Evaluation of Community-led Complementary Feeding and Learning Sessions

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ABSTRACT

Background

Undernutrition during the 1,000 most critical days – pregnancy through the first 24 months of life – is a particular risk factor for morbidity and mortality among infants and young children. Inadequate knowledge about complementary foods and feeding practices is often the cause and can be a greater determinant of undernutrition than lack of food. To help address undernutrition between 6 and 23 months of age, Catholic Relief Services (CRS) developed Community-led Complementary Feeding and Learning Sessions (CCFLS), a preventive model building on the Positive Deviance (PD)/Hearth approach. PD/Hearth is a home-based and community-based recuperative nutrition approach for children at risk for protein-energy malnutrition in developing countries. CCFLS aims to enable households to improve their nutrition through high-nutrient, low-cost and available foods. CRS Zambia leads the five-year Mawa project, which aims to improve food and economic security for households in target communities Chipata and Lundazi districts in Zambia's Eastern Province. CCFLS is one component of Mawa's integrated approach and targets children at risk for underweight aged 6 to 23 months with a weight for age (WAZ) Z score below 0 standard deviation (SD) and above -2 SD.

Research Question

What is the mean weight gain of Zambian children aged 6 to 23 months with a WAZ less than 0 SD and greater than -2 SD who participate in CCFLS compared to the 400 gram weight gain expected under the PD/Hearth model?

Methods

We analyzed child weight and length data collected by the CRS Mawa project during CCFLS sessions and six-month follow up visits. All variables were analyzed using descriptive and multivariable analyses using IBM SPSS Statistics Version 19. WHO Child Growth Standards SPSS Syntax File was used to calculate Z scores. All variables were disaggregated by sex and age (6-11 months and 12-23 months).

Results

Out of 144 children in study, 91 were girls (63%), 56 were 6 to 11 months of age (39%) and 88 were 12 to 23 months (61%). By day 12 of CCFLS, the mean weight gain was 250 grams (290 for boys and 230 for girls). Forty-six children (32%) had gained at least 400 grams (the target weight gain), with more boys reaching 400 grams (42%) than girls (26%). The mean weight gain from day 1 of CCFLS to the six-month follow up visit was 1,360 grams, with boys gaining slightly less than girls (1,260 to 1,420 grams respectively). The mean six-month weight gain overall was 1% more than what would be expected per the World Health Organization (WHO) child growth standards (1,350 grams); while the mean weight gain for boys was 7% less than the WHO expected weight gain, the mean weight gain for girls was 5% greater than the WHO expected weight gain. The mean six-month length gain was 4.7 cm, with 4.3 cm for boys and 5 cm for girls. The mean six-month length gain was 27% lower than expected per the WHO child growth standards, with the mean length gain for boys 33% less than WHO standards and the mean six-month length gain for girls 25% less than the WHO standards.

Conclusion

Children participating in CCFLS generally demonstrated robust weight gain over the six-month follow up period, i.e., mean ponderal growth relatively close to or exceeding the expected according to WHO growth standards. Height gain was not as robust. This analysis calls into question whether the target weight gain of 400 grams over the 12-day CCFLS sessions, a target weight gain which was carried over from PD/Hearth, a recuperative program, is the most appropriate for CCFLS as a preventive intervention.

Four hundred grams is much higher than what would be expected for children following a growth trajectory based on WHO growth standards over a 12-day period. Despite study limitations related to the lack of a comparison group, insufficient data quality, the small sample size, and unclear attribution of six-month follow up data due to other Mawa and community interventions, these results indicate that CCFLS is a promising intervention. Enrollment in the program is ongoing; more in-depth analysis of Mawa CCFLS data is required to better understand the impact of the program.

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1. INTRODUCTION

1.1 Childhood Undernutrition

The causes of child undernutrition are numerous and include insufficient food intake, poor feeding practices, maternal undernutrition, and/or repeated infectious diseases (UNICEF 2006). Anthropometric assessments compared against World Health Organization (WHO) Child Growth Standards (2006) represent a common form of assessment for child undernutrition. These include:

- **Stunting** - A child who is below minus two standard deviations (SD) from the median for length for age Z score (LAZ) is considered short for his/her age, or moderately stunted, which is a sign of chronic undernutrition. A child who is below -3 SD is considered severely stunted. Recumbent length is used to assess linear growth in children less than two years of age while standing height is used for children 24 months or older. Length is used to describe linear assessment in this manuscript since the population of interest is under two years of age.
- **Wasting** - A child who is below -2 SD for weight for length Z score (WLZ) is considered too thin for his/her length, or moderately wasted. This is a sign of an acute nutritional deficit. A child who is below -3 SD is considered severely wasted.
- **Underweight** - Using this composite indicator, a child who is below -2 SD from the median for weight for age Z score (WAZ) is considered moderately underweight. A child can be underweight for his/her age due to stunting, wasting or both. A child who is below -3 SD is considered severely underweight.

Undernutrition puts children at substantially higher risk of morbidity and mortality from common childhood infections, such as pneumonia, diarrhea, malaria, HIV and AIDS, and measles. Black et al. (2013) estimate that undernutrition in the aggregate is a cause of 3.1 million child deaths per annum or 45% of child deaths in 2011.

