The use of an algorithm and tailored counselling improves the frequency of growth monitoring and promotion sessions and proportion of mothers receiving counselling in a rural district

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ABSTRACT

The lack of counselling tools and aids and the poor health personnel knowledge of infant and young child feeding practices in Ghanaian growth monitoring and promotion (GMP) services impede efforts to address mild (-2 ≤ weight-for-length z score (WLZ) < -1) to moderate (-3 ≤ WLZ < -2) wasting. A cluster-randomized intervention was used to compare three treatments targeted at children less than 24 months: (i) control group, use of the standard-of-care (SOC) weight measurements, weight-for-age z-score (WAZ) chart, and the Ghana Health Service counselling cards; (ii) algorithm group, use of a newly-developed algorithm and SOC; and (iii) length group, measurement of length, use of WLZ chart, and SOC. Thirty clusters of rural community-based GMP clinics were randomly assigned to the three treatment groups (n = 10 per group). Using cross-sectional surveys at baseline (n = 661) and one year later (n = 666), we tested differences in prevalence of low WLZ (WLZ < -1) in children from 0 to 24 months. Analyses were by intention-to-treat, adjusting for clustering effect. There was no significant effect of the intervention on low WLZ (p = 0.66). However, the quality of GMP implementation differed among the treatments. The algorithm and length groups had a significantly higher (mean difference: 2.7 [95% CI: 0.01 - 5.40] and 2.93 [95% CI: 0.55 – 5.31], respectively) number of GMP sessions held compared to the control. Compared to the length group, the algorithm and control groups had higher (mean difference: 0.24 [95% CI: 0.17 – 0.31] and 0.23 [95% CI: 0.15 – 0.31], respectively) proportions of mothers receiving individual counselling at sessions. Having a simple focused tool may improve the frequency of GMP sessions and quality of nutrition counselling provided. There is a need for an evaluation of rural GMP programs to identify bottlenecks and how these can be addressed for higher program impact.

Key words: growth monitoring and promotion, wasting, nutrition counselling, community nurse, health volunteer

Introduction

In Ghana, undernutrition remains a significant public health problem. Nationally, the prevalence of wasting (weight-for-length [WLZ] < -2) in children less than 5 years was 9% in 2008 (GSS, 2008). However, the prevalence was as high as 29% in infants aged 6-8 months (GSS, 2008). Wasting, even when mild (-2 ≤ WLZ < -1) or moderate (-3 ≤ WLZ < -2) in severity, is associated with retarded linear growth, a high risk of infectious diseases, developmental delays, and mortality in childhood, and an increased risk of chronic diseases later in adulthood (Martorell Reynaldo, 2012; Walker, Grantham-McGregor, Himes, & Powell, 1996).

In rural areas where availability and access to health facilities is limited or non-existent, community-based health programs have proved successful in bringing primary health care to the people (UNICEF, 1990; Nyonator et. al., 2005). The World Health Organization (WHO)/ United Nations Children's Fund (UNICEF)'s

Integrated Management of Childhood Illnesses (IMCI) algorithm has been implemented in many parts of SSA for the step-by-step diagnoses and management of common childhood illnesses. For example, for management of malnutrition, the focus is on identifying visible signs of severe acute malnutrition ((SAM); muscle wasting in the gluteal region, prominence of bony structure particularly over the thorax, and loss of subcutaneous fat) (WHO, 2012) and measuring WAZ. Tailored nutritional counselling is prescribed for low- and very low-WAZ; referral to a health facility is recommended for SAM (WHO/UNICEF, 2013).

Through the Ghana Health Service's (GHS) outreach program, growth monitoring and promotion (GMP) reaches remote rural areas that would otherwise have no access to nutrition services and primary health care. However, poor health personnel knowledge of infant and young child feeding practices in GMP services impede efforts to address mild to moderate wasting. Monitoring growth is worthless if it does not lead to appropriate responses. To provide nutrition promotion advice, health personnel need to improve their own nutrition knowledge and individual counselling skills.

It is evident that nutrition educational interventions that use key messages based on formative research, taught with engaging, participatory styles, and delivered through a primary healthcare system can improve energy and nutrient intakes and growth in food secure populations (N. Bhandari *et al.*, 2004; Dewey & Adu-Afarwuah, 2008; Penny *et al.*, 2005). Considering the high burden of malnutrition in Ghana, there remains a need to improve capacity of health workers to provide sound nutrition counselling and introduce tools for monitoring mild and moderate wasting before it becomes severe. This paper presents the results of a capacity-building intervention which compared the effect on wasting prevalence of the mandated SOC GMP activities and alternative tools to improve early detection and mitigation of growth faltering.

Methods

Study design and participants

The cluster-randomized trial took place within the context of GHS's monthly community-based GMP clinics in Upper Manya Krobo district, a predominantly rural district located in the Eastern region of Ghana. A cluster was defined by the catchment area of the GMP community-based clinics. This was defined by the community boundaries in most cases; however, some catchment areas were made up of two to three small contiguous villages. The UMKD is a new district (commissioned in 2008) and information on population size at the community level was not available (District Health Directorate., 2011). Communities with monthly outreach GMP service were identified. Outreach GMP clinics were selected based on having an active GMP service (held a session for the past two consecutive months) and being accessible by road. The district was stratified by its six sub-districts and the number of clusters included for each sub-district was weighted by its population size. Within each sub-district, clusters were selected by simple random sampling. An equal number (N = 23) of households were selected from each cluster by the random walk method (Magnani, 1997). In each household, the youngest child between the ages of 0-24 months was selected. A total sample of 690 children were surveyed. This sample size provided the ability to detect group differences at the final survey of 9 percentage points or larger (18%[1] before intervention and a reduction to 9%[2]) (Atuobi-Yeboah, 2010; GSS, 2008; Hulley, 2007).

Procedures

The intervention was implemented from June, 2013 through June, 2014 in the 30 selected GMP clinics. The clinics were equally (n = 10) randomized into control (mandated SOC) and two intervention (algorithm and length measurement) groups:

[1] From a cross-sectional study conducted in UMKD to understand determinants of undernutrition in young children [Atuobi-Yeboah, 2010].

[2] From a national wasting prevalence in children less than five years old [GSS, 2019].

