

TITLE

Admission profile and discharge outcomes for infants aged less than 6 months admitted to inpatient therapeutic care in 10 countries. A secondary data analysis.

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SHORT RUNNING TITLE

Management of acute malnutrition in infants.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest

CONTRIBUTIONS

AJS, MK, MM conceived the study. CW, JCH and PD contributed data. CSGE analysed and interpreted the data, and wrote the initial draft of the manuscript. All authors contributed to the manuscript revisions. All authors read and approved the final manuscript.

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Admission profile and discharge outcomes for infants aged less than 6 months admitted to inpatient therapeutic care in 10 countries. A secondary data analysis.

ABSTRACT

Evidence on the management of acute malnutrition in infants aged less than 6 months (infants <6mo) is scarce. To understand outcomes using current protocols, we analysed a sample of 24,045 children aged 0-60 months from 21 datasets of inpatient therapeutic care programmes in 10 countries. We compared the proportion of admissions, the anthropometric profile at admission, and the discharge outcomes between infants <6mo and children aged 6-60 months (older children).

Infants <6mo accounted for 12% of admissions. The quality of anthropometric data at admission was more problematic in infants <6mo than in older children with a greater proportion of missing data (a 6.9 percentage points difference for length values, 95%CI: 6.0; 7.9, $p<0.01$), anthropometric measures that could not be converted to indices (a 15.6 percentage points difference for weight-for-length z-score values, 95%CI: 14.3; 16.9, $p<0.01$), and anthropometric indices that were flagged as outliers (a 2.7 percentage points difference for any anthropometric index being flagged as an outlier, 95%CI: 1.7; 3.8, $p<0.01$). A high proportion of both infants <6mo and older children were discharged as recovered. Infants <6mo showed a greater risk of death during treatment (risk ratio 1.30, 95%CI: 1.09; 1.56, $p<0.01$).

Infants <6mo represent an important proportion of admissions to therapeutic feeding programmes and there are crucial challenges associated with their care. Systematic compilation and analysis of routine data for infants <6mo is necessary for monitoring programme performance and should be promoted as a tool to monitor the impact of new guidelines on care.

KEYWORDS

Malnutrition, Infant and Child Nutrition, Management of Acute Malnutrition, Mortality, Anthropometry, Wasting.

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2 **to inpatient therapeutic care in 10 countries. A secondary data analysis.**

3

4 **INTRODUCTION**

5 Acute malnutrition is a serious global health concern (Black et al. 2013). Global estimates
6 indicate that wasting, a type of acute malnutrition characterized by acute mass loss (WHO
7 1995), affects 50 million children aged <5 years and accounts for 11.5% of their total deaths
8 (UNICEF et al. 2015;Black et al. 2013). Severe wasting affects 16 million children and
9 accounts for 7.8% of their total deaths (UNICEF et al. 2015;Black et al. 2013). Moreover, it is
10 also estimated that wasting affects 8.5 million infants aged less than 6 months (henceforth
11 referred to as infants <6mo) (Kerac et al. 2011). Beyond its short-term impact on survival and
12 health, this wasting burden has long-lasting consequences for both individuals and societies
13 (Victora et al. 2008).

14 Despite these high global burdens, infants <6mo were only recently included in the new World
15 Health Organisation (WHO) guidelines for the management of severe acute malnutrition
16 (SAM) (WHO 2013;WHO & UNICEF 2009). Although, inclusion of infants <6mo in these
17 guidelines represents an important development, there is also a recognised need for developing
18 the evidence base in order to improve care in this age group (Angood et al. 2015).

19 Describing the profile and outcomes associated with the management of acute malnutrition in
20 infants <6mo is central for expanding our understanding about the effectiveness of current care
21 strategies and setting the baseline evidence to help guide improved future care. This study,
22 which preceded the new WHO 2013 guidelines (WHO 2013), aimed at providing evidence on
23 infants <6mo receiving inpatient therapeutic care to determine what is their proportion among
24 children aged 0-60 months, what is their anthropometric profile at admission, and what their
25 outcomes are at discharge.

26 PARTICIPANTS AND METHODS

27 *Ethics*

28 This study carried out a secondary analysis of routinely collected and fully anonymised
29 programme data. The analysis of data from programmes in which there is no intervention trial
30 of planned change in procedures is widely classified as audit or service evaluation by research
31 ethics committees. Consequently, no ethical approval was required.

32

33 *Field datasets*

34 An appeal for datasets containing individual-level programme data on acute malnutrition care
35 of infants <6mo was put out from May to December 2008. We received a total of 30 datasets
36 from Action Contre la Faim (ACF) and one from Médecins Sans Frontières. Of these, only 23
37 datasets from ACF contained inpatient therapeutic care programme data from 25,195 children
38 aged 0-60 months from 34 field sites located in 12 countries. **Table 1** provides details of the
39 children in these datasets by country and the type of inpatient therapeutic programme care. The
40 majority of the individuals in our dataset (81.9%) were admitted into therapeutic feeding
41 centres (TFC). We excluded the data from Afghanistan and Ethiopia (n=1,150) as their
42 programme data included only very young children with no older children for comparison. A
43 final sample of 24,045 children aged 0-60 months was used for analysis.

44

45 *Data available*

46 Age, the presence of bilateral pitting oedema, and anthropometric data, namely weight, length
47 or height, and mid-upper arm circumference (MUAC), were available for most children at
48 admission. For most children, discharge outcomes were also available. Anthropometric data
49 was also available at discharge but there was a large heterogeneity in the type and timing of

50 data collected. Consequently, this analysis focused only on anthropometric and oedema data at
51 admission and outcomes at discharge.

