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A good egg: An evaluation of a social and behavior change communication campaign to increase egg consumption among children in Rwanda

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Abstract

Childhood malnutrition, which is endemic in rural areas of low-income countries, leads to a host of deleterious outcomes such as poor cognitive development, low educational attainment and lower lifetime wages. Promoting the consumption of eggs among young children has emerged as a promising strategy to combat childhood malnutrition, though pathways to scale remain unclear. In this paper, we evaluate the impact of a social and behaviour change communication (SBCC) campaign combined with a program in which rural families purchased chickens on credit (poultry + SBCC; $n = 769$) relative to an arm in which families only received the poultry intervention (poultry only; $n = 750$), using a difference-in-difference estimation strategy with propensity score matching. The SBCC consisted of radio messages, in-person training, text message reminders and posters. We found a relatively modest but statistically significant increase in the number of times per week respondents in the poultry + SBCC arm reported feeding eggs to children of 0.28 ($p = 0.02$) compared to the poultry-only arm. The increase in egg feeding, however, was more pronounced for boys (0.42, $p < 0.01$) than for girls (0.14, $p = 0.26$). In addition, the campaign increased egg feeding more for those who were already feeding eggs to children (0.63, $p < 0.01$) than those who were not engaging in those practices at baseline (0.26, $p < 0.01$). However, the difference in these differences was not statistically significant. Future campaigns should ensure higher saturation of messaging and include specific messaging around the importance of feeding girls as well as boys. Campaigns seeking to scale up egg feeding quickly could potentially target the easier-to-reach segment of caregivers who already occasionally feed eggs to children though these might not be the neediest group.

KEYWORDS
childhood malnutrition, egg consumption, radio campaign, social and behaviour change communication

1 | INTRODUCTION

Childhood malnutrition, which is endemic in rural areas of low-income countries, leads to a host of deleterious outcomes such as poor cognitive development, low educational attainment and lower lifetime wages and productivity (Adair et al., 2013; Casale et al., 2014; Chang et al., 2002; Daniels & Adair, 2004; Dewey & Begum, 2011; Grantham-McGregor et al., 1996; Kar et al., 2008; Udani, 1992). In addition to the increased morbidity and loss of human potential, childhood malnutrition exacts a toll at the macro level through reduced economic productivity due to adults who have lower wages, lower physical and mental capabilities and more work absences, thereby exacerbating global inequities (Hoddinott et al., 2013). Promoting the consumption of eggs—a convenient source of animal protein—among young children has emerged as a promising strategy to combat childhood malnutrition. Eggs are a nutritional dynamo: they are a key source of essential fatty acids, which are critical for early brain development (Riediger et al., 2009), and they have a higher protein-digestibility-corrected amino acids score than fish or meat (Tome, 2012). Eggs also contain more choline—a nutrient responsible for cell division and brain development—than almost any other food source (Caudill, 2010; Zeisel & da Costa, 2009). In the past decade, a mounting body of evidence from randomized trials demonstrates that increasing egg consumption through direct egg or poultry delivery and behaviour change campaigns can improve child nutritional status, including stunting (Baum et al., 2017; Iannotti, et al., 2017a, 2017b;Stewart, et al., 2019; Larsen & Lilleør, 2017; McKune et al., 2020; Omer et al., 2019; Passarelli et al., 2020). However, some studies had more qualified results or failed to find improvements in linear growth in areas where stunting was less common and other animal source protein was available (Iannotti et al., 2020; Stewart et al., 2019).

The interventions to date, however, have been run on relatively small samples with expensive interventions, such as direct daily delivery of eggs or giveaways of poultry. So, there is room to explore mechanisms for increasing egg consumption among more children, at scale, more sustainably. This study tests just such an intervention wherein rural families purchase an improved variety of chicken on credit through a trusted NGO and are encouraged to feed eggs to their children through a multi-pronged social and behaviour change communication (SBCC) campaign designed to address their unique consumption barriers.