Control: Participants received the mandated SOC activities: weighing of a child, plotting of weight on the World Health Organization (WHO) WAZ chart, interpreting the child's growth curve, and providing individual counselling using the GHS counselling cards. Nurses identified children with inadequate growth by a descent or flattening of a growth curve based on three consecutive weights. The GHS counselling cards were based on the WHO's IYCF guidelines (PAHO/WHO, 2003), and made up of picture cards and guiding open-ended questions for specific age-groups (0-6; 6-9; 9-12; 12-24 months). For each age group, counselling guides and messages were separated for children who had gained adequate weight and those who had faltered growth.

Individual counselling had to be provided for mothers of all children less than 24 months using the GHS cards whether their growth was adequate or not.

Algorithm: SOC activities were carried out and enriched with counselling from the algorithm tool. Based on the literature and the *a priori* conceptual framework (UNICEF Conceptual Framework for Determinants of Malnutrition) (Engle et. al., 2010), a secondary analysis of data from the Research to Improve Infant Nutrition and Growth (RIING) project, Eastern Ghana was conducted to identify predictors of wasting in infants (Okronipa et. al, 2012; Chehayber et. al., 2011). These predictors were used in developing a simple one-paged algorithm that community nurses could use to identify relevant factors that contribute to a child's wasting status or risk and provide tailored counselling for these factors.

The one-page algorithm was made up of a total of six questions covering WAZ status, exclusive breastfeeding for children under 6 months and consumption of animal source food (ASF) for older children, child sleeping under a bednet, and having an episode of diarrhea or fever or cough in the previous month. The first question (WAZ status) was a filter and identified those children with WAZ < 0. Only caregivers of these children were then asked the other five questions. Responses (Yes or No) given by caregivers were recorded on the algorithm and corresponding counselling messages from algorithm were provided. The development of this algorithm is discussed in detail elsewhere (Laar, 2015).

Length: SOC activities were carried out and child length was also measured. The measurements were charted on both the SOC WAZ and the WHO's WLZ charts, and growth curves were interpreted. WAZ was used as in non-participating clinics to document underweight in children. A cut-off of WLZ ≥ - 1 versus WLZ < -1 were used to separate children with adequate and inadequate growth, respectively, to guide counselling with GHS cards.

We trained all nurses to deliver all three treatments because the existing health delivery system restricted nurses working in outreach communities to their assigned subdistrict but allowed them to visit any GMP outreach community clinic in their subdistrict. All children, regardless of intervention group, received the usual preventive treatments provided at GMP clinics appropriate for their age. Non-participating GMP clinics continued using SOC GMP activities.

Program data were collected using direct observations. The number of monthly GMP clinic sessions held out of the total scheduled and the proportion of mothers receiving individual counselling at GMP sessions were documented. Field workers were trained to collect weights and lengths of young children using standard procedures (Cogill, 2001). Children were weighed in duplicate to the nearest 0.1 kg (Tanita Corporation of America Inc.; Arlington Heights, IL, USA) and recumbent length was measured in duplicate to the nearest 0.1 cm (Shorr Production; Maryland, USA).

Two cross-sectional surveys were conducted to obtain information at baseline (August - October, 2012), six months before the introduction of the intervention tools and at endline (July - August, 2014), a year after implementation of the intervention (Fig. 1). Both baseline and endline surveys used a household questionnaire that gathered information from the caregiver (usually the mother) on the youngest child in each household. Children's anthropometric (weight and length) and dietary data (food frequency questionnaire), caregivers' young child feeding and child care practices, and household characteristics, demographics, and food security were collected.

Ethics approval

Ethical clearance on all procedures involving human subjects was obtained from McGill University Ethical Review Board, Noguchi Memorial Institute of Medical Research Internal Review Board, University of Ghana and the Ghana Health Service Ethical Review Board. Mothers signed or provided a thumb-print to show consent for participation.

Statistical analyses

All analyses were conducted with the intention-to-treat approach. The primary outcome of interest was prevalence of wasting at the cluster level collected at endline. As a secondary outcome, we focused on wasting status (wasted vs. not wasted) at the individual (child) level at endline.

Bivariate analyses compared children among groups. At baseline, maternal characteristics (age, parity, education, occupation, and marital status), household characteristics (housing materials and assets) and basic amenities (source of water, electricity, and toilet facilities) were assessed. A proxy indicator of socioeconomic status (SES) used previously in our study population was created from housing materials (walls, roof), source of drinking water, electricity, and type of toilet facility (Cofie, 2012). Anthropometric data were converted into WLZ scores using WHO Anthro software 2006. WLZ scores were categorised into the variables wasted (WLZ < -2) vs. not wasted (WLZ ≥ -2), and low WLZ (WLZ < -1) vs. not low WLZ (WLZ ≥ -1).

Group comparisons for the primary outcome were made using a linear mixed-effects model adjusting for baseline prevalence and clustering (SAS software; PROC MIXED). A random effect logistic regression model was used for individual-level binary outcome (low vs. not low WLZ) adjusting for cluster, maternal education, episode of illness (fever, cough, diarrhoea) in the last month, consumption of ASF the previous day, feeding frequency of a child, household food security, and SES (SAS software; PROC GLIMMIX). We controlled for sex and age because both factors represent biological (vulnerability to illnesses) and social (perception of nutrition needs) factors that predict wasting in a child (Frongillo Jr & Begin, 1993). Statistical significance was set at 5% for all tests.

Results

Program evaluation

Nine out of thirty communities in the study held all 12 sessions; eleven communities held 11 out of 12 sessions and 10 communities held 8 or fewer sessions (Fig. 2). Differences in the number of monthly GMP sessions held by study group and the provision of individual counselling at a session are presented in Table 3. Both the algorithm and length groups had a significantly higher number of sessions held compared to the control communities. Unprompted reasons for missed sessions included disabled transportation, scheduling conflicts, understaffing, bad weather, poor road conditions, and limited access to vaccines needed for immunizations at GMP clinics. There was no significant association between the number of sessions held in a year and the prevalence of low WLZ in a cluster at endline ($p = 0.39$). Compared to the length group, the algorithm and control groups had significantly higher proportions of mothers receiving individual counselling at GMP sessions. Reported reasons for not providing individual counselling at GMP included nurses' complaints of exhaustion from multiple tasks, time constraints due to the late arrival of community nurses, health volunteers and/or mothers to GMP sessions, mothers' complaints that GMP was taking too long, and sibling (minor) or an adult other than caregiver bringing the child to GMP. The correct intervention tools were used consistently by nurses and health volunteers to collect anthropometric measurements in all three study groups. However, algorithm questions were observed being asked (from memory) in 13% of all control sessions and 9% of all length sessions held.

