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Can Women's Empowerment Increase Animal Source Food Consumption in Flood Prone Areas of Bangladesh?

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INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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ABSTRACT

Bangladesh is one of the most flood-prone countries in the world and households located in at-risk areas endure periodic destruction and losses, thus making them worse off than those not prone to flooding. Our paper provides evidence that promoting women's empowerment could be a promising way to improve quality of life for these at-risk households. Our focus is on the relationship between empowerment and improved dietary quality, specifically through the increased consumption of animal source foods (ASF). We find that empowerment is associated with greater egg, dairy, and fish consumption by at-risk non-producers and with dairy consumption by producers, regardless of risk. We find no associations with meat and poultry consumption. These dietary improvements are most likely driven by women's increased participation in decisions related to food expenditure, rather than in those related to livestock production.

Keywords: women's empowerment, animal source foods, flooding, Bangladesh

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1. BACKGROUND

Flooding in Bangladesh is a high-priority issue in both the development and earth sciences fields, due to its cyclicality (Mirza, 2010; Rasid & Paul, 1987), unpredictability (Choudhury & Haque, 2016), and the likelihood that it will worsen with climate change (Gosling et al., 2011; IPCC, 2013). A large body of literature has quantified how flooding impacts food security (Khanom, 2016; Smith & Frankenberger, 2018; Yu et al., 2010), agricultural income (Banerjee, 2007; Haque & Jahan, 2015; Karim, 2018), and livelihoods (Xenarios et al., 2016), while at the same time demonstrating how the negative consequences of climate-related disasters are experienced disproportionately by women (Cutter, 2017; De Silva & Jayathilaka, 2014; Mahanta & Das, 2017).

This paper adds to current discourse by exploring the role that women's empowerment plays in increasing dietary quality in at-risk households in Bangladesh. We focus on Animal Source Foods (ASF), which are foods that come directly from animals or are made primarily of animal-sourced products, such as milk, eggs, meat, fish, or cheese. As one of the most nutrient-dense food groups, ASF are particularly important for vulnerable groups such as children under five and pregnant and lactating women (Murphy & Allen, 2003; Neumann et al, 2002) and can play an essential role in ensuring dietary adequacy.

Bangladeshi Diets

Diets in Bangladesh tend to be dominated by starchy-staples and fish, whereas other ASF are considered luxury goods and can be very expensive (Hossain et al., 2005). Rice prices have been found to be deterministic of spending on other non-grain goods (Rashid et al., 2011), yet even in the highest quintiles of wealth, households still consume animal sources foods infrequently (Thorne-Lyman et al., 2010) and much of the population still lacks sufficient intake of both the macro- and micro- nutrients commonly found in ASF (Hossain et al., 2005).

Livestock & Fish Production

In Bangladesh, households rely on home production and/or informal markets for ASFs (BIDA, 2016) and women are traditionally involved in rearing livestock (Tangka et al. 1989). Although women do tend to have some control over decisions related to small livestock, such as chickens and goats, men control those related to larger livestock, such as cattle (Quisumbing et al., 2013).

Patterns of fish production vary by the variety of fish raised. Small Indigenous Species (SIS) are traditionally raised in either existing open water bodies or in seasonal backyard ponds, whereas larger fish are raised in larger or even commercial-sized ponds (Roos et al, 2003). The difference in scales mean that, in general, SIS are raised for home consumption while larger fish species, such as carp and tilapia, are more likely to be raised for sale (Roos et al, 2003).

The Role of Empowerment

Previous research has shown the ability of women's empowerment to protect household dietary diversity and improve dietary quality (Malapit et al., 2015; Rashid et al., 2011). Additional research has shown that these positive effects are not evenly distributed among household members, and that different aspects of women's empowerment may be more influential for improving the diets of household members depending on their age and sex (Sraboni & Quisumbing, 2018; Sraboni et al., 2014).

Given the social context and gender dynamics of livestock rearing and fish cultivation in Bangladesh, it seems plausible that empowerment could influence ASF consumption either through increased say in decision-making related to raising, purchase, or sale of livestock (Sraboni et al., 2014), or through increased autonomy in purchase decisions (Jin & Iannoti, 2014). Similarly, it is plausible that empowerment may be particularly important for households raising SIS in small backyard ponds, as opposed to larger ponds which may be more likely to be market-oriented cultivation in which mobility restrictions hinder women's ability to attend markets unaccompanied (Hallman et al., 2007).

Women's empowerment could also have important implications for both a household's coping capacity and initial vulnerability to flooding. Women's empowerment has the potential to influence a variety of previously documented coping strategies. This includes improved capacity to participate in the mobilization or utilization of resources (Sultana & Rayhan, 2012); increased say in decisions related to reallocating household labor (Kochar, 1995); autonomy over of purchase and sale of assets, particularly livestock (Fafchamps et al., 1998); and improved access to credit and loans (Ninno et al., 2001; Sultana & Rayhan, 2012). In addition to post-disaster behaviors, women's empowerment could also influence what Paul & Routray (2010) coined the "enabling environment for coping strategies," including enhancing freedom to participate in social networks (Dey et al., 2017) and cultivate or share knowledge of adaptive strategies (Dey et al., 2017; Williams et al., 2015), which could reduce pre-disaster vulnerability to risk.

This paper seeks to understand the relationships between ASF consumption, women's empowerment, flood-risk, and livestock ownership/fish production. First, we explore if women's empowerment has differential association with ASF consumption in at-risk and not at-risk households. We then seek to understand to what extent this relationship shifts for livestock owners and non-owners.

METHODS

Data

This analysis utilizes data from both waves of the Bangladesh Integrated Household Survey (BIHS). This is a nationally representative survey conducted first in 2011/2012 and then again in 2015. The sample included 6,500 households in 325 primary sampling units and followed a two-stage stratified sampling method. Attrition between the two survey waves was approximately 1.26% per year.

In each wave of the BIHS, a total of 6,500 households were interviewed. The analysis sample for this paper was restricted to households that had answered all modules necessary to create the outcome variables and covariates. In addition, households that had split between the first wave and second wave were excluded. In total this captured 4,991 households, 3,861 of which include data for both waves and 1,130 of which only include data from one of the two waves.

