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Women's agency in nutrition in the association between women's empowerment in agriculture and food security: A case study from Uganda

Farzaneh Barak[1] | **Jackson Efitre**[3] | **Robinson Odong**[3] | **Hugo Melgar-Quiñonez**[1,2]

[1]School of Human Nutrition, McGill University, Montreal, Quebec, Canada

[2]Margaret A. Gilliam Institute for Global Food Security, McGill University, Montreal, Quebec, Canada

[3]Department of Zoology, Entomology and Fisheries Sciences, College of Natural Sciences, Makerere University, Kampala, Uganda

Correspondence
Farzaneh Barak, School of Human Nutrition, McGill University, Ste-Anne-de-Bellevue, Montreal H9X 3V9, QC, Canada.
Email: farzaneh.barak@mail.mcgill.ca

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Abstract

This study examined the relationship between women's empowerment in agriculture (WEA), women's agency in nutrition, and their food security. It aimed to quantify the moderating effect of women's agency in nutrition on the association between WEA and food security. Data from the NutriFish project, a gender- and nutrition-sensitive agricultural intervention in fishing villages in Uganda, were utilized. The study included 380 primary Ugandan female decision makers in dual adult households. WEA was measured using the Project-level Women's Empowerment in Agriculture Index (pro-WEAI). Women's agency in nutrition was assessed through measures of agency in regular diet, pregnancy diet, breastfeeding diet, and food purchase. Binary logit regression models were employed to estimate differential associations between WEA and food security, testing three-way interactions between WEA, agency in regular diet, and food purchase. Results showed that WEA was associated with a 0.18

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increase in the predicted probability of food security ($p < .01$). Women's participation in food purchase decisions strengthened the WEA-food security association by 0.33 ($p < .05$). The results suggested that promoting women's food purchase agency can enhance the positive link between WEA and food security. Prioritizing interventions empowering women in food purchase decisions improves food security in gender- and nutrition-sensitive programs.

KEYWORDS

agency in nutrition, food purchase agency, food security, Uganda, women's empowerment

1 | INTRODUCTION

Recent studies have suggested that to identify and address barriers to the food security of women, a complementary set of indicators is needed to capture the empowerment status of women explicitly in the domain of nutrition (Narayanan et al., 2019, 2022). Narayanan et al. (2019) defined empowerment in nutrition as "the process by which individuals acquire the capacity to be well fed and healthy, in a context where this capacity was previously denied to them" (p. 2). One of the key dimensions of empowerment is "agency," which is the ability to define goals and act upon them (Kabeer, 1999, p. 438). Kabeer (1999) operationalized agency as quantified decision making that can be indicated by cognitive actions of reflection and analysis such as deceiving or manipulating, bargaining, and subverting (Kabeer, 1999). In the current study, women's agency in nutrition was referred to the participation of women in the decisions about their dietary intake and food purchases in the household.

Narayanan et al. (2019) adapted the definition of empowerment by Kabeer (1999) and conceptualized the empowerment of women in nutrition as the expansion of the capacity through processes that support the voice of women around their nutritional status (Narayanan et al., 2022). Supportive processes include promoting access to and control over sufficient and nutritious food, increasing knowledge related to nutrition, participating in the decisions related to individual health and nutrition, and having the support of the family, community, and other institutions to maintain healthy practices (Narayanan et al., 2022).

Empowerment in nutrition indicates individual ability to be empowered and the broader structural and contextual freedom from constraints such as power relations in food and gender systems. Several researchers have attempted to quantify women's empowerment in nutrition; yet these indices are not widely or rigorously applied (Hannan et al., 2020; Malapit et al., 2014; Olney et al., 2016). The recent Women's Empowerment in Nutrition Index (WENI) served to introduce an approach aimed at quantifying empowerment in nutrition (Narayanan et al., 2019, 2022). The explicit focus of WENI researchers is on the quantification of nutrition-focused empowerment, which was shown to be a statistically significant and meaningful predictor of

body mass index (BMI), anemia, and women's minimum dietary diversity (Gupta et al., 2022; Lentz et al., 2021; Narayanan et al., 2019; Saha & Narayanan, 2022).

Methods for the quantification of women's empowerment in nutrition are relatively new, and scholars in many disciplines have researched the quantification of women's empowerment. Ewerling et al. (2017) operationalized empowerment in terms of economic empowerment, Alkire et al. (2013) and Malapit et al. (2019) quantified empowerment in agriculture, Colverson et al. (2020) and Galiè et al. (2019) introduced measurements tools for empowerment in livestock, and Malapit et al. (2020) did so for empowerment in agricultural value chains. Among them, women's empowerment in agriculture (WEA) has received more attention as an effective strategy to enhance food security within nutrition-sensitive agriculture interventions in the context of low- and middle-income countries (LMICs) (Di Prima et al., 2022; Ruel et al., 2013, 2018). Evidence of a positive association between WEA and food security is however inconclusive (Asitik & Abu, 2020; Aziz et al., 2020; Bhandari & Burroway, 2018; Sraboni et al., 2014; Wei et al., 2021).

To elaborate, in studying the association between the indicators of empowerment and food security, findings often indicate trade-offs (Aziz et al., 2020; Wei et al., 2021); that is, empowerment does not necessarily affect food security, or other nutrition outcomes, positively for women (Cornwall, 2016; Essilfie et al., 2021; Quisumbing et al., 2021; Tsiboe et al., 2018). This outcome is likely because existing indices do not account for nutrition-sensitive indicators in operationalizing empowerment, and their focus is mainly on economic enablers and productive resources while targeting a nutrition or food security outcome. In effect, as the results of prior research suggested, empowering women in agriculture did not necessarily empower them in nutrition-focused decisions at individual or household levels (Narayanan et al., 2019; Quisumbing et al., 2021; United Nations Women, 2018).

The study herein argued that empowering women in both agriculture *and* nutrition might complement each other by addressing respective shortcomings, while strengthening one another. It was hypothesized that empowering women in nutrition could moderate the association between WEA and their food security. To that end, this study aimed to (a) examine the relationship between aggregated and disaggregated measures of WEA and (i) women's empowerment in nutrition and (ii) the food security status of women; and (b) quantify the moderating effect of women's empowerment in nutrition in the association between WEA and their food security. The interest was to expand the analysis to assess whether women's empowerment in nutrition could explain the relationship between WEA and their food security, an approach currently absent in the literature.