This study was conducted in rural districts of Rwanda, where rates of child stunting remain high at 41% in rural areas (NISR, 2016). Despite the relatively common practice of chicken rearing, egg consumption in Rwanda is among the lowest in the world (Cocchini & Steeg, 2019). One Acre Fund, a non-governmental organization that supplies smallholder farmers training and farm inputs on credit, has a large presence in Rwanda, serving over 800,000 farmers throughout 31 districts in 2021. In 2020, as part of the agricultural loan package, One Acre Fund offered Sasso dual-purpose chickens on credit in 10 districts. About 30,000 farm families elected to purchase them and purchased an average of 3.2 chickens per family. These birds are bred to be resilient to rural conditions and to scavenge for feed, which reduces feed costs and makes the birds more profitable. Earlier qualitative work conducted by the research team found that Rwandan families generally understand the benefits of eggs and do not generally hold any countervailing perceptions about the harms of young children consuming eggs. However, the greatest barrier to feeding children eggs was in valuing the nutritional benefits enough to justify the costs. Eggs are relatively expensive per calorie, so most rural families choose to sell them to local markets rather than consume them in the home.

Key messages

- A multi-pronged social and behaviour change communication campaign increased egg consumption among young children in rural Rwanda.
- While the egg consumption gains were modest, the social behaviour change campaign was not fully implemented due to COVID-19 and other challenges, so it is possible that a more fully implemented campaign could achieve greater impacts.
- Effects appeared to be most pronounced for boys and those who were already feeding eggs to children.

2 | METHODS

2.1 | Study location and intervention design

The study intervention consisted of two arms, a poultry-only arm and a poultry + SBCC arm, each situated in separate districts in Rwanda. The poultry-only arm included families with children under 5 who elected to purchase Sasso chickens on credit and received training on poultry raising but who did not receive the behaviour change campaign. The poultry + SBCC arm included families with children under 5 who elected to purchase poultry on credit and received training on poultry raising and lived in the catchment area in which they could hear a community radio campaign emphasizing the benefits of feeding eggs to young children through narratives, discussions with expert and peer testimonials. The poultry + SBCC families also received limited in-person training from One Acre Fund trainers, a poster to hang in the home with the message that read, 'Eggs are precious, and so is my child', along with the image of a mother lovingly looking at her young child eating eggs, and text message reminders to feed eggs to children and to listen to the radio programming. The surveyed families were selected at random from One Acre Fund administrative rosters.

The study also initially included a comparison arm of families who received neither the poultry nor the SBCC interventions. However, after the baseline survey was conducted, the study team learned that two large nutrition projects began offering free chicken distribution

and promoting egg consumption among young children in the comparison district area, which invalidated that area as an appropriate comparison. Therefore, this study assessed the effectiveness of the behaviour change campaign in promoting egg consumption in an environment in which access to eggs has been increased, comparing the poultry-only arm with the poultry + SBCC arm.

The behaviour change campaign focused on increasing the perceived value of feeding eggs to children. The SBCC campaign included three key behaviour change levers. First, to increase the perceived value of feeding eggs to children, the campaign emphasized eggs as a 'superfood', associating feeding eggs to children with an act of love and as an aspirational activity/source of positive gossip. Second, the campaign sought to address caregiver's present bias by making the potential future pay-off of improved childhood outcomes, particularly related to education, more salient, with radio messages and training booklets tying egg feeding to educational attainment. The message on the poster read, 'Eggs are precious and so is my child. Eggs have protein and nutrients which help his/her brain development'. Finally, the campaign attempted to increase the salience of egg feeding through visual cues (posters) and regular reminders (text messages). The campaign relied on narratives, metaphors and testimonials from experts and peers, all of which have evidence supporting their efficacy (Cahill & McGaugh, 1995; Heath & Heath, 2007; Shen & Han, 2014; Sopory & Dillard, 2002; Tabanico & Schultz, 2008).

2.2 | Study design, sampling and statistical analysis

Because the radio campaign relied on a community radio station, randomization at the individual or village level was not possible. We selected a comparison district which was similar in terms of average number of chickens raised, population density, poverty levels, education levels and average household size but was out of reach of the community radio station. We used a difference-in-difference (DiD) estimation strategy comparing the change in egg-feeding behaviour over time between the poultry-only group and the poultry + SBCC group. We randomly selected families with children under the age of 5 in each district who had adopted poultry in the 2021 agricultural season and aimed for a sample of 800 families in each arm, which would allow us to detect a difference in egg feeding frequency of 0.2 times per week, assuming an *alpha* of 0.05, a *Beta* of 0.8, and we assumed 20% attrition between baseline and endline and a baseline-endline correlation of 0.8.