Intervention effect

The algorithm, length, and SOC groups had complete anthropometric data for 222, 219, and 220 children at baseline and 231, 213 and 222 at endline, respectively.

At baseline, 3.9% (3.2% in both the algorithm and length groups, 4.5% in control) of children were wasted. Study groups were different for some characteristics (Tables 1 and 2). Mothers who never attended school, household access to basic amenities (source of water, use of sanitation facilities and electricity) were significantly different among study groups ($p < 0.05$). At the end of the one year intervention, the prevalence of stunting and underweight for the algorithm, length and SOC groups were 17.5%, 18.5%, and 13.3%, and 10.1%, 9.9%, 7.6%, respectively. The overall prevalence of wasting in our sample was 3.9% (95% CI: 2.5% to 5.3%). Prevalence of wasting by treatment group was 3.4% in the algorithm group, 3.2% in the length group, and 4.9% in control. The prevalence of wasting in our population was lower than expected (previous reports ranged from 18%[3]- 29%[4]) and could not be successfully used for our analysis. Thus, WLZ < -1, hereafter referred to as 'low WLZ', was used. The prevalence of low WLZ in our study population was 22% at endline. Prevalence of low WLZ at the cluster level ranged from 4.5% to 39.1% at baseline, and 5.0% to 43.5% at the end of the intervention. No significant effect of intervention ($p = 0.66$) on low WLZ prevalence was found (adjusting for baseline prevalence and cluster; Table 4).

At the individual level, mean (SD) WLZ for the algorithm, length, and SOC groups were -0.17 (1.14), -0.11 (1.09), and -0.23 (1.15) at baseline, and -0.12 (1.31), -0.08 (1.22), and -0.04 (1.36) at endline, respectively. The intervention had no effect on low WLZ at the individual level ($p = 0.71$; Table 5). A statistically significant effect of child's age ($p < 0.001$) was found on risk of low WLZ at the child-level analysis with younger (0-11 months) children having lower WLZ scores compared to their older (12-24 months) peers. The interaction age*intervention was not significant ($p = 0.17$). Age tended to modify or modified the association of cough (interaction, $p=0.07$) and animal source food consumption (interaction, $p<0.05$) on WLZ status, respectively. Similar trends were observed when the continuous WLZ was used as the outcome (Figs. 3 and 4). Children older than six months were more likely to have low WLZ with an episode of illness (cough) compared to younger children (Fig. 3). In children with no consumption of animal source foods, lower WLZ was associated with increasing age. However, in children consuming animal source foods, this negative effect was not observed (Fig. 4). Feeding frequency (number of times a child was fed in a day) had a statistically significant association ($p = 0.05$) with low WLZ status, with an odds ratio (per feed) of 0.83 (95% CI: 0.68 – 0.94).

[3] based on cross sectional study. Prevalence of wasting in selected communities in the Upper Manya Krobo District was 18% in children 6- 24 months (2010) [Atuobi-Yeboah, 2010]

[4] based on the Ghanaian Demographic Health Survey. Prevalence of wasting in Ghanaian children 6-8 months old was 29% (2008) [GSS, 2018]

Discussion

In this study, we compared the effect of using the mandated SOC GMP practices to the use of an algorithm for identifying and providing tailored counselling to caregivers of children with low WLZ, or measuring length and assessing WLZ status and providing individual counselling to caregivers of children under 24 months. We found no significant effect of our intervention on low WLZ prevalence in our study population. The effectiveness of nutrition education depends heavily on the performance and motivation of counselors, their perception of the program's impact, and the managerial practices employed by their supervisors (Dickin, Dollahite, & Habicht, 2005). In a statewide nutrition program in the United States, a survey of community nutrition educators (paraprofessionals) was conducted to examine how work context, program management, and program and educators characteristics affected program effectiveness (Dickin *et al.*, 2005). Compared to program participants with educators who had low ratings for the value of the program and the managerial practices of supervisors, greater behavior change was observed in participants whose educators recorded high ratings ($p < 0.02$) (Dickin *et al.*, 2005). Also, sites that used individual counselling reported higher behavior change scores than sites that employed other counselling methods ($p < 0.001$). In our study, reasons for not providing individual counselling at GMP included overburdened GMP staff and mothers low motivation. The lower proportion of mothers receiving individual counselling in the length communities could be attributed to delays as a result of the longer time commitments in taking length measurements (inexperienced nurses and health volunteers) and mother's lack of interest as a result of discomfort (due to struggling, inconsolable children) during measurements. These factors could have contributed to the lack of effect in our intervention.

Intervention studies in mild to moderately undernourished children suggested that counselling caregivers about family foods could achieve good rates of weight gain and improved linear growth (Ashworth & Ferguson, 2009; Penny *et al.*, 2005). In Peru, Penny and colleagues conducted a cluster randomized intervention delivered through the governmental health services system to emphasize three key messages (food consistency, ASF, responsive feeding) (Penny *et al.*, 2005). After the intervention, the rate of stunting in the intervention group was one-third of that in the control group. Both our study and the Peru study were cluster randomized interventions, conducted through existing health services system and provided nutrition messages developed from formative research (Peru) or preliminary research on predictors of low WLZ (algorithm). However, many differences exist between the two studies that could explain the difference in effect of the studies. Firstly, Penny *et al.* enrolled and followed newborns until 18 months collecting relevant data every 3 months (Penny *et al.*, 2005). In our study, we focused on the effect of the intervention at the community level and conducted cross-sectional surveys at baseline and endline after one year of the intervention. Secondly, children in the Peru study were exposed to the nutrition education intervention for 18 months while our intervention was implemented for 12 months. Thirdly, the design of our data collection tools and activities did not allow us to measure reliably how often our household-surveyed children at endline had used GMP services in the past year. In Peru, the use of health services and exposure to nutrition messages were collected at nine (birth, 3, 4, 6, 8, 9, 12, 15, 18 months) time points during the intervention period. Fourthly, food availability and affordability of cheap ASF (chicken liver, egg, and fish) in the Peruvian peri-urban population contributed to the effectiveness of the nutrition education intervention. The UMKD is a predominantly rural under-resourced district, with most inhabitants engaging in small-scale farming, producing much of what their families eat. The inhabitants of villages on the border of the Volta lake also engaged in fishing. Starchy roots, palm oil, and vegetables (including green-leafy ones) were widely available and accessible in this population at baseline (89% were food secure) (Cofie, 2012). However, the consumption of animal foods, mainly fish, at baseline and endline was 3% and 26%, respectively. Poor access to nutrient-rich ASF could be an important limiting factor for nutrition education effectiveness in our study. Finally, the Peru intervention incorporated an accreditation scheme that assessed implementation and provided public recognition to accredited health facilities as a mechanism of institutional change. The commitment of facilities motivated individual involvement in implementing the intervention (Penny *et al.*, 2005). Our study lacked such a motivational mechanism to get the district health directorate, the management body of GMP health personnel, fully involved.