1.1 | Measuring women's empowerment

In this study, the project-level Women's Empowerment in Agriculture Index (pro-WEAI) was used to measure WEA (Malapit et al., 2019). The pro-WEAI survey aims to measure empowerment in agriculture development programs in rural contexts. This tool is mainly operationalized by the agency dimension of empowerment, as Kabeer (1999) defined (p. 437). Empowerment, the ability to make strategic life choices, can be exercised through three interrelated dimensions: resources (pre-conditions), agency (process), and achievement (outcome) (Kabeer, 1999). In agricultural development studies, the agency dimension of empowerment has been less studied compared with other dimensions (Malapit et al., 2019).

To measure women's empowerment in nutrition, pro-WEAI includes a Health and Nutrition (H&N) module as an add-on, but it has not yet been widely used (Hannan et al., 2020;

Heckert et al., 2023). This module is focused on women's agency in health and nutrition. In this study, only questions related to women's agency in nutrition were used, which were operationalized empowerment as decision making through four sections: (a) women's regular diet (what to prepare and what to eat); (b) women's diet during pregnancy and/or breastfeeding (intake of dairy products, eggs, and meat, poultry, or fish); (c) children's diet (same as b); and (d) women's agency related to purchasing food and supplements for themselves, their households, and children (see Table 1).

2 | MATERIALS AND METHODS

2.1 | Country context and data

Uganda's Demographic and Health Survey (UDHS) in 2016 showed that among women of reproductive age, 32% suffered from anemia, 9% were underweight, and 24% were overweight or obese (Uganda Bureau of Statistics [UBOS] & ICF, 2018). These data suggested a high risk of micronutrient deficiencies for Ugandan women.

Limited data on the quantity and quality of food consumed by Ugandan households suggest a poor-quality diet with one-third of households having low dietary diversity (four or fewer food groups per day) (World Food Program [WFP], 2019). The main source of household food intake is energy-providing staple foods such as plantain (green banana, locally called matooke), cassava, rice, and white maize, which do not provide the required micronutrient intake, especially for vulnerable groups such as women and adolescent girls. The main barriers to consuming a diverse and balanced diet among Ugandan households are lack of food availability and economic access to sufficient and nutritious food, indicating high rates of food insecurity (WFP, 2019).

The recent report on the State of Food Security and Nutrition in the World (SOFI 2022) showed a 9% increase in the prevalence of moderate or severe food insecurity from 2014–2016 (63.4%) to 2019–2021 (72.5%). This increase was mainly affected by the adverse effects of the COVID-19 pandemic and increased food prices resulting in lower affordability of a healthy diet (Food and Agriculture Association [FAO] et al., 2022).

To improve the quality of diet among low-resource households, the NutriFish project was implemented in Uganda to promote the availability, accessibility, and consumption of underutilized small fish. Incorporating culturally preferred small fish into low diverse diets can address nutritional issues among vulnerable groups like women (Ahern et al., 2021). Built on the overarching goal of NutriFish, which aimed to foster sustainable food security and better livelihood of vulnerable groups, including women, the project focused on promoting nutrition- and gender-sensitive fisheries through three intervention components: (a) group-based training for men and women, (b) nutrition behavior change, and (c) gender sensitization.

The study herein involved a secondary data analysis using cross-sectional data from the larger NutriFish project. The project collected survey data from January to February 2020, covering $n = 381$ dual-adult households (DHHs), which included both a male and a female adult, and $n = 23$ female-adult-only households (FHHs) in six fishing villages on the shores of Lakes Victoria and Albert in Uganda, mapped into five districts. The pro-WEAI score for FHHs was not constructed due to missing responses for some of the indicators. Instead, the analysis was conducted with data from primary female decision makers in DHHs.

TABLE 1 Definitions of empowerment, outcome, and explanatory variables.

Indicator	Definition of indicator
Women's empowerment in agriculture (WEA) score and its indicators	
Empowerment score	Calculated using project-level Women's Empowerment in Agriculture Index (Pro-WEAI) composed of 12 indicators mapped into three domains of empowerment (3DE), as three categories of agency, including instrumental, intrinsic, and collective. Empowered (=1) if adequate 9 out of 12 indicators, otherwise, disempowered (=0).
3DE indicators	Adequate if meeting a pre-defined threshold (=1), otherwise inadequate (=0). See tab. 2 in Malapit et al. (2019) for more details about adequacy. *Intrinsic agency*: autonomy in income, self-efficacy, attitudes toward domestic violence, and respect among household members *Instrumental agency*: input in productive decisions, ownership of land and other assets, access to and decision on credit, control over use of income, work balance, and visiting important locations *Collective agency*: group membership and membership in influential groups
Household gender parity (HGP)	A household achieves gender parity (=0) if either the woman is empowered, or her score is greater than or equal to the empowerment score of the male decision maker in the household.
Women's agency in nutrition	
Women's agency on own diet (regular diet)	Input into decisions about what foods to prepare and what foods to eat. A woman has agency on her own diet (=1) if she is sole decision maker or contributes to a medium or high extent when decision is made jointly for both decisions. The questions about regular diet were asked from all female participants in the study ($n = 380$). See Heckert et al. (2023) and Hannan et al. (2020) for more details about pro-WEAI Health and Nutrition modules.
Women's agency on own diet during pregnancy (pregnancy diet)	Input into decisions whether a woman can eat (a) eggs; (b) milk and milk products; and (c) meat, poultry, or fish during her current or most recent pregnancy. A woman has agency on her own diet during pregnancy (=1) if she is sole decision maker or contributes to a medium or high extent when decision is made jointly for at least two items. The questions about pregnancy diet were asked from female participants who have been pregnant or gave birth within the previous 2 years (including currently pregnant women) ($n = 152$).
Women's agency on own diet during breastfeeding (breastfeeding diet)	Input into decisions whether a woman can eat (a) eggs; (b) milk and milk products; and (c) meat, poultry, or fish when her youngest child was being breastfed. A woman has agency on her own diet during breastfeeding (=1) if she is sole decision

TABLE 1 (Continued)

Indicator	Definition of indicator
	maker or contributes to a medium or high extent when decision is made jointly for at least two items. The questions about breastfeeding diet were asked from female participants who have been pregnant or gave birth within the previous 2 years (including currently pregnant women) ($n = 152$).
Women's agency on food purchase	Input into decisions about purchasing food items, medications, and supplements for herself or her household ($n = 7$); a woman has agency on food purchase (=1) if she is sole decision maker or contributes to a medium or high extent when decision is made jointly for four or more decisions. The questions about food purchase were asked from all female participants in the study ($n = 380$).
Food security	
Food security	Measured by Household Food Insecurity Access Scale (HFIAS) at individual level. Food secure (=1) if experiences none of the food insecurity conditions or just experiences worry but rarely in the previous 4 weeks; otherwise, the person is food insecure (=0).
Sociodemographic variables	
Age	Three categories: 15–25, 26–45, and >45 years old.
Education	High education at secondary and tertiary or higher level (=1); low education with no formal education or at primary level (=0).
Household size	Number of household members
Occupation	Fisheries versus non-fisheries; fisheries (=1) includes fishing, fish processing, fish trading, and causal work in fisheries.