To estimate changes in egg-feeding behaviour, our primary outcome of interest, we ran an ordinary least squares regression with egg consumption as the dependent variable and dummy variables for time and treatment status and an interaction term of time*treatment, which produced the DiD estimate. We also estimated the DiD outcomes adjusted with propensity score matching. Propensity score matching allows us to match groups on observable characteristics to minimize any differences between groups. We matched the treatment and comparison group on gender, number of cows, land size, marital status, educational status, age of respondent, Ubudehe (wealth) status, household size, whether the household had a phone and the age of the child, all of which had differences at baseline between the groups and/or we had reason to believe would affect the outcome and were unlikely to be affected by the treatment. We used a nearest neighbour matching strategy with replacement and restricted the sample to individuals with overlapping propensity scores from the two groups. Finally, we ran the DiD adjusted analysis, both with propensity score and the social desirability bias index as defined by the Marlowe–Crowne Short Form C, which estimates a social desirability score for each respondent and can be used to adjust for respondent bias (Reynolds, 1982; Vu et al., 2011). Because the primary outcome of interest is self-reported and the campaign was making the case that feeding eggs to children is a desirable activity, it was important to attempt to control for any social desirability bias.

2.3 | Data collection

The first round of data collection, hereafter referred to as the 'baseline survey', took place in all districts in May 2021 and was completed before any SBCC activities began. The One Acre Fund chicken distribution had been completed at the time of the baseline survey, but the chicks had not yet reached the age of maturity in which they would be laying any eggs. The primary respondent for data collection was the person in the family who was most responsible for food consumption decisions of children under 5 years old. The endline survey took place in December 2021. All questions were written in English, translated into Kinyarwanda and then back-translated, by a different translator, into English and checked for consistency of meaning. The survey was coded into an online platform (Commcare) and administered through electronic tablets by trained enumerators. Ten percent of surveys were back-checked, enumerators and supervisors conducted regular spot checks and GPS data were analysed as a quality control measure.

Surveys included questions on basic demographic characteristics (e.g., age, gender, household size, marital status, education level and land size), beliefs and practices around egg production and consumption, and the number of times per week that the youngest child in the house who was older than 6 months but under 5 years consumed milk, eggs and meat in the past 7 days. Acknowledging that self-reported data are subject to social desirability bias, we used several mitigation strategies. The survey questions about egg consumption were part of a larger module examining the overall diets of multiple food groups. In addition, the survey included a social desirability bias scale (the Marlow–Crowne social desirability scale, short form C), which had been validated for use in similar contexts and to be used as a statistical control variable (Vu et al., 2011).

2.4 | Ethical concerns and IRB approval

This study was approved by the George Washington University Committee on Human Research, Institutional Review Board (IRB# NCR213380) as well as the Rwanda National Council for Science and Technology Institutional Review Board (RP00000093). Both survey rounds were also provided survey approval by the Rwanda National Institute of Statistics. All face-to-face interviews were conducted respecting the Ministry of Health guidelines pursuant to COVID-19, and enumerators were socially distanced, conducted the interview outside, when possible, and fully masked.

3 | RESULTS

We achieved a sample of 750 respondents in the poultry-only district and 769 in the poultry + SBCC district. The typical survey respondent was a married woman around 40 years of age with a six-person household who owned about an acre of land, and 18.5% of respondents had some secondary education (see Supporting Information: Table 1). The youngest child between the ages of 6 months and 5 years (the focus of the egg-feeding questions) was 2.7 years of age on average. There were some differences in terms of demographic characteristics between the two groups at baseline, with the poultry-only arm having a larger percentage of female respondents, slightly larger family size, fewer cows and greater cell phone ownership, and we matched on all of these characteristics in our propensity score matching estimates. At baseline, each family had on average 3.2 Sasso variety chickens and 4.2 total chickens capable of producing eggs. Both groups had a similar number of chickens and breeds, but the poultry-only group was slightly more productive, producing 10.01 eggs per week compared to 9.3 eggs in the poultry + SBCC group.

3.1 | Exposure to treatment

Exposure to the SBCC campaign was more limited than anticipated. Just under half of the respondents in the poultry + SBCC district reported having heard the radio campaign at all. Of those who did, two thirds heard the radio spots 10 or fewer times, despite the spots airing nine times per day for 5 months. This low exposure was somewhat anticipated due to lower listenership of community radio, when compared with national radio (19% vs. 84%). About 71% of respondents had a poster hanging in their homes. Finally, the in-person training did not happen as planned. Due to COVID-19, planned group nutrition and egg promotion training was not permitted during the study period. Instead, field officers (agricultural extension officers employed by One Acre Fund to deliver agricultural training and collect loan repayments) were supplied with talking points and picture books for training and trained to conduct one-on-one training during regular household visits. However, this task was one of many of One Acre Fund field officers' overall duties; therefore, adherence among field officers was poor, and only 40.5% of respondents reported receiving any in-person training.