Undernutrition during the 1,000 most critical days – pregnancy through the first two years of life – is a particular risk factor for morbidity and mortality as well as delayed mental and motor development among young children. Poor nutrition during this period is also linked to impaired intellectual performance, low work capacity, poor reproductive outcomes and overall poor health during adolescence and into adulthood. (UNICEF 2013, Crosby et al 2013 and Victora et al. 2008) During this crucial time of life, children have heightened nutritional needs to promote growth and development, yet they are at their most vulnerable – more susceptible to infections and dependent on others for nutrition, care and social interaction. (UNICEF 2013) The physical and mental deficits resulting from undernutrition acquired during the 1,000 days period are difficult to reverse later. (WHO 2008)

Too often, undernutrition remains an undetected problem until it becomes severe, yet even moderate undernutrition increases a child's risk of dying. (UNICEF 2009) Because it is highly prevalent and frequently comes on gradually, families, communities and governments often ignore undernutrition. (CORE Group 2003) Mild and moderate undernutrition are more prevalent than severe undernutrition and therefore much of the mortality burden is associated with mild and moderate undernutrition. (WHO, World Health Report 2002)

Globally, 26% of children under 5 years of age were stunted (LAZ<-2) in 2011 – about 165 million children – with 40% of children under 5 in sub-Saharan Africa affected. (UNICEF 2013) In 2011, an estimated 16% of children under 5 worldwide were underweight or WAZ<-2 (roughly 101 million children), with 21% of children under 5 in sub-Saharan Africa affected (approximately 30 million children). (UNICEF 2013) Moderate and severe wasting affected 52 million children under 5 in 2011, with 9% of children under 5 in sub-Saharan Africa suffering from this form of acute undernutrition. (UNICEF 2013) It is estimated that undernutrition causes 45% of child deaths (around 3.1 million children per annum). (Black et al. 2013)

Complementary feeding is the period when exclusive breastfeeding ends and the introduction of family foods begins, while breastfeeding should continue until the child is at least 24 months of age. There is considerable agreement on the critical importance of appropriate complementary feeding practices for children aged 6 to 24 months in reducing undernutrition and achieving healthy growth and development, with long-term benefits into adolescence and adulthood. (UNICEF 2009, UNICEF 2013, Black et al. 2013, WHO 2013, Stewart et al. 2013, WHO 2008, Lutter et al 2011, Victora et al. 2010, Bhutta et al. 2008, van der Merwe et al. 2007)

However, data show that complementary feeding practices are not ideal, despite improvements in some countries. (Black et al. 2013) According to WHO (2013), inadequate and inappropriate knowledge about foods and feeding practices is often a greater determinant of malnutrition than a lack of food. A number of practices can directly lead to poor growth including untimely (too early or too late), inappropriate and insufficient complementary feeding, poor access to or use of diverse types of food and inadequate micronutrient intake. (Black et al. 2013, UNICEF 2013, van der Merwe et al. 2007, Bhandari et al. 2005) Results of a review by Dewey et al. (2008) stressed the importance of starting appropriate complementary feeding programs during infancy, when the child's ability to respond to a nutritional intervention is the highest. Further, evidence supports the idea that a preventive approach might be more effective than recuperative methods to reduce childhood undernutrition. (Ruel et al. 2008)

Evidence on the effectiveness of community-based behavioral change interventions to improve complementary feeding practices for children 6-23 months of age has shown positive effects, including reductions in stunting and improved linear growth. (WHO 2008, Bhutta et al. 2013, Lamstein et al. 2014, Fabrizio et al. 2014) Appropriate complementary feeding requires accurate information and culture-specific nutrition counselling on the most appropriate use of local foods that can be prepared and fed safely in the home, as well as support from the family, community and the health care system. (WHO 2003) Complementary feeding messages should be grounded in local child rearing knowledge (Paul et al. 2011) and evidence shows that approaches that tackle nutrition and stimulation together lead to greater improvements in child development. (Crosby et al. 2013)

A review of 17 studies in developing countries by Imdad et al. (2011) found that the combination of providing appropriate complementary foods or the resources to buy them with nutrition education is a key intervention that should be scaled up in developing countries.

Dewey et al. (2008) included 42 papers in a review of the efficacy and effectiveness of complementary feeding interventions in developing countries and found that a food-based comprehensive approach to complementary feeding programs may be more effective and sustainable than targeting specific nutrient deficiencies. The authors found that among the many different approaches to complementary feeding interventions – "education/counselling about child feeding, food supplementation, fortification or home fortification of complementary foods, and food processing techniques to increase energy density or enhance nutrient quality of prepared complementary foods" (Dewey et al.) that there is no single best package (also WHO 2008, Stewart et al. 2013). The impact of such interventions depends on the prevalence of undernutrition, the level of household food insecurity, the energy density of local traditional complementary foods and the availability of micronutrient-rich foods. (Dewey et al. 2008)

A study by Ruel et al. (2008) in Haiti found that an age-based preventive model for delivering food assistance and maternal and child health and nutrition interventions proved more effective at reducing childhood undernutrition than a traditional recuperative model. Despite indications of positive results for recuperative and preventive approaches, there remain significant gaps in the evidence base for complementary feeding interventions and many unanswered questions. (Dewey et al. 2008, WHO 2008, Stewart et al. 2013, Fabrizio et al. 2014)

1.2 Community-led Complementary Feeding and Learning Sessions

To help address undernutrition during the crucial 1,000 days period, Catholic Relief Services (CRS) has developed the Community-led Complementary Feeding and Learning Sessions (CCFLS) approach, with the goal of preventing undernutrition among the most vulnerable – children under two. CRS delivers CCFLS to enable households to improve the nutritional value of their diet by encouraging use of high-nutrient, low-cost foods that are commonly available to families in rural communities. CCFLS is a preventive approach against child malnutrition that builds on the Positive Deviance (PD)/Hearth approach,[1] which aims to rehabilitate malnourished children. PD/Hearth identifies families whose children are well nourished despite living in the same conditions as other families and documents their feeding and care practices to incorporate them into a nutrition program knowing they are affordable and culturally acceptable. The approach then uses small group, community-based "Hearth" sessions to deliver nutrition education to mothers. (Bisits Bullen et al. 2011) A systematic review by Bisits Bullen in 2011 assessed PD/Hearth effectiveness across different settings, looking at peer reviewed and grey literature results. The study found mixed results in terms of effectiveness, but did note that sibling studies suggest that the model may have a role in preventing malnutrition, not just in rehabilitation.