2.2 | Analytical approach

The authors adapted the methodology employed by Malapit et al. (2015) and Quisumbing et al. (2021) to conduct analysis using aggregated and disaggregated WEA scores, which were key independent variables. The individual empowerment status of men and women in pro-WEAI is an aggregated measure of three domains of agency (3DE): intrinsic, instrumental, and collective agencies mapped into 12 indicators (Malapit et al., 2019) (see Table 1). Each indicator has a threshold to meet the adequacy in pro-WEAI (Malapit et al., 2019). An individual is categorized as empowered if she or he is adequate in nine out of 12 indicators (3DE $\geq$ 0.75), ranging from 0 to 1. Both aggregated and disaggregated measures were used in this study.

2.2.1 | Aggregated score

Two measures of the aggregated WEA were calculated. The first one relied only on the women's empowerment scores (WEA). The second one, which was household gender parity (HGP), compared the empowerment score of men and women within the same household. The HGP score

measures gender parity in the household; a household achieves gender parity when the woman is empowered (3DE $\geq$ 0.75) or her 3DE score is equal or greater than her male counterparts in the household (Malapit et al., 2019). These two measures were included in the analysis as the aggregated measures of empowerment. See Table 1 for the empowerment and food security measures and explanatory variables used in the analysis and how they were operationalized.

2.2.2 | Disaggregated score

To assess the association between the 3DE indicators and the outcomes, 12 separate binary logit models were estimated for each of the 3DE indicators to avoid collinearity among the indicators followed by Quisumbing et al. (2021).

2.2.3 | Outcome variables

The first outcome measure was women's agency in nutrition in four independent categories: women's agency on their diet (regular, during pregnancy, and when breastfeeding) and food purchase. It was hypothesized that WEA was associated with these measures of women's agency in nutrition, estimated by four binary logit regression models. The same procedure was repeated for HGP.

The second outcome measure was the Household Food Insecurity Access Scale (HFIAS). HFIAS measures the food security status of women at the individual level using nine questions to assess the access dimension of food security (Coates et al., 2007). It was hypothesized that women's agency in nutrition can moderate the association from WEA to food security. Two measures of women's agency on their diet and food purchase were included in this model because the data were available for the total sample size ($n = 380$) and not for the measures of women's agency on pregnancy and breastfeeding diets ($n = 152$). The researchers additionally tested whether WEA, women's agency on their regular diet, and women's agency on food purchase have interactive effects beyond their independent additive effects on the food security status of women. In so doing, tests of three-way interactions were carried out by running a binary logit model estimating the difference in the predicted probabilities (Pr) of food security, referred to as marginal effects (MEs).

MEs measure how much the outcome changes (a) for a change in one focal independent variable while (b) holding other control variables constant. For example, there are two Pr (s) of food security for a dichotomous variable like WEA: Pr_1 is when WEA is set at empowered (=1), and Pr_0 is when WEA is set at disempowered (=0), holding other control variables at a specific value such as Average Marginal Effect (AME)[1] in the analysis. The difference between Pr (s) is referred to as MEs ($Pr_1 - Pr_0$). Whereas the independent variable is a three-way interaction term between three dichotomous variables, there are eight Pr (s). The following text contains an elaboration of the steps of testing the three-way interaction effect referred to herein as the difference in difference in difference approach (diff-in-diff-in-diff) (Mize, 2019).

[1]Average Marginal Effects (AME) represent an effect on average across the sample, which is the average (mean) of the marginal effects calculated for each observation in the sample; for further details, see Mize (2019).

Step 1) MEs were estimated to compare two conditions of whether women are empowered in agriculture or not at four levels having or not having agency on general diet and food purchase, as follows:

1) No agency: Food Purchase agency = 0, Regular diet agency = 0
2) Only purchase agency: Food Purchase agency = 1, Regular diet agency = 0
3) Only regular diet agency: Food Purchase agency = 0, Regular diet agency = 1
4) Both agency: Food Purchase agency = 1, Regular diet agency = 1

At each level, MEs were computed, referred to as the first differences (1st diff):

$$\Pr(\text{food security} \mid \text{WEA} = 1) - \Pr(\text{food security} \mid \text{WEA} = 0) = \text{ME}_{\text{i}\,(1-4)}.$$

Step 2) Second differences (2nd diff) were estimated: a test of the equality of MEs, comparing two conditions of whether women have agency on their regular diet or not:

$$\text{2nd diff}_1 = \text{ME}_1 - \text{ME}_2.$$

$$\text{2nd diff}_2 = \text{ME}_3 - \text{ME}_4.$$

Step 3) Third differences (3rd diff) were estimated to test the equality of the second differences, comparing two conditions of whether women have agency on food purchase or not.

$$\text{3rd diff} = \text{2nd diff}_1 - \text{2nd diff}_2.$$

All models were estimated using binary logit regression and controlled for the following variables in all models: age, education, occupation, and household size, clustering standard errors at the level of fishing villages. Women's agency on food purchase was included in all models except model four (food purchase model). Stata (version 17) was used to conduct the analysis.[2]

3 | RESULTS

3.1 | Sample characteristics

After removing the missing responses, the final sample size was $N = 380$ individuals. Overall, 37% of women were food secure, and 26% were empowered in agriculture ($n = 380$) (see Table 2). Almost 81% were able to decide on what food to prepare and what food to eat (agency on their regular diet) ($n = 380$). Among the total sample, $n = 152$ (40%) of women had been pregnant or given birth within the previous 2 years with 76% and 80% reporting agency on their diet during pregnancy and while breastfeeding, respectively. The rate of women's agency on

[2]Standard Stata do-files were employed to calculate the pro-WEAI score available on the International Food Policy and Research Institute's (IFPRI) website and modified as needed to suit the NutriFish baseline data.

