Weighing scales used in the anthropometric assessment of infants under 6 months in emergency situations:
A survey of humanitarian relief workers

Researched and written by Chloe Angood, Emergency Nutrition Network (ENN)
Submitted as MSc research project
University of Southampton, Institute of Human Nutrition

Abstract

Objective: The objective of this study was to discover the type of weighing scales most commonly used by humanitarian relief workers to weigh infants under 6 months in emergencies and the type of weighing scales that this group believes to be most suitable for weighing infants under 6 months in emergencies, to generate a hypothesis for field trials.

Design: Cross-sectional surveys were carried out by email and telephone.

Subjects: The subjects were 41 humanitarian relief workers from different UN agencies, international and local Non-Governmental Organisations (NGOs) and governments, working in 25 different countries. All subjects work in emergency nutrition programmes and have recent direct experience weighing infants under 6 months.

Results: Respondents most frequently use lightweight, mechanical scales with a maximum capacity of 20-29kg and 100g graduations, for weighing infants under 6 months. Scales are not usually used exclusively for this age group. Hanging spring scales are the most common type of weighing scales used, particularly when respondents work in the community. When working exclusively in clinical settings, respondents are most likely to use balance beam scales with higher precision. Few respondents use adult bench scales and none use infant bench scales. Respondents do not regard any of the existing types of scales as ideal for weighing infants under 6 months. However, of those that exist, respondents believe balance beam scales to be the most suitable for both clinical and community work. Hanging scales are regarded as the least suitable. Adult bench and infant bench scales remain untested.

Conclusions: Different weighing scales are needed, from those currently used, to satisfy the demands of humanitarian workers for weighing infants under 6 months in emergencies. Demands may be satisfied by balance beam scales; their suitability now needs to be tested in field trials to form the basis of recommendations to this end. Manufacturers could also consider developing a new type of weighing scales specifically designed for this purpose.

Introduction

Vulnerability of young infants in emergency situations

Under 5 child mortality is a serious global problem, with around 11 million children under 5 dying each year (UNICEF, 2006). This age group is particularly vulnerable in emergency situations where they are often the first and most common victims of violence, disease, malnutrition and death (WHO-UNICEF, 2003). Under 5 child mortality rates are between 2 and 70 times higher than average in emergencies and can increase twenty-fold in as short a period as two weeks (WHO, 2004). Of children under the age of 5, infants under 6 months are particularly vulnerable in emergencies, usually as a result of inappropriate feeding practices (WHO-UNICEF, 2003). Optimal infant and young child feeding comprises early initiation of exclusive breastfeeding for the first 6 months of life, followed by nutritionally adequate and safe complementary foods, whilst breastfeeding continues for up to 2 years or beyond (ENN, 2006). This has been repeatedly identified as necessary to reduce infant and young child mortality (Jones et al, 2003). Experience demonstrates, however, that infants are often not fed appropriately in emergency situations. Case studies from Liberia, Burundi, Afghanistan, Pakistan, Sudan, Uganda, Tanzania, Bangladesh and Iraq show that severely malnourished infants are consistently admitted to therapeutic feeding centers as a result of non-exclusive breastfeeding, the cessation of breastfeeding and/or inappropriate artificial feeding (ENN, 2005). Infants may also be at greater risk of malnutrition in this context due low birth weight, caused by intra-uterine growth retardation due to maternal malnutrition (Prudhon, 2000) and HIV/AIDS.

Anthropometric Assessment and Monitoring of Young Infants

Interventions to treat and prevent infant malnutrition in emergencies depend on the regular assessment of infant nutritional status. Body weight compared to age is the most commonly used anthropometric indicator of the nutrition status of infants and young children (de Onis et al., 2004a). However, weight for age lacks biological specificity as it fails to separate weight from length or height-related deficits and excesses in growth (de Onis et al., 2004b). Body weight compared to height/length gives the simplest measure of attained skeletal size (height/length) and soft tissue mass (weight) (Bates et al., 2005) and is a particularly effective measure where growth retardation and wasting are common and age is uncertain (WHO, 2002). For this reason weight-for-length is the recommended body measurement to use in the assessment of infants in emergencies (WHO, 2002).

It has been argued that simpler and cheaper anthropometric indicators are more appropriate than weight-for-length measurements in emergency situations, where large numbers of children are measured quickly, often without equipment and expertise. Mid Upper Arm circumference (MUAC), for

example, can be used as a proxy for soft tissue mass and is a well established measure of malnutrition in children aged 12 to 60 months (Bates et al., 2005). One study has shown MUAC to be a reliable surrogate for weight-for-age of infants aged 6-12 months in India (Sharma & Bora, 1998) and another to be an effective proxy for birth weight in newborns (Das et al., 2005). However, there continue to be questions over the precision and accuracy of MUAC compared to weight-for-length and it has not yet been proven as a reliable indicator of malnutrition of infants beyond newborn to 6 months (WHO, 2002).

Chest circumference has also been identified as a surrogate measure for birth weight in screening for low birth weight in the few days after birth (Rondo & Tomkins, 1996; Naik et al., 2003; Kapoor et al., 1996; Ngowi et al., 1993; Fawcus et al., 1993). This, again, may be a useful measure for newborns where equipment and expertise are unavailable. However, there is little evidence to suggest that chest circumference is an effective indicator of nutrition status of infants after newborn up to 6 months. Weight-for-length therefore remains the recommended method of anthropometrically assessing young infants in emergency situations.

Furthermore, in the treatment of severely malnourished infants, serial weight measurements are essential to monitor the hydration status and response of infants to therapeutic treatment (ENN et al., 2004). For these reasons accurate weight measurements are vital in safeguarding infant health in emergencies.

Requirements of weighing scales for young infants in emergencies

For weight measurements to be useful, they must be accurate and precise (Bates et al., 2005). An important prerequisite to this is a set of weighing scales that will provide an accurate and precise reading, whilst being fit for purpose. Figure 1 demonstrates that the purpose, spread, frequency and location of anthropometric assessment varies between different programme activities concerning infants in emergencies. This shows that the requirements of weighing scales for young infants in emergencies are complex. Weighing scales need to be portable, for activities that take place in the community, durable and easy to use, to assess large groups of infants, and precise and accurate, to measure very small increments of change in severely malnourished infants (ENN et al., 2004; Golden, 2000). A set of weighing scales that is suitable for use in emergencies must take these different factors into account.

Figure 1: Characteristics of nutritional assessment of young infants in different prpogramme activities in emergencies

Programme Activity	**Purpose of nutritional assessment**	**Spread**	**Frequency of assessment required**	**Where assessment takes place**
1) Nutritional surveillance	To detect changes in nutritional status of infants over time	Sample of young infants	Periodically	Community *Mobile*
2) Individual screening	To assess for admission of infants/ mothers into interventions (activities 4 and 5)	Whole population of young infants	Periodically	Community *mobile*
3) Growth monitoring	Prevent malnutrition by identifying growth faltering of infants for early intervention	Whole population of young infants	Monthly	Community *mobile*
4) Support for lactating mother of malnourished infant	Monitor the prevalence of malnutrition of infants to see effect of intervention and time discharge	Young infants of all individual mothers admitted	Monthly	Community centers (supplementary feeding centers or other community points) *semi-mobile*
5) Therapeutic feeding for severely malnourished infants	To give appropriate treatment to infants, monitor response to treatment and time discharge	All young infants admitted	Daily	Clinical setting (therapeutic feeding centre or hospital) *immobile*

Guidelines on weighing scales for young infants

In the WHO's field guide, "The management of nutrition in severe emergencies", hanging spring scales measuring in 100g graduations are recommended for weighing infants from birth (WHO, 2002). However, the need for weighing scales with greater precision for the management of severely malnourished infants is not considered here. In the recent Multicentre Growth Reference Study (MGRS) portable electronic scales with taring ability were used (specifically the UNICEF electronic scale 890 or UNISCALE) (de Onis et al., 2004b). However, these scales have not been tested in

emergencies, or with very low weight infants. The ‘direct recording scale’ has been recommended for use in growth monitoring in the community (Morley & Elmore-Meegan, 2000). However, whilst these seem to provide an effective option for growth monitoring, (Meegan et al., 1994) they are unlikely to be suitable for other types of programme activity.

Repeated communication to the Emergency Nutrition Network (ENN) suggests that the lack of clear guidelines in this area is a frustrating hindrance to emergency programming and can prevent the anthropometric assessment of young infants in emergencies altogether (Seal et al., 2001; Prudhon, 2000). There is, therefore, a pressing need for more specific guidance on which weighing scales to use. This study will provide a first step in this process.

Research question: Which type of weighing scales are most commonly used by humanitarian relief workers and researchers for weighing infants under 6 months in emergencies and which type of weighing scales do the same group believe to be the most suitable for this purpose?

The results of this study will generate a hypothesis for field tests, as follows:

Hypothesis: Weighing scales x (the preferred option according to humanitarian relief workers and researchers) provide a more suitable set of scales, in terms of precision, function, ease of use, portability, durability and cost, for weighing infants under 6 months in emergencies than weighing scales y and z (the most commonly used weighing scales).

Methods

Study Objectives

Objectives of this study are as follows:

- To show the type of weighing scales currently being used by humanitarian relief workers and researchers to weigh infants under 6 months in emergency situations
- To evaluate the opinions of humanitarian relief workers and researchers on the suitability of scales currently in use, in terms of their precision, function, ease of use, portability and durability
- To compare the costs of the different types of scales currently used by humanitarian relief workers and researchers
- To identify the type of scales that humanitarian workers and researchers believe to be most suitable for weighing infants under 6 months in emergency situations using a scoring system
- To assess the opinions of humanitarian relief workers and researchers of the features of an ideal set of weighing scales for weighing infants under 6 months in emergencies

Protocol

Study design: The study was a cross-sectional survey, using a questionnaire. Participants completed the questionnaire themselves and returned it by email. In some cases, questions were asked over the telephone.

Variables to be measured:

- Type and characteristics of scales currently used to weigh infants under 6 months in emergencies
- Respondent opinions of the scales that they use in terms of their:
    - Precision in weighing infants under 6 months
    - Functions to enable them to easily weigh infants under 6 months
    - Ease of use
    - Portability
    - Durability in field conditions
    - Cost
- Respondent opinions of the features of an ideal set of scales

Procedures:

The method of measurement was a questionnaire, which can be found in Appendix 1. The cost of scales used was evaluated separately. This was researched during one day by the researcher. Information was gathered from manufacturers' websites.