In 2006, CRS began implementing a Food for Peace Title II program called Improving Livelihoods through Increasing Food Security (I-LIFE) in Malawi. The main health and nutrition component was to protect and enhance the nutrition status of children under five and pregnant and lactating women through growth monitoring and PD/Hearth. The mid-term evaluation found that the maternal and child health and nutrition achievements were below expectations and recommended improving integration with agricultural interventions, adopting a peer-to peer support intervention targeting mothers, and modifying PD/Hearth to better suit the local context. As a response to these recommendations, CRS created the CCFLS approach by adapting the PD/Hearth model and focusing on prevention of undernutrition, rather than on recuperation.

Since 2006, CRS has implemented CCFLS in seven projects in Malawi, Zambia, South Sudan and Ethiopia. CRS has conducted internal evaluations of CCFLS and identified positive trends. Data has been lacking or weak in these projects, with the exception of the CRS-led, USAID Food for Peace-funded Wellness and Agriculture for Life Advancement (WALA) program (2009-2014) in Malawi, in which CCFLS was a component. A CRS study of WALA data found a mean weight gain of 496 grams from day 1 to day 12 of CCFLS (Ferraz de Campos et al. 2013). This is a notable increase over the PD/Hearth recommended graduation weight gain of 400 grams. The PD/Hearth approach uses weight gain by the end of the 12-day session as one method of determining graduation and children who have gained between 400 and 800 grams and are growing as fast as the 'International Standard Median' are considered to have a successful outcome. (CORE Group Nutrition Working Group 2003) PD/Hearth, as a recuperative model,

[1] See more information on the PD/Hearth approach at: http://www.coregroup.org/our-technical-work/initiatives/diffusion-of-innovations/84.

uses 400 grams as the target weight gain over the 12-day intervention. Given that CCFLS is a modification of PD/Hearth, CRS has been using 400 grams as the recommended minimum weight gain.

The Zambia Demographic and Health Survey 2013-14 data illustrate the nutritional vulnerability of children in the critical period when exclusive breastfeeding ends and complementary feeding begins. The DHS data show that 40% of Zambian children under 5 were stunted, 17% were severely stunted, and the prevalence of stunting increased from 14% for infants under six months to 54% for children aged 18 to 23 months. Six percent of children under five were wasted, 2% were severely wasted, and prevalence of wasting was highest among children aged 9-11 months (10%). Finally, 15% of children were underweight (low weight-for-age), 3% were severely underweight, and underweight was highest in children aged 18 to 23 months (18%). Stunting in Zambia's Eastern Province is slightly higher than the national average, with 43% of children under five are stunted. (Central Statistical Office 2014)

CRS Zambia leads the five year (2012-2017), USAID Feed the Future-funded Mawa project, which aims to improve food and economic security for 21,500 households in target communities of 19 agricultural camps in Chipata and Lundazi districts in Zambia's Eastern Province. CCFLS is one component of Mawa's integrated approach to reduce stunting and improve household nutritional status. Mawa community-based nutrition volunteers register all households with children under two and pregnant and lactating women in target communities. The nutrition volunteers conduct twice monthly visits to registered households and support health promoters to conduct growth monitoring and deliver key health and nutrition messages. Mawa trains health promoters and nutrition volunteers to take anthropometric measurements during growth monitoring sessions (weight, length and MUAC). The project also trains them to check the weight trajectories on growth cards, examine growth trend (upward, downward or stagnated) and to counsel the child's caregiver appropriately. Mawa also aims to conduct periodic refresher training on these topics. In addition, many of the same households participate in Mawa interventions to increase and diversify agricultural production for nutrition and markets, as well as interventions to increase income and productive assets. Mawa was designed so targeted households would benefit from significant overlap of project interventions. Households in the same communities may also participate in Government of Zambia and other NGO interventions.

During systematic household visits, Mawa nutrition volunteers refer children aged 6-23 months to CCFLS who have WAZ scores below 0 SD and above -2 SD or growth faltering children based on weight measurements recorded in their under-five cards during monthly growth monitoring. Per the 2015 CCFLS Guidelines, CRS defines growth faltering as flat or declining growth trajectory as recorded on the growth chart and based on the last three measurements. However, anecdotal evidence suggests that Mawa nutrition volunteers are not confident in analyzing trends to determine growth faltering and instead refer children to CCFLS based on the WAZ recorded when taking monthly growth monitoring weight measurements during household visits. CRS uses WAZ to track and refer children at the community level per Government of Zambia Ministry of Health guidelines.

Table 1: CCFLS referral guidelines for children 6 - 23 months

U5 card growth (WAZ)	Referral
Above 0 SD, increasing trend	No referral needed
Above 0 SD, stagnant or decreasing trend	CCFLS
Between 0 and -2 SD	**CCFLS**
Below -2 SD	Health facility

Health promoters and nutrition volunteers coordinate to implement CCFLS with support from government health workers and community leaders. Health promoters and nutrition volunteers conduct CCFLS sessions for referred children as needed throughout the year. The sessions last for 12 days (as under the PD/Hearth approach), during which participants meet for two to three hours daily with activities including cooking demonstrations and practice; proper food processing, preparation and preservation; health and hygiene messages; and optimal child feeding and care practices.

