

Effects of anticipatory humanitarian cash assistance to households forecasted to experience extreme flooding: evidence from Bangladesh

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ABSTRACT

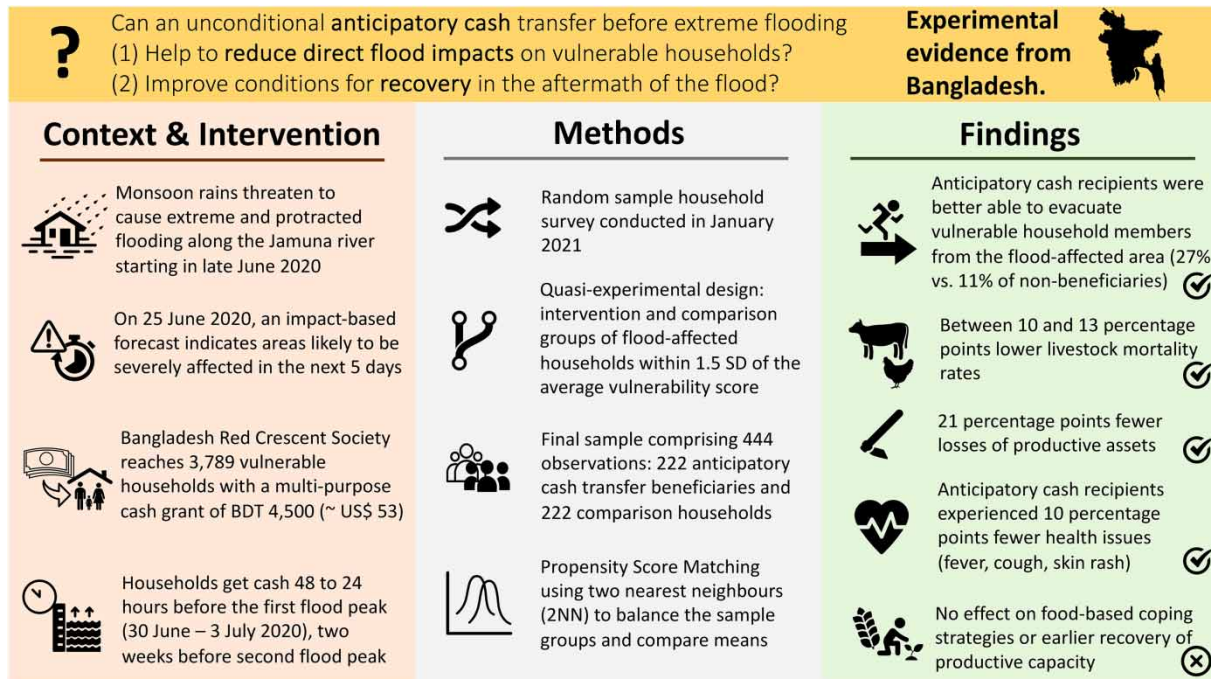
The 2020 monsoon floods in Bangladesh were among the most severe and protracted in decades. Instead of waiting for disaster to strike, the Bangladesh Red Crescent Society used impact-based forecast data to reach nearly 3,800 vulnerable households along the Jamuna River with a one-off unconditional cash transfer of BDT 4,500 (about \$53) before peak flooding in July 2020. Anticipatory action to help at-risk populations avoid or mitigate extreme weather event impacts has become widely used by governments and humanitarian organisations worldwide. However, robust evaluations of the effectiveness of forecast-based assistance are limited. This assessment follows a quasi-experimental approach, drawing on survey data from a sample of cash recipients and equally vulnerable and flood-affected households that were not reached by BDRCS before the flood. Our analysis finds robust statistical evidence that the intervention was effective in helping households evacuate the flood-affected area, protecting personal health and well-being, and safeguarding people's productive assets and livestock. It was also effective in enabling beneficiaries to avoid taking on high-interest loans and selling valuable assets during and after the flood. The intervention does not appear to have helped cash recipients avoid food-based coping mechanisms or regain their productive capacity sooner after the flood.

Key words: anticipatory action, Bangladesh, cash transfer, floods, forecast, humanitarian

HIGHLIGHTS

- Impact-based forecasting enabled a one-off humanitarian cash transfer reaching thousands of vulnerable households days before an expected severe flood peak in Bangladesh.
- This study presents robust statistical evidence from a quasi-experimental assessment of the effectiveness of the intervention in helping cash recipients avoid or mitigate the impacts of the flood, one of few such rigorous evaluations in the anticipatory humanitarian action literature.
- The study confirms positive impacts of the forecast-based cash assistance on households' ability to evacuate, on protecting their health, well-being and assets, and avoiding negative coping strategies, while other expected effects regarding food consumption and productive capacity could not be detected.

GRAPHICAL ABSTRACT



INTRODUCTION AND LITERATURE REVIEW

The concept of anticipatory humanitarian action has gained broad-based acceptance in recent years. In 2022, 35 countries had anticipatory action frameworks covering 7.6 million people (Weingärtner *et al.* 2020; Pople *et al.* 2021; Anticipation Hub 2023). Instead of waiting for a disaster to occur and providing response assistance to the affected population, governments and humanitarian organisations now increasingly use weather forecast and risk data to act before the shock materialises. When a pre-defined, impact-based trigger threshold is reached, forecast-based financing (FbF) releases pre-arranged funding to assist the at-risk population before an extreme weather event, like flooding or drought, to help the most vulnerable avoid or mitigate the impacts of the hazard. Building on an extensive body of Early Warning Early Action work within the humanitarian sector, the anticipatory action approach was piloted with limited funding in a handful of countries starting in 2015 (Coughlan de Perez *et al.* 2015) and has since seen significant scale-up.

Today, around 60 countries implement anticipatory humanitarian action (Anticipation Hub 2022). Major humanitarian actors are mainstreaming anticipation: the International Federation of Red Cross and Red Crescent Societies (IFRC) has established Forecast-based Action by the Disaster Response Emergency Fund (FbA by the DREF), a funding mechanism dedicated to help National Societies take early action before disasters strike. The United Nations Office for the Coordination of Humanitarian Affairs (OCHA) has committed US\$ 140 million from the Central Emergency Response Fund (CERF) to support anticipatory action in a diverse range of contexts and for different types of shocks.

Despite the notable proliferation of anticipatory humanitarian action across countries and actors, the number of impact evaluations to assess whether the approach is effective in helping disaster-affected households avoid or mitigate negative impacts is growing but remains limited overall (Weingärtner *et al.* 2020).

This study seeks to contribute to the evidence base on anticipatory action by examining the effects of a forecast-based unconditional cash transfer provided to households about to experience severe flooding. The Bangladesh Red Crescent Society (BDRCS), in collaboration with other partners,¹ activated their early action protocol (EAP) on 25 June 2020,

¹ German Red Cross (GRC), Red Cross Red Crescent Climate Centre (RCCC), International Federation of the Red Cross Red Crescent Societies (IFRC), American Red Cross (AmCross), Swiss Red Cross (SRC), Government of Bangladesh's Ministry of Disaster Management and Relief (MoDMR), Department of Disaster Management (DDM), Bangladesh Post Office (BPO), Flood Forecasting and Warning Centre (FFWC), and World Food Programme (WFP).

ahead of the 2020 monsoon floods that were among the most extreme and protracted in decades. BDRCS reached 3,789 households across three districts along the Jamuna River with a multi-purpose cash grant of BDT 4,500 (about US\$ 53) between 48 and 24 h before the first flood peak which occurred between 30 June and 3 July 2020, and 2 weeks before a second flood peak started on 14 July 2020. The cash transfer value is equivalent to approximately 2 weeks' food expenditure (Hill & Genoni 2019). To assess whether the anticipatory cash transfer was effective in helping households to evacuate in a timely manner, protect their health and assets, avoid negative coping strategies, and recover more quickly from the shock, we follow a quasi-experimental approach and compare households that received the forecast-based transfer to otherwise comparable households that did not.