TABLE 2 Study sample characteristics.

Variables	% ($n = 380$)
Food secure	37.11
Women's empowerment in agriculture status and its indicators	
Empowered	26.32
Intrinsic agency	
Autonomy in income	57.37
Self-efficacy	56.58
Attitudes toward domestic violence	45.00
Respect among household members	33.16
Instrumental agency	
Input in productive decisions	69.47
Ownership of land and other assets	69.74
Access to and decision on credit	56.05
Control over use of income	70.53
Work balance	30.00
Visiting important locations	60.79
Collective agency	
Group membership	60.79
Membership in influential groups	56.58
Women's agency in nutrition	
Regular diet	80.79
Pregnancy diet	76.32 ($n = 152$)
Breastfeeding diet	80.26 ($n = 152$)
Food purchase	68.68
Sociodemographic variables	
Age (y)	
15–25	57.11
26–45	58.95
>45	13.95
Education (high educated)	26.32
Household size (#)	6.2 (3.2)[a]
Occupation (fisheries)	52.89

[a]Mean (SD).

food purchase was among the lowest WAN rates, $n = 380$ (69%). Only 26% of mothers were highly educated (secondary, tertiary, or higher level) with the majority <45 years old. More than half of them worked in the fisheries sector. Out of the 12 indicators of 3DE categorized into three agency types, women scored the lowest in intrinsic agency indicators such as having respect among household members (%33). They also faced obstacles in realizing their agency to achieve work–life balance (30%) and access to making decisions about credit (56%) in the

instrumental agency category. Additionally, membership in influential groups (57%) in the collective agency category was also a challenge for women.

3.2 | WEA and their agency in nutrition

The aggregated WEA score tended to be associated with a 0.07 and 0.06 increase in women's diet agency and pregnancy diet agency ($p < 0.1$) (see Table 3**)**. Having agency on food purchase was positively associated with women's agency on their regular (0.18, $p < .01$), pregnancy (0.26, $p < .05$), and breastfeeding (0.32, $p < .01$) diets (Models 1–3, Table 3). On the contrary, the absence of gender parity in the household was associated with a 0.12 decrease in women's agency on their regular diet ($p < .05$) and tended to be associated with a 0.05 increase on women's agency on their pregnancy diet ($p < .1$) (see Table 4). Similar to the results shown in Table 3, the higher participation of women in decisions related to food purchase was associated with an increase in the predicted probability of having an agency on the regular (0.18, $p < .01$), pregnancy (0.26, $p < .05$), and breastfeeding (0.33, $p < .01$) diets (Models 1–3, Table 4). The results from model 4 in both Tables 3 and 4 showed a positive association between higher education (0.12, $p < .01$) and adult age (26–45 years) (0.10, $p < .05$) and women's voice in food purchase decisions.

Figure 1 presents MEs using the 12 indicators of women's empowerment. In all models, work balance was negatively associated with the measures of women's agency in nutrition, except their agency on food purchase. Having control over the use of income and respect among household members were, respectively, associated with a 0.15 ($p < .01$) and 0.14 ($p < .05$) increase in the participation of women in decision making about their regular diet. Visiting important places (i.e., hospital, health center, community meetings/gatherings, and market) more frequently was negatively related with breastfeeding agency (−0.15, $p < .01$), and group membership improved it (0.05, $p < 0.05$). Income control (0.08, $p < .05$) and asset ownership

TABLE 3 Aggregated women's empowerment in agriculture and women's agency on own diet (regular, pregnancy, and breastfeeding) and on food purchase.

	Model 1: regular diet ($n = 380$)		Model 2: pregnancy diet ($n = 152$)		Model 3: breastfeeding diet ($n = 152$)		Model 4: food purchase ($n = 380$)	
Variables	**Pr**[a]	**SE**	**Pr**	**SE**	**Pr**	**SE**	**Pr**	**SE**
Women's empowerment	.07*	.04	.06*	.03	−.03	.05	−.01	.05
Food purchase agency	.18***	.05	.26**	.12	.32***	.04		
Age (y): 26–45 vs. 15–25	.03	.07	.06	.10	.08	.08	.10**	.04
Age (y): >45 vs. 15–25	.06	.04	−.11	.21	−.08	.06	.09	.09
Age (y): >45 vs. 26–45	.03	.09	−.17	.24	−.16	.11	−.01	.07
Education	.07*	.04	.01	.12	−.02	.05	.12***	.03
Household size	−.01	.01	−.01	.02	−.01	.01	.00	.01
Occupation	.00	.02	−.02	.02	−.04	.05	.05	.07

[a]Predicted probability, marginal effects reported. Robust standard errors were clustered by fishing villages.
*$p < .1$, **$p < .05$, and ***$p < .01$.

TABLE 4 Household gender parity status and women's agency on her own diet (regular, pregnancy, and breastfeeding) and on food purchase.

	Model 1: regular diet ($n = 380$)		Model 2: pregnancy diet ($n = 152$)		Model 3: breastfeeding diet ($n = 152$)		Model 4: food purchase ($n = 380$)	
Variables	**Pr[a]**	**SE**	**Pr**	**SE**	**Pr**	**SE**	**Pr**	**SE**
Household gender parity status	−.12**	.05	.05*	.03	.08	.05	.00	.05
Food purchase agency	.18***	.05	.26**	.12	.33***	.04		
Age (y): 26–45 vs. 15–25	.02	.06	.07	.11	.09	.09	.10**	.05
Age (y): >45 vs. 15–25	.04	.03	−.14	.22	−.06	.05	.08	.09
Age (y): >45 vs. 26–45	.02	.09	−.21	.25	−.15	.11	−.02	.07
Education	.07*	.04	−.21	.25	−.02	.05	.12***	.03
Household size	−.01	.01	−.01	.02	−.01	.01	.00	.01
Occupation	.00	.03	−.01	.02	−.03	.05	.05	.07

[a]Predicted probability, marginal effects reported. Robust standard errors were clustered by fishing villages.
*$p < .1$, **$p < .05$, and ***$p < .01$.

(0.25, $p < .01$) were positively associated with food purchase agency, and negative attitudes toward gender violence was associated with a 0.14 decrease in food purchase agency ($p < 0.05$). Detailed results are in Table S1.

