A poultry value chain intervention promoting diversified diets has limited impact on maternal and child diet adequacy during the lean season in a cluster randomized controlled trial\textsuperscript{1-4}

Elodie Becquey\textsuperscript{5}, Loty Diop\textsuperscript{5}, Josue Awonon\textsuperscript{5}, Ampa D. Diatta\textsuperscript{5}, Rasmame Ganaba\textsuperscript{6}, Abdoulaye Pedehombga\textsuperscript{6}, and Aulo Gelli\textsuperscript{5}.

\textsuperscript{5} International Food Policy Research Institute (IFPRI), 1201 I Street NW, Washington, DC 20005, USA, \textsuperscript{6} AFRICSante, Burkina Faso.

**Corresponding author**: Elodie Becquey, International Food Policy Research Institute (IFPRI), 1201 I Street NW, Washington, DC 20005, USA. Email: e.becquey@cgiar.org

**Authors’ last names for PubMed indexing**: Becquey, Diop, Awonon, Diatta, Ganaba, Pedehombga, Gelli

**Word count**: 4,631

**Number of figures**: 1

**Number of tables**: 5

**Running title**: Poultry interventions and maternal and child diets.

\textsuperscript{1}Supplementary Tables 1-5 are available from the “Online Supporting Material” link in the online posting of the article and from the same link in the online table of contents at jn.nutrition.org

\textsuperscript{2}Funding: This work was supported by the Bill & Melinda Gates Foundation (grant number: OPP1149709). Additional support was from the CGIAR Research Program on Agriculture for Nutrition and Health (A4NH), led by IFPRI (subgrant number A4NH-202004.040.500).
Author disclosures: EB, LD, JA, ADD, RG, AP, AG, no conflicts of interest.

Abbreviations:

BCC  Behavior change communication
IDDS  Individual Dietary Diversity Score
IYC  Infants and young children
IYCF  Infant and young child feeding
MPA  Mean probability of adequacy
NGO  Non-governmental organization
PA  Probability of adequacy
pp  Percentage point
SELEVER  Soutenir l’Exploitation Familiale pour Lancer l’Élevage des Volailles et Valoriser l’Économie Rurale, a nutrition- and gender-sensitive poultry value chain project designed and implemented by international NGO Tanager which consists of poultry market facilitation and behavior change activities aiming at increasing poultry production and improving diets without free inputs transfer.
SELEVER+WASH  SELEVER interventions with a hygiene and sanitation intervention
WASH  Water, Hygiene and Sanitation
A poultry value chain intervention promoting diversified diets had limited impact on maternal and child diet adequacy during the lean season in a cluster randomized controlled trial

Abstract

**Background:** SELEVER is a nutrition- and gender-sensitive poultry value chain project designed and implemented by international NGO Tanager which consists of poultry market facilitation and behavior change activities aiming at increasing poultry production and improving diets without free inputs transfer.

**Objective:** The study aimed at assessing the impact of SELEVER on diets of women and children during the lean season.

**Methods:** Within a cluster-randomized controlled trial, 45 communes were assigned to one of three arms, including 1) SELEVER interventions; 2) SELEVER with an intensive hygiene and sanitation component (SELEVER+WASH); and 3) a control group without intervention. Two rounds of survey were conducted 2 years apart during the lean season. Primary dietary outcomes were the probability of adequacy (PA) of iron, zinc and vitamin A intakes, mean PA (MPA) of 11 micronutrients and individual dietary diversity score collected through quantitative 24-hour recall in longitudinal samples of women and index children (2-4 years old) in 1,054 households; and minimum acceptable diet in the repeated cross-sectional sample of their younger sibling aged 6-23 months. Impacts were assessed by intention-to-treat analysis of covariance.

**Results:** Relative to control, SELEVER interventions (groups 1+2) increased the PA of iron intakes in women by 1.8 pp (P=0.030). We found no further impact on primary outcomes,
although eggs consumption increased in index children (+0.73 pp, P=0.010; +0.69 kcal/d, P=0.036). Across the three groups, we observed negative effects of SELEVER on the PA of zinc intakes in women relative to SELEVER+WASH (-4.1 pp, P=0.038), and on a variety of secondary dietary outcomes relative to both other groups.

**Conclusions:** information-only-based value-chain interventions may not have meaningful positive effects on diets of women and children in the lean season in settings with largely inadequate diets. We found suggestive evidence that synergies between intervention components may have introduced heterogeneity in effects on diet.

**Keywords:** Behavior change communication; cluster-randomized controlled trial; dietary diversity; micronutrient intake; nutrition-sensitive poultry value chain.

The study was registered on the ISCRCTN registry (ISRCTN16686478).
Introduction

Recent estimates on the global burden of disease attribute 20% of deaths to unhealthy diets (1). In their development of the United Nations 2030 Sustainable Development Agenda, policymakers highlighted the need for agricultural programs to support improved diets, nutrition and health. Nutrition-sensitive programs can be leveraged to deliver nutrition interventions at scale (2). In particular, evidence reviews have found that integrated agriculture and nutrition interventions consistently improve household access to nutritious foods, leading to improvements in the diets of mothers and young children (2,3).

Within nutrition-sensitive agriculture intervention, livestock interventions in particular can provide low-income households with both a livelihood and a source of high-quality protein and bioavailable micronutrients (4,5). Poultry interventions are particularly relevant for poverty alleviation due to their near ubiquity in low-income settings (6), the potential market opportunity from the demand from urban consumers to accelerate poultry-sector transformation, the relatively modest investment needed, and the potential contribution from eggs and poultry meat to diets in both rural and urban settings (7).

Despite this potential, there is little rigorous evidence on the role of livestock interventions in improving diets, particularly those involving information only (3). The potential role of interventions in food value chains in improving diets has received recent attention, including the need to consider how food is produced, processed, distributed and marketed (8–10). However, there is also a dearth in the evidence on the effectiveness on diet outcomes of scaling-up nutrition interventions through value chain and market facilitation platforms. The one experimental study we are aware of which measured diet outcomes in the context of a poultry value chain intervention found promising results in Ethiopia, with a positive impact of the intervention on
child diet diversity (11), although the impact on the micronutrients adequacy of the diet was not assessed and remains unknown. Yet, the positive impact on diet diversity was not found in the lean season. However, in countries such as Burkina Faso (our country of focus), evidence shows that overall diet adequacy significantly decreases in the lean season, when food insecurity increases (12–14). Therefore, the burning question of the actual effectiveness on diet adequacy of poultry value chain interventions aiming at improving diets needs to be answered while considering the possible modifying effect of the season.

This study aimed at providing new experimental evidence on the impact on the diets of women and young children during the lean season of an integrated livestock production and nutrition intervention implemented in a poultry market system in Burkina Faso. Our hypothesis was that impact estimates during the lean season would be lower bounds for effectiveness of Behavior Change Communication (BCC) type interventions because rural households face higher resource constraints and consume lower quality diets compared to the post-harvest period. This paper draws on the pre-specified analysis of data from a sub-sample of the SELEVER trial and focusses on the diet-related primary outcomes of the trial (15). The results on the other primary outcomes (poultry production and marketing) in the lean season have been published separately (16).

**Methods**

**Country context**

Burkina Faso, a Sahelian country, chronically suffers from high rates of child and maternal malnutrition (17). Infant and young child feeding (IYCF) practices are particularly poor. A recent study estimated that Burkina Faso had the second lowest dietary diversity score in the
world (18). Fourteen percent of children under two years had consumed poultry flesh and egg consumption was limited to 3% of children in the same age group, whilst 80% of households owned poultry.

