2 (0.0; 1.0)	1.01	1
Age + sex: 00-05 mo.m	961.2	1050	2.0 (1.1; 3.7)	6.1 (4.4; 8.2)	7.6 (5.9; 9.7)	1.8 (1.0; 3.2)	1.37	0
Age + sex: 06-11 mo.m	889.9	917	3.0 (2.0; 4.4)	12.2 (10.0; 14.8)	2.1 (1.3; 3.6)	0.3 (0.1; 1.1)	1.27	2
Age + sex: 12-23 mo.m	1611.0	1643	4.3 (3.2; 5.6)	14.7 (12.7; 16.9)	1.1 (0.6; 2.0)	0.2 (0.0; 1.1)	1.17	8
Age + sex: 24-35 mo.m	1631.0	1605	2.0 (1.3; 3.1)	8.3 (6.8; 10.2)	1.1 (0.6; 2.0)	0.0 (0.0; 0.1)	1.09	7
Age + sex: 36-47 mo.m	1515.4	1529	1.0 (0.5; 1.9)	5.1 (3.9; 6.6)	1.7 (1.1; 2.8)	0.1 (0.0; 0.4)	1.07	3
Age + sex: 48-59 mo.m	1091.0	1063	1.0 (0.6; 1.8)	5.5 (4.0; 7.4)	1.4 (0.8; 2.7)	0.1 (0.0; 0.2)	1.04	1
Geographical region: 1	171.5	807	1.1 (0.6; 2.1)	8.1 (5.8; 11.1)	1.1 (0.6; 1.9)	0.5 (0.2; 1.3)	1.07	0
Geographical region: 2	2507.6	882	1.9 (1.2; 3.2)	8.3 (6.6; 10.3)	1.4 (0.8; 2.4)	0.3 (0.1; 1.0)	1.12	2
Geographical region: 3	971.1	927	2.4 (1.4; 3.9)	7.8 (6.1; 9.9)	1.6 (1.0; 2.7)	0.4 (0.2; 1.1)	1.15	4
Geographical region: 4	357.3	945	1.1 (0.6; 1.9)	5.7 (4.2; 7.7)	2.6 (1.9; 3.8)	0.8 (0.4; 1.7)	1.17	0
Geographical region: 5	228.9	973	0.7 (0.4; 1.4)	3.4 (2.2; 5.1)	3.5 (2.5; 4.9)	0.8 (0.4; 1.7)	1.11	1
Geographical region: 6	468.0	927	3.3 (2.3; 4.9)	10.4 (8.2; 13.0)	1.2 (0.6; 2.3)	0.4 (0.2; 1.1)	1.21	4

ANNEX 10. SUGGESTED QUALITY CHECKLIST FOR ANTHROPOMETRY REPORTS

CRITERION	DESCRIPTION	YES	NO
Cover page	Survey title, dates of the survey, author		
Executive summary			
Introduction	Survey title and details: geographic area surveyed (areas excluded if any and why), description of the population: total population, population surveyed, type of population surveyed (residents, immigrants, refugees, displaced, etc.).		
	Contextual information: food security, nutrition, health situation or any other information likely to have an impact on the nutrition status of the population.		
	Objectives: population including age group surveyed.		
Survey objectives	Are the objectives stated clearly?		
Methodology	Sample size determination		
	Sampling frame details including whether any region, district, PSU or other area or population has been excluded from the first stage sample (and why).		
	Sampling design and procedure: full details about all sampling stages, especially the initial stage (i.e. selection criteria for PSUs), second stage (i.e. mapping and listing procedures) and last stage (i.e. selection of households and participants, etc.) and any additional step or stage applied in the survey (e.g. subsampling, etc). Include a definition of household and household member.		
	Questionnaire: procedures for translation and back translation, pre-testing if any, development and instructions for using the local events calendar, pre-testing if any, procedures for translation and back-translation, etc.		
	Measurements procedures		
	Case definitions and inclusion criteria		
	Training (content, number of days, number of trainees, testing in the field, etc.)		
	Standardization exercises		
	Field work procedures: data collection, number and composition of teams, period of data collection, procedures for call-backs when children absent or for re-measuring children, etc.		
	Equipment used and calibration procedures		
	Coordination and supervision process: checks for procedures in the field.		
	Data entry procedure		
	Data analysis plan: software (name, version and link if available), data cleaning, imputation factors		
	Type of flags used.		