A large body of literature exists on recurring cash transfers to assist vulnerable populations in resource-poor settings (Bastagli *et al.* 2016). The evidence suggests that regular monetary support can effectively buffer the adverse income effects of exogenous shocks and reduce negative coping behaviours. However, there is very limited rigorous evidence on the effectiveness of one-off cash transfers, despite humanitarian agencies making increasing use of them for disaster relief since the early 2000s (Bailey & Harvey 2015). A systematic review specifically of the evidence for anticipatory action (Weingärtner *et al.* 2020) found little rigorous evidence of their effectiveness in improving outcomes for the populations covered, with several notable exceptions and recent additions: an early assessment of anticipatory cash transfers in Bangladesh, provided by BDRCS ahead of severe flooding in 2017, showed that the cash grants contributed to improving households' access to food, a reduction in high-interest debt accrual of vulnerable households, and reduced psychosocial stress during and after the flood period, compared to a control group of similarly vulnerable and flood-affected communities that did not receive the forecast-based cash assistance (Gros *et al.* 2019). A similar study of an anticipatory cash transfer by WFP in 2020, drawing on a larger sample size, found comparable results, indicating that households who received money before the flood peak were less likely to go a day without eating during the flood, reported significantly higher child and adult food consumption and well-being 3 months after the flood, and experienced lower asset loss, engaged in less costly borrowing after the flood, and reported higher earning potential (Pople *et al.* 2021).

Our paper seeks to answer two overarching research questions:

1. Did the anticipatory humanitarian cash transfer help to reduce the direct impact of the flood on beneficiary households vis-a-vis the counterfactual of comparable, disaster-affected households that did not receive the intervention, considering their health and well-being, and the loss of personal and productive assets such as agricultural tools and livestock?
2. Did the intervention improve beneficiaries' conditions for recovery in the aftermath of the flood event, particularly regarding avoiding negative coping strategies, their financial situation and earning potential?

STUDY AREA AND DATA

Bangladesh is among the countries most vulnerable to natural disasters and climate change-related extreme weather in the world. Flood events occur annually in the monsoon season (June to September). The areas most exposed to flood hazards are the Jamuna, Padma, and Meghna River systems, and especially poor and vulnerable households living on char lands² and along the riverbanks.

The 2020 monsoon floods in Bangladesh were the second highest in the past 35 years. More than one million households were inundated and over 5 million people were directly affected by flooding. Flood waters disrupted agricultural production, food markets, schools, health services, and damaged infrastructure. The Ministry of Agriculture estimates that 110,000 hectares of cropland were damaged, while 257 people lost their lives due to the floods (United Nations Resident Coordinator and Office 2020).

The trigger model is used by BDRCS to activate the anticipatory cash transfer protocol factors in multiple historical flood impact parameters. These variables are used to identify the areas that are likely to be most severely affected by the flooding: the observed discharge (cubic metre per second) measured at Bahaduarabad station in the Jamuna River, the duration of the water level remaining above the danger level (days), the number of homes fully or partly damaged (millions), and the number of people affected (millions). Based on these parameters, the impact-based forecast identified the unions eligible for the anticipatory action intervention (see map in Figure 1); a union is the smallest rural administrative and local government unit in

² Temporary river islands.

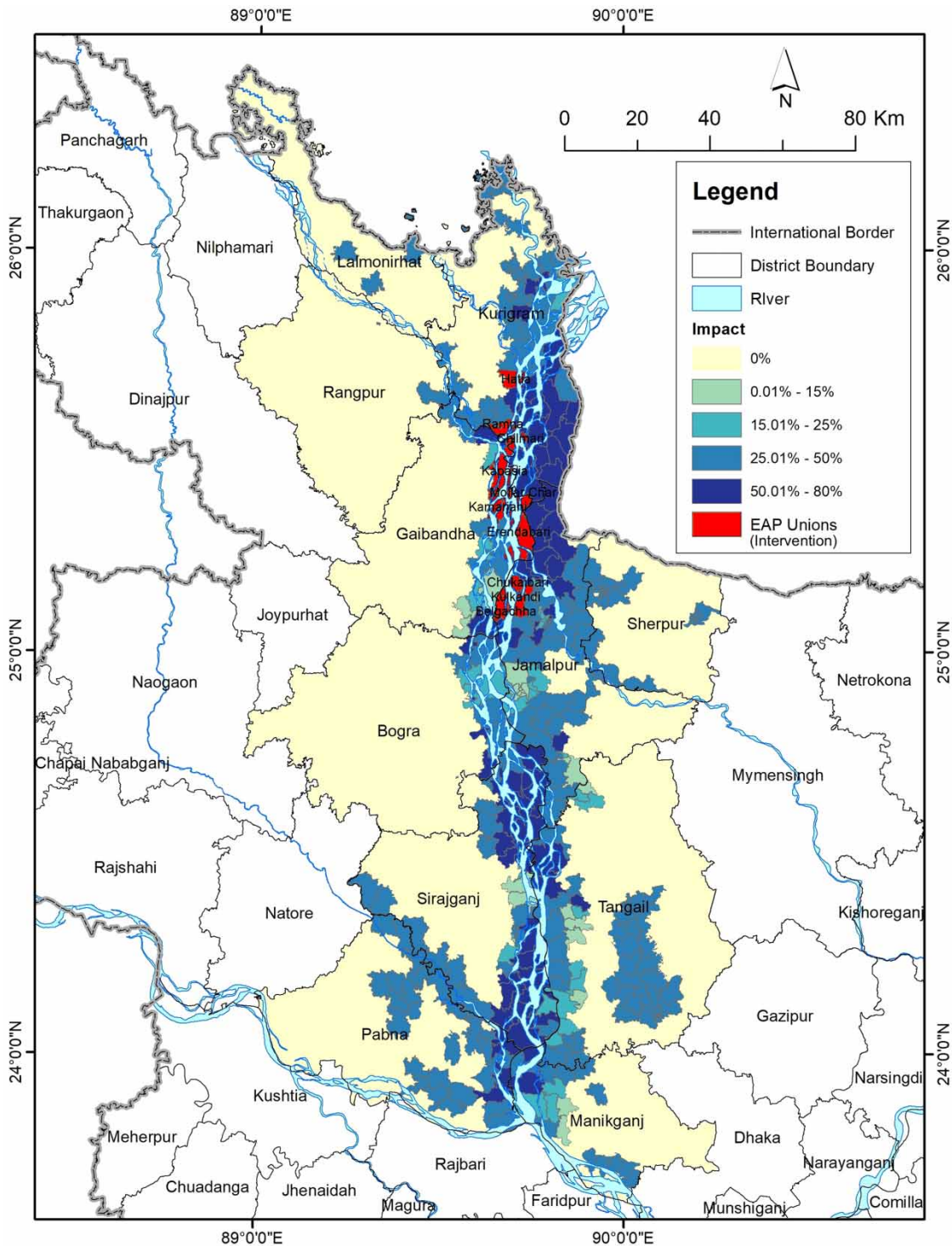


Figure 1 | Forecast flood exposure map indicating the anticipatory action intervention areas (Source: BDRCS).

Bangladesh. The impact forecast also correlates flood depth with damage to the housing structure and movable asset classes, such as furniture, cooking utensils, and livestock. This is based on a levelling survey of nearly 2,000 households along the river. The valuation of the estimated asset damages, depending on flood depth, is normalised to account for different asset classes and income groups. A forecast impact level of 0% as shown in Figure 1 means no damages to the household

assets will be incurred given the forecast flood depth in the respective area, while 100% corresponds to a likely total loss of assets included in the valuation. Since the impact-based forecast identified more eligible intervention areas than could be covered with available resources, BDRCS prioritised ten unions across three districts that were likely to be hit hardest for the anticipatory action activation.

