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Social Assistance and Adaptation to Flooding in Bangladesh

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Abstract

As climate change exacerbates weather shocks, there is growing interest in understanding whether social assistance programs can support coping among poor rural households and whether program effects vary by gender. We assess whether a social assistance program – the Transfer Modality Research Initiative (TMRI) – influenced the effects of prior monsoon flooding on household consumption and adult diets in southern Bangladesh. TMRI provided cash or food transfers, with or without nutrition behavior change communication, from 2012-2014. Within the study sites and years, flooding was substantial but moderate. Our findings suggest that, without TMRI, a one-standard-deviation increase in lagged flooding led to households smoothing consumption by drawing down savings and reducing diet quality among both men and women. In contrast, among TMRI treatment households, lagged flooding did not reduce savings, and both men's and women's diet quality improved. Effects on diet quality appeared largely driven by legumes and by fruits and vegetables, and improvements appeared strongest among households receiving both transfers and behavior change communication. Results indicate that social assistance can help households cope with effects of moderate flooding in southern Bangladesh, protecting household savings and improving both men's and women's diets.

Keywords

Social protection, flooding, diets, gender equality, climate resilience, Bangladesh

1. Introduction

The southern coast of Bangladesh is highly susceptible to flooding, with climate change intensifying both the frequency and severity of these events (Huq and Ayers, 2008; Mirza et al., 2010). Studies document a range of coping mechanisms used by households exposed to flooding, such as reducing expenditures, selling assets, borrowing, and using savings held in preparation for disasters (Paul and Routray, 2010; Del Ninno et al., 2003; DuttaGupta and Roy, 2024). Strategies to reduce expenditures include, among others, changing the amounts and types of foods consumed (Del Ninno et al., 2003). Some literature suggests that household coping strategies in response to shocks can disproportionately harm women – for example, disproportionately reducing the quantity or quality of women's diets or liquidating women's assets – while others do not find evidence of gender inequality in responses (Quisumbing et al., 2018; Del Ninno et al., 2003).

In recent years, there is growing interest in the potential of social protection to support resource-poor rural households in coping with and adapting to climate change (IPCC, 2023; Costella et al., 2023). With recognition that adverse impacts of weather shocks tend to be worse for women in many resource-poor rural settings (Bryan et al., 2024; FAO, 2024), there is also interest in understanding whether social protection improves or worsens gender equality amidst these shocks. Social assistance programs – such as cash or in-kind transfers – are of particular interest, as they are already implemented at large scale in many low- and middle-income countries. Yet evidence is limited on gender-disaggregated impacts of social assistance in the context of weather shocks, including those related to climate change (Hidrobo et al., 2024a; Nesbitt-Ahmed, 2023). Although several studies show social assistance can be effective in supporting households' coping behavior (e.g., Hou, 2010; Asfaw et al., 2017; Christian et al. 2019; Pople et al. 2021; Premand and Stoeffler, 2022; Hirvonen et al., 2023; Hidrobo et al. 2024b), fewer studies distinguish how social assistance influences the effect of weather shocks for men versus women. Among those that do, evidence is mixed on whether effects differ by gender (Christian et al. 2019; Hidrobo et al. 2024b).

In this analysis, we assess the role of a social assistance program in influencing the effects of flooding among men and women in southern Bangladesh. We study the Transfer Modality Research Initiative (TMRI), implemented by the World Food Programme between 2012-2014. TMRI provided monthly cash or food transfers, with or without nutrition behavior change communication (BCC), following a randomized control trial design in two regions of rural Bangladesh, including the coastal south. Prior analysis has shown that, during TMRI's implementation, all its treatment arms improved household consumption (Ahmed et al., 2024), and the combination of transfers and BCC improved child diets (Ahmed et al., forthcoming). Here, we focus on how TMRI shaped the effect of the *prior* monsoon season's flooding, on household consumption and adult diets in the subsequent year. We note that, although there was substantial flooding within the study sites and relevant monsoon seasons for this analysis, these flooding events were not among the most severe in the region's recent history. Moreover, we do not assess consumption and diets *during* the flooding events, but rather several months later. Thus, we do not look at the most immediate effects of the most severe flooding events, but rather lingering effects of modest flooding events. Our analysis sheds lights on the following, distinguishing by gender: (1) How did an increase in prior monsoon's flooding affect household consumption and adults' diets several months later, among households that did *not* receive TMRI? (2) How did an increase in prior monsoon's flooding affect household consumption and adults' diets several months later, among households that *did* receive TMRI? (3) What factors may have shaped these effects?

2. Study context, data, and methods

2.1 Transfer Modality Research Initiative

2.1.1 Intervention

From May 2012 to April 2014, the Transfer Modality Research Initiative (TMRI) was implemented by the World Food Programme in two regions of Bangladesh: Rangpur division in the northwest; and Barisal and Khulna divisions near the southern coast (hereafter "the South").[1] In this analysis, we focus on the South (Figure 1). The program provided mothers of young children in poor rural households with monthly food or equal-value cash transfers (worth 1500 taka or about 25% of households' pre-intervention monthly income), with or without a complementary nutrition behavior change communication (BCC) component.

[1] The administrative units in Bangladesh are divisions, districts, sub-districts, unions, and villages.

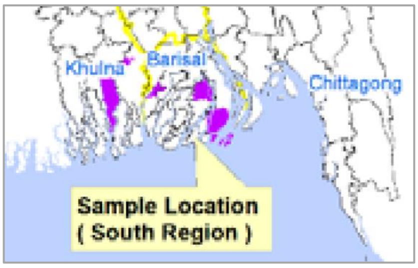

Figure 1. TMRI's study areas in the South

To be eligible to participate in TMRI, study households needed to meet poverty-based criteria, not already participate in a government social assistance program, and have a child aged 0-24 months. The mother of the child aged 0-24 months was both the cardholder for receiving transfers and the target participant in BCC activities.

Cash transfers were monthly payments of 1,500 Taka per household (approximately 19 USD, or 25% of households' pre-intervention monthly consumption). Payments were delivered using a mobile phone cash transfer system, in which women collected cash from designated distribution sites using mobile verification of identity. Food transfers were monthly rations for the household (worth 1,500 Taka, as of April 2012), consisting of the following: 30 kilograms of rice, 2 kg of mosoor pulse (a lentil), and 2 liters of micronutrient-fortified cooking oil. Food transfers were handed to beneficiaries at designated food distribution points. The BCC component focused on promoting knowledge and adoption of recommended practices for young children's nutrition and health, through three activities: (1) Weekly interactive group sessions led by a community nutrition worker – some with only target mothers and some also inviting other family members; (2) Twice-a-month home visits; (3) Monthly group meetings with influential community leaders. Some group sessions discussed producing healthy foods as a means of accessing them.