3.3 | WEA and food security

Empowering women in agriculture was strongly associated with a 0.18 increase in their food security (see Table 5 and Figure 2). HGP and women's agency on their regular diet and food purchase appeared to have no association with food security. In both models, education showed opposite associations with food security. In Model 1, higher education was associated with a 0.06 decrease in food security ($p < .01$), whereas in Model 2, it was associated with a 0.15 increase in food security ($p < .01$). The smaller household size was strongly associated with a better food security status in both models (−0.03, $p < .01$). Having control over income, respect among household members, and negative attitudes toward gender violence improved the food security status of women by 11 ($p < .05$), 21 ($p < .01$), and 13 ($p < .01$) percentage points, respectively. Detailed results are in Table S2.

3.4 | Interactions between WEA and agency on regular diet and food purchase

The predicted probabilities of food security were higher when women were empowered in agriculture compared with when they were not (see Table 6 and Figure S1). The highest probability for the condition occurred when women were empowered in agriculture *and* had agency on food purchase but not on their general diet (Pr = 0.88) compared with their disempowerment

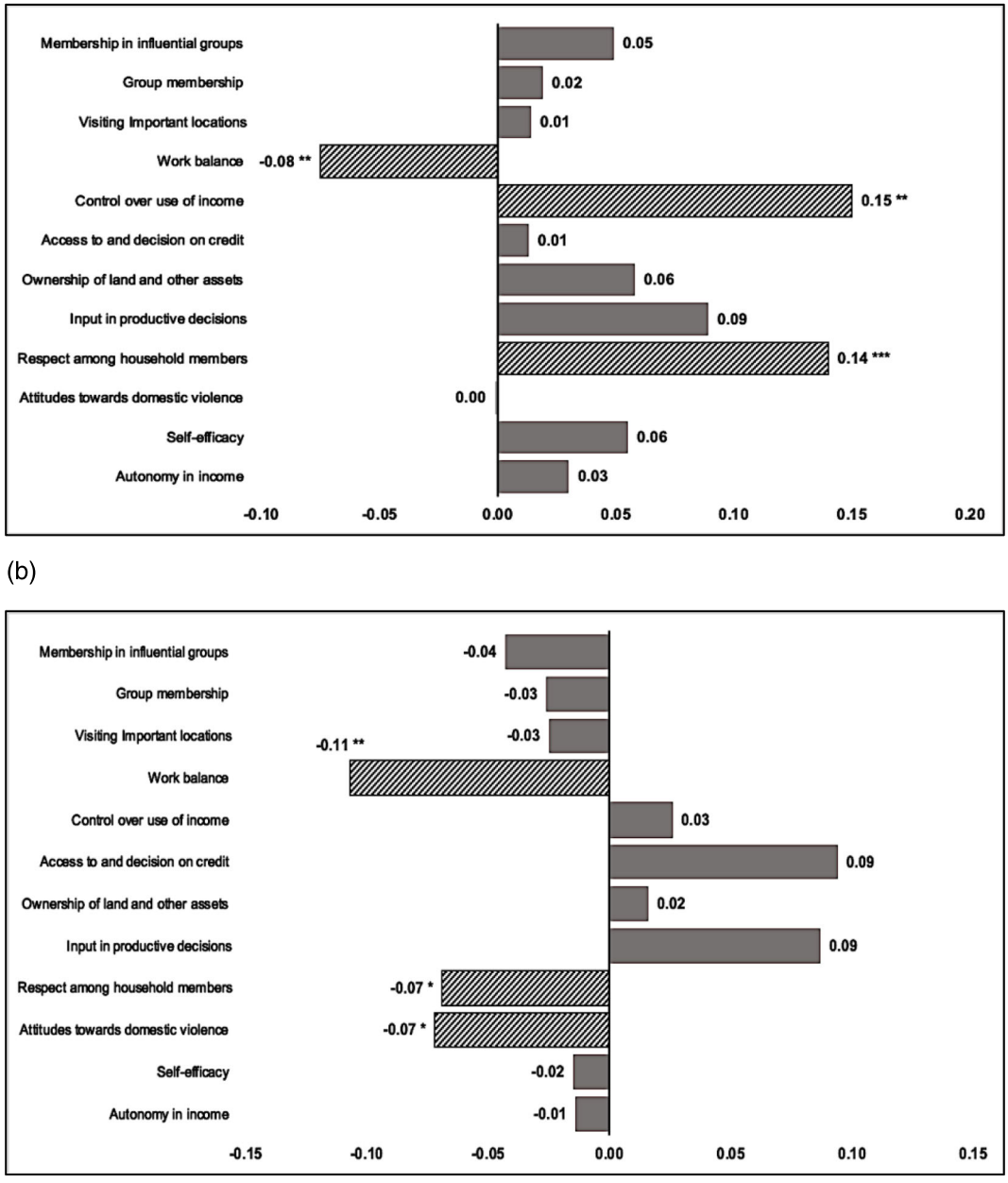
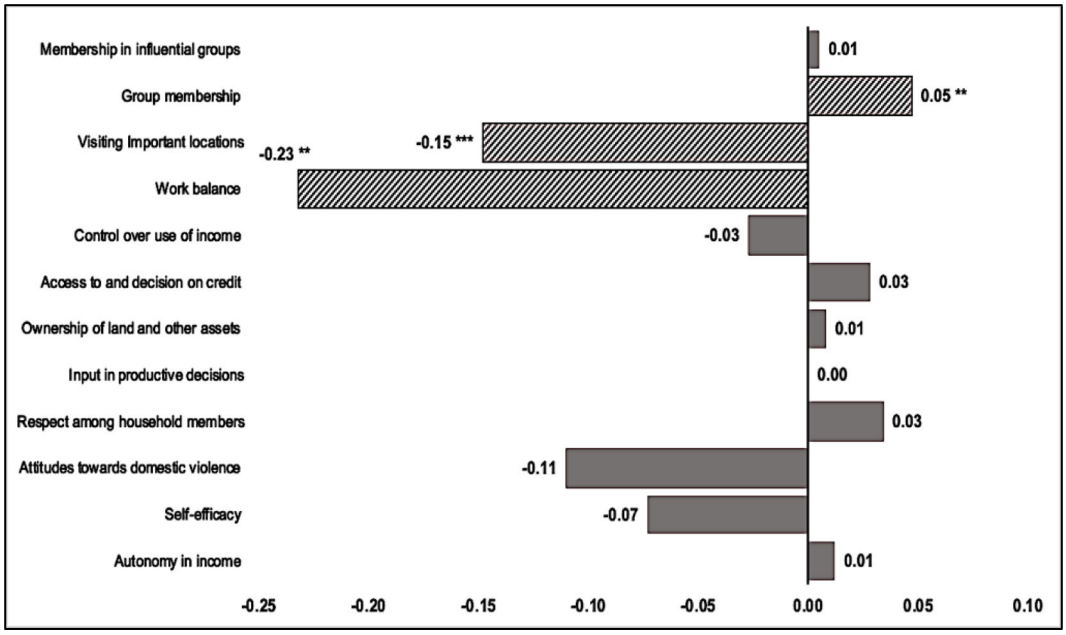