52

53 *Data handling and data analysis*

54 Data was manipulated and analysed in Stata software (Stata Statistical Software: release 14,
55 2015; StataCorp LP). We calculated the anthropometric indices weight-for-age, height/length-
56 for-age and weight-for-height/length z-scores (WAZ, HAZ, WHZ, respectively) from weight,
57 height or length, age and sex variables at admission, based on the 2006 WHO Growth Standards
58 (WHO Multicentre Growth Reference Study Group 2006) using the zscore06 command (Leroy
59 2011). Extreme z-score values are usually assumed to represent measurement or data entry
60 errors (WHO 1995). We flagged these extreme values as outliers using commonly applied
61 cleaning criteria (Crowe et al. 2014) as follows: Flag 1: WAZ <-4 or >4 z-scores from the
62 observed mean; Flag 2: HAZ <-4 or >3 z-scores from the observed mean; and Flag 3: WHZ <-
63 4 or >4 z-scores from the observed mean. Acute malnutrition, based on WHZ and/or the
64 presence of oedema, was classified as global (GAM; WHZ<-2 and/or oedema), moderate
65 (MAM; WHZ<-2 but \geq -3), and severe (SAM; WHZ<-3 and/or oedema). Wasting, based on
66 WHZ among children without reported oedema, was classified as total (WHZ<-2), moderate
67 (WHZ<-2 but \geq -3), and severe (WHZ<-3).

68 Discharge outcomes were coded differently between and within datasets, differing primarily in
69 the terminology used and the manner in which they were abbreviated. Discharge codes were
70 grouped into the four Sphere discharge codes recovered, died, defaulted, and non-recovered
71 (The Sphere Project 2011); as well as admission error, or missing: if no discharge outcome data
72 was available (see **Table S1**).

73 To describe the burden for programmes providing therapeutic care for acute malnutrition to
74 infants <6mo, we calculated what proportion of programme admissions were within this age

75 group. To assess the quality of the anthropometric data collected at admission for infants <6mo,
76 we compared the proportion of missing values, the proportion of values that failed to convert
77 into anthropometric indices, and the proportion of anthropometric indices that were categorised
78 as outliers against their older counterparts. To assess the nutrition profile at admission for
79 infants <6mo, we compared the proportion of GAM, MAM, SAM, oedema, and of total,
80 moderate and severe wasting against their older counterparts. Lastly, we compared the
81 proportions of discharge outcomes and performed a meta-analysis to assess the risk of death
82 during treatment between the different age groups. To test for the equality of means and
83 proportions we used the ztest and prtest commands, respectively. For meta-analysis we used
84 the metan command.

85 RESULTS

86 *Programme burden - Proportion of children aged <6 months*

87 Our sample for analysis included 24,045 children aged 0-60 months who were receiving
88 therapeutic care for acute malnutrition (see **Table 1**). We observed that a large proportion of
89 these were young; i.e. 17,963 (75%) and 2,939 (12%) were aged 0-24 months and less than 6
90 months, respectively. **Figure S1** shows the age frequency distribution of the sample, where one
91 can also observe rounding of age to the nearest half-year from 12 months of age onwards.
92 Infants <6mo represented 16% of the sample of children aged 0-24 months. Regarding the type
93 of programme therapeutic care, infants <6mo accounted for 6%, 10%, 18% and 13% of the
94 sample for Day Centre (DC), Home Treatment (HT), Stabilisation Centre (SC) and TFC
95 programmes, respectively. The proportion of boys was similar between the two groups, i.e.
96 50.3% and 50.6% for infants <6mo and 6-60 months, respectively.

97

98 *Quality of data at admission*

99 **Table 2** displays the difference in the quality of anthropometric data at admission for infants
100 <6mo and children aged 6-60 months. At admission, data on infants <6mo contained a
101 significantly greater proportion of missing values for length and for MUAC than their older
102 counterparts; but both age groups had a similar low proportion of missing values for weight
103 and for the presence of bilateral pitting oedema.

104 Secondly, the WHZ index could not be calculated for a significantly greater proportion of
105 infants <6mo using the anthropometric data collected at admission. The main reason for this
106 difference was that for most infants <6mo, for whom WHZ could not be calculated (467 out of
107 471), their length was lower than 45cm, the minimum reference value needed for calculating
108 this index. The proportion of WAZ and HAZ indices that could not be calculated was very low
109 for both groups.

110 Lastly, there is a significantly greater proportion of anthropometric indices that were flagged
111 as statistical outliers in infants <6mo compared to children aged 6-60 months. **Figure S2**
112 provides a visual comparison of the difference in the availability of anthropometric data
113 between infants <6mo and their older counterparts. After accounting for missing data, poor
114 quality or out of range anthropometric data, only 74% of the sample of infants <6mo have
115 anthropometric data that would allow for the assessment of wasting, as defined by WHZ,
116 compared with 97% of their older counterparts.

