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# Unconditional cash transfers do not prevent children's undernutrition in the Moderate Acute Malnutrition Out (MAM'Out) cluster-randomized controlled trial in rural Burkina Faso

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## 1 **Abstract**

2 **Background:** Limited evidence is available on the impact unconditional cash transfer  
3 programs can have on child nutrition, particularly in West Africa where child undernutrition is  
4 still a public health challenge.

5 **Objective:** This study examined the impact of a multiannual seasonal unconditional cash  
6 transfer program to reduce the occurrence of wasting (weight-for-height, mid upper arm  
7 circumference), stunting (height-for-age) and morbidity among children under 36 months old  
8 in Tapoa Province, Eastern region of Burkina Faso.

9 **Methods:** The study was designed as a two-arm cluster randomized controlled trial, with 32  
10 villages randomly assigned to either the intervention or control group. The study population  
11 consisted of households classified as poor or very poor according to household economy  
12 approach criteria and having at least one child under one-year of age at inclusion. The  
13 intervention consisted of seasonal unconditional cash transfers, provided monthly from July  
14 to November, over two years (2013 and 2014). A monthly allowance of 10,000 XOF  
15 ( $\approx$ US\$17) was given by mobile phone to mothers in participating households. Anthropometric  
16 measurements and morbidity were recorded on quarterly basis.

17 **Results:** We found no evidence that multiannual seasonal unconditional cash transfers  
18 reduced the cumulative incidence of wasting among young children (incidence rate ratio:  
19 0.92, 95% CI: 0.64, 1.32;  $p=0.66$ ). We observed no significant difference ( $p>0.05$ ) in  
20 children's anthropometric measurements and stunting at end point, between the two groups.  
21 However, children in the intervention group had a lower risk (21%, 95%CI: 3.20, 34.2;  
22  $p=0.02$ ) of self-reported respiratory tract infections compared to children in the control group.

23 **Conclusion:** We found that seasonal unconditional cash transfers in the framework of safety  
24 nets did not result in a significant decrease in the incidence of child acute malnutrition in  
25 Tapoa Province. Cash transfers combined with complementary interventions targeted on

26 child nutrition and health should be further investigated. This trial was registered at  
27 clinicaltrials.gov as NCT01866124.

28 **Key words**

29 Seasonal unconditional cash transfers, children, Burkina Faso, nutritional status, morbidity

30

## 31 **Introduction**

32 Child undernutrition remains a serious health problem in developing countries, especially in  
33 West Africa where it is still a public health challenge [1]. Although encouraging progress has  
34 been made in reducing the proportion of hungry people and the number of undernourished  
35 people in the past two decades, 31.5 million people in West Africa are still undernourished  
36 [2]. West African countries with a sub-Saharan tropical climate have a wet season from June  
37 to September and a dry season during the remaining eight months. Trends in children's  
38 morbidity and nutritional status vary according to these seasons, with increased rates during  
39 the rainy season [3, 4]. Twenty percent of West African children under age 5 are underweight  
40 [2] and the prevalence of acute malnutrition is 9%, nearly reaching the public health  
41 emergency range [5]. Given that acute malnutrition is associated with increased morbidity  
42 and mortality risks [6], effective interventions are urgently needed. The introduction of the  
43 community-based management of acute malnutrition (CMAM) model in many Sub-Sahara  
44 African countries, including the use of ready-to-use therapeutic foods, made the treatment of  
45 acute malnutrition more accessible and convenient to beneficiaries [7]. However, low  
46 coverage of scaled-up CMAM programs in a number of countries implies that there remains  
47 room for improvement [8]. Complementary strategies aimed at preventing acute malnutrition  
48 can therefore play an important role.