Finally, the Mawa project has a more rigorous data collection system than previous CRS CCFLS projects, including a CommCare mobile application,[2] which allows for real-time data collection and analysis.

1.3 Research question

The aim of this study was to evaluate the effectiveness of the CCFLS approach under the Mawa project in Eastern Province, Zambia to preventing progression to moderate acute malnutrition and consequent stunting among children under two. The study answered the following research question:

> What is the mean weight gain of Zambian children aged 6 to 23 months with a WAZ less than 0 SD and greater than -2 SD who participate in CCFLS compared to the 400 gram weight gain expected under the PD/Hearth model?

The study also examined additional variables, as outlined below under Results.

2. METHODS

The study analyzed data collected by the CRS Mawa project for CCFLS sessions and six-month follow up visits conducted between August 2014 and June 2015 in Chipata and Lundazi Districts in Eastern Province, Zambia. Mawa health promoters collected data using CommCare's mobile data collection application.[3] CRS hired Dimagi[4] to adapt the CommCare application for the Mawa project and train CRS Mawa staff as well as health promoters to use the CommCare application on Nokia mobile phones. Dimagi also provided ongoing technical support, along with the Mawa Monitoring, Evaluation Accountability and Learning team. Health promoters registered participants, took daily attendance and recorded child weight, length and MUAC measurements on the first, sixth and twelfth days of the CCFLS session. They then recorded weight, length and MUAC measurements one, two, three and six months after the first day of the CCFLS session. The lead study author (JS) was provided with a de-identified data set and the University of Washington Institutional Review Board determined that the proposed thesis activity did not engage UW in human subjects research and UW IRB review was not required.

All key variables were analyzed using descriptive and multivariable analyses using IBM SPSS Statistics Version 19. WHO Child Growth Standards SPSS Syntax File was used to calculate Z scores since the CommCare data collection platform did not include Z score calculations. All variables were disaggregated as follows:

- **Sex:** 1) male and 2) female
- **Age:** 1) 6-11 months and 2) 12-23 months

Summary statistics were presented in tables. Mean weight gain was analyzed using ANOVA.

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[2] See more information on CommCare at: http://www.commcarehq.org/home/.
[3] See more information on CommCare at: http://www.commcarehq.org/home/.
[4] See more information on Dimagi at: http://www.dimagi.com/.

Cases were excluded based on the following criteria:

- Younger than 6 months or 24 months or older on CCFLS day 1 registration.
- Participated in fewer than six days of CCFLS
- Did not have any measurements recorded.
- Missing day 1 weight.
- Missing day 1 length.
- Missing day 12 weight.
- Missing day 12 length.
- Day 1 WAZ of ≤ -2 SD or ≥ 0 SD

In addition, the following outliers were removed from the analysis: 4 full records, 1 day 1 length, 6 day 6 weight, 5 day 12 weight, 1 day 12 length, 4 month 6 weight gain, and 11 month 6 length.

3. RESULTS

The Mawa project referred 359 children (175 boys and 184 girls) to participate in 23 round 1 CCFLS sessions between January and December 2014. Of those:

- 19 were younger than 6 months or 24 months or older on CCFLS day 1 registration.
- 28 children (and their caregivers) participated in fewer than six days of CCFLS
- 8 did not have any measurements recorded.
- 33 were missing day 1 weight.
- 34 were missing day 1 length.
- 74 were missing day 12 weight.
- 75 were missing day 12 length.
- The above eliminated 91 cases, leaving **268** cases.

123 of the remaining 268 cases (45.9%) had a WAZ ≤ -2 SD or ≥ 0 SD as follows:

Table 2: Day 1 WAZ ≤ -2 SD or ≥ 0 SD

	Day 1 WAZ ≤ -2	Day 1 WAZ ≥ 0	Total
Overall	96/268 (35.8%)	27/268 (10.1%)	123 (45.9%)
Males	62/125 (49.6%)	9/125 (7.2%)	71 (26.5%)
Females	34/143 (23.8%)	18/143 (12.6%)	52 (19.4%)
6-11 months	23/100 (23.0%)	20/100 (20.0%)	43 (16.0%)
12-23 months	73/168 (43.5%)	7/168 (4.2%)	80 (29.9%)
Males 6-11 months	16/50 (32.0%)	7/50 (14.0%)	23 (8.6%)
Males 12-23 months	46/75 (61.3%)	2/75 (2.7%)	48 (17.9%)
Females 6-11 months	7/50 (14.0%)	13/50 (26.0%)	20 (7.5%)
Females 12-23 months	27/93 (29.0%)	5/93 (5.4%)	32 (11.9%)

A difference in the rate of exclusion by sex was observed. Of the 96 cases excluded for having a day 1 WAZ less than or equal to -2 SD, the majority (64.6%) were boys.

After eliminating the 123 cases with a WAZ that was too high or too low, the total study population was **144** children (40% of the original 359 cases). While the original 359 cases had an almost even number of boys and girls (175 (49%) and 184 (51%) respectively), the final study population looked quite different with 37% boys and 63% girls. This difference was particularly striking in the 12-23 month age group with 31% boys and 69% girls seen in Table 3 below. The boy-girl difference in the 6-11 month age group was not nearly as pronounced. As seen in Table 2 above, 50% of the boys were eliminated from the study group for having a day 1 WAZ of less than or equal to -2 SD, while only 24% of the girls were eliminated for having a day 1 WAZ of less than or equal to – 2 SD. Children with WAZ of -2 SD or less require referral to recuperative services at local health facilities.