2.1.2 Randomized design

TMRI was designed as a cluster-randomized control trial, at the village level. In each region, 250 villages were selected and randomly assigned to either a control group or to one of four treatment groups. Because we focus only on the South for this analysis, we describe only the randomization relevant to this region (Figure 2). In the South, the arms were (1) "Control": no intervention, (2) "Cash": unconditional monthly cash transfers, (2) "Food": unconditional monthly food rations, (3) "½ Cash, ½ Food": half the monthly unconditional cash transfers and half the monthly unconditional food rations, (4) "Food+BCC": monthly food rations along with nutrition BCC.[2] From each village, 10 eligible households were selected for inclusion in the study. Thus, in the South, TMRI included a total of 2,500 targeted households: 500 in each of the arms.

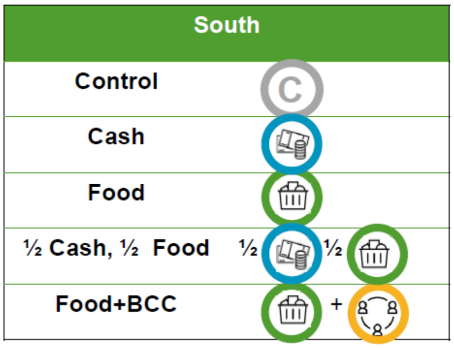

Figure 2. TMRI's randomized control and treatment arms in the South, 2012-2014

2.1.3 Household survey data

To evaluate the impacts of TMRI, three rounds of longitudinal survey data were collected immediately before and during the intervention. A baseline survey was conducted from March-April 2012 (prior to the start of the intervention in May 2012). A midline survey was conducted in June 2013 (after approximately one year of intervention). An endline survey was conducted in

[2] In the Food+BCC arm, there was a "soft conditionality," in that households were expected to attend BCC sessions in order to receive food transfers, but in practice, no one was excluded from receiving transfers due to absence.

April 2014 (just before the end of intervention). In each round, rich data were collected at the household level as well on all individuals in the household.

2.2 Flood measures

For information on flooding, we use remote sensing data that detects whether units of area are inundated. We construct a "flooding extent" variable for the monsoon season at the union-level (Chen et al., 2017; Chen and Mueller, 2018), which captures the difference between inundation observed in the monsoon season versus in the dry season (i.e., quarters 3 and 4 versus quarter 1, to distinguish flooding from standing water bodies). Although this measure does not directly capture the depth or duration of flooding, it correlates in our dataset with key correlates for "large floods" demonstrated in prior literature (Kocornik-Mina et al., 2020). We then construct a flooding extent z-score, which standardizes the flooding extent for each year, relative to the distribution of flooding extent in that union from 2001-2018. Thus, the flooding extent z-score captures flooding *anomalies*, relative to the union's own historical distribution.

Since the timing of the TMRI survey rounds was between March and June in 2012-2014, for assessing how flooding affected households at the time of these surveys, we consider flooding in the *prior* monsoon season for each survey round. Therefore, we focus on the union-level flooding extent z-score in 2011-2013, for survey rounds in 2012-2014 respectively.

Across the years of 2011-2013 and across our study sites, there was meaningful variation in flooding (Figure 3), considering the limited timeframe and geographic coverage. As expected due to randomization, the distribution of flooding extent z-scores did not meaningfully differ between the TMRI control and treatment groups (Figure 4). We note that the distribution of z-scores over these years suggests that flooding over these years and locations was not among the most extreme in recent history (for example, in the overall 2001-2018 dataset in these sites, there are several observations of z-scores exceeding 3). While the range reflects flooding anomalies, these are relatively modest and not among the most severe, consistent with other data on disasters in this timeframe and geography (EM-DAT, CRED / UCLouvain, 2024).

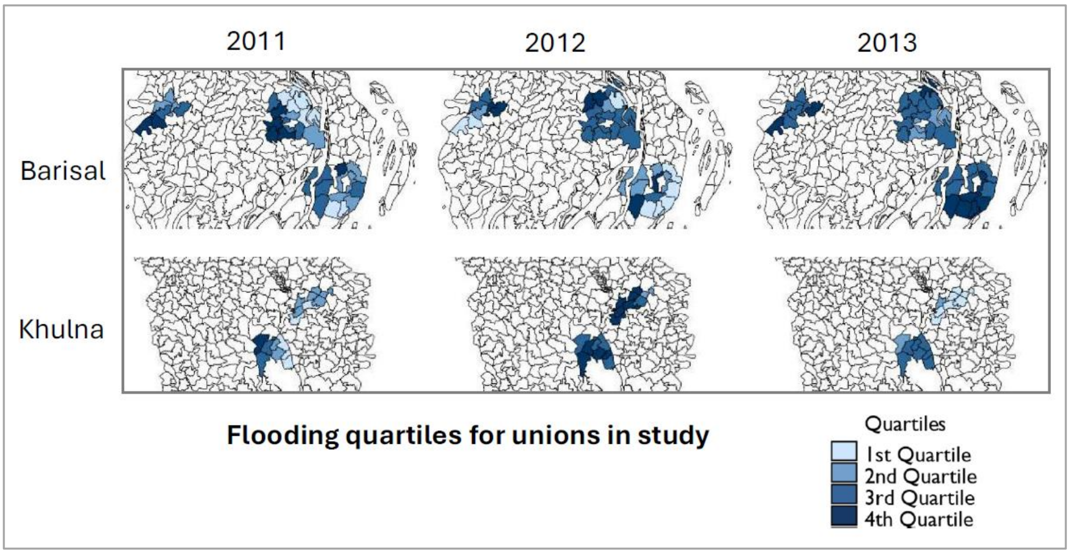

Figure 3. Flooding quartiles for unions in TMRI study sites in the South (Barisal and Khulna), 2011-2013