Regression Models

To analyze the nature of the relationship between women's empowerment and animal source food consumption in the absence or presence of flood risk, the following regressions were used:

$$CONS_i = \alpha_0 + \beta_1 FP_i + \beta_2 WEAI_i + \beta_3 (FP_i * WEAI_i) + \beta_4 X_i + \varepsilon_i ,$$

where $CONS_i$ is one of the ten consumption outcome variables listed above (binary egg, binary dairy, binary fish, binary meat, binary poultry, egg frequency, dairy frequency, fish frequency, meat frequency, and poultry frequency), FP_i is the designation of flood prone area, and $WEAI_i$ is the demeaned women's empowerment score of the primary female decisionmaker in household *I* (background on the WEAI is provided in the subsequent section entitled *Primary Covariates)*. X_i is vector of controls that includes the wealth quintile, the number of chickens owned (for egg and poultry), number of cows and goats owned (for dairy and meat), or total weight (in kg) of fish raised (for fish), if yesterday was a holiday, distance to market in minutes, and household demographics including religion, household head age, household head sex, household head literacy, and composition of household by age groups, all for household *i*.

A second model was used to analyze the differing nature of the relationship between women's empowerment and animal source food consumption for livestock owners and non-owners in the absence or presence of flood risk. The models took the following form:

$$CONS_i = \alpha_0 + \beta_1 FPOW_i + \beta_2 WEAI_i + \beta_3 (FPOW_i * WEAI_i) + \beta_4 X_i + \varepsilon_i ,$$

where $CONS_i$ is one of the ten consumption outcome variables listed above, $FPOW_i$ is combination of livestock and flood prone variables, and $WEAI_i$ is the interviewed women's demeaned 5DE WEAI score for household *i*. X_i is vector of controls that includes the wealth quintile, if yesterday was a holiday, distance to market in minutes, and household demographics including religion, household head age, household head sex, household head literacy, and composition of household by age groups, all for household *i*.

For all models, those with binary outcome variables are logit models, while models with frequency of consumption are zero-inflated negative binomial models. Zero-inflated negative binomial models were used due to the fact that variance of the count variables was high relative to the mean, and a large proportion of the sample reported 0 days of consumption.

Regression equations were calculated with the data pooled across years and include dummies for both year and survey month fixed effects. Although the data were collected in a way that would allow for a panel data analysis of within-household variation, it was decided that the staggered timing of the two surveys so that they each coincide with distinct seasons meant that results from such a model would not be easily interpretable.

A limitation of the analysis is the potential endogeneity of the production-related variables (e.g., the number of chickens, cows, and goats owned and the total weight of fish raised). Each of these variables could be codetermined with consumption. One possible solution would to use lagged values of these variables, however, this was not possible given the aforementioned decision to pool data across survey waves. Another solution would be an instrumental variable approach, but this was prevented by a

lack of suitable candidates for instruments. Subsequently, our results should be interpreted as evidence of correlations—rather than causal relationships—between ASF consumption, women's empowerment, and livestock ownership/fish production.

Fixed Effects

Both survey year and survey month fixed effects were included in our models. These are important because the two years of the survey were conducted in two distinct seasons, with the 2011/2012 wave of the survey conducted mainly during the dry season and the 2015 wave conducted mainly during the monsoon season. Seasonality is very important for diet quality and composition in Bangladesh (Hassan et al., 1985; Stevens et al., 2017), and including year and survey month is the best way to capture both between season and between year differences that may influence diet.

Village fixed effects were not included in these models. This is because the flood prone variable should capture much of the variation from village locations. Including a fixed effect for village on top of that may unnecessarily reduce variation attributable to flood vulnerability.

Outcome Variables

This analysis seeks to measure animal-source food consumption by examining egg, dairy, fish, meat, and poultry consumption. For each food group, two types of outcome variables are used. The first is a binary indicator of household consumption over the past seven days. If a household reported consuming one of the specified food items at least one day in the past seven, they were coded as having consumed the product. If they reported zero days, they were coded as not consuming the product.

The other set of outcome variables used in this analysis is frequency of consumption of each eggs, dairy, fish, meat, and poultry. Frequency is measured as the number of days in the past seven in which someone in the household consumed the specific product. The reference questions used to create both sets of outcome variables were asked of the adult female or main food-preparer.

Primary Covariates

In order to model consumption as a function of women's empowerment and environmental risk, this analysis employs indicators from the Women's Empowerment in Agriculture Index (WEAI) and data on flood prone areas from the Dartmouth Flood Observatory. Additionally, to explore how this relationship differs for livestock-owners and non-owners, data on chicken, goat, and cow ownership as well as current stocks of both small and large fish, which are grown in household fishponds, were used to create categorical variables of ownership and flood risk.

The WEAI was developed to quantify the extent of women's engagement in important domains of the agriculture sector (Alkire et al., 2013). The WEAI includes multiple measures of empowerment, including responses from both male and female respondents. However, this paper utilizes only the weighted average of the primary female decisionmaker's response to the ten WEAI indicators, hereafter referred to as the women's empowerment score. The indicators include: input in productive decisions, control over use of income, autonomy in production, ownership of assets, purchase/sale/transfer of assets, access to and decisions on credit; comfort with speaking in public, group membership, leisure time, and workload. For a full description of how WEAI is calculated, refer to Alkire et al. (2013).

Household coordinates were used to assign binary flood risk using spatially-explicit flood data from the Dartmouth Flood Observatory (Dartmouth Flood Observatory, 2013). Vulnerability to floods was used as a proxy for environmental risk. Although flood risk does not encompass all environmental risk that Bangladesh faces, the country is prone to extreme flood events (Shahid, 2009). This is due in part to both its extreme and variable weather patterns as well as inherent geographic characteristics, including: low elevation, location along tidal planes, and proximity to the Himalayas (Shahid, 2009).

Livestock ownership and fish cultivation data were used to understand the differing relationship between women's empowerment and environmental risk for livestock/fish owners and non-owners. Binary ownership was defined as reporting owning at least 1 chicken or cow, or in the case of fish, reporting producing at least 1 kg of any species regardless of cultivation area (pond vs. open water, for example). This binary indicator was grouped with the binary flood prone variable to create a factor

variable with four values: owner in flood prone area, non-owner in flood prone area, owner in non-flood prone area, and non-owner in non-flood prone area. Analyses on egg and poultry consumption included only ownership of chickens, while analyses on dairy and meat consumption included only ownership of cows. Goat ownership was omitted from the livestock ownership regressions due to the non-significant coefficient obtained in the intital regressions.

Other Covariates

Other covariates included in the analysis are distance to market, a wealth index, whether the previous day was a holiday, and a vector of household demographics. Distance to market, self-reported in minutes, was included to control for access to food purchases and ability to sell livestock and other agricultural products apart from at the farm gate.

The wealth index was created using principal components analysis, modeled after USAID Demographic Health Survey's wealth index for Bangladesh (DHS). Components covered housing quality (number of rooms, electricity, wall type, and floor type), ownership of assets (bicycle, armoire, electric fan, and TV), and household characteristics (cooking fuel type, number of people per room and number of household members). The raw index was then divided into five quintiles.