Validity of assessment:

The questionnaire provided a consistent way of gathering information from participants to ensure that everyone was asked the same questions and the possibility of interviewer bias was reduced. The questionnaire also provided a good means of capturing the ideas and opinions of individuals, as they were less likely to be influenced by others (as they might be in focus group discussions for example). When phone interviews were conducted, care was taken not to deviate from the given questions so as to unduly influence answers given. The ideal way to have conducted the questionnaire would have been in person, to ensure that questions were understood and interpreted correctly. However, this was not possible as participants were from a wide range of countries and the study was limited by time and resources. It was therefore important that the questionnaire was designed as clearly and concisely as possible, with clear instructions, to enable participants to self-administer effectively. The questionnaire was tested in the field by CARE USA with field staff of CARE's partner organizations in Dadaab Refugee Camp (Northwest Kenya). Feedback from field testing led to the refining of questions to make them as straightforward and easy to understand as possible. Several experts in the anthropometric assessment of infants were also consulted on the draft questionnaire to ensure that everything necessary was covered to provide as useful a set of data as possible.

Research into the cost of scales took place on the same day and information was gained straight from the manufacturer to avoid any mark-up by sales companies. This ensured that the comparison was as fair as possible.

Assessment of measurement error:

As the questionnaire was self-administered, there was a high chance that some of the questions could be misinterpreted. This may have been a particular issue for participants for whom English was not their first language. Participants may also have had difficulties completing the questionnaire electronically if they had old computer software. Participants may not have known the answers to some questions, particularly if they were not responsible for sourcing and purchasing the weighing scales, and so may have guessed, in which case answers given may not be accurate. Individuals may also have had different ideas about the meaning of ratings (one person's "very" may be another person's "average") and so the numerical answer given may not have been a true picture of their opinion. To mitigate these issues, care was taken to write the questions in plain English and, as stated above, the questionnaire was tested with people for whom English was not their first language. Rated answers were also validated by several open-ended questions. In cases where there was doubt about

the validity of a numerical rating given, the respondent was contacted by email or phone to check the answer. Any measurement error that might have occurred as a result of fear of exposure or 'malpractice' was overcome by assuring participants that they would not be identified in the write up of results.

Sample

Subjects: The criteria for subjects was individuals who are directly involved in weighing infants under 6 months as part of their role, and who work in emergency situations. The definition of an emergency situation used in this context is the situation arising in the aftermath of a disaster. This may be as a result of natural disasters, e.g. earthquake or famine, or human-induced disasters, e.g. war. There was an emphasis on emergencies where nutrition is a key problem.

Sample size: As this is a hypothesis generating study, it was not possible to do a sample size calculation. In order for the study to be as representative as possible of the population (humanitarian relief workers and researchers working in nutrition related emergencies), individuals were selected from a spread of geographic locations, types of emergencies and types of organizations. It was estimated that a sample size of 40 would enable this kind of spread, whilst taking into account the time and resource constraints of the study.

Selection bias: The selection of subjects may have been biased towards those who have access to email and those who are computer literate. The study may therefore be biased to those who are likely to be using more sophisticated weighing equipment. The study may also have been biased towards those who speak English, as it was not be possible to translate the questionnaire due to resource constraints. To overcome this, phone calls were offered to individuals who agreed to participate and some individuals were asked to interview others in their organization or locality who could not speak English, or who did not have access to email or phone.

Techniques, tools and settings

The survey was conducted virtually, by email and, in some cases, phone. The administration of the survey was based in Oxford, in the researcher's home office, and at the University of Southampton. Primary tools used were a laptop, with broadband access, and a phone.

Validity and Reproducibility

The study is based on the opinions of respondents and findings are therefore subject to their different perceptions. Results may not therefore provide a true picture of the reality. They do, however, provide

as true as possible a reflection of the opinions and views of the sample group. As the sample represents the population with arguably the most knowledge and experience about weighing infants in emergencies, the results can nevertheless be expected to carry some weight and should provide a good foundation from which field tests can be carried out.

Results of some sections were measured using a scoring system. As no known scoring system exists, one was created for the purposes of this study through careful research and consultation with experts. The scoring system provides a degree of validity to the results, by giving a standard from which subjects' opinions can be measured. The scoring system is, however, subjective, and is based on the opinions of those involved in the study about what makes a good set of weighing scales. This opinion may not necessarily match the reality of what makes a good set of weighing scales. This could compromise the validity of results. As the scoring system used is so specific, the same results are unlikely to be reproduced unless the exact same system is used.

Ethical considerations

Results do not identify individuals involved in the study. Results are presented as subjective and caution has been taken not to treat the data as tested, or the results as definitive. Results will be shared with participants at the end of the study and will be shared with collaborators, such as CARE USA and ENN, to enable them to take the work forward.

Results

1. Respondents

1.1 Number of respondents

All individuals known by the Emergency Nutrition Network (ENN) that are involved in nutrition programming and research in emergency situations were invited to participate in the study. The total number of individuals invited to take part was 223. A total of 50 of these individuals agreed to participate and were asked to complete the questionnaire. Of these, 42 returned completed questionnaires. One questionnaire was completed by an individual who does not weigh infants under 6 months, and therefore this was not included. The final sample number was therefore 41. All respondents included currently work in nutrition in emergency situations and have recent direct experience weighing infants under 6 months in this context. Details of respondents are as follows:

1.2 Organisational spread

Respondents work for a range of different organisations. Table 1 shows the number of respondents working for different types of organisations. This shows that most respondents are employed by international Non-Governmental Organisations (NGOs). This is to be expected, as most nutrition programmes in emergencies are run by international NGOs. The main international NGOs that run nutrition programmes in emergencies are included in the study, including ACF, MSF, CARE, World Vision, Save the Children, CORD, Merlin and International Medical Corps. Many international NGOs, such as Oxfam, do not engage directly in nutrition programming in emergencies and therefore could not participate. International Federation of the Red Cross also participated in the study.

Table 1: Types of organizations represented by respondents

Organisation Type	***No. Respondents***	***% Respondents***
UN agency	5	12.2
International NGO	24	58.5
Local NGO	7	17.1
Government body	4	9.8
Red Cross	1	2.4
Total	*41*	*100.0*

5 respondents were direct employees of United Nations (UN) agencies, including UNICEF, UNHCR and WFP. These are the three main UN agencies that run nutrition programmes in emergency

situations. All local NGOs and Government bodies that participated were implementing partners of one of these same UN agencies. Respondents that represented the same organisations worked in different countries on different programmes. No research institutions participated in the study.

1.3 Location spread

30 of the 41 respondents currently work at the field or country level and the remaining 11 either work at regional or international levels. Respondents not currently working at the field or country level have recent experience doing so.

Individuals working in a very wide range of countries and regions were invited to participate in the study. However, as table 2 shows, most of the 41 respondents work in Africa. The results are therefore not as regionally representative as intended. This may be because there are more disaster relief programmes focusing on African countries. Nevertheless, a large range of countries (25) were represented by the 41 respondents, which are: Afghanistan, Angola, Armenia, Bangladesh, Burundi, Central African Republic, Chad, DRC Eritrea, Ethiopia, Ivory Coast, Kenya, Liberia, Malawi, Mali, Mauritania, Niger, Pakistan, Senegal, Sierra Leone, Somalia, Sudan, Tanzania, Uganda and Zimbabwe.

Table 2: Regions where respondents are located

Region	***No. Respondents***	***% Respondents***
Africa	33	80.5
Asia	6	14.6
Central Asia	1	2.4
Unknown	1	2.4
Total	*41*	*100.0*

2. Scales currently used

This first section of results relates to the types and features of weighing scales currently used by respondents to weigh infants under 6 months.

2.1 Types of weighing scales used

Table 3 displays the different types of scales used by respondents. Illustrations of each type of scales can be found in Appendix 2. Table 3 shows that by far the most commonly used type of weighing scales are hanging spring scales. The second most popular weighing scales are balance beam bowl. Only three respondents use adult bench scales (also known as the mother-baby scale or UNISCALE) and no respondents use an infant bench scale with bowl.

Table 3: Types of weighing scales used by respondents

Type of scales	***No. Respondents***	***% Respondents***
Hanging	26	63.4
Infant bench bowl	0	0
Balance beam bowl	12	29.3
Adult bench taring	3	7.3
Total	*41*	*100.0*

All hanging scales used by respondents are made by Salter and, in 23 out of 26 cases, this is the Salter 235 6S model. Most balance beam scales are made by Seca and in 6 out of 8 cases this is the Seca 725 model. The make and model of the 3 adult bench scales used varies. A table of makes of different types of scales can be found in Appendix 3 (table A1).

38 out of 41 respondents (92.7%) use mechanical scales. Only 3 respondents use scales that require power, all of which use adult bench scales powered either by battery or a combination of battery and solar. A full table of the power sources of scales by type can be found in Appendix 3 (table A2).

Data displayed in table 4 show the weight of different types of scales used by respondents. This shows that the weight of scales used varies, however, most respondents use scales that are lightweight (5kg or less). Hanging scales and some balance beam scales are the lightest scales used (2kg or less).

Table 4: Weights of different types of weighing scales used by respondents

Weight of scales		***Type***			***Total***
		Hanging	***Balance beam bowl***	***Adult bench taring***	
2kg or less	No. scales	15	3	0	18
	% weight within Type	71.4%	50.0%	.0%	60.0%
3-5kg	No. scales	6	1	3	10
	% weight within Type	28.6%	16.7%	100.0%	33.3%
6-8kg	No. scales	0	1	0	1
	% weight within Type	.0%	16.7%	.0%	3.3%
9-12kg	No. scales	0	1	0	1
	% weight within Type	.0%	16.7%	.0%	3.3%
Total	*No. scales*	*21*	*6*	*3*	*30*
	% weight within Type	*100.0%*	*100.0%*	*100.0%*	*100.0%*

2.2 Functions of weighing scales used

Data displayed in table 5 show that most respondents do not use scales exclusively for infants under 6 months, with the exception of 7 respondents using balance beam scales. Instead respondents most often use scales to weigh a wider age group. Most hanging scales appear to be used for either all infants (under 23 months) or all children under 5 years. Adult bench scales are designed to weigh all age groups, including adults, and results show that they are indeed being used in this way by all 3 users.

Table 5: Age groups that respondents use different types of scales to weigh

User group		***Type***			***Total***
		Hanging	***Balance beam bowl***	***Adult bench taring***	
0-6 months	No. respondents	2	7	0	9
	% user group within Type	7.7%	58.3%	.0%	22.0%
0-23 months	No. respondents	13	3	0	16
	% user group within Type	50.0%	25.0%	.0%	39.0%
0-59 months	No. respondents	8	2	0	10
	% user group within Type	30.8%	16.7%	.0%	24.4%
0-14 years	No. respondents	3	0	0	3
	% user group within Type	11.5%	.0%	.0%	7.3%
All ages	No. respondents	0	0	3	3
	% user group within Type	.0%	.0%	100.0%	7.3%
Total	*No. respondents*	*26*	*12*	*3*	*41*
	% user group within Type	*100.0%*	*100.0%*	*100.0%*	*100.0%*

Table 6 displays the maximum capacities of different types of scales used by respondents. Scales with a lower capacity are designed to weigh lower weights (and therefore lower age groups), whilst those with higher capacity are designed to weigh wider age ranges. Only 10 scales used have a low maximum capacity (19kg or less), most of which are balance beam scales. Most hanging scales used have a medium capacity and all adult bench scales used have a very high capacity.