117

118 *Anthropometric and clinical profile at admission*

119 **Table 3** presents the nutrition profile data from the subsample of children aged 0-60 months
120 that had no missing weight or height/length data and their calculated WHZ values were not
121 flagged as outliers. Overall, the nutritional profile of infants <6mo was better compared to their
122 older counterparts. Infants <6mo showed a significantly lower GAM proportion than older
123 children, of which a significantly larger and lower proportion were MAM and SAM,
124 respectively. In addition, infants <6mo presented with a significantly lower proportion of
125 bilateral pitting oedema. Similarly, after removing from the sample those reported to have
126 oedema, infants <6mo had a significantly lower proportion of wasting compared to their older
127 counterparts, of which a significantly larger and lower proportion were moderate and severe
128 wasting, respectively. Lastly, mean WHZ values were significantly greater for infants <6mo.

129

130 *Discharge outcomes*

131 **Table 4** displays the discharge outcomes by age group. Overall, both age groups have a similar
132 high proportion of children being discharged as recovered. However, we observed a
133 significantly lower proportion of infants <6mo discharged as defaulted. **Figure 1** presents a
134 forest plot of the pooled risk ratio for death during treatment for infants <6mo against their

135 older counterparts. Overall, the risk ratio for death was significantly greater for infants <6mo.
136 However, there was a high level of variation in the risk ratio between study sites (86.6%
137 variation in risk ratio attributable to heterogeneity; chi-squared = 67.0 p< 0.01).

138 **DISCUSSION**

139 *Main findings*

140 To our knowledge, this is the first analysis of programme information from a variety of
141 countries and care programmes containing data on infants <6mo receiving therapeutic care for
142 acute malnutrition. One of our main findings is infants <6mo represent an important proportion
143 of the children receiving malnutrition care in the programmes run by international relief
144 agencies.

145 Our analysis provides insights into some of the main challenges that malnutrition care
146 programmes face when assessing infants <6mo. We found that the collection of anthropometric
147 data in infants <6mo is challenging as indicated by the greater proportion of missing data at
148 admission, particularly length. The MUAC data was also missing, far more than in older
149 children; however, this was not surprising as MUAC is not recommended as an admission
150 criterion for infants <6mo (Kerac et al. 2012). Furthermore, even when weight and length data
151 were successfully collected, it was not possible to convert a large proportion of them into any
152 useful anthropometric index since WHZ cannot be calculated when length is <45cm. In
153 addition, when this index calculation was possible, a large proportion of the values were
154 observed to be extreme.

155 Furthermore, our study found that infants <6mo who are receiving therapeutic care for acute
156 malnutrition presented a better nutritional profile at admission when compared with their older
157 counterparts. Specifically, infants <6mo presented a lower proportion of oedema and had, on
158 average, greater WHZ values at admission. These differences were manifested in the lower
159 proportion of GAM and total wasting, as well as the proportion of SAM and severe wasting
160 observed in infants <6mo.

161 Lastly, our analysis showed that infants <6mo have a similar proportion of recovered outcomes
162 at discharge. However, infants <6mo had a higher risk ratio for death during treatment.

163

164 *Programme burden*

165 We have previously showed that despite the lack of focus on assessing the nutritional status in
166 this age group (Lopriore et al. 2007), acute malnutrition among infants <6mo is a public health
167 concern (Kerac et al. 2011); a prevalence that others have characterised as an underestimated
168 public health problem (Patwari et al. 2015). Our analysis contributes to this evidence by
169 showing that infants <6mo also account for an important proportion of children receiving
170 inpatient therapeutic care. This burden of care is important given the weak evidence base on
171 which care for this age group is based, and their care often falls in the gap between neonatal
172 care and the management of malnutrition for older children (Kerac et al. 2015).

173 It is not possible for us to assess the extent to which the disease burden observed in our sample
174 reflects the actual prevalence of acute malnutrition in the catchment areas of the therapeutic
175 programme, as infants <6mo are not routinely included in prevalence surveys of acute
176 malnutrition. Recent evidence has shown that the proportion of infants <6mo suffering from
177 acute malnutrition compared to their older counterparts is greater in hospital settings than in
178 the wider community (Karunaratne et al. 2015). Furthermore, others and we have argued that
179 because it is commonly assumed that this age group is better protected from nutritional stress
180 than their older counterparts, the available estimates are likely to represent an underestimate of
181 its prevalence in both inpatient and community settings that provide malnutrition care.
182 However, evidence supporting the assumption of greater protection among infants <6mo exists
183 (Pongou et al. 2006), making it difficult for us to extrapolate our findings to the wider
184 population.

185

186 *Assessing nutritional status of infants aged <6 months*

187 How acute malnutrition among infants <6mo should be defined is, at present, a top priority
188 research question (Angood et al. 2015). This definition will determine who will receive
189 malnutrition care. The two anthropometric indicators commonly used for assessing SAM in
190 children aged 6-59 months are also being considered for infants <6mo (WHO 2013;WHO &
191 UNICEF 2009), namely low WHZ and low MUAC. Discussions about which of these
192 indicators is better suited to assess acute malnutrition in older children have focused almost
193 exclusively on their predictive value for assessing a high risk of death (Walters et al. 2012), in
194 spite of the large body of evidence about the long-term consequences of the impaired
195 development associated with acute malnutrition (Victora et al. 2008).

