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Predicted implications of using percentage weight gain as single discharge criterion in management of acute malnutrition in southern Ethiopia.

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Contributions
EE designed the greater study providing data for this paper together with YB and provided supervision throughout the research and writing process. EB provided valuable information and input on study design and data collection on the ground. EF carried out the data analysis and drafted the paper in close collaboration with EE. All authors have contributed in preparation of the final version of the paper.

Conflicts of interest
The authors declare that they have no conflicts of interest.
Introduction

Globally, it has been estimated that over 51 million children under the age of five years suffer from acute malnutrition (UNICEF et al. 2012). Severe acute malnutrition (SAM) is associated with a mortality risk nine times higher than that of a non-malnourished child and among children with moderate acute malnutrition (MAM) the risk of dying is more than two-fold of that of the reference group (Black et al. 2008). Management of acute malnutrition hence plays a vital role in reducing child mortality and reaching Millennium Development Goals (MDG) no. 1 and 4 (WHO and UNICEF 2009).

In 2007, the UN endorsed Community-Based Management of Acute Malnutrition (CMAM) as a treatment model for SAM, supporting its integration with other initiatives at primary health care level to reduce child mortality (WHO et al. 2007). Core components of CMAM include early detection of SAM cases by screening in the community and treatment at home with ready-to-use therapeutic foods. In emergency contexts with high levels of external input of resources and staff by Non-Governmental Organizations, the model has performed well in achieving high coverage levels, high recovery rates, low case fatality rates and decreased opportunity costs for families (Chaiken et al. 2006; Collins 2004; Collins et al. 2006a). Its application to non-emergency contexts has subsequently been encouraged in order to increase coverage (Chaiken et al. 2006; Collins 2007). This typically entails lower caseloads over longer time periods, with more reliance on the resources of existing health systems and less external input compared to emergency interventions (Gatchell et al. 2006). Currently, CMAM is integrated into primary health care in an increasing number of countries, predominantly in Sub-Saharan Africa and South Asia (UNSCN and UNICEF 2011).

WHO defines SAM as a weight-for-height z-score (WHZ) <-3 of the reference median, or presence of bilateral pitting edema, or mid-upper arm circumference (MUAC) of <115mm (WHO and UNICEF 2009). The MUAC cut-off defining SAM has been raised from the initially recommended <110mm, though the latter is still applied in some settings. The integration of management of acute malnutrition into existing primary health care systems often involves staff with limited medical training such as community health workers (Chamois 2009; Kopplow 2010). This implies a demand for simplified protocol for admission and discharge procedures as well as for case management of
malnutrition and childhood illnesses. MUAC has been introduced as an independent and single admission criterion for non-edematous SAM, partly in response to this need. Recent research comparing performance of W/H and MUAC supports this shift in methods, finding that MUAC identifies children at risk of dying within 6 months better than W/H in 6-59 month-olds (Briend et al. 2012). Use of MUAC-based admission criteria also avoids the previous problem of having different tools for screening and admission (Collins et al. 2006b). Further, MUAC assessment can quickly be carried out by one person with limited training (Myatt et al. 2006), and is less prone to measurement error than W/H (Mwangome et al. 2012). As use of MUAC also has additional advantages in terms of cost and maintenance it is increasingly used when CMAM programs are implemented and scaled up.

To have the full benefit of using MUAC in CMAM, e.g. no need to assess height, there is a need for other discharge criteria than those based on W/H. A set target of 15% weight gain from admission weight is currently recommended as discharge criteria for programs relying on MUAC for admission (WHO and UNICEF 2009) and is applied in commonly utilized CMAM training manuals (FANTA 2008; GNC 2011). Use of this 15% weight gain cut-off has projected about 50% of beneficiaries recovering from SAM (Myatt et al. 2006). While the recommendation was set to 15% it was also advised that a 20% weight gain might be required for sufficient recovery depending on context (WHO and UNICEF 2009).