Table 7 displays the minimum graduations of different types of scales used by respondents. This shows that most scales used measure in 100g graduations. Most of these are hanging scales and adult bench scales. Very few scales used measure in small graduations (20g or less). However, most of those that do are balance beam scales.

It was expected that some scales would have secondary functions. However, most scales used by respondents (92.7%) only measure weight and perform no other functions, with the exception of 3 scales used (2 hanging and 1 balance beam) which also measure length or height. A table displaying secondary functions of different types of scales can be found in Appendix 3 (table A3).

Table 6: Maximum capacity of different types of weighing scales used by respondents

Capacity		***Type***			***Total***
		Hanging	***Balance beam bowl***	***Adult bench taring***	
14kg or less	No. scales	0	4	0	4
	% capacity within Type	.0%	33.3%	.0%	10.0%
15-19kg	No. scales	2	4	0	6
	% capacity within Type	8.0%	33.3%	.0%	15.0%
20-29kg	No. scales	22	3	0	25
	% capacity within Type	88.0%	25.0%	.0%	62.5%
30-49kg	No. scales	1	1	0	2
	% capacity within Type	4.0%	8.3%	.0%	5.0%
More than 100kg	No. scales	0	0	3	3
	% capacity within Type	.0%	.0%	100.0%	7.5%
Total	*No. scales*	*25*	*12*	*3*	*40*
	% capacity within Type	*100.0%*	*100.0%*	*100.0%*	*100.0%*

Table 7: Minimum graduations of different types of scales used by respondents

Graduations		***Type***			***Total***
		Hanging	***Balance beam bowl***	***Adult bench taring***	
10g or less	No. scales	0	8	0	8
	% graduations within Type	.0%	66.7%	.0%	20.0%
20g	No. scales	1	0	1	2
	% graduations within Type	4.0%	.0%	33.3%	5.0%
50g	No. scales	0	2	0	2
	% graduations within Type	.0%	16.7%	.0%	5.0%
100g	No. scales	24	2	2	28
	% graduations within Type	96.0%	16.7%	66.7%	70.0%
Total	*No. scales*	*25*	*12*	*3*	*40*
	% graduations within Type	*100.0%*	*100.0%*	*100.0%*	*100.0%*

2.3 Who selected the scales that are used

Of those respondents that know who selected the scales that they use, only 27% were directly involved in the choice. Most scales were chosen by either field or regional offices (41%) and in 32% of cases, scales were donated by UNICEF or UNHCR. Of those donated by UNICEF or UNHCR half were hanging scales and half were balance beam scales. A table displaying these results can be found in Appendix 3 (table A4).

2.4 Comparing weighing scales used in different contexts

Data reveal some interesting differences when analysed by the different contexts in which respondents work. Figure 2 displays the types of weighing scales used in exclusively clinical settings, those that are used in exclusively community settings and those that are used in both (exact figures can be found in Appendix 3, table A5). Data show that most respondents use one set of weighing scales for both clinical and community work and in this case they are most likely to use hanging scales. In an exclusively clinical context, respondents are most likely to use balance beam scales. When working exclusively in the community, respondents are still most likely to use hanging scales, however, most users of adult bench scales are also part of this group. Using a Fishers exact test we can see that the difference between the types of scales used in different contexts is statistically significant (p=.035). This demonstrates that respondents tend to use different scales for different purposes. Specifically, respondents are more likely to use balance beam scales in a clinical context and hanging scales in a community context.

Figure 2: Graph showing types of scales used by respondents in different contexts

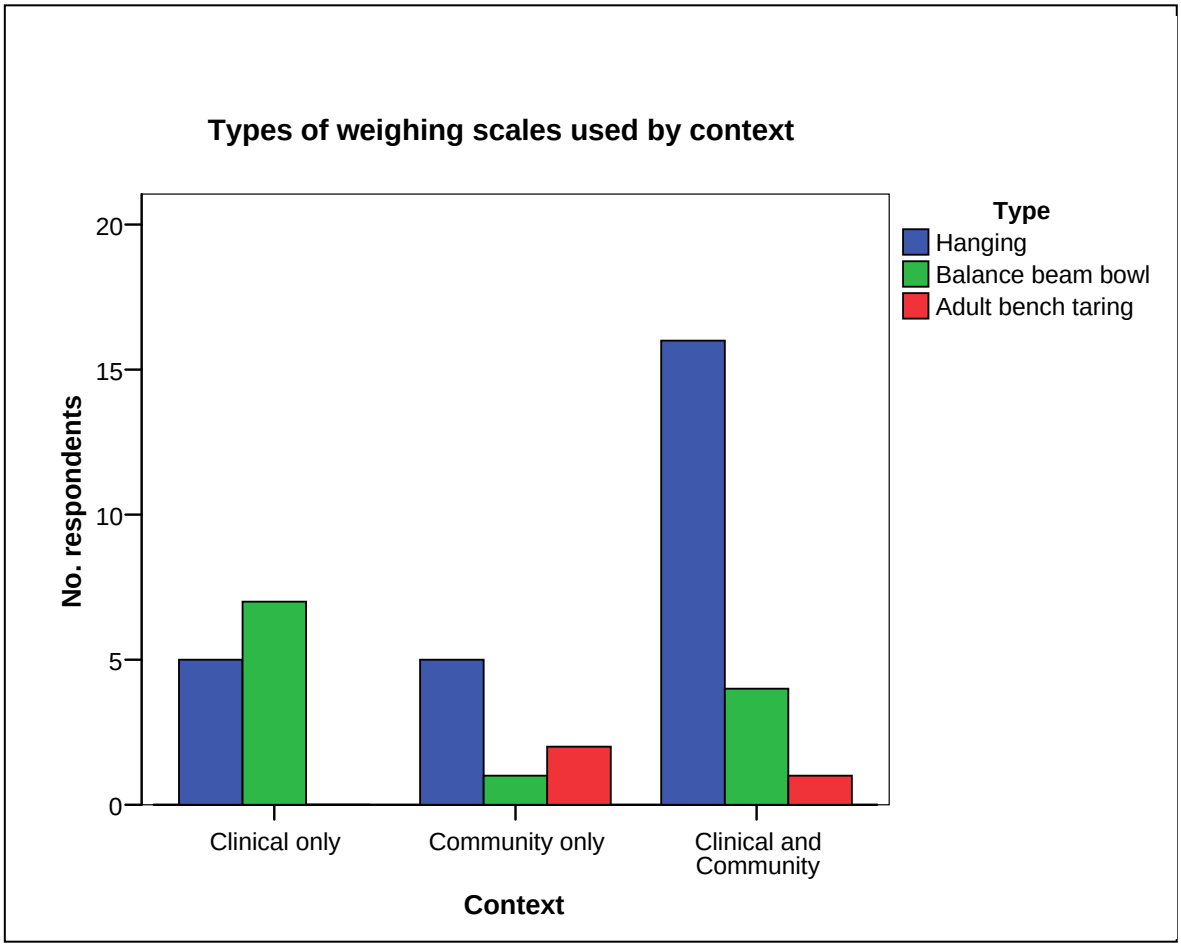


Table 8 shows the different capacities of scales used in different contexts. This shows that respondents that use scales with a lower capacity are more likely to use them in a clinical context. Respondents using a middle or high capacity set of scales seem to be more likely to use them in the community (either exclusively or not). A Kruskal-Wallis exact test shows that there is a statistically significant difference between the capacities of scales used in different contexts (p=.001). Therefore, respondents are more likely to use scales with lower graduations in a clinical context and scales with higher graduations in a community context.

Table 8: Maximum capacity of scales used by respondents in different contexts

Capacity		***Context***			***Total***
		Clinical only	***Community only***	***Clinical and Community***	
14kg or less	No. scales	3	0	1	4
	% capacity within Context	27.3%	.0%	4.8%	10.0%
15-19kg	No. scales	4	0	2	6
	% capacity within Context	36.4%	.0%	9.5%	15.0%
20-29kg	No. scales	4	6	15	25
	% capacity within Context	36.4%	75.0%	71.4%	62.5%
30-49kg	No. scales	0	0	2	2
	% capacity within Context	.0%	.0%	9.5%	5.0%
More than 100kg	No. scales	0	2	1	3
	% capacity within Context	.0%	25.0%	4.8%	7.5%
Total	*Count*	*11*	*8*	*21*	*40*
	% within Context	*100.0%*	*100.0%*	*100.0%*	*100.0%*

Table 9 displays different graduations of scales used in different contexts. This appears to show that respondents working in the community are unlikely to use scales that measure in lower graduations and respondents using scales with the smallest graduations (10g or less) are likely to use them in a clinical context (either exclusively or not). However, a Kruskal-Wallis exact test shows that this difference is not statistically significant (p=.372).

Table 10 shows the weight of different types of scales used in different contexts. This appears to show that scales used in the community (exclusively or not) generally weigh less than those scales used exclusively in the clinical setting. However, a Kruskal-Wallis exact test shows that there is no significant association between the weight of scales and the context in which they are used (p = .099).

Table 9: Graduations of scales used by respondents in different contexts

Graduations		***Context***			***Total***
		Clinical only	***Community only***	***Clinical and Community***	
10g or less	No. scales	4	0	4	8
	% graduations within Context	36.4%	.0%	19.0%	20.0%
20g	No. scales	0	1	1	2
	% graduations Context	.0%	12.5%	4.8%	5.0%
50g	No. scales	1	1	0	2
	% graduations within Context	9.1%	12.5%	.0%	5.0%
100g	No. scales	6	6	16	28
	% graduations Context	54.5%	75.0%	76.2%	70.0%
Total	*No. scales*	*11*	*8*	*21*	*40*
	% graduations within Context	*100.0%*	*100.0%*	*100.0%*	*100.0%*

Table 10: Weights of scales used by respondents in different contexts

Weight of scales		***Context***			***Total***
		Clinical only	***Community only***	***Clinical and Community***	
2kg or less	No. scales	1	3	14	18
	% weight within Context	33.3%	42.9%	70.0%	60.0%
3-5kg	No. scales	0	4	6	10
	% weight within Context	.0%	57.1%	30.0%	33.3%
6-8kg	No. scales	1	0	0	1
	% weight within Context	33.3%	.0%	.0%	3.3%
9-12kg	No. scales	1	0	0	1
	% weight within Context	33.3%	.0%	.0%	3.3%
Total	*No. scales*	*3*	*7*	*20*	*30*
	% weight within Context	*100.0%*	*100.0%*	*100.0%*	*100.0%*

In conclusion, analysis of the data shows that the most popular scales used to weigh infants under 6 months in emergencies are salter hanging scales, followed by seca infant balance beam scales. Almost all scales used are mechanical and most are lightweight and therefore easily portable. Data show that most respondents use scales with medium capacity (20-20kg) and that measure in graduations of 100g. Data also show that respondents are most likely to use the scales for a wider age group than just infants aged 0 – 6 months, particularly users of hanging spring and adult bench scales.