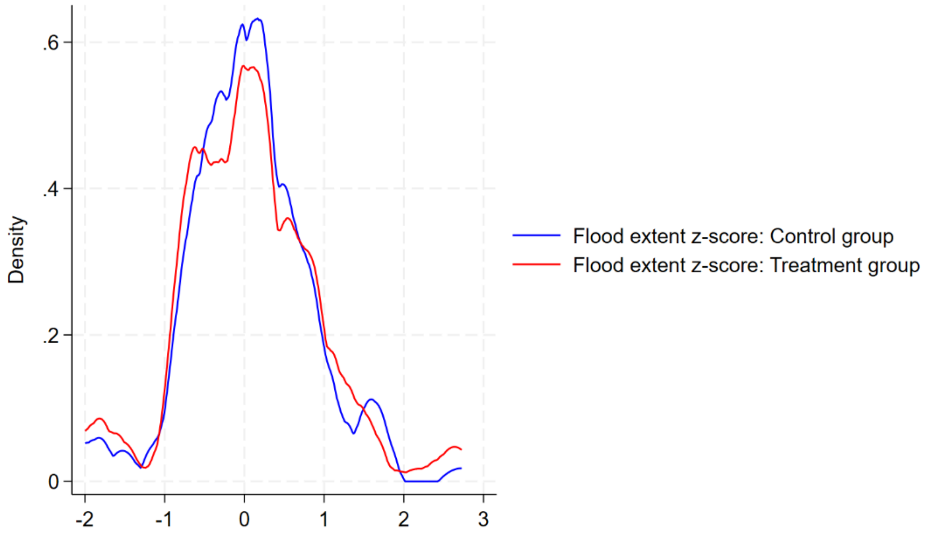

Figure 4. Flooding extent z-scores in TMRI study sites in the South, 2011-2013, by control vs. treatment

2.3 Outcome variables

Our focus is understanding impacts on household consumption and individual diet quality. To measure household consumption (Deaton and Zaidi, 2002), we construct two outcomes based on recall from the last 7 days prior to the survey: (1) Value of food consumption (purchased, consumed out of own production, gifts and transfers, and food consumed outside the home), (2) Value of total consumption: the sum of food consumption and nonfood non-durables (clothing, fuel, hygiene, transport, etc.). Both are in terms of total monthly expenditures, deflated to 2012 Taka. We then winsorize and take the logarithm of each, noting there are no cases where reported expenditures were zero.

To measure individual diet quality, we construct the Global Diet Quality Score (GDQS) based on recall from the 24 hours prior to the survey. The GDQS has been validated for global use to reflect overall diet quality (Bromage et al., 2021; Intake, 2021). It accounts for not only the diversity of the diet, but the quantities consumed of various food groups (scoring the quantity consumed in grams per day, based on whether it falls in healthy or unhealthy ranges, informed by global epidemiological evidence), and is sensitive to both nutrient adequacy and non-communicable disease risk outcomes. Originally validated for non-pregnant non-lactating women ages 15-49 years, it has been used more broadly for adults aged 15-49 years. We construct it for all men and women aged 15-49 years. The GDQS creates a score between 0-49 (higher indicates better diet quality), based on scoring for 25 different food groups. The mean consumption by food group in our sample in March-April 2012, as well as the scoring for the food groups, are shown below (Table 1).

Table 1. GDQS food groups (Intake, 2021) and mean quantities consumed in study sample of men and women aged 15-49 years in March-April 2012

		Sample		**GDQS scoring**							
		Mean consumed amounts (grams/day)		**Categories of Consumed Amounts (grams/day)**				**Points Assigned**			
	GDQS food groups	Men	Women	Low	Middle	High	Very High	Low	Middle	High	Very High
Healthy Food Groups	Citrus fruits	0.1	0.2	24	24-69	69		0	1	2	
	Deep orange fruits	2.1	1.8	25	25-123	123		0	1	2	
	Other fruits	17.9	23.3	27	27-107	107		0	1	2	
	Dark green leafy vegetables	39.7	48.9	13	13-37	37		0	2	4	
	Cruciferous vegetables	2.8	2.6	13	13-36	36		0	0.25	0.5	
	Deep orange vegetables	23.7	26.5	9	9-45	45		0	0.25	0.5	
	Other vegetables	108.3	107.7	23	23-114	114		0	0.25	0.5	
	Legumes	21.5	24.0	9	9-42	42		0	2	4	
	Deep orange tubers	0.0	0.0	12	12-63	63		0	0.25	0.5	
	Nuts and seeds	1.0	1.1	7	7-13	13		0	2	4	
	Whole grains	163.3	139.2	8	8-13	13		0	1	2	
	Liquid oils	17.8	18.1	2	2-7.5	7.5		0	1	2	
	Fish and shellfish	34.7	34.7	14	14-71	71		0	1	2	
	Poultry and game meat	3.4	3.6	16	16-44	44		0	1	2	
	Low-fat dairy	0.0	0.0	33	33-132	132		0	1	2	
	Eggs	3.0	2.7	6	6-32	32		0	1	2	
Healthy food groups when consumed in moderation	High-fat dairy (in milk equivalents)	10.0	9.8	35	35-142	142-734	>734	0	1	2	0
	Red meat	2.1	1.2	9	9-46	46		0	1	0	
Unhealthy food groups	Processed meat	0.1	0.1	9	9-30	30		2	1	0	
	Refined grains and baked goods	462.7	514.9	7	7-33	33		2	1	0	
	Sweets and ice cream	6.9	5.5	13	13-37	37		2	1	0	
	Sugar-sweetened beverages	0.3	0.2	57	57-180	180		2	1	0	
	Juice	0.0	0.1	36	36-144	144		2	1	0	
	White roots and tubers	107.7	112.2	27	27-107	107		2	1	0	
	Deep fried food	0.8	1.0	9	9-45	45		2	1	0	

Note: Sample means shaded to reflect scoring (pink = low if healthy food group, high if unhealthy; yellow = medium if healthy or unhealthy; green = high if healthy, low if unhealthy). Nearly all rice consumed in this sample is refined grains.

For this analysis, we aggregate some of these 25 food groups, to construct subscores for 6 consolidated groups: (1) Fruits and vegetables, (2) Legumes, (3) Fish, (4) Poultry, (5) Other healthy foods, (6) Unhealthy foods. The consolidated food group subscores allow us to explore which types of food are driving any changes in GDQS, while aggregating groups with little variation (Table 1).