196 Recent evidence, relevant for infants <6mo, has shown that MUAC data, collected at the age
197 of routine vaccination, 6-14 weeks of age, predicts child survival at age 12 months better than
198 WHZ data (Mwangome et al. 2012a). Furthermore, collection of MUAC data among infants
199 <6mo has also been shown to be more reliable and accurate than WHZ when collected by
200 trained community health workers, using hanging scales with a precision of 100g (Mwangome
201 et al. 2012b;Mwangome & Berkley 2014). Our study adds to this evidence by showing that for
202 inpatient therapeutic care programmes, obtaining reliable WHZ data in infants <6mo is
203 problematic because of problems arising at different steps, from collection of anthropometric
204 data through calculation of indices and cleaning of data. That a greater number of WHZ were
205 flagged for infants <6mo is also relevant from an epidemiological standpoint; and suggests that
206 further work is necessary to better understand if the cleaning criteria originally envisioned to
207 be applied to older children should be applied to this younger age group. It is difficult to draw
208 any conclusion regarding the reliability of MUAC data collection in this analysis, as the data
209 was collected during a period when the use of MUAC measures in therapeutic care was not a

210 firmly established practice in older children; and it has never been recommended in infants
211 <6mo.

212 Despite the relative ease of MUAC data collection, compared to WHZ, and its strong
213 association with mortality risk, doubt remains as to how well it indicates acute weight loss in
214 infants <6mo. A recent study of a sample of healthy infants aged ≤ 6 months in Ethiopia showed
215 that MUAC values in this very young population are weakly associated with body composition
216 (Grijalva-Eternod et al. 2015). MUAC variability among these infants reflects more the
217 variability in length, independently of age and sex, and less the variability of tissue masses.
218 Conversely, WHZ variability seems to index nutritional status better as it more closely reflects
219 variability in tissue masses. Given that these two indicators have a different relationship with
220 body composition data and mortality, it has been proposed that MUAC measurements among
221 infants <6mo might have a greater capacity to assess growth failure as opposed to an acute loss
222 of tissue mass, for which WHZ might be better-suited (Grijalva-Eternod et al. 2015). Further
223 longitudinal evidence is needed to empirically test this proposal. Nonetheless, even if WHZ is
224 a better indicator of acute tissue mass loss, and MUAC a better indicator of mortality, the
225 challenge remains that collection of anthropometric data, like length, and calculation of indices,
226 like WHZ, among infants <6mo is highly problematic.

227

228 *The nutrition profile of infants aged <6 months at admission to therapeutic care*

229 At admission to therapeutic care, infants <6mo present a better anthropometric profile than
230 their older counterparts do, even after accounting for oedema. To our knowledge, this is the
231 first report of this difference. There is scarce literature to help us understand why oedema was
232 significantly lower among infants <6mo; or why they seem to be admitted to therapeutic care
233 at a less severe stage of malnutrition. In infants <6mo, oedema might be more difficult to
234 diagnose; as in older children of whom most can stand, gravity might influence in narrowing

235 the location of the oedema to the limbs. Also, infants <6mo compartmentalise body water
236 differently than older children. Studies have shown that total body water, as a percentage of
237 body weight, and extracellular water, as a fraction of total body water, decrease rapidly during
238 the first 130 days of life, with extracellular water decreasing more rapidly (Fomon & Nelson
239 2002). It might be that clinically detectable oedema is more likely only after certain
240 developmental milestones have taken place, such as the decrease in the ratio of extracellular to
241 cellular water mentioned above. This idea is supported by the observation that the proportion
242 of oedema among older children with SAM increases with age, peaking at three to five years
243 of age (Girma et al. 2013).

244

245 *Care outcomes*

246 We are not the first to show that a high proportion of infants <6mo admitted to receive care for
247 acute malnutrition recover (Singh et al. 2014;Vygen et al. 2013). However, our findings adds
248 to this evidence. We showed that the proportions discharged as recovered are similar between
249 infants <6mo and older children, as well as the proportions discharged as non-recovered. We
250 also observed a lower proportion of infants <6mo being discharged as defaulted. However, this
251 findings may be because the proportion discharged as dead is higher in this age group
252 (borderline significant). To investigate this borderline fatality, we conducted a meta-analysis
253 of the data from different countries. This revealed that infants <6mo have a higher relative risk
254 of death; despite a better nutritional profile at admission.

255 The higher relative risk of death for infants <6mo observed in our study needs cautious
256 interpretation given the high level of heterogeneity observed between the countries where the
257 data was collected. It is not possible to disentangle whether the observed heterogeneity in our
258 results reflects a different mortality risk among infants <6mo in these different settings, at
259 comparable levels of anthropometrically defined malnutrition; or if this observed heterogeneity

260 may be due to differences in the quality of therapeutic care provided to infants <6mo. Likewise,
261 it is not possible to assess how much of the higher relative risk of death observed in infants
262 <6mo may be due to suboptimal care driven by the existence of inadequate care protocols, or
263 an inadequate provision of care, or both, given the lack of international guidelines for the
264 management of malnutrition in infants <6mo.

265

266 *Limitations*

267 Our study has some limitations. First, most programmes were less likely to have actively sought
268 infants <6mo in the community compared to older children aged 6-59 months, and might not
269 have recommended inpatient care for all cases of SAM identified in infants <6mo. This
270 potential bias may have resulted in an under-representation of malnourished infants <6mo, that
271 may have varied between contexts, but could not be quantified. Second, the absence of a clear
272 anthropometric criterion for admission to therapeutic feeding of many infants <6mo suggests
273 that alternative criteria were also used. The alternative criteria might include a number of non-
274 anthropometric criteria, such as clinical signs of infection, disability, feeding difficulties, and
275 maternal factors; an assumption that is supported by a review of admission criteria used for this
276 age group (ENN & CIHD 2010). How much these additional criteria might help explain the
277 differences observed in the nutritional profile of these two age groups where infants seems to
278 be admitted to care at a less severe stage in malnutrition is unknown and could not be quantified
279 in our analysis. Lastly, all datasets used for this analysis originate from one international relief
280 agency limiting the study capacity to extrapolate our findings to the other care providers.