Table 3: Study population age and sex

Age	Male	Female	Total
Overall	53 (36.8%)	91 (63.2%)	144 (100.0%)
6-11 months	26 (46.4%)	30 (53.6%)	56 (38.9%)
12-23 months	27 (30.7%)	61 (69.3%)	88 (61.1%)

As shown in Table 4 below, the mean day 1 weight for boys was slightly higher than that for girls (mean difference = 9.4 kg). This difference was noticeably greater in the 6-11 month group (mean difference = 1.01) than in the 12-23 month (mean difference = 0.69).

Mean weights for males are higher than for females in healthy populations of this age, and these gender differences are accounted for in calculating WAZ scores. The mean day 1 WAZ was slightly higher for boys than for girls although not statistically significant (difference = 0.107, 95% CI = -0.077 – 0.291, p = .288 ANOVA). Using an analysis variance with an interaction term between sex and age group, we found a statistically significant effect of the interaction (p=.011, ANOVA test for interaction), with WAZ for males higher than girls in the 6-11 month group (mean difference = 0.34) and lower than girls in the 12-23 month group (mean difference = 0.13).

The overall mean length was 71.8 cm, with boys just over 1 cm longer than girls (72.6 to 71.4). However, in the 6-11 month age range, the mean length for boys was 3 cm longer than girls (70 to 67).

Table 4: Study population day 1 weight, WAZ, length and LAZ

Variable	No.	Minimum	Maximum	Mean	SD
Day 1 weight (kg)					
Overall	144	6.1	11.0	8.39	0.98
Males	53	6.5	11.0	8.77	0.94
Females	91	6.1	10.0	8.16	0.94
6-11 months	56	6.1	9.0	7.66	0.77
12-23 months	88	7.2	11.0	8.85	0.81
Males 6-11 months	26	6.5	9.0	8.20	0.59
Males 12-23 months	27	8.0	11.0	9.33	0.89
Females 6-11 months	30	6.1	8.5	7.19	0.58
Females 12-23 months	61	7.2	10.0	8.64	0.68
Day 1 weight for age Z score					
Overall	144	-1.99	-.02	-1.03	0.54
Males	53	-1.93	-.02	-0.97	0.56
Females	91	-1.99	-.03	-1.07	0.53
6-11 months	56	-1.95	-.02	-0.92	0.51
12-23 months	88	-1.99	-.04	-1.10	0.55
Males 6-11 months	26	-1.80	-.02	-0.74	0.49
Males 12-23 months	27	-1.93	-.14	-1.19	0.54
Females 6-11 months	30	-1.95	-.03	-1.08	0.49
Females 12-23 months	61	-1.99	-.04	-1.06	0.55

Variable	No.	Minimum	Maximum	Mean	SD
Day 1 length (cm)					
Overall	144	59.0	83.0	71.83	5.09
Males	53	64.0	83.0	72.60	5.23
Females	91	59.0	80.0	71.38	4.99
6-11 months	56	59.0	80.0	68.38	4.71
12-23 months	88	63.3	83.0	74.02	4.01
Males 6-11 months	26	64.0	80.0	69.95	4.87
Males 12-23 months	27	68.9	83.0	75.16	4.26
Females 6-11 months	30	59.0	76.0	67.02	4.19
Females 12-23 months	61	63.3	80.0	73.52	3.82
Day 1 length for age Z score					
Overall	144	-5.05	3.22	-1.55	1.56
Males	53	-5.05	3.22	-1.49	1.71
Females	91	-4.94	3.05	-1.59	1.47
6-11 months	56	-4.28	3.22	-1.07	1.81
12-23 months	88	-5.05	1.36	-1.86	1.29
Males 6-11 months	26	-4.06	3.22	-0.89	1.91
Males 12-23 months	27	-5.05	.39	-2.08	1.25
Females 6-11 months	30	-4.28	3.05	-1.22	1.73
Females 12-23 months	61	-4.94	1.36	-1.77	1.31

The key variable examined by the study was the mean weight gain by day 12 of CCFLS. As shown in Table 5 below, the overall mean weight gain was 250 grams, while boys gained slightly more than girls (290 and 230 grams respectively). Boys in both age ranges gained more than girls in the same age ranges. However, using an analysis variance with an interaction term between sex and age group, we did not find a statistically significant effect of the interaction (p= 0.759). The difference between WAZ in males and females aged 6-11 months is not different than the difference in WAZ between males and females aged 12-23 months.

Table 5: Mean weight gain by day 12 (grams)

Sex/age category	No.	Min.	Max.	Mean	SD
Overall	144	-700	1,200	250	0.31
Males	53	-700	1,100	290	0.36
Females	91	-700	1,200	230	0.27
6-11 months	56	-700	1,200	260	0.36
12-23 months	88	-600	1,100	250	0.27
Males 6-11 months	26	-700	1,000	280	0.38
Males 12-23 months	27	-400	1,100	310	0.35
Females 6-11 months	30	-700	1,200	230	0.34
Females 12-23 months	61	-600	1,000	230	0.23

Another key outcome was the number of children who gained at least 400 grams by day 12 of CCFLS. As shown in Table 6 below, overall 46 children (32%) gained at least 400 grams. More boys than girls gained 400 grams (42% to 26%).