When data is analysed by the different contexts in which respondents use them, a difference is revealed in the types of scales used. In other words, the context that respondents work in seems to influence which scales they use. Respondents working in an exclusively clinical context are more likely to use balance beam scales and respondents working in the community are more likely to use hanging scales. Data also show that respondents working in an exclusively clinical context are more likely to use scales that have lower maximum capacities and those that work in the community are more likely to use scales with higher capacities. This suggests that the scales used in an exclusively clinical context are more likely to be designed for weighing young infants and will have greater precision, compared to scales used in the community that are less precise and able to weigh a wider range of age groups.

3. Respondent opinions of the scales they use

Respondents were asked to rate different aspects of the scales that they used between 0 (lowest) and 5 (highest). The answers to these questions were calculated into scores for precision, function, ease of use, portability and durability which also range from 0 (lowest) to 5 (highest). These scores represent the subjective opinions of respondents in each of these areas about the scales that they use. Scores in each of these areas will now be compared between the three different types of weighing scales used.

3.1 Precision: Table 11 displays summary statistics for precision scores for different types of weighing scales used. This shows that, on average, respondents do not rate the precision of any of the scales that they use very highly. However, of the three types, they believe balance beams to be the most precise scale, even though there is a fairly large range of scores within this group, which suggests that opinions on this vary. Hanging scales and adult bench scales score much lower, with adult bench scales scoring the lowest. A Kruskal-Wallis exact test shows that the difference between these scores is statistically significant (p=.000). Therefore, it can be said that respondents believe balance beams to be the most precise type of weighing scales for young infants of those that are used.

3.2 Function: Table 12 displays summary statistics for function scores for different types of scales. This shows that respondents believe there to be a large difference in how well different types of scales function for infants under 6 months. Respondents believe adult bench scales to be extremely functional and consistently give this type of scale the maximum score. Survey responses reveal that this is because infants are held in their mothers' arms during weighing, and are therefore unlikely to struggle.

Table 11: Summary statistics of precision scores for different types of scales

Hanging	N	Valid	26
	Median		**2.6700**
	Minimum		2.00
	Maximum		3.50
	Percentiles	25	2.3300
		75	3.0825
Balance beam bowl	N	Valid	12
	Median		**3.8350**
	Minimum		2.33
	Maximum		4.67
	Percentiles	25	3.3300
		75	4.2475
Adult bench taring	N	Valid	3
	Median		**2.3300**
	Minimum		2.00
	Maximum		2.67
	Percentiles	25	2.0000
		75	2.6700

Table 12: Summary statistics of function scores for different types of scales

Hanging	N	Valid	26
	Mean		**2.4100**
	Std. Deviation		1.13468
	Minimum		1.00
	Maximum		4.50
Balance beam bowl	N	Valid	12
	Mean		**3.5833**
	Std. Deviation		.76376
	Minimum		2.50
	Maximum		5.00
Adult bench taring	N	Valid	3
	Mean		**5.0000**
	Std. Deviation		.00000
	Minimum		5.00
	Maximum		5.00

Balance beam scales score fairly high on function and hanging scales score very low, although there is a very high range of scores in the hanging spring group. A one-way ANOVA test shows that the difference in function scores between the three types of scales is significant (p=.000). Thus, respondents believe adult bench scales to be significantly more functional than others scales for weighing infants under 6 months.

3.3 Ease of use: Table 13 displays summary statistics for the ease of use scores of different types of scales. This shows that respondents believe all scales to be fairly easy to use, although there is a wide range of scores for each type of scales, which suggests that opinions on this vary. A one-way ANOVA test shows that there is no significant difference between scores for the three different types of scales (p=.194) which suggests that, according to respondents, no one type of scale is easier to use than the others.

Table 13: Summary statistics of ease for use scores for different types of scales

Hanging	N	Valid	26
	Mean		**3.4446**
	Std. Deviation		.70145
	Minimum		2.17
	Maximum		5.00
Balance beam bowl	N	Valid	12
	Mean		**3.8833**
	Std. Deviation		.68601
	Minimum		2.50
	Maximum		5.00
Adult bench taring	N	Valid	3
	Mean		**3.3767**
	Std. Deviation		.83164
	Minimum		2.80
	Maximum		4.33

3.4 Portability: 11 cases were excluded from this section where respondents did not regularly transport scales to different locations. Table 14 displays summary statistics, for the 30 respondents that do regularly transport the scales, of portability scores by type. This shows that respondents believe all three types of scales to be portable. However, hanging scales are clearly believed to be the most portable, followed by balance beam scales. A Kruskal-Wallis exact test shows that this difference in opinions is significant (p=.015). Therefore, it can be deduced that, whilst respondents believe all types of scales to be portable, they believe hanging scales to be the easiest scales to transport to different sites.

Table 14: Summary statistics of portability scores for different types of scales

Hanging	N	Valid	21
	Median		**4.5000**
	Minimum		3.50
	Maximum		5.00
	Percentiles	25	4.0000
		75	5.0000
Balance beam bowl	N	Valid	6
	Median		**4.0000**
	Minimum		1.50
	Maximum		4.50
	Percentiles	25	2.2500
		75	4.5000
Adult bench taring	N	Valid	3
	Median		**3.5000**
	Minimum		2.50
	Maximum		4.50
	Percentiles	25	2.5000
		75	4.5000

3.5 Durability: Table 15 displays summary statistics for durability scores of different types of scales. This shows that respondents believe all three types of weighing scales to be durable. Data also appears to show that respondents believe adult bench scales to be the most durable, followed by the balance beams. Hanging scales are believed to be the least durable. However, a Kruskal-Wallis exact test shows that there not a significant difference in durability scores between the scales (p=.155). This suggests that respondents do not believe any one type of scales to be more durable than the others.

3.6 Overall Score: For each case, the above scores were combined to give an overall score. For cases where weighing scales were not regularly transported, the following calculation was performed:

Overall score = (Precision score + Function score + Ease of Use score + Durability score) / 4

For cases where weighing scales were regularly transported to different sites, the following calculation was performed:

Overall score = (Precision score + Function score + Ease of Use score + Portability + Durability score) / 5

Table 15: Summary statistics of durability scores for different types of scales

Hanging	N	Valid	26
	Median		**3.4150**
	Minimum		1.50
	Maximum		5.00
	Percentiles	25	3.0000
		75	4.0000
Balance beam bowl	N	Valid	12
	Median		**4.0000**
	Minimum		2.67
	Maximum		4.67
	Percentiles	25	3.3725
		75	4.5000
Adult bench taring	N	Valid	3
	Median		**4.5000**
	Minimum		3.00
	Maximum		5.00
	Percentiles	25	3.0000
		75	5.0000

The above calculations provide an overall score for each set of scales used between 0 (lowest) and 5 (highest). This score represents how high respondents rate the weighing scale that they use overall in terms of their suitability for weighing infants under 6 months in emergencies. Table 16 shows summary statistics for the overall score of the three different types of scales. This shows that, overall, respondents are only moderately happy with the scales that they use. Data also reveal that respondents believe balance beam scales to be the most suitable type of scales for weighing infants under 6 months in emergencies. Hanging scales scored the lowest and are therefore believed by respondents to be the least suitable type of weighing scales. A one-way ANOVA shows that this difference in overall scores between the different types of scales is statistically significant (p=.039).

3.7 Considering cost: It was not possible to find the cost of each specific model of scales used by respondents, as many are no longer manufactured. Instead, therefore, information was gathered from manufacturers about the cost of different types of scales and an average range of prices was calculated for each type. A score between 0 (lowest score, or highest cost) and 5 (highest score, or lowest cost) was then given to each scale on this basis. Results are displayed in table 17.

Table 16: Summary statistics of overall scores for different types of scales

Hanging	N	Valid	26
	Mean		**3.2740**
	Std. Deviation		.50789
	Minimum		2.40
	Maximum		4.30
Balance beam bowl	N	Valid	12
	Mean		**3.7043**
	Std. Deviation		.45362
	Minimum		2.95
	Maximum		4.53
Adult bench taring	N	Valid	3
	Mean		**3.6747**
	Std. Deviation		.49062
	Minimum		3.30
	Maximum		4.23

Table 17: Cost of different types of scales and related scores

Type of scales	**Cost range**	**Score**
Hanging	£60 - £100	4
Infant bench bowl	£300 - £600	1
Balance beam bowl	£200 - £250	3
Adult bench	£200 - £400	2

The cost score was added to the existing data and the overall score was then recalculated, using the following calculations: For cases where weighing scales were not regularly transported:

Overall score = (Precision score + Function score + Ease of Use score + Durability score + Cost score) / 5

For cases where weighing scales were regularly transported to different sites:

Overall score = (Precision score + Function score + Ease of Use score + Portability + Durability score + Cost score) / 6

Table 18 displays summary statistics of the overall score adjusted for cost. This shows that the overall score changes significantly once cost is taken into account. Scores are now much closer together and

a one-way ANOVA test shows that there is now no significant difference between the average overall score of different types of scales (p=.792).

Table 18: Summary statistics of overall score for each type of scales, adjusting for cost

Hanging	N	Valid	26
	Mean		**3.3995**
	Std. Deviation		.42081
	Minimum		2.67
	Maximum		4.25
Balance beam bowl	N	Valid	12
	Mean		**3.3943**
	Std. Deviation		.38464
	Minimum		2.76
	Maximum		4.11
Adult bench taring	N	Valid	3
	Mean		**3.2294**
	Std. Deviation		.40979
	Minimum		2.92
	Maximum		3.69

In conclusion, respondents believe balance beam scales to be the most suitable type of scales to weigh infants under 6 months in emergency situations and hanging scales to be the least suitable. Respondents also believe that different types of scales have different strengths and weaknesses. Respondents believe hanging scales to have low precision, to be less functional for infants under 6 months and possibly to be slightly less durable than other scales, but to be the most portable. Respondents believe balance beam scales to have the highest precision, to function well for infants under 6 months and to be portable and durable. Respondents believe adult bench scales to be the least precise and the least portable, however to be the most functional scale for infants under 6 months (as infants are held by their mothers) and possibly the most durable. When cost is taken into account, the overall scores show no significant difference, which suggests that the different types of scales are priced according to their performance. The strengths and weaknesses of the different types of scales can be summarized in the following table:

Table 19: Summary of the strengths and weaknesses of different types of scales used

Criteria	**Hanging scale**	**Balance Beam**	**Adult bench**
Precision	Low	Medium	Low
Function	Low	Medium	High
Ease of use	Medium	Medium	Medium
Portability	High	High	Medium
Durability	Medium	High	High
Cost	Low	Medium	Medium

Qualitative statements made in the questionnaires, in answer to open questions, reveal more about why respondents rated the different scales in this way. A common complaint about hanging scales was that they function poorly, given that infants have to sit rather than lie down and are therefore often uncomfortable and distressed. It also takes time to find a suitable place to hang the scales, as the surface needs to be level and at the right height so that the dial is at eye height of the person taking the measurement. Some respondents said that it is not always possible to find an appropriate place and, as a result, errors in measurement commonly occur. Those that use a rod to hang the scales from commented that it then takes three people to do the weighing (2 people are needed to hold the rod) which is an inconvenience. This explains why the function and ease of use scores are low to moderate for hanging scales. Furthermore, respondents often commented that hanging scales are not very durable, as the spring is easily overloaded by a heavy weight, or by overuse, after which function is permanently impaired. The plastic on the dial face is also not very resistant and easily breaks. This explains why the durability rating was only medium.