281 Our study has also strengths. To our knowledge this is the largest multicentre analysis of
282 inpatient therapeutic care data that includes data on infants <6mo. As such, this dataset allows
283 for a more global understanding of differences in the management of acute malnutrition in
284 these two groups. Likewise, given the paucity of the evidence base for the management of acute

285 malnutrition in infants <6mo (Kerac et al. 2015), even after their inclusion in the WHO
286 guidelines (WHO 2013), our analysis provides the best available comparisons at admission and
287 discharge between these two age groups.

288

289 *Conclusions*

290 Infants <6mo represent an important proportion of admissions to therapeutic feeding
291 programmes for acute malnutrition. There are numerous challenges associated with their care:
292 anthropometric measurement; knowing which measures and signs of illness or poor feeding
293 are best to use for assessment; interpreting current programme outcomes and knowing to what
294 extent the observed mortality is avoidable through better guidelines or better implemented
295 guidelines. Systematic compilation and analysis of routine data of infants <6mo is important
296 for monitoring programme performance and should be promoted as a tool to assess the impact
297 of new guidelines on care.

KEY MESSAGES

- Infants aged less than 6 months account for an important proportion of patients that receive inpatient therapeutic care for acute malnutrition.
- Collection of infant's anthropometric data at admission to therapeutic care is problematic compared to that of their older counterparts (children aged 6-60 months). Data on infants had a greater proportion of missing anthropometric data, anthropometric data that could not be used to estimate nutrition indicators, and estimated nutrition indicators that were flagged as extreme and unlikely values.
- At admission to therapeutic care, infants aged less than 6 months presented with a better nutritional profile, including a lower proportion of oedema, global acute malnutrition and severe acute malnutrition compared to their older counterparts.
- The proportion of infants aged less than 6 months and older children discharged as recovered was similar. However, infants aged less than 6 months suffered a higher case fatality rate.
- Systematic compilation and analysis of routine data is an important tool for monitoring programme performance and should be promoted as a tool to monitor the impact of rolling out new guidelines on therapeutic care.

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LEGENDS TO FIGURES

Figure S1. Age frequency distribution of a sample of 24,045 children aged 0-60 months from 10 countries (Burundi, Kenya, Liberia, Myanmar, Niger, Democratic Republic of Congo, Somalia, Sudan, Tajikistan and Uganda). The continuous line denotes the cumulative frequency.

Figure S2. Proportion of values of the weight-for-height z-score that are available for the assessment of the nutritional status at admission, by age group, from a sample of 24,045 children aged 0-60 months from 10 countries (Burundi, Kenya, Liberia, Myanmar, Niger, Democratic Republic of Congo, Somalia, Sudan, Tajikistan and Uganda).

Figure 1. Forest plot of the risk ratio (RR) of death during treatment for infants aged <6 months compared to children aged 6-60 months, by country, from a sample of 24,045 children aged 0-60 months from 10 countries (Burundi, Kenya, Liberia, Myanmar, Niger, Democratic Republic of Congo, Somalia, Sudan, Tajikistan and Uganda).

Test for heterogeneity chi-squared = 67.0 (degrees of freedom = 9; $p < 0.01$).

I-squared (variation in RR attributable to heterogeneity) = 86.6%.

Test of RR=1: $z = 2.96$ ($p < 0.01$)

TABLES

Table 1. Programme datasets by country

Country	Years	Type of Therapeutic Care				6-60 months	<6 months	Age (months)		
		DC	HT	SC	TFC	n (%)	n (%)	mean \pm s.d.	Min	Max
Afghanistan ^a	2002-04	633			460	63 (5.8)	1,030 (94.2)	3.4 \pm 1.5	0.5	9
Burundi	2006-07	2,359				2,213 (93.8)	146 (6.2)	33.5 \pm 16.7	0	60
DRC	2005-07				6,229	4,829 (77.5)	1,400 (22.5)	18.7 \pm 15.6	0	60
Ethiopia ^a	2008			57		24 (42.1)	33 (57.9)	4.3 \pm 1.9	0	8
Kenya	2005-07				539	502 (93.1)	37 (6.9)	18.2 \pm 11.4	1.5	60
Liberia	2006-08				2,436	2,269 (87.1)	167 (6.9)	16.3 \pm 9.8	1	60
Myanmar	2006-08		1,143	248		1,211 (87.1)	180 (12.9)	22.9 \pm 14.6	0.1	60
Niger	2006-08				1,108	963 (86.9)	145 (13.1)	14.6 \pm 9.2	1	58
Somalia	2006-08				2,997	2,595 (86.6)	402 (13.4)	17.7 \pm 13.0	1	60
Sudan	2005-08			109	5,218	4,967 (93.2)	360 (6.8)	18.0 \pm 9.7	0	60
Tajikistan	2005-06				373	287 (76.9)	86 (23.1)	10.9 \pm 6.7	1	46
Uganda	2005-07				1,286	1,270 (98.8)	16 (1.2)	21.6 \pm 10.8	1	60
Total	2002-08	2,992	1,143	414	20,646	21,193 (84.1)	4,002 (15.9)	19.0 \pm 14.0	0	60

DC: Day centre, HT: Home treatment, SC: Stabilisation centre, TFC: Therapeutic feeding centre, DRC: Democratic Republic of Congo

^a This programme data was excluded from analysis as it included only very young children with no older children for comparisons.