For similar reasons as in SAM management the use of MUAC is also increasing in Supplementary Feeding Programs (SFP) aiming to manage the less severe form of wasting; non-edematous moderate acute malnutrition (MAM). The current definition of MAM is WHZ ≥-3 and <-2 (WHO 2006) but increasingly admission of MAM children is based on MUAC applying different cut-offs, often combined with WHZ criteria in a two-stage screening and admission process (Bahwere et al. 2006; Federal Ministry of Health and UNICEF 2004). In a consultation by WHO, UNICEF, WFP and UNHCR in 2010, MUAC ≥115 and <125mm was stated as an alternative case definition for MAM, a recommendation to be considered for systematic review. In regards to discharge criteria no clear guidance has so far been given on the use of percentage weight gain, although a 8-10% weight gain is mentioned as a possible target (WHO et al. 2010).
Using percentage weight gain as discharge criterion for both SAM and MAM children appears attractive for its simplicity in use, e.g. by look-up tables for weight gain and avoided need for height and length measurement and associated equipment. However, there is also a need for concern as little is known as to what extent the recommended percentage weight gain will translate into nutritional recovery at discharge. A recent study in Burkina Faso found that discharge after 15% of weight gain paradoxically resulted in shorter lengths of stay for the more malnourished children than for the less malnourished ones (Goossens et al. 2012), which intuitively appears inappropriate.

In the context of a newly established integrated CMAM program in rural Wolaita Zone, Ethiopia, our study simulates weight gain and aims to examine to what extent the application of different percentages of weight gain as discharge criterion would lead to nutritional recovery in children admitted for treatment of acute malnutrition.

**Study population and methods**

The data used for this analysis were taken from a larger project; “Effectiveness of community based management of severe acute child malnutrition: Importance of maternal care and health system context (COMSAM)”, aiming to evaluate effectiveness of the integrated CMAM program in parts of Wolaita Zone, Southern Nations, Nationalities and People’s Region, Ethiopia.

From July to December 2011, weekly visits were conducted at 94 health posts providing CMAM in 4 districts in Wolaita zone, known as prone to food insecurity. Health post registration books were used to identify children admitted to the outpatient treatment program (OTP). A household visit was made within 7 days of registration to all listed children by trained research teams. At the household, anthropometric measurements including height, weight and MUAC of the listed child were taken using recommended anthropometric procedures (GNC 2011). The household visits were used to collect information on other characteristics of the child, such as age (by use of a local calendar), presence of edema and pallor as well as characteristics of the main caretaker and household including socio-economic factors. Double entry was applied when entering
data into the database. Stata statistical software version 12.1 (StataCorp 2011) was used in analyzing the dataset.

High quality instruments were used for anthropometrical assessment; MUAC was measured by the standard color-branded plastic tapes with 1mm increments used by the program, weight was assessed by use of Uniscale (precision of 100g, provided by UNICEF) and height/length was assessed by locally constructed wooden boards, also used in national surveys. Children under the age of 24 months were measured lying down and older children in standing position. The children’s age, weight and length/height were used to calculate the anthropometric indices of weight-for-height, height-for age and weight-for-age using the WHO Anthro software (WHO 2010). Additional weight variables were created by multiplying the child’s weight with 1.10, 1.15 and 1.20 to mimic weight gains at discharge of 10, 15 and 20 percent respectively. These simulated discharge weights were converted to W/H z-scores using admission height/length, disregarding any potential changes in age and height. In this way, nutritional status by WHZ was established at the three weight gain targets. Nutritional recovery was defined as WHZ ≥ -2.

For inclusion in our analyses we selected children with a MUAC <125 mm. We excluded children with pitting edema, as we had no record of their lowest weight after start of treatment for acute malnutrition. Starting weight with unresolved edema was deemed inappropriate for calculations of percent weight gain for discharge. In agreement with current recommendations and praxis (WHO and UNICEF 2009), only children between 6 and 59 months of age were included. Further exclusion was made of children with implausible z-scores for W/H (<-5 and >5) and H/A (<-6 and >6) and of cases with WHZ >5 after a 15% of weight gain.