49 During the last decade, social safety nets and cash based interventions have gained  
50 attention in developing countries. Cash transfer programs are increasingly implemented in  
51 emergencies [9-12] and in developing contexts [13-15] to alleviate poverty and food  
52 insecurity in vulnerable households. Large scale conditional cash-transfer programs first  
53 showed their efficacy in Latin America to improve food security [16], health care utilization  
54 [17-19], health outcomes [20] and child nutritional status [21, 22]. Less evidence is available  
55 regarding unconditional cash transfers (UCTs). Only a few studies showed positive effects on  
56 food access and diversity [13, 14], health expenditures [13] and preventive visits to health  
57 centers [23]. In the 2013 Lancet Series on Child and Maternal Health, cash transfer

58 programs designed with a nutritional objective were highlighted as having a potential to  
59 prevent child undernutrition [24]. However, to date, few rigorous studies have evaluated the  
60 impact of UCTs on child nutrition. On the basis of the comprehensive conceptual model of  
61 under-nutrition proposed by Black RE et al. [25], the "moderate acute malnutrition Out"  
62 (MAM'Out) study, implemented in rural Burkina Faso, intended to influence several  
63 underlying causes of undernutrition during the lean season when the prevalence of  
64 undernutrition is high, by delivering a cost-efficient intervention. The study aimed to assess  
65 the impact of cash transfer program in reducing the incidence of acute malnutrition and  
66 morbidity, and the prevalence of stunting among children under 36 months old.

67

## 68 **Methods**

### 69 **➤ Study design and participants**

70 Burkina Faso is a landlocked country located in the Sahel region in West Africa. A national  
71 social protection policy which promotes social transfer mechanisms to the poorest and most  
72 vulnerable was adopted in 2012 to enhance population food security [26]. The study was  
73 carried out in the North of Tapoa province which is characterized by inappropriate child  
74 feeding practices (such as non-exclusive breastfeeding and low diet diversity after one year  
75 of age), insufficient access to sanitation and safe water [27, 28].

76 The study was designed as a two-arm cluster randomized controlled trial, in which 32  
77 villages in three municipalities were randomly assigned to either the intervention or control  
78 group. With a type I error of 5%, a statistical power of 90% and a minimum follow-up time of  
79 24 months, assuming a 33% reduction in the cumulative incidence of wasting, a coefficient of  
80 variation K of 0.25 and an anticipated 25% drop-out, 16 clusters with 50 children were  
81 required in each study group [29]. Randomization of villages to the intervention and control  
82 groups was performed during a ceremony, to keep the allocation of cash transparent and  
83 fair. Representatives of each of the 32 villages drew blindly from a bag one of the 32 identical

84 papers with “cash” or “no cash” written on it from the bag. Sixteen villages were assigned to  
85 the intervention group and 16 others to the control group.

86 Within villages, household participation in the study was voluntary and based on the following  
87 inclusion criteria: household classified as poor or very poor according to household economy  
88 approach criteria [30] and having at least one child under 1 year old at inclusion regardless of  
89 his/her nutritional status. Study objectives and implementation were explained to both wives  
90 and husbands and informed consent obtained from the heads of household by signature or  
91 fingerprint.

## 92 ➤ **Intervention**

93 Prior to the MAM’Out study, a needs assessment was conducted in two steps at the end of  
94 2012: an analysis of the causes of undernutrition using nutrition causal analysis (NCA)  
95 methodology [31] and formative research related to the cash transfer intervention. Results of  
96 the NCA showed that financial insecurity of women, birth spacing and access to potable  
97 water were perceived causes of malnutrition [32]. Based on the existing literature and reports  
98 from the study area, a theoretical framework of pathways through which cash transfers can  
99 impact acute malnutrition was constructed (unpublished paper). The formative research  
100 assessed the relevance of a cash based intervention and provided detailed operational  
101 guidance on the study area, the target population, the type of cash transfer, the seasonality,  
102 the amount of the cash transfer and the delivery mechanism.

103 The intervention consisted of seasonal UCTs, provided monthly from July to November, over  
104 two years (2013 and 2014) [29]. This period partly overlapped with the annual rainy season  
105 (May to August) perceived as the “hunger” season because of the cereal shortage observed  
106 at household level [4, 33]. As there was no national transfer size defined for cash transfer  
107 programs in Burkina Faso, the MAM’Out transfer size was defined during a formative  
108 research jointly with Action Contre la Faim operational team in Burkina Faso, based on  
109 previous cash transfer experiences in Burkina Faso and in the sub-Saharan African countries.



