Maternal Participation Level in a Nutrition-Sensitive Agriculture Intervention Matters for Child Diet and Growth Outcomes in Rural Ghana

Diana Dallmann,[1] Grace S Marquis,[1] Esi K Colecraft,[2] Roland Kanlisi,[3] and Bridget A Aidam[4]

[1]School of Human Nutrition, McGill University, Montreal, Quebec, Canada; [2]Department of Nutrition and Food Science, University of Ghana, Legon, Ghana; [3]Animal Science Department of the University of Ghana, Legon, Ghana; and [4]Technical Services and Innovation, Action Against Hunger, NY, USA

ABSTRACT

Background: Little is known about how the level of program participation affects child nutrition in rural interventions.

Objectives: This study examined the association between participation level in a nutrition-sensitive agriculture intervention and children's diet and anthropometric outcomes in rural Ghana.

Methods: Nutrition Links was a cluster randomized controlled trial (clinicaltrials.gov NCT01985243), which enrolled caregivers with children (aged less than 2 mo in 2014–2015 and less than 18 mo in 2016–2017). Of the 287 caregivers in 19 intervention communities who enrolled, 233 adopted the intervention and received layer poultry, garden inputs, and weekly child feeding education. The egg production and repayment of poultry were monitored, and feed was sold at the weekly meetings. After endline, the nutrition educators rated each woman who adopted the intervention on a scale [very poor (1) to excellent (5)] for: *1*) meeting attendance, *2*) egg productivity, *3*) feed and poultry loan payment, *4*) contributions during meetings, and *5*) attentiveness towards group members. Participation level was classified as high, medium, and low by dividing the sum of these 5 items into tertiles; 54 women who did not adopt the intervention were classified as "no participation." Generalized mixed linear models tested the difference in changes in children's diet and anthropometric indices between the participation levels and the control category – 213 caregiver-child dyads in 20 communities who received standard-of-care health and agricultural services.

Results: Compared with the control category, only high participation was associated with egg consumption [adjusted OR (aOR) = 3.03; 95% CI: 1.15, 7.94]. Both medium and high participation levels were associated with length-for-age *z*-scores (LAZ)/height-for-age *z*-scores (HAZ) [adjusted β-coefficients (aβ) = 0.44; 95% CI: 0.16, 0.72 and 0.40; 95% CI: 0.12, 0.67, respectively].

Conclusion: These results highlight the importance of promoting and monitoring the level of beneficiary participation to estimate the full potential of nutrition-sensitive agriculture interventions to improve nutritional outcomes. *Curr Dev Nutr* 2022;6:nzac017.

Keywords: nutrition program implementation, nutrition-sensitive agriculture, eggs, infant, child, participation, diet, growth, low-income population, Ghana

Manuscript received July 2, 2021. Initial review completed December 2, 2021. Revision accepted January 27, 2022. Published online February 1, 2022.

Supported by Global Affairs Canada, Grant/Award Number: S065653 (GSM); International Development Research Centre (DD).

Author disclosures: The authors report no conflicts of interest.

Supplemental Tables 1–4 are available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at https://academic.oup.com/cdn/.

Address correspondence to DD (e-mail: diana.dallmann@mail.mcgill.ca).

Funding information: Global Affairs Canada, Grant/Award Number: S065653 (GSM); International Development Research Centre (DD)

Abbreviations used: aOR, adjusted OR; aβ, adjusted β-coefficients; ICC, intraclass correlation coefficient; LAZ/HAZ, length-for-age *z*-scores/height-for-age *z*-scores; MDD, minimum dietary diversity; NL, Nutrition Links; NSA, nutrition-sensitive agriculture; RCT, randomized controlled trial; WAZ, weight-for-age *z*-scores; WLZ/WHZ, weight-for-length *z*-scores/weight-for-height *z*-scores.

Introduction

In Ghana, the prevalence of stunting decreased from 22% in 2006 to 18% in 2017/2018 (1, 2); however, inequalities persist across different settings and income levels (3). For instance, in 2017/2018, 14% of children living in urban areas were stunted compared with 20% of children in rural areas. This disparity was more pronounced when national wealth quintiles were compared; stunting affected 1 in 4 children living in households in the lowest wealth quintile compared with less than 1 in 10 in the highest quintile households. Considering that the rural poor accounted for 80% of the total poor in Ghana in 2012, children living in poor households in rural areas are expected to be at the highest risk of undernutrition (4).

Nutrition-sensitive agriculture (NSA) interventions address the underlying determinants of nutrition, including poverty and food insecurity. These interventions might impact nutrition through several pathways, such as improving food sources for home consumption and income for food purchases and healthcare as well as enabling women's decision-making through access to and control over resources (5, 6). Although these theoretical pathways are well established, systematic reviews show a dearth of evidence regarding the impact of NSA interventions on child nutritional status due to poor evaluation designs, small sample sizes, short intervention duration, and targeting the wrong age group for demonstrating an effect on growth (5–11). As a result, there has been a call for more research to understand the implementation of such interventions (5).

Following a logic model approach, beneficiaries' level of participation is an intermediary outcome of the implementation of interventions and, as such, is a critical step to achieve final nutritional outcomes (12, 13). Moreover, estimating the effect of participation level on outcomes of interest could provide insights beyond those gained from an intention-to-treat analysis (14). An earlier nutrition education intervention in health facilities that reduced stunting in Peru included a process evaluation to explain intermediate outcomes (15, 16). Their midtrial process evaluation showed that exposure to intervention components—assessed by a composite score that included attendance and engagement—increased mothers' recall of ≥1 of the 3 key nutrition education messages (16). Remembering ≥1 message, in turn, was associated with a 2-fold increased likelihood of improved dietary behaviors [feeding nutrient-dense thick foods at main meals; adjusted OR (aOR) = 2.16; 95% CI: 1.18, 3.96].

The effect of participation is rarely addressed in NSA interventions (8, 11). A recent systematic review on pathways of NSA identified only 2 out of 43 studies that assessed participation level (6). Examining the association between participation level and outcomes is challenged by the lack of standardized methods for its measurement and the use of different terminologies. For example, in 1 of the 2 NSA studies identified by Sharma et al., participation level was assessed through a composite score of 8 aspects of the village's involvement in the intervention (17), whereas the second study evaluated participation through the number of intervention components in which farmers partook (from 0 to 3) (18).