3.2 | Change in knowledge and perceived ability

Knowledge of the benefits of egg consumption at baseline was already quite high, with most respondents agreeing that eggs were good for children's overall health and brain development. From this baseline, we estimate the *change* in knowledge and perceived ability among the SBCC + poultry group relative to the poultry-only group at endline (see Table 1). In this analysis, we find statistically significant improvements in the poultry + SBCC arm relative to the poultry-only arm in knowledge of egg benefits, but these did not translate into real changes in perceived ability of reserving or purchasing and feeding eggs to children.

3.3 | Changes in behaviour

The primary behaviour change of interest was the caregiver's self-reported increase in the number of times in the past 7 days that they fed eggs to the youngest child in the household between 6 months and 5 years of age. At the time of the endline survey, respondents reported that their flocks were producing on average 10.5 eggs per week (an increase from 9.6 eggs per week at baseline) and there were no statistically significant differences between the poultry-only and poultry + SBCC group. Questions about egg consumption frequency were asked early in the survey and amid a full food frequency survey module to obscure the focus on egg consumption alone and minimize social desirability bias. Overall, we found positive trends in the SBCC + poultry district (+0.182, $p = 0.010$) and a negative trend in the poultry-only district (−0.109, $p = 0.092$) (see Table 2).

The reduction in egg consumption among the poultry-only arm is unexpected. To understand that trend, we examined the overall trend in food consumption over the time period and found an overall reported reduction in food consumption of nearly all food groups for young children in that same time period in all study areas (see Supporting Information: Table 3). Among the food categories recalled from the past 3 days, 10 out of 12 statistically significant food group changes were negative, meaning that the frequency of consumption reduced over the study period overall for both groups. However, the poultry + SBCC group increased the frequency of egg consumption even amid this overall decline.

We also present the DiD estimates and DiD with propensity score matching from the eggs consumed per week and the per cent of respondents who reported increased egg consumption. We hypothesized that the poultry + SBCC would increase the frequency of egg consumption relative to the arm with only poultry provided, since earlier formative research indicated that a key barrier was the perceived value of eggs. In fact, this is what

TABLE 1 Difference-in-difference results for changes in knowledge and attitude around feeding eggs to children among caregivers.

Sample	Poultry + SBCC versus poultry-only 1497 Change (%)	*p* Value
Knowledge		
Change in per cent who strongly agree that feeding eggs improve health of young kids	18.2	0.000
Change in per cent who strongly agree that eggs improve brain development	19.6	0.000
Change in per cent who strongly agree that feeding eggs to children is a 'good investment'	32.2	0.000
Change in per cent who disagree/strongly disagree that too many eggs are bad for children	−3.1	0.150
Perceived ability		
Change in per cent who agree or strongly agree that they are confident in reserving eggs for their children	−0.8	0.775
Change in per cent who agree or strongly agree that they are confident in buying eggs for their children	2.7	0.300
Change in per cent who agree or strongly agree that they are confident in feeding eggs to their children two times per week	3.9	0.111

Note: Results from ordinary least squares regression controlling for gender, marital status, number of cows, education, age, wealth status and household size with an interaction term of time and treatment status. The sample includes only respondents who were reached both at baseline and at endline (98.6% of the original sample).

Abbreviation: SBCC, social and behavior change communication.

TABLE 2 Reported number of times feeding youngest child eggs, past 7 days.

	Poultry + SBCC	Poultry-only
Baseline	0.70	0.65
Endline	0.88	0.55
Change	**0.18**	**−0.10**
Paired *t* test (*p*)	0.010	0.09

Abbreviation: SBCC, social and behavior change communication.

we found. The poultry + SBCC intervention increased the reported frequency of egg consumption by about 0.28 times per week (0.276 times in the DiD estimate and 0.275 in the model, which included propensity score matching and controls for social desirability bias), and this was robust across all model specifications (see Table 3). We also found that between 6% and 8% of respondents reported the frequency of their child's egg consumption increased, and this was also robust across multiple model specifications.