**Intervention**

Soutenir l’Exploitation Familiale pour Lancer l’Élevage des Volailles et Valoriser l’Économie Rurale (SELEVER) or Women’s Poultry Program to Improve Income and Nutrition project, funded by the Bill & Melinda Gates Foundation, was implemented by the international non-governmental organization (NGO) Tanager in partnership with in-country NGOs, private institutions, and government services. SELEVER aimed at increasing poultry production and improving the diets and nutritional status of women and children. The project approach involved a set of components combining poultry revenue generation, women’s empowerment, and nutrition BCC, and specifically excluded any input or food distribution for free. The roll-out at community level by the NGOs involved cascade trainings (i.e. training of trainers), follow-up home visits, peer-group support and advocacy/sensitization, and was facilitated and/or conducted by key community members such as religious or traditional community leaders, women leaders, “Champion husbands”, “Model women”.

The poultry component included training of volunteers on poultry husbandry and of village volunteer popularizers to improve the quality of their extension services. Trainings included nutrition-related modules for the promotion of consumption of animal source foods and basic hygiene practices, as well as messaging on women’s empowerment. Other activities at community level included leveraging micro-credit groups as platforms to implement the poultry related trainings.
The nutrition component included BCC on nutrition and diets provided through women’s groups, poultry producer groups and local community leaders. The topics of the BCC activities included basic hygiene and the promotion of improved diets at key stages of the lifecycle: this included IYCF practices and diet diversity promotion through the promotion of daily consumption of 3 key food groups: energy giving foods (starchy staples and fats), protective foods (fruits and vegetables) and body building foods (animal source foods, legumes and nuts). The gender component included community-level sensitization on women’s economic empowerment and gender equity, including strengthening of women’s groups, training participants from existing women’s associations on enterprise development and strengthening women’s role in decision-making within households and in the community.

The program impact pathways through which the integrated agriculture and nutrition intervention could affect children’s diets were based on the program theory of value chain for nutrition interventions (19). Briefly, the SELEVER package could have an impact on diets through four interlinked pathways based on leveraging (i) demand; (ii) supply of nutritious foods; (iii) enhancing nutrition related value addition along a chain and (iv) empowering women (15).

**Study design**

A cluster randomized controlled trial was designed to assess the 3-year impact on dietary and poultry production outcomes of the SELEVER intervention, with (SELEVER+WASH) or without (standard SELEVER) additional poultry-related hygiene and sanitation (WASH) behavior change activities inspired from the community-led total sanitation approach. This manuscript presents an intermediary analysis to assess the impact of the intervention on dietary
outcomes (see below) during the lean season after two years of implementation. The overall study protocol was published elsewhere (15).

**Sampling design**

The study area includes rural and peri-urban communities from sixty communes within the Hauts-Bassins, Boucle du Mouhoun, and Centre-Ouest regions. The random allocation was undertaken in two stages through restricted randomisation by modelling selection using a set of commune- and village-level variables obtained from the 2006 census (20). During the first stage randomization, communes were randomly assigned to one of two treatment arms (SELEVER Treatment versus Control). The second stage randomization further divided the treatment communes into two, including a SELEVER group (standard SELEVER intervention) and a SELEVER+WASH group with additional poultry-WASH BCC activities (Figure 1). The control communes were also further divided into two, and diet data collection was conducted in 15 control communes. The program randomly selected two villages in each commune. In each village, 12 households with children in the 2-4 years age group were randomly selected from a census conducted prior to the baseline survey, with over-representation of large poultry producing households (defined as owning over 20 chickens/fowls at baseline), and an index child in the 2-4 years age range was then randomly selected for inclusion in the biomedical component of the analysis, with the primary female caregiver. We also surveyed repeated cross-sectional samples of infants and young children (IYC sample) comprising, for each survey round, the youngest child aged less than 24 months of age of the index caregiver, if any. The power calculations for selecting sample size for women, and target children, were based on 80% statistical power and \( \alpha = 0.05 \), and were calculated using data from an observational study examining food intake in two of the three selected regions (12,21).
Primary outcomes

Primary outcomes for women (aged 15–49 years at baseline) and target children (aged 2–4 years at baseline) were individual dietary diversity score (IDDS, defined as the number of food groups consumed the previous day of 10 standard food groups)(22); and the probability of adequacy (PA) of intake for iron, zinc, and vitamin A, and mean probability of adequacy (MPA) in micronutrient intake of 11 micronutrients; Minimum acceptable diet in 6-23 months old children (23) was defined as the primary outcome in the cross-sectional IYC samples. Household poultry production, sales, and profits were the remaining primary outcomes of this study and were published separately (16).

Data collection

Data collection was performed electronically using a user-friendly Computer Assisted Personal Interview survey form designed in the application SurveyBe. Enumerators completed the survey on Android and Microsoft Windows tablets. All survey tools were written in French and the enumerators spoke both French and local languages.

Enumerators visited the household a first time and collected a wide range of indicators at village, household, caregiver and child-level. Index women and their husbands were separately asked about their participation in the various activities related to SELEVER over the previous 12 months. Individual responses were aggregated to obtain household level estimates of exposure. Standard IYCF practices were then collected through recall with caregivers of children in the IYC sample (24). At the end of this visit, enumerators distributed standard kitchen utensils commonly used in the area. They instructed women to not change their eating habits or the ones of the index child on the following days, except for both eating separately from the rest of the family and from each other, using one plate and one bowl each to serve their food. This was
intended to minimize difficulties in quantifying individual dietary intakes, as serving food in a common pot was standard practice. Enumerators also emphasized that the mother paid attention to quantities consumed for herself and her child. Although such recommendations might slightly influence behavior, we expected gains in accuracy of data and did not expect this potential bias to differ by treatment group.

Two or three days after the first visit, dietary intake data was collected by specifically-trained enumerators using an interactive 24-hour recall method (25). A second recall was collected at least two days after the first recall in 2 randomly selected dyads per village. All days of the week were considered. The steps in the recall were as follows:

- First pass, caregiver: the respondent recalled the complete list of all foods, drinks and snacks consumed during the previous 24-hrs period.
- Second pass, caregiver: a precise description and mode of preparation of all foods consumed, including recipes for mixed dishes, allowed the enumerator to select the appropriate foods within a pre-loaded, comprehensive list of foods based on previous work in Burkina Faso (26,27) and the FAO food Composition Table for West Africa (28).
- Third pass, caregiver: the respondent was prompted to mentally visualize and then quantify the amount of each ingredient used in recipes, as well as the size of the portions consumed, using the most appropriate method (see below). Wasted and non-consumed parts of foods and ingredients were documented.
- Passes 1-3, child: Once the recall was finished for the mother, the enumerator used the same method to recall food consumption of her child.
• Forth pass: The enumerator recapitulated the whole list of foods consumed by both the mother and her child to verify if every food was correctly listed and quantified for each respondent.

Prior to the survey, each unique food in the food list had been assigned a preferred measurement method and defined other authorized measurement methods. Enumerators were made aware of these methods through the software. These methods included the weighing of a replicate, volume measurements with water, referring to a picture atlas, modeling food size with clay or using wooden or plastic models, calibrating household measures, or collecting prices.

**Data Management and indicators creation**

All data management was executed in Stata. Volumes and household measures were converted to weight values using conversion tables of density and of specific household measures. Conversion factors were calculated as the average of household-specific conversion factors collected in other households of the whole sample, when available, or were collected through a separate market survey, and some came from a previous survey (27).