110 A monthly allowance of 10,000 XOF ( $\approx$ US\$17) was given by mobile phone (offered by the  
111 project) to participating households. Over a year, a total amount of 50,000 XOF ( $\approx$ US\$85)  
112 was transferred to each eligible household, representing about 33% of the 2014 annual  
113 national poverty line estimated at 153,530 XOF ( $\approx$ US\$260) [34]. The grant value allowed to  
114 cover on average the survival gap and 85% of the livelihoods gap for the very poor  
115 households, and the entire livelihoods gap of poor households. We specifically designated  
116 mothers as primary recipients of the transfer since they are usually in charge of child care  
117 [35]. Mothers were told that the cash was given to them to support their child's development  
118 and to prevent malnutrition.

119 A dedicated team supervised and followed up cash transfers activities jointly with the  
120 research team. A partnership with a mobile phone company enabled cash distribution via  
121 mobile phone. Prior to the intervention, all mothers in the intervention group received an  
122 identity card provided by the field teams, a mobile phone and a sim card linked to an  
123 electronic account. At the time of distribution, mothers received a text message with a code  
124 number notifying them that their account was credited. Mothers were thus invited to visit cash  
125 withdrawal points to collect their money. Presentation of the identify card and the code  
126 number granted access to the money. Mothers confirmed the cash withdrawal by signing  
127 follow-up lists. All study participants in the intervention group received their monthly  
128 allowance within a week time. Mothers of children in the control group did not receive a cash  
129 grant. Incentives (cooking kit, fabrics, etc.) were given to households in the control group to  
130 compensate for the time they spent answering the MAM'Out questionnaires. Next to the  
131 approval by the ethical committee of the Ghent University Hospital (Belgium) and the  
132 Burkinabe national ethics committee, administrative authorities as well as all heads of  
133 villages gave their consent prior to the start of the study. The trial was registered at  
134 [clinicaltrials.gov](http://clinicaltrials.gov) as NCT01866124.

135           ➤ **Measurements**

136 Trained fieldworkers performed quarterly home visits to collect data. A pretested  
137 questionnaire was used to collect socioeconomic (education, occupation and asset  
138 ownership) and demographic data on a half-yearly basis, whereas anthropometrics and  
139 morbidity (diarrhea, fever and respiratory tract infections) data were collected on a quarterly  
140 basis. All anthropometric measurements were taken in duplicate by team members. The  
141 average of the two values was used for analysis. A diarrheal episode was defined as having  
142 at least three loose stools within a day. Tactile assessment technique was used to identify  
143 fever. Respiratory tract infection episode was defined as persistent cough and/or fast or  
144 difficult breathing. Morbidity episodes were recalled by mothers over the last seven days.  
145 Child age at recruitment was estimated from a birth certificate or using a locally adapted  
146 special events calendar. The protocol provides more details on measurement tools and  
147 standardization procedures used to ensure good quality of data [29]. Baseline data were  
148 collected one month earlier in the intervention group than in the control group, to enable cash  
149 transfer to start in due time. Follow up visits were performed at the same time in the two  
150 groups. Data collection lasted 29 months (June 2013 to October 2015).

151 Weight-for-height Z-score (WHZ), height-for-age Z-score (HAZ) and weight-for-age Z-score  
152 (WAZ) were calculated according to 2006 WHO growth standards to conform with the  
153 Burkinabe national protocols for the management of acute malnutrition. Wasting was defined  
154 as WHZ <-2 or presence of bilateral pitting edema, stunting as HAZ <-2 and underweight as  
155 WAZ <-2 [36]. All children identified as wasted were referred to the nearest health centers for  
156 adequate nutritional care as per national protocol. If a child was absent from home, another  
157 home visit was planned within the round of data collection to ensure complete measurements  
158 of the child. In case of a child's death, a verbal autopsy was adapted from WHO standards  
159 [37, 38].

160 In the first round, data were collected on paper forms and entered in double using EpiData  
161 version 3.1 (EpiData Association) by two groups of data clerks. From the fifth round on, we

162 switched to computer assisted personal interviews with tablets using open data kit  
163 application (Core ODK, UW-CSE) to allow real time follow-up of collected data. The lot  
164 quality assurance sampling method was applied on a monthly basis to ensure both good  
165 quality data collection and data entry.