FIGURE 1 Women's empowerment in agriculture indicators and women's agency on (a) her regular diet, (b) pregnancy diet, (c) breastfeeding diet, and (d) food purchase. In all models, work balance is negatively associated with the measures of women's agency in nutrition, except their agency on food purchase. Marginal effects reported; patterned colors depict statistically significant coefficients. *$p < .1$, **$p < .05$, ***$p < .01$.

(c)



(d)

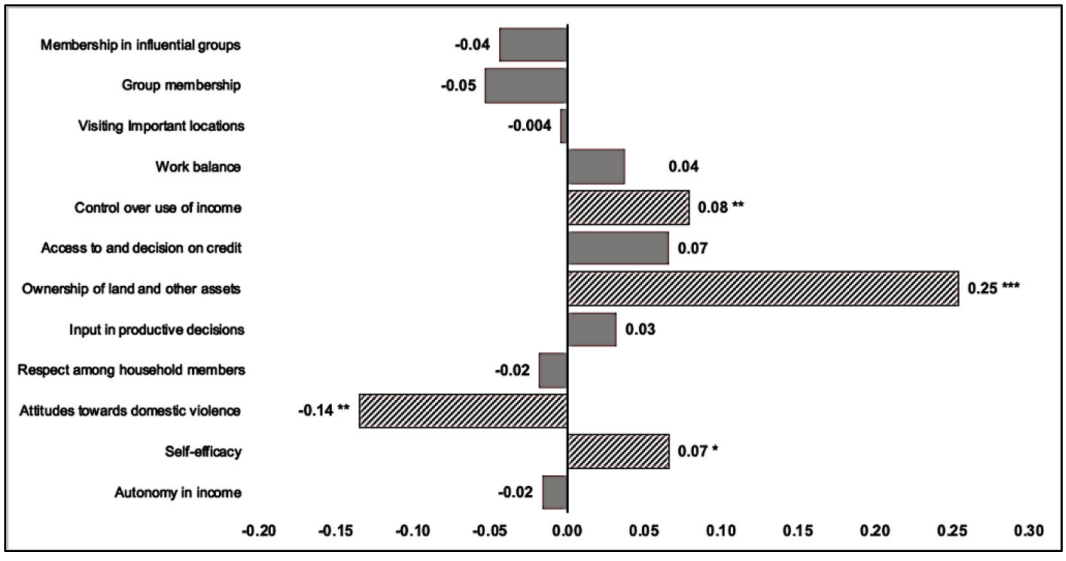


FIGURE 1 (Continued)

status in WEA (Pr = 0.28), which showed a 61% significant difference ($p < .01$). This result meant that when WEA was paired with agency on food purchase, there was a higher probability of being food secure compared with the condition when women were not empowered in agriculture despite having agency on food purchase.

TABLE 5 Aggregated women's empowerment in agriculture score, household gender parity, and women's food security.

	Food security ($n = 380$)			
	Model 1		Model 2	
Variables	Pr[a]	SE	Pr	SE
Women's empowerment in agriculture	.18***	.05		
Household gender parity status			−.07	.05
Regular diet agency	−.01	.05	.02	.05
Food purchase agency	.03	.07	.04	.07
Age (y): 26–45 vs. 15–25	−.06	.07	−.05	.08
Age (y): >45 vs. 15–25	.08	.11	.09	.11
Age (y): >45 vs. 26–45	.14*	.08	.14*	.08
Education	−.06***	.07	.15***	.04
Household size	−.03***	.01	−.03***	.01
Occupation	−.03	.01	.00	.06

[a]Predicated probability, marginal effects reported. Robust standard errors were clustered by fishing villages.
*$p < .1$, **$p < .05$, and ***$p < .01$.

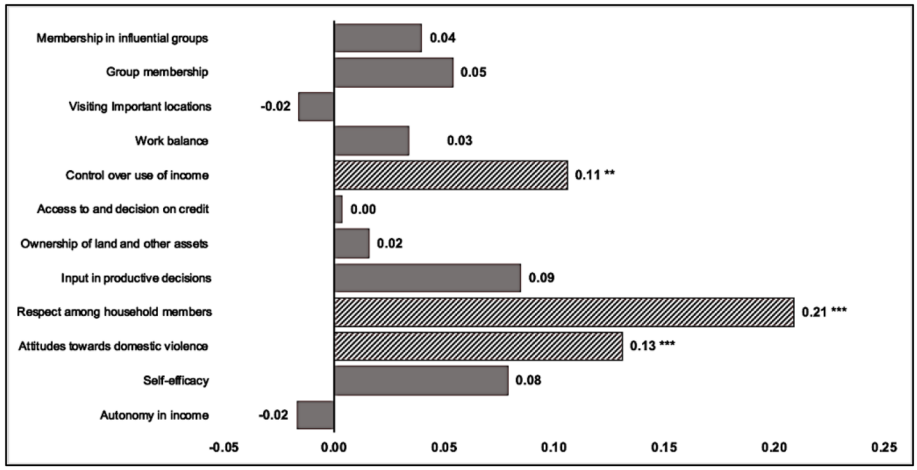


FIGURE 2 Pro-WEAI indicators and women's food security. Marginal effects reported; patterned colors depict statistically significant coefficients; *$p < .1$, **$p < .05$, ***$p < .01$.

