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Household decision-making, women's empowerment, and increasing egg consumption in children under five in rural Burkina Faso: Observations from a cluster randomized controlled trial

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Malnutrition is one of the most long-suffering problems facing women and children across the world—it is endemic to many low- and low-middle income countries and is a leading comorbidity in CU5 mortality. Malnutrition and food security are gendered issues; not only are boys and girls differently affected by these issues, but societal norms and differing roles of women and men are often drivers of these different outcomes. The United Nations seeks to address both malnutrition and gender inequality by reaching its Sustainable Development Goals by 2030. Researchers have shown that women's empowerment is inextricably linked to the nutritional outcomes of children. As one dimension of women's empowerment, intra-household decision-making is an important determinant of child health and nutrition outcomes, as it can determine how resources are allocated within the household. To better understand how gender inequalities within household decision-making may contribute to child nutrition, this study examines the association between household decision-making and the adoption of behavior change to increase chicken egg consumption among infants and young children in Burkina Faso, and explores the relationship(s) between the *Un Oeuf* project and women's empowerment. This study analyzes data collected during the *Un Oeuf* cRCT (July 2018–April 2019) and additional data that were collected in conjunction with the *Un Oeuf* endline household survey in April 2019. Significant relationships were found between women's household decision-making about eggs and child egg consumption at the end of the project. This was true for women who did not have decision-making power at baseline ($p = 0.006$, OR 3.822) as well as for women who indicted having had that power and sustaining it through endline ($p = 0.013$, OR 6.662). Results indicate that the *Un Oeuf* project significantly increased women's household decision-making ($p > 0.005$, OR 4.045). Finally, significant relationships were found between a woman's overall level of empowerment and household

decision-making power surrounding (1) what is done with household eggs ($p < 0.005$, OR 2.87) and (2) how foods are portioned ($p = 0.012$, OR 6.712). These findings illustrate the importance and potential of women's decision-making as a point of entry to improving nutritional outcomes through changes in empowerment.

KEYWORDS

sustainable develop goals, nutrition, women's empowerment, household decision making, food security, children under five, animal source food, egg consumption

Introduction

Malnutrition is one of the most long-suffering problems facing children under 5 (CU5) across the world, endemic to many low- and low-middle income countries (LMIC), and a leading comorbidity in CU5 mortality (Müller and Krawinkel, 2005; Sundaram, 2012; Bain et al., 2013; UNICEF, 2019). The United Nations prioritizes this global issue with its explicit inclusion in the Sustainable Development Goals (SDGs) under SDG 2, or "Zero Hunger" (WCF(UK), 2017). Global aspirations and understandings of food security have evolved toward nutrition security, or the conditions under which "all people, at all times, have physical, social and economic access to food which is safe and consumed in sufficient quantity and quality to meet their dietary needs and food preferences, and is supported by an environment of adequate sanitation, health services and care, allowing for a healthy and active life" (Bhagowalia et al., 2010; Cunningham et al., 2015; Workicho et al., 2016; Galiè et al., 2019). This reframing positions nutrition security as the foundation upon which many other SDGs will be achieved, including good health and well-being, quality education, gender equality, decent work and economic growth, and reduced inequalities (WCF(UK), 2017). Importantly, researchers have shown that women's empowerment (WE) is inextricably linked to the nutritional outcomes of children. As one dimension of women's empowerment, intra-household decision-making is an important determinant of child health and nutrition outcomes, as it can determine how resources are allocated within the household (Peterman et al., 2021). In this paper, we explore the relationship between women's empowerment and household decision-making and the role of each in an intervention conducted in Burkina Faso to increase egg consumption in infants and young children.

Malnutrition and women's empowerment

Nutrition studies have shown that malnutrition can be mitigated and outcomes improved through a variety of intervention strategies, including education and empowerment of mothers through training programs on nutrition and safe animal husbandry practices (Olney et al., 2015; Haselow et al., 2016), as well as improved nutrient intake through the inclusion of ASF in the child's diet, including egg consumption (Iannotti et al., 2017; Omer et al., 2018). Animal source food (ASF) consumption can improve the growth, nutritional status, cognitive development, and overall health of a child when it is regularly included in the child's diet, especially during critical times of development (Neumann et al., 2003; Darapheak et al., 2013). Unfortunately, both egg and other ASF consumption are low in most LMIC, particularly among women and children. In these countries, women's educational status is also often low, with many women achieving less than primary or secondary school completion—both of which are associated with childhood malnutrition and low women's empowerment (Oxaal, 1997; Jin and Iannotti, 2014; Haggblade et al., 2016). Furthermore, in Burkina Faso as in other parts of Africa, cultural beliefs and stigma further limit ASF consumption, creating barriers that significantly constrain its consumption among population sub-groups such as pregnant women and young children, in particular the consumption of chicken eggs (Rogers, 1996; Iannotti and Lesorogol, 2014). There is growing evidence that targeting and empowering mothers in livestock production and programing may improve child nutrition outcomes through increased ASF consumption (Chen et al., 2021). Primary female caregivers (most often, but not always, mothers) can play an essential role in improving childhood nutrition; therefore, it is critical to involve and train them in livestock production. A more holistic approach that combines livestock and nutritional knowledge, attitudes, and practices is needed if the nutritional status of CU5 is to improve through the regular inclusion of ASF in their diets.