#### 166       ➤ **Statistical analysis**

167 Our primary outcome was the cumulative incidence of wasting. Secondary outcomes  
168 included the mean WHZ change over time, the mean HAZ change over time, the mean mid-  
169 upper arm circumference (MUAC) change over time, the prevalence of stunting at end point,  
170 and the cumulative incidence of morbidity episodes [29]. Z-scores were calculated using the  
171 *zscore06* command in Stata 14.2 [39].

172 We described baseline characteristics using proportions, means and standards deviations. A  
173 household socioeconomic status (SES) proxy was created using a principal component  
174 analysis (PCA) based on declared asset ownership recorded as a binary variable (possessed  
175 or not) and collected throughout the intervention. A PCA was applied to 20 asset indicator  
176 variables, which showed a relevant contribution (>10% of the variability of the component) to  
177 the combined SES score factor. The first principal component (explaining 18% of the  
178 variation in the dataset) with the highest eigenvalue (3.61) was categorized into tertiles (low,  
179 middle and high) and used as proxy indicator for the household socioeconomic status [40].

180 All analyses were conducted on intention-to-treat basis and children were analyzed as from  
181 the initial group assignment. We used 2-sided tests for all analyses with statistical  
182 significance set at 5%.

183 The intervention effect on continuous growth outcomes (weight, length, WHZ, HAZ, WAZ and  
184 MUAC) was analyzed using linear mixed-effect models with cluster, household and children  
185 as random effects. Because of the time difference at baseline, the month of data collection  
186 was used to harmonize the unit of time for the follow-up measurements between the two  
187 groups. A likelihood ratio test was used to test if the addition of the month of data collection

188 (as random slope) and the addition of a quadratic term of the month of data collection (fixed  
189 effect) improved the model fit.

190 We examined the intervention effect on the incidence of wasting and self-reported morbidity  
191 outcomes (diarrhea, fever and respiratory tract infections) using a multilevel mixed-effects  
192 Poisson regression model adjusted for clustering by village, household and child. For binary  
193 morbidity outcomes, we used a robust estimation of standard errors to relax the assumption  
194 for a Poisson distribution [41]. We adjusted these models for the number of recalls that were  
195 recorded. We analyzed the effect of the intervention on the prevalence of stunting at  
196 endpoint using mixed-effects logistic regression model with cluster and household as random  
197 effects. Fixed effects included in all of the models were child's sex, child's age, SES at  
198 baseline and the outcome at inclusion.

199 Finally, we used Kenward-Roger adjustment for continuous outcomes and bootstrap  
200 methods for binary outcomes, to provide reasonable estimates that account for the relatively  
201 small number of clusters [42]

202

## 203 Results

204 A total of 1,278 children from the 32 selected villages were enrolled in the study in May 2013,  
205 after their parents gave their informed consent at home. During the course of the study, 99  
206 children of which 57.6% in the intervention group, dropped out from the study for different  
207 reasons, mainly related to child death or leaving the study area (**Figure 1**).

208 A total of 1,250 children aged 0 to 15 months from 1,162 households (630 children in the  
209 intervention group and 620 children in the control group) provided at least two measurements  
210 and were accounted for in the analyses. This sample size was equivalent to the necessary  
211 size required to ensure enough statistical power. Overall, baseline characteristics were  
212 balanced between the intervention and the control groups (**Table 1**). Children in the  
213 intervention group were more likely to be one month younger and wasted. About 31.7% of all

214 children were less than 6 months old and 8% were aged 12 months or older at study  
215 inclusion.

216 Children contributed to 15,394 and 14,458 months of follow-up in the intervention and control  
217 groups respectively (**Table 2**). Non-response rate was rather similar (2.17% vs. 2.21%;  
218  $p=0.93$ ) in the intervention and the control group respectively. We observed no difference in  
219 the mean change in WHZ in the intervention and the control groups over the 24 months of  
220 follow-up. We found no difference in the incidence of wasting episodes in the intervention  
221 and the control groups (incidence rate ratio: 0.92, 95% CI: 0.64, 1.32;  $p=0.66$ ). Similar results  
222 were obtained when we broke down the analysis for moderate and severe wasting, and also  
223 by sex (data not shown). The longitudinal analysis of child's MUAC showed similar results as  
224 for WHZ with absence of difference in the mean MUAC change over time (-0.02 mm/month;  
225 95% CI: -0.08, 0.02;  $p=0.33$ ). The mean change in HAZ was similar ( $p=0.78$ ) in the control  
226 and the intervention groups over the 24 months of follow up. The odds of stunting at the end  
227 of the intervention in the two groups (OR: 0.73, 95%CI: 0.47, 1.14;  $p=0.17$ ) was comparable.