Table 2. Consolidated food group subscores derived from GDQS food groups (Intake, 2021)

GDQS food group classifications and score ranges			Consolidated food groups and subscore	
Healthy Food Groups	Citrus fruits	0-2	Fruits and vegetables	0-11.5
	Deep orange fruits	0-2		
	Other fruits	0-2		
	Dark green leafy vegetables	0-4		
	Cruciferous vegetables	0-0.5		
	Deep orange vegetables	0-0.5		
	Other vegetables	0-0.5		
	Legumes	0-4	Legumes	0-4
	Fish and shellfish	0-2	Fish	0-2
	Poultry and game meat	0-2	Poultry	0-2
	Deep orange tubers	0-0.5	Other healthy foods	0-15.5
	Nuts and seeds	0-4		
	Whole grains	0-2		
	Liquid oils	0-2		
	Low-fat dairy	0-2		
	Eggs	0-2		
Healthy food groups when consumed in moderation	High-fat dairy (in milk equivalents)	0-2		
	Red meat	0-1		
Unhealthy food groups	Processed meat	0-2	Unhealthy foods	0-14
	Refined grains and baked goods	0-2		
	Sweets and ice cream	0-2		
	Sugar-sweetened beverages	0-2		
	Juice	0-2		
	White roots and tubers	0-2		
	Deep fried food	0-2		

Note: Food groups re-ordered for consolidation. Food groups included within "Healthy food groups when consumed in moderation" are very infrequently consumed in the excessive range in this sample, thus are grouped in "Other healthy foods."

We also construct an indicator for "high-risk" GDQS, i.e., whether an individual's GDQS is below 15, which predicts high risk of nutrient inadequacy and NCD-related outcomes (Intake, 2021). In our study sample in 2012, 23% of individuals aged 15-19 years had "high-risk" GDQSs, similar for men and women (Figure 5).

Figure 5. Distribution of GDQS among men and women aged 15-49 years in study sample, March-April 2012

To further understand effects on consumption and dietary outcomes, we construct several other outcomes: value of household savings (winsorized, in 2012 Taka); rice and pulses produced from field crops (winsorized, in kilograms); fruits and vegetables produced from field crops and homestead crops (winsorized, in kilograms).

2.4 Methods

We aim to estimate how lagged flooding affects key outcomes, as well as how the impacts of lagged flooding on key outcomes are shaped by whether households receive TMRI treatments. To capture maximum spatial and time variation within our data, we pool across the 2012-2014 survey data and corresponding 2011-2013 flooding measures. Our core specifications include the following right-hand-side variables: a treatment dummy (=0 for all in 2012 and for the control group in 2013-2014, =1 for treatment in 2013-2014); lagged flood extent z-score; interaction of treatment dummy with lagged flood extent z-score; year fixed-effects; baseline covariates to improve precision (whether the household is female-headed, education of the head, household size, whether the household owns land). To disaggregate impacts by different TMRI treatments, we modify the specification to include multiple treatment dummies. Standard errors account for clustering at the village level.

For impact estimates on the logarithm of household consumption, we conduct ordinary least squares (OLS) regressions. For the probability of high-risk GDQS, we also use OLS to estimate linear probability. For all other outcomes (GDQS, consolidated food group subscores, savings, crop production), we use Poisson regressions. Several of these are count variables; others are continuous but take non-negative values and have a mass at zero, thus are recommended to be analyzed non-transformed (Mullahy and Norton, 2024). For Poisson regressions, a coefficient ß on variable X is interpreted as follows: for a one-unit increase in X, the independent variable changes by 100 x ($e^{ß}$ – 1) in percentage terms.

For this analysis, we sum together the relevant regression coefficients to present estimated impacts on key outcomes of a one-standard-deviation increase in lagged flooding among households that received no TMRI treatment, as well as the impacts of lagged flooding among households that received TMRI. In particular, we show 95% confidence intervals for the estimated effect of *"Flood with No Treatment"* (i.e., for households in the control group, the impact of an increase by 1 in lagged flood extent z-score relative to the mean flood extent z-score in this sample) and the estimated effect of *"Flood with Treatment"* (i.e., for households that received cash transfers, food transfers, half cash and half food transfers, or food transfers with BCC, the impact of an increase by 1 in lagged flood extent z-score relative to the mean flood extent z-score in this sample). For select outcomes, to explore which components of the treatment are driving effects, we further disaggregate effects: *"Flood with No Treatment"* (i.e., control group), *"Flood with Transfers" (*i.e., cash transfers, food transfers, half cash and half food transfers), and *"Flood with Transfers+BCC"* (food transfers with BCC).

Impacts on individual-level outcomes are disaggregated by gender. Our sample size for this analysis is 7,179 households, with 15,045 individuals aged 15-49 years (6,392 men and 8,653 women).

3. Findings

3.1 Household consumption and savings

We first assess how flooding in the prior monsoon season affected household consumption during the subsequent year, and whether TMRI changed this effect. In the control group, we find no significant impacts of lagged flooding on log household value of total consumption or food consumption (Figure 6). But we find that lagged flooding significantly reduced household savings in the control group (Figure 7), by about 18 percent. These results suggest that control group households may have drawn down their savings as a coping strategy to protect their consumption. In the treatment group, the impact of flooding on household consumption was not meaningfully different from the impact in the control group; however, in the treatment group, flooding did not hurt savings. These results suggest that households in the control group (although poor) may have kept precautionary savings to cope with possible flooding in this flood-prone setting, thus a modest increase in lagged flooding did not significantly hurt their consumption. But TMRI allowed households to avoid needing to draw down these savings; presumably transfer resources were used to smooth their consumption, thus protecting their savings.