Table S1. Coding of original discharge outcomes (Supplementary Appendix)

Recovered	Died	Non-recovered	Defaulted	Admission error
C	Dead	Autres	Abandon	Admission mistake
Cured	Death	C.N.R	D	AM
Guéri	Décédé	CNR	Default	CH
	Décès	Critères non-atteints	Defaulter	Cheating
	Died	Criteria not reached		Erreur d'admission
	M	DNG		Error
		Inconnu		Mistake
		Medical transfer		Mistake admission
		Non guéri		
		Non répondant		
		Non respondant		
		Non respondent		
		Non responder		
		Non response		
		Non-respond		
		NR		
		Other		
		Others		
		T		
		TFC		
		To other OTP		
		Transfer		
		Transfer HP		
		Transfer Others		
		Transfer TFC		
		Transfer to other OTP		
		Transfer to OTP		
		Transfer to TFC		
		Transféré		
		Transfert		
		Transfert Centre de s		
		Transfert CNT		
		Transfert CS		
		Transfert H		
		Transfert hospital		
		Transfert medical		
		Transfert vers crenas		
		Unknown		

Table 2. Quality of anthropometric data at admission by age group.

Percentage of anthropometric data at admission that was missing							
	<6 months (n = 2,939)		6 – 60 months (n = 21,106)		Difference		
	%	95%CI	%	95%CI	%	95%CI	p-value
Weight	0.51	0.25; 0.77	0.62	0.51; 0.72	-0.11	-0.38; 0.17	0.24
Height/length	7.55	6.60; 8.50	0.63	0.53; 0.74	6.92	5.96; 7.89	<0.01
MUAC	49.4	47.6; 51.2	24.2	23.6; 24.8	25.2	23.3; 27.1	<0.01
Oedema data	1.60	1.15; 2.05	1.57	1.41; 1.74	0.03	-0.46; 0.51	0.46
Percentage of anthropometric indices that could not be calculated when measurement data was available							
	<6 months (n = 2,939)		6 – 60 months (n = 21,106)		Difference		
	%	95%CI	%	95%CI	%	95%CI	p-value
WAZ	0.00	--	0.01	0.00; 0.02	-0.01	-0.02; 0.00	0.30
HAZ	0.00	--	0.00	--	0.00	--	--
WHZ	16.0	14.7; 17.3	0.40	0.31; 0.48	15.6	14.3; 16.9	<0.01
Percentage of anthropometric indices flagged as outliers							
	<6 months (n = 2,939)		6 – 60 months (n = 21,106)		Difference		
	%	95%CI	%	95%CI	%	95%CI	p-value
Flag 1	1.40	0.97; 1.82	0.70	0.58; 0.81	0.70	0.26; 1.14	<0.01
Flag 2	6.91	5.99; 7.82	4.26	3.99; 4.53	2.65	1.69; 3.60	<0.01
Flag 3	1.91	1.41; 2.40	1.54	1.37; 1.71	0.37	-0.16; 0.89	0.07
Any flag	8.47	7.47; 9.48	5.71	5.40; 6.02	2.76	1.71; 3.82	<0.01

WAZ: Weight-for-age z-score, HAZ: Height-for-age z-score, WHZ: Weight-for-height z-score, MUAC: Mid-upper arm circumference.

Flag 1: WAZ <-4 or >4 z-scores from the observed mean

Flag 2: HAZ <-4 or >3 z-scores from the observed mean

Flag 3: WHZ <-4 or >4 z-scores from the observed mean

Table 3. Nutritional profile at admission of children aged 0-60 months by age group.

Proportion of acute malnutrition at admission							
Indicator	<6 months (n = 2,190)		6 – 60 months (n = 20,556)		Difference		
	mean or %	95%CI	mean or %	95%CI	mean or %	95%CI	p-value
Global (%)	85.4	84.4; 87.3	98.7	98.5; 98.8	-12.8	-14.3; -11.4	<0.01
Moderate (%)	13.7	12.2; 15.1	4.70	4.41; 4.99	8.95	7.49; 10.4	<0.01
Severe (%)	72.2	70.3; 74.1	94.0	93.7; 94.3	-21.8	-23.7; -19.9	<0.01
Oedema (%)	5.53	4.57; 6.48	35.3	34.7; 36.0	-29.8	-31.0; -28.6	<0.01
Proportion of wasting ^a at admission							
Indicator	<6 months (n = 2,069)		6 – 60 months (n = 13,295)		Difference		
	mean or %	95%CI	mean or %	95%CI	mean or %	95%CI	p-value
Total (%)	85.0	83.5; 86.6	98.0	97.7; 98.2	-12.9	-14.5; -11.4	<0.01
Moderate (%)	14.5	12.9; 16.0	7.27	6.82; 7.71	7.19	5.61; 8.76	<0.01
Severe (%)	70.6	68.6; 72.5	90.7	90.2; 91.2	-20.1	-22.2; -18.1	<0.01
WHZ (z-score)	-3.89	-3.93; -3.85	-4.31	-4.32; -4.29	0.42	0.37; 0.46	<0.01

WHZ: Weight-for-height z-score.

Acute malnutrition: Global (WHZ<-2 and/or oedema), moderate (WHZ<-2 but \geq -3) and severe (WHZ<-3 and/or oedema).