Among the different terminologies used to refer to participation of the end user, some authors used enactment or responsiveness (19). Enactment has been further described as the practice of treatment-related behavioral skills (20, 21), and responsiveness as the enthusiasm of the end-users (e.g. shown by attendance in some research (22) or level of engagement in a classroom (23, 24)). A recent scoping review, which assessed the operationalization of dose in 130 articles on health-promotion interventions, differentiated between dose delivered and dose received (25). Dose received was further operationalized as passive or active, with the latter defined as "the extent to which participants actively engage with, interact with, are receptive to, and/or use materials or recommended resources." This last definition more completely reflects the concept of participation, therefore, we used this definition to operationalize the level of participation of women in an NSA cluster randomized controlled trial (RCT) in rural Ghana, which successfully increased the likelihood of a child to meet the minimum dietary diversity (MDD) as well as children's length-for-age (LAZ)/height-for-age (HAZ) and weight-for-age (WAZ) *z*-scores (26). We investigated how the level of participation of women in this intervention was associated with the change in dietary and anthropometric outcomes over the study period.

Methods

The Nutrition Links (NL) project took place in the Upper Manya Krobo District, located in Ghana's Eastern region. This district's 2010 census reported over 72,000 inhabitants, most of them living in rural areas (87%) and engaging in agriculture activities (83%), predominantly as subsistence farmers (27), with 96% of farming households planting crops and 61% rearing livestock, mainly poultry. The NL cluster RCT was carried out in 3 of 6 subdistricts and recruited, over 2 enrollment phases, 287 women in the 8 intervention clusters (composed of 19 communities) and 213 in the 8 control clusters (composed of 20 communities) who had children aged <12 mo during Phase 1 (2014–2015) and less than 18 mo during Phase 2 (2016–2017).

The trial's agriculture component was intensive poultry production. After undergoing a series of training on poultry husbandry, 233 of the 287 women recruited in the intervention communities (144 in Phase 1 and 89 in Phase 2) built their chicken coop on time and received 40 (Phase 1) or 35 (Phase 2) point-of-lay hybrid chickens and related inputs. The remaining 54 women did not adopt the intervention (i.e. did not receive birds). In addition to rearing fowl, women also received inputs and training to enable them to establish a home garden.

Women who received birds had to repay their cost [∼ 400 United States Dollars (USD)] over a period of 50 wk [Heifer International's Passing on the Gift® (28)] and were expected to attend the intervention's weekly group meetings held in their communities. During these meetings, nutrition education on infant and young child feeding practices was provided by 3 trained educators who rotated among all participating communities. The lessons included: *1*) techniques and nutritional benefits of breastfeeding, *2*) benefits of responsive feeding, *3*) nutritional benefits of complementary feeding with eggs, local green leaves, and orange-fleshed sweet potatoes, *4*) feeding during illness, and *5*) hygiene; Phase 2 also included child stimulation.

The weekly meetings were also an opportunity to monitor egg production and for women to buy feed (∼ USD 20 bag of feed for 2 wk) and medication and to repay the cost of the poultry. All payments were done with cash or its equivalent in eggs. Although these meetings were open to all women in the intervention communities, they were mainly attended by those who adopted the intervention ($n = 233$). The control communities continued to receive the standard services from the district-level government agriculture and health institutions but did not receive the NL intervention package. More information on the NL intervention has been described by Marquis et al. (26).

Participation

Women who adopted the intervention (i.e. received birds) were assessed for their level of participation in NL. The data collection tool included 5 items observed by the nutrition educators during the weekly meetings, each of which was rated on a scale from very poor (1) to excellent (5). The items included: *1*) attendance (present at the meetings), *2*) poultry productivity (eggs produced), *3*) payment (timely and complete payments for feed and contribution to Passing on the Gift®), *4*) contribution (actively answering questions and making comments during nutrition education), and *5*) relationship (helping and being attentive towards group members). The nutrition educators assessed by consensus 224 women (data were missing for the remaining 9 women). The evaluations were done 4 (Phase 1) and 3 (Phase 2) months after the end of the NL endline surveys and were repeated after 1 mo (Phase 1: November and December 2017, Phase 2: October and November 2018). In Phase 2, 1 educator was unavailable and the remaining 2 educators completed the assessment. The 54 women who did not adopt, did not participate in any of these 5 components and, thus, were not evaluated.

Next, the stability reliability and internal consistency reliability of the participation items were checked. The stability reliability of the 2 evaluations completed 1 mo apart was assessed through the intraclass correlation coefficient (ICC) and the corresponding 95% CIs for each participation item (29, 30). This analysis was based on absolute agreement of both evaluations, using a 2-way mixed-effects model in which moderate and good reliability are indicated by ICC values between 0.5 and 0.75 and between 0.75 and 0.90, respectively (31). The reliability of most participation items was good in both phases, with the ICC lower limit of the CI being >0.75. Two items from Phase 2—active contribution during the weekly nutrition education sessions and poultry productivity—had moderate reliability with the lower limit of the CI for the ICC >0.70.

Internal consistency reliability was assessed using Cronbach's α; ≥0.9 was considered satisfactory (32). All items in both evaluations done 1 mo apart showed a satisfactory level of internal consistency. Finally, the unidimensionality of the items was assessed through principal component analysis (33). Only 1 component had Eigenvalues >1, which explained >70% of the total variance for both intervention phases. All items strongly loaded only in this first component, showing that the items were unidimensional and explained by only 1 latent variable.

A participation level categorical variable was developed to reflect the range from no to high interaction with the project. First, a composite index was created for the 233 women in the intervention communities who adopted the intervention by obtaining the mean value of the 5 items at each evaluation and then the average of the 2 evaluation means. The resulting index ranged from 1 to 5 and had a nonnormal distribution and was categorized into tertiles. These women were categorized into the 3 participation levels (n; median; interquartile): low ($n = 74$; 2.6; 1.9, 3.1), medium ($n = 78$; 3.8; 3.5, 4.1), and high ($n = 72$; 4.7; 4.5, 4.9). Then, the 54 women in the intervention communities who did not adopt the intervention but may have been exposed to community-wide project activities were classified as a fourth category, "no participation." Finally, the 213 women in the nonintervention communities were classified as a fifth category, "control," and were used as the reference category in the primary analyses.

Outcome variables

This analysis used the same infant and young child dietary and anthropometric outcomes reported in Marquis et al. (26). These include 2 binary outcomes: MDD [≥4 of the following food groups: grains, roots, and tubers; legumes and nuts; dairy products; flesh foods; eggs; vitamin A-rich fruits and vegetables; and other fruits and vegetables (34)] and egg consumption in the past 24 h in addition to 3 continuous outcomes: LAZ/HAZ, weight-for-age z-scores (WAZ), and weight-for-length z-scores (WLZ)/weight-for-height z-scores (WHZ) , obtained using the WHO growth references (35).