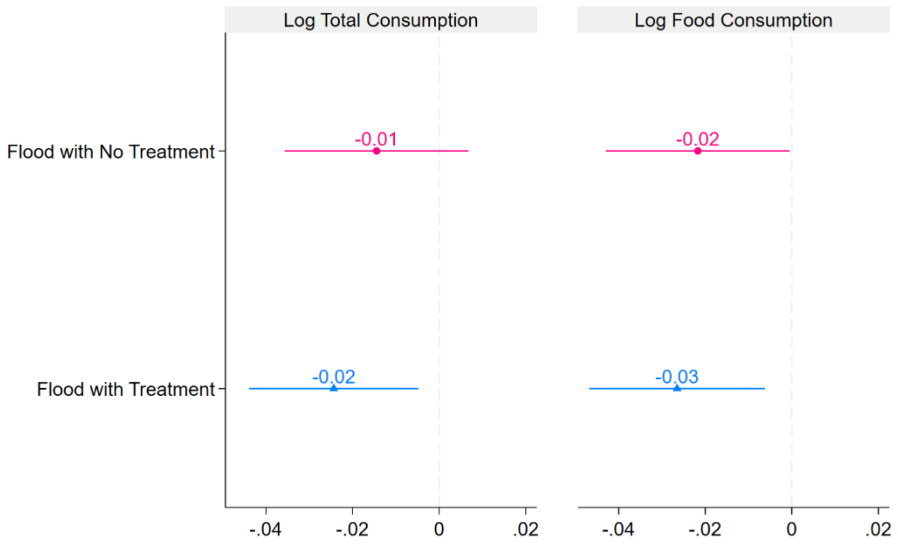

Figure 6. Impacts of lagged flooding on monthly value of total household consumption (in 2012 Taka, winsorized), with vs. without treatment (OLS)

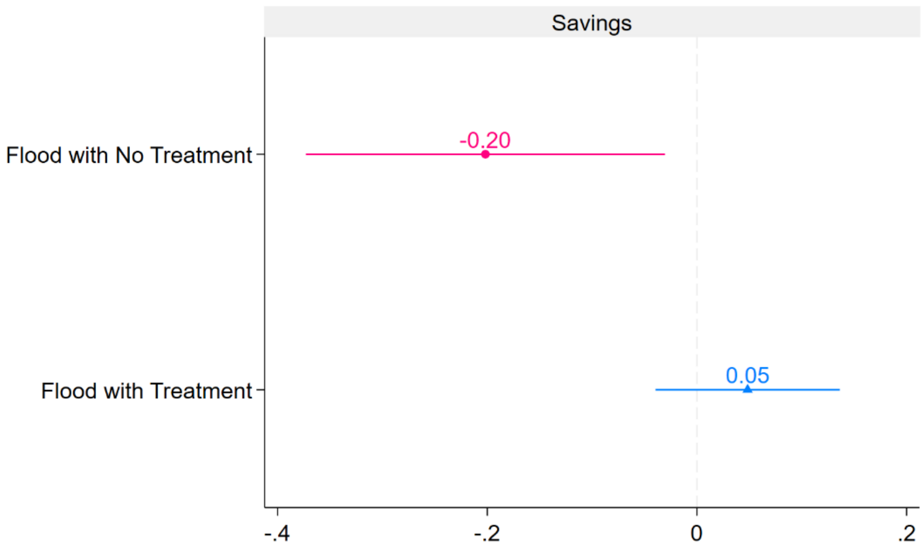

Figure 7. Impacts of lagged flooding on value of household savings (in 2012 Taka, winsorized), with vs. without treatment (Poisson)

3.2 Individual diet quality

We next assess how flooding in the prior monsoon season affected individual diet quality, and whether TMRI changed this effect. Even without meaningful shifts in the value of household consumption, if small reallocations occurred in quantities consumed of different foods due to lagged flooding, this could lead to changes in diet quality.

In the control group, we find a very small but significant negative effect of lagged flooding on average GDQS (Figure 8). The small negative impact is similar for men and women. However, in the treatment group, we find that the effect of flooding on GDQS is significantly different than in the control group; for both men and women, the treatment protected diet quality in the context of lagged flooding.

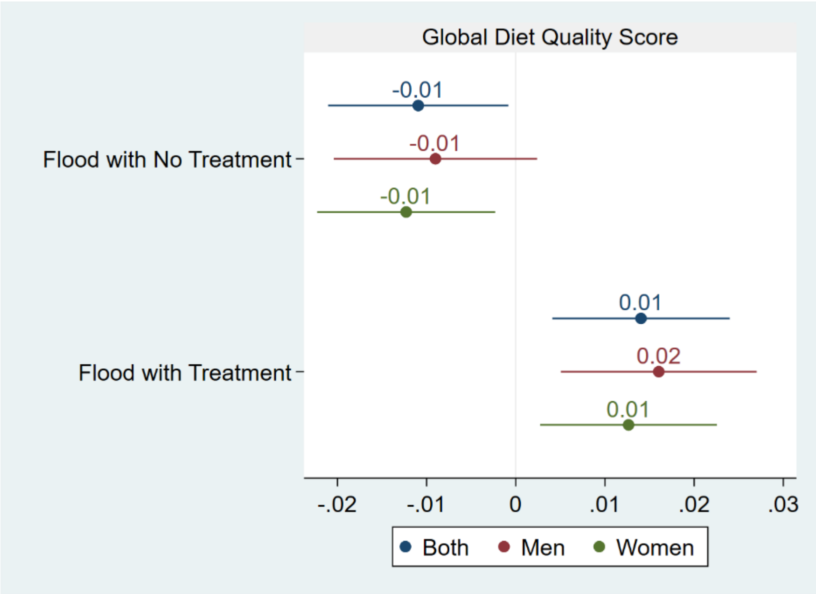

Figure 8. Impacts of lagged flooding on Global Diet Quality Score for adults aged 15-49, by gender, with vs. without treatment (Poisson)

We also see that, in the control group, lagged flooding had no significant effect on the probability of individuals having "high-risk" GDQS (<15). However, in the treatment group, lagged flooding significantly *reduced* the probability of both men and women having high-risk GDQS, by about 3 percentage points (Figure 9). Given 23% prevalence of high-risk GDQS in 2012, this represents about a 13% decline. We find that the pooled treatment's effect on high-risk GDQS after lagged flooding appears driven partly by transfers alone but seems stronger from the combination of transfers with BCC (Figure 10).