At the household level, the eligibility to be included as beneficiaries in the anticipatory cash distribution was assessed based on a vulnerability score calculated for each household using five criteria: the quality of the housing structure; the level of inundation during previous floods; the number of household members who are children, elderly, or disabled; family structure (being female-headed, widowed, or divorced); and the primary livelihood strategy. Based on the vulnerability score and available resources, BDRCS transferred 4,500 BDT (about \$53) to 3,789 households in the ten unions across three districts along the Jamuna River.

This study is based on a random sample household survey among anticipatory cash transfer recipients and comparably vulnerable, flood-affected households not reached by the forecast-based assistance because of resource limitations. Comparison group households were identified using the same targeting criteria that were applied for identifying cash transfer beneficiaries. To ensure comparability of all households in the survey, only those within 1.5 standard deviations (SD) of the average vulnerability score across all screened households were considered for inclusion in the sample.³

BDRCS volunteers collected the data in January 2021⁴ in the area affected by the flood. In addition to questions assessing the flood impact and potential effects of the anticipatory action cash transfer, the survey gathered demographic, socio-economic, and geographical information from each respondent household to enable propensity score matching (PSM) for a balanced sample. The sampling was stratified by districts and unions where the anticipatory actions were implemented. The sample was distributed proportional to the size of the beneficiary group in each geographic area. The final sample comprised 444 observations, with 222 anticipatory cash transfer beneficiaries and 222 comparison households. Supplementary Table A1.1 in Appendix 1 describes the geographical distribution of the two groups by unions.

The main variables for the analysis were divided into confounding characteristics used for the matching method and outcome variables used for measuring the effect of the anticipatory actions on beneficiaries. The final dataset contains 444 observations on 187 variables. Supplementary Table A1.2 in Appendix 1 presents the main socio-economic, demographic, and geographical characteristics of the sample, while Supplementary Table A1.3 in Appendix 1 shows the main outcome variables used in the analysis to assess the effectiveness of the interventions.

METHODS

The study follows a quasi-experimental design, a widely used approach in the literature for the evaluation of development and humanitarian interventions and unconditional cash transfers to cope with climate hazards (Bastagli *et al.* 2019; Gros *et al.* 2019, 2022). Quasi-experimental methods simulate the randomisation of the intervention assignment and apply balancing methods between the two groups under study – the programme beneficiaries and the comparison group representing the counterfactual. With this empirical framework, any differences observed in the outcome variables can be attributed to the intervention. To this end, a matching method is used to associate observations in the intervention group (i.e., the households that received the anticipatory cash transfer) with similar observations in the comparison group, factoring in potentially confounding variables to reduce any bias due to structural differences between the two groups. Only households that are comparable in terms of demographic, socio-economic, and geographical characteristics are retained in the sample.

We employ a PSM approach, using the two nearest neighbours algorithm (2NN) for comparing the two groups (Angrist & Pischke 2009; Cerulli 2015). The use of PSM is a well-established, non-parametric technique often adopted in policy evaluations and econometric analysis (Card & Krueger 1993; Angrist & Pischke 2009; Imbens & Wooldridge 2009). It does not rely on any prior distributional assumptions and allows for the identification and correction of the selection process and imbalances in the data, thereby ascertaining the comparability between the two groups (Baser 2006; Cerulli 2015). We use PSM to select subsamples of beneficiaries and non-beneficiaries for comparison according to their background characteristics

³ The average total vulnerability score across all households was 83.5, the SD was 7.93.

⁴ The survey started on the 29th of January and ended on the 6th of February 2021.

(e.g., socio-economic, geographical, or demographic variables).⁵ We then calculate the area of common support and the main differences in each variable of interest. In this way, the final difference between the two groups for each target variable can be considered as the average treatment effect on the treated (ATT). In this study, the ATT represents the effect of the anticipatory cash transfer on the beneficiaries.

The PSM balancing method was successful. No statistically significant differences in the confounding variables of the two groups were found after the creation of the area of common support (see Supplementary Table A2.2 and Figure A2.1 in Appendix 2). This is also evident considering the kernel density before and after the matching; Figure 2 shows an improvement in the overlap of the area of common support for the two groups. The propensity scores (the likelihood to receive the anticipatory action cash transfer) are balanced. Further information on the PSM method is provided in Supplementary Appendix 2, where the overlap graphs and statistical balancing tests are also shown (see Supplementary Tables A2.1 and A2.2 and Figures A2.1–A2.3 in Appendix 2).

RESULTS AND DISCUSSION

The main findings of the study are reported in Table 1 which shows only statistically significant results related to the key outcome variables of interest. The data indicate that anticipatory financial assistance played an important role in helping households mitigate the flood impacts and recovering in the aftermath of the event. We discuss each finding in detail in the following sections.

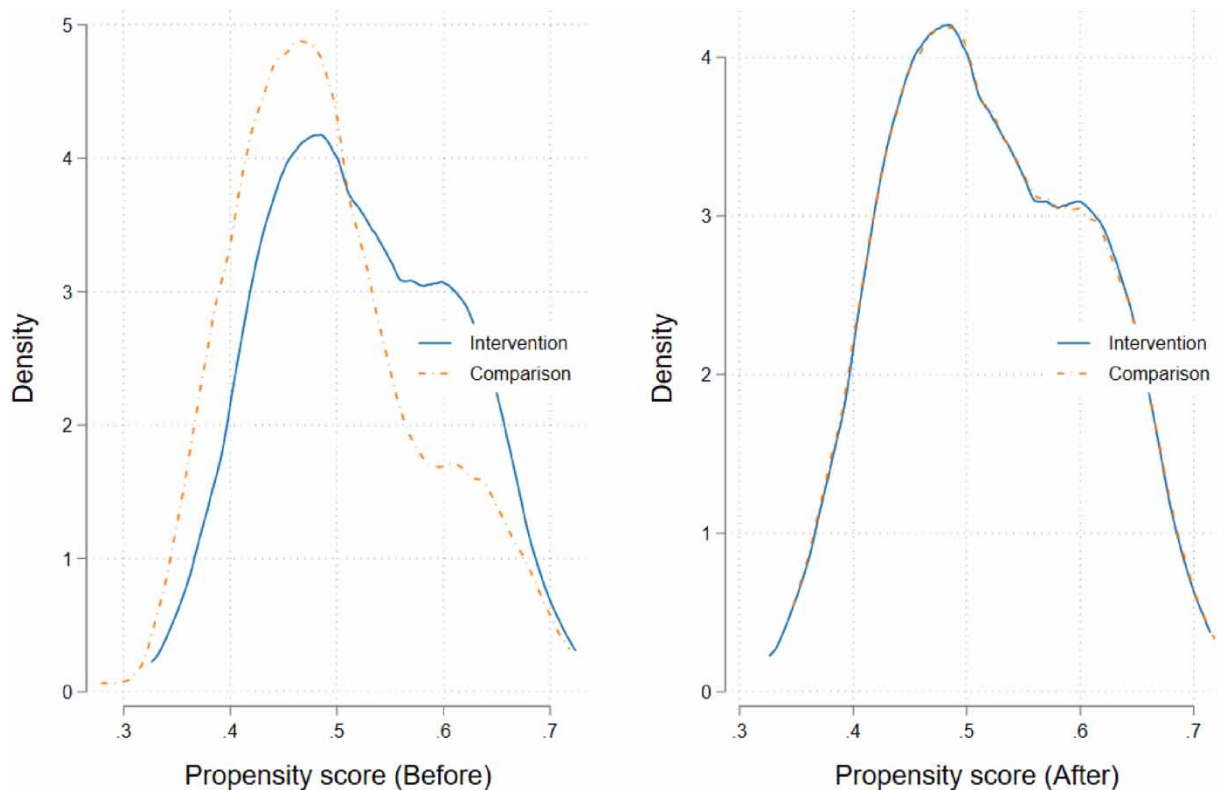


Figure 2 | PSM before matching and after matching.

⁵ The confounding variables used for matching the two groups in the area of common support, which approximates all the distinctive characteristics of the two groups, were: district Upazila (the administrative division below the district); severity of the flood at the household location as reported by the survey respondent on a scale from 1 to 5 according to the height of the water line in relation to the housing structure; the age of the household head; being a female-headed household (dummy variable); the number of household members; the number of children in the household; no primary education of the respondent (dummy); income level of the previous month; food expenditure during the previous week; and whether the household is engaged in agricultural activities (dummy).