Surprisingly, balance beam scales scored well for portability. This is unexpected as the Seca 725 weighs 6kg. However, respondents commonly claimed to have “no difficulty” in transporting it to different sites. Comments were also often made about how easy balance beam scales are to use and how suitable they are for weighing young infants, as infants are able to lie down. Comments were also made about balance beam scales being durable and strong. Respondents did, however, comment that balance beam scales require a flat, hard surface to give an accurate reading, which possibly explains why the ease of use score is only medium.

Adult bench scales seem to have scored high in function because respondents like the fact that the infant is held securely in the mother’s arms during weighing. They therefore do not struggle, are secure and less likely to become distressed. This seems to be a large advantage of the adult bench scale in respondents’ opinions. Adult bench scales scored low in ease of use because, again, a flat and hard surface is required, which is not always easy to find.

4. An ideal set of weighing scales

Respondents were asked questions about the features of an ideal set of weighing scales for use in their particular context. 37 out of 41 respondents completed this section. Table 20 shows the functions of an ideal set of scales to weigh infants under 6 months in emergency situations in the opinions of respondents. A high proportion of respondents would prefer mechanical scales and, second to this, solar powered scales. This suggests that mains and battery power are difficult to sustain in emergency situations. Respondents generally agree that scales should be light and precise, with a fairly low maximum capacity and should measure in small graduations. Most respondents do not believe a secondary function is necessary, however, the most popular secondary function of those mentioned is to measure length. These features seem to point towards balance beam scales more than any of the other three types of scales (hanging scales and adult bench scales measure in larger graduations with larger maximum capacity and infant bench scales tend to be digital). This correlates with answers provided by respondents in section 3.

These same results were analysed by context (clinical only, community only and both) to see if there is difference between the features desired by respondents that work in different settings. No significant difference was found in any of the different features listed in table 20. A second analysis was performed by dividing respondents into two groups, those working in a clinical context and those not working in a clinical context, to see if any difference could be found. However, the only feature that respondents from clinical and non-clinical settings felt significantly different about was the capacity of scales (Using a Kruskal-Wallis exact test p=.026). This reveals that respondents working in a clinical context are significantly more likely to desire a set of weighing scales with a lower maximum capacity (and therefore more suited to weighing infants under 6 months). These results are displayed in Appendix 3 (Table A6). Aside from this, the context in which respondents use weighing scales does not seem to significantly influence their ideas about the type of scales that are ideal.

Table 20: Frequency of respondents the require different features in an ideal set of scales

	No. Respondents	***% Respondents***
Ideal Power source		
None (mechanical)	24	64.9
Battery	3	8.1
Battery and mains	3	8.1
Solar	5	13.5
Battery and solar	2	5.4
Total	*37*	*100*
Ideal weight		
2kg or less	24	64.9
3-5kg	11	29.7
13-20kg	1	2.7
Missing	1	2.9
Total	*37*	*100*
Ideal capacity		
14kg or less	21	56.8
15-19kg	3	8.1
20-29kg	12	32.4
50-100kg	1	2.7
Total	*37*	*100*
Ideal graduations		
10g or less	19	51.4
20g	3	8.1
50g	8	21.6
100g	7	18.9
Total	*37*	*100*
Ideal secondary functions		
Measures length	12	32.4
Weighs other ages	2	5.4
Out of range signal	1	2.7
Infant tray/bowl/belt	4	10.8
Stand	1	2.7
Nothing	17	45.9
Total	*37*	*100*

Chapter 4: Discussion and Conclusions

The ultimate purpose of the study was to contribute to a body of evidence from which recommendations can be made to humanitarian relief organizations and research institutions about the type of weighing scales to use to weigh infants under 6 months in emergency situations. The specific aim of the study was to generate a hypothesis for the field testing of different types of weighing scales which would then lead to recommendations. In order to do this, the study aimed to discover which weighing scales are most frequently used by humanitarian relief workers and researchers and which weighing scales this group prefers to use. Key findings are as follows:

1. Scales currently used

Overall, hanging scales are the most common type of weighing scales used by respondents. Of hanging scales, the model used most commonly is the Salter 235 6S. Almost all respondents use mechanical scales and most use very lightweight scales. Most weighing scales used have a capacity of between 20-29kg and measure in 100g graduations. Users of balance beam scales tend to use them exclusively to weigh infants under 6 months. However, overall, most respondents use scales for wider age groups than infants 0-6 months. Hanging spring scales are likely to be used to weigh either all children under 5 or all infants under 24 months. Adult bench scales are likely to be used for all age groups, including adults.

When examined by the context that respondents work in (clinical or community) data show that respondents use different types of scales for different purposes. When working exclusively in a clinical context respondents are more likely to use balance beam scales, which usually have a lower capacity and weigh in smaller graduations (down to 10g) and are therefore more precise. When working exclusively in the community respondents are more likely to use hanging scales, or adult bench scales, which have a higher maximum capacity and measure in higher graduations and are therefore less precise. Most respondents, however, use the same set of weighing scales for both clinically based and community based activities and, in this case, hanging scales are most commonly used.

2. Opinions of the weighing scales used

When costs of scales are not taken into account, the most popular type of scales is balance beam scales. Respondents believe balance beam scales to have the highest precision, to function well for infants under 6 months and to be fairly portable and durable. The least popular type of scales of respondents is hanging scales, even though this is the type of scales used most frequently. Hanging

scales are believed to be the least precise type of scales, the least functional for infants under 6 months and therefore the least suitable overall.

3. An ideal set of weighing scales

There was consensus among respondents that an ideal set of scales for weighing infants under 6 months in emergencies should be mechanical, very lightweight, have a low capacity, should measure in small graduations and, if they do have a secondary use, this should be to measure infant length. Balance beam scales are the type of weighing scales most likely to have these features in the current market. There is no difference between the opinions of respondents working in clinical or community contexts, which suggest that respondents view balance beam scales as ideal no matter which context they will be used in.

In summary, Respondents rate balance beam scales to be the most suitable type of scales for weighing infants under 6 months in emergencies. However, the type of weighing scales most frequently used are hanging scales, which are used most frequently when respondents work in the community. This suggests that, whilst balance beam scales may be the ideal, it is not always possible to use this type of scales in the community and therefore compromises are made.

Study quality

Sample bias: The sample is a good size compared to the population and represents a good spread of organizations. All of the main organizations working in nutrition in emergencies are included. Respondents represent a large range of countries, 25 altogether and respondents are included that do not speak English. These individuals were interviewed by English speaking colleagues or managers. Individuals are also included who do not have access to email and telephone, again, by interview. This reduces sample bias to some extent. However, the sample is not regionally representative, as most respondents work in Africa (33 out of 41). No research institutions are included in the sample, in spite of many being invited to participate.

Confounding factors: The skill of respondents in weighing infants under 6 months may have influenced some of their responses, and therefore the results. This is evident in the answers provided to questions about the calibration of scales. Some respondents answered that the scales they use do not need calibrating, or only need to be calibrated rarely, when in fact cross-referencing with manufacturers reveals that these scales do need frequent calibration. Therefore, one confounding factor may be the lack of skills and/or training of those individuals taking weight measurements.

Another confounding factor may be the age of scales used. If scales have not been replaced for some time and have been over-used, they may perform poorly compared to the same make and model that is relatively new and in good working order. Indirectly, this may point to another confounding factor: the resources of the organization represented by the respondent. If the organization lacks resources, then they are perhaps not able to replace scales as often as needed, or indeed train their staff as well as needed, which may have lead to the scales that they use performing badly in the study.

Data bias: Data from the sample provides accurate information about the types of scales currently being used. As the sample was selected to represent the population as a whole, these inferences are reliable. However, due to the large difference in numbers of respondents using the different types of scales, the data is biased when it comes to testing their suitability. As only 3 out of 41 respondents use adult bench scales, the sample size is too small to make reliable inferences about their suitability and therefore an accurate comparison between these and other types of scales cannot be made. Therefore, the study provides a reliable comparison between the opinions of respondents using hanging scales and balance beam scales, but not between users of these types of scales and adult benches. Furthermore, the study reveals no information about the performance of infant bench scales in emergency situations and therefore their suitability according to humanitarian field workers remains unknown.

Measurement error: The questionnaire was constructed very carefully and was tested in the field by CARE USA. Significant improvements were made following these field tests and, as a result, most respondents were able to complete the questionnaire with few errors. However, it was evident that, when using the scoring system, some people's perceptions of the same rating were different. The open ended questions provided a helpful check and revealed a few cases where ratings given were generally very high or very low compared to comments made and to ratings given by most respondents (for example, when one person's "very" scored 2 out of 5 when, on the whole, most people scored "very" as 4 out of 5). In cases where this occurred, the researcher checked the answers given with the respondent by email and phone to ensure that they understood the rating system. In one case several answers were adjusted by the respondent as a result.

Validity and reproducibility: The study presents a valid picture of the opinions and ideas of a certain group: humanitarian relief workers largely operating in Africa. However, these views have not yet been tested and may not therefore be a true picture of the reality. Furthermore, the results assume that the scoring system reflects the aspects of weighing scales that humanitarian relief workers believe to be important. This may not always be the case. Therefore, the results, again, cannot claim to be a true picture of reality, but simply a guide that will inform future field tests. In terms of reproducibility, the results would only be reproducible if the exact same scoring system was used.

Discussion

Limitations of existing weighing scales

All of the three types of weighing scales rated in the study (hanging, balance beam and adult bench) scored in the range of 3.27 to 3.70 out of 5 overall (5 being the highest score and 0 the lowest), not taking cost into account. This suggests that respondents do not believe any of the scales currently used to be ideal for weighing infants under 6 months in emergencies. Each type therefore has limitations, which will be discussed in turn.

Hanging scales

Hanging scales are rated by respondents as the least suitable type of scales for weighing infants under 6 months in emergencies. Hanging scales rate particularly badly in terms of precision. This partly seems to be because they only measure in 100g graduations, but also because they seem to generate a large potential for measurement error. Respondents frequently commented that, when hanging scales are not hung from the correct surface and/or users do not read the dial from the correct angle, measurements are not accurate. This is concerning, as false readings may lead to wrong decisions being made and therefore negative health outcomes. This is particularly concerning in cases where hanging scales are used to weigh severely malnourished infants in clinical environments, such as therapeutic feeding centers. In this context it is unlikely that hanging scales will provide the level of accuracy and precision required to treat infants effectively (ENN et al, 2004). Hanging scales also score very badly in terms of their functionality for young infants. Respondents often commented that young infants are not very well supported in hanging scales during weighing, which often leads to them becoming distressed.