Women's empowerment and household decision-making

Women's empowerment is a complex and contested concept, for which different definitions exist, are variable across contexts, and are subjective in nature. While women's

empowerment is difficult to measure holistically, several tools have been developed to both quantitatively and qualitatively capture and measure selected aspects of empowerment. In 2012, the International Food Policy Research Institute (IFPRI), in collaboration with Oxford Poverty and Human Development Initiative (OPHI) and USAID's Feed the Future, launched a new tool designed to measure women's empowerment within agricultural contexts—the Women's Empowerment in Agriculture Index (WEAI). This tool has since been modified in numerous forms, including an abbreviated version (A-WEAI). The latter measures five domains of women's empowerment (production, resources, income, leadership, and time) through six indicators (input in productive decisions, ownership of assets, access to and decisions on credit, control over use of income, group membership, and workload). The application of these domains of empowerment into research inquiries provides insight into the roles of women in the livestock sector (Malapit et al., 2017).

Women's agency has been associated with improved nutritional outcomes (Jones et al., 2019). Often measured by the degree of women's decision-making within the household, this dimension of empowerment can play an important role in determining the nutritional outcome of children (Doss, 2013). In order to understand the relationship between women's empowerment and ASF consumption, it is helpful to examine a woman's level of household decision-making specific to nutritional aspects of her family life that may either facilitate or constrain ASF consumption by her child(ren) (Agarwal, 1997; Ahmed, 2006; Seebens, 2011; Richards et al., 2013).

This study will examine both women's empowerment, as defined by the five domains of empowerment (5DE) within the A-WEAI, and household decision-making related to ASF consumptions as predictors of an improved nutritional behavior (child egg consumption). The decision-making questions were tailored to decisions surrounding nutrition and egg consumption, which was the targeted behavior of the *Un Oeuf* intervention. Overall empowerment was measured only at endline through the A-WEAI and thus measures a broader set of domains, reflective of Kabeer's and other scholars' conceptual frameworks, which went into the development of the WEAI tools.

Burkina Faso

Burkina Faso is a low-income country (LIC) which suffers from high rates of malnutrition, anemia, and stunting in CU5 (INSD, 2012). Much of this burden is attributable to high levels of food insecurity, inadequate complementary feeding practices, and poor dietary diversity, including insufficient levels of ASF consumption (Stewart et al., 2013). As with many other low-income countries, the rate of child mortality in Burkina Faso is closely associated with the nutritional status of the children (UNICEF, 2012). Childhood malnutrition can cause severe disease that impairs a child's physical and mental development and increases the overall chance of mortality from other illnesses.

Gender inequalities are pervasive in Burkina Faso, and strongly impact outcomes within maternal and child health (Nikièma et al., 2008; Isler et al., 2020). According to the Gender Gap Index (GGI) developed by the United Nations Development Programme, Burkina Faso ranks 182nd in the world with a Gender Inequality Index of 0.434—meaning that women's achievements in the measured domains are only 43% as those by men (UNDP, 2019). Gender inequalities are far reaching, extending into the political, educational, economic, health, nutrition, and intra-household domains. Women's under-achievements in several domains at once severely impact the nutritional and overall health outcomes in children, since women's empowerment has long been shown to directly impact both (Ayele and Peacock, 2003; Nelson and Stathers, 2009; Kariuki et al., 2013).

Un Oeuf study

Responding to a call for innovative, holistic approaches to combat malnutrition in CU5 in Burkina Faso (Request for Applications (RFA) No. RFA AID-OAA-L-15-00003-Livestock Systems Innovation Lab-03), researchers from the University of Florida and the *Institut de l'Environnement et Recheres Agricoles* (Environmental Institute for Agricultural Research; INERA) designed a cluster randomized controlled trial (cRCT; *Un Oeuf)* to test a culturally tailored behavior change intervention designed to increase infant egg consumption in the Kaya Department of rural Burkina Faso. The *Un Oeuf* study's intervention was conducted between July 2018 and April 2019. The intervention tested in the *Un Oeuf* cRCT aimed to increase egg consumption in infants 6–12 months old by increasing production and productivity of household livestock assets (chickens) and empowering mothers through educational trainings on agriculture and nutrition. The *Un Oeuf* study had three research arms consisting of (1) a full intervention group, in which enrolled children were gifted chickens at the onset of the project and enrolled mothers received monthly Integrated Nutrition and Agriculture (INA) trainings throughout the length of the project; (2) a partial intervention group, in which enrolled mothers received the same monthly INA trainings as the full intervention group (but no asset); (3) and a control group, in which mothers received neither trainings nor livestock assets.