Covariates

The following variables assessed at baseline were used to describe the sample and were explored as potential covariates: child characteristics (sex, age, MDD, eggs, LAZ/HAZ, WAZ, and WLZ/WHZ); maternal characteristics (age, ethnicity, marital status, education level, and main income-generating activity); household characteristics (size, food security) (36), and wealth [tertiles for the first component of a principal components analysis using 13 household assets: floor material, wall material, cooking fuel, electricity, and ownership of a telephone, radio, television, video player, DVD/CD player, refrigerator, sewing machine, motorcycle, and car (26)]. Phase was not considered as a covariate as there were no women in the "no participation" group in Phase 2.

Statistical analysis

The association between the participation level categorical variable (control; no, low, medium, and high participation) and baseline characteristics was tested using 1-factor ANOVA for continuous variables and chi-square test of independence [with a z-test to compare levels if the P value was <0.10 (37)] for categorical variables. Post hoc Bonferroni correction was used to compare groups.

Primary analysis.

To develop the final adjusted models, first, the association between each potential covariate and diet (MDD and eggs) and growth (z-scores) outcomes was tested including and excluding the baseline value of the outcome as an explanatory variable. The covariates were retained in the final model if the P value was <0.10 for either the binary association or the model adjusted for the baseline of the outcome. The association between the outcomes of interest and the participation level (control; no, low, medium, and high participation) was tested initially with generalized linear mixed models (PROC GLIMMIX) that included: *1*) the covariates, *2*) the random effect of the clusters, and *3*) the random effect of the interaction of the clusters with women's participation level, which accounted for any potential latent correlation within clusters. The COVTEST ZeroG test showed that none of the random effects were statistically significant. Moreover, the variance among the clusters was zero, and the SE for the variance of the interaction was larger than the estimate. Finally, the results with or without these interaction effects did not vary. Thus, the random effect of the interaction between participation level and clusters was dropped from the models and only the random effect of the clusters was retained (38).

The normality of the residuals for continuous outcomes was confirmed through the Shapiro–Wilk test. There was nothing biologically unlikely about the few identified outliers, and the results did not change if these cases were included or excluded from the models. Thus, we kept all cases. For all covariates with >2 categories, the Dunnett's method was used to adjust the α-level and the CIs were corrected using this method (39). Post hoc power calculations were performed for each model in which the association between 1 or more participation levels and the primary outcome was not significant, following the Stroup method (40).

Secondary analyses.

Two secondary analyses were conducted. First, for comparative purposes, the association between each separate participation item (e.g. attendance, productivity) and the outcomes of interest was explored. Second, the participation was tested as a continuous score only with data from women in the intervention communities. For those who had "no participation," the variable was scored as 0. For those who participated (i.e. adopted the intervention), the mean value of the 5 items at each evaluation was taken and then the average of the 2 mean values was used. The final score ranged from 0 to 5. A dummy variable ("no participation" compared with "participation") was included and an interaction between the dummy variable and the continuous score was added to obtain a regression coefficient for those who participated.

Ethical approval

The NL trial was registered at clinicaltrials.gov as NCT01985243. Institutional Review Board approval for the trial was obtained in Ghana from the Noguchi Memorial Institute for Medical Research at the University of Ghana (#060/13-14) and McGill University (# 822-0514) in Canada. All participants provided written informed consent for themselves and their children.

Results

Baseline characteristics by participation level

Overall, women who did not adopt the intervention (no participation) differed from others (**Table 1**). They were less likely to be of Krobo ethnicity than women in the control, medium, and high participation level categories. Moreover, women with no participation were less likely to be farmers than those with medium and high participation levels. There were no group differences in children's characteristics.

Primary analysis

The unadjusted values of the outcomes of interest by participation level (control; no, low, medium, and high participation) are shown in **Supplemental Table 1**. The participation level was associated with endline egg consumption but not with meeting the MDD (**Table 2**). Compared with children in the control category, those in the intervention whose mothers had a high participation level were twice as likely to have consumed eggs the previous day (aOR = 3.03, 95% CI: 1.15, 7.94). Consuming eggs or meeting the MDD at baseline predicted their consumption at endline. Maternal ethnicity (Krobo) and marital status (married/cohabitating) were also associated with meeting the MDD, with maternal occupation (having an income-generating activity) associated with egg consumption.

The level of participation was also associated with anthropometric outcomes. High and medium participation levels were associated with a similar increase in linear growth (adjusted β-coefficients [aβ] = 0.44; 95% CI: 0.16, 0.72 and 0.40; 95% CI: 0.12, 0.67), respectively (**Table 3**). The baseline values of all anthropometric indicators were positively associated with their respective outcomes. Children who were older at baseline had better endline Z-scores compared with those who were aged less than 6 mo, whereas female children had a higher decrease in WLZ/WHZ compared with males. No interactions between participation level and other covariates were significant for both dietary and anthropometric outcomes. The post hoc power for nonsignificant outcomes ranged from 5% for egg consumption in the "no participation" category to 44.5% for WAZ in the "high participation" level category (**Supplemental Table 2**).

Secondary analyses

Outcomes by individual items of participation.

The association between the 5 individual items of participation level and the dietary and anthropometric outcomes was consistent with that of the participation level index, with only a few exceptions noted in the models for egg consumption (medium level of attendance item was significant) and LAZ/HAZ (medium level of relationship item was not significant) (**Supplemental Table 3**).

Outcomes by participation score.

When the analysis used participation as a continuous score, the association between participation and egg consumption and LAZ/HAZ remained statistically significant. For every additional point in the participation score, the likelihood of children consuming eggs nearly doubled (aOR = 1.85; 95% CI: 1.16, 2.95). In addition, there was an increase of 0.18 z-scores for LAZ/HAZ (aβ; 95% CI: 0.06, 0.31) (**Supplemental Table 4**).

Discussion

Integrated NSA interventions similar to NL have been promoted as one approach to improve child nutrition (5). The objective of this study was to determine the association between mothers' level of participation in the NL project and their children's dietary and anthropometric outcomes. Our adjusted analysis showed that mothers' high participation level was associated with a higher likelihood of child egg consumption, with high and medium participation levels similarly increasing children's linear growth compared with the control.

To the best of our knowledge, only 2 published NSA studies assessed the effect of some measure of participation on nutritional outcomes through an assessment of the dose received actively (17, 18). The first example was a prospective 5-y quasi-experiment in Malawi, which assessed the association between level of village participation (labeled as involvement) and child growth (17). Village participation included 8 items (e.g. number of people from the village who participated in project activities, grew project crops, and were members of farmer research teams) that were evaluated by key informants on a scale from very involved (1) to minimal involvement (4). There was no effect of the project when intervention villages were compared with the control, but children from villages with the highest level of participation increased their WAZ by 0.8 [from −0.6 (SD: 0.4)to 0.2 (SD: 0.4)] ($P < 0.05$).