The children were categorized into four MUAC groups representing; MAM as defined by MUAC (115-124mm), SAM according to the currently recommended cut-off (<115mm), SAM as defined by the previous cut-off (<110m) and SAM with a MUAC in between the two cut-offs (110-114mm). Descriptive statistics were then used to determine effects of the different percentages of weight gain on nutritional status in the four respective MUAC groups.
In order to distinguish between WHZ and MUAC based definitions for moderate and severe acute malnutrition, we are using the following terms in the paper: MUAC-SAM (<115mm), MUAC-MAM (115-124mm), severe wasting (WHZ < -3) and moderate wasting (WHZ ≥ -3 < -2).

The Helsinki declaration was applied in the research project including informed consent procedure. The research protocol were reviewed and approved by the Regional Health Bureau of SNNPR, The District Health bureau of Wolaita, the Ethical Review Board at Addis Continental Institute of Public Health, Addis Ababa and the Regional Ethical review Board in Uppsala, Sweden.

**Results**

The flow of participants is displayed in Figure 1. Among the 926 children initially registered, 31 cases did not fit age criteria for OTP. 156 children presented with edema including 17 cases with unilateral edema and 17 that had information on edema missing. After establishing z-scores, 108 children had implausible values, with irregularities in height-for-age especially. After exclusion of the above-mentioned cases, a total of 631 children were used in analyses.

Demographic and socio-economic characteristics of households, caretakers and children are presented in Table 1. Families typically lived in wood and mud houses, had open pit latrines and drew water from a public tap or protected well. Caretakers were on average 30.8 years old, married and reported farming as their main occupation. An average household had 3.9 children and 8.9% of all households reported that a member had gone a full day without eating in the past month. Among the 631 analyzed children, 41.8% were male and 58.2% female. The mean age was 16 months (SD 12 months) with 49.1% aged 6 to 11 months and 31.4% aged 12 to 23 months.

Nutritional status at time of admission to OTP and the predicted effects of applying different percentages of weight gain as discharge criteria are displayed in Table 2. In the sample 77% of the children were identified as SAM by MUAC <115mm. Of these SAM
children 70.7% were also defined as wasted by W/H, divided into 39% moderately wasted and 31.7% severely wasted. Accordingly, the rest was judged as normal (WHZ ≥ -2). When applying the old MUAC criteria (<110 mm), 73.7% of the sample was defined as SAM with 38.7 and 35% respectively being moderately and severely wasted whereas 26.3% were normal. In the group identified as SAM cases by the new MUAC cut-off only (MUAC 110-114mm), 22.9% were severely wasted, 39.7% were moderately wasted and 37.4% were considered normal.

Among the 23% of children fitting the MUAC definition for MAM, 52.1% were either moderately (40.4%), or severely wasted (11.7%) and 47.9% were normal according to W/H definitions.

In children with MUAC <115mm, after simulation of 15% of weight gain, wasting would have decreased to 7.8 (moderate) and 1.3% (severe). When examining the children who would have remained severely wasted after reaching the targeted 15% of weight gain, it was found that all had initial z-scores below -4. Children with moderate wasting as outcome had initial z-scores ranging from -4.4 to -3.6. With 20% of weight gain, severe wasting would have been eliminated (0%) and moderate wasting would have decreased further to 2.7%.

When the lower cut-off for MUAC (<110mm) was applied, recovery proportions were similar. A 15% of weight gain would have brought moderate wasting down from 38.7 to 7.6% and severe wasting from 35 to 1.4%. Children who would not have recovered were those who had z-scores between -3.7 and -5 at baseline. An additional 5% of weight gain (total 20%) would have generated a reduction in moderate wasting to 3.4% and reduced severe wasting to 0%.

In the third MUAC-SAM group, displaying the additional group of children identified by the higher MUAC cut-off, a discharge after 15% of weight gain would have resulted in 8.4% remaining moderately wasted and 0.8% severely wasted. Again, a weight increase by 20% would have eliminated severe wasting and brought moderate wasting down to 0.8%.
For children with MUAC-MAM, 10% of weight gain would have resulted in 6.2% of children remaining moderately wasted and 2.0% severely wasted. After 15% of weight gain the fraction of children with moderate or severe wasting would have been reduced to 3.4% and 1.4% respectively. A 20% weight gain would have brought the portion of children with remaining moderate wasting down to 2.1%.