3.4 | Heterogeneous effects

In addition to estimating the average impacts, it is important to understand if there are subgroups which are particularly likely or unlikely to benefit from the intervention. We hypothesized that the impacts could differ by wealth status because those who are wealthier are more likely to be able to act on the message of encouragement and feed their children eggs. We also hypothesized that the behaviour change campaign might be more effective for those who were already feeding some eggs to their children at baseline, as it may be easier to convince families to increase the level of egg consumption among those who were already feeding eggs, rather than convincing families to undertake an entirely new activity. Third, we examined if impacts could differ by education level. Those with higher education might be better prepared to absorb and act on information from training; however, it is also possible that those with lower education levels might get a greater impact as they might have lower baseline levels of knowledge. Finally, we assessed whether the intervention was differentially effective for children depending on their gender.

In Table 4 below, we present the results of the DiD analysis for each subgroup. In this analysis, we regress egg feeding on treatment; however, we do so on one sub-sample at a time (e.g., for only girls and then for only boys). We did not attempt any propensity score matching due to the reduced sample size for this subgroup analysis. We find in this subgroup analysis that the poultry + SBCC program increased egg consumption relative to the poultry-only group for all groups except for girls, those who were wealthier, and those who were more educated. However, the more educated constituted only 17% of the sample, so this analysis was likely underpowered to detect a meaningful effect. The largest differences for any of these subgroups were between girls (0.138 increase in egg feeding per week, $p = 0.255$) and boys (0.417 increase in egg feeding per week, $p = 0.002$). In addition, the program increased the frequency of egg feeding among those who were already feeding eggs to their children at baseline (0.629 increase in egg feeding per week, $p = 0.004$), and this increase appeared to be higher than for those who were not engaging in those practices at baseline (0.256 increase in egg feeding per week, $p = 0.002$). We also find that those not feeding eggs at baseline were poorer (wealth index of 0.45 vs. 0.65, $p < 0.001$) than those who were already feeding eggs at baseline. To see if any of the

TABLE 3 Difference-in-difference estimates for reported egg consumption frequency, across multiple models.

	Unadjusted		With propensity score matching[a]		With PSM + controls for social desirability[b]	
Sample	1426		1322		1322	
	Coeff.	***p***	**Coeff.**	***p***	**Coeff.**	***p***
7-day recall (eggs)	0.276	0.002	0.205	0.079	0.275	0.020
Per cent who increased their child's egg consumption	8.02%	0.000	7.91%	0.008	7.03%	0.018

[a]Propensity scores were generated based on gender, number of cows, land size, marital status, educational status, age of respondent, Ubudehe (wealth) status, household size, whether the household had a phone and the age of the child. We restricted the sample to respondents who had overlapping propensity scores and used a nearest neighbour matching with replacement.

[b]The same propensity score method as above but adding in a matching criteria for the Marlowe–Crown Social Desirability Score, using the Short Form C. This form consists of 13 statements that respondents state as either true or false, from which an index is created.

TABLE 4 Results of DiD analysis (poultry + SBCC vs. poultry-only) for various subgroups.

	Sample	Times eggs consumed per week	*p*
Wealth[a]			
High wealth status	669	0.224	0.112
Low wealth status	662	0.312	0.011
Already feeding eggs at baseline			
Egg feeder at baseline	395	0.629	0.004
Non-egg feeder at baseline	1037	0.256	0.002
Education			
Some secondary education	265	0.313	0.184
No secondary education	1167	0.272	0.005
Gender of child			
Boy child	717	0.417	0.002
Girl child	715	0.138	0.255
Gender of the caregiver			
Female caregiver	1064	0.221	0.049
Male caregiver	486	0.297	0.034

Abbreviations: DiD, difference-in-difference; SBCC, social and behavior change communication.

[a]Wealth index was created using principal components analysis (PCA), which included assets, land size, Ubudehe status and education. We then created a binary variable separating the data at the median of the PCA variable.

differences in impact between subgroups were statistically significant (i.e., to see if the intervention impact of being high wealth status is statistically significantly different from the intervention impact on being low wealth status), we ran regressions including an interaction term between treatment and subgroup status in the full sample. In this analysis, none of the interaction terms were significant.

TABLE 5 Increase in egg consumption frequency per week, by various levels of SBCC exposure.