The study was designed to explicitly engage women's empowerment in agriculture as a pathway to achieving its goal: child egg consumption. This was operationalized by targeting

rural women with an infant 6–12 months of age with training (which aimed to improve knowledge, attitudes, and practices related to poultry production and human nutrition), targeting husband as well as community leaders for support of the project, establishing cohorts of mothers who provided social support to the activities of the program, equipping the mothers with educational materials of their own, both to reinforce knowledge and to become teachers to those around them, and providing one-on-one counseling and support to meeting the goals of the project. The study collected data at baseline and endline on four dimensions of household decision-making related to nutrition. Subsequently, at the end of the study, additional funding allowed for a follow-up study (the Enhance study) to examine women's empowerment, as indicated by the A-WEAI. This occurred at endline of the *Un Oeuf* study, in April 2019.

Study aims

Using household decision-making surrounding nutrition and women's empowerment at endline, as defined by the A-WEAI, this study aims to (1) examine the statistical associations between household decision-making surrounding nutrition and chicken egg consumption among IYC; (2) test the effect of the *Un Oeuf* project intervention on household decision-making surrounding nutrition; and (3) explore the overall relationship between household decision-making regarding nutrition and women's empowerment within the study population.

Methods

Study location and population

This study was conducted in the Kaya Department within the Sanmatenga Province of the Center-Nord Region of Burkina Faso. The study population for this study ($n = 260$) is identical to that of the *Un Oeuf* study, having enrolled those participants for the Enhance study. The full participant recruitment and enrollment protocol can be found elsewhere (Stark et al., 2021). Children were 6–12 months old at enrollment and were followed for 10 months. A total of 260 mother-child dyads were used for this study.

Study design

This longitudinal study leverages data collected during baseline and endline of the *Un Oeuf* cRCT (July 2018–April 2019), and uses additional data from the Enhance Study, which was collected in conjunction with, and simultaneous to, endline data collection of the *Un Oeuf* study (April 2019).

Data collection instruments

Household survey

For this study, a household was defined as a "shared cooking pot". The household survey (HHS) was successfully administered to and completed by 260 mother-child dyads at baseline of the *Un Oeuf* study. Basic demographics, including gender, age, age at first live-birth, marital status (including presence of co-wives), and education level of the respondent, were all controlled for within the cRCT study design.

The HHS sections relevant to this paper are those on household demographics; knowledge, attitudes, and practices of household child-feeding, with an emphasis on egg consumption; and household decision-making (HHDM) data. The HHS section on knowledge, attitudes, and practices of household child-feeding was tailored to assess the observable behavior change across research arms, as well as to understand current and past feeding practices with an emphasis on egg consumption. Questions were also included to understand who makes household decisions surrounding nutrition and division of food resources. The aim of these questions was to assess the level of decision-making the mother had within her household, any intervening change from baseline to endline, and what, if any, effect this change in decision-making had on egg consumption. Household decision-making surrounding nutrition included four variables—who decides, whether "self" or "other", (1) what foods are fed to children (HHDM-F), (2) what foods are bought (HHDM-B), (3) how foods are portioned (HHDM-P), and (4) what is done with household eggs (HHDM-E). The HHDM are thus binary variables and were collected at both baseline and endline.

Abbreviated women's empowerment in agriculture index

Quantitative women's empowerment data were collected at a household-level using the Abbreviated Women's Empowerment in Agriculture Index (A-WEAI). This tool uses a validated questionnaire designed to measure women's inclusion and agency in the agricultural sector. It was created to be administered to household-gender-pairs of men and women, to generate a score for women's (and men's) 5 Dimensions of Empowerment (5DE) and a gender parity index due to a lack of male participants. In this study, the questions were only administered to women, thus generating a women's empowerment score based on the 5DE, without consideration of gender parity. Adequacy scores are first determined for each indicator of empowerment and a respondent is considered to be empowered if she is adequate in at least 80% of the indicators. The A-WEAI questionnaire was used to gather 5DE data at endline, within the same 260 households that also took part in the HHS at baseline and endline. An electronic version of A-WEAI questionnaire, implemented in RedCap as originally

developed (Malapit et al., 2017), was used to gather 5DE data within the same 260 households that also took part in the HHS at baseline and endline.