In spite of this, however, the study shows that hanging scales are the type of scales used most frequently by respondents. An obvious point for discussion is *why*, when they are rated so badly? The answer to this question seems to lie in the fact that respondents use different scales for different purposes. Specifically, hanging spring scales are more likely to be used by respondents working in the community (either exclusively or not). This suggests that, even though humanitarian relief workers regard hanging scales as fairly unsuitable for weighing infants under 6 months, they believe them to fit the specific requirements of community work more than other types of scales. One possible reason for this is that hanging scales are very portable, given that they are very light, usually weighing 2kg or less. This makes them very easy to carry to different sites. However, even though hanging scales are rated by respondents as the most portable set of weighing scales (rated 4.5 out of 5 on average), balance beam scales also rate very high in this area (4 out of 5 on average). This makes it unlikely that hanging scales are selected over balance beam scales because they are more portable.

Another possible reason for using hanging scales in the community is because relief workers believe them to be more durable than other types of scales. However, results do not show this either. Data in fact reveal no statistically significant difference in durability ratings between all three of the different types of scales used. Comments from respondents reveal that hanging scales often have to be replaced as the spring has been overstretched, the dial face broken, or the dial has stopped working. No such comments are given for other types of scales. Therefore, it does not seem that hanging scales are selected above others for community work because they are believed to be more durable.

Where hanging scales do seem to provide a significant advantage over other types of scales is in their apparent short term cost-effectiveness. Hanging scales are by far the cheapest on the market, which reduces immediate costs and also makes them easier to replace when broken. It is possible that cost is more of a consideration in community work than in clinical work, as in the community scales will have a higher usage and be more prone to damage due to frequent transportation. Humanitarian personnel may be less willing to pay a higher initial cost for scales that they know are likely to wear in this way. What the study does not show us, however, is whether hanging scales are truly a cost effective option. The survey failed to ask respondents how often scales *should* be replaced and therefore it is not known if their initial low cost is outweighed by the cost of frequent replacement. As their durability appears to be fairly low, it could be the case that hanging scales are in fact more expensive in the long term than other scales because they need to be replaced more often. This needs to be researched further. If this is the case, then the purchasing of hanging scales for community work could be a false economy.

Another important feature of hanging scales is that they have a larger maximum capacity than other scales. They are therefore frequently used to weigh all infants under 24 months (and sometimes all children under 60 months). Hanging scales may provide a convenient option in this way, as only one set of weighing scales is needed for all infants or young children, rather than several. This may be another way of reducing costs. Data show that most scales (41%) are selected by either head offices or regional offices. As these offices are more likely to manage budgets and negotiate with donors, they are perhaps more likely to make choices based on cost rather than function. Choosers of scales may also be influenced by recommendations from the United Nations. As the literature shows, WHO recommends the use of hanging scales in emergencies (WHO, 2002). UN agencies, particularly UNICEF, also seem to supply weighing scales to humanitarian agencies in some cases. Therefore, the UN may also have a large influence over the choices made.

Balance beam scales

In this study respondents rate balance beams as the most suitable type of scales for weighing infants under 6 months. This seems to be true whether respondents weigh infants in clinical or community settings. Respondents rate balance beam scales the highest of all scales used in terms of precision.

They also score balance beam scales highly in terms of ease of use, portability and durability, and fairly highly on function. Even though balance beam scales are heavier than hanging scales, respondents report “no difficulties” in transporting them to field sites. This may be because their shape makes them easier to carry, even though they are heavier, or because respondents feel that their benefits outweigh this apparent disadvantage.

Balance beam scales nevertheless have limitations. One disadvantage is their cost (they cost more than hanging scales) and the second is that they are only suitable for weighing young infants and cannot be used for wider age groups. This may make them a less cost effective and practical choice, as at least two sets of scales will be required where all infants and young children are being weighed. It seems that balance beam scales could be the most suitable set of scales, of those currently used, for weighing infants under 6 months in clinical settings. Balance beam scales may also offer a viable alternative to hanging scales in the community where infants under 6 months are the only age group being weighed. However, where all infants and young children are being weighed, it may be necessary to consider another option.

Adult bench scales

This study shows that very few humanitarian relief workers are using adult bench scales to weigh infants under 6 months in emergencies. It is difficult to infer from the study why this is, as the sample size of adult bench users is so small. However, data on the features of an ideal set of scales show that respondents prefer mechanical scales over those that require power. One important limitation of existing adult bench scales may therefore be that they require solar and/or battery power. Added to this, adult bench scales are the second most expensive type of scales, with average costs ranging from £200 - £400, which may be another limiting factor. Data also suggest that adult benches have lower precision than other sets of scales, usually measuring in 100g graduations, although this need not be a limiting factor, as some models, such as the Tanita 1582, weigh in 20g graduations.

Adult bench scales appear also to have advantages. They seem to provide an extremely functional scale for weighing young infants, as infants are weighed in their mother’s arms. The literature from the Multicentre Growth Reference Study (MGRS) shows that this can provide a major advantage, as infants are calm and relaxed and mothers are therefore more likely to have a positive perception of the intervention and continue to participate (de Onis et al. 2004b). Data from the study also suggest that humanitarian relief workers find adult bench scales to be very durable; if this is the case, then the higher initial cost of purchasing a set may pay off in the longer term. Furthermore, adult bench scales have the capacity to weigh all ages, including adults, and could therefore provide the most cost-effective and practical option for community-based work, given that they would be the only type of scales required. For these reasons, adult benches may well have potential as a viable alternative to hanging scales for use in the community.

Infant bench scales

No respondents use infant bench scales. Even though no direct data exists from this study, inferences can be made about why this is. Infant bench scales are the most expensive type of scales out of all four types included in the study. Average costs range from £300 to £600. Infant bench scales also require power, usually either mains or battery. These both appear to be significant limitations for humanitarian relief organizations and may therefore be the reason that infant bench scales are not selected. However, there is no information available on their advantages, other than obvious physical features, such as the fact that infant bench scales usually measure in low graduations (10-20g) and are lightweight (3-5kg). However, as there is no literature available on their use in emergencies, and they do not appear to have been tested by humanitarian relief workers as yet, no conclusions can be drawn at this stage.

Generating a hypothesis for field tests

The study shows that humanitarian relief workers believe balance beam scales to be the most suitable type of scales for weighing infants under 6 months in emergencies of those currently used. Balance beam scales also seem to provide the 'best fit' option in terms of features that respondents believe to be 'ideal', given that balance beam scales are mechanical, have a low capacity, measure in small graduations and in some cases are able to measure infant length as a secondary function. On the basis of this information a hypothesis can be generated for field tests. The hypothesis should compare balance beam scales, as the preferred type, with hanging scales, the type used most frequently. As very little information is available from this study or in the literature about adult bench and infant bench scales, balance beam scales should also be compared against these. Therefore the hypothesis should test balance beam scales as the 'ideal' type of scales for weighing infants under 6 months, compared to hanging, adult bench and infant bench scales.

A key finding from this study is that the requirements of weighing scales are different according to the different contexts in which anthropometric assessment is taking place, i.e. clinical or community settings. For this reason it is recommended that field tests consider the suitability of balance beam scales compared with other scales in clinical and community contexts separately. As the requirements of weighing scales are different in each context, the criteria used for testing the scales in each should also differ. Results of this study, and the literature (see table 1, introduction), show that in community work (nutritional surveillance, individual screening and growth monitoring) anthropometric assessment tends to be infrequent and of large numbers of infants in different locations and is often carried out by non-health professionals. Therefore the requirement is likely to be for scales with less precision, but greater durability and portability and that are easy to use. In clinical settings (therapeutic feeding either in therapeutic feeding centers or hospitals, and some supplementary feeding centers) the requirement

is likely to be for scales that have high precision and that function very well for very small infants. This is depicted in table 21.

Table 21: Requirements of weighing scales in community and clinical contexts

Criteria	**Community**	**Clinical**
Precision	Low	High
Function	Medium	High
Ease of use	High	Medium
Portability	High	Low
Durability	High	Low

The criteria against which balance beams are tested in clinical and community contexts should differ according to this pattern. Thus, rather than testing one hypothesis, it is recommended that two hypotheses are tested, as follows:

Hypothesis 1: Infant balance beam scales are more suitable, in terms of their *function, ease of use, portability and durability*, than hanging scales, adult bench scales and infant bench scales, for weighing infants under 6 months in *community-based emergency programmes*.

Hypothesis 2: Infant balance beam scales are more suitable, in terms of their *precision, function and ease of use* than hanging scales, adult bench scales and infant bench scales, for weighing infants under 6 months in *clinically based emergency programmes*.

Cost effectiveness could also be considered in both contexts and therefore included in both hypotheses. On the basis of the literature and results of this study, it is recommended that the following models of each type of scales are used to test the above hypotheses:

- Balance beam scale: Seca 745, as this is the updated version of the Seca 725, the most frequently used balance beam scale in the study. The 745 has an improved bowl which makes the baby more secure (therefore its function should be improved)
- Hanging scale: Salter 235 6S, 25kg capacity with 100g graduations, as this is the most frequently used hanging scale in the study and fits the criteria of scales recommended by WHO (WHO, 2002). A bowl/ tray should be used for the infant rather than a sling for improved function for infants 0-6 months.
- Adult bench scale: Tanita 1582, as this is similar to the UNISCALE and UNICEF electronic scale 890 used in the multi-centre growth reference study (de Onis et al., 2004b) but measures in 20g graduations and is therefore more precise.

- Infant bench scale: There is no guidance here on what to use from the results or literature. Therefore, any infant bench could be selected. It is recommended, however, that an infant bench scale is selected that is powered by solar, as well as battery, is lightweight and measures in small graduations.

The results of field tests based on the above hypotheses may well reveal that different types of scales are most suitable for use in different contexts. If this is the case, field tests may also reveal that one particular type of scales provides an adequate compromise if only one type can be used for both. If this is the case then the result of the field tests may be multiple recommendations, rather than just one.

An ideal set of weighing scales: potential for manufacturers?