Table 6: Number and percentage of children who gained at least 400 grams by day 12

Sex/age category	No. (%)
Overall	46 (31.9%)
Males	22 (41.5%)
Females	24 (26.4%)
6-11 months	21 (37.5%)
12-23 months	25 (28.4%)
Males 6-11 months	11 (42.3%)
Males 12-23 months	11 (40.7%)
Females 6-11 months	10 (33.3%)
Females 12-23 months	14 (23.0%)

An additional key outcome is the mean weight gain from day 1 of CCFLS to the six-month follow up visit shown in Table 7. Overall, CCFLS participants gained 1,360 grams, with boys gaining somewhat less than girls (1,260 to 1,420 grams). Girls in both age ranges gained slightly more than boys. However, using an analysis variance with an interaction term between sex and age group, we did not find a statistically significant effect of the interaction (p=.887). The difference between WAZ in males and females 6-11 is not different than the difference in WAZ between males and females 12-23 months. It should be noted that of the 144 cases in the study sample, 34 were missing from six-month follow up measurements.

Table 7 also compares the study results against the expected six-month weight gain for children 6-11 months and 12-23 months per WHO child growth standards for boys and girls at 0 WAZ.[5] This was calculated for the 6-11 month age category by taking the average of the expected 6-month weight gain for 0 WAZ for a child starting at 6 months (ending at 12 months) and a child starting at 11 months (ending at 17 months). For the 12-23 month age category, this was calculated by taking the average of the expected 6-month weight gain for 0 WAZ for a child starting at 12 months (ending at 18 months) and a child starting at 23 months (and ending at 29 months).

The mean six-month weight gain overall was 1% more than what would be expected per the WHO child growth standards. There was however a noticeable difference between the sexes: the mean weight gain for boys overall was 7% less than the WHO expected weight gain, whereas the mean six-month weight gain for girls overall was 5% higher than the WHO expected weight gain. In addition, the mean weight gain for children aged 6-11 months overall was 2% lower than the WHO standards, while the mean weight gain for children aged 12-23 months was 8% higher than the WHO standards. The sex differences are particularly striking when comparing boys 6-11 months (9% less than the WHO expected weight gain) with girls 12-23 months (10% higher than WHO expected weight gain).

[5] Calculated using WHO Child Growth Standards: Boys weight-for-age birth to 5 years (z-scores): http://www.who.int/childgrowth/standards/sft_wfa_boys_z_0_5.pdf.and Girls weight-for-age birth to 5 years (z-scores): http://www.who.int/childgrowth/standards/sft_wfa_girls_z_0_5.pdf.

Table 7: Mean weight gain from day 1 to final 6-month follow up visit

Sex/age at enrollment	No.	Missing	Min.	Max.	Mean	SD	WHO[a]	Diff.	% Diff.
Overall	110	34	-1,000	3,600	1,360	870	1,350	-10	1%
Males	39	14	-900	2,500	1,260	760	1,350	90	-7%
Females	71	20	-1,000	3,600	1,420	930	1,350	-70	5%
6-11 months	40	16	-1,000	3,500	1,450	860	1,475	25	-2%
12-23 months	70	18	-900	3,600	1,320	880	1,225	-95	8%
Males 6-11 months	17	9	200	2,400	1,360	670	1,500	140	-9%
Males 12-23 months	22	5	-900	2,500	1,180	830	1,200	20	-2%
Females 6-11 months	23	7	-1,000	3,500	1,510	990	1,450	-60	4%
Females 12-23 months	48	13	-600	3,600	1,380	910	1,250	-130	10%

[a]Expected weight gain based on WHO growth standards

Closely related to the above variable, as shown in Table 8 below, the number of children overall with WAZ < +1 SD and > 0 SD at the 6-month follow up visit was 12%. Consistent with Table 7, there was a difference between the sexes: only 5% of boys had WAZ < +1 SD and > 0 SD by the six-month follow up visit, while 16% of girls did. There was also a difference between age categories, with 10% of children aged 6 to 11 months having WAZ < +1 SD and > 0 SD at the six-month follow up visit, while nearly 13% of children aged 12 to 23 months had WAZ < +1 SD and > 0 SD at the six-month follow up visit.

Table 8: Number and percentage of children with WAZ < +1 SD and > 0 SD at 6-month follow up visit

Sex/starting age	No. (%)	Missing
Overall	13/110 (11.8%)	34
Males	2/39 (5.1%)	14
Females	11/71 (15.5%)	20
6-11 months	4/40 (10.0%)	16
12-23 months	9/70 (12.9%)	18
Males 6-11 months	1/17 (5.9%)	9
Males 12-23 months	1/22 (4.5%)	5
Females 6-11 months	3/23 (13.0%)	7
Females 12-23 months	8/48 (16.7%)	13

As seen in Table 9 below, the mean length gain from day 1 to the final six-month follow up visit was 4.7 cm, with boys and girls experiencing a comparable length gain overall (4.3 cm for boys as compared to 5 cm for girls).

Table 9 also compares the study results against the expected six-month length gain for children 6-11 months and 12-23 months per WHO child growth standards for boys and girls at 0 LAZ[6]. This was calculated for the 6-11 month age category by taking the average of the expected 6-month length gain for 0 WAZ for a child starting at 6 months (ending at 12 months) and a child starting at 11 months (ending at 17 months). For the 12-23 month age category, this was calculated by taking the average of the expected 6-month length gain for 0 WAZ for a child starting at 12 months (ending at 18 months) and a child starting at 23 months (and ending at 29 months).

[6] Calculated using WHO Child Growth Standards: Boys length/height-for-age birth to 5 years (z-scores) http://www.who.int/childgrowth/standards/chts_lhfa_boys_z/en/ and Girls length/height-for-age birth to 5 years (z-scores): http://www.who.int/childgrowth/standards/chts_lhfa_girls_z/en/

The mean six-month length gain overall was 27% lower than what would be expected per the WHO child growth standards. There was also a difference between the sexes: the mean length gain for boys overall was 33% less than the WHO expected length gain, whereas the mean six-month length gain for girls overall was 25% less than the WHO expected length gain. In addition, the mean length gain was less for younger children: boys aged 6-11 months gained 39% less than the WHO expected child growth and mean length gain for girls 6-11 months was 27% less than WHO expected gain, whereas mean length gain for boys aged 12-23 months was 22% less than WHO expected gain and the mean length for girls aged 12-23 months was 18% less than WHO expected length gain.