Table 1 | Summary of main findings on the effects of anticipatory cash assistance

Variable	Unit	Intervention	Comparison	ATT	SE	T-stat	Sign	N
Preparatory action taken (evacuated adult)	Dummy	0.27	0.11	0.16	0.05	3.00	***	322
Borrowed money	Dummy	0.44	0.56	-0.11	0.06	-1.99	**	414
Subjective well-being	Scales 1–5	3.60	2.30	1.30	0.13	9.91	***	414
Animal mortality: Cows and calves	% animals dead	0.09	0.22	-0.13	0.05	-2.46	**	179
Animal mortality: Chickens and pigeons	% animals dead	0.50	0.60	-0.11	0.06	-1.68	*	197
Working equipment damaged	Dummy	0.51	0.72	-0.21	0.09	-2.17	**	145
Destitution sales of valuable assets (House items, e.g., bed, furniture)	Dummy	0.00	0.12	-0.12	0.07	-1.63	*	98
Health issues after flood ('other' category, e.g., cough, skin rash)	Dummy	0.73	0.84	-0.11	0.05	-2.24	**	339

Note: The effect of the intervention is shown in column 5 (ATT) where the average treatment effect on the treated is shown. It measures the impact of the intervention as the average difference between the intervention and comparison group for each variable. In column 7 (T-stat), the t-statistics and in column 8 (Sign), the significance level (* 90%, ** 95%, ***99%) are shown, respectively; column 9 (N) shows the number of observations used for the analysis of each variable.

Use of the anticipatory cash transfer and preparatory actions taken

We first look at how the anticipatory cash transfer was used by the beneficiary households (see Supplementary Table A1.4 and Figure A1.1 in Appendix 1). Cash recipients spent the money principally on food: 91% of the respondents reported to have spent at least some of the funds received on foodstuff. Other relevant expenditure categories are purchasing of new livestock (34% of respondents), evacuation (24%), health expenses (29%), and reinforcing the housing structure in preparation for the flood (19%).⁶ These cash grant expenditure patterns are similar to the findings of previous anticipatory cash transfer assessments in Bangladesh (Gros *et al.* 2019; Pople *et al.* 2021).

Importantly, the data suggest that the unconditional cash transfer before the flood successfully enabled beneficiary households to evacuate the flood-affected area where needed: an average of 87% of the survey respondents reported to have received an early warning ahead of the flood, with no significant differences between the two groups. Early warning is a government service, typically disseminated via community radio, phone or disaster committees 3 days before water levels are forecast to cross the danger threshold. It is not impact-based or location-specific but includes a general alert that flood waters are rising. After having received an early warning, 27% of anticipatory cash recipients reported that they evacuated adults vs. only 11% of the non-beneficiaries; the difference is statistically highly significant at the 99% level (see Figure 3). This suggests that having the extra means afforded by the anticipatory cash transfer allowed beneficiaries to bring vulnerable family members to safety, often the elderly or sick, while children are always prioritised for evacuation. It is not surprising that evacuation rates are not higher. Leaving homes and property unattended is a last resort measure because of the perceived risks of destruction and looting.

Impacts on household assets

The analysis indicates that anticipatory action beneficiaries were better able to protect their productive assets from the flood than the comparison group, thanks to the unconditional cash grant provided by BDRCS. Specifically, 72% of comparison households lost their working equipment (such as agricultural tools and fishing equipment) or found it damaged by the flood, vs. only 51% of anticipatory action beneficiaries experiencing such losses – a difference of 21 percentage points. The study did not detect statistically significant differences between the two groups for other asset categories, especially household possessions (e.g., beds, furniture, cooking stoves, and kitchen items). This may suggest that the anticipatory action was effective in enabling households to prepare and protect their valuable assets, especially those needed for economic production and working activities. This is typically done by using the additional cash resources to construct elevated

⁶ Total values can be higher than 100% as multiple answers were allowed. The question was related if some amount of money was spent for each category of expenditure items. The total number of respondents for this question was 222 (only Intervention group), see Table A1.4 in Appendix.

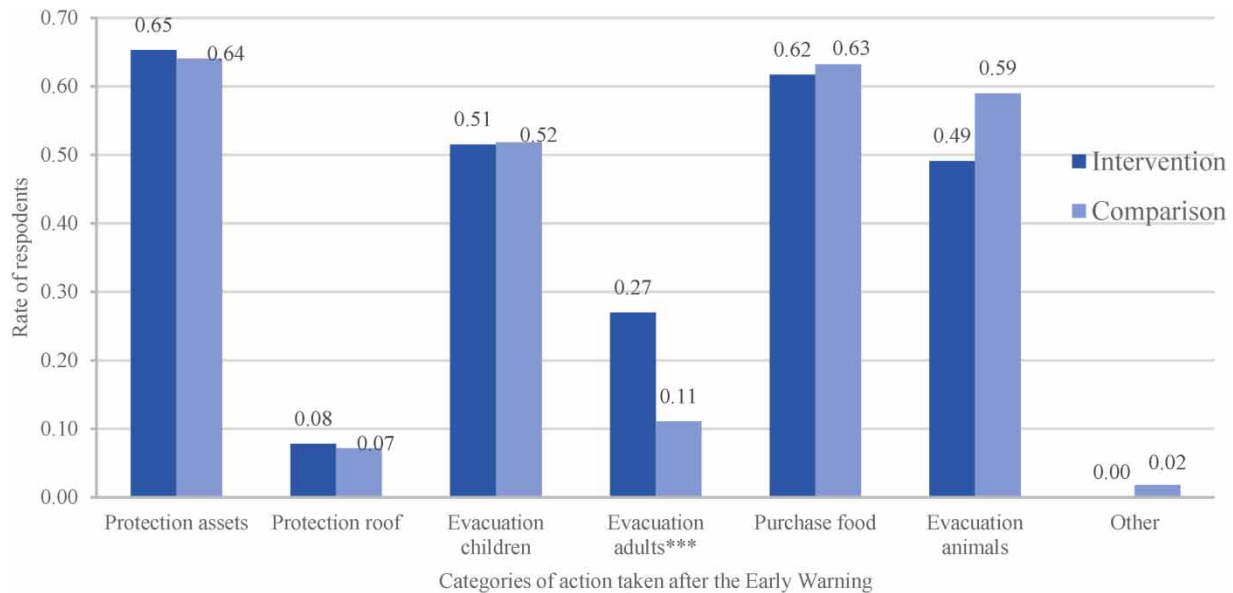


Figure 3 | Comparison of preparatory actions taken after receiving an early warning, by group. *Note:* Asterisks indicate statistical significance. Levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

platforms or rafts to keep assets dry during the flood period, or to pay for boat transport to ferry property to safety. Results are shown in Figure 4.