Household demographics in the analysis are age of the household head, sex of the household head, literacy of the household head, number of household members under 6, number of household members 15-65, number of household members 65+, and religion of the household.

Raw livestock numbers were only included in the first set of regressions. The number of chickens, goats, and cows were used. The weight of total fish stocks was also used, separated by large fish and Small Indigenous Species (SIS). All were topcoded at the 99th percentile to reduce the effect of outliers. Summary statistics for all the covariates as well the empowerment score and dietary outcomes variables are presented in Table 2.1.

Table 2.1 Summary Stats of Sample – Pooled

Variables	Mean	S.D.	Min.	Max.
Age of household head	45.041	13.12	19.00	78.00
Female headed household	0.18	0.39	0.00	1.00
Muslim	0.89	0.31	0.00	1.00
Literate household head	0.78	0.41	0.00	1.00
Children under 6	0.55	0.70	0.00	5.00
Adults 15-65	2.48	1.15	0.00	12.00
Adults 65 plus	0.22	0.46	0.00	2.00
Previous day holiday	0.02	0.15	0.00	1.00
Wealth (quintiles)	3.00	1.39	0.00	5.00
Flood prone	0.44	0.50	0.00	1.00
Women's empowerment^{+}	0.68	0.18	0.00	1.00
Distance to market (mins)	16.50	10.09	0.00	50.00
Number of chickens	3.97	5.46	0.00	26.00
Number of goats	0.42	1.06	0.00	5.00
Number of cows	0.46	0.90	0.00	4.00
SIS fish stock (kg)	8.83	35.13	0.00	280.00
Large fish stock (kg)	18.09	71.03	0.00	540.00
Pond Aquaculture	0.18	0.38	0.00	1.00
Area (decimals)	22.61	48.15	0.50	367.00
Eggs eaten in past 7 days	0.65	0.48	0.00	1.00
Days in past 7 eggs eaten	1.80	2.00	0.00	7.00
Dairy eaten in past 7 days	0.44	0.50	0.00	1.00
Days in past 7 dairy eaten	2.07	2.86	0.00	7.00
Fish eaten in past 7 days	0.94	0.25	0.00	1.00
Days in past 7 fish eaten	3.77	2.02	0.00	7.00
Meat eaten in past 7 days	0.19	0.39	0.00	1.00
Days in past 7 meat eaten	0.28	0.69	0.00	7.00
Poultry eaten in past 7 days	0.35	0.48	0.00	1.00
Days in past 7 poultry eaten	0.56	0.91	0.00	7.00
Number of observations				8848

Source: 2011/2012 and 2015 BIHS
Notes:$^{+}$Demeaned empowerment score used in all regressions

2. RESULTS

Summary statistics of the independent and dependent variables, separated by risk of flooding, are presented in Table 3.1. Flood prone households, which make up approximately 44% of the sample (Table 3.1), are significantly less likely to be headed by a female and have a literate household head. Notably the two types of households do not differ significantly in terms of women's empowerment, despite the fact that at-risk households are significantly poorer and have significantly more children under six.

Table 3.1 Difference in Means of Key Covariates by Flood Risk

	Mean: Not Flood Prone	Mean: Flood Prone	Difference
Household Characteristics			
Age of Household Head	45.0	45.1	0.123
	(12.9)	(13.4)	(0.281)
Female headed household	0.194	0.17	-.024***
	(0.395	(0.376)	(0.008)
Muslim	0.879	0.914	0.035***
	(0.327)	(0.281)	(0.007)
Literate household head	0.807	0.744	-.063***
	(0.395)	(0.436)	(0.009)
Wealth (quintiles)	3.09	2.89	-.201***
	(1.38)	(1.39)	(0.03)
Children under 6	0.492	0.619	0.126***
	(0.659)	(0.75)	(0.015)
Adults 15-65	2.48	2.47	-.01
	(1.11)	(1.19)	(0.025)
Adults 65 plus	0.204	0.233	0.029***
	(0.452)	(0.474)	(0.01)
Other Covariates			
Women's empowerment score^{+}	0.678	0.673	-.005
	(0.187)	(0.18)	(0.004)
Previous day holiday	0.023	0.024	0.001
	(0.15)	(0.154)	(0.003)
Distance to market (mins)	16.4	16.7	0.298
	(9.56)	(10.7)	(0.216)
Number of chickens	4.12	3.78	-.339***
	(5.57)	(5.31)	(0.117)
Number of goats	0.467	0.368	-.099***
	(1.11)	(0.983)	(0.023)
Number of cows	0.46	0.458	-.001

	Mean: Not Flood Prone	Mean: Flood Prone	Difference
	(0.908)	(0.898)	(0.019)
Have Fish Pond	0.208	0.132	-.075***
	(47.7)	(49.0)	(2.61)
Fish Pond Area	21.9	24.0	2.01
	(47.7)	(49.0)	(2.61)
SIS fish stock (kg)	5.42	13.2	7.82***
	(23.4)	(45.7)	(0.749)
Large fish stock (kg)	19.3	16.5	-2.85*
	(72.3)	(69.4)	(1.52)
Outcome Variables			
Eggs eaten in past 7 days	0.676	0.626	-.05***
	(0.468)	(0.484)	(0.01)
Days in past 7 eggs eaten	1.89	1.68	-.213***
	(2.02)	(1.95)	(0.043)
Dairy eaten in past 7 days	0.419	0.478	0.059***
	(0.493)	(0.50)	(0.011)
Days in past 7 dairy eaten	2.00	2.16	0.161***
	(2.86)	(2.87)	(0.061)
Fish eaten in past 7 days	0.928	0.945	0.018***
	(0.259)	(0.227)	(0.005)
Days in past 7 fish eaten	3.67	3.90	0.236***
	(2.04)	(1.98)	(0.043)
Meat eaten in past 7 days	0.20	0.173	-.027***
	(0.4)	(0.379)	(0.008)
Days in past 7 meat eaten	0.303	0.261	-.042***
	(0.699)	(0.673)	(0.015)
Poultry eaten in past 7 days	0.362	0.334	-.027***
	(0.48)	(0.472)	(0.01)
Days in past 7 poultry eaten	0.583	0.529	-.054***
	(0.93)	(0.888)	(0.02)
Number of Observations	4993	3855	8848

Source: 2011/2012 and 2015 BIHS
Notes: Standard deviations in parentheses.
* p<0.10, ** p<0.05, *** p<0.01
[+] Demeaned empowerment score used in all subsequent regressions

Households in flood prone areas own significantly fewer small livestock, including chickens and goats. This is expected, as it possible these households will have faced post-flood livestock losses due to disease and fodder loss (Jabbar, 1990; Younus, 2016). However, there is no significant difference in the number of cows owned which is surprising given they are often included as measures of socioeconomic status, and as mentioned previously these households are indeed economically worse off. Additionally,

at-risk households are less likely to own a fish pond, yet raise significantly more SIS, which in general are for home consumption while larger fish, such as carp and tilapia. It is possible at-risk households are raising a greater proportion of their fish for their own consumption, as opposed for sale.