	Yes[a]	No	*p*
Sample = 684			
Heard the radio campaign, had a poster hanging and attended a training	0.259	0.174	0.696
Heard the radio campaign ***or*** had a poster hanging and ***or*** attended a training	0.198	0.143	0.733
Heard the radio campaign	0.227	0.144	0.156
Have a poster hanging	0.220	0.157	0.664
Attended a training	0.195	0.183	0.938

Note: Estimates determined by OLS regression on the poultry + SBCC sample controlling for gender of respondent, marital status, number of cows owned, education, age, wealth status and household size.

Abbreviations: OLS, ordinary least squares; SBCC, social and behavior change communication.

[a]Yes/No estimates are marginal effects for those in and out of each subgroup.

3.5 | Treatment on the treated

Given the relatively weak uptake of the SBCC intervention, it is also important to look at the impact of the programm on those who actually received it. This is challenging because the SBCC programme is multifaceted and prone to spillovers. Any given participant could have received any combination of direct training, exposure to the radio spots, text message reminders and receiving and hanging a poster. In addition, over half of those who heard the radio campaign (51%) reported discussing it with their friends and neighbours. So, there is no clear delineation of those who were treated and those who were not. Despite these limitations, we investigated the trends among those who had various levels of exposure to the behaviour change campaign. As shown in Table 5, we find that those with programme exposure reported they increased their children's egg consumption more than those who did not for every level of programme exposure; however, none of these differences were statistically significant.

4 | DISCUSSION

The SBCC campaign was designed to address the main motivational barriers uncovered in formative research by increasing the knowledge of perceived benefits relative to the costs. In particular, the messaging was designed to make the long-term promise of children's greater cognitive development and education (something parents highly prize) more salient. Messages repeated themes that we identified as particularly important in child feeding practices, such as the promise of eggs as a superfood of nutrients, as a demonstration of love, and as an aspirational activity, all while acknowledging the very real challenges and trade-offs of engaging in that behaviour change. However, the SBCC campaign did not ultimately have a very high penetration and occurred over a relatively short duration. Therefore, the fact that we found a statistically significant impact on egg consumption should be considered promising and may be considered a lower bound for what a fully administered behaviour change campaign might achieve.

We unexpectedly found that egg consumption decreased over time among the poultry-only group. Because the respondents are all subsistence farmers, this likely reflects a seasonal fluctuation, whereby the endline survey was conducted during a leaner period, in which families were reducing the overall amount of food consumed, as seen in Supporting Information: Table 3. In addition, it is possible that the effects of COVID-19 in restricting mobility, increasing sickness and reducing remittances led to a reduction in food frequency over the study period. In fact, a survey conducted by One Acre Fund and International Livestock Research Institute over the study period in Rwanda found that the majority of respondents reported severe (>50%) reductions in their agricultural incomes, and 75% of respondents reported reducing the amount of food consumed and the variety of food consumed (Hammond et al., 2022). The decline in egg consumption over this period in the poultry-only arm likely reflects this overall downward trend, and the poultry programm did not appear to do anything to mitigate the overall food consumption decline among eggs. However, the behaviour change campaign reversed this negative trend and saw a slight increase in egg consumption.

We found that knowledge of egg-feeding benefits in the poultry + SBCC group increased relative to the poultry-only group. However, there was no increase in perceived ability to feed eggs to children. So, while knowledge was improved, the poultry distribution might not have been large enough or subsidized enough to remove the cost barrier of raising chickens or the opportunity costs of feeding eggs to children. Families received an average of 3.2 chickens and there was only a slight increase in overall eggs produced per flock over the study period. It is also possible that not all the birds survived. One Acre Fund has found that death rates of this particular bird range can be as high as 26%, mostly due to sickness and predators, and other studies have found similar challenges in large poultry distribution programs (Wegmüller et al., 2022). In addition, the relatively short duration of the study may obscure impacts which could occur once more chickens reach the age of egg-laying maturity and/or the knowledge change has more time to translate into practice change.

We found suggestive differences in the impact of the poultry + SBCC compared to the poultry-only group among sub-groups. Notably, the SBCC campaign appeared to have no statistically significant effect on girls but increased egg consumption among boys, though the difference in these differences was not statistically significant. While the campaign included imagery of girls being fed eggs, and girls were featured in the radio spots, there was no explicit message to encourage egg feeding equally among children, regardless of gender. Prior data, collected by One Acre Fund, showed that there were no differences in overall dietary diversity by the gender of the child. Therefore, encouraging the feeding of eggs to girls was not made an explicit component of the campaign. It is possible that feeding habits of more common foods are not gender differentiated, but for more expensive food, boys are prioritized. The suggested greater impact on boys might also be due to a general preference for investing in boys (though school enrolment rates are generally similar for boys and girls in Rwanda) or because boys are more likely to be stunted than girls in Rwanda (Nshimyiryo et al., 2019). To reduce this potential disparity, future campaigns might consider encouraging caregivers to feed girls, as well as boys, and could feature girls more prominently in all materials.