**Discussion**

This study evaluated effects of percentage weight gain as a discharge criterion by simulating nutritional status by W/H after 10, 15 and 20% of weight gain in admitted children aged 6-59 months with MUAC <125mm. Findings showed that in this sample, 15% of weight gain would result in roughly 9% of children with MUAC-SAM to still being wasted after treatment regardless of MUAC cut-off level used. If 20% of weight gain had been used as a target, no MUAC-SAM child would remain severely wasted at discharge and moderate wasting would be reduced to around 3%. To generate a recovery proportion of about 8% in MUAC-MAM children, 10% of weight gain would be sufficient.

Many children identified by MUAC as being acutely malnourished were not wasted according to W/H definitions. The proportion was largest in the MUAC-MAM group where almost half of the children could be classified as normal by W/H. About 30% of children in the MUAC-SAM <115mm group were not wasted at baseline and only a slightly smaller proportion (26%) if the MUAC-SAM <110mm cut off was applied. Of importance to recognize is also that when the lower MUAC-SAM cut off was used for case definition almost half of those who were left out (children with MUAC 110-115) out were wasted and many of them severely so.

Though there is substantial overlap in case definition by MUAC and WHZ they are also known to select slightly different children as being acutely malnourished (Berkley et al. 2005; Ross et al. 1990) and choosing one method over the other implies potentially leaving high risk children untreated. However, a recent study showed that MUAC, apart from its practical advantages, is a better predictor of mortality and that combining the methods is of no advantage. This supports the ongoing shift to MUAC based case
definition for screening and admission of SAM children (Briend et al. 2012). It should also be noted that overlap between MUAC and W/H differ between population groups, especially between agrarian and nomadic populations (Myatt et al. 2009), implying that if the same method used in this study was applied elsewhere it might produce somewhat different results.

Application of the currently recommended discharge criteria of 15% weight gain in children with MUAC-SAM <115mm would have resulted in 9.1% of children not recovering from wasting (<2 WHZ). Little other research than that which underlies the WHO recommendation describes the expected effect of percentage weight gain on nutritional status, leaving few options for comparison of our findings. In their technical background paper, Myatt et al. (2006) found that 15% weight gain resulted in approximately 50% of beneficiaries recovering to the threshold of moderate wasting, when applying the previously used case definition and growth reference (≥80% of the National Centre for Health Statistics reference median). Other data supporting the proposed cut-off for weight gain estimated the average amount of weight gain needed to move from -3 WHZ to -2 WHZ to 9%, and that 19% facilitated a move from -3 WHZ to -1 WHZ (WHO and UNICEF 2009). In our study, however, children who would have failed to recover from wasting to a large extent had WHZ below -4 at baseline. This indicates highly elevated risk of death, which increases exponentially with worsened nutritional status (Pelletier et al. 1994). An upward adjustment of targeted weight gain may therefore be necessary in some settings, as is also suggested in the WHO/UNICEF recommendation.

The lower MUAC cutoff <110mm for screening for SAM is still for various reasons applied in some settings, including the Ethiopian program (Federal Minstry of Health 2008). Despite the fact that it selects children with more severe forms of wasting the recovery results among children with MUAC <110mm were similar to those where MUAC <115mm had been used, i.e. 9% would fail to recover from wasting if a weight gain of 15% was applied. This suggests that there is no need to increase percent weight gain discharge criteria for these children if 9% failure is deemed acceptable. The similarity in recovery proportion may be due to the fact that there was a substantial overlap between the groups; MUAC-SAM <110mm identified about ¾ of the MUAC-SAM
However, the use of the lower MUAC cut off for admission would leave out many children who would otherwise have benefitted from treatment, as is shown by the more than 90% of children in the MUAC 110-114mm group that would have recovered from wasting if 15% weight gain as discharge criteria had been used.

In the case of children with MUAC-MAM (115-124mm), findings suggest 10% weight gain would reduce wasting to less than 10%, and 15% weight gain would take the portion of children still wasted after treatment below 5%. However, MAM interventions are intended not only to bring beneficiaries up to but also beyond the threshold of acute malnutrition in order to sustain nutritional recovery and prevent relapse (Chang et al. 2013; UNHCR and WFP 2011). Briand et al. (2011) advise that individual needs as well as mean WHZ in the population should be taken into consideration when determining which goal to set for WHZ increase. Overall, management protocols for MAM still relies largely on W/H based definitions for admission and discharge, the introduction of MUAC for admission is still in an early stage and the use of percentage weight gain as discharge criterion an item of discussion (WHO et al. 2010).