Differences in the outcome variables suggest that flood prone households are more likely to have reported eating dairy and fish and with a greater frequency, while not at-risk households are more likely to have reported eating eggs, meat, and poultry and with greater frequency. Of all the ASFs, fish is by far the most commonly consumed product, which is to be expected given that fish is staple of the typical Bangladeshi diet (Roos et al, 2003). Flesh foods, meat and poultry, are the least commonly consumed and with the lowest frequency, which is also to be expected and consistent with their consideration as luxury items (Thorne-Lyman et al., 2010).

Consumption of ASF – Flood Prone Interaction Models

Tables 3.2 and 3.3 examine associations between egg, dairy, fish, meat, and poultry consumption and women's empowerment. Since the empowerment term is demeaned, all results should be interpreted as the effects in households in which the woman has an average level of empowerment. Results of the binary consumption models (Table 3.2) will be discussed first, followed by results of the frequency of consumption models (Table 3.3).

Table 3.2 Animal Source Food Consumption, Flood Risk, and Women's Empowerment

	Eggs	Dairy	Fish	Meat	Poultry
Flood Prone	0.853***	1.344***	1.444***	0.855**	0.924^{+}
	(-3.32)	(6.33)	(3.91)	(-2.71)	(-1.66)
Women's empowerment (β_2)	1.463*	1.921***	0.876	1.208	1.103
	(2.24)	(3.91)	(-0.44)	(0.95)	(0.59)
Flood Prone x Empowerment (β_3)	1.494	0.977	2.886*	0.937	1.071
	(1.57)	(-0.09)	(2.18)	(-0.21)	(0.27)
Number of chickens	1.031***				1.019***
	(6.39)				(4.50)
Number of cows		1.448***		1.139***	
		(13.79)		(4.30)	
Number of goats		0.967		0.975	
		(-1.55)		(-0.93)	

	Eggs	Dairy	Fish	Meat	Poultry
SIS Fish Stock (kg)			1.004*		
			(2.17)		
Large Fish Stock (kg)			1.000		
			(0.27)		
Testing Empowerment Association in Flood Prone Households[a]					
Empowerment in flood prone households	2.186***	1.877**	2.527*	1.132	1.180
	(0.43)	(0.37)	(0.98)	(0.28)	(0.24)
Observations	8848	8848	8848	8848	8848

Source: 2011/2012 and 2015 BIHS
Notes: Models are logit and include year and survey month fixed effects. Coefficients are Odds Ratios. Standard errors in parentheses.
+ p<0.1, * p<0.10, ** p<0.05, *** p<0.01
[a] Significance reported from the F-test: $\beta_2 - \beta_3 = 0$

Table 3.3. Frequency of Animal Source Food Consumption, Flood Risk, and Women's Empowerment

	Days Eggs Consumed	Days Dairy Consumed	Days Fish Consumed	Days Meat Consumed	Days Poultry Consumed
Flood Prone	0.921***	0.942**	1.049***	0.904*	0.947
	(-3.51)	(-2.78)	(4.16)	(-2.00)	(-1.62)
Women's empowerment (β_2)	1.211*	0.966	1.139**	1.071	0.896
	(2.36)	(-0.42)	(3.14)	(0.40)	(-0.93)
Flood Prone x Empowerment (β_3)	0.969	1.304*	1.011	1.159	1.100
	(-0.25)	(2.17)	(0.17)	(0.54)	(0.51)
Covariates for Zero Counts					
Number of chickens	0.937***				0.963***
	(-4.90)				(-4.51)
Number of cows		0.690***		0.832***	
		(-13.27)		(-4.06)	
Number of goats		1.031		1.023	
		(1.37)		(0.62)	
SIS Fish Stock (kg)			0.973+		
			(-1.93)		
Large Fish Stock (kg)			0.982*		
			(-2.08)		
Testing Empowerment Association in Flood Prone Households[a]					
Empowerment in flood-prone households	1.173	1.260*	1.151**	1.241	0.986
	(0.12)	(0.12)	(0.05)	(0.27)	(0.14)
Observations	8848	8848	8848	8848	8848

Source: 2011/2012 and 2015 BIHS
Notes: Models are zero-inflated negative binomial and include year and survey month fixed effects. Coefficients are IRRs. Standard errors in parentheses.
+ p<0.1, * p<0.10, ** p<0.05, *** p<0.01
[a] Significance reported from the F-test: $\beta_2 - \beta_3 = 0$

Binary Consumption Models (Table 3.2)

Results suggest flood risk has important implications in terms of a household's consumption of ASF. For households with average women's empowerment, flood risk is associated with a significantly lower

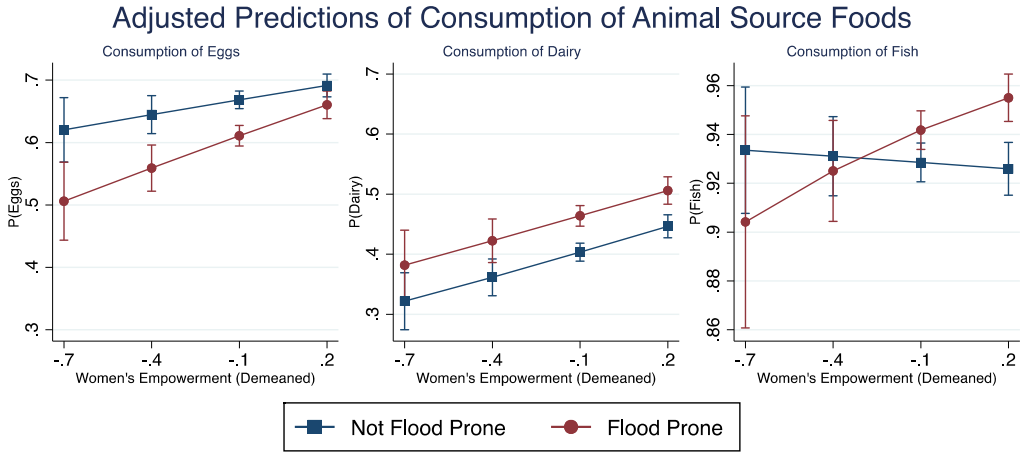
probability of consuming eggs, meat and weakly poultry. It is also associated with a significantly higher probability of consuming dairy and fish.