In addition, we found suggestive evidence that the program had a larger impact on those who were already feeding eggs at baseline. The campaign's messages may have been more resonant with those who were already engaging in the behaviour, and it may have been tougher to convince caregivers to adopt a wholly new behaviour. In some sense, we would have preferred to have seen the opposite. The baseline non-egg feeders were poorer, and thus likely had greater malnutrition and greater need for increasing egg consumption. So, we might prefer the greater impact of the campaign to be on those who needed it most. However, knowing that the campaign may have been more effective with those who were already feeding their children eggs, it could make sense to target that group in future interventions or alternatively to focus extra attention on the harder-to-reach non-adopting families.

The overall increases in egg consumption frequency were rather low and unlikely to make a significant impact on the nutritional status of children; however, these increases are something that future campaigns can build on. The fact that we observed some reported increases in egg consumption despite low penetration of the behaviour change campaign suggests that a campaign with deeper penetration into the community, such as more in-person interactions and a radio campaign on the highly popular national radio, could have even a greater impact.

4.1 | Limitations and future research

As noted above, the SBCC campaign was not implemented at the ideal scale that would have reached a higher percentage of intended recipients or at the intensity likely to prompt significant behaviour change. Therefore, it is unsurprising that the impacts we found were quite small. In addition, it is also possible that a longer campaign

would yield different results. Six months is likely insufficient to adequately change norms of behaviour, particularly when it comes to sticky preferences like food or entails a perceived or real sacrifice. A recent study of a radio campaign in Burkina Faso encouraging behaviours associated with child survival found changes in some care-seeking behaviours, but only after a full 20 months of the campaign (Sarrassat et al., 2015). So, it will be important, given the initial signs of early impact, to continue this campaign and study effects after a longer duration.

The conclusions reached here are also potentially unique to the Rwandan context. Rwandans have a high radio listenership in general, and the society tends to be hierarchical with a strong deference to authority (Staub, 2014). Therefore, it is possible that social and behaviour change campaigns will be more effective in Rwanda than in other places.

Finally, the DiD design and propensity score matching both rely on assumptions which were not wholly testable. For DiD estimates, we have to assume that egg consumption patterns were on parallel trends in all study areas. While the available data from Rwanda Demographic and Health surveys suggests that this was the case, the data are not fully comparable in terms of the frequency, target group, recall period and geography. So, it is not possible to fully satisfy this assumption. In addition, propensity score matching relies on the assumption that, conditional on some observable characteristics, untreated units can be compared to treated units, as if the treatment has been fully randomized. This is also not wholly testable, and we cannot rule out that there are some unobservable differences among the treatment groups.

Future studies should attempt to ensure either a higher penetration (e.g., more frequent in-person training, a higher radio listenership) or longer duration, given how challenging it can be to change feeding behaviours. In addition, to avoid the problems associated with non-comparability of groups, researchers should attempt, where possible, to include a greater number of clusters for each arm and to randomize where feasible. Finally, where possible, confirmation of self-reports is essential through biomarkers or other physical evidence, such as measures of linear growth.

AUTHOR CONTRIBUTIONS

Kim Siegal developed the study design and tools and conducted the analysis. Brendah Wekesa, Emily Custer and Kim Siegal designed the overall intervention, and Jane Uweh helped to design and oversaw the development and implementation of the radio campaign. Emily Custer, Brendah Wekesa andMarthe Niyonshuti managed and supervised the intervention implementation. Thierry Wekesa oversaw enumerator training and managed the data collection. Brendah Wekesa, Emily Custer and Thierry Gatwaza reviewed the data collection protocols and provided support in interpreting the data. Kim Siegal wrote the manuscript, and all authors have read and reviewed the manuscript for publication.

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CONFLICT OF INTEREST STATEMENT

All authors were employed by One Acre Fund at some point during their study. However, Kim Siegal and Emily Custer are no longer employed at One Acre Fund and no longer have any professional or financial ties.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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