There were some inevitable weaknesses in the study design. The study could not be blinded and that could have led to bias and treatment contamination. Also, community nurses and health volunteers were trained to provide all three treatments and instructed on the importance of maintaining the randomized treatment assignment. Nonetheless, knowledge of the communities' treatment groups could have influenced nurses' enthusiasm in providing effective individual counselling. Tools for algorithm and length clusters were kept in the community by resident health volunteers who assisted nurses in GMP sessions and study fieldworkers were present at every GMP session to make sure the right tool was used for each community. We envisaged that the most likely form of contamination would be the use of algorithm counselling questions in the other treatment groups. At each GMP session, field workers documented if a nurse asked an algorithm question during individual counselling in the length or control communities. The observed contamination of nutrition messages (use of algorithm group messages in length and SOC groups) was less than 13%.

The prevalence of wasting (WLZ < -2) in our population was about five times lower than what we had expected. Thus, we were unable to use wasting as an outcome for our analysis. Limitations in sample selection for the expected prevalence are discussed in detail elsewhere (unpublished work, Laar *et al.*, 2015). A more recent DHS (2013) report indicated vast changes in the indicators of undernutrition. Overall, the national wasting prevalence reduced from 9% in 2008 to 5% in 2013 (Ghana Statistical Service (GSS), 2013). The prevalence of wasting in children 6-8 months old was 10.2%, less than half the prevalence in 2008 (Ghana Statistical Service (GSS), 2013). Although the rates of wasting are reducing nationally, considerable differences in wasting indicators still exist among different age groups, regions, and districts of the country (Ghana Statistical Service (GSS), 2013; GSS, 2008). We would have needed a sample size of 2621 per group to detect group differences of 1.4 percentage points or larger (initial wasting prevalence of 3.9% and a reduction to 2.5% expected in a healthy population) with a power of 80%, a sample size larger than the infant population in the district. The lower wasting prevalence observed in the UMKD may be attributed to the implementation of health programs (including higher coverage of community clinics, water, sanitation and hygiene, and child nutrition) by the GHS health directorate and non-governmental organizations since the district was commissioned in 2008. Our intervention targeted a group of children who, on average, had fairly good WLZ scores and this may have impeded our ability to see a significant effect of the intervention.

The prevalence of wasting was very low in the UMKD and thus, had little potential for benefit regardless of how well the intervention was implemented.

With a low WLZ prevalence of 22%, we were trying to make a difference in 6% of the population, that is, the proportion above what one will expect (16% with WLZ < -1) in a healthy population. The problem of encountering lower undernutrition burden on the ground compared to that published in the available literature is not uncommon in nutrition studies. Precautions can be taken to avoid these situations and promote the best use of research funds. Previous research that serves as the basis for expected levels of the indicator in sample populations must be recent, based on sound sampling strategy and sample size calculation. Considering that there is often a significant lag between the period of data collection and research publication, attention needs to be paid to the time of data collection especially for transient conditions. When previous literature are not available, it is important that time and resources be invested in preliminary studies to measure the current level of the indicator of interest before implementing an intervention. Findings from such studies should inform decisions of whether to maintain the sample population or identify a more suitable population for the study.

A further limitation was the differences in some baseline characteristics. Mothers' education, household access to sanitation facilities, water and electricity, and the time of initiation of breastfeeding after birth were significantly different among study groups at baseline. Socioeconomic characteristics including parent's educational level, birth weight, hygiene and housing are known to affect variation in growth outcomes at the population level (Penny *et al.*, 2005). We adjusted for these factors in our random logit models at the individual level and still found no effect of the intervention. However, we found the association of some known determinants (feeding frequency, cough, ASF consumption) with low WLZ in the expected direction. A one-unit increase in the number of times a child was fed was associated with an almost 20% reduction in the odds of having a low WLZ. Feeding frequency is an important component of the Guiding Principles for Complementary Feeding of the Breastfed Child (PAHO/WHO, 2003). Meeting the recommended meal frequency improves a child's ability to consume enough energy and accompanying micronutrients to support normal growth. The association between illness and dietary factors and the outcome (low WLZ) varied by the age of the children. Whereas children less than six months had similar WLZ scores regardless of whether they experienced an illness episode or not, this was not the case for older children. This could be explained by the high breastfeeding rates (95%) in children less than six months in our study population. Breast milk is the optimum nutrition for infants less than six months endowed with immunological components that build the immune responses of infants through enhancing their immature immunologic system and strengthening of host defense mechanisms against infective and other foreign agents (Arifeen *et al*., 2001; Nita Bhandari *et al*., 2003; Dewey & Mayers, 2011; Oddy, 2001). Children who consumed animal source foods had similar WLZ scores regardless of age, whereas older children who did not have animal source foods had lower WLZ scores. ASF is a protein- and micronutrient-rich food source needed for optimal growth of children (Dewey & Adu-Afarwuah, 2008; PAHO/WHO, 2003). A review of the literature on the inclusion of ASF in complementary feeding showed that ASF improved growth indicators in undernourished children (Dror & Allen, 2011). In addition, intervention studies that emphasized nutrient-rich animal-based foods in nutrition education were more likely to show an effect than general complementary feeding education (Dewey & Adu-Afarwuah, 2008). In our study, nutrition messages on ASF were provided in all study groups in addition to other dietary and health messages. Although food security reduced from 89% at baseline to 68% at endline, no corresponding change in low WLZ prevalence was observed. Nutrition education has proved to be effective in promoting growth in populations that are food secure [9, 10]. No effect of food security on low WLZ prevalence was found. This could be explained by an overall low level of low WLZ in the district.