228 Children in the intervention group had a lower risk (21%, 95%CI: 3.20, 34.2;  $p=0.02$ ) of self-  
229 reported respiratory tract infections compared to children in the control group (**Table 3**). No  
230 difference in other self-reported morbidity outcomes was observed between the study  
231 groups. Death incidence rate is similar in the two groups (incidence rate ratio: 0.97, 95% CI:  
232 0.92, 1.02;  $p=0.308$ ) (data not shown).

233

## 234 Discussion

235 This study assessed the effectiveness of multiannual seasonal UCTs to prevent acute  
236 malnutrition in young children in Tapoa province, Eastern region of Burkina Faso. We were  
237 unable to demonstrate a significant reduction in the incidence of wasting children belonging  
238 to households that received the seasonal cash transfers as compared to control children. In  
239 addition, we did not find any intervention effect on child linear growth, resulting in similar

240 odds of stunting at the end of the intervention. However, distributing cash reduced the  
241 incidence of self-reported episodes of respiratory tract infections.

242 The absence of evidence on the impact of the intervention on children's anthropometrics is  
243 consistent with results reported in the few available impact studies of UCTs. Previous  
244 randomized controlled intervention studies of UCTs in Zambia, Kenya and Burkina Faso  
245 have recently (after the inception of the MAM'Out study) reported the absence of significant  
246 improvements on wasting, stunting and mean HAZ of children under five years of age [43-  
247 46].

248 Different reasons could explain the absence of evidence about the MAM'Out intervention  
249 effect on child anthropometrics. First, the money received by the participating mothers was  
250 not (only) used for the child's needs. Although during cash distributions and home visits,  
251 program staff emphasized that the money should be used for the targeted child, there was no  
252 mechanism or conditions imposed to guarantee the exclusive use of the money for the  
253 targeted child. Qualitative and study expenditure data collected during the MAM'Out  
254 intervention revealed that the two first investment domains for the cash received were food  
255 and health, not only for the child, but for the whole family. Women reported using  
256 approximately one quarter of the monthly allowance to buy food for the child while the main  
257 part was used to increase the household food stock (unpublished data). This situation may  
258 have been worsened by the stressful "hunger" season during which additional household  
259 budget is required to counter the dwindling granary supplies and to cover expenses related  
260 to the seasonal increase in disease [4]. Presumably, the cash transfer benefited all  
261 household members which, as consequence, might have diluted the cash related impact on  
262 child nutrition and health outcomes. The total value of the cash transfer may not have been  
263 enough to cater for both the child's specific needs and the households' needs altogether. On  
264 the other hand, the intervention related improvement might have been insufficient to translate  
265 into a sustained improvement in their nutritional status. A quantitative 24-hour dietary recall  
266 carried out during the UCT study reported better dietary quality in children belonging to the