Data collection

Quantitative data were collected from all available mother-child dyads enrolled in the *Un Oeuf* study at baseline and endline. Women were surveyed using a questionnaire, which consisted of the *Un Oeuf* study HHS and the A-WEAI (only at endline). The HHS gathered basic household demographic information; livestock knowledge, attitudes, and practices; household nutrition; household decision-making; water and sanitation; egg consumption of the enrolled child; and other information (see Stark et al., 2021). The A-WEAI questionnaire was used to generate the 5DE, after having been tailored by local members of the study team for cultural relevancy, with assistance of highly experienced in-country gender experts.

Data were collected using a team of graduate students from the University of Ouagadougou, Burkina Faso. University of Florida researchers trained data collectors for the *Un Oeuf* HHS prior to the start of the project. Additional training on implementation of the A-WEAI was provided by the local gender experts during the Spring of 2019, prior to endline data collection. The team pilot tested 5DE data collection and made necessary modifications for the local context.

Data management, quality control, and preparation

Data management for data collected in both the *Un Oeuf* and Enhance studies was conducted in REDCap, while data organization, standardization, and cleaning procedures were carried out using Microsoft Excel and R Studio. Quality control procedures were conducted with all longitudinal data, and mother-child dyads were verified by participant and household IDs against enrollment information for each month of data collection.

The 5DE data were prepared and analyzed in using standard protocol as developed (Malapit et al., 2017), implemented in R with IFPRI validated scripts using the electronic data downloads from the RedCap. Indicators for each domain of empowerment were generated for each respondent then an overall 5DE score was generated using the weighted average score as explained in the standard protocol (Malapit et al., 2017). These indicators were used in linear regression models to examine the relationship between each subdomain of empowerment and behavior change (egg consumption) as captured by household surveys.

Data analysis

The variables used in this study include: four variables on household decision-making regarding nutrition, the overall 5DE adequacy score and associated sub-domains of empowerment, and child egg consumption. The primary variables were derived

TABLE 1 Baseline summary statistics for the study population.

Baseline summary statistics					
		Control ($n = 88$)	**Partial ($n = 89$)**	**Full ($n = 83$)**	**Total ($n = 260$)**
Egg consumption	No	76 (86%)	82 (92%)	76 (92%)	234 (90%)
	Yes	12 (14%)	7 (8%)	7 (8%)	26 (10%)
HHDM-F	Other	22 (25%)	29 (33%)	33 (40%)	84 (32%)
	Self	62 (70%)	58 (65%)	49 (59%)	169 (65%)
	No response	4 (5%)	2 (2%)	1 (1%)	7 (3%)
HHDM-B	Other	77 (87%)	82 (92%)	76 (92%)	235 (90%)
	Self	7 (8%)	5 (6%)	6 (7%)	18 (7%)
	No response	4 (5%)	2 (2%)	1 (1%)	7 (3%)
HHDM-P	Other	39 (15%)	38 (43%)	46 (55%)	123 (47%)
	Self	45 (80%)	49 (55%)	36 (44%)	130 (50%)
	No response	4 (5%)	2 (2%)	1 (1%)	7 (3%)
HHDM-E	Other	57 (65%)	54 (61%)	58 (70%)	169 (65%)
	Self	26 (29%)	33 (37%)	24 (29%)	83 (32%)
	No response	5 (6%)	2 (2%)	1 (1%)	8 (3%)

These data were collected in July 2018.

TABLE 2 Endline summary statistics for the study population.

Endline summary statistics					
		Control ($n = 88$)	**Partial ($n = 89$)**	**Full ($n = 83$)**	**Total ($n = 260$)**
Egg consumption	No	33 (38%)	1 (1%)	0	34 (13%)
	Yes	54 (61%)	85 (95%)	79 (95%)	218 (83.9%)
	Not surveyed	1 (1%)	3 (4%)	4 (5%)	8 (3.1%)
HHDM-F	Other	0	2 (2%)	0	2 (0.8%)
	Self	87 (99%)	83 (93%)	79 (95%)	249 (95.7%)
	No response	–	1 (1%)	–	1 (0.4%)
	Not surveyed	1 (1%)	3 (4%)	4 (5%)	8 (3.1%)
HHDM-B	Other	85 (97%)	84 (94%)	76 (92%)	245 (94.2%)
	Self	2 (2%)	1 (1%)	3 (3%)	6 (2.3%)
	No response	–	1 (1%)	–	1 (0.4%)
	Not surveyed	1 (1%)	3 (4%)	4 (5%)	8 (3.1%)
HHDM-P	Other	7 (8%)	11 (13%)	7 (8%)	25 (9%)
	Self	80 (91%)	74 (83%)	72 (87%)	226 (87%)
	No response	–	1 (1%)	–	1 (0.4%)
	Not surveyed	1 (1%)	3 (3%)	4 (5%)	8 (3%)
HHDM-E	Other	61	44 (49%)	29 (35%)	134 (51.6%)
	Self	26	41 (46%)	50 (60%)	117 (45%)
	No response	–	1 (1%)	–	1 (0.4%)
	Not surveyed	1 (1%)	3 (4%)	4 (5%)	8 (3%)
5DE overall score adequacy	Inadequate	50	53	39 (47%)	142 (55%)
	Adequate	33	33	40 (48%)	106 (41%)
	No response	3 (4%)	–	–	3 (1%)
	Not surveyed	2 (2%)	3	4 (5%)	9 (4%)