CRITERION	DESCRIPTION	YES	NO
Results	Total number of PSUs sampled versus PSUs areas completed (including reasons for non-completion)		
	Total number of sampled households		
	Breakdown of survey outcomes (e.g. completed, refused, including random and flagged re-measurements) for all sampled households		
	Total number of children under 5 who met the definition of household member in sampled households (and indicate if all children are eligible); if data are collected in a subsample, present the total number of eligible children in this subsample.		
	Total number of eligible children under 5 years old with weight measurement, number with length/height measurement and number with date of birth (at least month and year of birth)		
	Total number of eligible children under 5 years old selected for random remeasurements with weight measurement, length/height measurement and at least month and year of birth		
	Prevalence of different forms or malnutrition based on anthropometric indicators and recommended cut-offs (with confidence intervals)		
	Design effects observed		
	Mean z-score for each index		
	z-score Standard deviations		
	Standard errors (SE) for prevalence and mean z-score estimates		
	95% confidence intervals for prevalence and mean z-score estimates		
	Frequency distribution plots versus the reference distribution		
	Results presented by disaggregation categories: sex, age groups, urban/rural and subnational levels, wealth quintiles and mother's education (when available)		
	Weighted and unweighted total number of individuals (n) for each indicator		
Report on indicators for data quality	Number and percentage of cases excluded when applying fixed exclusion criteria based on WHO Child Growth Standards for each anthropometric index (should include the overall number and percentage of cases as well as for lowest and highest performing teams)		
	Missing data: number and stratification by age group and type of residence, number and percentage of children without height or weight measurements and/or at least month and year of birth		
	Digit heaping charts (mapping variable levels) including for length, height, weight and age		
	Distribution issues: z-score distributions by age group, sex and geographical region		

CRITERION	DESCRIPTION	YES	NO
Report on indicators for data quality	Percentage of date of birth information obtained from birth certificate, vaccination card, caretaker's recall or other source out of the total number of eligible children. Children lying down/ standing up for measurement by age: % of children below 9 months standing, % of children over 30 months lying down, % mismatches for position measured versus recommended position		
	Mean, SD, median, min, max, absolute difference between the first and second measurement for the random cases		
	Percentage of random measurements within the maximum acceptable difference		
	Indicate other eventual data quality pitfalls and other survey limitations		
Discussion	Interpretation of nutritional status of children		
	Contextual factors of interest when interpreting results		
	Limitations		
	Discussion		
Conclusions	Conclusion present		
Annexes	Sample design details		
	Questionnaire		
	Local events calendar used		
	Map of area		
	Result of standardization exercises		
	Field check tables used		

ANNEX 11. CHILD ANTHROPOMETRY INDICATORS TRENDS AND TARGETS TRACKING EXCEL SPREADSHEET

Child anthropometric indicators-trends and targets tracking Excel spreadsheet

Instruction: fill in only cells in purple

Target 6 - Wasting

Region	Year period	YEAR1	Wasting (%)	Under-5 population (000's)
SRI LANKA	1987	1987	14,9	1883,7
SRI LANKA	1993	1993	17,5	1723,8
SRI LANKA	1995	1995	15,3	1716,7
SRI LANKA	2000	2000	15,5	1641,6
SRI LANKA	2006-07	2007	14,7	1797,1
SRI LANKA	2009	2009	11,8	1797,3
SRI LANKA	2012	2012	21,4	1743,7
SRI LANKA	2016	2016	15,1	1601,5

Current AARR calculation data series (2008 and after)

YEAR1	Wasting (%)	LN(Wasting)
2009	11,8	2,4681
2012	21,4	3,0634
2016	15,1	2,7147

Current AARR -2,902

! Disclaimer: There is no What-if calculator for child wasting as this indicator is prone to sudden changes and thus national trends are not meaningful. The AARR estimate should be interpreted with caution. Countries should aim to reach the level of 5% as early as possible and keep rates below that threshold throughout.