Conclusion

The objective of this study was to determine the effect of a capacity-building intervention using an algorithm or length measurement, in addition to the SOC, on the prevalence of low WLZ at the community level. The intervention revealed gaps in the quality of GMP implementation but failed to reduce prevalence of low WLZ or wasting at the community level. The algorithm and length groups had a significantly higher number of GMP sessions held compared to the control. Compared to the length group, the algorithm and control groups had higher proportions of mothers receiving individual counselling at sessions. The strengths of the study include the selection of existing GHS outreach GMP community clinics as a sustainable health service reaching remote rural areas, the use of a cluster randomized design and the use of independent intervention delivery and evaluation personnel. However, the prevalence of wasting and low WLZ were much lower than expected in our population. Implementation was burdened with a low contamination of nutrition education messages, logistic difficulties with GMP outreach services, and motivational issues with nurses, health volunteers and mothers. Having better tools, supportive supervision of nurses and health volunteers, and fewer logistic barriers may provide these health personnel with the needed work environment to improve GMP in Ghana. There is a need to evaluate GMP programs in rural settings in Ghana to identify bottlenecks and develop procedures to promote higher program impact.

References

Arifeen, S., Black, R. E., Antelman, G., Baqui, A., Caulfield, L., & Becker, S. (2001). Exclusive breastfeeding reduces acute respiratory infection and diarrhea deaths among infants in Dhaka slums. *Pediatrics, 108*(4), e67-e67.

Ashworth, A., & Ferguson, E. (2009). Dietary counselling in the management of moderate malnourishment in children. *Food Nutr Bull, 30*(3 Suppl), S405-433.

Atuobi-Yeboah, A. (2010). *Determinants of nutritional status among children 6-24months in communities of the Upper Manya Krobo district of Ghana.* (Masters), University of Ghana, Accra, Ghana.

Bhandari, N., Bahl, R., Mazumdar, S., Martines, J., Black, R. E., Bhan, M. K., & Group, o. m. o. t. I. F. S. (2003). Effect of community-based promotion of exclusive breastfeeding on diarrhoeal illness and growth: a cluster randomised controlled trial. *The Lancet, 361*(9367), 1418-1423.

Bhandari, N., Mazumder, S., Bahl, R., Martines, J., Black, R. E., & Bhan, M. K. (2004). An educational intervention to promote appropriate complementary feeding practices and physical growth in infants and young children in rural Haryana, India. *J Nutr, 134*(9), 2342-2348. doi:134/9/2342 [pii]

Chehayber, H. (2011).Postpartum nutrition education services for HIV-positive Ghanaian women are scarce despite their increased risk of weight loss. Masters eThesis, McGill University.

Cofie, A. (2012). Integrated Education Intervention to improve infant nutrition and growth in Ghana (PhD Thesis) McGill University.

Cogill, B. (2001). *Anthropometric Indicators Measurement Guide.* Retrieved from Washington DC:

Dewey, K. G., & Adu-Afarwuah, S. (2008). Systematic review of the efficacy and effectiveness of complementary feeding interventions in developing countries. *Matern Child Nutr, 4 Suppl 1*, 24-85. doi:10.1111/j.1740-8709.2007.00124.x

Dewey, K. G., & Mayers, D. R. (2011). Early child growth: how do nutrition and infection interact? *Matern Child Nutr, 7 Suppl 3*, 129-142. doi:10.1111/j.1740-8709.2011.00357.x [doi]

Dickin, K. L., Dollahite, J. S., & Habicht, J. P. (2005). Nutrition behavior change among EFNEP participants is higher at sites that are well managed and whose front-line nutrition educators value the program. *J Nutr, 135*(9), 2199-2205.

District Health Directorate. (2011). *Annual Report*. Retrieved from Asesewa, Eastern Region-Ghana:

Dror, D. K., & Allen, L. H. (2011). The importance of milk and other animal-source foods for children in low-income countries. *Food & Nutrition Bulletin, 32*(3), 227-243.

Engle PL, Menon P, Haddad L. Care and nutrition. Concepts and measurement. World Development 1999; 27:1309-37.

Frongillo Jr, E. A., & Begin, F. (1993). Gender bias in food intake favors male preschool Guatemalan children. *J Nutr, 123*(2), 189-196.

Ghana Statistical Service (GSS), G. H. S. G., ICF Macro. (2013). Ghana Demographic and Health Survey. In G. GSS, National Public Health and Reference Laboratory (NPHRL) and ICF Macro (Ed.). Accra, Ghana.

GSS, G. S. S.-. (2008). Ghana Demographic and Health Survey.

Hulley, S. B., Cummings S., Bowner W., Grady D., Newman T. (2007). *Designing Clinical Research* (Third ed.). Philadelphia, USA: Lippincot Williams & Wilkins.

Laar, M. E. (2015). Improving the capacity of community nurses and health volunteers to identify and mitigate low weight-for-length in young children in Ghana (PhD Thesis) McGill University.

Magnani, R. (1997). *Sampling Guide*. Retrieved from Washington DC:

Martorell Reynaldo, Y. M. (2012). Patterns of stunting and wasting: potential explanatory factors. *Advances in Nutrition, 3*(2), 227-233.

Nyonator F. K., Awoonor-Williams J. K., Phillips J. F., Jones T. C., Miller R. A. (2005). The Ghana community-based health planning and services initiative for scaling up service delivery innovation. Health Policy Plan; 20:25-34.

Oddy, W. H. (2001). Breastfeeding protects against illness and infection in infants and children: a review of the evidence. *Breastfeeding Review, 9*(2), 11.