These data were collected in April 2019.

from both the household survey and the A-WEAI. Data were analyzed for study population baseline and endline summary statistics, which can be seen, respectively, in Tables 1, 2, stratified by research arm and total population.

HHDM and egg consumption at endline

Bivariate analyses were conducted using the binary dependent variable (egg consumption) against each of the four independent variables of household decision-making (HHDM-F, HHDM-B, HHDM-P, and HHDM-E measured at endline) to test for independence at a study-population level and significance into the model. A standard p-value of ≤ 0.20 was used as the threshold for inclusion into a binomial logistic regression model.[1]

A binomial logistic regression model was conducted with the confidence interval set to 95% and a corresponding p-value of significance of ≤ 0.05, to determine the effects of household decision-making centered around egg consumption on the likelihood that participants would feed their child eggs.

Change in HHDM (ΔHHDM) and egg consumption at endline

Bivariate analyses were conducted using the dependent variable (child egg consumption in the past seven days) against each of the four categories representing change and directionality of change in household decision-making surrounding nutrition to test for independence and significance for inclusion into the regression model (p-value of ≤ 0.20). Statistically significant variables were then included in a logistic regression model, where a standard p-value of ≤ 0.05 was used to represent significance. The only HHDM variable to show significance below $p = 0.2$ for inclusion into the model was the variable for deciding what is done with the household's chicken

1 Adjustment for a cluster effect within the models was deemed unnecessary following insignificant fisher's exact tests between all outcome variables of interest and clusters. The standard threshold value of 0.5 was used for predictability within all logistic regression models.

TABLE 3 Variables depicting the change in household decision-making from baseline to endline.

Categories of change in household decision-making			
ΔHHDM	**Baseline HHDM**	**®**	**Endline HHDM**
Positive change	Other	®	Self
Positive sustainment	Self	®	Self
Negative sustainment	Other	®	Other
Negative change	Self	®	Other

eggs. This variable is a four-category variable that examines the ΔHHDM from baseline to endline (Table 3).

A binomial logistic regression was performed to examine the effects a change in household decision-making centered around egg consumption (ΔHHDM-E) had on the likelihood that participants would feed their child chicken eggs.

Household decision-making and 5DE at endline

The four bivariate variables for household decisions-making (HHDM-F, HHDM-B, HHDM-P, and HHDM-E) at the endline timepoint. A chi-squared test for association was carried out against each of the four, endline HHDM variables (HHDM-F, HHDM-B, HHDM-P, and HHDM-E) against the bivariate 5DE score for inclusion into a logistic regression model. A logistic regression model was built using variables found to be significant at the $p \leq 0.2$ value using 95% confidence intervals and listwise deletion. Variables were considered to have a significant relationship if the coefficient results showed a final p-value of ≤ 0.05.

Relationship between Un Oeuf intervention and household decision-making

In this analysis, the three research arms of the *Un Oeuf* study (Control, Partial, and Full) represent the *Un Oeuf* intervention. A logistic regression was conducted to examine the relationship between the research arms of the *Un Oeuf* study and household decision-making to better understand if any individual relationship existed between the *Un Oeuf* intervention and either of the household decision-making areas shown to have a significant positive correlation with the 5DE score at endline—decision-making on what is done with the household eggs (HHDM-E) and on how food is portioned (HHDM-P). All models were built using 95% confidence intervals and listwise deletion. Statistical significance was determined to exist for any variable included into the regression model with a p-value ≤ 0.05.

All study participants received information that adequately allowed each participant to make a well-informed decision about whether to consent to participate in this study. All members of the in-country research team were fluent in the local language of Moré and French. Project documents were translated from English into French and copies were provided to the University of Florida Institutional Review Board (IRB) and the Burkina Faso Ethical Review Board (ERB). Both the UF IRB and the Burkina Faso ERB approved the study prior to the collection of any data.