Food composition table (FCT) and the A table of edible proportions were based on the FAO FCT and previous literature and published work in Burkina Faso (26,28,29). To account for nutrients lost during cooking, retention factors were applied to all foods which underwent heat exposure during preparation (30).

Classification of foods into 10 food groups followed the FAO’s Minimum Dietary Diversity for Women guidelines for index children and caregivers (22). Unclassified foods included spices, sugar, salt, oils, and other condiments, defined as foods consumed in quantities of less than 10
grams in the day (31). For the IYC samples, we compiled IYCF indicators according to standard 2007 guidelines (24).

We used the NCI approach to calculate distributions of usual intakes of 11 micronutrients (vitamin A, vitamin C, thiamin, riboflavin, niacin, vitamin B6, vitamin B12, folate, calcium, zinc and iron) (32). Then, we used the probability approach to calculate the probabilities of adequacy of intake (PA) for these 11 micronutrients (33). We used the relevant estimated average requirements and standard deviations for age, sex and physiological status of the European Food Safety Authority’s dietary reference values for nutrients (34). We adjusted requirements assuming low levels of bioavailability for iron (5%) and zinc (15%), due to high cereal consumption and low animal-product consumption in our population. The MPA was calculated as the mean of the 11 micronutrient PAs.

**Data analysis**

We followed an intention-to-treat approach and used a single difference analysis of covariance (ANCOVA) controlling for village-level clustering (using robust estimations of standard errors) and taking sampling weights into account to examine effects in fist level (Treatment vs control) and second level (SELEVER+WASH vs standard SELEVER) comparisons. For ease of interpretation of coefficients, the regressions used linear (probability) models for both continuous and binary variables. In the latter case, if robust estimations of standard errors are computed, these models produce valid coefficients that represent percentage point changes in probability (35). All analyses adjusted for the baseline value of the outcome, as well as for age and gender (children outcomes) or for age and physiological status (caregivers’ outcomes). Analyses on diet outcomes were further adjusted on whether a market occurred the previous days as it can influence consumption (36). The level of significance was set at 5%. We also discussed
robustness of results of the three study-groups comparisons using the level of significance of 1.7%, which adjusts for multiple testing using the Bonferroni method. Statistical analyses were conducted using Stata 16.0 (Statacorp, TX, USA).

**Ethics**

Ethical clearance was obtained from the Comité d’éthique pour la Recherche en Santé MS/MRSI in Burkina Faso (approved 07/12/2016, ref: 2016-12-142) and from the International Food Policy Research Institute Institutional Review Board in Washington, DC (approved 26/12/2016, ref: IRB00007490). Informed consent was documented in written from each of the household heads prior to the interviews.

**Results**

**Baseline characteristics and loss to follow-up**

The dry season enrollment survey (round 1) included a total of 1054 households with index child and caregiver dyads in 45 communes across the three regions (Figure 1). Generally, there were no substantive differences between study groups at enrollment, except for income generating activities conducted by women (Table 1).

The lean-season pre-intervention baseline survey (round 2) successfully tracked 98% of households (Figure 1). The overall attrition rate at round 3 was inferior to 15% for any study group. Attrition was significantly higher in the SELEVER+WASH group relative to the SELEVER group. However, there were no statistically significant differences between study groups at enrollment in the subsample of non-attributed children, except that the proportion of female primary caregivers with income generating activity was significantly lower in the standard SELEVER group compared to the control group (Supplementary Table 1). We found
the same baseline difference in the subsample of households with a IYC during the lean season endline survey (Supplementary Table 2).

For diet analyses, we excluded 2 caregivers at round 2 who both reported extreme portions sizes across several foods consumed, resulting in more than 22,000 kcal consumed over 24h; 1 caregiver at round 2 who reported drinking only black coffee over 24h (0 kcal) with no explanation; and 1 index child at round 2 who was reported sick and consumed only 67 kcal of milk over 24h.

Program exposure

In the 12 months preceding the endline survey, 27% of households in treatment villages attended at least one training of each of the 3 themes (poultry, nutrition/gender and WASH) through the participation of the father and/or mother of an index child, hence were exposed to all 3 components of the intervention, compared to 2.3% of households in control villages (P<0.001, Table 2).

Impact of the intervention (SELEVER and SELEVER+WASH) compared to control

Overall nutrient adequacy was low in all study groups and all time points in both caregivers and index children (Table 3). The intervention increased the PA of iron intakes in women by 1.8 percentage points (pp). The intervention had no impact on the PA of iron intakes in index children, or on the PAs of vitamin A and zinc intakes and the MPA in women and index children.
In IYC, IYCF indicators were also suggestive of poor diets at baseline, with less than 15% of the sample meeting minimum acceptable diet; the intervention had no impact on this primary indicator (Table 4).

We also looked at the impact of the SELEVER interventions on secondary dietary indicators including the prevalence of consumption of food groups as promoted by the program BCC (Table 5), the prevalence of consumption and quantities consumed of food groups according to standard classifications (supplementary tables 4 and 5), other IYCF practices besides minimum acceptable diet (table 4), and the quantities of nutrients intakes and PAs of the 8 other micronutrients used to calculate MPA (supplementary table 3). We found a significant increase in eggs consumption in index children (in terms of both prevalence and quantity consumed), and a significant increase of the prevalence of IYC who consumed all 3 promoted food groups in the previous 24 hours; but no further impact of the SELEVER interventions.

Second-level comparison of the 3 study groups (SELEVER versus SELEVER+WASH versus control)

When examining comparisons of both primary and secondary indicators across the three treatment groups, we found either no differences across groups, or some negative results in the SELEVER group compared either to the control group (quantity of nuts and seeds consumed and quantity of zinc intakes in children; and IDDS in IYC) or to the SELEVER+WASH group (prevalence of consumption of pulses, quantity of protein consumed and PA of zinc intakes in women; quantity of iron consumed in children; and prevalence of flesh foods intake and IDDS in IYC). On the other hand, in IYC, the prevalence of consumption of oils and fats and the minimum meal frequency were greater in the SELEVER group compared to either the control or the SELEVER+WASH groups. There were no differences between the SELEVER+WASH...
group and the control group except for a positive effect of SELEVEL+WASH on the PA of iron intakes in women and on IDDS in IYC. The large majority of these differences were not significant at the revised level of significance of 1.7%.

**Discussion**

This study is among the first cluster randomized control trial evaluating the effectiveness on diets of using a poultry value chain platform to improve diets of women and children during the lean-season in rural, food-insecure settings; to our knowledge, this is the first which measured the impact on diet adequacy. The rigorous evidence presented in this paper suggests that during the lean season, the integrated agriculture and nutrition interventions, incorporating training to improve poultry production systems and market facilitation, alongside BCC on improved diets and women’s empowerment, had negligible to no effect on the adequacy of micronutrient intakes for women and children aged 2-4y, or on appropriate complementary feeding.

Participation to the intervention was offered to anyone interested in the community and the intervention relied mainly on community engagement and self-selection for trainings. The moderate program exposure in our sample may partially explain its limited impact. Both coverage and quality of counselling have been shown to be crucial to nutrition impact of BCC interventions (37). The moderate coverage may be reflective of an insufficient incentive power of this type of intervention for alleviating other barriers to program participation. In addition, previous evidence is suggestive that economic constraints, and not information constraints, may be binding during the lean season and thus information alone may be necessary but not sufficient to behavior change (10). Further evidence from implementation research on poultry-for-nutrition
projects including assets transfers in 4 African countries recognized that practices are challenging to increase, including egg consumption, as well as best poultry-rearing practices and productivity (38). This seemed to be the case for SELEVER, as households exposed to the intervention significantly increased their use of poultry inputs and reported higher revenue; however, there was no evidence of an increase in profits in the lean season (16). Therefore, we expected the impact of the intervention on diet during the lean season to be lower bounds of the potential effectiveness of the BCC intervention during the post-harvest season when household economic resources are less constrained.