Management of SAM aims at reducing morbidity and mortality by resolving acute malnutrition (GNC 2011). As in the present study, 15% of weight gain was insufficient for roughly 9% to reach adequate nutritional status, questions may be raised about what an acceptable level of remaining acute malnutrition after completed treatment might be. If it is deemed acceptable that 10% of children may not recover, 15% weight gain may serve well for children with MUAC <115mm. With 20% weight gain, the fraction of children still wasted at discharge would further decrease, but the children most vulnerable at baseline would still be closest to slipping back into malnutrition. Also, raising the weight gain target would likely create an unwanted and avoidable cost, as the majority of children (in this study >90%) who already recovered from acute malnutrition would be kept unnecessarily long in the program. In the study by Goossens et al. (2012), the use of 15% percent weight gain as discharge criterion resulted in shorter lengths of stay for the more malnourished children and longer stays for the less malnourished. This is arguably the opposite of a desired scenario, where morbidity and mortality risks are reduced among the most vulnerable in particular. It should also be taken into consideration that this study represents a best-case scenario for the outcome.
of malnutrition treatment, assuming 100% of treated children reach the desired target weight. The numbers of children remaining wasted after fulfilling discharge criteria are therefore optimistic, and the proportion of children at risk is likely larger in reality.

A limitation of this study is the relatively high number of children excluded from analysis due to implausible z-scores for H/A. This may in part be due to an intended or unintended tendency by parents to adjust date of birth in order to have children younger than six months, who would normally not qualify, admitted into the program. Of further importance for interpretation of our results is that children with edema, who are among the most affected by SAM, are not represented in the study. These cases were dropped from the analysis, as data on lowest weight during treatment was not available for edematous children. These factors represent a limitation for this study, as some of the more vulnerable children may have been lost from analyses, possibly reducing the number of children remaining malnourished after treatment. Strength, on the other hand may be seen in the high quality of anthropometric measurements achieved by using specially trained study teams. The overall coverage of SAM cases was probably good and the number of missed SAM cases low, since distribution of RUTF constituted a strong pull factor and health posts providing OTP are evenly distributed throughout the community. Numbers for MAM may be less representative of MAM in the population as these cases were not the target group for RUTF.

**Conclusion**

The present study used simulated weight gain and nutritional status by WHZ to evaluate effects of percentage weight gain as discharge criterion in a CMAM program using MUAC for screening and admission. Findings showed that 15% of weight gain, being the most commonly recommended target, was inadequate for some of the most vulnerable children to sufficiently recover. Consequently, using percent weight gain as single discharge criterion poses risk of not being equitable as it is not proportionate to nutritional need and may lead to insufficient recovery among those with severest condition. There is a need for further research to determine suitable discharge criteria in CMAM programs using MUAC for screening and admission.
**Key messages**

15% of weight gain was found to be insufficient for roughly 9% of children with SAM as defined by MUAC to recover from acute malnutrition.

20% weight gain as a single discharge criterion was more effective in securing sufficient nutritional recovery for SAM children but is likely to invoke higher costs of treatment.

10% of weight gain was insufficient for roughly 9% of children with MAM as defined by MUAC 115-124mm to recover from acute malnutrition.

**Keywords**

Community-based management of acute malnutrition, severe acute malnutrition, mid-upper arm circumference, percentage weight gain, discharge criteria.

**Source of funding**

The Swedish International Development Cooperation Agency (SIDA) department for research funded the project (SWE-2010-179). The Department of Women's and Children's Health, Uppsala University also contributed with funds. Weighing scales were provided by UNICEF Addis Ababa

**References**


StataCorp. 2011. "Stata Statistical Software: Release 12.". College Station, TX: StataCorp LP.