Wasting: Total (WHZ<-2), moderate (WHZ<-2 but \geq -3) and severe (WHZ<-3).

^a Wasting was measured among children with no reported oedema.

Table 4. Discharge outcomes of children aged 0-60 months

Discharge outcome	<6 months (n = 2,939)		6 – 60 months (n = 21,106)		Difference		
	%	95%CI	%	95%CI	%	95%CI	p-value
Recovered	75.7	74.2; 77.3	74.5	73.9; 75.1	1.23	-0.43; 2.89	0.08
Died	4.60	3.81; 5.31	3.95	3.68; 4.21	0.61	-0.19; 1.41	0.06
Non-recovered	10.2	9.14; 11.3	10.1	9.68; 10.5	0.15	-1.01; 1.32	0.40
Defaulted	6.43	5.54; 7.32	7.75	7.39; 8.11	-1.31	-2.27; -0.36	<0.01
Admission error	0.37	0.15; 0.60	0.50	0.41; 0.60	-0.13	-0.37; 0.11	0.18
Missing values	2.69	2.10; 3.27	3.24	3.00; 3.48	-0.55	-1.18; 0.08	0.05

FIGURES

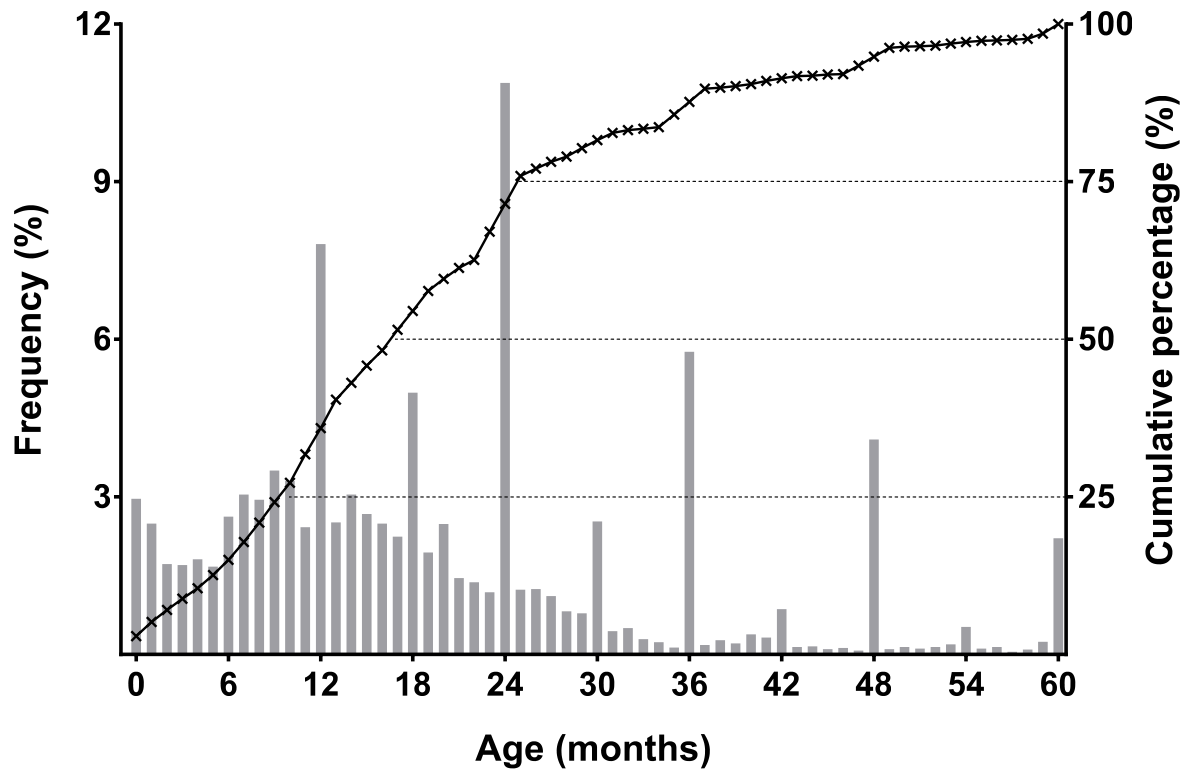


Figure S1 (Supplementary Appendix)