The significant, yet small in magnitude, association between chicken ownership and consumption of both eggs and poultry is in stark comparison to the significant and large association between cow ownership and consumption of both dairy and meat. This suggests cow ownership is more important for consumption of its products than chicken ownership is for consumption of its products. The association between SIS fish stock and fish consumption is significant, yet small in magnitude.

One surprising result was the lack of significant relationship found between goat ownership and meat consumption, which suggests perhaps an issue of survey timing if goats were recently eaten during a religious holiday, or that meat is more often purchased that consumed from home production.

In terms of the differential effects of empowerment by environmental risk, results suggest that empowerment is associated with significantly higher probability of consuming eggs and dairy regardless of risk. Empowerment is particularly important for egg consumption in flood prone households, which all else equal are 0.853 times as likely ($p<0.001$) to consume eggs, but women with average empowerment are 2.186 times as likely ($p<0.001$) to have reported consumption in their households. Women's empowerment is also more highly associated with fish consumption in flood prone households, as compared to non-flood prone households in which empowerment does not have a significant association with consumption. Exploration of the heterogeneity of the empowerment-consumption associations across risk was performed by using adjusted predictions in order to better understand the implications of these findings (Figure 3.1).

Figure 2.1



This reveals that while empowerment and dairy consumption have a constant across risk, this is not the case for egg or fish consumption. At high levels of empowerment, at risk households have significantly higher probability of consumption for these items. Similar exploration for meat and poultry consumption revealed little change in probability of consumption either across empowerment or flood risk (Figure A.1).

Frequency of Consumption Models (Table 3.3)

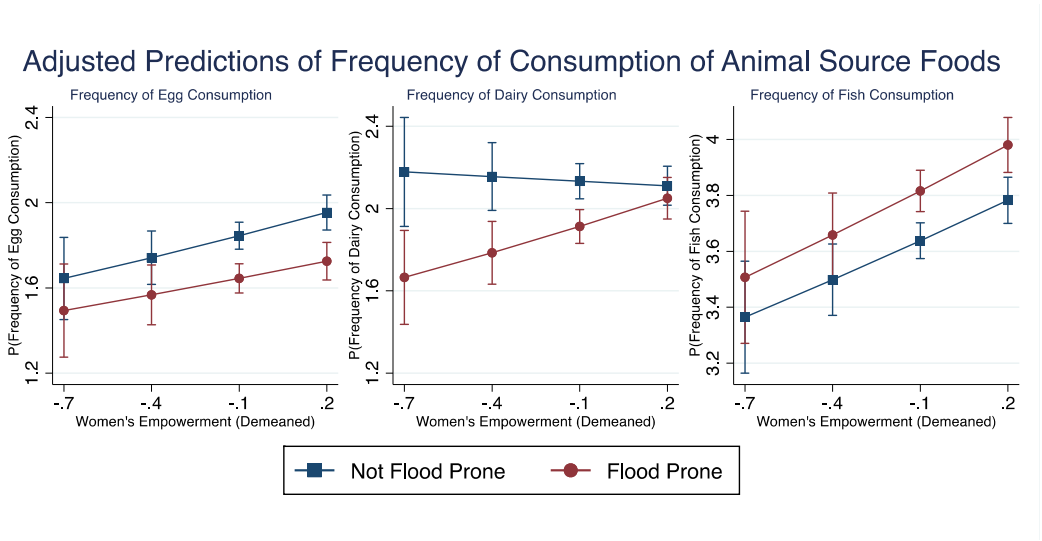
Results suggest that flood risk also has important implications in terms of a household's frequency of ASF consumption. For households with average women's empowerment, flood risk is associated with a significant decrease in the frequency of eggs, dairy, and meat, while it positively is associated with that of fish.

The signs of the flood prone coefficients all match with the binary models, except for dairy, suggesting that although at-risk households are more likely to have reported consuming any dairy, they do so with less frequency. One possible explanation is that instead of consuming home-produced milk, they are most likely to choose to sell their milk and buy other milk available for purchase. Yet, these households still face higher expenditure constraints due to their lower socioeconomic status, and thus do

not have milk as frequently as households that can either consume their daily produced milk or buy more frequently.

In terms of the differential effects of empowerment by environmental risk, results suggest that empowerment is associated with significantly higher frequency of fish regardless of risk. However, empowerment is particularly important for frequency of dairy consumption in flood prone households, overcoming the negative association commented on above. Exploration of the heterogeneity of the empowerment-consumption associations across risk was performed by using adjusted predictions to better understand the implications of these findings (Figure 3.2).

Figure 2.2



These patterns differ greatly from the ones observed for the binary regressions. There is a constant relationship between consumption frequency and empowerment across risk for both eggs and fish. For dairy, however, high levels of empowerment are associated with similar frequency of consumption as the not at-risk households at any level of empowerment. This is indicative of the particularly important implications that empowerment can have on the dietary quality of at-risk households. Similar exploration for meat and poultry consumption revealed little change in probability of consumption either across empowerment or flood risk (Figure A.2).

Consumption of ASF – Flood Prone & Ownership Interaction Models

Tables 3.4 and 3.5 examine continues to examine the differential associations between egg, dairy, fish, meat, and poultry consumption and women's empowerment across risk by exploring how these relationships differ for livestock owners and non-owners. Results of the binary consumption models (Table 3.4) will be discussed first, followed by results of the frequency of consumption models (Table 3.5).

Table 3.4. Animal Source Food Consumption, Flood Risk, and Women's Empowerment for Livestock Producers and Non-Producers

	Eggs	Dairy	Fish	Meat	Poultry
Non Owner + Flood Prone	0.833*	1.380***	1.526***	0.858*	0.857+
	(-2.32)	(5.96)	(3.89)	(-2.26)	(-1.93)
Owner + Not Flood Prone	1.388***	2.235***	1.717***	1.230*	1.091
	(4.91)	(11.23)	(3.91)	(2.43)	(1.33)
Owner + Flood Prone	1.220**	2.872***	2.209***	1.046	1.043
	(2.79)	(13.32)	(5.06)	(0.47)	(0.59)
Women's empowerment	1.099	1.556*	0.892	1.120	1.571
	(0.34)	(2.34)	(-0.33)	(0.50)	(1.62)
Non Owner + Flood Prone x Empowerment	2.189+	1.137	3.431*	0.890	0.808
	(1.91)	(0.45)	(2.20)	(-0.32)	(-0.50)
Owner + Not Flood Prone x Empowerment	1.576	1.754	0.678	1.292	0.617
	(1.30)	(1.41)	(-0.53)	(0.55)	(-1.40)
Owner + Flood Prone x Empowerment	1.739	1.072	1.108	1.388	0.719
	(1.46)	(0.16)	(0.12)	(0.60	(-0.87)
Testing Empowerment Association by Ownership and Flood Risk [a]					
Empowerment: Non Owner + Not Flood Prone	1.099	1.556*	0.892	1.120	1.571
	(0.30)	(0.29)	(0.31)	(0.25)	(0.44)
Empowerment: Non Owner + Flood Prone	2.406**	1.770**	3.06*	0.997	1.270
	(0.73)	(0.39)	(1.37)	(0.29)	(0.41)
Empowerment: Owner+ Not Flood Prone	1.732*	2.729**	0.605	1.447	0.968
	(0.37)	(0.96)	(0.40)	(0.60)	(0.20)
Empowerment: Owner+ Flood Prone	1.912*	1.668	0.989	1.555	1.129
	(0.50)	(0.67)	(0.79)	(0.78)	(0.29)
Observations	8848	8848	8848	8848	8848