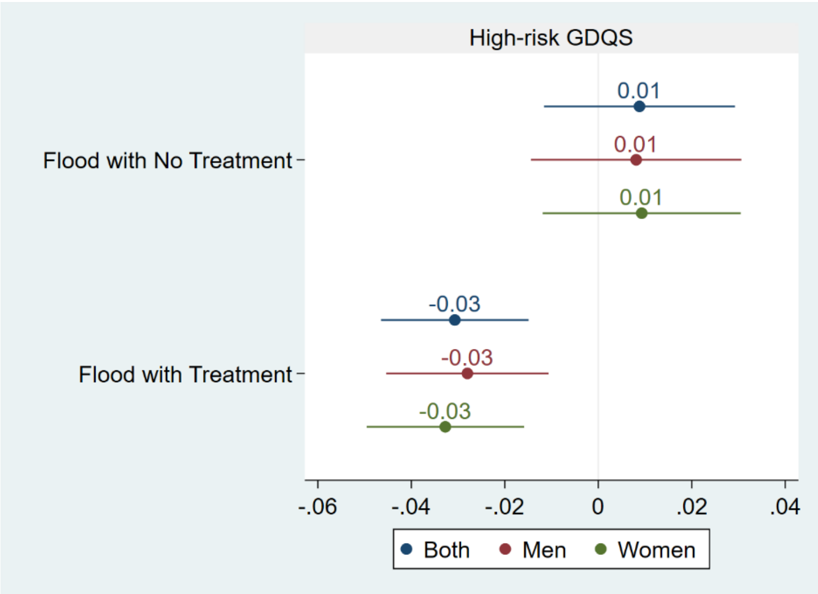

Figure 9. Impacts of lagged flooding on probability of High-Risk GDQS (<15) for adults aged 15-49, by gender, with vs. without treatment (Linear probability)

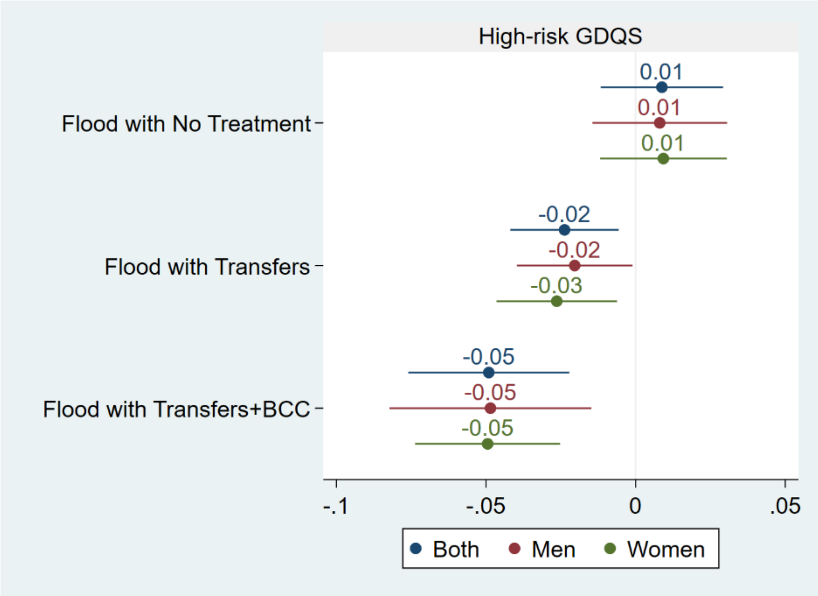

Figure 10. Impacts of lagged flooding on probability of High-Risk GDQS (<15) for adults aged 15-49, by gender, with different treatment components (Linear probability)

3.3 Food groups

To understand what drives these modest effects on individual diet quality, we look at how flooding in the prior monsoon season affected individuals' composite food group subscores, and whether TMRI changed these effects. In the control group, we find that the negative effect of lagged flooding on GDQS was driven by significant reductions in subscores for legumes (about 18% reduced) and fish (about 10% reduced) among both men and women, although lagged flooding also led to an average *increase* in the subscore for poultry among men only (Figure 11). One interpretation of this pattern is that, in the control group, prior monsoon flooding led to less protein intake from legumes and fish for both men and women, but this was compensated by an increase in protein intake from poultry only for men (not for women). In the treatment group, we see that the adverse impacts of lagged flooding on the legumes subscore were offset for both men and women; moreover, lagged flooding led to an average *increase* in the fruit and vegetable subscore (about 10% increased) for both men and women. Overall, in the control group, the small adverse impact of lagged flooding on GDQS appears driven by less legumes and fish for men and women, though partially compensated with more poultry for men. Treatment offset the small adverse impacts of lagged flooding on GDQS by increasing legumes, as well as fruits and vegetables, for both men and women. (The adverse effects of lagged flooding on the fish subscore were not offset by the treatment; possibly they could be due to prior monsoon flooding disrupting fish harvesting, for example due to fish from ponds escaping into floodwaters (Sultana and Thompson, 2017).)