267 intervention group as compared to the control group. More specifically, intervention children  
268 consumed animal source foods more frequently and demonstrated higher intakes in vitamin  
269 B12 and E. However, no difference in energy and protein intake between the intervention  
270 and the control groups was observed (unpublished data). The positive intervention effect on  
271 diet quality might have been too small (both in the percentage of children and nutrient  
272 quantity) to affect child anthropometry. Furthermore, the high number of cumulative morbidity  
273 episodes emphasizes the high frequency of illness (table 3). The cyclic interaction between  
274 undernutrition and infections is widely recognized [1, 47, 48]. Previous studies showed that  
275 diarrheal illnesses can prevent weight gain as well as height gain, with the greatest effects  
276 when illnesses are recurrent [49]. Infections can further reduce food intake and increase  
277 energy and nutrient needs to fight infection, maintaining tissue repair and constraining body  
278 resources to be used for basic maintenance [50, 51]. The cumulative growth faltering may  
279 have hampered the improvement in the children's nutritional status in both groups. Finally,  
280 seasonal UCT may not have been a sufficient intervention to prevent child acute malnutrition.  
281 Future studies on the prevention of child malnutrition should evaluate UCT interventions  
282 combined with other child nutrition sensitive interventions. One possible complementary  
283 intervention could be the behavior change communication (BCC) for better nutrition and  
284 health, which fosters behavior change at the individual household and community levels  
285 through behavior change trainings, monitoring and evaluation and a sustainability component  
286 [52]. The effectiveness of a similar approach (combining cash transfers with nutrition BCC)  
287 for the prevention of undernutrition is currently being assessed by the transfer modality  
288 research initiative (TMRI) in Bangladesh (ClinicalTrials.gov, identifier: NCT02237144).

289 Multiannual seasonal UCTs that targeted mothers in vulnerable households in Tapoa  
290 province significantly reduced episodes of respiratory tract infection in the seven days before  
291 the interview, as reported by mothers. As methods vary among studies, we found it difficult to  
292 compare our findings with the relatively small body of literature on UCTs. Most studies  
293 reported an effect of UCTs on overall children's well-being and health outcomes, but few

294 looked at the child morbidity indicators as defined by our study. After 24 months of  
295 implementation, the Zambian child grant program reported the intervention group of children  
296 had a 4.9 percentage points lower diarrheal prevalence compared to the control group, but  
297 did not find any intervention effect on cough [53]. After two years of cash transfers in an  
298 orphans and vulnerable children's program in Kenya, the evaluation team reported no  
299 intervention effect on morbidity indicators (diarrhea, fever and cough) among children under  
300 5 years old who sought care when sick compared to children belonging to a control group  
301 [54]. A randomized controlled trial in Malawi did find that children 6-17 years (therefore older  
302 than ours) included in a cash transfer program were less likely to be sick (with respiratory  
303 infections, malaria and abdominal pain as the most common reported illnesses), but does not  
304 provide insights on the pathways [23]. Although there was an apparent reduction in child's  
305 respiratory tract infections episodes in our study, it is difficult to support our findings with  
306 previous evidence. Therefore, the impact pathway for such an effect remains to be  
307 elucidated.

308 Our study has some limitations that need to be addressed. First, the sample size attained  
309 was smaller than foreseen, mainly due to logistical constraints (security, accessibility). Lost  
310 to follow-up was however lower than expected and the proportion of missing data was small  
311 thanks to the extra time invested in additional home visits when the participant was absent.  
312 In addition, adjustment for important prognostic covariates pre-specified in the protocol likely  
313 outweighed the loss of power due to the reduction in the sample size [55]. Secondly, child  
314 morbidity was recalled by mothers, which could have resulted in under or over-estimation.  
315 Finally, concerns about contamination between individuals are often present when it comes  
316 to the distribution of cash or food supplements. We chose a prospective interventional study  
317 with randomization at village level to limit these biases. However, we could not blind the  
318 study participants and the fieldworkers with respect to the intervention assignment because  
319 of the nature of the intervention (cash).

320



## 321 **Conclusion**

322 We did not find evidence of the effectiveness of multiannual seasonal unconditional cash  
323 transfers in preventing acute malnutrition in young children in Tapoa province. However, they  
324 resulted in a reduction in respiratory tract infection episodes. A cash-based program  
325 combined with a child nutrition and health behavior change communication component is a  
326 good compromise that requires further investigation.

327

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329 ATP, LH, MAA, JFH and PK designed the research; FH conducted the research; FH and  
330 ATP performed statistical analysis; FH, ATP, CA, JFH, LH and PK wrote the paper; FH had  
331 primary responsibility for final content. All the authors read and approved the final  
332 manuscript.