Whilst respondents believe balance beams to be the most suitable set of scales for weighing infants under 6 months in emergencies out of those currently used, respondents still feel that they have limitations. Balance beams are therefore not ideal and, in fact, it appears that the ideal type of scales for weighing infants under 6 months in emergencies does not currently exist. This is likely to be because manufacturers to date have not designed weighing scales with very small infants in emergency situations in mind. This reveals a gap in the current market which manufacturers could potentially fill. Evidence from this study suggests that humanitarian workers would be inclined to purchase a more suitable set of weighing scales if it was truly ideal and cost effective. Development organizations, UN agencies and governments of developing countries may also be interested in purchasing such scales, as requirements of weighing equipment for these users may be similar. If this is the case, then this could present a considerable market opportunity. Careful market research would need to be done and prototypes tested to ensure that any new set of scales does meet the specific requirements of emergency conditions, and of very underweight infants. However, evidence from this study suggests that one set of scales that can be adapted for use in community and clinical contexts would be ideal and that this set of scales should include the following features:

- Precision: able to measure in very small graduations (20g)
- Function: Suitable for use with all age groups possibly, or at least all children under 5, but with suitable adaptations to be highly functional for very small infants (either taring capacity to enable infants to be held in adult's arms or bowl attachment with suitable support for severely malnourished infants) This attachment could also measure infant length.
- Easy to use: Digital display to enable easy reading of results and therefore to avoid error of personnel (this will remove the need for high level of skills of users), powered by solar or a renewable energy source, such as wind-up power.

- Portable: Very lightweight (possibly made of plastic) with a handle so that it can be carried easily
- Durable: Able to use on a non-flat surface and with no holes to avoid clogging with dust and grit. Made of very durable materials that are less likely to wear/ break to avoid scales needing to be replaced often.

Significance of findings for policy and professional practice

The results from this study should not in themselves influence policy or professional practice. They simply provide a necessary foundation from which field tests can take place. Once field tests have taken place, however, it is expected that the findings will inform the policy of the Emergency Nutrition Network (ENN) about the advice they give to humanitarian organizations and research institutions engaging with infant and maternal health in emergency situations. It is also hoped that the findings will influence WHO, UNICEF and UNHCR, in the weighing scales that they recommend to field users, and in some cases provide. It is hoped that, in turn, such policy will affect professional practice to ensure that field users are using the most appropriate scales possible in their context to weigh infants under 6 months. Findings should also influence manufacturers to consider filling the existing gap in the market by creating a new type of weighing scales specifically designed for this purpose. It is hoped that this will raise the standard of anthropometric assessment of young infants in emergencies, and therefore increase the quality of measures to treat and prevent infant malnutrition. This, in turn, has the potential to decrease under 5 child mortality during emergencies (Pelletier & Frongillo, 2003) and reduce the consequences of infant malnutrition throughout the life cycle (Haddad & Geissler, 2005), including physical and intellectual stunting (Manary & Solomons, 2004) and chronic adult diseaseas such as obesity, hypertension, stroke, cardiac ischemia and diabetes (Barker et al., 2001). Accurate weight measurements, the vital technical component of which is appropriate weighing scales, are a fundamental aspect of health care at the individual, population and policy levels both during emergencies and beyond.

Conclusions

Aims and objectives: The overall aim of the study was to generate a hypothesis to field test weighing scales for infants under 6 months in emergencies. The objectives of the study were to find out the type of weighing scales currently being used in the field and the type of weighing scales humanitarian relief workers and researchers believe to be most suitable for this purpose.

Research process: The study design was a cross-sectional survey. 223 humanitarian relief workers and researchers were invited to take part in the study and, from this, a sample of 41 humanitarian

workers was gained from a range of different humanitarian organizations and countries, largely in Africa, who regularly weigh infants under 6 months. Participants completed a questionnaire that asked a range of questions about the weighing scales that they currently use for infants under 6 months and their ideas about an ideal set of scales. The results were statistically analysed using SPSS.

Findings:

- Spring scales, specifically the Salter 235 6S model, are the most common type of scales used by respondents for weighing infants under 6 months in emergencies. Respondents tend to use weighing scales that are mechanical, lightweight, with a capacity of 20-29kg and that measure in 100g graduations. Most do not use weighing scales exclusively for the 0-6 month age group, but for a wider age range.
- Respondents tend to use different scales for different purposes; in clinical settings they are likely to use more precise scales, usually balance beam scales, and in community settings they tend to use less precise scales, usually hanging spring scales. When using the same set of scales for both, respondents tend to use scales most suitable for community work, usually hanging spring scales.
- Respondents regard balance beam scales as the most suitable type of scales for weighing infants under 6 months. Balance beam scales are rated highly in terms of precision, function and ease of use and fairly highly on portability and durability. They are therefore believed to be the most suitable type of scales of those that exist.
- Humanitarian workers rate hanging scales as the least suitable type for weighing infants under 6 months in emergencies, even though they are the type used most frequently.
- Adult bench scales and infant bench scales are relatively unused by humanitarian workers and are therefore untested by the study.

Key issues discussed:

The results do not support existing guidelines and therefore, existing guidelines may need to be revised. Respondents are generally not happy with the scales that they are currently using most frequently (hanging spring scales) but seem to use them in the community because they believe them to be the most cost effective option in the short term and because they can be used to weigh wider age groups than just infants aged 0-6 months. This suggests that different weighing scales may be needed for different purposes and that it may not always be possible to use the ideal type of weighing scales in all settings. Nevertheless, the study suggests that the compromise currently being made by many humanitarian relief workers may not be appropriate. Adult bench scales and infant bench scales may not be used because of their high cost and power demands, but possibly also because they are relatively new compared to other types and have not yet been tested in emergencies.

Conclusion: Field tests should be carried out to test balance beam scales as the most suitable type of weighing scales of those that exist, compared to hanging scales (the most frequently used) and adult bench scales and infant bench scales (so far untested). Field tests should be carried out in clinical settings and community settings separately, using different criteria appropriate for each context. A potentially large market opportunity appears to exist for manufacturers to create a new type of weighing scales that meets the specific requirements of weighing infants under 6 months in emergency situations. This also needs to be explored.

Next steps to achieve desired change

Conduct field tests: Field trials should test balance beam scales as the most suitable type of scales of those available in the current market. Tests should be done using the hypotheses generated by this study. CARE USA has shown interest in taking the research forward and, if it does so, should be careful to ensure that tests are carried out in such a way as to produce as reliable and meaningful results as possible. Considerations might include using scales that are the same age and using the same individuals to test their use. This will ensure that age of scales and skills of users do not confound results. CARE USA may also wish to consider carrying out the same field tests in two or three different emergency situations, so that results have broad applicability. Manufacturers, UN agencies and other NGOs may be interested in collaborating with CARE USA on this research, given its wide significance. This should be encouraged to ensure that the research is well resourced and has wide buy-in, however, care should be taken to keep tests unbiased, regardless of stakeholder interests.

Recommendations: On the basis of field tests, recommendations should be made to all agencies working in nutritional emergencies through ENN. Key UN agencies, including UNICEF, WHO and UNHCR, should also be encouraged to adopt these as their recommendations, as well as to create much needed guidelines to fill the existing gap. Collaboration with UN agencies in field tests may make them more amenable to taking the resulting recommendations on board.

Manufacturing: Following field tests, manufacturers should be presented with the research and requested to fill the current gap in the market by designing and producing weighing scales that are fit for this specific purpose. Humanitarian personnel can be difficult to access and therefore assistance to manufacturers should be offered in this respect by participating NGOs, such as CARE USA and ENN. This will ensure that meaningful market research is carried out. Manufacturers should also be encouraged to consult with field based staff on designs and in the testing of prototypes. This will ensure that weighing scales produced by manufacturers are as close to the true ideal as possible. Collaboration with UN agencies, which often purchase large volumes of weighing scales, will give credibility and may help to persuade manufacturers to consider this as a viable opportunity.

Further research: Research should be conducted into the existing knowledge and skills base of humanitarian personnel in the anthropometric assessment of young infants. On the basis of findings, simple information and training materials could be produced for humanitarian personnel and disseminated through ENN and UN agencies. Training workshops could also be provided. This will ensure that, when the right technology is in place, it is used correctly to produce accurate results that will have the intended impact of reducing infant malnutrition in emergencies.

References

Ali, M. and Shah, I. H. (2000) Sanctions and childhood mortality in Iraq. *The Lancet*, 355 (9218), 1851-1857.

Bakewell, O. (2003) *Sharpening the development process: A practical guide to monitoring and evaluation.* Oxford: INTRAC.

Barker, D., Forsen, T., Uutela, A., Osmand, C.E. and Eriksoon, J.G. (2001) Size at birth and resilience to effects of poor living conditions in adult life: longitudinal study. *British Medical Journal*, 323, 1273-1276.

Bates, C.J., Nelson, M. and Ulijaszek, S.J. (2005) Nutritional assessment methods IN: Geissler, C. and Powers, H., eds. *Human Nutrition*, eleventh edition, London: Elsevier, 573-596.

Borrel, A., Taylor, A., McGrath, M., Seal, A., Hormann, E., Phelps, L. and Mason, F. (2001) From policy to practice: Challenges in infant feeding in emergencies during the Balkan crisis. *Disasters*, 25 (2): 149-163.

Das, J.C., Afroze, A., Khanam, S.T. and Paul, N. (2005) Mid-arm circumference: an alternative measure for screening low birth weight babies. *Bangladesh Medical Research Council Bulletin*, 31 (1): 16.

De Onis, M., Wijnhoven, T.M.A. and Adelheid, W.O. (2004a) Wordwide practices in child growth monitoring. *The journal of pediatrics*, 144 (4), 461- 465.

De Onis, M., Onyango, A.W., Ven den Broeck, J., Chumlea, W,C. and Martorell, R. (2004b) Measurement and standardization protocols for anthropometry used in the construction of a new international growth reference. *Food and Nutrition Bulletin*, 25 (1), supplement 1.

Duggan, M. and Golden, B. (2005) Deficiency diseases IN: Human Nutrition (eleventh edition) edited by Geissler, C and Powers, H. London: Elsevier. pp: 517-536.

Emergency Nutrition Network (ENN) (2006) Infant and young child feeding in emergencies: Operational guidance for emergency relief staff and programme managers, version 2.0, May 2006. Available from www.ennonline.net

Emergency Nutrition Network (ENN) (2005) Shared experiences in infant and young child feeding in emergencies. Available from www.ennonline.net

ENN, IBFAN, Terre des homes, UNICEF, UNHCR, WHO and WFP (2004) *Infant feeding in emergencies: Module 2, for health and nutrition workers in emergency situations*. Oxford: Emergency Nutrition Network.

Fawcus, S.R., Mware, R. and Bassett, M.T. (1993) Chest circumference as an indicator of low birth weight in Zimbabwe. *Journal of tropical pediatrics*, 39 (1): 48-49.

Golden, M. (2000) Comment on including infants in nutrition surveys: experiences of ACT in Kabul City. *Field Exchange* 9: 16-17.

Haddad, L. and Geissler, C. (2005) Food and nutrition policies and interventions. IN: Human Nutrition (eleventh edition) edited by Geissler, C and Powers, H. London: Elsevier, pp 617-640.

Jones, G., Steketee, R.W., Black, R.E., Bhutta, Z.A. and Morris, S.A. (2003) How many child deaths can we prevent this year? *The Lancet*, 362 (9377), 65-71.