Source: 2011/2012 and 2015 BIHS
Notes: Models are logit and include year and survey month fixed effects. Coefficients are Odds Ratios. Standard errors in parentheses.
+ p<0.1, * p<0.10, ** p<0.05, *** p<0.01
[a] Significance reported from the F-test: empowerment + empowerment*owner/floodprone

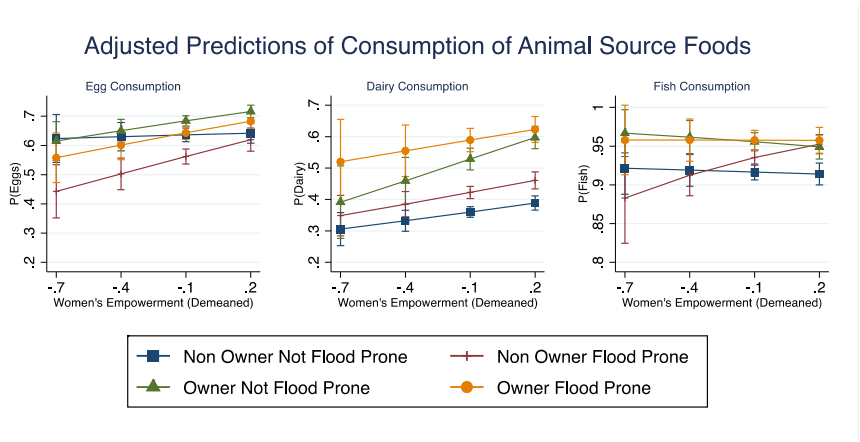
Binary Consumption Models (Table 3.4)

Results suggest that the associations between ASF consumption, empowerment, and flood risk are shaped by whether or not the household owns livestock. Of the four combinations of household types, non-owners regardless of risk are consistently the two lowest ranked in terms of probability of egg, dairy, or fish consumption. Positive associations of owning livestock are largest for dairy, which is not surprising given our previous findings, followed by fish.

In terms of the differential influence of empowerment and environmental risk by ownership status, it is notable that fish consumption is the only positive association with empowerment for non-owners in non-flood prone areas, which in some ways could be thought of as the least vulnerable group. The largest differences are for both dairy and egg consumption for non-owners in flood prone areas, although there are smaller positive associations with egg consumption for owners, regardless of risk and large positive associations with dairy consumption for owners in not flood prone households.

Using adjusted predictions analyses similar to the previous figures, further exploration of these relationships was possible (Figure 3.3). For both egg and fish consumption, we see the largest gains for non-owners in flood prone areas, who at the highest level of empowerment are able to achieve similar consumption probability as almost all the other groups. For dairy consumption, the positive association between women's empowerment and consumption is strongest for owners in non-flood prone areas. However, non-owners (regardless of their risk) are significantly less likely to consume dairy products than owners, even at high levels of empowerment. Similar exploration for meat and poultry consumption revealed little change in probability of consumption either across empowerment or flood risk (Figure A.3).

Figure 2.3



Frequency of Consumption Models (Table 3.5)

Results suggest that the associations between frequency of ASF consumption, empowerment, and flood risk are shaped less by household livestock ownership as the binary indicators are. Non-owners in flood prone areas consume eggs, dairy, meat, and poultry with significantly less frequency than non-owners in non-flood prone areas. However the clear advantage of being an owner for binary egg and dairy consumption are reflected but is not quite as great in magnitude. Once again, fish is the only positive association with empowerment for non-owners in non-flood prone areas.

Table 3.5 Frequency of Animal Source Food Consumption, Flood Risk, and Women's Empowerment for Livestock Producers and Non-Producers

	Eggs	Dairy	Fish	Meat	Poultry
Non Owner + Flood Prone	0.833*	1.380***	1.526***	0.858*	0.857+
	(-2.32)	(5.96)	(3.89)	(-2.26)	(-1.93)
Owner + Not Flood Prone	1.388***	2.235***	1.717***	1.230*	1.091
	(4.91)	(11.23)	(3.91)	(2.43)	(1.33)
Owner + Flood Prone	1.220**	2.872***	2.209***	1.046	1.043
	(2.79)	(13.32)	(5.06)	(0.47)	(0.59)
Women's empowerment	1.099	1.556*	0.892	1.120	1.571
	(0.34)	(2.34)	(-0.33)	(0.50)	(1.62)
Non Owner + Flood Prone x Empowerment	2.189+	1.137	3.431*	0.890	0.808
	(1.91)	(0.45)	(2.20)	(-0.32)	(-0.50)
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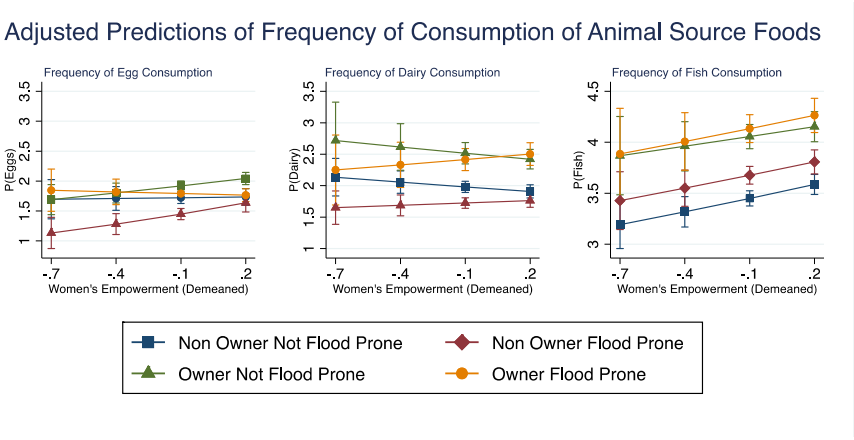
	(1.30)	(1.41)	(-0.53)	(0.55)	(-1.40)
	1.739	1.072	1.108	1.388	0.719