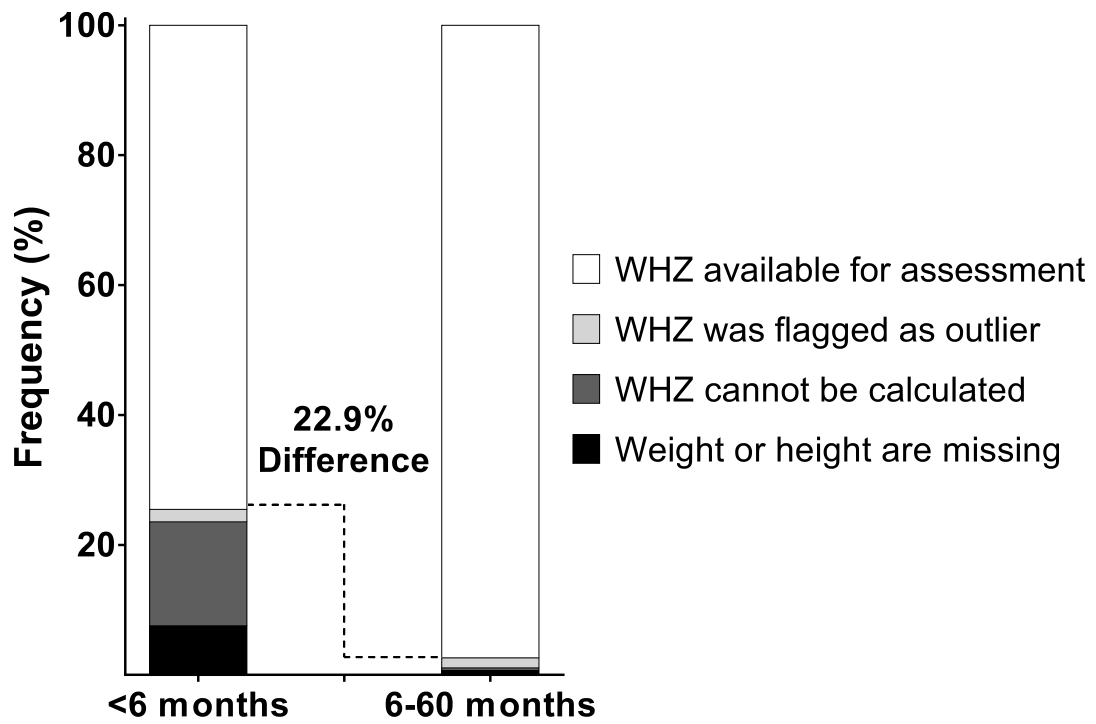


Figure S2 (Supplementary Appendix)

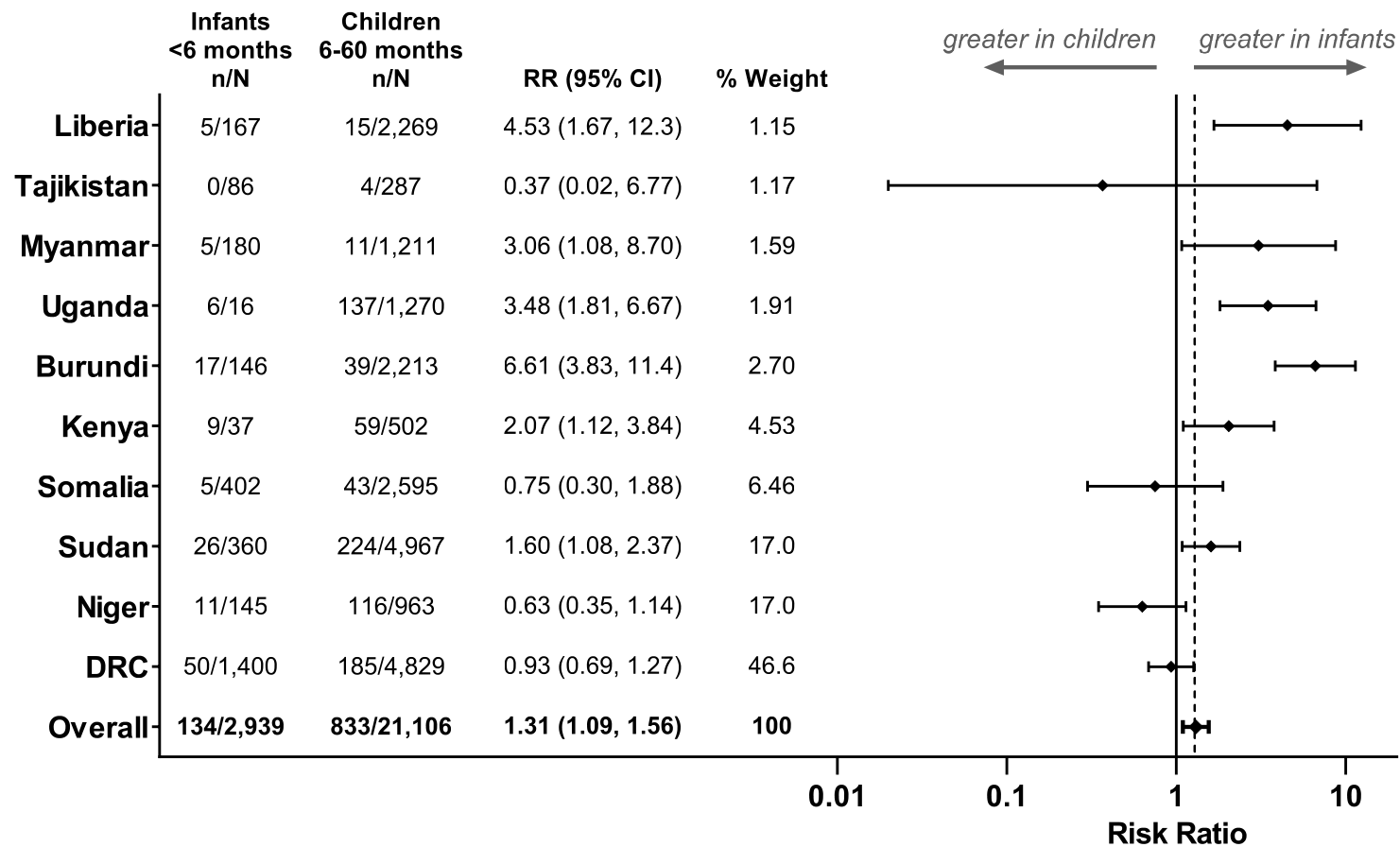


Figure 1