The second study was an RCT in Mozambique that aimed to increase the adoption and consumption of vitamin A-biofortified orange-fleshed sweet potatoes (18). The researchers categorized participation intensity into 3 levels, depending on how farmers participated in an agricultural and a nutritional component. In increasing order of intensity, participation in the agricultural and the nutrition components were categorized, respectively, as *1*) no participation, *2*) obtaining vines/attending ≥1 nutrition event, and *3*) category 2 plus partaking in extension meetings or category 2 plus acting as a nutrition promoter. Interestingly, the increases in the intervention's effect were similar to those observed for a high participation level in our analysis of NL data. Compared with children in control households, those whose households had the highest level of participation in the agricultural and the nutritional components improved their dietary diversity score by 2-fold (aβ = 0.40; SE: 0.11) and by 3-fold (aβ = 0.61; SE: 0.15), respectively, relative to the effect of the overall treatment (aβ = 0.20; SE: 0.11) ($P < 0.05$ for all analyses).

Other studies reported on the dose received passively. Two nutrition-sensitive social and behavior change communication interventions, 1 in Ethiopia and 1 in Nepal, assessed the effect of level of exposure to intervention components on nutritional outcomes (41, 42). The Ethiopian

TABLE 1 Characteristics of the sample of a nutrition-sensitive agriculture intervention in rural Ghana, by treatment group and level of participation[1]

		Intervention[2]			
	Control (n = 213)	No participation (n = 55)	Low participation (n = 74)	Medium participation (n = 78)	High participation (n = 72)
Child					
Baseline characteristics					
Sex, female	97 (45.5)	26 (47.3)	35 (47.9)	39 (50.6)	32 (45.7)
Age group, mo					
>12	65 (30.5)	14 (25.5)	21 (29.2)	31 (40.3)	22 (31.4)
10 to 12	52 (24.4)	11 (20.0)	12 (16.7)	14 (18.2)	15 (21.4)
6 to 9	59 (27.7)	18 (32.7)	28 (38.9)	16 (20.8)	21 (30.0)
<6	37 (17.4)	12 (21.8)	11 (15.3)	16 (20.8)	12 (17.1)
Minimum dietary diversity[3,4]	63 (36.6)	20 (47.6)	29 (49.2)	29 (49.2)	17 (29.8)
Consumed eggs[3]	36 (20.5)	12 (27.9)	16 (25.8)	12 (19.7)	13 (22.4)
Length-for-age, z-score[5]	−0.8 ± 1.3	−0.9 ± 1.4	−0.8 ± 1.0	−0.7 ± 1.5	−1.2 ± 1.1
Weight-for-age, z-score[5]	−0.7 ± 1.3	−1.0 ± 1.3	−0.7 ± 1.0	−0.7 ± 1.1	−0.7 ± 1.2
Weight-for-length, z-score[5]	−0.3 ± 1.2	−0.5 ± 1.2	−0.4 ± 1.0	−0.5 ± 1.0	−0.1 ± 1.3
Maternal					
Baseline characteristics					
Age group, y					
≥35	38 (18.6)	5 (9.3)	16 (23.2)	14 (19.2)	14 (21.5)
25 to 34	78 (38.2)	15 (27.8)	22 (31.9)	28 (38.4)	28 (43.1)
<25	88 (43.1)	34 (63.0)	31 (44.9)	31 (42.5)	23 (35.4)
Ethnicity, Krobo[6,***]	161 (77.4)[a]	31 (56.4)[b]	51 (70.8)[a,b]	65 (86.7)[a]	61 (87.1)[a]
Married/cohabiting[7]	162 (77.9)	36 (69.2)	43 (81.1)	41 (77.4)	43 (81.1)
Education[8]					
Secondary or higher	79 (38.0)	9 (17.3)	19 (35.8)	18 (34.0)	18 (34.0)
Primary	89 (42.8)	26 (50.0)	22 (41.5)	25 (47.2)	23 (43.4)
None	40 (19.2)	17 (32.7)	12 (22.6)	10 (18.9)	12 (22.6)
Income generating activity[9,*]					
Farmer	75 (36.1)[a,b]	9 (16.4)[b]	27 (37.5)[a,b]	34 (45.3)[a]	33 (47.1)[a]
Trader	72 (34.6)[a]	23 (41.8)[a]	27 (37.5)[a]	25 (33.3)[a]	22 (31.4)[a]
Others	20 (9.6)[a]	4 (7.3)[a]	6 (8.3)[a]	2 (2.7)[a]	4 (5.7)[a]
None	41 (19.7)[a]	19 (34.5)[a]	12 (16.7)[a]	14 (18.7)[a]	11 (15.7)[a]
Household					
Baseline characteristics					
Raised fowl[10]	181 (85.0)	39 (70.9)	58 (79.5)	66 (85.7)	59 (84.3)
Household size[11]	6.4 ± 2.8	6.7 ± 2.4	6.7 ± 2.4	7.5 ± 3.5	6.9 ± 2.4
Food security[12]					
Severely food insecure	95 (45.2)	22 (40.0)	28 (38.9)	36 (48.0)	33 (47.2)
Moderately food insecure	54 (25.7)	17 (30.9)	23 (31.9)	16 (21.3)	18 (25.7)
Mildly food insecure	39 (18.6)	8 (14.5)	10 (13.9)	15 (20.0)	15 (21.4)
Food secure	22 (10.5)	8 (14.5)	11 (15.3)	8 (10.7)	4 (5.7)
Wealth[13]					
High	70 (33.8)	25 (45.5)	25 (36.2)	21 (28.4)	18 (26.1)
Medium	67 (32.4)	20 (36.4)	23 (33.3)	25 (33.8)	21 (30.4)
Low	70 (33.8)	10 (18.2)	21 (30.4)	28 (37.8)	30 (43.5)