Results

Household decision-making and egg consumption at endline

The results of the binomial logistic regression can be found in Table 4. Only one HHDM variable was found significant for entry into the model—endline decision-making on who decides what to do with the household eggs (HHDM-E). To control for baseline HHDM-E, the baseline HHDM-E metric was entered into the model as a covariate, which was not found to be significant within the model.

The model is found to be statistically significant, $\chi^2(2) = 15.50$, $p < 0.0005$. It explained 11.4% (Nagelkerke R^2) of the variance in egg consumption and classified 86.8% of all cases correctly. A non-significant Hosmer and Lemeshow Test ($p = 0.854$) showed that the data fit the model well. The model sensitivity was 100% with a positive predictive value was 86.83%. The covariate of HHDM-E at baseline was not found to be statistically significant; however, it did show that women who reported "self" decision-making at baseline were 1.969 times more likely to feed their child eggs at endline. The relationship between HHDM-E at endline and egg consumption was found to be statistically significant ($p = 0.002$). Women who reported "self" decision-making over what is done with the household eggs had 4.439 times higher odds of feeding their child chicken eggs than women who reported that someone else makes that decision.

ΔHHDM and egg consumption at endline

To examine the relationship between an observed change in household decision-making about egg consumption between baseline and endline and women feeding their child chicken eggs at endline, a binomial logistic regression was performed, where the dependent variable is a four-category variable that examines the change in HHDM-E from baseline to endline

TABLE 4 Logistic regression results for egg consumption based on HHDM-E at endline.

Logistic regression predicting likelihood of egg consumption based on HHDM-E at endline								
Predictor	***B***	**SE**	**Wald**	***df***	***p***	**Odds ratio**	**95% CI for**	
							Lower	**Upper**
HHDM-E at baseline	0.678	0.486	1.945	1	0.163	1.969	0.760	5.102
HHDM-E at endline	1.490	0.476	9.809	1	0.002*	4.439	1.747	11.281
Constant	2.286	0.273	70.192	1	0.000*	9.834		

*Denotes significant p-value; HHDM-E is for self compared to other.

TABLE 5 Logistic regression results for egg consumption based on change in HHDM-E from baseline to endline.

Logistic regression predicting likelihood of egg consumption based on change in HHDM-E from baseline to endline								
Predictor	***B***	**SE**	**Wald**	***df***	***p***	**Odds ratio**	**95% CI for**	
							Lower	**Upper**
Change in HHDM-E (negative sustainment)			12.263	3	0.007			
Change in HHDM about household egg decisions (negative change)	0.843	0.586	2.074	1	0.150	2.324	0.738	7.322
Change in HHDM about household egg decisions (positive change)	1.341	0.490	7.498	1	0.006*	3.822	1.464	9.977
Change in HHDM about household egg decisions (positive sustainment)	1.896	0.763	6.171	1	0.013*	6.662	1.492	29.745
Constant	2.192	0.256	73.457	1	0.000	8.951		

*Denotes significant p-value; change in HHDM-E is for negative sustainment compared to negative change, positive change, and positive sustainment.

(previously shown in Table 3). As with the previous model, HHDM-E was the only variable to show significance below $p = 0.2$ when running univariate correlations, and to be included in the regression. The logistic regression model was statistically significant, $\chi^2(3) = 14.027$, $p < 0.0005$. The model explained 9.9% (Nagelkerke R^2) of the variance in egg consumption and classified 86.5% of all cases correctly, and the Hosmer and Lemeshow goodness-of-fit test showed the model was a good fit ($p = 1.0$). The model sensitivity was 100% with a positive predictive value was 86.51%. The categories of HHDM of "positive change" and "positive sustainment" were found to have a statistically significant positive correlation with egg consumption at endline ($p = 0.006$ and $p = 0.013$, respectively). Women who reported a "positive change"—reported that at endline they make the decision about what is done with the household eggs whereas at baseline it was someone else making that decision—had 3.822 times higher odds of feeding their child chicken eggs than women who reported both at baseline and at endline that someone other than themselves makes that decision. Furthermore, women who reported making these decisions at baseline and sustaining that decision-making power at endline had 6.662 times higher odds of feeding their child chicken eggs than women who reported at both baseline and endline that someone else made that decision. See Table 5 for results.

HHDM and an 5DE score at endline

A chi-squared test for association was conducted between each of the four HHDM variables at endline and the adequacy score of the 5DE. Of the four HHDM variables centered around feeding practices, two were found to have a statistically significant ($p \leq 0.2$) positive association with the 5DE score—(1) who makes decisions about how foods are portioned and (2) who makes decisions about what to do with the household eggs. Subsequently, a logistic regression was performed to examine the relationship amongst HHDM-E (and HHDM-P) and 5DE score.

TABLE 6 Logistic regression results for empowerment adequacy based on HHDM-P and HHDM-E at endline.