Our results are in line with this hypothesis, as we found very few dietary improvements overall. At the population level, the average PA of a given micronutrient is equivalent to a prevalence of adequacy of intake of this micronutrient. We found that the prevalence of adequate iron intakes in women improved by less than 2 pp, which does not seem meaningful at the population level. Furthermore, this was not supported by significant improvements in iron intakes or in intakes of iron-rich food groups. Likewise, the magnitude of the improvement in eggs consumption in children (less than 1 pp and 1 kcal/day) was far below what is required to improve diet adequacy (39). Results from the impact evaluation of a nutrition-sensitive poultry production intervention in Ethiopia further support, in the specific context of a poultry value chain, the hypothesis that nutrition BCC is necessary, but not sufficient, to impact diets in the lean season (11). Indeed, a positive impact on overall child diet diversity was observed only in the arm integrating nutrition BCC in addition to the poultry production intervention; however, this was observed only in the season of moderate food security (endline), but not in the season of lowest food security (midline). It must be acknowledged that the Ethiopia intervention involved a transfer of 25 chicks per household, which may have partially alleviated some of the economic constraints on
beneficiaries. Nevertheless, in our setting, it remains unknown if the negligible impacts on diet indicators in the lean season would increase in the dry season. This hypothesis will be examined explicitly on completion of the randomized trial.

Beyond the overall limited impact of the SELEVER intervention, our analysis highlighted unexpected differences across the two SELEVER implementation groups.

Firstly, some significant results are suggestive that the standard SELEVER intervention implemented without the additional WASH component had some negative effects on diets during the lean season relative to the control group or to the SELEVER+WASH group. Although these generally small to moderate differences did not result in significant differences in nutrient intakes, the fact they were negative warrants attention. One hypothesis is that they may result from the nutrition BCC strategy focusing on the promotion of three food groups (energy giving, body building and protective foods) to diversify diets. Baseline data showed that the large majority of caregivers and index children were already consuming every day all three food groups promoted through BCC, with the building food group being the only group with little room for improvement (Table 5). The intervention may have inadvertently sensitized communities with the messaging that daily consumption of all these 3 food groups was adequate in terms of having a healthy diet, leading to intervention households not diversifying within the 3 food groups and resulting in decreased overall diet diversification. The lack of within-group diversification is most relevant within the body building foods. This is also where we observed negative effects, although negatively impacted food groups varied across women (pulses), children (nuts and seeds) and infants (flesh foods). These particular findings have important policy and program design implications for BCC interventions in these low-income contexts. For
example, in Chad, the officially validated flipchart widely used to deliver IYCF BCC is based on this three food groups classification (40).

Nevertheless, as both SELEVER groups received the BCC intervention, this first hypothesis cannot explain alone why the SELEVER+WASH intervention was effective relative to the standard SELEVER intervention with regards to *not decreasing* diet outcomes. Then, three main program-related explanations for this result are possible, including 1) intervention design features providing additional nutrition information in WASH intervention; 2) differential exposure to nutrition BCC because of additional WASH activities (synergized implementers); and 3) synergies between nutrition BCC and WASH activities (synergized beneficiaries). From the intervention design perspective, the additional poultry-WASH related activities did not include additional diet related information. Rather, the activities focused on providing more intensive exposure to hygiene related messaging, including community level sensitization on the potential harmful effects on health of open defecation and livestock feces. The second hypothesis on the synergies between implementers, who because of the additional community level WASH activities were able to coordinate more effectively at community level, was suggested during the process evaluation (41). In this analysis, we had only suggestive evidence that additional WASH activities might have increased coverage or intensity of exposure to other SELEVER interventions, as the coefficients for program exposure indicators reported were consistently, but not significantly, slightly favouring SELEVER+WASH versus standard SELEVER. Also, the additional WASH activities may have somewhat attenuated the negative effects of SELEVER, by diluting some of the messaging on the 3 food groups, or by highlighting the importance of improving child nutrition more broadly, including diets, hygiene and health.
The main strength of this study relies in the rigorous experimental design. One important limitation is that the indicators reported in this analysis rely on self-reported dietary assessment and may thus suffer from respondent and enumerator bias (42). We intended to limit this constraint through prior notice and explanation to the respondents and the provision of standard plates and bowls; intense training and supervision of enumerators; and the use of a user-friendly computer-assisted personal interview giving the necessary probes and indications for the enumerator and the respondent to finely describe food items and use appropriate method(s) to quantify portions. Furthermore, there is no reason to believe that if bias occurred, it was different across study groups. An impact analysis of objective anthropometric and/or biochemical indicators of the nutritional status in our three samples is underway. However, such objective nutrition indicators are determined by a larger set of factors than just food consumption, and previous evidence in our study context confirm that they are not relevant to approximate diets (21).

Our findings have some important policy implications. Firstly, the rigorous evidence presented in this study suggests that information interventions that aim to improve diets in rural food insecure settings may not have a sufficient incentive power to largely expose communities; and may not be effective at the population level without additional transfers to alleviate economic constraints, especially in the lean season. Secondly, there might be synergies between inappropriate diet diversification BCC and the WASH intervention which might have impacted the intensity or salience of the BCC messaging, or of other SELEVER interventions. This highlights the potential to improve interventions effectiveness through better design of the BCC strategy and better understanding of the synergies across multiple intervention components.
Acknowledgments

We thank Tanager for program implementation. The authors’ contributions were as follows: A.G., E.B. designed research; All authors conducted research; L.D., E.B. analyzed data and performed statistical analysis; E.B., A.G. wrote the paper. E.B. had primary responsibility for final content. All authors have read and approved the final manuscript.
Role of funding source

This work was supported by the Bill & Melinda Gates Foundation (grant number: OPP1149709).

We also acknowledge support from the CGIAR Research Program on Agriculture for Nutrition and Health (A4NH), led by IFPRI (subgrant number A4NH-202004.040.500). Freedom to publish the study findings was protected contractually in the agreement between the respective funding sources and IFPRI. All final decisions on the manuscript were made by the researchers.
References

1. Afshin A, Sur PJ, Fay KA, Cornaby L, Ferrara G, Salama JS, Mullany EC, Abate KH, Abbafati C, Abebe Z, et al. Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. Elsevier; 2019;393:1958–72.

2. Ruel MT, Alderman H. Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? Lancet. Elsevier Ltd; 2013;382:536–51.

3. Ruel MT, Quisumbing AR, Balagamwala M. Nutrition-sensitive agriculture: What have we learned so far? Glob Food Sec. Elsevier; 2018;

4. Neumann C, Harris DM, Rogers LM. Contribution of animal source foods in improving diet quality and function in children in the developing world. Nutr Res. 2002;22:193–220.

5. Murphy SP, Allen LH. Nutritional importance of animal source foods. J Nutr. United States; 2003;133:3932S-3935S.

6. Guèye EF. The Role of Family Poultry in Poverty Alleviation, Food Security and the Promotion of Gender Equality in Rural Africa. Outlook Agric. SAGE Publications Ltd; 2000;29:129–36.