Annex 1

Figure 1. Flow of selection

Children with MUAC < 125 mm seeking OTP
n=926

Total excluded
n=187
- Bilateral edema present
  n=122
- Unilateral edema present
  n=17
- Info on edema missing
  n=17
- Age <6 months
  n=26
- Age >59 months
  n=5

MUAC < 125 mm, edema free, age 6-59 months
n=739

MUAC < 110 mm
n=430
- WHZ < -5 > 5 n=21
- HAZ < -6 > 6 n=53
- WHZ +15% w/g > 5 n=2

Analyzed
N=354

MUAC 110-114 mm
n=150
- WHZ < -5 > 5 n=5
- HAZ < -6 > 6 n=14

Analyzed
N=131

MUAC 115-124 mm
n=159
- WHZ < -5 > 5 n=3
- HAZ < -6 > 6 n=10

Analyzed
N=146

Total children analyzed
n=631
### Annex 2

**Table 1.** Socio-economic and demographic characteristics of households, caretakers and children

<table>
<thead>
<tr>
<th>Household Characteristics</th>
<th>N=628 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sanitation</strong></td>
<td></td>
</tr>
<tr>
<td>Pit latrine with slab</td>
<td>16 (2.5)</td>
</tr>
<tr>
<td>Open pit</td>
<td>468 (74.5)</td>
</tr>
<tr>
<td>Bush or open space</td>
<td>82 (13.1)</td>
</tr>
<tr>
<td>Disposed on farmland/other</td>
<td>62 (9.9)</td>
</tr>
<tr>
<td><strong>Source of drinking water</strong></td>
<td></td>
</tr>
<tr>
<td>Public tap</td>
<td>178 (28.3)</td>
</tr>
<tr>
<td>Protected well</td>
<td>233 (37.1)</td>
</tr>
<tr>
<td>Unprotected well</td>
<td>31 (5.0)</td>
</tr>
<tr>
<td>Protected spring</td>
<td>67 (10.7)</td>
</tr>
<tr>
<td>Unprotected spring/other</td>
<td>119 (18.9)</td>
</tr>
<tr>
<td><strong>House construction</strong></td>
<td></td>
</tr>
<tr>
<td>Corrugated iron roof with wood and mud walls</td>
<td>172 (27.4)</td>
</tr>
<tr>
<td>Thatch roof with wood and mud walls</td>
<td>381 (60.6)</td>
</tr>
<tr>
<td>Thatch roof with reed or grass walls/other</td>
<td>75 (12.0)</td>
</tr>
<tr>
<td><strong>Household member went whole day without eating</strong></td>
<td></td>
</tr>
<tr>
<td>Did not happen</td>
<td>569 (90.6)</td>
</tr>
<tr>
<td>Once or twice last month</td>
<td>27 (4.3)</td>
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<tr>
<td>Once or twice every week</td>
<td>31 (4.9)</td>
</tr>
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<table>
<thead>
<tr>
<th>Caretaker Characteristics</th>
<th>N=629 (%)</th>
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<tr>
<td><strong>Relationship to child</strong></td>
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<tr>
<td>Biol. Mother</td>
<td>559 (88.9)</td>
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<tr>
<td>Stepmother</td>
<td>6 (1.0)</td>
</tr>
<tr>
<td>Grandparent</td>
<td>59 (9.4)</td>
</tr>
<tr>
<td>Aunt/Uncle/Other</td>
<td>5 (0.8)</td>
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<tr>
<td><strong>Marital status</strong></td>
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<tr>
<td>Single</td>
<td>2 (0.3)</td>
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<tr>
<td>Married</td>
<td>553 (88.0)</td>
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<tr>
<td>Separated/Divorced</td>
<td>16 (2.5)</td>
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<tr>
<td>Widowed</td>
<td>39 (6.2)</td>
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<td>19 (3.0)</td>
</tr>
<tr>
<td><strong>Age (in years)</strong></td>
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</tr>
<tr>
<td>Mean ± SD</td>
<td>30.8 ± 7.4</td>
</tr>
<tr>
<td>15-19</td>
<td>6 (1.0)</td>
</tr>
<tr>
<td>20-29</td>
<td>257 (40.9)</td>
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<td>30-39</td>
<td>291 (46.3)</td>
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<td>40-49</td>
<td>44 (6.9)</td>
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<td>≥50</td>
<td>17 (2.7)</td>
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Current occupation