Table 9: Mean length gain from day 1 to final 6-month follow up visit (cm)

Sex/age at enrollment	No.	Missing	Min.	Max.	Mean	SD	WHO[a]	Diff.	% Diff.
Overall	101	43	.00	14.00	4.73	3.14	6.5	1.77	27%
Males	35	18	.40	9.00	4.32	2.37	6.4	2.08	33%
Females	66	25	.00	14.00	4.95	3.48	6.6	1.65	25%
6-11 months	38	18	.40	12.50	5.19	3.50	7.6	2.41	32%
12-23 months	63	25	.00	14.00	4.46	2.90	5.5	1.04	19%
Males 6-11 months	16	10	.40	9.00	4.56	2.84	7.5	2.94	39%
Males 12-23 months	19	8	1.00	7.50	4.12	1.96	5.3	1.18	22%
Females 6-11 months	22	8	.50	12.50	5.65	3.91	7.7	2.05	27%
Females 12-23 months	44	17	.00	14.00	4.60	3.23	5.6	1	18%

[a]Expected length gain based on WHO growth standards.

4. DISCUSSION

Was CCFLS effective?

The results of this study show an improvement in the nutritional status of children aged 6-23 months participating in CCFLS when looking at the research question:

> What is the mean weight gain of Zambian children aged 6 to 23 months with a WAZ less than 0 SD and greater than -2 SD who participate in CCFLS compared to the 400 gram weight gain expected under the PD/Hearth model?

By day 12 of CCFLS, boys gained 290 grams, as compared to 230 grams for girls. Gaining 400 grams by day 12 was identified by CRS as a marker of success and the earlier CRS study on CCFLS in Malawi showed a mean weight gain of 490 gram over 12 days. (Ferraz de Campos et al. 2013) The Mawa data showed that overall 46 children (32%) gained at least 400 grams, with more boys than girls passing that threshold (42% as compared to 26%). However, WHO growth standards show that for a 12 month old child at 0 WAZ, for example, a weight gain of approximately 120 grams is expected over 12 days, much less than the 400 grams initially utilized in CCFLS as a gauge of success. The 400 gram target was carried over from the PD/Hearth recuperative approach. This study calls into question the 400 gram target for CCFLS which is a preventive intervention.

At the six-month follow up visit, boys had gained, on average 1,260 grams, which is slightly less than girls 1,420 grams. Interestingly, boys gained more weight than girls over the 12-day CCFLS sessions, but did not appear to sustain it relative to girls. In addition, at the 6-month follow up visit only 5% of boys had optimal WAZ, while 16% of girls did. The CRS CCFLS study in Malawi did not look at six-month follow up data, so it is not possible to compare the two studies.

When compared to the expected weight gain per the WHO child growth standards, CCFLS showed promising results. The overall mean six-month CCFLS follow up weight gain was 1% more than the expected weight gain per the WHO child growth standards. There was a striking difference between the sexes: with boys at 7% less than the WHO expected weight gain and girls 5% higher than the WHO expected weight gain. Even more remarkable was that girls aged 12-23 months actually measured 10% higher than WHO expected weight gain, which is a real achievement.

With respect to length, the results were not as encouraging. The mean length gain for boys was 33% less than the WHO standards and 25% less for girls. The children in the study population had a lower mean LAZ (-1.55, with a minimum of -5.05) than WAZ (-1.03, with a minimum of -1.99), indicating that many of the children were already stunted. While CCFLS did appear to help children gain sufficient weight as per WHO standards, six months is not be enough time to recover from stunting.

Despite these results, it is difficult to draw strong conclusions as to the effectiveness of CCFLS in the Mawa project context due to the small sample size (144 for data through day 12 and 110 for data through the six-month follow up visit) and other limitations outlined below.

Targeting

The large number of children participating in CCFLS who on day 1 were not within the target WAZ range of > -2 SD and < 0 SD indicates serious challenges with targeting. During the data cleaning process, after 91 cases had already been eliminated due to other criteria, 96 (36%) of the 268 remaining cases had a WAZ ≤ -2 and should have been referred to a health facility. In discussions with Mawa project staff, it seems that health promoters and nutrition volunteers refer children to CCFLS based on visual interpretation of WAZ on the growth chart on their under-five card during home visits, but they do not actually calculate children's WAZ on day 1 of the CCFLS session – they simply keep everyone already referred to CCFLS. This is a critical issue because CCFLS is a preventive approach and the recipes are not designed to have a high enough caloric content to recuperate malnourished children. Possible explanations for health promoters and nutrition volunteers not referring children who are clearly underweight (whether they have calculated the WAZ or not) to a health facility include: 1) they may think the local health facility does not have the capacity to help undernourished children or the necessary ready to use therapeutic foods (RUTF) and CCFLS is better than nothing; 2) lack of understanding of the danger if the child is not properly treated for undernutrition; and 3) the distance to the health facility and the cost of the trip are disincentives if the caregiver thinks the health facility does not have the RUTF anyway. It is critical to understand more about the targeting issue and make the necessary course corrections to ensure children receive the appropriate interventions.