7. Iannotti LL, Lutter CK, Bunn DA, Stewart CP. Eggs: the uncracked potential for improving maternal and young child nutrition among the world’s poor. Nutr Rev. United States; 2014;72:355–68.

8. Hawkes C, Ruel MT. Value Chains for Nutrition Case study titles and authors. 2011;
9. Donovan J, Gelli A. Designing interventions in local value chains for improved health and nutrition: Insights from Malawi. World Dev Perspect. Elsevier; 2019;16:100149.

10. Gelli A, Donovan J, Margolies A, Aberman N, Santacroce M, Chirwa E, Henson S, Hawkes C. Value chains to improve diets: Diagnostics to support intervention design in Malawi. Glob Food Sec. Elsevier; 2019;

11. Passarelli S, Ambikapathi R, Gunaratna NS, Madzorera I, Canavan CR, Noor AR, Worku A, Berhane Y, Abdelmenan S, Sibanda S, et al. A chicken production intervention and additional nutrition behavior change component increased child growth in Ethiopia: A cluster-Randomized trial. J Nutr [Internet]. Oxford University Press; 2020 [cited 2021 May 21];150:2806–17. Available from: https://doi.org/10.1093/jn/nxaa181.

12. Arsenault JE, Nikiema L, Allemand P, Ayassou KA, Lanou H, Moursi M, De Moura FF, Martin-Prevel Y. Seasonal differences in food and nutrient intakes among young children and their mothers in rural Burkina Faso. J Nutr Sci [Internet]. 2014 [cited 2018 Nov 29];3:1–9. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4473133/pdf/S2048679014000536a.pdf

13. Becquey E, Martin-Prevel Y, Traissac P, Dembéle B, Bambara A, Delpeuch F. The Household Food Insecurity Access Scale and an Index-Member Dietary Diversity Score Contribute Valid and Complementary Information on Household Food Insecurity in an Urban West-African Setting. J Nutr [Internet]. Oxford University Press; 2010 [cited 2019 Feb 4];140:2233–40. Available from: https://academic.oup.com/jn/article/140/12/2233/4630653

14. Becquey E, Delpeuch F, Konaté AM, Delsol H, Lange M, Zoungrana M, Martin-Prevel Y.
Seasonality of the dietary dimension of household food security in urban Burkina Faso. Br J Nutr [Internet]. Cambridge University Press; 2012 [cited 2021 Dec 27];107:1860–70. Available from: https://www.cambridge.org/core/journals/british-journal-of-nutrition/article/seasonality-of-the-dietary-dimension-of-household-food-security-in-urban-burkina-faso/A2DA70C6B58AD8BC9DA30C59737D4BF6

15. Gelli A, Becquey E, Ganaba R, Headey D, Hidrobo M, Huybregts L, Verhoef H, Kenfack R, Zongouri S, Guedenet H. Improving diets and nutrition through an integrated poultry value chain and nutrition intervention (SELEVER) in Burkina Faso: study protocol for a randomized trial. Trials. BioMed Central; 2017;18:412.

16. Leight J, Awonon J, Pedehombga A, Ganaba R, Martinez EM, Heckert J, Gelli A. The impact of an integrated value chain intervention on household poultry production in Burkina Faso: Evidence from a randomized controlled trial. 2020 [cited 2021 Aug 6]; Available from: https://ebrary.ifpri.org/digital/collection/p15738coll2/id/133686

17. Institut National de la Statistique et de la Démographie - INSD/Burkina Faso and ICF International. Burkina Faso Enquete Demographique et de Sante et Indicateurs Multiples (EDSBF-MICS IV) 2010. Calverton, Maryland, USA: Institut National de la Statistique et de la Demographie - INSD/Burkina Faso and ICF International; 2012.

18. Gelli A, Headey D, Ngure F, Becquey E, Ganaba R, Huybregts L, Pedehombga A, Sanou A, Traore A, Zongo F, et al. Assessing the health and nutrition risks of smallholder poultry production in Burkina Faso: Insights from formative research. Washington, DC; 2017. Report No.: 1665.

19. Gelli A, Hawkes C, Donovan J, Harris J, Allen S, De Brauw A, Henson S, Johnson N,
Garrett J. Value Chains and Nutrition: A Framework to Support the Identification, Design, and Evaluation of Interventions. Washington, DC; 2015.

20. Hayes RJ, Moulton LH. Cluster randomised trials.

21. Martin-Prevel Y, Allemand P, Nikiema L, Ayassou KA, Ouedraogo HG, Moursi M, De Moura FF. Biological status and dietary intakes of iron, zinc and Vitamin A among women and preschool children in rural Burkina Faso. PLoS One. Public Library of Science; 2016;11.

22. FAO and FHI 360. Minimum Dietary Diversity for Women- A Guide to Measurement [Internet]. Rome: FAO; 2016. 82 p. Available from: http://www.fao.org/3/a-i5486e.pdf

23. WHO. Indicators for assessing infant and young child feeding practices Part 1 Definitions [Internet]. Geneva; 2007. Available from: http://apps.who.int/iris/bitstream/handle/10665/43895/9789241596664_eng.pdf?sequence=1

24. WHO. Indicators for assessing infant and young child feeding practices Part 1 Definitions. Geneva; 2007.

25. Gibson RS, Ferguson EL. An interactive 24-hour recall for assessing the adequacy of iron and zinc intakes in developing countries. HarvestPlus Technical Monograph 8. Washington, DC and Cali: International Food Policy Research Institute (IFPRI) and International Center for Tropical Agriculture (CIAT); 2008. 157 p.

26. Arsenault JE, Nikiema L, Allemand P, Ayassou KA, Lanou H, Moursi M, De Moura FF, Martin-Prevel Y. Seasonal differences in food and nutrient intakes among young children and their mothers in rural Burkina Faso. J Nutr Sci [Internet]. 2014;3:e55. Available from:
http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4473133&tool=pmcentrez&rendertype=abstract

27. Becquey E, Delpeuch F, Konaté AM, Delsol H, Lange M, Zounggrana M, Martin-Prevel Y. Seasonality of the dietary dimension of household food security in urban Burkina Faso. Br J Nutr. Cambridge University Press; 2012;107:1860–70.

28. Stadlmayr B, Charrondiere R, Enujiugha VN, Bayili RG, Fagbohoun EG, Samb B, Addy P, Barikmo I, Ouattara F, Oshaug A, et al. West African Food Composition Table. Roma; 2012. 171 p.

29. Becquey E, Capon G, Martin-prével Y. Dietary diversity as a measure of micronutrient adequacy of women’s diet: Results from Ouagadougou, Burkina Faso site. 2009;197.

30. United States Departement of Agriculture. USDA Table of Nutrient Retention Factors - Release 5. 2003.

31. Unicef, WHO, FANTA III, USAID. Meeting Report on Reconsidering, Refining, and Extending the WHO IYCF Indicators. New York; 2017.

32. Tooze JA, Kipnis V, Buckman DW, Carroll RJ, Freedman LS, Guenther PM, Krebs-Smith SM, Subar AF, Dodd KW. A mixed-effects model approach for estimating the distribution of usual intake of nutrients: the NCI method. Stat Med [Internet]. Stat Med; 2010 [cited 2021 Dec 15];29:2857–68. Available from: https://pubmed.ncbi.nlm.nih.gov/20862656/

33. Institute of Medicine. Using the Estimated Average Requirement for Nutrient Assessment of Groups. Dietary Reference Intakes, Applications in Dietary Assessment : a report of the Subcommittees on Interpretation and Uses of Dietary Reference Intakes and Upper Reference Levels of Nutrients, and the Standing Committee on the Scientific Evaluation
of Diet. Washington, DC: National Academy of Sciences; 2000. p. 73–105.