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<th>Current occupation</th>
<th>N</th>
<th>(%)</th>
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<tr>
<td>No job</td>
<td>88</td>
<td>(14.0)</td>
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<tr>
<td>Attending school</td>
<td>3</td>
<td>(0.5)</td>
</tr>
<tr>
<td>Farmer</td>
<td>350</td>
<td>(55.6)</td>
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<tr>
<td>Skilled work/wage work</td>
<td>34</td>
<td>(5.4)</td>
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<tr>
<td>Petty trade</td>
<td>152</td>
<td>(24.2)</td>
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<td>(0.3)</td>
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Educational status

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<th>Educational status</th>
<th>N</th>
<th>(%)</th>
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<tbody>
<tr>
<td>Never attended school</td>
<td>20</td>
<td>(3.2)</td>
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<tr>
<td>Did not complete primary school</td>
<td>430</td>
<td>(68.5)</td>
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<tr>
<td>Completed primary school</td>
<td>124</td>
<td>(19.6)</td>
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<tr>
<td>Completed secondary school</td>
<td>50</td>
<td>(7.9)</td>
</tr>
<tr>
<td>In or completed vocational school</td>
<td>5</td>
<td>(0.8)</td>
</tr>
</tbody>
</table>

Number of children in household (mean ± SD) 3.9 ± 1.8

---

Child Characteristics

N=631 (%)

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<thead>
<tr>
<th>Sex</th>
<th>N</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>264</td>
<td>(41.8)</td>
</tr>
<tr>
<td>Female</td>
<td>367</td>
<td>(58.2)</td>
</tr>
</tbody>
</table>

Age (in months)

<table>
<thead>
<tr>
<th>Age (in months)</th>
<th>N</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>16</td>
<td>± 12</td>
</tr>
<tr>
<td>6-11 months</td>
<td>310</td>
<td>(49.1)</td>
</tr>
<tr>
<td>12-23 months</td>
<td>198</td>
<td>(31.4)</td>
</tr>
<tr>
<td>24-47 months</td>
<td>98</td>
<td>(15.5)</td>
</tr>
<tr>
<td>48-59 months</td>
<td>25</td>
<td>(4.0)</td>
</tr>
</tbody>
</table>

SD, standard deviation
## Annex 3

### Table 2. Nutritional status of children at admission and after theoretical percentages of weight gain, grouped according to admission MUAC.

<table>
<thead>
<tr>
<th>Group by MUAC</th>
<th>Status on admission</th>
<th>Status after simulated weight gain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (%)=631 (100)</td>
<td>10%</td>
</tr>
<tr>
<td><strong>MUAC-MAM 115-124mm</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n/N (%)=146/631 (23.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MUAC mean (95% CI)</td>
<td>117.6 (117.2-118.0)</td>
<td></td>
</tr>
<tr>
<td>HAZ mean (95% CI)</td>
<td>-2.9 (-3.1 - -2.6)</td>
<td></td>
</tr>
<tr>
<td>WAZ mean (95% CI)</td>
<td>-3.1 (-3.2 - -2.9)</td>
<td></td>
</tr>
<tr>
<td>WHZ mean (95% CI)</td>
<td>-2.0 (-2.2 - -1.9)</td>
<td>-2.3 (-2.4 - -2.1)</td>
</tr>
<tr>
<td>n/N (%) = 146/631</td>
<td>70/146 (47.9, 39.7-56.1)</td>
<td>134/146 (91.8, 87.2-96.3)</td>
</tr>
<tr>
<td><strong>MUAC-SAM &lt;115mm</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n/N (%)=485/631 (76.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MUAC mean (95% CI)</td>
<td>105.4 (104.8-105.9)</td>
<td></td>
</tr>
<tr>
<td>HAZ mean (95% CI)</td>
<td>-3.6 (-3.7 - -3.5)</td>
<td></td>
</tr>
<tr>
<td>WAZ mean (95% CI)</td>
<td>-3.8 (-3.9 - -3.6)</td>
<td>-3.1 (-3.2 - -3.0)</td>
</tr>
<tr>
<td>WHZ mean (95% CI)</td>
<td>-2.5 (-2.5 - -2.4)</td>
<td>-1.3 (-1.4 - -1.2)</td>
</tr>
<tr>
<td>n/N (%) = 485/631</td>
<td>142/485 (29.3, 25.2-33.3)</td>
<td>376/485 (77.5, 73.8-81.3)</td>
</tr>
<tr>
<td><strong>MUAC-SAM &lt;110mm</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n/N (%)=354/485 (73.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MUAC mean (95% CI)</td>
<td>103.1 (102.5-103.6)</td>
<td></td>
</tr>
<tr>
<td>HAZ mean (95% CI)</td>
<td>-3.7 (-3.9 - -3.6)</td>
<td></td>
</tr>
<tr>
<td>WAZ mean (95% CI)</td>
<td>-4.0 (-4.1 - -3.9)</td>
<td>-3.3 (-3.4 - -3.2)</td>
</tr>
<tr>
<td>WHZ mean (95% CI)</td>
<td>-2.5 (-2.6 - -2.4)</td>
<td>-1.4 (-1.5 - -1.3)</td>
</tr>
</tbody>
</table>
n/N (%), 95% CI ≥ -2 WHZ  
93/354 (26.3, 21.7–30.9)  
269/354 (76.0, 71.5–80.5)  
322/354 (91.0, 88.0–94.0)  
342/354 (96.6, 94.7–98.5)  