Livestock and agricultural impacts

The anticipatory action intervention was effective in helping households protect their livestock, with cash that can be used to construct floats or hire boats to take the animals out of the flooded area. A total of 42% of surveyed households reported to

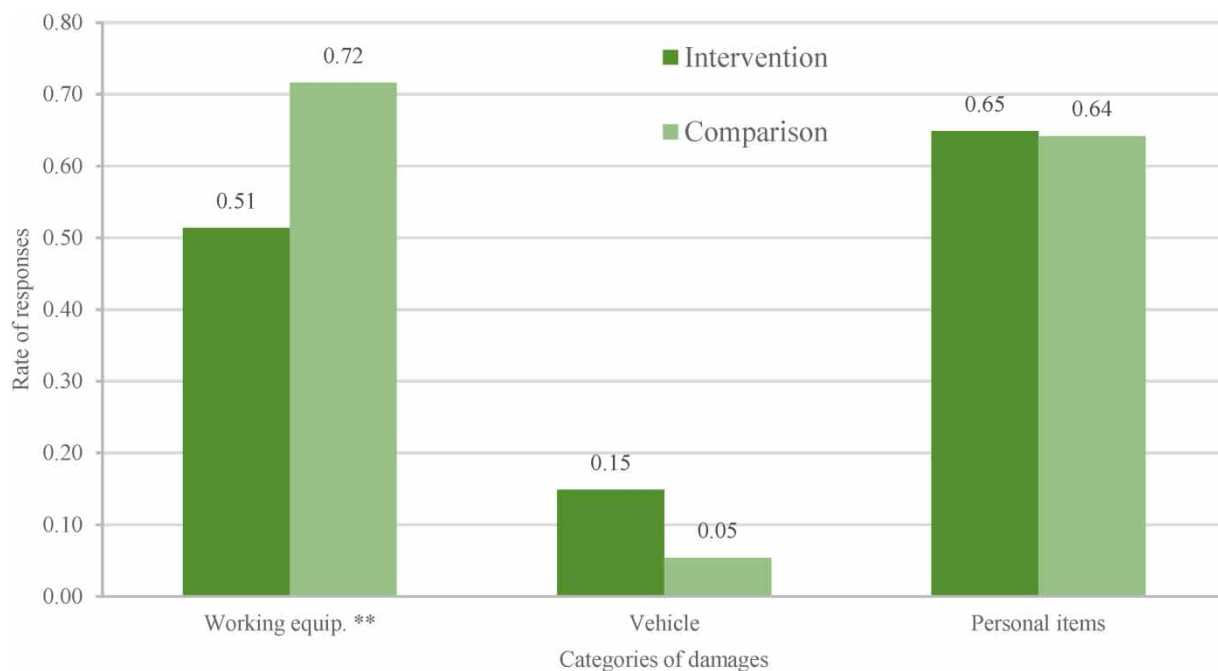


Figure 4 | Comparison of asset losses between groups (ATT). *Note:* Asterisks indicate statistical significance. Levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$, see Supplementary Table A1.7 in Appendix 1 for details.

have at least one cow or calf before the floods. It is important to note that ownership of cows or calves among the highly vulnerable, poor, and landless households that were targeted by the anticipatory cash transfer is unlikely. Instead, most who reported taking care of this very valuable type of animal will have done so on behalf of more affluent families. Nevertheless, losing someone else's expensive cow in the flood can have significant negative repercussions for the household that is deemed responsible for the loss. Anticipatory action beneficiaries reported to have lost only 9% of their cows and calves (calculated as the number of dead animals over the total number of animals owned before the flood event occurred), while the households in the comparison group reported an animal mortality rate of 22%, a statistically significant difference at the 95% level (Figure 5).

A similar benefit of anticipatory cash assistance was detected for smaller livestock, particularly the popular category of chickens and pigeons that are owned by many poor households. 46% of survey respondents indicated to have had at least one chicken or pigeon before the flood. Among them, the anticipatory action beneficiaries reported to have lost 50% of their small fowl, while households in the comparison group experienced a mortality rate of 60%, a statistically significant difference at the 90% level. There were no statistically significant differences in the mortality rates of other types of livestock (sheep and goats, ducks). Regarding potential agricultural impacts, we did not find any significant differences in terms of crop or food stock losses between the two groups.

Impacts on health and psychological well-being

Despite an overall high incidence of health issues that were experienced because of the flood, the survey results indicate that the anticipatory cash transfer succeeded in helping beneficiaries protect their well-being better vis-a-vis the counterfactual of non-beneficiaries. In particular, 73% of beneficiaries reported to have experienced various health issues (such as coughing, skin rash, and fever) after and because of the flood, vs. 83% of comparison households, a statistically significant difference at the 95% level. A review of the data on more severe health impacts, for example, diarrhoea, dysentery, and physical injuries (e.g., broken bones), did not reveal statistically significant differences (Figure 6).

Regarding psychological well-being in the aftermath of the flood, the unconditional anticipatory cash grant appears to have helped beneficiaries cope better with the impacts than non-beneficiaries: On a scale for assessing subjective well-being from 1 (very bad) to 5 (very well), beneficiaries reported an average status of 3.6 vs. 2.3 among the comparison group, with a statistically significant difference at the 99% level (Figure 7).

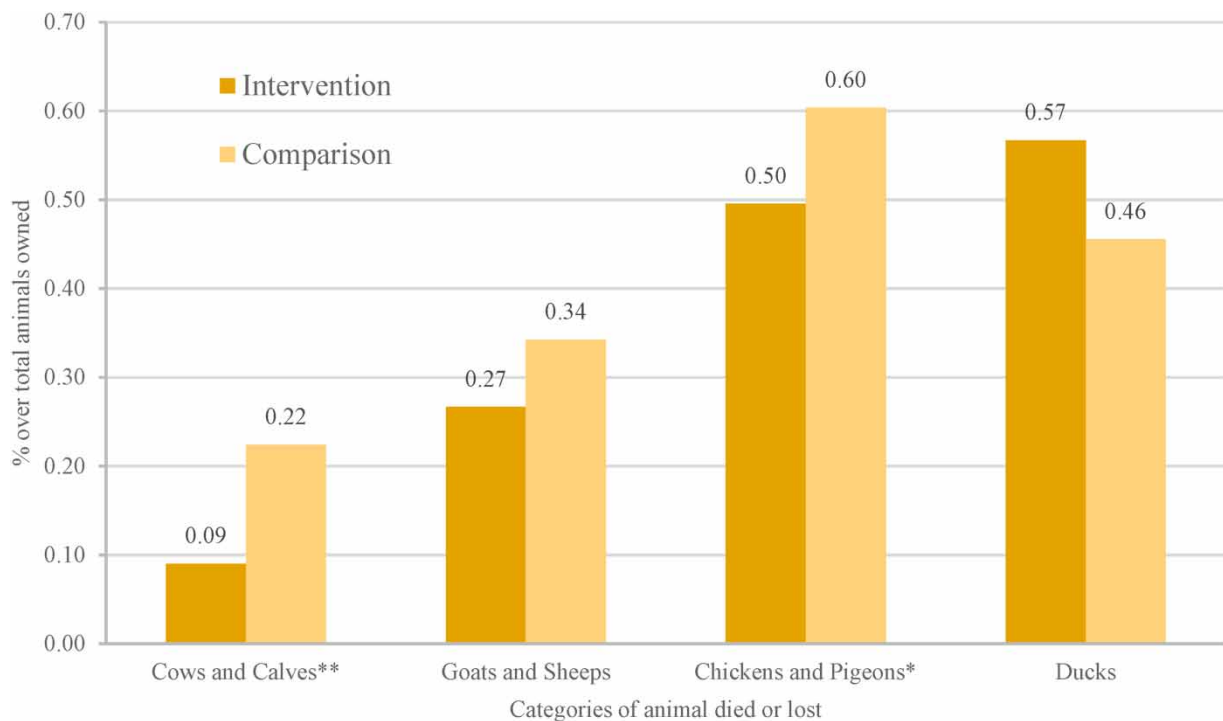


Figure 5 | Comparison of animal mortality rate between groups, by type of livestock. *Note:* Asterisks indicate statistical significance. Levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. See Supplementary Table A1.5 in Appendix 1 for details.