Similarly, women had significantly a higher probability of food security when they were empowered in agriculture and had agency on their general diet and food purchase compared with when they were disempowered in agriculture (first difference = 0.17, $p < .05$). Testing the difference between these two conditions in terms of second differences showed a 0.44 increase in the predicted probability of food security. This result implied that the first difference in the predicted probability of food security for women with an agency on their regular diet was 0.17, compared with a significantly higher predicted probability of about 0.61 for women with no agency on their diet (second difference = −0.44, $p < .01$). In other words, there was an

TABLE 6 Probability of women's food security by women's empowerment in agriculture status with test of three-way interaction effect (difference-in-difference).

	Empowered (=1)		Disempowered (=0)		1st diff[a]		2nd diff[b]		3rd diff[c]	
	Pr[d]	SE	Pr	SE	Pr	SE	Pr	SE	Pr	SE
Regular diet agency = 0 Food Purchase agency = 0	.39	.15	.24	.10	.14	.17	−.11	.22	−.33**	.13
Regular diet agency = 1 Food Purchase agency = 0	.40	.10	.36	.07	.04	.06				
Regular diet agency = 0 Food Purchase agency = 1	.88	.13	.28	.05	.61***	.12	−.44***	.15		
Regular diet agency = 1 Food Purchase agency = 1	.50	.08	.34	.05	.17**	.08				

Note: Models were estimated using binary logit regression adjusted for age, education, occupation, and household size. Because of rounding, the differences do not always equal the MEs in one pattern minus the MEs in another pattern, similar to the 2nd differences.

[a]Statistics for first difference (1st diff) is the difference in the effect for each specific condition across women's empowerment in agriculture status.

[b]The second differences (2nd diff) column reports whether the effect of agency on regular diet varies across each of the two conditions.

[c]The third difference (3rd diff) column reports whether the effect of purchase agency varies across the two conditions.

[d]Pr (FS): predicated probability of food security. Marginal effects (MEs) reported and robust standard errors were clustered by fishing villages.

*$p < .1$, **$p < .05$, and ***$p < .01$.

insignificant moderation role of women's agency on their regular diet in the relationship between WEA and their food security.

The moderation role of women's agency on food purchase was tested through a third difference to compare the 2-s differences, with or without a food purchase agency. The participation of women in food purchase decision making strongly moderated the association between WEA and food security by 0.33 compared with the condition with the absence of a food purchase agency (third difference = −0.33, $p < .05$). These results confirmed that while WEA was positively associated with food security, the food purchase agency could change the strength of this relationship regardless of the status of the women's agency on their regular diet.

4 | DISCUSSION

Results indicated a lack of association between aggregated WEA score and the measures of women's agency in nutrition, except marginal significant associations with improvement in women's agency on their diet and pregnancy diet. A similar pattern appeared for lack of HGP with women's agency on pregnancy diet. Nevertheless, gender disparity in household was negatively related to women's agency on their diet. When the empowerment indicators were analyzed, trade-offs emerged. Not all WEA indicators were associated with women's agency in nutrition outcomes. Previous studies similarly reported that WEA indicators were not always associated with better nutrition outcomes (Quisumbing et al., 2021; Sraboni et al., 2014). Results herein showed the same pattern in relation to the women's agency in nutrition outcomes rather than the nutrition outcomes. For instance, the increased workload of women (>10 h per day) was associated with an increase in their participation in all nutrition-related decision making. Previous empowerment studies reported similar results between longer work hours of women and better nutrition outcomes for themselves and their children (Malapit et al., 2015; Quisumbing et al., 2021; Santoso et al., 2019).

In addition to emerging trade-offs, it became apparent that the WEA indicators that were significant for women's agency in nutrition in one category did not always overlap with other categories. This result suggested that different indicators of WEA may be important for different measures of women's agency in nutrition at each life stage. For example, while having income control was positively associated with women's agency on both regular diet and food purchase, it was not significantly related to breastfeeding and pregnancy agencies. On the other hand, group membership was positively associated with only breastfeeding agency, whereas having mobility by visiting important places was negatively associated with this category of agency in nutrition. These results supported a call for careful designing of gender- and nutrition-sensitive programs and policies to promote the most important aspects of WEA as immediate goals. In doing so, implementers and policymakers should be aware of the differences that women experience at each critical life stage (especially motherhood), in addition to trade-offs between WEA indicators.

Results showed positive associations between women's agency on purchasing food and other measures of women's agency in nutrition. Current evidence related to women's decision making regarding household purchases is mostly available through analysis of Demographic and Health Survey (DHS) questions in various settings, focusing on women's participation in large and daily household purchases. These studies have shown that women having a voice in household purchase decisions (alone or jointly) are associated with better nutritional status for themselves and/or their children (Amugsi et al., 2016; Bhagowalia et al., 2010; Hindin, 2006; Saaka, 2020; Tebekaw, 2011). In addition to the two aforementioned questions, this study's food

purchase indicator also focused on nutrition-sensitive decisions by including questions about the purchase of eggs, milk and milk products, meat, poultry, or fish (recognized nutritious food sources for mothers recommended by a health worker); medications; vitamins and supplements for mothers and children; and special food for children.

There is a dearth of knowledge on the association between women's food purchase agency and outcomes such as women's empowerment either in agriculture or nutrition and food security. Results showed that education, age, income control, and land/asset ownership were predictors of having food purchase agency. Likewise, previous studies have overwhelmingly highlighted that age and education are strong determinants of women's greater agency in household purchasing decisions (Acharya et al., 2010; Chandradasa et al., 2021; Riaz & Pervaiz, 2018; Tebekaw, 2011). Education in particular may be associated with improvement in a woman's level of self-efficacy, which could affect her ability to participate in the decision-making processes related to her food intake as well as her children's. Similar to our results, previous studies, i.e., Bain et al. (2020), Haley and Marsh (2021), and Mishra and Sam (2016), have discussed the important role of enabling economic resources such as income control and land/asset ownership in promoting women's empowerment in various domains. Results herein and from previous studies affirmed the importance of economically empowering women as a focal point in the pathway to nutritionally empowering them. Placing women's food purchase agency prior to other forms of agency in nutrition as an intermediate step may facilitate this process.

In the second section of the analysis of the food security model, suggestive evidence was found regarding the association of WEA with women's food security status, but HGP was not significantly related to food security. This result aligned with existing evidence in the literature that the relationship between WEA and food security is inconclusive and becomes very limited when it examines HGP as a gender-sensitive predictor of food security. To illustrate, Quisumbing et al. (2021) recently reported mixed associations between these two measures of empowerment and various nutrition outcomes. They reported that decreasing intrahousehold inequality was associated with reduced child stunting and improved women's BMI, but it did not contribute to either women's or household dietary diversity. Similar to the results of this study, a subtle pattern of trade-offs was displayed in assessing the relationship between WEA indicators and food security.