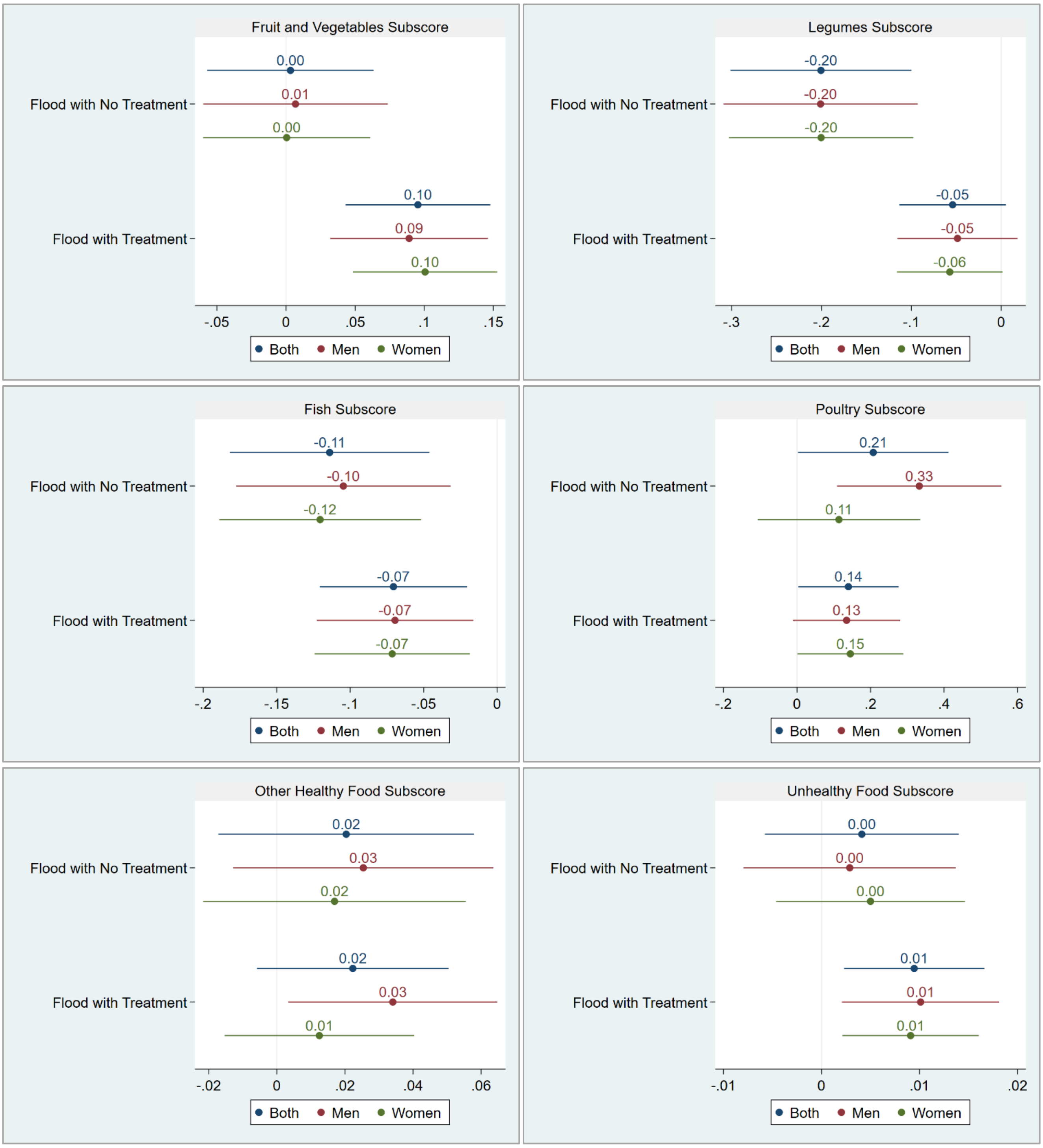

Figure 11. Impacts of lagged flooding on Global Diet Quality Composite Food Group Subscores for adults aged 15-49, by gender, with vs. without treatment (Poisson)

We further explore how different components of TMRI influenced the effect of lagged flooding on subscores for fruits and vegetables and for legumes (Figure 12). We see that the adverse impact of lagged flooding on legumes was similarly offset by transfers alone or by transfers with BCC. This seems intuitive, since the food transfers included lentils (which are legumes). In the treatment group, the increase in fruits and vegetables from lagged flooding appears driven by the combination of transfers with BCC.

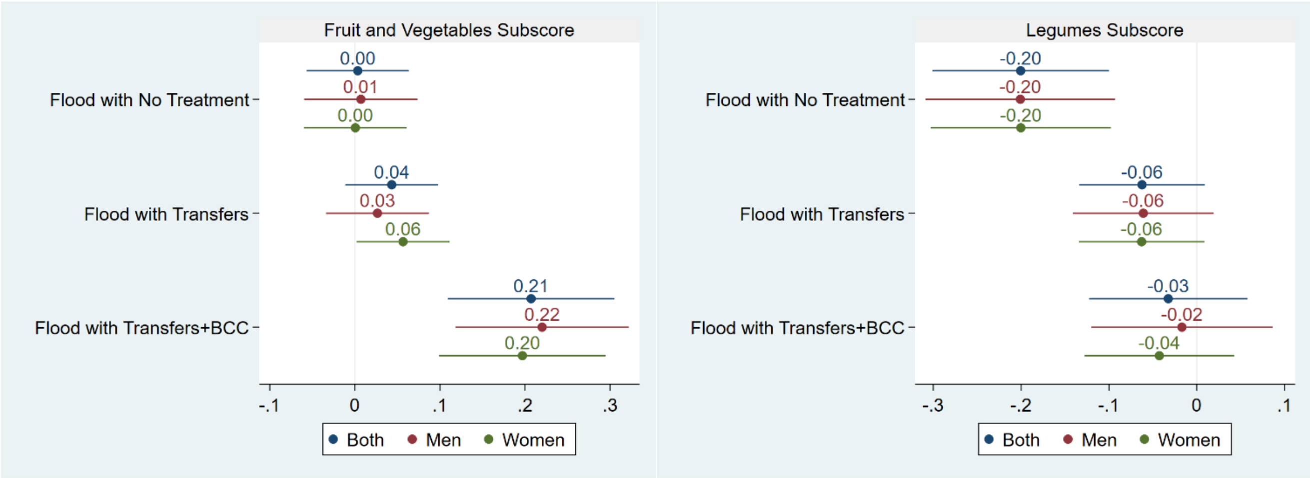

Figure 12. Impacts of lagged flooding on Fruit and Vegetables Subscore and Legumes Subscore for adults aged 15-49, by gender, with different treatment components (Poisson)

3.4 Crop production

Because households in the study sample consumed foods from purchase in the market as well as from own production and other sources, changes in foods consumed may not correspond with changes in own production of these foods. Nonetheless, we explore households' production of crops that may be linked to the dietary changes.

We first assess how flooding in the prior monsoon season affected crop production: specifically of rice (staple crop in Bangladesh), pulses (which include lentils, and are a type of legume), and fruits and vegetables (produced on the field or homestead). In the control group, we do not find precise impacts of lagged flooding on production of these crops (Figure 13). However, in the treatment group, lagged flooding appears to significantly increase production of fruits and vegetables from field crops. Disaggregating the treatment suggests that transfers with lagged flooding may have increased fruit and vegetable production even without BCC; plausibly, the transfers facilitated investing in fruit and vegetable crops after flooding (Figure 14).