*$P < 0.05$, ***$P < 0.001$.
Values are n (%) or mean ± SD.
Column comparisons were done between the 5 participation levels (control; no, low, medium, and high participation). One-factor ANOVA test for continuous variables; chi-square test of independence for categorical variables (with z-test to compare columns). Bonferroni correction method was used to correct α for all multiple comparisons. Superscripts within a row indicate whether pairwise comparisons were statistically different ($P < 0.05$).
[1]Project nutrition educators evaluated twice, 1 mo apart, the participation of women who adopted the intervention [on a scale of very poor (1) to excellent (5)] for 5 items: *1*) attendance (attending nutrition education weekly meetings), *2*) productivity (eggs produced), *3*) payment (timely and complete payment of project inputs), *4*) contribution (active participation during meetings), and *5*) relationship (being attentive and helpful to group members at weekly education meetings). The mean value of the 5 items was obtained at each evaluation and the average of the 2 evaluations was then divided into tertiles (high, medium, low). Women who did not adopt the intervention were coded as "no participation." Women in the nonintervention communities were coded "control."
[2]Included only cases with complete participation level data.
[3]Assessed for the previous 24 h; included only children aged ≥6 mo.
[4] ≥4 of the following food groups: grains, roots, and tubers; legumes and nuts; dairy products; flesh foods; eggs; vitamin A-rich fruits and vegetables; and other fruits and vegetables in the last 24 h (34).
[5]z-scores calculated using WHO growth standards as reference (35).
[6]Krobo, the local ethnic group, was compared with others (Akan, Ewe, Ga, among others).
[7]Married/cohabiting compared with not married/cohabitation.
[8]Highest education level completed.
[9]Primary income-generating activity; others included seamstress, hairdressers, among others.
[10]Raised birds during the year before the intervention.
[11]Number of people who usually reside in the household.
[12]Classification based on a 15-item Food Insecurity Experience Scale (36).
[13]Wealth: tertiles for the first component of a principal component analysis using 13 household assets: floor material, wall material, cooking fuel, electricity, and ownership of a telephone, radio, television, video player, DVD/CD player, refrigerator, sewing machine, motorcycle, and car.

TABLE 2 Association between participation level in a nutrition-sensitive agriculture intervention and diet outcomes of Ghanaian rural children

	Minimum dietary diversity[1,2]		Egg consumption[1]	
	Unadjusted (*n* = 418)	Adjusted (*n* = 289)	Unadjusted (*n* = 418)	Adjusted (*n* = 297)
Participation level[3]				
High	1.79 (0.80, 4.01)	1.15 (0.40, 3.28)	3.30 (1.43, 7.64)**	3.03 (1.15, 7.94)*
Medium	1.45 (0.68, 3.11)	0.75 (0.26, 2.18)	1.82 (0.79, 4.22)	1.75 (0.63, 4.84)
Low	1.19 (0.55, 2.57)	0.69 (0.23, 2.13)	0.98 (0.38, 2.55)	0.87 (0.28, 2.75)
No participation	0.78 (0.33, 1.84)	0.77 (0.25, 2.36)	1.35 (0.49, 3.71)	1.04 (0.3, 3.62)
Control (ref)				
Child				
Baseline of outcome[4]	—	2.65 (1.53, 4.58)***	—	2.19 (1.17, 4.11)*
Maternal				
Ethnicity[5]				
Other	—	0.34 (0.18, 0.66)**	—	—
Krobo (ref)				
Marital status				
Married/cohabitation	—	2.71 (1.42, 5.16)**	—	—
Not married (ref)				
Education level				
Secondary or higher	—	—	—	1.32 (0.57, 3.04)
Primary	—	—	—	0.70 (0.31, 1.58)
None (ref)				
Income-generating activity				
Farmer	—	—	—	2.50 (0.90, 6.96)
Trader	—	—	—	2.71 (0.96, 7.65)
Other[6]	—	—	—	3.72 (0.90, 15.39)
None (ref)				
Household				
Food security[7]				
Severely food insecure	—	0.45 (0.16, 1.26)	—	0.49 (0.15, 1.63)
Moderately food insecure	—	0.68 (0.29, 1.60)	—	1.04 (0.42, 2.59)
Mildly food insecure	—	1.35 (0.62, 2.93)	—	0.87 (0.39, 1.96)
Food secure (ref)				
Constant	1.30 (0.95, 1.78)	0.25 (0.10, 0.64)*	0.29 (0.19, 0.43)***	0.13 (0.05, 0.37)**

$^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$.
Values shown are ORs (95% CIs adjusted using Dunnett's method for multiple groups) from generalized linear mixed models adjusted for random effect of clusters. The adjusted models retained all covariates that had a $P < 0.10$ either in the bivariate analysis with the outcome or with the outcome adjusted by the baseline value.
[1]Assessed for the previous 24 h.
[2]≥4 of the following food groups: grains, roots, and tubers; legumes and nuts; dairy products; flesh foods; eggs; vitamin A-rich fruits and vegetables; and other fruits and vegetables in the last 24 h (34).
[3]Project nutrition educators evaluated twice, 1 mo apart, the participation of women who adopted the intervention [on a scale of very poor (1) to excellent (5)] for 5 items: *1*) attendance (attending nutrition education weekly meetings), *2*) productivity (eggs produced), *3*) payment (timely and complete payment of project inputs), *4*) contribution (active participation during meetings), and *5*) relationship (being attentive and helpful to group members at weekly education meetings). The mean value of the 5 items was obtained at each evaluation and the average of the 2 evaluations was then divided into tertiles (high, medium, low). Women who did not adopt the intervention were coded as "no participation." Women in the nonintervention communities were coded "control." The reference group was the control category.
[4]Includes only children aged ≥6 mo.
[5]Krobo, the local ethnic group, was compared with others (Akan, Ewe, Ga, among others).
[6]Seamstress, hairdresser, among others.
[7]Classification based on a 15-item Food Insecurity Experience Scale (36).

study was a 2-y large-scale trial. Its agricultural component consisted of agricultural extension workers delivering infant and young child feeding messages such as designating the eggs of a specific chicken for a child aged less than 2 y in the household (41). This study found that children aged 6–23.9 mo whose mothers were exposed to ≥3 out of 4 program delivery platforms had an increase in the odds of meeting the MDD (aOR = 3.15; 95% CI: 2.18, 4.57) and had a 2-fold increase in LAZ/HAZ (aβ = 0.24; 95% CI: 0.04, 0.44) compared with having no exposure. Similar to the study in Ethiopia, a large multi-platform program in Nepal, which included behavior change communication and homestead food production, found a greater increase in the dietary diversity score of children aged 24–59 mo when their mothers were exposed to 3 program platforms compared with only 1 (aβ = 0.41; 95% CI: 0.16, 0.67 compared with aβ = 0.19; 95% CI: 0.03, 0.36) (42).