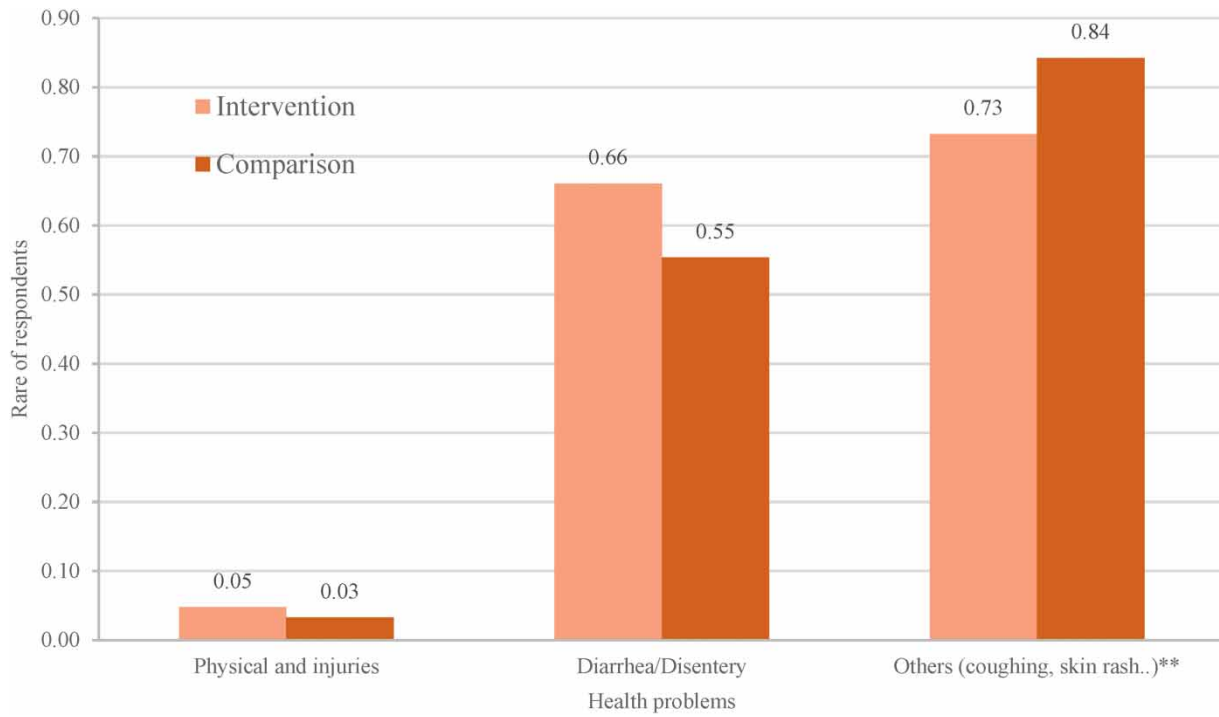


Figure 6 | Comparison of health impacts by group. Note: Asterisks indicate statistical significance. Levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. See Table A1.8 in Appendix for details.

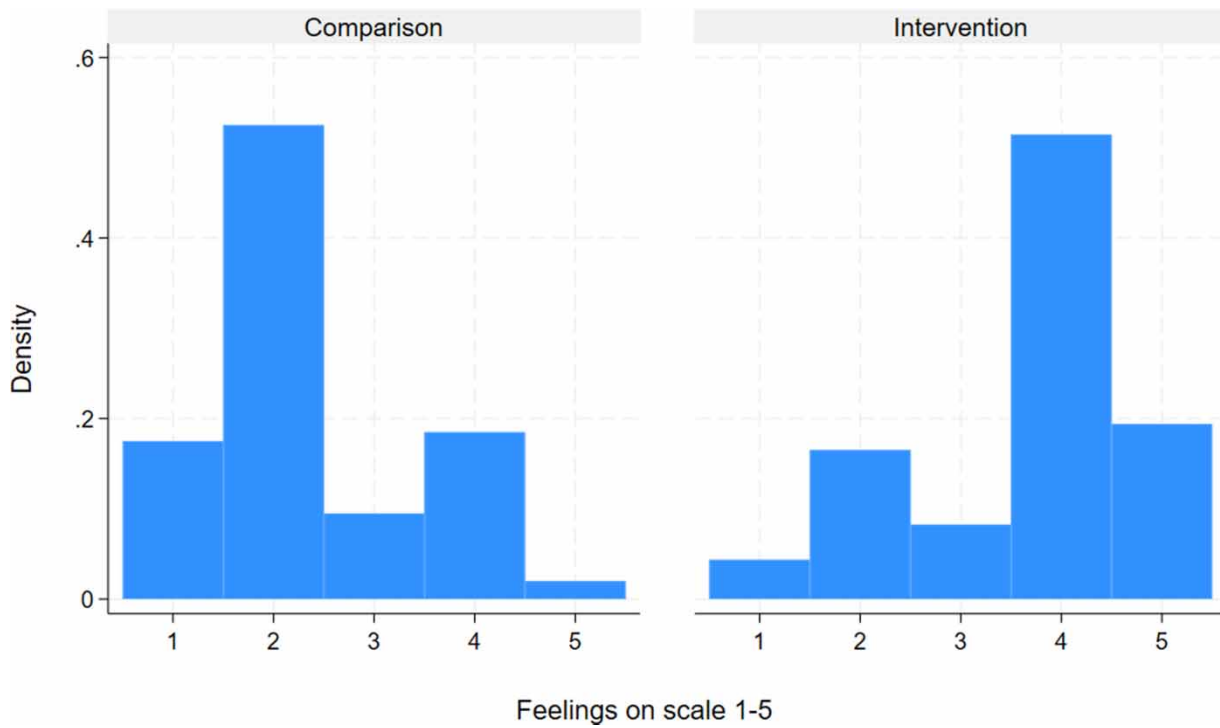


Figure 7 | Comparison of subjective psychological well-being by group (personal feelings rated on a scale of 1–5: 0 Don't know, 1 Very unsatisfied, 2 Unsatisfied, 3 Neutral, 4 Satisfied, 5 Very satisfied).

Impact on productive activities

The analysis indicates that the forecast-based cash transfer intervention was not effective in reducing the impact of the flood on the earning potential of beneficiaries. In fact, 97% of beneficiaries reported that they, or another adult member of their household, were unable to work for a period of time because of the flood, compared to only 86% of comparison households. One possible explanation is that the anticipatory cash assistance enabled households to spend time repairing their house, taking care of family members, or recovering assets damaged by the flood, while non-beneficiaries had no choice but to go back to their working activities because of financial constraints. There was no statistically significant difference in the number of days that households were unable to work, reported at an average of 46 days per household across both groups (Figure 8). In future evaluations of anticipatory cash transfer assistance, the reasons behind the reported inability to work should be explored further.

Coping strategies and recovery after the flood event

The results of this quasi-experimental assessment suggest that the intervention was effective in helping beneficiaries avoid negative coping strategies: The analysis shows a lower incidence of high-interest debt accrual among anticipatory cash recipients than among comparison households, indicating that they did not need to borrow money to cope with the impacts of the flood. Still, 44% of beneficiaries reported that they had to borrow money to cope with the flood impacts, while 56% of the comparison group declared the same, with a statistically significant difference at the 95% level. This result demonstrates that the anticipatory action helped households in their financial recovery, thus reducing the risk of over-indebtedness. Among the households who did borrow money (Figure 9), the analysis detected no statistically significant differences in either the amount of money borrowed (beneficiary mean: 10,462 BDT, median: 5,500 BDT; comparison group mean: 13,031 BDT, median: 7,000 BDT) or the interest rates of borrowing (beneficiary group mean: 6.32%, median: 5%; comparison group mean: 5.70%, median: 6%).