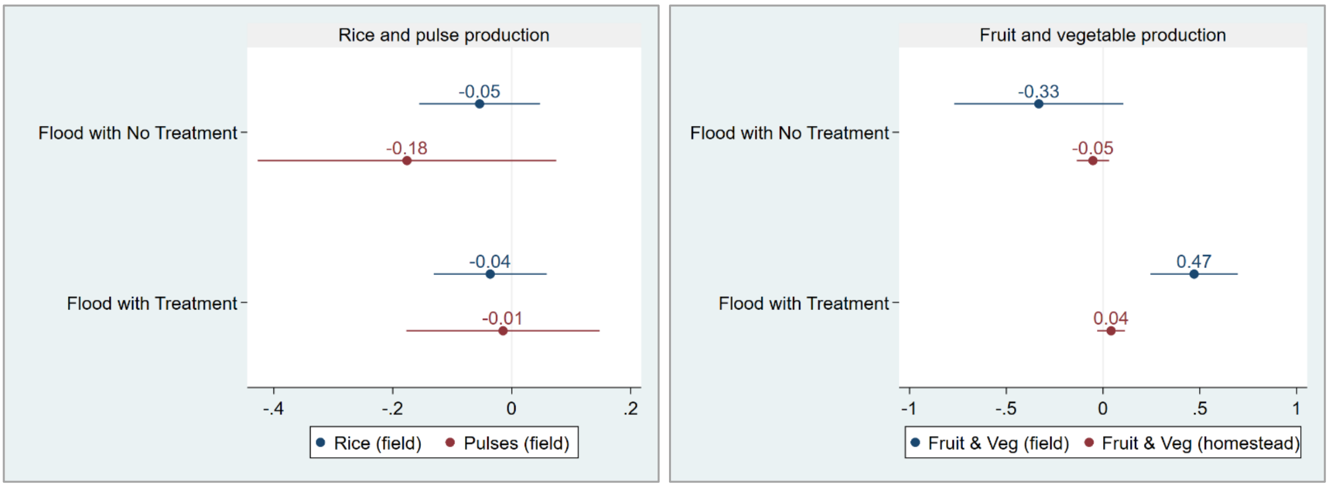

Figure 13. Impacts of lagged flooding on household production of rice, pulses, and fruits and vegetables in last 12 months (in kilograms, winsorized), with vs. without treatment (Poisson)

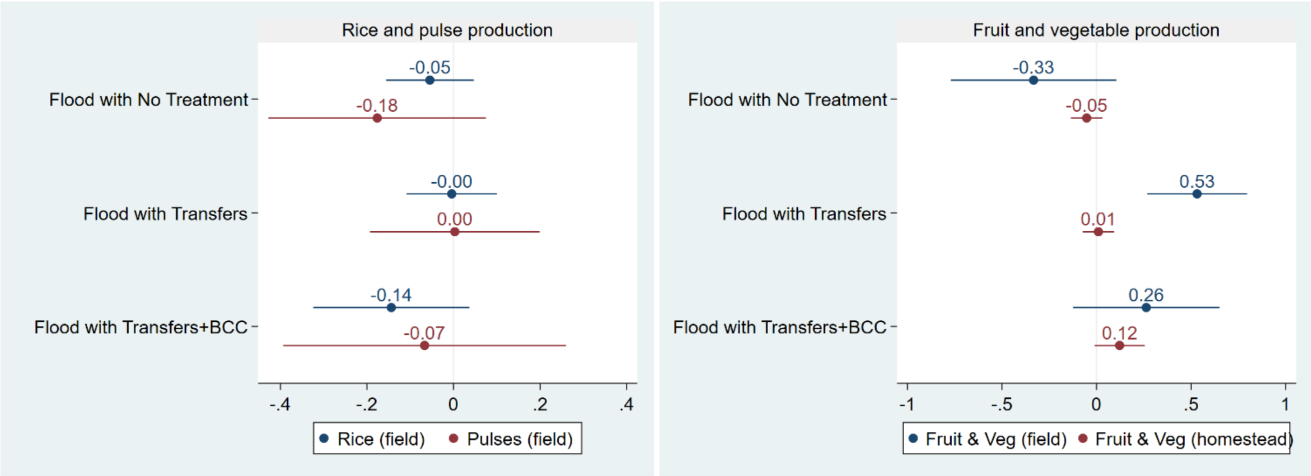

Figure 14. Impacts of lagged flooding on household production of rice, pulses, and fruits and vegetables in last 12 months (in kilograms, winsorized), with different treatment components (Poisson)

4. Conclusion

We find that, among poor households in southern Bangladesh who did not receive TMRI, an increase in flooding extent z-score during the prior monsoon season did not meaningfully affect household consumption several months later, but did lead to significantly reduced household savings. An increase in lagged flooding also led to small but significant reductions in diet quality for both men and women aged 15-49 years. However, among households that *did* receive TMRI, an increase in lagged flooding did *not* reduce household savings. Moreover, among TMRI treatment households, an increase in flooding led to a small *improvement* in diet quality among both men and women aged 15-49, corresponding to a 13% decline in the probability of both men and women having high-risk GDQS. Improvements appear stronger for TMRI households that received both transfers and BCC. Effects on diet quality appear largely driven by legumes, fish, and fruits and vegetables. For both men and women, absent TMRI, lagged flooding substantially decreased subscores for individual intake of legumes and for fish; with TMRI, the effect of lagged flooding was not meaningfully different for fish, but led to an *increase* in subscores for legumes (driven by transfers) and for fruits and vegetables (driven by transfers+BCC). With TMRI treatment, lagged flooding also increased households' production of fruits and vegetables from field crops.

These patterns suggest that, in the absence of TMRI, poor households attempted to cope with lagged flooding and smooth their consumption by drawing down precautionary savings and adjusting household members' diets. Receiving TMRI allowed households to cope *without* resorting to using savings (presumably due to transfer resources) and *without* adverse impacts on men's and women's diet quality. These findings are consistent with qualitative evidence from a similar sample in Bangladesh (DuttaGupta and Roy, 2024), as well as earlier evidence on gender dimensions of coping responses to flooding in Bangladesh (Del Ninno et al., 2003). In terms of diets, the adverse effects of lagged flooding on intake of fish may have been due to disruptions in fish harvesting; receiving TMRI did not change this. But among TMRI treatment households, the *improvements* due to lagged flooding in intake of legumes and of fruits and vegetables may have been due to, respectively, the food transfers including lentils and TMRI facilitating investments in production of fruits and vegetables. We see few differential impacts by gender, suggesting that households' coping responses to lagged flooding – with or without TMRI – did not appear to worsen gender equality in terms of diets. The exception is that lagged flooding without TMRI appeared to slightly increase poultry intake *only* among men – possibly to compensate for less protein intake from legumes and fish – and not among women. Receiving TMRI offset this effect.

Our findings contribute to growing evidence that social assistance can support households' coping responses to weather shocks. Although we do not find that coping strategies strongly disfavor women's diets in the absence of TMRI, we also find that TMRI does not worsen gender equality. We caveat that these results are specific to the setting we analyze – including the range of flooding, the timing, the study sites, the study years – and patterns may differ with more severe flooding, immediate measurement during flooding, in other parts of Bangladesh, or in different years. However, our analysis indicates that, among poor households in southern Bangladesh, social assistance allows smoothing consumption several months after flooding *without* reducing savings or worsening diets, with benefits for both men and women, and possibly stronger improvements when transfers are combined with nutrition BCC.

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