Compared with other studies, the effect size that we obtained for LAZ/HAZ in the intervention compared with control analysis is similar to that reported by the Ethiopian 2-y large-scale trial. This intervention used several delivery platforms (from individual to mass media) but did not provide poultry (41). Another study with a similar effect size on LAZ/HAZ (aβ = 0.28; 95% CI: 0.05, 0.50) was found in a recent intention-to-treat analysis analysis of an 18-mo cluster RCT in Ethiopia, which provided 25 chickens (both layers and roosters) and agriculture

TABLE 3 Association between participation level in a nutrition-sensitive agriculture intervention and anthropometric outcomes of Ghanaian rural children

	Length-for-age/height-for-age z-scores		Weight-for-age z-scores		Weight-for-length/weight-for-height z-scores	
	Unadjusted (n = 406)	Adjusted (n = 398)	Unadjusted (n = 407)	Adjusted (n = 347)	Unadjusted (n = 406)	Adjusted (n = 398)
Participation level[1]						
High	0.25 (−0.13, 0.63)	0.44 (0.16, 0.72)***	0.32 (−0.06, 0.70)	0.23 (−0.08, 0.54)	0.28 (−0.15, 0.71)	0.12 (−0.19, 0.44)
Medium	0.47 (0.10, 0.84)**	0.40 (0.12, 0.67)**	0.20 (−0.17, 0.56)	0.21 (−0.10, 0.52)	−0.08 (−0.50, 0.34)	−0.02 (−0.32, 0.29)
Low	−0.10 (−0.48, 0.29)	−0.02 (−0.30, 0.26)	0.04 (−0.35, 0.42)	0.16 (−0.17, 0.48)	0.13 (−0.31, 0.56)	0.19 (−0.13, 0.51)
No participation	−0.11 (−0.54, 0.33)	0.02 (−0.30, 0.35)	−0.19 (−0.62, 0.25)	0.04 (−0.29, 0.37)	−0.18 (−0.65, 0.30)	−0.01 (−0.37, 0.34)
Control (ref)						
Child						
Sex						
Female	—	—	—	−0.12 (−0.26, 0.02)	—	−0.19 (−0.33, −0.05)**
Male (ref)						
Baseline of outcome	—	0.59 (0.53, 0.65)***	—	0.63 (0.56, 0.69)***	—	0.53 (0.47, 0.60)***
Age at baseline, mo						
>12	—	0.29 (0.03, 0.56)*	—	0.58 (0.31, 0.85)***	—	0.64 (0.37, 0.91)***
10–12	—	0.33 (0.04, 0.61)**	—	0.59 (0.32, 0.85)***	—	0.66 (0.38, 0.93)***
6–9	—	0.10 (−0.16, 0.37)	—	0.35 (0.10, 0.60)**	—	0.45 (0.19, 0.71)***
<6 (ref)						
Maternal						
Ethnicity[2]						
Other	—	−0.12 (−0.30, 0.06)	—	−0.09 (−0.27, 0.10)	—	—
Krobo (ref)						
Education level						
Secondary or higher	—	—	—	0.12 (−0.09, 0.33)	—	—
Primary	—	—	—	−0.05 (−0.26, 0.15)	—	—
None (ref)						
Intercept	−1.41 (−1.56, −1.26)***	−1.38 (−1.69, −1.07)***	−1.01 (−1.16, −0.86)***	−1.04 (−1.34, −0.74)***	−0.39 (−0.59, −0.20)***	−0.59 (−0.81, −0.37)***

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

Values shown are β-coefficients (95% CIs adjusted using Dunnett's method for multiple groups, or SE) from generalized linear mixed models adjusted for random effect of clusters. The adjusted models retained all covariates that had a $P < 0.10$ either in the bivariate analysis with the outcome or with the outcome adjusted by the baseline value. Outcomes were estimated using WHO growth standards as reference (35).

[1]Project nutrition educators evaluated twice, 1 mo apart, the participation of women who adopted the intervention [on a scale of very poor (1) to excellent (5)] for 5 items: *1*) attendance (attending nutrition education weekly meetings), *2*) productivity (eggs produced), *3*) payment (timely and complete payment of project inputs), *4*) contribution (active participation during meetings), and *5*) relationship (being attentive and helpful to group members at weekly education meetings). The mean value of the 5 items was obtained at each evaluation and the average of the 2 evaluations was then divided into tertiles (high, medium, low). Women who did not adopt the intervention were coded as "no participation." Women in the nonintervention communities were coded "control." The reference group was the control category.

[2]Krobo, the local ethnic group, was compared with others (Akan, Ewe, Ga, among others).

training to self-selected families with children aged less than 36 mo in their intervention villages (43). The effect size that we observed for children whose mothers had medium or high participation levels in NL was similar to that reported by a large Malawi 12-mo cluster RCT NSA delivered through community-based childcare centers (44). This intervention recruited preschool children and their younger siblings and added agriculture training and nutrition education to a government-led early childhood development program. At endline, LAZ/HAZ increased in the younger siblings (children aged 6–24 mo) [difference-in-differences analysis (DID) = 0.44; $P < 0.05$)].

Several aspects could have determined higher participation levels in the items we evaluated in NL. For example, women who had good relationships with group members might have had more social support to participate and been more willing to attend meetings. Attending meetings more often and interacting with other group members could have helped women learn better how to care for their birds, resulting in higher egg production. A higher production, in turn, would enable the procurement of inputs to maintain healthy birds ensuring the production cycle. Finally, a higher participation would improve child diet and growth outcomes. Based on the results from the study in Peru (16), we could expect that women's higher attendance in NL increased the recall of nutrition education messages, which in turn, led to a greater likelihood of feeding eggs to their children. Also, an increased egg production would facilitate household consumption and sale to procure other nutrient-rich foods. There might be several other pathways to explain these associations (5, 6, 45); further research, particularly qualitative, is recommended to understand them better.

When interpreting our results, it is important to consider that the NL trial was not designed to demonstrate its effects based on participation level. The low power obtained for those with low participation level and no participation renders inconclusive results for these groups in all models (46). Nonetheless, our analysis using participation as a continuous score supports our conclusion that higher participation is needed to improve egg consumption and linear growth outcomes.

Another limitation is that we did not assess participation in other NL platforms. Specifically, the project promoted diverse and balanced diets through Mother-to-Mother Support Groups and food demonstrations in the intervention areas; these activities were less frequent and were open to all community members. Thus, it was more difficult to evaluate the involvement of the intervention participants and we did not include the participation in these components. Nonetheless, some of these activities might have contributed to the outcomes.

Our estimate of women's participation level has limitations. For instance, unobservable traits that could explain women's higher participation, such as willingness to participate at a specific level or expectations of the outcomes, could introduce positive selection bias into our estimates. Women who are more eager to participate or who are interested in obtaining specific outcomes are likely to have participated more intensely. We were not able to correct for this potential endogeneity. To our surprise, some of the observable traits that could have increased selection bias, such as having raised chickens in the past (18) and household size (47)—a proxy for support—were not associated with participation level. Other nuances such as having experience raising free-ranged compared with caged chickens, small compared with large flock sizes, and household composition should be further analyzed in future studies.