Okronipa H. E., Marquis G. S., Lartey A., Brakohiapa L., Perez-Escamilla R., Mazur R. E. (2012). Postnatal Depression Symptoms are Associated with Increased Diarrhea Among Infants of HIV-Positive Ghanaian Mothers. AIDS Behav; 10: 604-16

PAHO/WHO. (2003). Guiding Principles for complementary feeding of the breastfed child Retrieved from Washington D.C.:

Penny, M. E., Creed-Kanashiro, H. M., Robert, R. C., Narro, M. R., Caulfield, L. E., & Black, R. E. (2005). Effectiveness of an educational intervention delivered through the health services to improve nutrition in young children: a cluster-randomised controlled trial. Lancet, 365(9474), 1863-1872. doi:S0140-6736(05)66426-4 [pii]

Walker, S. P., Grantham-McGregor, S. M., Himes, J. H., & Powell, C. A. (1996). Relationships

between wasting and linear growth in stunted children. Acta Paediatr, 85(6), 666-669. 1016/S0140-6736(05)66426-4 [doi]

World Health Organization. Community-based management of severe acute malnutrition. A joint statement by the World Health Organization, the World Food Programme. In United Nations System Standing Committee on Nutrition and the United Nations Children's Fund Geneva. World Health Organization. http.//www.who.int/nutrition/topics/statement_commbased_malnutrition/en/index.html. 2007. Accessed 26 March 2012.

UNICEF. Strategy for Improved Nutrition of Children and Women in Developing Countries. New York. United Nations Childrens Fund; 1990.