Logistic regression predicting empowerment adequacy based on HHDM-P and HHDM-E at endline								
Predictor	***B***	**SE**	**Wald**	***df***	***p***	**Odds ratio**	**95% CI for**	
							Lower	**Upper**
HHDM-P at endline	1.904	0.762	6.247	1	0.012*	6.712	1.508	29.871
HHDM-E at endline	1.056	0.275	14.773	1	0.000*	2.876	1.678	4.929
Constant	−1.109	0.380	8.509	1	0.004	0.330		

*Denotes significant p-value; HHDM-P and HHDM-E are for "self" compared to "other".

TABLE 7 Logistic regression results for egg consumption based on HHDM-E at endline.

Logistic regression predicting likelihood of egg consumption based on HHDM-E at endline								
Predictor	***B***	**SE**	**Wald**	***df***	***p***	**Odds ratio**	**95% CI for**	
							Lower	**Upper**
HHDM-E at baseline	0.836	0.480	3.039	1	0.081	2.308	0.901	5.911
Empowerment 5DE at endline	0.276	0.399	0.480	1	0.489	1.318	0.603	2.878
Constant	2.128	0.245	75.347	1	0.000	8.397		

HHDM-E at baseline is for "self" compared to "other", and empowerment is for "adequate" compared to "inadequate".

The logistic regression model was statistically significant, $\chi^2(2) = 30.787$, $p < 0.0005$. The model explained between 11.7% (Cox and Snell R^2) and 15.7% (Nagelkerke R^2) of the variance 5DE adequacy and classified 66% of all cases correctly, while Hosmer and Lemeshow test was not significant ($p = 0.882$) and showed the model to be a good fit. The model sensitivity was 64.2%, specificity was 67.4%, positive predictive value was 59.65%, and a negative predictive value was 71.43%. Both HHDM-E and HHMD-P were significant within the model ($p < 0.0005$ and $p = 0.012$, respectively), and showed that an increase in either resulted in an increase in likelihood for an adequate 5DE score. Women who reported making decisions about what is done with the household eggs were 2.876 times more likely to have an adequate 5DE score compared to women who reported others making those decisions. Similarly, women who reported making decisions about how food is portioned were 6.712 times more likely to have an adequate 5DE score compared to women who reported not making those decisions. See Table 6 for results.

Women's empowerment (5DE) and egg consumption at endline

A chi-squared test for association was performed to examine if any significant association existed between 5DE score and egg consumption at endline. The test showed no significant relationship between the two variables. To further confirm these results, a logistic regression was performed with egg consumption as the dependent variable and 5DE as a regressor—HHDM-E was controlled for at baseline—the model was not significant ($p = 0.489$) (Table 7).

Relationship between *Un Oeuf* study and women's empowerment

Since a significant statistical relationship was shown to exist between, on the one hand, 5DE adequacy score and, on the other hand, HHDM-E and HHDM-P, logistic regressions were performed to explore the relationship between likelihood of egg consumption and HHDM-E and HHDM-P within each of the three research arms (full, partial, and control) of the *Un Oeuf* study.

No statistically significant relationship was observed amongst any of the three research arms and HHDM-P ($p = 0.531$). However, the logistic regression performed to examine the relationship between egg consumption amongst the research arms and HHDM-E was found to be statistically significant, $\chi^2(2) = 19.091$, $p < 0.0005$. The Hosmer and Lemeshow Test ($p = 0.997$) confirmed the data to be a good fit for the model. The model explained between 7.3 (Cox and Snell R^2) and 9.8% (Nagelkerke R^2) of the variance 5DE adequacy and

TABLE 8 Logistic regression results for egg consumption at endline based on HHDM-E across research arms.

Logistic regression predicting likelihood of egg consumption at endline based on HHDM-E across research arms

Predictor	*B*	SE	Wald	*df*	*p*	Odds ratio	95% CI for	
							Lower	Upper
Research arm (control)			17.950	2	0.000			
Research arm (partial)	0.782	0.319	5.999	1	0.014*	2.186	1.169	4.088
Research arm (full)	1.398	0.331	17.862	1	0.000*	4.045	2.116	7.734
Constant	−0.126	0.132	0.916	1	0.338	0.881		

*Denotes significant p-value; Research arm is for control compared to partial and full.

classified 61.8% of all cases correctly with a good model fit (Hosmer and Lemeshow, $p = 1.0$). The model sensitivity was 42.7%, specificity was 78.4%, positive predictive value was 63.29%, and a negative predictive value was 61.05%. The egg consumption in both the Full and Partial Research Arms were significant within the model with respective values of $p < 0.0005$ and $p = 0.014$ and showed that an increase was correlated with an increase in likelihood that a woman, herself, makes decisions on household eggs. Results (Table 8) showed that women in the partial intervention arm were 2.186 times more likely to report decision-making over what is done with eggs within the household compared to women in the control arm. Comparatively, women in the full intervention arm were 4.045 times more likely to report decision-making over what is done with eggs within the household compared to women in the control arm.