34. Dietary Reference Values for nutrients Summary report. EFSA Support Publ [Internet]. Wiley; 2017 [cited 2021 Dec 15];14. Available from: https://www.efsa.europa.eu/en/supporting/pub/e15121

35. Wooldridge JM. Introductory Econometrics: A Modern Approach. 5th Edition [Internet]. Manson, OH: Cengage Learning; 2012 [cited 2019 Jun 25]. 881 p. Available from: https://economics.ut.ac.ir/documents/3030266/14100645/Jeffrey_M._Wooldridge_Introductory_Econometrics_A_Modern_Approach__2012.pdf

36. Savy M, Martin-Prével Y, Traissac P, Delpeuch F. Measuring dietary diversity in rural Burkina Faso: Comparison of a 1-day and a 3-day dietary recall. Public Health Nutr. Public Health Nutr; 2007;10:71–8.

37. Nguyen PH, Frongillo EA, Sanghvi T, Kim SS, Alayon S, Tran LM, Mahmud Z, Aktar B, Menon P. Importance of coverage and quality for impact of nutrition interventions delivered through an existing health programme in Bangladesh. Matern Child Nutr [Internet]. Wiley-Blackwell; 2018 [cited 2021 Dec 27];14:12613. Available from: /pmc/articles/PMC6175250/

38. Nordhagen S, Klemm R. Implementing small-scale poultry-for-nutrition projects: Successes and lessons learned. Matern Child Nutr [Internet]. Blackwell Publishing Ltd; 2018 [cited 2021 May 21];14. Available from: /pmc/articles/PMC6865962/

39. Caswell BL, Arnold CD, Lutter CK, Iannotti LL, Chipatala R, Werner ER, Maleta KM, Stewart CP. Impacts of an egg intervention on nutrient adequacy among young Malawian children. Matern Child Nutr [Internet]. Wiley-Blackwell; 2021 [cited 2021 Dec 15];17.
Available from: /pmc/articles/PMC8189245/

40. Republique du Tchad, Ministere de la sante Publique Direction de la Nutrition et Technologie Alimentaire. Alimentation du nourrisson et du jeune enfant (Boite a images/Flipchart).

41. Gelli A, Pedehombga A, Diatta AD, Sanou A, Becquey E, Diop L, Eissler S, Heckert J, Ganaba R. Examining the implementation of multisectoral programs: The SELEVER process evaluation [Internet]. 2019. Available from: https://ebrary.ifpri.org/digital/collection/p15738coll2/id/133434

42. Willett W. Nutritional Epidemiology. Oxford, UK: Oxford University Press; 2012.
Figure 1: flow chart of study participants, including longitudinal samples of index children and caregivers and cross-sectional sample of IYC. Abbreviation used: IYC, Infants and young children
Table 1: Characteristics of the study population at enrollment in SELEVER and control communities, Burkina Faso

|                          | Control | Treatment | SELEVER | SELEVER+WASH |
|--------------------------|---------|-----------|---------|--------------|
| **Target children**      |         |           |         |              |
| n                        | 356     | 698       | 353     | 345          |
| Age, mo                  | 40 ± 9.7| 41 ± 10   | 41 ± 10 | 41 ± 10      |
| Male                     | 50%     | 50%       | 48%     | 52%          |
| Sick during the recall day | 7.3%   | 9.7%      | 11%     | 8.4%         |
| **Women**                |         |           |         |              |
| n                        | 356     | 698       | 353     | 345          |
| Biological mother of child | 99%   | 98%       | 98%     | 98%          |
| Age, y                   | 31 ± 7.0| 31 ± 7.1  | 31 ± 7.6| 31 ± 6.5    |
| Married                  | 96%     | 96%       | 96%     | 96%          |
| Never been to formal school | 82%  | 82%       | 79%     | 85%          |
| Income generating activity | 34%  | 26%       | 23%     | 29%          |
| Sick during the recall day | 1.4% | 3.2%      | 4.5%    | 1.7%         |
| Breastfeeding            | 42%     | 39%       | 36%     | 42%          |
| Pregnant                 | 15%     | 13%       | 13%     | 13%          |
| Has a child aged 0-24 months | 39%  | 37%       | 35%     | 38%          |
| Has a child aged 6-24 months | 28%  | 26%       | 25%     | 26%          |
| **Households**           |         |           |         |              |
| n                        | 356     | 698       | 353     | 345          |
| Household head (HH) age, y | 44 ± 13| 44 ± 14   | 43 ± 13 | 45 ± 14      |
| HH is male               | 97%     | 97%       | 98%     | 97%          |
| HH has never been to formal school | 71%  | 70%       | 67%     | 73%          |
| HH has income generating activity | 46%  | 45%       | 45%     | 44%          |
| Household: Moderate or severe hunger | 4.8% | 3.7%   | 2.4%    | 4.9%         |
| Yesterday was a market day in the village | 18%  | 22%       | 18%     | 26%          |

Descriptive values are unadjusted percentages or means with standard deviations.
### Table 2: Exposure in the 12 months prior to the lean season endline survey (round 3) of primary female and male caregivers of the index child to various services which may be provided within SELEVER, by study group

| Component                                    | Control | Treatment | Δ pp | P-value | Round 3 | SELEVER | SELEVER+WASH | SELEVER+WASH | P-value |
|----------------------------------------------|---------|-----------|------|---------|---------|---------|--------------|--------------|---------|
| Father or mother heard of SELEVER            | 27      | 53        | 27   | p<0.001** | 29      | 56      | 26           | p<0.001**     | 3.1     | 0.69    |
| Father or mother said HH benefitted from SELEVER | 2.0    | 27        | 22   | p<0.001** | 23      | 31      | 20           | p<0.001**     | 5.6     | 0.41    |
| **Poultry component**                        |         |           |      |         |         |         |              |              |         |
| Father or mother in Poultry related group     | 4.0     | 24        | 18   | p<0.001** | 20      | 27      | 14           | p<0.001**     | 9.3     | 0.10    |
| Father or mother participated to a talk/group training on poultry raising | 12 | 49 | 32 | p<0.001** | 45 | 52 | 30 | p<0.001** | 4.6 | 0.46 |
| Father and mother, number of poultry training talks attended | 0.18 | 1.7 | 1.3 | p<0.001** | 1.6 | 1.7 | 1.3 | p<0.001** | 0.025 | 0.94 |
| Father or mother benefited from any service at home provided by a VVV | 59 | 66 | 8.0 | 0.25 | 62 | 69 | 5.9 | 0.47 | 10 | 0.20 |
| **Nutrition and gender component**           |         |           |      |         |         |         |              |              |         |
| Father or mother in Nutrition group           | 5.8     | 15        | 8.7  | p<0.001** | 11      | 19      | 5.9          | 0.019*        | 12      | 0.001** |
| Father or mother in Gender group              | 2.9     | 14        | 11   | p<0.001** | 13      | 16      | 10           | p<0.001**     | 13      | 0.043   |
| Father or mother attended meetings on nutrition or gender | 19 | 39 | 19 | p<0.001** | 36 | 42 | 20 | 0.001** | 10 | -1.1 |
| Father and mother, number of nutrition/gender sessions | 0.52 | 1.8 | 1.1 | p<0.001** | 1.5 | 2.0 | 1.1 | p<0.001** | 1.2 | 0.15 |
| Father or mother received a home visit to discuss about nutrition | 4.9 | 14 | 7.0 | 0.0012** | 12 | 16 | 5.2 | 0.045* | 8.8 | 0.0044** |
| Father or mother received a home visit to discuss about women's role | 3.2 | 12 | 6.9 | 0.0024** | 11 | 14 | 4.5 | 0.062 | 9.0 | 0.0021** |
| **WASH component**                           |         |           |      |         |         |         |              |              |         |
| Father or mother in WASH group                | 10      | 27        | 17   | p<0.001** | 19      | 36      | 9.1          | 0.035*        | 26      | p<0.001** |
| Father or mother participated to WASH training attended | 28 | 51 | 25 | p<0.001** | 44 | 55 | 18 | 0.0015** | 32 | p<0.001** |
| Father or mother, number of WASH training sessions | 0.64 | 1.3 | 0.68 | p<0.001** | 1.1 | 1.5 | 0.54 | 0.012** | 0.81 | p<0.001** |
| Father or mother received a home visit to discuss link between children health and hygiene | 11 | 24 | 12 | 0.0012** | 19 | 28 | 6.9 | 0.056 | 17 | 0.001** |
| **Combination of multiple components**        |         |           |      |         |         |         |              |              |         |
| Father or mother attended trainings on poultry and group talks on nutrition, gender | 3.2 | 31 | 25 | p<0.001** | 29 | 34 | 25 | p<0.001** | 25 | 0.001** |
| Father and mother, number of non-WASH sessions | 0.70 | 3.4 | 2.5 | p<0.001** | 3.1 | 3.7 | 2.4 | p<0.001** | 2.5 | 0.012 |
| Father or mother attended trainings on poultry and group talks on nutrition, gender and trainings on WASH | 2.3 | 27 | 21 | p<0.001** | 25 | 29 | 21 | p<0.001** | 23 | 0.001** |
| Father and mother, total number of sessions | 1.3 | 4.7 | 3.7 | p<0.001** | 4.3 | 5.2 | 2.9 | p<0.001** | 3.3 | 0.001** |