Results also indicated that women's agency on their regular diet and their food purchase were not significant predictors of their food security. That said, results from testing the moderating effect of these two forms of nutrition agency in the association from WEA to food security showed that food purchase could strengthen the positive association between WEA and food security. These results suggested that food purchase agency can strengthen the positive relationship of WEA with food security. Hence, this should be considered an effective strategy in future nutrition-sensitive agriculture interventions, so women can reach their full potential in improving their own food security status and that of their households.

On the contrary, women's agency on their regular diet alone did not show a significant moderating effect. In the present study, food security was a measure of food access rather than food utilization. Measuring the access dimension of food security might explain the positive moderator role of food purchase agency compared with women's agency on their regular diet. Food purchase agency may better measure the food access dimension and more likely to be correlated with this measure of food security, and the measure of women's agency on their diet could be closer to the utilization dimension of food security. Furthermore, the measure of women's agency on their regular diet might not be a sufficiently comprehensive and rigorous measure of women's agency in nutrition, as it only asks about women's input in decisions about which foods to prepare and eat. Incorporating the other dimensions of nutritional

empowerment in such analyses could shed more light on the role of such indicators in the pathway from WEA to food security.

Narayanan et al. (2019) argued that focusing on the agency dimension of empowerment is insufficient to quantify the complexity of nutritional empowerment. Other important factors, such as knowledge and broader institutional resources, should be considered, as they are included in WENI. The measures of women's agency in nutrition in the optional H&N module of pro-WEAI are missing these two important aspects. This is unfortunate because broader context such as sociocultural norms, that is, taboos around eating some types of nutritious food like fish, are significant barriers to the optimal dietary intake of women. Despite these shortcomings, H&N module covers important nutrition-focused questions that are not included in WENI.

For example, the optional H&N module asks about a detailed list of foods to purchase, which is missing in WENI. Results revealed that this indicator had a significant role in understanding the association between WEA and food security. Moreover, the pro-WEAI questions differentiate between different life stages and conditions to better understand which dimensions and domains matter most at each stage and for whom. Nonetheless, validity testing in various contexts and in relation to other nutrition outcomes is still needed to ensure that the questions can be well understood and interpreted in different cultures and settings as intended (Hannan et al., 2020; Heckert et al., 2023).

Aside from debates on which tool can better measure nutritional empowerment, there are challenges at the implementation and analysis stages that make it difficult to implement, analyze, and interpret (Alsop & Heinsohn, 2012). These challenges may explain the shortcomings of current measures, which focus on capturing limited proxy indicators depending on the goals of the project and on considering both generic approaches and parsimonious of quantifying empowerment in nutrition (Narayanan et al., 2019; Saha & Narayanan, 2022).

4.1 | Study limitations

First, pro-WEAI's optional H&N module targeted women only and did not include responses from male counterparts. This limitation did not allow for further gender-sensitive analysis to capture intrahousehold disparities. This is particularly important in low-resource communities such as the context of this study, where both men and women were economically, and therefore nutritionally, maybe not equally, deprived. Second, available data did not provide information about sociocultural norms around food consumption of women and their decision-making capacity in the household, such as imposed dietary restrictions, namely, during pregnancy and breastfeeding, the type and portion of distributed food, or the order of eating within a household.

Third, more socioeconomic information about the household background (e.g., wealth) could shed more light on the important role of food affordability and availability. The structural and institutional context outside of households, such as community and government services, can significantly affect women's empowerment in nutrition (Narayanan et al., 2022). For example, market access can change women's food purchase agency despite having a voice within the household. If they do not have access to the market, other barriers such as lack of affordable transportation or hindering social norms for traveling to the market can impede their active participation in household food purchase decisions. These variables should be included in future research. Finally, the measures of women's agency in nutrition and their food security status used in this study were confined to representing aspects for which secondary data were available. The context-specific results limit their generalizability to other populations.

5 | CONCLUSION

Results from this study have several important implications for future practice. Primarily, the study uncovered and identified obstacles to women's agency in nutrition in different life stages and conditions as a subset of women's empowerment in nutrition. Also, results provided additional evidence on the importance of assessing all 12 indicators instead of focusing on top contributors to women's disempowerment in agriculture. Furthermore, results suggested that awareness of existing trade-offs between WEA indicators by policymakers and program implementers can provide a context-specific and comprehensive picture of the gaps in nutrition-sensitive agriculture interventions in the studied population.

Results affirmed that the aggregated WEA score was not associated with the measures of women's agency in nutrition, but food purchase agency was strongly associated with the other measures of women's agency in nutrition. That said, several other WEA indicators were positively associated with food purchase agency. Taken together, these results prompted the following research question in need of further investigation: "Does women's food purchase agency mediate the relationship between the WEA and any of the outcomes related to women's agency in nutrition?" More research is needed to better understand the role of food purchase agency in this pathway.

Conclusively, the present study provided additional evidence with respect to the importance of looking beyond the current measurements of empowerment in agriculture (e.g., pro-WEAI) to uncover and identify the determinants of food insecurity. Although empowering women in agriculture is essential on its end, and is progressing in nutrition-sensitive agriculture programs, the evidence about its promising association with food security and nutrition outcomes is still mixed. As noted earlier, one reason could be the lack of including complementary and rigorous nutritional empowerment indicators that are more sensitive to nutrition outcomes (Narayanan et al., 2019). Given the shortcomings of current measurement tools of empowerment in nutrition, including WENI and the pro-WEAI optional nutrition module, an approach to measuring this phenomenon is needed that includes all crucial indicators, such as direct decision-making questions related to food practices and intake, or access to technology and the internet as well as education and healthcare.

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CONFLICT OF INTEREST STATEMENT

The authors report no conflicts of interest.

ETHICAL CONSIDERATIONS

Before commencing the study, ethical clearance was sought and obtained from Makerere University and the Uganda National Council for Science and Technology (UNCST) for primary

data collection by the NutriFish team. Additionally, ethical approval for secondary data analysis was obtained from McGill University, Canada (REB 21-04-041).

ORCID

Farzaneh Barak https://orcid.org/0000-0002-0546-5072

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