333

334 **Abbreviations:** ACF-France, Action Contre la Faim-France; BCC, behavior change  
335 communication; CMAM, Community-based management of acute malnutrition; HAZ, height-  
336 for-age Z-score, MUAC, mid-upper arm circumference; NCA, Nutrition Causal Analysis; OR,  
337 odds ratio; PCA, Principal component analysis; SES, socioeconomic status; TMRI, transfer  
338 modality research initiative; UCT, unconditional cash transfers; WAZ, weight-for-age Z-score;  
339 WHO, World Health Organization; WHZ, weight-for-height Z-score; XOF, West African CFA  
340 (Financial Community of Africa) franc.

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## Tables

**Table 1:** Baseline characteristics of children enrolled in the MAM'Out study

| Characteristics  | Control arm<br>(620) | Intervention arm<br>(630) |
|--|----------------------|---------------------------|
| Children's age in months, mean $\pm$ SD                      | 7.79 $\pm$ 2.93      | 6.83 $\pm$ 3.29           |
| Children's age category, frequency (percent)                 |                      |                           |
| Children aged < 6 months                                     | 161 (26.0)           | 236 (37.5)                |
| Children aged 6 – 11 months                                  | 396 (63.8)           | 358 (56.8)                |
| Children aged 12 – 15 months                                 | 63 (10.2)            | 36 (5.7)                  |
| Children's gender categories, frequency (percent)            |                      |                           |
| Male children  | 313 (50.5)           | 349 (55.4)                |
| Female children  | 307 (49.5)           | 281 (44.6)                |
| Children's anthropometric measurements, mean $\pm$ SD        |                      |                           |
| Children's weight, kg  | 6.7 $\pm$ 1.12       | 6.3 $\pm$ 1.22            |
| Children's height, cm  | 65.8 $\pm$ 4.25      | 64.4 $\pm$ 5.10           |
| Children's MUAC, mm <sup>a</sup>                             | 133.1 $\pm$ 11.7     | 131.3 $\pm$ 12.8          |
| Children's weight-for-height z-score                         | -1.07 $\pm$ 1.12     | -1.24 $\pm$ 1.23          |
| Children's height-for-age z-score                            | -1.33 $\pm$ 1.24     | -1.18 $\pm$ 1.44          |
| Children's wasting forms, frequency (percent)                |                      |                           |
| Wasted children with weight-for-height z-score < -2          | 119 (19.2)           | 164 (26.0)                |
| Severely wasted children with weight-for-height z-score < -3 | 22 (3.55)            | 44 (7.00)                 |
| Wasted children with mid upper arm circumference < 125 mm    | 82 (18.2)            | 115 (29.2)                |
| Severely wasted children with mid upper arm                  | 19 (4.23)            | 39 (9.92)                 |



|  |            |            |
|--|------------|------------|
| circumference < 115 mm   |            |            |
| Children's stunting forms, frequency (percent)                                 |            |            |
| Stunted children with height-for-age < -2                                      | 169 (27.2) | 175 (27.7) |
| Severely stunted children with height-for-age z-score < -3                     | 56 (9.03)  | 64 (10.1)  |
| Households' socio-economic status categories, frequency (percent) <sup>b</sup> |            |            |
| Low category   | 248 (40.1) | 288 (45.7) |
| Middle category  | 205 (33.1) | 224 (35.6) |
| High category  | 166 (26.8) | 118 (18.7) |

Data are frequency (percent) or mean  $\pm$  SD

<sup>a</sup> Mid upper arm circumference was measured in children  $\geq$  6months old

<sup>b</sup> Socio-economic status data was not completed for one child in the control group