**Notes:** Descriptive values are unadjusted percentages. Δ is the linear regression coefficient and represents the change in the outcome in a group versus another group, as indicated in column headers. Stars indicate p-values of comparison of Δ to 0 value. * means p-value <0.05, which is the level of significance set for the study ** means p-value <0.017, which is the level of significance when adjusting for multiple testing across 3 study groups using the Bonferroni method. Abbreviations used: VVV, village volunteer vaccinator and popularizer; WASH, Water, Hygiene and Sanitation.
Table 3: Impact of SELEVER on the probability of adequate intakes of vitamin A, iron and zinc, on the mean probability of adequacy and on IDDS, in caregivers and index children

|       | Round 2 | Round 3 | Treatment versus Control | P value | Treatment versus Control | P value | SELEVER versus Control | P value | SELEVER+ Wash versus Control | P value | SELEVER+ Wash versus SELEVER | P value |
|-------|---------|---------|--------------------------|---------|--------------------------|---------|------------------------|---------|---------------------------|---------|-----------------------------|---------|
| **Caregivers** |         |         |                          |         |                          |         |                        |         |                           |         |                            |         |
| n=339 | n=673   | n=326   | n=630                    |         | n=343                    |         | n=330                  |         | n=328                    |         | n=302                      |         |
| Energy intake, kcal/d | 2007 ± 929 | 2151 ± 886 | 2127 ± 1163 | 2144 ± 984 | 2103 ± 878 | 2201 ± 893 | 2109 ± 885 | 2182 ± 1081 | 2.9 | 0.97 | 126 | 0.33 | 122 | 0.20 |
| PA Vitamin A, % | 0.47 ± 5.1 | 0.57 ± 4.7 | 0.53 ± 5.8 | 0.49 ± 3.4 | 0.25 | 0.23 | 0.29 ± 2.6 | 0.85 ± 6.2 | 0.58 ± 4.3 | 0.39 ± 2.0 | 0.34 | 0.32 | 0.17 | 0.35 | -0.16 | 0.64 |
| PA Iron, % | 44 ± 10 | 43 ± 10 | 38 ± 10 | 37 ± 11 | 1.8 | 0.030* | 43 ± 11 | 43 ± 10 | 36 ± 12 | 38 ± 10 | 1.7 | 0.059 | 1.9 | 0.035* | 0.2 | 0.78 |
| PA Zinc, % | 72 ± 40 | 64 ± 41 | 69 ± 42 | 64 ± 42 | -2.0 | 0.25 | 60 ± 42 | 68 ± 40 | 60 ± 43 | 62 ± 31 | -4.0 | 0.052 | 0.69 | 0.96 | 4.1 | 0.038* |
| MPA, % | 32 ± 5.2 | 31 ± 5.5 | 31 ± 6.3 | 30 ± 7.1 | 0.14 | 0.75 | 31 ± 5.5 | 32 ± 5.4 | 28 ± 7.9 | 31 ± 5.9 | -0.21 | 0.68 | 0.49 | 0.3 | 0.69 | 0.1 |
| IDDS2, food groups | 3.6 ± 0.94 | 3.6 ± 0.99 | 3.7 ± 0.96 | 3.8 ± 1.0 | 0.060 | 0.59 | 3.6 ± 1.0 | 3.6 ± 0.99 | 3.8 ± 1.0 | 3.7 ± 1.0 | -0.020 | 0.87 | -0.10 | 0.49 | -0.081 | 0.60 |

**Index Children**

| n=342 | n=676 | n=321 | n=623 | n=345 | n=331 | n=326 | n=297 |
|-------|-------|-------|-------|-------|-------|-------|-------|
| Energy intake, kcal/d | 1292 ± 628 | 1368 ± 574 | 1512 ± 669 | 1494 ± 642 | 1359 ± 562 | 1378 ± 588 | 1455 ± 627 | 1536 ± 656 | -31 | 0.60 | 46 | 0.53 | 77 | 0.23 |
| PA Vitamin A, % | 11 ± 23 | 12 ± 25 | 6.5 ± 19 | 7.1 ± 18 | 0.82 | 0.58 | 11 ± 23 | 13 ± 20 | 7.1 ± 19 | 7.2 ± 18 | 0.64 | 0.69 | 1.0 | 0.54 | 0.37 | 0.79 |
| PA Iron, % | 90 ± 15 | 90 ± 15 | 84 ± 23 | 83 ± 24 | -1.4 | 0.5 | 91 ± 14 | 90 ± 16 | 83 ± 24 | 82 ± 24 | 0.38 | 0.86 | -3.3 | 0.21 | -3.7 | 0.17 |
| PA Zinc, % | 100 ± 0.90 | 100 ± 1.6 | 94 ± 16 | 93 ± 16 | -1.4 | 0.38 | 100 ± 2.2 | 101 ± 0.70 | 94 ± 17 | 93 ± 16 | -0.17 | 0.90 | -2.7 | 0.27 | -2.5 | 0.29 |
| MPA, % | 60 ± 9.3 | 60 ± 9.9 | 51 ± 12 | 51 ± 12 | -0.39 | 0.70 | 60 ± 9.6 | 60 ± 10 | 51 ± 12 | 51 ± 12 | 0.16 | 0.88 | -0.98 | 0.43 | -1.1 | 0.37 |
| IDDS2, food groups | 3.6 ± 0.96 | 3.6 ± 1.0 | 3.8 ± 0.95 | 3.8 ± 1.0 | -0.048 | 0.63 | 3.6 ± 1.0 | 3.7 ± 1.0 | 3.9 ± 1.0 | 3.8 ± 0.99 | -0.036 | 0.76 | -0.062 | 0.61 | -0.025 | 0.85 |