Discussion

Findings of these analyses contribute to the growing body of literature surrounding women's empowerment and animal source food consumption, underscoring that increasing a women's household decision-making ability surrounding the nutrition of her children is an important and direct pathway to increasing the ASF consumption of CU5 (Ayele and Peacock, 2003; Tolhurst et al., 2008; Lépine and Strobl, 2013; Richards et al., 2013; Jin and Iannotti, 2014). While no significant relationships were shown to exist between egg consumption and 5DE adequacy score, significant positive relationships were shown to exist at endline between women's household decision-making regarding nutrition (notably, HHDM-E and HHDM-P) and both egg consumption of CU5 and 5DE adequacy score. This finding highlights the importance of decision-making *about nutrition related resources and decisions,* something for which the A-WEAI does not directly account.

Intrahousehold bargaining power is extremely important to inspect within the concept of women's empowerment but can be difficult to understand if a study does not include information on the woman's role in household decision-making. Intrahousehold bargaining power can be thought of as the weight one can exert on the scales of decision-making within the household—some women have full control of specific domains with the support of their spouses, while others may have little to no control and are unable to tip the scale in their favor (Agarwal, 1997; Ahmed, 2006; Seebens, 2011). Literature shows that many projects have examined women's empowerment and childhood nutrition through household surveys and anthropometrics; however, a validated means for assessing women's empowerment is often missing from these study designs (Bhagowalia et al., 2010; Doss, 2013).

Regarding the impact of the *Un Oeuf* study on women's empowerment, it is apparent that the intervention successfully changed household decision-making in choices that significantly impact the consumption of ASF (eggs) in CU5. This can be seen in the relationship established between those who experienced a positive change in their own decision-making and egg consumption—a woman who was not previously making decisions about eggs who reports making those decisions by the end of the project was 3.82 times more likely to feed her child eggs compared to a woman whose decision-making power did not increase. This is important, because although other studies have shown a relationship between increasing broader dimensions of women's empowerment (as measured by A-WEAI and reflected in women's adequate 5DE score in this study) and increasing ASF consumption in children, this is not the only approach to increasing ASF consumption in children. A more direct pathway may be possible by focusing on *empowering women* to make decisions surrounding children's nutrition and consumption of specific forms of food, such as ASF. Our research indicates that it may be possible to change the balance of decision-making within the household in a manner that is favorable to support behavior change that increases ASF consumption in children prior to her being more generally "empowered", as indicated by tools such as the 5DE, which

may take longer and may not be successful. Limitations to this study include the lack of women's empowerment data at baseline, which limited the ability to fully examine whether a change in overall women's empowerment (as measured by the 5DE) occurred within the study population and to what extent it was specific to the intervention, as well as the lack of men's participation in the A-WEAI. A possible limitation to this study is that survey respondents to questions about decision-making (outside of the A-WEAI) were asked who takes the decision, and options did not include joint decision-making. While this limits our ability to know where women made progress, provided input, or increased engagement with decision-making but did not report as "taking" the decision, this yielded results that are a conservative measure of where increased decision-making may have occurred. Consequently, women's engagement in decision-making, be that in bargaining power, influence, or joint decision-making, may be greater than that captured in our indicator. One strength this study had was the partnership with gender experts in Burkina Faso. This collaboration allowed for rigorous training of data collectors to facilitate high quality data collection of the A-WEAI. Additional strengths include a high degree of trust and rapport with the women in the study population, which aided in the response rate of all questions.

Conclusion

In conclusion, this study found a significant and positive relationship between women's decision-making and egg consumption among CU5. Importantly, overall women's empowerment (as indicated by the 5DE in this study) was not associated with CU5 egg consumption. Given the emphasis on women's empowerment as a pathway by which agriculture can improve nutrition, the study underscores the need to better understand which domains of empowerment are those that most directly affect nutritional outcomes; specifically, the potential for women's decision-making about household-produced ASF to directly affect own-consumption needs further study.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: https://dataverse.harvard.edu/dataverse/livestock-lab-burkina-egg-consumption.

Ethics statement

The studies involving human participants were reviewed and approved by University of Florida Institutional Review Board Committee of Ethics of the Government of Burkina Faso. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

EM is the primary author who wrote this article with support and guidance from RS and SM. NS provided statistical expertise and coding for the scoring of the 5DE instrument and adherence to methodology. SM supervised the research and findings of this work as the principal investigator of the Un Oeuf study. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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