	Eggs	Dairy	Fish	Meat	Poultry
Owner + Flood Prone x Empowerment	(1.46)	(0.16)	(0.12)	(0.60	(-0.87)
Testing Empowerment Association by Ownership and Flood Risk [a]					
Empowerment: Non Owner + Not Flood Prone	1.099	1.556*	0.892	1.120	1.571
	(0.30)	(0.29)	(0.31)	(0.25)	(0.44)
Empowerment: Non Owner + Flood Prone	2.406**	1.770**	3.06*	0.997	1.270
	(0.73)	(0.39)	(1.37)	(0.29)	(0.41)
Empowerment: Owner+ Not Flood Prone	1.732*	2.729**	0.605	1.447	0.968
	(0.37)	(0.96)	(0.40)	(0.60)	(0.20)
Empowerment: Owner+ Flood Prone	1.912*	1.668	0.989	1.555	1.129
	(0.50)	(0.67)	(0.79)	(0.78)	(0.29)
Observations	8848	8848	8848	8848	8848

Source: 2011/2012 and 2015 BIHS
Notes: Models are logit and include year and survey month fixed effects. Coefficients are Odds Ratios. Standard errors in parentheses.
+ p<0.1, * p<0.10, ** p<0.05, *** p<0.01
[s] Significance reported from the F-test: empowerment + empowerment*owner/floodprone

The positive differential relationships for non-owners in flood prone areas are also seen for egg and fish consumption frequency, suggesting that for these groups empowerment is particularly important for dietary quality. Further exploration of these relationships across the four risk and ownership categories were completed using adjusted prediction analyses (Figure 3.4). For non-owners in flood prone areas, women's empowerment has a strong, positive association with number of days eggs are consumed. For both dairy and eggs, non-owners (regardless of their risk) consume significantly less frequently than owners, even at high levels of empowerment. Similar exploration for meat and poultry consumption revealed little change in consumption frequency for the four groups (Figure A.4).

Figure 2.4


Adjusted Predictions of Frequency of Consumption of Animal Source Foods
Frequency of Egg Consumption
P(Eggs)
1
1.5
2
2.5
3
3.5
-.7
-.4
-.1
.2
Women's Empowerment (Demeaned)
Frequency of Dairy Consumption
P(Dairy)
1
1.5
2
2.5
3
3.5
-.7
-.4
-.1
.2
Women's Empowerment (Demeaned)
Frequency of Fish Consumption
P(Fish)
3
3.5
4
4.5
-.7
-.4
-.1
.2
Women's Empowerment (Demeaned)
Non Owner Not Flood Prone
Non Owner Flood Prone
Owner Not Flood Prone
Owner Flood Prone

3. DISCUSSION & CONCLUSION

This paper has demonstrated that exposure to risk in the form of flooding is associated with decreased consumption and consumption frequency of most ASFs, and that empowerment appears to be an important pathway through which these households can increase their intake of this nutrient-dense food group. In addition, this benefit is conferred particularly on at-risk households that do not own livestock in the form of increased probability of egg, dairy, and fish consumption.

In general, our results are in line with previous findings of significant and positive correlations between aggregate empowerment and household dietary diversity in both Ghana (Malapit & Quisumbing 2015), Nepal (Malapit et al. 2015), and adult dietary diversity in Bangladesh (Sraboni & Quisumbing, 2018). Our analyses show that in the highest quartiles of empowerment, consumption by at-risk households can be similar to that of non-at-risk households particularly for the binary outcomes. This suggests households are improving their dietary quality by adding in additional food items to their diets. This pattern is not as clear for frequency of consumption, with the exception of dairy.

It is notable that some of the greatest gains in achieving consumption levels similar to those of not at-risk households are seen in at-risk non-livestock owners. In addition to being poorer than not at-risk households, the at-risk non-owners are arguably also more vulnerable due to their less diverse agricultural strategies. This is in line with work by Sraboni et al (2014) that showed that the effects of empowerment on food insecurity outcomes is greater for households that are the least well-off.

In addition, this finding provides evidence that for this group empowerment more likely works through greater control over decisions related to household expenditures, as opposed to control over livestock assets or production decisions. This would mean that in the absence of home production, food expenditure on ASF increases in households with more empowered women. This is similar to findings by Quisumbing et al. (2013), who found causal impact of the participation in a women-centered dairy program on women's participation on decision-making regarding household expenditures, but no effect on her participation in decisions regarding livestock.

A couple of surprising findings are worth examining. This first is the consistent significant and positive association of fish consumption and frequency of consumption among flood-prone households. One possible explanation is that flood-prone households are closer to water bodies, and thus able to consume wild-caught fish in addition to farmed fish. This consumption would primarily be in the form of SIS, which at-risk households report owning significantly more of.

Additionally, flood prone households were found have a higher probability of dairy consumption, although it was consumed less frequently. One possible explanation is that there is a preference for cows over other animal types or possibly they are advantageous to own versus smaller livestock in the event of flooding. It's almost important to note that unlike chickens, which tend to be women's domain, cows are typically controlled and managed by men. Women do tend to have control over intra-household allocation of milk products but not the external sale due to restrictions in mobility (Quisumbing et al., 2013). Thus, our findings that empowerment in cow-owning households, regardless of risk, is associated with the decision to consume milk at all, rather than how often it is consumed, suggests more empowered women are most likely redistributing the home production for consumption.

The lack of relationship between empowerment and consumption of both meat and poultry is indicative that perhaps determinants of these uncommonly consumed foods are different than the other ASF. If, as suggested previously, empowerment is working mainly through women's increased say in expenditure decisions, it is plausible that due to the even higher prices of these foods compared to the other ASFs studied that women run up against prohibitive price constraints. Thus, they choose to buy cheaper products, such as eggs and SIS, as opposed to flesh foods.

The analyses included in this paper are limited to examining correlations and associations and cannot provide insight into causal relationships, which would be necessary for more concrete policy recommendations. In addition, the findings fail to address the intra-household allocation of ASF. Given that our results support women-driven redistribution of existing resources, as opposed to greater involvement of women in livestock-related decisions, an analysis of the differential effects on consumption by different families or by sex could reveal other important ways that women use their

expanded ability to redistribute resources within the household. Indeed, previous research has shown significant differential impacts on nutritional outcome dependent on both household member age and sex (Malapit et al., 2015, Sraboni et al., 2014).

Given our findings and the results of others related to overlapping themes, it seems plausible that the diets of households in countries that face sizable and inevitable environmental disruptions, such as Bangladesh, could benefit from interventions focused on women's empowerment. This could be particularly powerful in areas in which traditional diversification programs that involve providing livestock or improving livestock production practices is unfeasible to implement due to budget constraints or impracticality. This is promising not only for improving dietary diversity, but possibly in reducing the initial vulnerability of the households to the detrimental impacts of flooding.