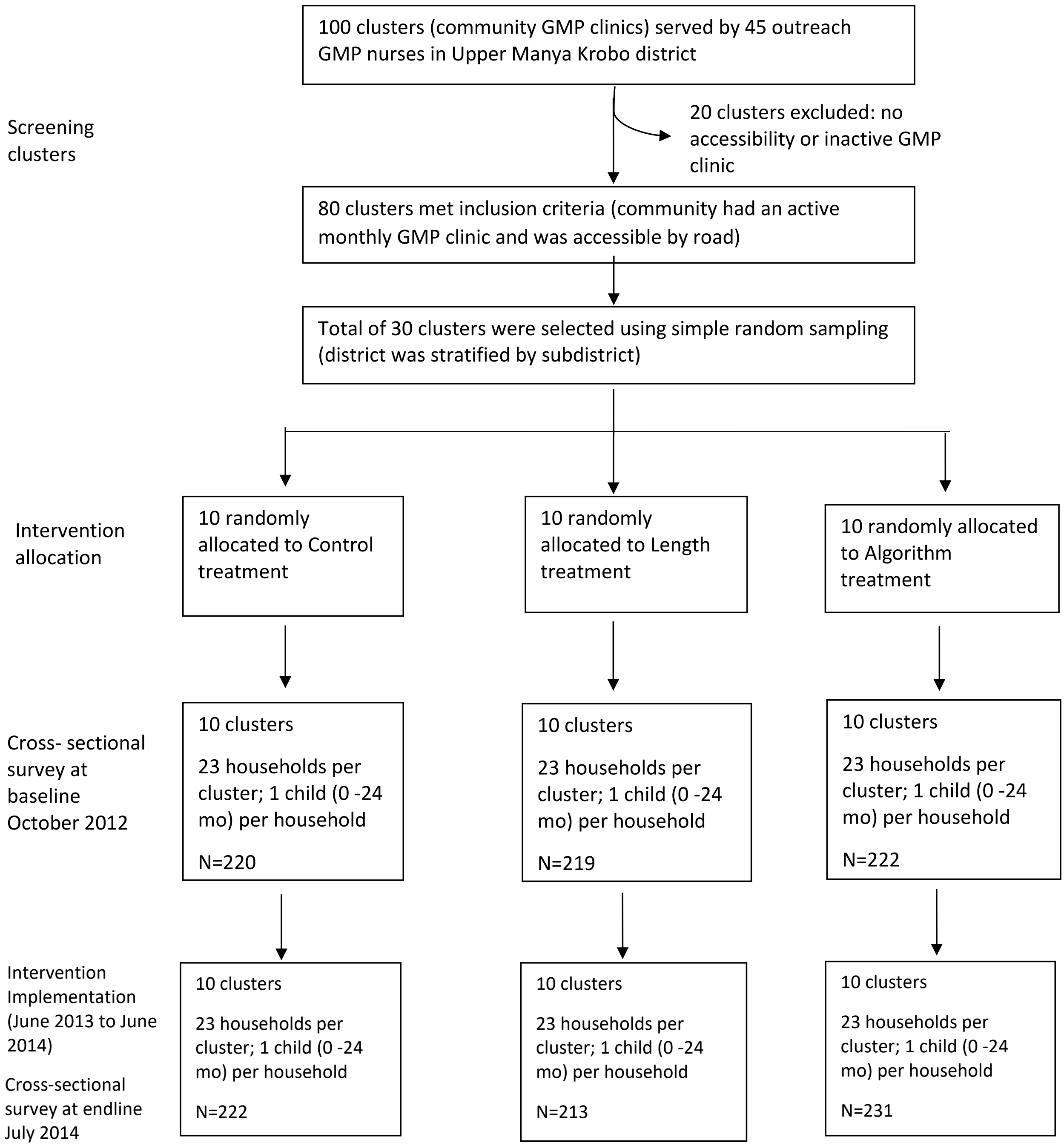

Fig. 1. Intervention profile

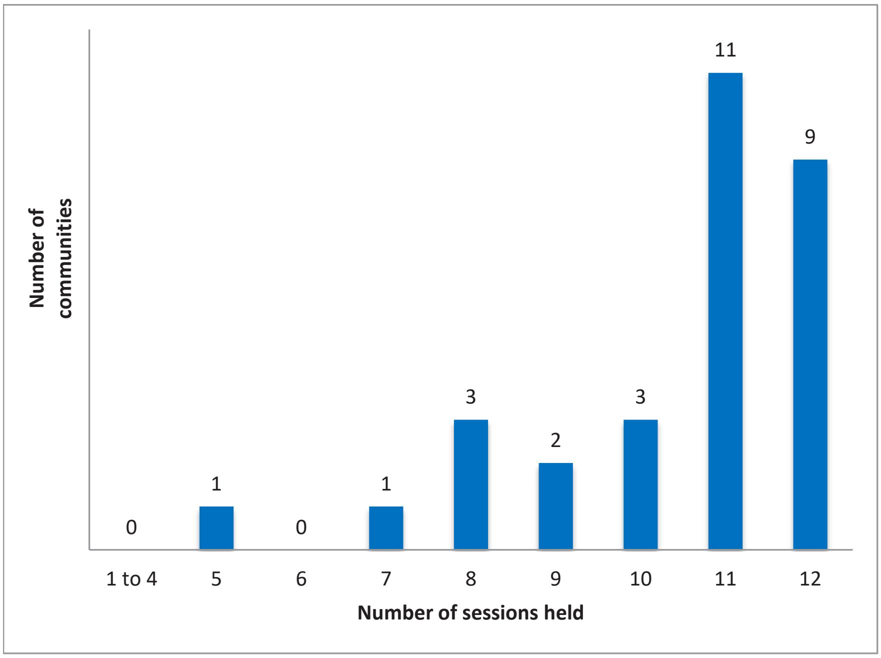

Fig. 2. Number of monthly growth monitoring sessions held in 12 months (June, 2013 – June, 2014) in 30 community-based clinics in the Upper Manya Krobo district, Ghana

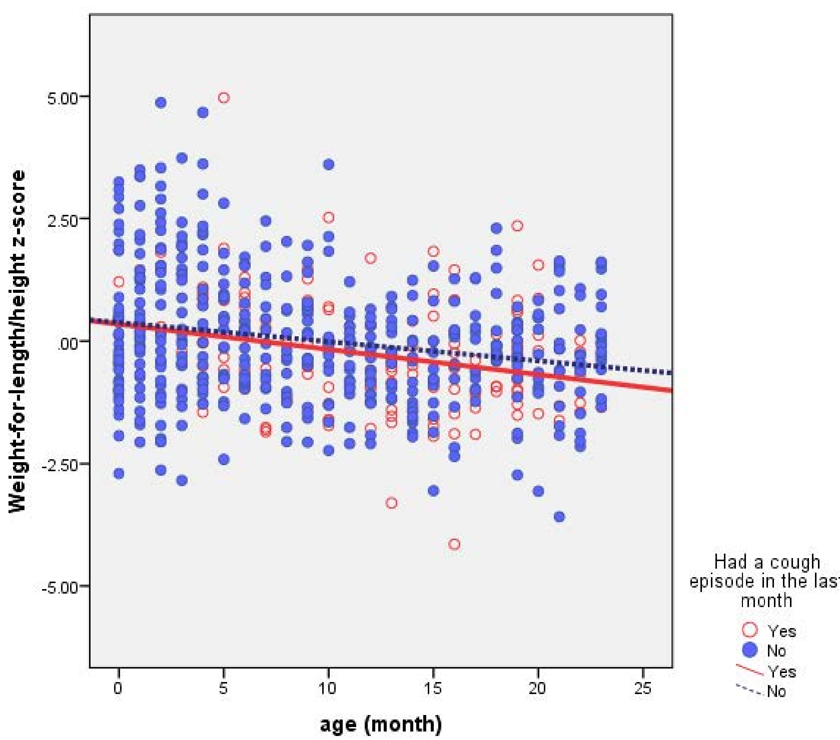

Fig. 3. The association of cough episode by age on weight-for-length Z-score in 30 community clinics in the UMKD, Ghana

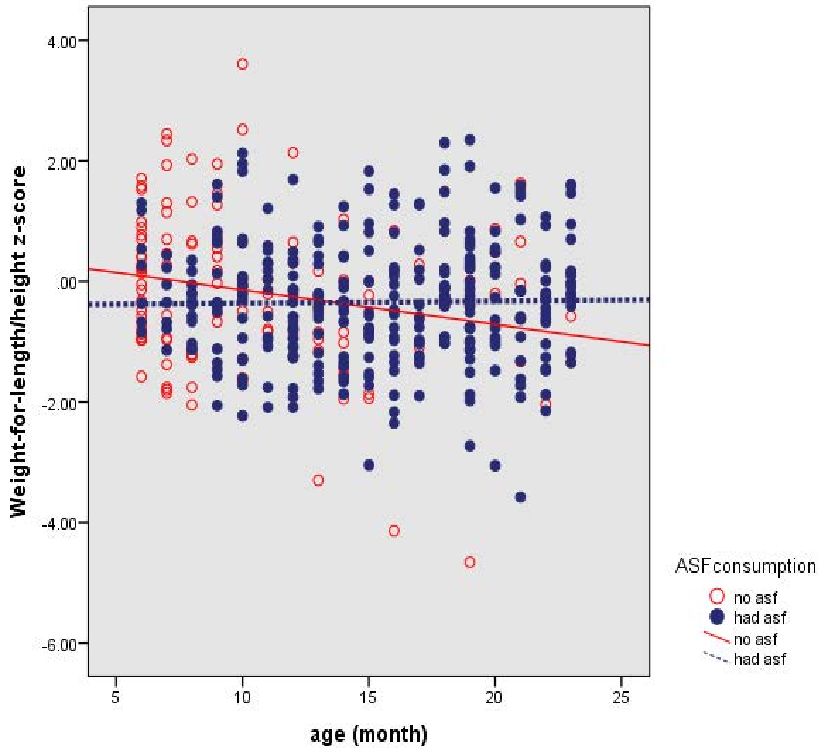

Fig. 4. The effect of consumption of animal source food (ASF) by age on weight-for-length Z-score in 30 community clinics in the UMKD, Ghana

Table 1. Baseline cluster-level characteristics of in 30 community-based clinics by study group in UMKD, Ghana †

	Control (n=10 clusters)	Algorithm (n=10 clusters)	Length (n=10 clusters)	p value
Weight-for-length (Z)	-0.25±1.11[1]	-0.15±1.09	-0.14±1.02	0.50
Length-for-age (Z)	-0.32±1.89	-0.28±1.56	-0.50±1.32	0.30
Weight-for-age (Z)	-0.31±1.47	-0.25±1.28	-0.33±1.11	0.82

†Differences in group means were tested using simple linear models.

[1]data are shown as mean±standard error.