Kapoor, S.K., Kumar, G. and Anand, K. (1996) Use of mid-arm and chest circumferences to predict birth weight in rural north India. *Journal of Epidemiology and Community Health*, 50: 683-686.

Manary, M.J. and Solomons, N.W. (2004) Public health aspects of under nutrition. IN: Public Health Nutrition, edited by Gibney, M.J., Margetts, B.M., Kearney, J.M. and Arab, L. Oxford: Blackwell, pp:178-191.

Margetts, B. (2004) An overview of public health nutrition. IN: Public Health Nutrition, edited by Gibney, M.J., Margetts, B.M., Kearney, J.M. and Arab, L. Oxford: Blackwell, pp1-25.

Meegan, M., Morley, D.C. and Brown, R. (1994) Child weighing by the unschooled: a report of a controlled study of growth monitoring over 12 months of Massai children using direct recording scales. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 88, 635-637.

Morley, D. and Elmore-Meegan, M. (2000) Growth monitoring: A forgotten subject. *FAO: Food, Nutrition and Agriculture*, 27, 14-18.

Naik, D.B., Kulkarni, A.P. and Aswar, N.R. (2003) Birth weight and anthropometry of newborns. *The Indian Journal of Pediatrics*, 70 (2), 145-6.

Ngowi, J.A., Redding-Lallinger, R. and Hirji, K.F. (1993) An assessment of the use of anthropometric measures for predicting low birth weight. *Journal of Tropical Pediatrics*, 39 (6), 356.

Pelletier, D.L. and Frongillo, E.A. (2003) Changes in child survival are strongly associated with changes in malnutrition in developing countries. *The journal of nutrition,* 133: 107-119.

Prudhon., C. (2000) Including infants in nutrition surveys. *Field Exchange*, 9, 15.

Rondo, R.H. and Tomkins, A.M. (1996) Chest circumference as an indicator of intrauterine growth retardation. *Early Human Development*, 44 (3), 161-7.

Seal, A., Taylor, A., Gostelow, L. and McGrath, M. (2001) Review of policies and guidelines on infant feeding in emergencies: common ground and gaps. *Disasters*, 25 (2), 136- 148.

Scherbaum, V. (2003) Infant formula distribution in Northern Iraq, *Field Exchange,* 20, 6.

Sharma, J.N. and Bora, P. (1998) Mid Arm Circumference as an index of protein energy malnutrition between 6 to 12 months. *Indian Pediatrics*, 35 (10), 1005-1008.

Shetty, P. (2002) Food and nutrition: the global challenge. IN: *Introduction to human nutrition.* Edited by Gibney, M.J., Vorster, H.H. and Kok, F.J. Oxford: Blackwell. pp 318-333.

Talley, L., Spiegel, P.B. and Girgis, M. (2001) An investigation of increasing mortality among Congolese refugees in Lugutu camp, Tanzania, May-June, 1999. *Journal of Refugee Studies*, 14 (4).

UN Department of Economic and Social Affairs, Statistics Division (2006) *Progress towards the millennium development goals, 1990-2005*. New York: United Nations.

UNHCR, UNICEF, WFP and WHO (2003) *Food and nutrition needs in emergencies.* Rome: WFP.

UNICEF (2006) *Progress for children: A report card on nutrition, number 4, May 2006*. New York: UNICEF.

UNICEF (2001) *The state of the world's children 2001: Early childhood.* New York: UNICEF.

UNICEF (1998) *The state of the world's children: Focus on nutrition.* New York: UNICEF.

Webb, P. and Harinarayan, A. (1999) A measure of uncertainty: the nature of vulnerability and its relationship to malnutrition. *Disasters*, 23 (4): 292-305.

WHO (2004) *Guiding principles for feeding infants and young children in emergencies*. Geneva: WHO.

WHO (2003) *Global strategy for infant and young child feeding*. Geneva: WHO.

WHO (2002) *The management of nutrition in major emergencies*. Geneva: WHO.

WHO (1981) *International code of marketing of breastmilk substitutes.* Geneva: WHO.

WHO-UNICEF (2003) *Consultation on child health in complex emergencies, 21-22nd October, 2003*. Geneva: WHO.

WHO, UNICEF, LINKAGES, IBFAN and ENN (2001) *Infant feeding in emergencies: module 1, for emergency relief staff.* Oxford: ENN.

World Bank (2006) *Repositioning nutrition as central to development: A strategy for large-scale action.* Washington: The International Bank for Reconstruction and Development/ The World Bank.

Acknowledgements

Thank you to Alan Jackson from the University of Southampton and Marie McGrath from ENN for their support and guidance throughout the study. Thank you to Mary Lungaho for advice and carrying out pilot interviews with CARE USA partners in Kenya. Sincere thank you to all respondents who gave generously of their time in completing the questionnaire. A number of individuals gave of their expertise during initial discussions and study design, including David Morley, Mark Myatt, Michael Golden, Geza Harzczi and Thomas Diste. Advice on statistical analysis was given by Scott Harris. Input was also received from Mercedes de Onis.

Appendix 2: Illustrations of different types of scales

Figure A1: Hanging spring scales

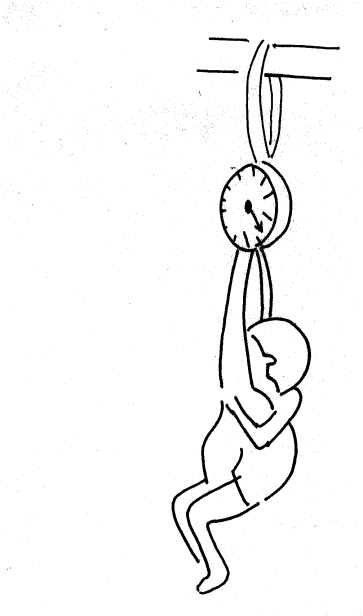


Figure A2: Balance beam scales

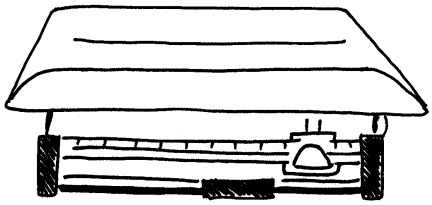


Figure A3: Adult bench scale

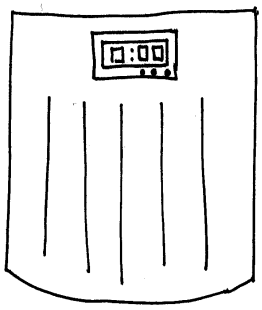
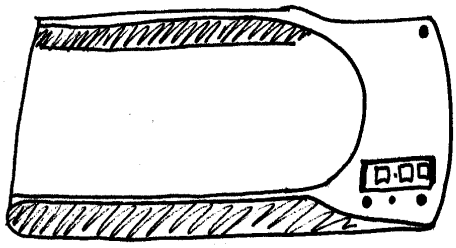


Figure A4: Infant bench scale



Appendix 3: Extra tables

Table A1: Makes of different types of weighing scales used by respondents

Make of Scales		***Type***			***Total***
		Hanging	***Balance beam bowl***	***Adult bench taring***	
Wuxi	No. scales	0	2	0	2
	% make within Type	.0%	16.7%	.0%	5.3%
Tanita	No. Scales	0	0	1	1
	% make within Type	.0%	.0%	50.0%	2.6%
Seca	No. Scales	0	8	1	9
	% make within Type	.0%	66.7%	50.0%	23.7%
Salter	No. Scales	24	0	0	24
	% make within Type	100.0%	.0%	.0%	63.2%
Dong	No. Scales	0	1	0	1
	% make within Type	.0%	8.3%	.0%	2.6%
Detecto	No. Scales	0	1	0	1
	% make within Type	.0%	8.3%	.0%	2.6%
Total	*No. Scales*	*24*	*12*	*2*	*38*
	% make within Type	*100.0%*	*100.0%*	*100.0%*	*100.0%*

Table A2: Power sources of different types of weighing scales used by respondents

Power type		***Type***			***Total***
		Hanging	***Balance beam bowl***	***Adult bench taring***	
Battery and solar	No. scales	0	0	1	1
	% power within Type	.0%	.0%	33.3%	2.4%
Battery	No. scales	0	0	2	2
	% power within Type	.0%	.0%	66.7%	4.9%
None	No. scales	26	12	0	38
(mechanical)	% power within Type	100.0%	100.0%	.0%	92.7%
Total	*No. scales*	*26*	*12*	*3*	*41*
	% power within Type	*100.0%*	*100.0%*	*100.0%*	*100.0%*

Table A3: Secondary functions of different types of weighing scales used by respondents

Secondary use		***Type***			***Total***
		Hanging	***Balance beam bowl***	***Adult bench taring***	
None	No. scales	24	11	3	38
	% uses within Type	92.3%	91.7%	100.0%	92.7%
Length board	No. scales	2	1	0	3
	% uses within Type	7.7%	8.3%	.0%	7.3%
Total	No. scales	26	12	3	41
	% uses within Type	100.0%	100.0%	100.0%	100.0%

Table A4: Chooser of different types of weighing scales used

Chooser		Type			Total
		Hanging	Balance beam	Adult bench	
Myself	Count	1	0	2	3
	% within Type	3.8%	.0%	66.7%	7.3%
Field staff	Count	5	1	0	6
	% within Type	19.2%	8.3%	.0%	14.6%
Regional office	Count	3	2	0	5
	% within Type	11.5%	16.7%	.0%	12.2%
Head office	Count	7	2	1	10
	% within Type	26.9%	16.7%	33.3%	24.4%
UNICEF	Count	6	6	0	12
	% within Type	23.1%	50.0%	.0%	29.3%
Consultation with multiple	Count	1	0	0	1
	% within Type	3.8%	.0%	.0%	2.4%
Don't know	Count	3	1	0	4
	% within Type	11.5%	8.3%	.0%	9.8%
Total	Count	26	12	3	41
	% within Type	100.0%	100.0%	100.0%	100.0%

Table A5: Types of weighing scales used in different contexts

Type		***Context***			***Total***
		Clinical only	***Community only***	***Clinical and Community***	
Hanging	No. scales	5	5	16	26
	% type within Context	41.7%	62.5%	76.2%	63.4%
Balance beam bowl	No. scales	7	1	4	12
	% type within Context	58.3%	12.5%	19.0%	29.3%
Adult bench taring	No. scales	0	2	1	3
	% type within Context	.0%	25.0%	4.8%	7.3%
Total	No. scales	12	8	21	41
	% type within Context	100.0%	100.0%	100.0%	100.0%

Table A6: Ideal capacity of scales by clinical and non clinical context

	Context		***Total***
Ideal capacity	***Clinical***	***Not clinical***	
More than 100kg	0	1	1
50-100kg	0	1	1
20-29kg	9	3	12
15-19kg	3	0	3
14kg or less	19	2	21
Total	*31*	*7*	*38*