n/N (%), 95% CI < -2 WHZ  
261/354 (73.7, 69.1–78.3)  
85/354 (24.0, 19.5–28.5)  
32/354 (9.0, 6.0–12.0)  
12/354 (3.4, 1.5–5.3)  

n/N (%), 95% CI -3 ≤ WHZ > -2  
137/354 (38.7, 33.6–43.8)  
69/354 (19.5, 15.3–23.6)  
27/354 (7.6, 4.8–10.4)  
12/354 (3.4, 1.5–5.3)  

n/N (%), 95% CI < -3 WHZ  
124/354 (35.0, 30.0–40.0)  
16/354 (4.5, 2.3–6.7)  
5/354 (1.4, 0.2–2.6)  
0/354 (0.0)  

**MUAC-SAM 110-114mm**  
n/N (%)=131/485 (27.0)  
MUAC mean (95% CI)  
111.7 (111.4–111.9)  
HAZ mean (95% CI)  
-3.2 (-3.5 – -3.0)  
WAZ mean (95% CI)  
-3.4 (-3.6 – -3.3)  
-2.7 (-2.8 – -2.5)  
-2.3 (-2.5 – -2.1)  
-1.9 (-2.1 – -1.8)  
WHZ mean (95% CI)  
-2.3 (-2.4 – -2.1)  
-1.1 (-1.3 – -0.9)  
-0.6 (-0.7 – -0.4)  
-0.1 (-0.2 – 0.1)  

n/N (%), 95% CI ≥ -2 WHZ  
49/131 (37.4, 29.0–45.8)  
107/131 (81.7, 75.0–88.4)  
119/131 (90.8, 85.8–95.8)  
130/131 (99.2, 97.7–100.7)  

n/N (%), 95% CI < -2 WHZ  
82/131 (62.6, 54.2–71.0)  
24/131 (18.3, 11.6–25.0)  
12/131 (9.2, 4.2–14.2)  
1/131 (0.8, 0.7–2.3)  

n/N (%), 95% CI -3sWHZ≥ -2  
52/131 (39.7, 31.2–48.2)  
22/131 (16.8, 10.3–23.3)  
11/131 (8.4, 3.6–13.2)  
1/131 (0.8, 0.7–2.3)  

n/N (%), 95% CI < -3 WHZ  
30/131 (22.9, 15.6–30.2)  
2/131 (1.5, 0.6–3.7)  
1/131 (0.8, 0.7–2.3)  
0/131 (0.0)  

MUAC, mid-upper arm circumference; CI, confidence interval; WAZ, weight-for-age z-score; HAZ, height-for-age z-score; WHZ, weight-for-height z-score; SD, standard deviation.