Table 2. Baseline individual-level characteristics of in 30 community-based clinics by study group in UMKD, Ghana‡∫

	Control	Algorithm	Length	p value
Child Characteristics	n=222	n=220	n=219	
Wasted[2]	10 (4.5)[3]	7 (3.2)	7 (3.2)	0.74
Low WLZ[4]	55 (25.0)	45 (20.3)	47 (21.5)	0.46
Stunted[5]	19 (8.6)	16 (7.6)	22 (10.0)	0.66
Age (mo)	9.2 ±11.9	9.9 ±6.7	10.6 ±6.7	0.24
Sex (female)	100 (45.1)	108 (49.1)	122 (55.7)	0.05
Breastfed within 1hour after birth	57 (25.8)	75 (34.2)	53 (24.1)	0.04
Child fed in previous 24 hours (#)[6]	2.6±1.5	2.7±1.6	2.6±1.5	0.85
Food groups eaten by child in previous 24 hours (#)[7]	2.9± 1.4	2.9± 1.5	2.9 ±1.5	0.94
Consumed ASF in previous 24 hours[8]	8 (5.6)	3 (2.1)	7 (4.5)	0.28
Caregiver characteristics				
Age at birth (y)	27.8±7.6	27.3±7.5	27.30±7.4	0.72
Live births (#)	3.0±1.9	3.0 ±2.0	3.1± 2.0	0.99
Formal schooling (y)	4.5±3.6	5.1±3.4	5.2±3.2	0.07
Never attended school	71 (32.10)	47 (22.2)	41 (18.8)	0.02
Living with a partner	195 (88.6)	192 (86.5)	193 (88.1)	0.77
Occupation of caregiver				0.60
Unemployed	30 (13.6)	22 (9.9)	25 (11.3)	
Farming	131 (58.8)	120 (54.7)	120 (55.2)	
Trade/Market	34 (15.4)	45 (20.6)	46 (20.8)	
Other[9]	27 (12.2)	33(14.8)	28 (12.7)	
Household characteristics				
Children (<5 y) (#)	1.6±0.6	1.6±0.7	1.6±0.7	0.53
Material for roof [10]	222 (100)	186 (84.6)	195 (89.0)	0.01
Material for walls[11]	8 (3.7)	31 (14.1)	9 (4.1)	0.01
Own house	73 (37.0)	105 (47.7)	99 (45.4)	0.06
Have electricity	10 (7.3)	63 (28.8)	43 (19.6)	0.01
Use pit latrines	219 (99.0)	220 (100)	215 (98.6)	0.01
Use borehole in the community	106 (47.7)	107 (48.6)	132 (60.1)	0.01
Food secure[12]	203 (91.4)	192 (87.4)	194 (88.7)	0.39

‡Differences in the prevalence of wasting were tested using a random effects logit model, controlling for cluster effects.

∫Differences in child, caregiver and household characteristics were tested at the individual level, with ANOVA tests for means and χ^2 tests for proportions.

[2] Prevalence of weight-for-length Z score (WLZ) < -2.

[3]data are shown as n (%) or mean±standard deviation.

[4] Prevalence of WLZ < -1.

[5] Prevalence of length-for-age Z score < -2.

[6] Number of times fed in children 6 to24 months (N: Control 143; Algorithm 149; Length 143).

[7] Number of food groups (Grains, roots and tubers, legumes and nuts, dairy products, flesh animal source

foods, eggs, vitamin-A rich fruits and vegetables, and other fruits and vegetable) eaten by children 6 to24 months (N: Control 143; Algorithm 149; Length 143).

[8] Consumption of animal source foods (ASF; eggs, fish, or meat) in children 6 to 24 months (N: Control 143; Algorithm 149; Length 143).

[9]Other caregiver occupation: artisan, nurse, teacher.

[10]Material for roof: aluminum/corrugated iron sheets.

[11]Material for walls: cement blocks only and mud mixed with cement.

[12]Food security based on modified version of USDA Household Food Security Module. I9 item scale, score ≥ 1: food insecure, raw score = 0: food secure [36].

Table 3. Differences in number of monthly sessions held and the provision of individual counselling, by study group in 30 communities in the Upper Manya Krobo District, Ghana

		Mean±SD	**Group comparison**	**Difference between groups**	
				Mean difference	95% CI
Sessions held	Algorithm	10.3±2.8	Algorithm - Control	2.7	0.01, 5.4
	Length	10.5±3.4	Length - Control	2.9	0.6, 5.3
	Control	7.6±3.8	Length - Algorithm	0.2	-2.1, 2.6
Individual counselling	Algorithm	0. 9±0.2	Algorithm - Control	0.01	-0.1, 0.1
	Length	0.7±0.4	Length - Control	-0.2	-0.2, -0.3
	Control	0.9±0.2	Length - Algorithm	-0.2	-0.2, -0.3

Table 4. Low weight-for-length z-score levels at endline in 30 community-based clinics in the Upper Manya Krobo District, Ghana at cluster level †

Outcome	Control	Algorithm	Length	p-value
	n=10	**n=10**	**n=10**	
Low WLZ				
(WLZ <-1)				
Unadjusted	0.20 (0.03)[1]	0.22 (0.03)	0.23 (0.03)	0.66
Adjusted	0.22 (0.02)	0.21 (0.02)	0.22 (0.02)	0.97

Table 5. Low weight-for-length z-score levels at endline in 30 community-based clinics in the Upper Manya Krobo District, Ghana at individual level‡

Outcome	Control	Algorithm	Length	p-value
	n=222	**n=231**	**n=213**	
Low WLZ				
(WLZ <-1)				
Unadjusted	0.20 (0.03)[1]	0.23 (0.03)	0.23 (0.03)	0.63
Adjusted	0.20 (0.03)	0.22 (0.03)	0.23 (0.03)	0.71
Wasting (WLZ <-2)				
Unadjusted	0.05 (0.02)	0.03 (0.01)	0.03 (0.01)	0.65
Adjusted	0.03 (0.01)	0.02 (0.01)	0.02 (0.01)	0.48

[1]Data are mean proportion (SE)

†Differences in prevalence at cluster level were tested using linear mixed models, adjusting for baseline prevalence and clustering.

‡Differences in proportion of low WLZ at individual level were tested using a random effects logit model, adjusting for cluster effects, age, sex, and episode of illness (cough, fever, and diarrhea) in child, feeding frequency, food security and socioeconomic status of household and subdistrict.