APPENDIX

Figure A.1

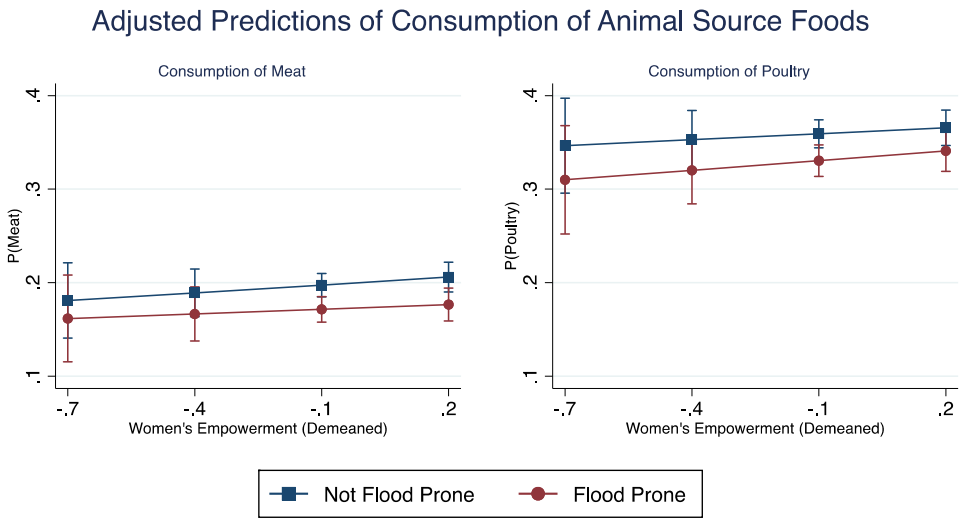


Figure A.2

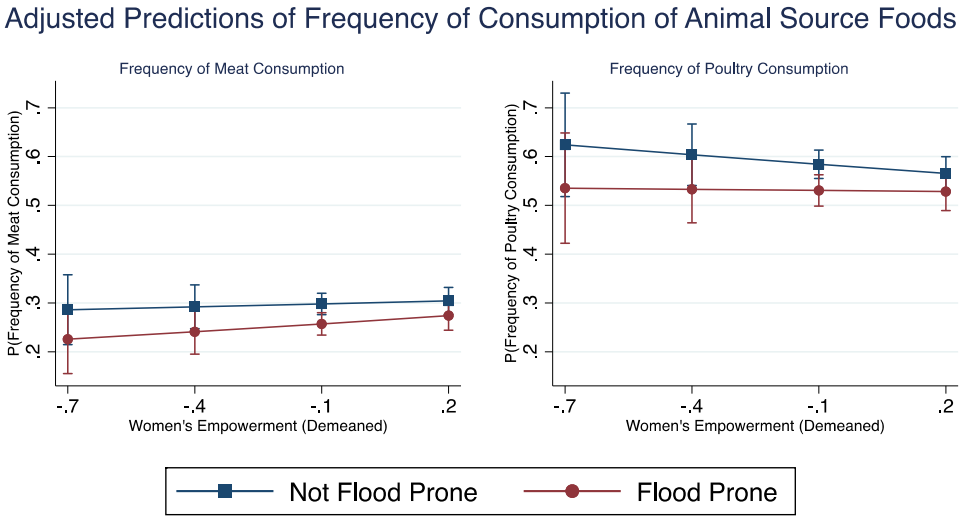


Figure A.3

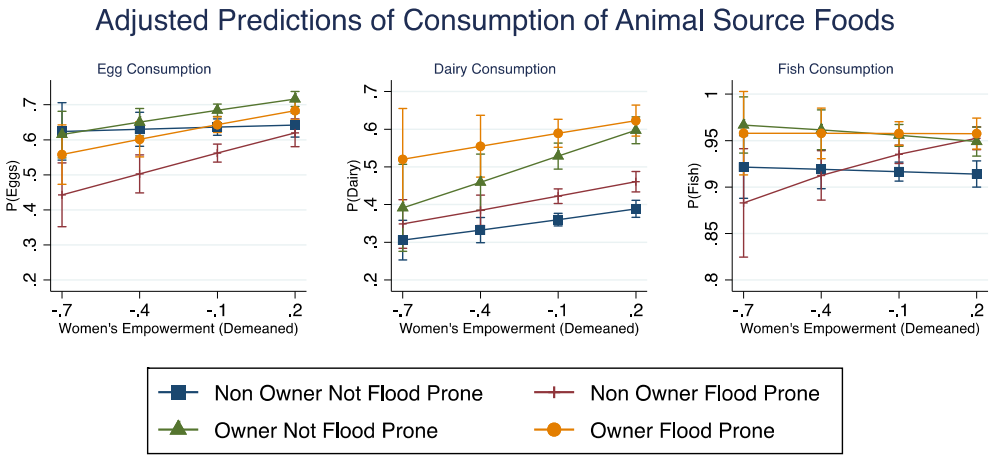
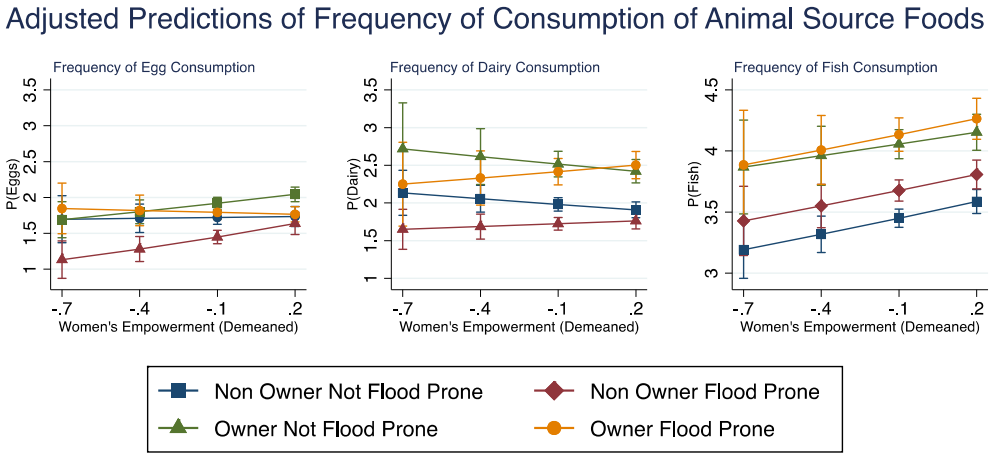


Figure A.4



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