Region	Baseline				Target year 2025 (below 5%)				Target year 2030 (below 3%)			
	year	wasting prevalence (%)	under-5y population estimate (000's)	number of wasted children (000's)	2025 target wasting prevalence (%)	under-5y population estimate at target year (000's)	number of wasted children (000's)	required AARR from baseline year until 2025	2025 target wasting prevalence (%)	under-5y population estimate at target year (000's)	number of wasted children (000's)	required AARR from baseline year until 2025
SRI LANKA	2012	21,4	1 743,7	373,2	5,0	1 421,5	71,1	10,6	3,0	1 361,5	40,8	10,3

ANNEX 12. INDEX OF DISSIMILARITY CALCULATOR FOR TERMINAL DIGITS

Index of dissimilarity calculator terminal digits

Calculation template for index of dissimilarity (unblended Myers index) for terminal digit of height or weight

Fill in all yellow cells using your survey data

Terminal digit	Frenqunecy of terminal digits: Survey findings (s)	Frenqunecy of terminal digits: Expected (e)	Ratio survey X_{is}	Ratio expected X_{ie}	Absolute difference $\lvert X_{is} - X_{ie} \rvert$
0	100	10	0,10	0,10	0,00
1	100	10	0,10	0,10	0,00
2	100	10	0,10	0,10	0,00
3	100	10	0,10	0,10	0,00
4	100	10	0,10	0,10	0,00
5	100	10	0,10	0,10	0,00
6	100	10	0,10	0,10	0,00
7	100	10	0,10	0,10	0,00
8	100	10	0,10	0,10	0,00
9	100	10	0,10	0,10	0,00
Total	1000	100			0,00

Index	Formula	Output
Myers unblended	$0.5 * \Sigma \lvert X_{is} - X_{ie} \rvert$	0,00

Interpretation of output for example values	
output	**interpretation**
0,00	perfect distribution in line with expected - ***minimum value possible***
0,10	10 per cent of the terminal digits from the survey would need to be redistributed to obtain a perfect distribution
0,15	15 per cent of the terminal digits from the survey would need to be redistributed to obtain a perfect distribution
0,30	30 per cent of the terminal digits from the survey would need to be redistributed to obtain a perfect distribution
0,50	50 per cent of the terminal digits from the survey would need to be redistributed to obtain a perfect distribution
0,67	67 per cent of the terminal digits from the survey would need to be redistributed to obtain a perfect distribution
0,90	all survey values on one terminal digit; 90 per cent would need to be redistributed to obtain a perfect distribution- ***maximum value possible***

ANNEX 13. DHS HEIGHT STANDARDIZATION TOOL

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1		DHS Height standardization tool													
2															
3	Measurement of length/height (in cm)														
4															
5		Measurement round 1													
6		Child 1	Child 2	Child 3	Child 4	Child 5	Child 6	Child 7	Child 8	Child 9	Child 10				
7	Expert														
8	Name A														
9	Name B														
10	Name C														
11	Name D														
12	Name E														
13	Name F														
14	Name G														
15	Name H														
16	Name I														
17	Name J														
18															
19															
20															
21		Measurement round 2													
22		Child 1	Child 2	Child 3	Child 4	Child 5	Child 6	Child 7	Child 8	Child 9	Child 10				
23	Expert														
24	Name A														
25	Name B														
26	Name C														
27	Name D														
28	Name E														
29	Name F														
30	Name G														
31	Name H														
32	Name I														
33	Name J														
34															
35															
36															
37		Child 1	Child 2	Child 3	Child 4	Child 5	Child 6	Child 7	Child 8	Child 9	Child 10				
38	Expert														
39	Mean														
40															
41		Difference in measurement 1 and 2													
42		Child 1	Child 2	Child 3	Child 4	Child 5	Child 6	Child 7	Child 8	Child 9	Child 10			Precision	
43	Expert														
44	Name A														
45	Name B														
46	Name C														
47	Name D														
48	Name E														
49	Name F														
50	Name G														
51	Name H														
52	Name I														
53	Name J														
54															
55															
56	Precision														
57															
58		Difference in measurement from expert													
59		Child 1	Child 2	Child 3	Child 4	Child 5	Child 6	Child 7	Child 8	Child 9	Child 10			Accuracy	
60	Expert														
61	Name A														
62	Name B														
63	Name C														
64	Name D														
65	Name E														
66	Name F														

Notes | Worksheet | Accuracy | Precision | Results | Work Accuracy | Work Precision | +

ENDNOTES

LINKS TO TOOLS

Section 1.1 Planning

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ISBN 978-92-4-151555-9

World Health Organization | unicef