The anticipatory cash assistance also enabled beneficiaries to completely avoid having to sell household assets (such as beds, furniture, cooking stoves, and kitchen items) to cope with the impact of the flood, while 12% of the comparison group had to adopt that strategy to cope with difficult economic conditions in the aftermath of the shock (statistically significant at the 95% level). Other statistically significant differences related to selling other asset categories (land, livestock,

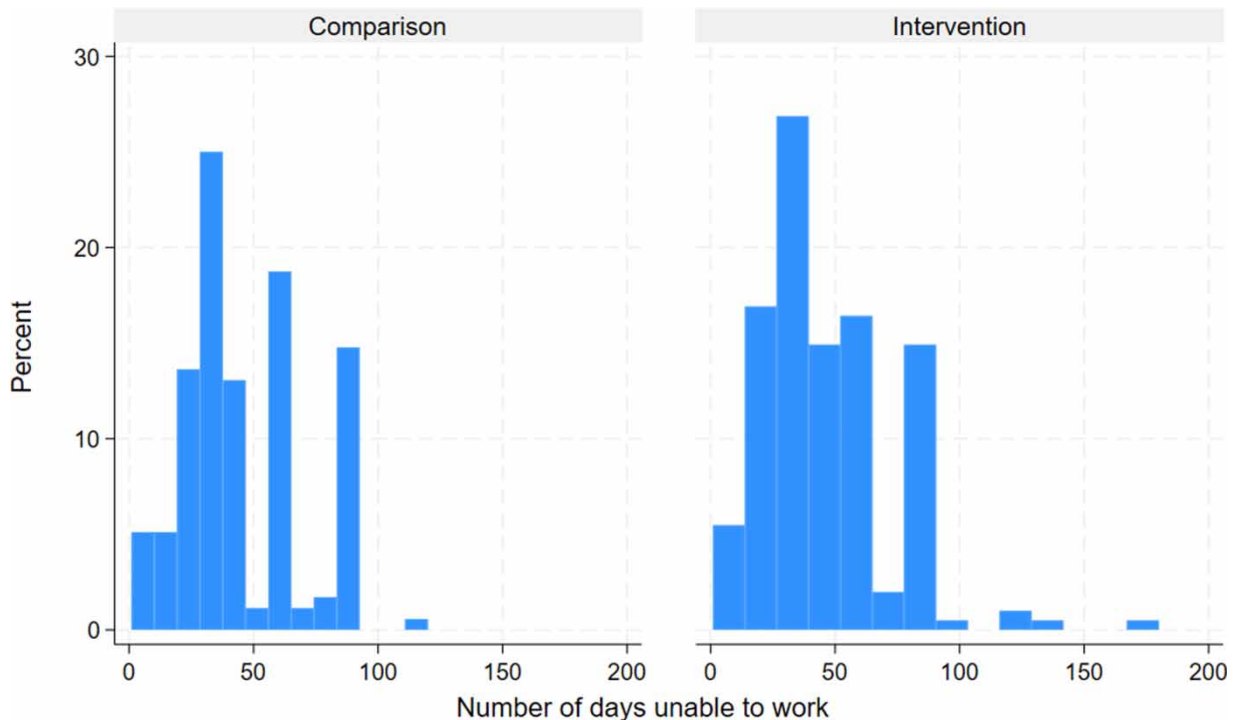


Figure 8 | Comparison of the duration of being unable to work because of the flood, by group. *Note:* No statistically significant difference in the number of days being unable to work, only in the dummy variable indicating if any adult household member was unable to work in the aftermath of the flood.

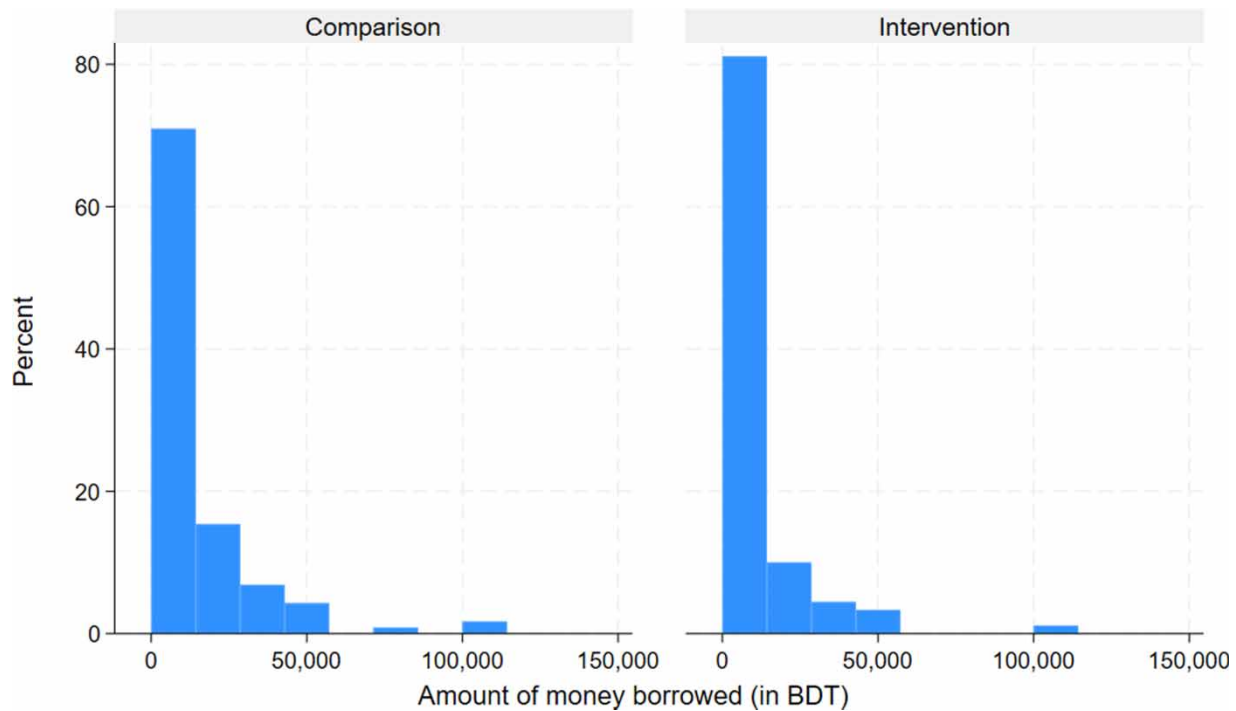


Figure 9 | Comparison of the amount of money borrowed by group (no statistically significant differences).

working equipment, or personal items) were not detected. Results are shown in [Figure 10](#), while data are available in Supplementary Table A1.6 in Appendix 1.

Food-based coping strategies, such as reducing the number, frequency, or nutritional content of meals, did not show any statistically significant differences between beneficiary and non-beneficiary households. The average reduced coping strategy index (rCSI) (Maxwell & Caldwell 2008) score was 26.4 among beneficiaries and 25.4 among comparison households, on an

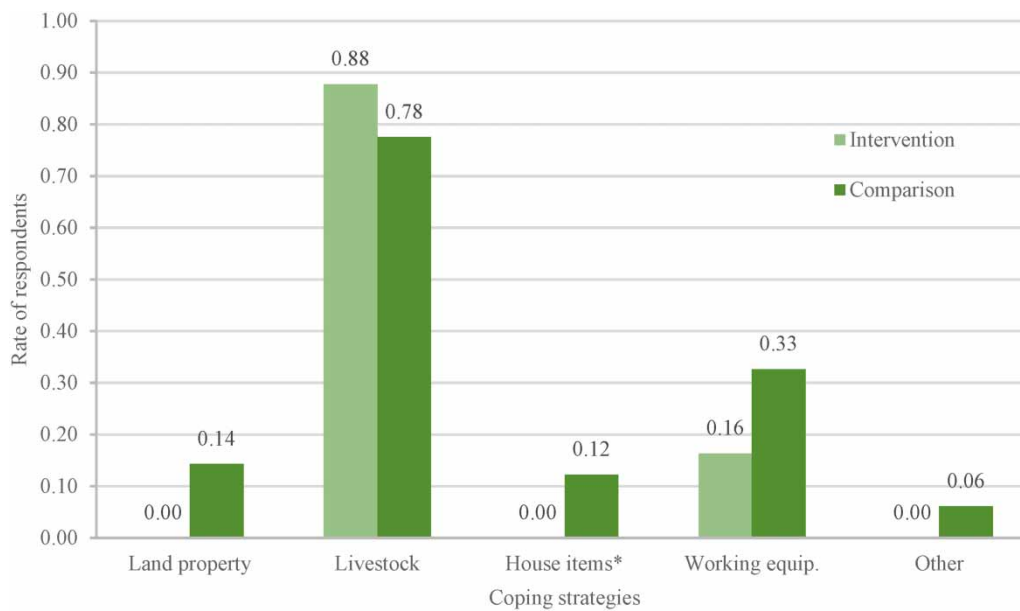


Figure 10 | Comparison of types of assets sold in the aftermath of the flood, by group. Note: Asterisks indicate statistical significance. Levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

index scale ranging from 0 to 56 (Supplementary Figure A.1.2 in Appendix 1). This is even though 91% of cash beneficiaries spent at least some of the transfer on food. While this raises questions about the effectiveness of anticipatory cash to avoid food-based coping strategies, the rCSI is a relatively crude measure that does not capture dietary quality. This could have been measured with a more granular metric, such as the food consumption score (FCS), which we propose to use in future research.