1 Descriptive values are unadjusted means with standard deviation. Δ is the linear regression coefficient and represents the change in the outcome in a group versus another group, as indicated in column headers. It is expressed in the same unit as the outcome or, when the unit is a percentage, it is expressed in percentage points. Star indicate p-values of comparison of Δ to 0 value: ** means p-value <0.05, which is the level of significance set for the study; *** means p-value <0.017, which is the level of significance when adjusting for multiple testing across 3 study groups using the Bonferroni method. Abbreviations used: IDDS, Individual Dietary Diversity Score; MPA, mean probability of adequacy; PA, probability of adequacy. 2 Number of food groups consumed the previous day of 10 food groups: starchy staples, pulses, nuts and seeds, dairy, meat & poultry & fish, eggs, dark green leafy vegetables, other vitamin A-rich fruits and vegetables, other vegetables, other fruits.
Table 4: Impact of SELEVER on minimum acceptable diet and other IYC feeding indicators in children 6–23 months of age of the IYC repeated cross-sectional samples\(^1\)

|                      | Round 2     | Round 3     | Treatment  | Control | Treatment | Δ    | \(P\)-value | SELEVER | SELEVER+WASH | SELEVER | SELEVER+WASH | SELEVER | SELEVER+WASH | SELEVER | SELEVER+WASH | SELEVER | SELEVER+WASH |
|----------------------|-------------|-------------|------------|---------|-----------|------|-------------|---------|--------------|---------|--------------|---------|--------------|---------|--------------|---------|--------------|
|                      | n=108       | n=197       | Control    | n=99    | n=186     |      |             |         |              |         |              |         |              |         |              |         |              |
| Minimum acceptable diet | 9.3 ± 1.1   | 2.8 ± 1.2   | 2.8 ± 1.2  | 2.8 ± 1.2 | 2.8 ± 1.2 | 2.8  | 0.47        |         |              |         |              |         |              |         |              |         |              |
| IDDS\(^2\), food groups | 2.5 ± 1.1   | 2.6 ± 1.2   | 2.6 ± 1.2  | 2.6 ± 1.2 | 2.6 ± 1.2 | 2.6  | 0.17        |         |              |         |              |         |              |         |              |         |              |
| Minimum dietary diversity | 15 ± 20    | 14 ± 20    | 19 ± 24   | 20 ± 24  | 24 ± 24   | 2.6  | 0.94        |         |              |         |              |         |              |         |              |         |              |
| Minimum meal frequency | 49 ± 57    | 47 ± 55    | 55 ± 58   | 53 ± 59  | 59 ± 59   | 11   | 0.37        |         |              |         |              |         |              |         |              |         |              |
| Consumption of iron-rich foods/supplements | 23 ± 24    | 26 ± 31    | 31 ± 24   | 24 ± 24  | 24 ± 24   | 0.67 | 0.39        |         |              |         |              |         |              |         |              |         |              |

\(\Delta\) is the linear regression coefficient and represents the change in the outcome in a group versus another group, as indicated in column headers. It is expressed in the same unit as the outcome or, when the unit is a percentage, it is expressed in percentage points. Stars indicate \(p\)-values of comparison of \(\Delta\) to 0 value: * means \(p\)-value <0.05, which is the level of significance set for the study; ** means \(p\)-value <0.017, which is the level of significance when adjusting for multiple testing across 3 study groups using the Bonferroni method. Abbreviations used: IDDS, Individual Dietary Diversity Score. \(^2\)Number of food groups consumed the previous day of 7 food groups: starchy staples, legumes & nuts, dairy, flesh foods, eggs, vitamin A-rich fruits and vegetables, other fruits and vegetables.

\(^1\) Descriptive values are unadjusted percentages or unadjusted means with standard deviation.
Table 5: Impact of SELEVER on consumption of the 3 food groups used in the behavior change communication strategy in caregivers, index children and IYC

|                | Round 2 Control | Round 2 Treatment | Round 3 Control | Round 3 Treatment | Treatment versus Control | SELEVER versus Control | SELEVER+WASH versus Control | SELEVER+ WASH versus SELEVER |
|----------------|----------------|------------------|-----------------|-------------------|--------------------------|------------------------|----------------------------|----------------------------|
|                | n=339          | n=673            | n=320           | n=622             | Δ pp | P-value | Δ pp | P-value | Δ pp | P-value |
| **Caregivers** |                |                  |                 |                   |                |             |              |          |      |         |
| Energy giving  | 100            | 100              | 100             | 100               | -0.098        | 0.33        | 100          | 100       | -0.011 | 0.30    | -0.19 | 0.33    | -0.18 | 0.33    |
| Protective     | 96             | 95               | 98              | 98                | -1.2          | 0.12        | 96           | 95        | -0.37  | 0.65    | -2.1   | 0.080   | -1.8  | 0.19    |
| Body building  | 83             | 84               | 85              | 84                | -6.1          | 0.15        | 83           | 86        | -4.3   | 0.32    | -8.0   | 0.16    | -3.7  | 0.50    |
| All foods groups | 80           | 80               | 84              | 82                | -6.3          | 0.14        | 79           | 82        | -2.1   | 0.41    | -9.2   | 0.10    | -5.6  | 0.31    |
| **Index children** | n=342  | n=676            | n=316           | n=621             | Δ pp | P-value | Δ pp | P-value | Δ pp | P-value |
| Energy giving  | 100            | 100              | 100             | 100               | -0.032        | 0.33        | 100          | 100       | -0.005 | 0.36    | -0.064 | 0.32    | -0.055| 0.32    |
| Protective     | 97             | 95               | 99              | 98                | -1.3          | 0.085       | 96           | 95        | -0.72  | 0.33    | -1.9   | 0.13    | -1.2  | 0.39    |
| Body building  | 85             | 85               | 87              | 84                | -6.1          | 0.091       | 84           | 86        | -6.4   | 0.11    | -5.8   | 0.23    | 0.65  | 0.90    |
| All foods groups | 83           | 81               | 86              | 83                | -6.9          | 0.059       | 80           | 82        | -6.4   | 0.11    | -7.4   | 0.12    | -1.1  | 0.83    |
| **IYC**        | n=108          | n=197            | n=99            | n=186             | Δ pp | P-value | Δ pp | P-value | Δ pp | P-value |
| Energy giving  | 98             | 98               | 98              | 98                | -0.92         | 0.63        | 100          | 97        | -3.2   | 0.29    | 1.6    | 0.14    | 4.8   | 0.089   |
| Protective     | 70             | 75               | 76              | 76                | 3.8           | 0.57        | 83           | 69        | 3.8    | 0.65    | 3.8    | 0.59    | -0.044| 1.0     |
| Body building  | 53             | 52               | 54              | 62                | 12            | 0.17        | 51           | 52        | 6.4    | 0.48    | 19     | 0.08    | 12    | 0.18    |
| All foods groups | 37           | 36               | 32              | 46                | 12            | 0.040*       | 38           | 34        | 12     | 0.091   | 12     | 0.092   | 0.44  | 0.96    |

* Descriptive values are unadjusted percentages. Δ is the linear regression coefficient and represents the change in the outcome in a group versus another group, as indicated in column headers. Stars indicate p-values of comparison of Δ to 0 value: * means p-value <0.05, which is the level of significance set for the study ** means p-value <0.017 which is the level of significance when adjusting for multiple testing across 3 study groups using the Bonferroni method. Abbreviations used: IYC, Infants and Young Children