Other aspects that affect program adoption, according to the diffusion of innovations theory are education, wealth status, and social connections (48). To our surprise, wealth was inversely associated with participation in our sample. Finally, other studies could also explore self-efficacy (49) regarding animal husbandry, nutrition knowledge (50), financial literacy, time demand (51), and income decision-making (52) as determinants of adoption and participation.

Participation might have varied through the year by seasons, festivities, and by the duration of program exposure. Yet, our post hoc assessment of overall participation did not allow us to elucidate these differences. Also, weekly contact with the participants for an entire year might have introduced bias in the nutrition educators' assessments, given that during this time they might have become acquainted with some participants. Moreover, having had only 2 of the 3 nutrition educators evaluating Phase 2 participants might have introduced bias in the evaluation, which might be reflected in the lower reliability values found for this phase.

The high correlation coefficients among the items in our participation composite index—an indication that all items are measuring the same underlying concept—might also show redundancy in our measurement (53). In addition, this unidimensionality could reflect that some characteristics of women that increase participation also increase its immediate outcomes, as mentioned earlier. Finally, it also suggests that assessing only 1 item of participation level (e.g. attendance) might suffice when examining the immediate outcomes of interventions.

Despite these limitations, our study responds to the scarcity of research regarding participation in NSA interventions. In summary, the results of our study and those mentioned above revealed that participation level—measured either through a composite index, through the number of intervention components partaken, or through the degree of exposure to the components—is essential to maximize children's dietary and anthropometric outcomes. These results are promising for stakeholders showing that if higher participation levels are reached, NSA interventions could double their impact on child nutritional outcomes, independently of the baseline characteristics of the children's mothers. However, further studies are needed to identify the most relevant components of participation in NSA interventions for different child nutritional outcomes. With standardized instruments to monitor and evaluate participation levels in different interventions, future studies could examine the determinants of participation levels to address and improve it as well as estimate thresholds in participation levels needed to maximize nutrition outcomes.

Finally, our results show the level of participation in an NSA intervention under real-life situations. The NL was delivered as initially designed, the project facilitated the procurement of inputs for gardens and chicken husbandry. Future interventions might benefit from understanding the facilitators and barriers to adoption and participation to adapt their designs and improve outcomes (54) or use this information to recruit participants who might be more motivated to participate and more likely to benefit.

Acknowledgments

We thank Roger Cue for his advice on statistical analyses, and Afua Atuobi-Yeboah, Boateng Bannerman, Felix Tettey Tetteh, Baadu

Kingsford Kwesi, and Stephen Asare Matey for their constant support in providing field monitoring information.

The authors' responsibilities were as follows—GSM, EKC, RK, and BAA: designed the NL intervention; DD: designed and conducted research on the participation level assessment, analyzed data, wrote the manuscript, and had primary responsibility for final content; and all authors: read and approved the final manuscript.