**Table 2:** Effect of multiannual seasonal UCTs on children's anthropometric measurements and their nutritional status

| Outcome   | Control arm<br>(n=620) | Intervention arm<br>(n=630) | p-Value |
|---|------------------------|-----------------------------|---------|
| Children's wasting  |                        |                             |         |
| End point mean weight-for-height z-score, mean $\pm$ SD                               | -0.61 $\pm$ 0.93       | -0.56 $\pm$ 0.95            |         |
| Intervention effect (95% CI) on weight-for-height z-score, z-score/month <sup>a</sup> | Reference              | -0.003 (-0.008 ; 0.0003)    | 0.07    |
| Cumulative episodes of weight-for-height z-score < -2                                 | 542                    | 537                         |         |
| Number of observed child-months   | 14,458                 | 15,394                      |         |
| Number of episodes per child-month (95%CI) <sup>b</sup>                               | 0.045 (0.036 ; 0.057)  | 0.039 (0.031 ; 0.051)       |         |
| Incidence rate ratio (95% CI) <sup>c</sup>  | Reference              | 0.92 (0.64 ; 1.32)          | 0.66    |
| Children's stunting   |                        |                             |         |
| End point mean height-for-age z-score, mean $\pm$ SD                                  | -1.99 $\pm$ 1.04       | -1.96 $\pm$ 1.03            |         |
| Intervention effect (95% CI) on height-for-age z-score, z-score/month <sup>a</sup>    | Reference              | -0.0005 (-0.004 ; 0.003)    | 0.78    |
| Odds ratio of the end point stunting (95% CI) <sup>d</sup>                            | Reference              | 0.73 (0.47 ; 1.14)          | 0.17    |
| Mid upper arm circumference   |                        |                             |         |
| End point mean mid upper arm circumference in mm, mean $\pm$ SD                       | 144.2 $\pm$ 10.3       | 144.3 $\pm$ 11.0            |         |
| Intervention effect (95% CI) on mid upper   | Reference              | -0.02 (-0.08 ; 0.02)        | 0.33    |

|  |  |  |  |
|--|--|--|--|
| arm circumference, mm/month <sup>a</sup> |  |  |  |
|--|--|--|--|

<sup>a</sup> Analyzed using a linear mixed model with cluster, household and children as random effects, adjusted for child's age at baseline, child's sex, socio-economic status at inclusion and the baseline value of the outcome under analysis.

<sup>b</sup> Confidence intervals were estimated from a mixed Poisson model with random effects cluster, household and child.

<sup>c</sup> Analyzed using a mixed Poisson regression model with cluster, household and children as random effects, adjusted for child's age at baseline, child's sex, socio-economic status at inclusion and weight-for-height z-score baseline value.

<sup>d</sup> Analyzed using a mixed logistic model with cluster and household as random effects, adjusted for child's age at baseline, child's sex, socio-economic status at inclusion and baseline value

**Table 3:** Effect of multiannual seasonal UCTs on children's self-reported morbidity

| Outcome   | Control arm<br>(n=620) | Intervention arm<br>(n=630) | p-Value |
|---|------------------------|-----------------------------|---------|
| Number of child-months recalled <sup>a</sup>  | 1261                   | 1266                        |         |
| Diarrhea  |                        |                             |         |
| Number of diarrhea episodes   | 1049                   | 1083                        |         |
| Number of diarrhea episodes per child-month (95% CI) <sup>b</sup>                     | 0.83 (0.80 ; 0.85)     | 0.85 (0.82 ; 0.88)          |         |
| Incidence rate ratio (95% CI) <sup>c</sup>  | Reference              | 1.00 (0.97 ; 1.03)          | 0.89    |
| Fever   |                        |                             |         |
| Number of fever episodes  | 2574                   | 2302                        |         |
| Number of fever episodes per child-month (95% CI) <sup>b</sup>                        | 2.03 (1.99 ; 2.08)     | 1.81 (1.78 ; 1.85)          |         |
| Incidence rate ratio (95% CI) <sup>c</sup>  | Reference              | 0.98 (0.96 ; 1.03)          | 0.31    |
| Respiratory tract infections  |                        |                             |         |
| Number of respiratory tract infections episodes                                       | 1198                   | 1106                        |         |
| Number of respiratory tract infections episodes per child-month (95% CI) <sup>b</sup> | 0.95 (0.92 ; 0.97)     | 0.87 (0.84 ; 0.89)          |         |
| Incidence rate ratio (95% CI) <sup>c</sup>  | Reference              | 0.79 (0.78 ; 0.81)          | 0.000   |

<sup>a</sup> Calculated by number of recalls x recall duration

<sup>b</sup> Confidence intervals are estimated from a mixed Poisson model with cluster, household and child random effects.

<sup>c</sup> Analyzed using a mixed Poisson regression model with cluster, household and child as random effects, adjusted for child's age at baseline, child's sex, socio-economic status at inclusion and morbidity status at baseline.