CONCLUSIONS

Our paper presents the results of a quasi-experimental evaluation of the effectiveness of an unconditional cash transfer to vulnerable households that were about to experience severe flooding in Bangladesh. We found robust statistical evidence to conclude that the anticipatory humanitarian intervention was effective in achieving its main objectives of helping households evacuate the flood-affected area effectively, reducing the flood impacts on personal health and well-being, and protecting their productive assets and livestock. The forecast-based cash transfer before the flood event was also effective in enabling beneficiaries to avoid negative coping strategies, such as taking on high-interest loans and selling valuable assets.

We did not find evidence of the effectiveness of the intervention in helping cash recipients avoid food-based coping mechanisms. Reducing the number or nutritional content of meals can have adverse effects on the health of household members, particularly women and children. We also did not detect significant effects of the intervention on the earning potential of beneficiary households after the flood. This is consistent with the earlier evaluation from Bangladesh (Gros *et al.* 2019) whereby intervention and comparison households were equally unable to go back to work for an extended period after the flood shock. A more recent evaluation of an anticipatory cash transfer of equal size in Bangladesh, albeit for a larger group of beneficiaries and drawing on a larger sample size, found that the intervention had a positive effect on the number of paid hours of work per adult over the previous week (Pople *et al.* 2021). While our metric – the number of days having been unable to go back to work after the flood – captures the immediate impact of the flood on the household's productive capacity in the aftermath of the flood, it is more likely to be subject to recall bias. Asking the respondent to remember the number of paid hours worked during the previous week is more likely to receive an accurate response, although this is a somewhat different measurement concept.

This analysis has confirmed the positive effects of providing unconditional cash assistance to vulnerable households in anticipation of severe weather events. This is particularly relevant given that cash transfers have been widely adopted as a fungible assistance modality in anticipatory action interventions (UNOCHA 2021; Asia-Pacific TWG on AA 2022; Anticipation Hub 2023). Further research is required to better understand the effect of forecast-based cash transfers on households' productive and recovery capacity in the aftermath of the flood.

AUTHOR ATTRIBUTION STATEMENT

C.G. designed the quasi-experimental study, developed the sampling frame, and guided data collection and analysis; he also led the write-up of findings. A.P. conducted the quantitative data analysis, prepared the results, tables, and charts, and contributed to the write-up. K.S., A.H., and M.S. led the study team in Bangladesh, oversaw the data collection and advised on the analysis.

DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

CONFLICT OF INTEREST

The authors declare there is no conflict.

REFERENCES

- Angrist, J. D. & Pischke, J. S. 2009 *Mostly Harmless Econometrics. An Empiricist's Companion*. Princeton University Press, USA.
- Anticipation Hub 2022 *Anticipation Hub Website* [WWW Document]. Available from: <https://www.anticipation-hub.org/>.
- Anticipation Hub 2023 *Anticipatory Action in 2022: A Global Overview*.
- Asia-Pacific TWG on AA 2022 *Asia-Pacific Technical Working Group on Anticipatory Action and Asia-Pacific Regional Cash Working Group (2022). Anticipatory Action and Cash Transfers for Rapid-Onset Hazards: Practitioners' Note for Field Testing*. Bangkok.

- Bailey, S. & Harvey, P. 2015 *State of Evidence on Humanitarian Cash Transfers: Background Note for the High Level Panel on Humanitarian Cash Transfers*. Overseas Development Institute.
- Baser, O. 2006 Too much ado about propensity score models? Comparing methods of propensity score matching. *Value Health* **9**, 377–385. <https://doi.org/10.1111/j.1524-4733.2006.00130.x>.
- Bastagli, F., Hagen-zanker, J., Harman, L., Barca, V., Sturge, G., Schmidt, T. & Pellerano, L. 2016 *Cash Transfers: What Does the Evidence Say? A Rigorous Review of Programme Impact and of the Role of Design and Implementation Features*. Overseas Development Institute, London.
- Bastagli, F., Hagen-Zanker, J., Harman, L., Barca, V., Sturge, G. & Schmidt, T. 2019 The impact of cash transfers: A review of the evidence from low- and middle-income countries. *J. Soc. Policy* **48**, 569–594. <https://doi.org/10.1017/S0047279418000715>.
- Card, D. & Krueger, A. 1993 *Minimum Wages and Employment: A Case Study of the Fast Food Industry in New Jersey and Pennsylvania (No. w4509)*. National Bureau of Economic Research, Cambridge, MA. <https://doi.org/10.3386/w4509>.
- Cerulli, G. 2015 *Econometric Evaluation of Socio-Economic Programs, Advanced Studies in Theoretical and Applied Econometrics*. Springer Berlin Heidelberg, Berlin, Heidelberg. <https://doi.org/10.1007/978-3-662-46405-2>.
- Coughlan de Perez, E., van den Hurk, B., van Aalst, M. K., Jongman, B., Klose, T. & Suarez, P. 2015 Forecast-based financing: An approach for catalyzing humanitarian action based on extreme weather and climate forecasts. *Nat. Hazards Earth Syst. Sci.* **15**, 895–904. <https://doi.org/10.5194/nhess-15-895-2015>.
- Gros, C., Bailey, M., Schwager, S., Hassan, A., Zingg, R., Uddin, M. M., Shahjahan, M., Islam, H., Lux, S., Jaime, C. & Coughlan de Perez, E. 2019 Household-level effects of providing forecast-based cash in anticipation of extreme weather events: Quasi-experimental evidence from humanitarian interventions in the 2017 floods in Bangladesh. *Int. J. Disaster Risk Reduct.* **41**, 101275. <https://doi.org/10.1016/j.ijdrr.2019.101275>.
- Gros, C., Easton-Calabria, E., Bailey, M., Dagys, K., de Perez, E. C., Sharavnyambuu, M. & Kruczkiewicz, A. 2022 The effectiveness of forecast-based humanitarian assistance in anticipation of extreme winters: A case study of vulnerable herders in Mongolia. *Disasters* **46**, 95–118. <https://doi.org/10.1111/disa.12467>.
- Hill, R. & Genoni, M. E. 2019 *Bangladesh Poverty Assessment: Facing Old and New Frontiers in Poverty Reduction*. World Bank Group, Washington, DC.
- Imbens, G. W. & Wooldridge, J. M. 2009 Recent developments in the econometrics of program evaluation. *J. Econ. Lit.* **47**, 5–86. <https://doi.org/10.1257/jel.47.1.5>.
- Maxwell, D. & Caldwell, R. 2008 *The Coping Strategies Index: A Tool for Rapid Measurement of Household Food Security and the Impact of Food Aid Programs in Humanitarian Emergencies, Field Methods Manual*, 2nd edn. Cooperative for Assistance and Relief Everywhere, Inc. (CARE), Atlanta, GA.
- Pople, A., Hill, R. V., Dercon, S. & Brunckhorst, B. 2021 *Anticipatory Cash Transfers in Climate Disaster Response (Working Paper 6)*. Centre for Disaster Protection, London.
- United Nations Resident Coordinator, Office 2020 *HCTT Monsoon Flood Humanitarian Response Plan: Monitoring Dashboard, Humanitarian Coordination Task Team*.
- UNOCHA 2021 *CERF Anticipatory Action*. OCHA, New York.
- Weingärtner, L., Pffor, T. & Wilkinson, E. 2020 *The Evidence Base on Anticipatory Action*. World Food Programme.

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