References

1. Ghana Statistical Service (GSS). Multiple Indicator Cluster Survey (MICS 2006), Survey Findings Report. Accra (Ghana): GSS; 2006.
2. Ghana Statistical Service (GSS). Multiple Indicator Cluster Survey (MICS 2017/18), Survey Findings Report. Accra (Ghana): GSS; 2018.
3. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, Ezzati M, Grantham-McGregor S, Katz J, Martorell R, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet 2013;382(9890):427–51.
4. Cooke E, Hague S, McKay A. The Ghana Poverty and Inequality Report: Using the 6th Ghana Living Standards Survey. UNICEF, University of Sussex UK, Ashesi University College Ghana; 2016.
5. Ruel MT, Alderman H. Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? Lancet 2013;382(9891):536–51.
6. Sharma IK, Di Prima S, Essink D, Broerse JEW. Nutrition-sensitive agriculture: a systematic review of impact pathways to nutrition outcomes. Adv Nutr 2021;12(1):251–75.
7. Berti PR, Krasevec J, FitzGerald S. A review of the effectiveness of agriculture interventions in improving nutrition outcomes. Public Health Nutr 2004;7(5):599–609.
8. Masset E, Haddad L, Cornelius A, Isaza-Castro J. Effectiveness of agricultural interventions that aim to improve nutritional status of children: systematic review. BMJ 2012;344(jan17 1):d8222.
9. Webb Girard A, Self JL, McAuliffe C, Olude O. The effects of household food production strategies on the health and nutrition outcomes of women and young children: a systematic review. Paediatr Perinat Epidemiol 2012;26 (Suppl 1):205–22.
10. Webb P, Kennedy E. Impacts of agriculture on nutrition: nature of the evidence and research gaps. Food Nutr Bull 2014;35(1):126–32.
11. Ruel MT, Quisumbing AR, Balagamwala M. Nutrition-sensitive agriculture: what have we learned so far? Glob Food Sec 2018;17:128–53.
12. Menon P, Covic NM, Harrigan PB, Horton SE, Kazi NM, Lamstein S, Neufeld L, Oakley E, Pelletier D. Strengthening implementation and utilization of nutrition interventions through research: a framework and research agenda. Ann NY Acad Sci 2014;1332(1):39–59.
13. Rossi PH, Lipsey MW, Henry GT. Evaluation: a systematic approach. 8th ed. Thousand Oaks (CA): SAGE Publications; 2018.
14. Bell SH, Peck LR. On the feasibility of extending social experiments to wider applications. JMDE 2016;12(27):93–111.
15. Penny ME, Creed-Kanashiro HM, Robert RC, Narro MR, Caulfield LE, Black RE. Effectiveness of an educational intervention delivered through the health services to improve nutrition in young children: a cluster-randomised controlled trial. Lancet 2005;365(9474):1863–72.
16. Robert RC, Gittelsohn J, Creed-Kanashiro H, Penny ME, Caulfield LE, Narro MR, Black RE. Process evaluation determines the pathway of success for a health center-delivered, nutrition education intervention for infants in Trujillo. J Nutr 2006;136(3):634–41.
17. Bezner Kerr R, Berti PR, Shumba L. Effects of a participatory agriculture and nutrition education project on child growth in northern Malawi. Public Health Nutr 2011;14(8):1466–72.
18. de Brauw A, Eozenou P, Moursi M. Programme participation intensity and children's nutritional status: evidence from a randomised control trial in Mozambique. J Dev Stud 2015;51(8):996–1015.
19. Century J, Rudnick M, Freeman C. A framework for measuring fidelity of implementation: a foundation for shared language and accumulation of knowledge. Am J Eval 2010;31(2):199–218.
20. Borrelli B, Sepinwall D, Ernst D, Bellg AJ, Czajkowski S, Breger R, DeFrancesco C, Levesque C, Sharp DL, Ogedegbe G. A new tool to assess treatment fidelity and evaluation of treatment fidelity across 10 years of health behavior research. J Consult Clin Psychol 2005;73(5):852.
21. Resnick B, Inguito P, Orwig D, Yahiro JY, Hawkes W, Werner M, Zimmerman S, Magaziner J. Treatment fidelity in behavior change research: a case example. Nurs Res 2005;54(2):139–43.
22. Forman SG, Shapiro ES, Codding RS, Gonzales JE, Reddy LA, Rosenfield SA, Sanetti LMH, Stoiber KC. Implementation science and school psychology. Sch Psychol Q 2013;28(2):77.
23. Carroll C, Patterson M, Wood S, Booth A, Rick J, Balain S. A conceptual framework for implementation fidelity. Implement Sci 2007;2(1):40.
24. Durlak JA, DuPre EP. Implementation matters: a review of research on the influence of implementation on program outcomes and the factors affecting implementation. Am J Community Psychol 2008;41(3–4):327–50.
25. Rowbotham S, Conte K, Hawe P. Variation in the operationalisation of dose in implementation of health promotion interventions: insights and recommendations from a scoping review. Implement Sci 2019;14(1):56.
26. Marquis GS, Colecraft EK, Kanlisi R, Aidam BA, Atuobi-Yeboah A, Pinto C, Aryeetey R. An agriculture-nutrition intervention improved children's diet and growth in a randomized trial in Ghana. Matern Child Nutr 2018;14:e12677.
27. Ghana Statistical Service (GSS). 2010 Population and Housing Census. District analytical report. Upper Manya Krobo District. Accra (Ghana): GSS; 2014.
28. De Vries J. Passing on the gift as an approach to sustainable development programmes. Dev Pract 2012;22(3):373–84.
29. Baumgartner TA. Estimating the stability reliability of a score. Meas Phys Educ Exerc Sci 2000;4(3):175–8.
30. Neuman WL. Social research methods: qualitative and quantitative approaches. 7th ed. Harlow (ND): Pearson Education, Inc.; 2014.
31. Koo TK, Li MY. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. J Chiropr Med 2016;15(2):155–63.
32. Bland JM, Altman DG. Statistics notes: Cronbach's alpha. BMJ 1997;314(7080):572.
33. DeVellis RF. Scale development: theory and applications. 4th ed. Los Angeles (CA): SAGE Publications; 2017.
34. WHO. Indicators for Assessing Infant and Young Child Feeding Practices: Part 1: definitions: conclusions of a consensus meeting held 6–8 November 2007 in Washington DC, USA: WHO; 2008.
35. WHO. WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development. Geneva (Switzerland): WHO; 2006. Report No.: 924154693X.
36. ELCSA Scientific Committee. Escala Latinoamericana y Caribena de Seguridad Alimentaria (ELCSA): Manual de Uso y Aplicaciones. Rome (Italy): FAO; 2012.
37. Sharpe D. Chi-square test is statistically significant: now what? Pract Assess Res Evaluation 2015;20: Article 8.
38. SAS Institute Inc. SAS/STAT® 15.1 user's guide. Cary (NC): SAS Institute Inc.; 2018.
39. Lee S, Lee DK. What is the proper way to apply the multiple comparison test? Korean J Anesthesiol 2018;71(5):353.
40. Stroup WW. Mixed model procedures to assess power, precision, and sample size in the design of experiments. Proceedings-Biopharmaceutical Section. Alexandria (VA): American Statistical Association; 1999. p. 15–24.
41. Kim SS, Nguyen PH, Yohannes Y, Abebe Y, Tharaney M, Drummond E, Frongillo EA, Ruel MT, Menon P. Behavior change interventions delivered through interpersonal communication, agricultural activities, community mobilization, and mass media increase complementary feeding practices and reduce child stunting in Ethiopia. J Nutr 2019;149(8):1470–81.
42. Suresh S, Paxton A, Pun BK, Gyawali MR, Kshetri ID, Rana PP, Cunningham K. Degree of exposure to interventions influences maternal and child dietary

practices: evidence from a large-scale multisectoral nutrition program. PLoS One 2019; 14(8):e0221260.
43. Passarelli S, Ambikapathi R, Gunaratna NS, Madzorera I, Canavan CR, Noor AR, Worku A, Berhane Y, Abdelmenan S, Sibanda S. A chicken production intervention and additional nutrition behavior change component increased child growth in Ethiopia: a cluster-randomized trial. J Nutr 2020;150(10):2806–17.
44. Gelli A, Margolies A, Santacroce M, Roschnik N, Twalibu A, Katundu M, Moestue H, Alderman H, Ruel M. Using a community-based early childhood development center as a platform to promote production and consumption diversity increases children's dietary intake and reduces stunting in Malawi: a cluster-randomized trial. J Nutr 2018;148(10): 1587–97.
45. Kadiyala S, Harris J, Headey D, Yosef S, Gillespie S. Agriculture and nutrition in India: mapping evidence to pathways. Ann NY Acad Sci 2014;1331(1):43–56.
46. Fagley NS. Applied statistical power analysis and the interpretation of nonsignificant results by research consumers. J Couns Psychol 1985;32(3):391.
47. Sodjinou E, Henningsen A. Community-based management and interrelations between different technology adoption decisions: innovations in village poultry farming in Western Africa. Copenhagen (Denmark): University of Copenhagen, Department of Food and Resource Economics (IFRO); 2012.
48. Rogers EM. Diffusion of preventive innovations. Addict Behav 2002;27(6):989–93.
49. Bandura A. Self-efficacy: toward a unifying theory of behavioral change. Psychol Rev 1977;84(2):191.
50. Damron D, Langenberg P, Anliker J, Ballesteros M, Feldman R, Havas S. Factors associated with attendance in a voluntary nutrition education program. Am J Health Promot 1999;13(5):268–75.
51. Kumar N, Nguyen PH, Harris J, Harvey D, Rawat R, Ruel MT. What it takes: evidence from a nutrition- and gender-sensitive agriculture intervention in rural Zambia. J Dev Effect 2018;10(3):341–72.
52. Santoso M, Bezner Kerr R, Kassim N, Mtinda E, Martin H, Hoddinott J, Young S. Predictors of program participation in a nutrition-sensitive agroecological intervention in Singida. Curr Dev Nutr 2020;4(Supplement_2):903.
53. Tavakol M, Dennick R. Making sense of Cronbach's alpha. Int J Med Educ 2011;2:53–5.
54. Nguyen PH, Menon P, Keithly SC, Kim SS, Hajeebhoy N, Tran LM, Ruel MT, Rawat R. Program impact pathway analysis of a social franchise model shows potential to improve infant and young child feeding practices in Vietnam. J Nutr 2014;144(10):1627–36.