Gender

While boys and girls participated in CCFLS in nearly equal numbers (174 and 185 respectively), 121 boys (70%) were eliminated from the analysis, along with 94 (51%) of girls. Particularly striking is that 50% of the boys were eliminated for having a day 1 WAZ of ≤ -2 SD, while only 24% of the girls were eliminated for the same reason. This is not surprising given the context: the 2013-2014 Zambia DHS findings show that among children under five, 16% of boys and 13.5% of girls were underweight. The final study population of 144 children was therefore composed of a lot more girls than boys with only 53 boys (37%) as compared to 91 girls (63%). The gender difference was even more pronounced in the 12-23 month age group, of which only 31% were boys as compared to 69% girls. It is not clear what these differences can be attributed to, but such a discrepancy reinforces the notion that it is difficult to draw conclusions from this data as to the effectiveness of CCFLS in the Mawa project context.

Limitations
This study had several limitations, including the following:

1. **Lack of comparison group:** Since the study used existing Mawa project data and the project was not designed to evaluate effectiveness against a control group comparison data are not available. The baseline was the children's day 1 measurements compared against their measurements on day 12 and month 6, as well as interim measurements (day 6, month 1, month 2 and month 3 that were not part of this study).
2. **Insufficient data quality and a small sample size:** While Mawa data quality was better than the data encountered in the CCFLS study under the WALA project in Malawi, the Mawa data quality has not yet lived up to expectations, despite use of the CommCare real-time data collection platform. In terms of accuracy of anthropometric measurements and data entry and usage, Mawa has experienced a number of challenges beyond the digital platform. CCFLS was a new approach for the project's health promoters and nutrition volunteers, who did not have previous experience taking anthropometric measurements. Although health promoters and nutrition volunteers were trained in taking weight, length and MUAC measurements, quality control was inadequate. It was particularly challenging for health promoters and nutrition volunteers to obtain accurate recumbent length measurements using a length board, as evidenced by large discrepancies in measurements, including children measured as having decreased length, according to the data entered, and were then not included in this analysis. In addition, these community-based Mawa staff were new to collecting data using mobile phones, which coupled with inadequate supervision may account for the low level of usable records (144 of the 359 or 40%).
3. **Unclear attribution of six-month follow up results:** Attributing weight and length gain by the end of the six-month follow up period to CCFLS is problematic. CCFLS does not take place in a controlled environment and the Mawa project was intentionally designed to have mutually reinforcing nutrition and agriculture components, in addition to Government of Zambia and other NGO interventions that may have taken place in target communities during the same period.

5. CONCLUSION AND RECOMMENDATIONS

CRS has been implementing CCFLS in Southern Africa since 2006 and has conducted internal analyses of the intervention. After an evaluation in 2013 of project data in Malawi showed a mean 12-day weight gain of 496 grams, CRS wanted to take advantage of the higher quality data envisioned under the Mawa project's CommCare real-time data platform to confirm the positive findings. While the Mawa CCFLS data quality is not yet as high as hoped, it is improving all the time as health promoters and nutrition volunteers become more adept at taking anthropometric measurements and entering them into the digital CommCare data platform. In addition, as Mawa management increasingly use CCFLS data for decision-making and course corrections, it is envisioned that nutritional outcomes for children participating in CCFLS will continue to improve.

As mentioned previously, it is difficult to draw definitive conclusions about the effectiveness of CCFLS based results found under this study, given the limitations outlined above. However, as Mawa is ongoing, the findings of this study can help the project adapt its approach to ensure high-quality CCFLS implementation and improve targeting and data collection.

Several recommendations emerge for the Mawa project and other CRS projects in Southern Africa implementing CCFLS:

1. **Examine 12-day weight gain target:** Examination of WHO growth standards indicates that 400 grams is much higher than the weight gain that would be expected over a 12-day period for a preventive approach among children expected to gain maintenance weight only, i.e., not requiring catch-up growth. Given that CCFLS is a preventive intervention targeting children without wasting, it is recommended that CRS work with a nutrition expert to confirm or revise the 400-gram 12-day weight gain target.
2. **Ensure appropriate targeting:** Train health promoters and nutrition volunteers to use the day 1 WAZ to keep children in CCFLS (if they have a WAZ > -2 SD and < 0 SD) and refer those with a WAZ ≤ -2 SD to the local health facility. Mawa should consider adding Z score calculations to the CommCare data platform so health promoters and nutrition volunteers do not have to estimate Z scores visually using WHO child growth standard charts, which are hard to read accurately. Until the CommCare data platform is set up to calculate Z scores, Mawa could consider using the WHO simplified WAZ tables for boys and girls[7] to facilitate targeting. The Mawa project staff should also talk to health promoters to learn why they are not referring underweight children to health facilities, as well as ensure there are health facilities in target communities that can accommodate underweight children referred from CCFLS.
3. **Ensure correct anthropometric measurements and data entry:** Provide training, refresher training and supportive supervision on taking accurate anthropometric measurements and entering data into the phones. Conduct regular data quality control checks.
4. **Take advantage of real-time data to improve quality:** Regular checks would catch missing data, inconsistencies and incorrect data. To ensure quality, Mawa could verify data twice a month during CCFLS sessions and monthly during follow up visits to catch any gaps, inconsistencies or inaccuracies in capturing anthropometric measurements.

The study author will discuss the findings of this CCFLS effectiveness study with the Mawa project team and will analyze project data that has entered the system since the data analyzed under this study. It is expected that data quality will have improved considerably, along with nutritional outcomes, as health promoters and nutrition volunteers have become more comfortable with and skilled in taking anthropometric measurements and using phones to enter data into a digital platform.

[7] http://www.who.int/childgrowth/standards/sft_wfa_girls_z_0_5.pdf and http://www.who.int/childgrowth/standards/sft_wfa_boys_z_0_5.pdf.

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