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Food insecurity and COVID-19 risk in low- and middle-income countries

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Abstract

The COVID-19 pandemic prompted social distancing, workplace closures, and restrictions on mobility and trade that had cascading effects on economic activity, food prices, and employment in low- and middle-income countries. Using longitudinal data from Bangladesh, Kenya, and Nigeria covering a period from October 2020 to April 2021, the paper assesses whether knowledge of a person infected with COVID-19 is associated with food insecurity, job loss and business closures, and coping strategies to smooth consumption. The likelihood of households to experience food insecurity at the extensive and intensive margins increased among those who knew an infected person in Bangladesh and Kenya.

KEYWORDS
COVID-19, food insecurity, low- and middle-income countries

JEL CLASSIFICATION
O15, Q18

At the early stage of the COVID-19 pandemic, international policy responses prompted economic precarity in low- and middle-income countries (LMICs) (Egger et al., 2022, 2021b; Mobarak & Barnett-Howell, 2020; Mueller et al., 2021). Social distancing, workplace closures, and restrictions on mobility and trade had cascading effects on economic activity, food prices, and employment globally. Since the onset of the COVID-19 (the coronavirus disease of 2019) pandemic, there have been several attempts to quantify its effects on food insecurity in LMICs. Thus far, studies show an overall decrease in the quality and quantity of foods consumed.

Although personal savings and borrowing can protect the liquidity-constrained, adjusting diet and consumption remains a primary strategy for individuals to cope with the pandemic's disruption of food access, exposure to food price inflation, and income loss.

We take advantage of longitudinal data collected in Bangladesh, Kenya, and Nigeria (October–December 2020 and April 2021) to shed light on whether the food insecurity of households persisted. A strength of using our dataset to measure COVID-19 effects is that we collected panel information about the food insecurity, employment, and vulnerability to shocks from male and female respondents at a later stage in the pandemic. We also collected information on the perceived exposure to COVID-19 through one's own network to capture whether personal risk positively correlates with food insecurity. Whether an individual knows someone personally infected with coronavirus is likely representative of a suite of factors, which would affect earning potential, such as the perceived risk of transmission, subsequent enforcement of subnational policies to mitigate local objective risk, as well as a weakening of social structures that typically facilitate risk sharing.

We apply a linear regression model to estimate whether food insecurity is positively correlated with the perceived presence of COVID-19 in personal networks. Our findings suggest that households with elevated COVID-19 risk were more likely to report not having enough financial resources to buy food in the last 7 days in Bangladesh. Perceptions in COVID-19 risk-affected households at the intensive margin in Kenya: conditional on not having enough resources to purchase food, men and women who knew someone that was personally infected with COVID-19 were more likely in households that experienced greater increases in a composite index of food insecurity. They also had a greater likelihood of experiencing extreme food insecurity according to the index.

To provide greater clarity on the potential source of food insecurity, we assess how employment shocks and constraints on coping correspond with risk. These effects on the intensity of food insecurity experienced by households coincided with a higher likelihood to report experiencing a business closure in Kenya. While households appeared to adopt a variety of coping strategies, Kenyans more often reported reducing their food consumption when exposed to COVID-19 risk through their own networks, which suggests fewer alternatives may have been available to buffer against the economic shock.

In what follows, we first review through what channels the pandemic is believed to contribute to food insecurity in LMICs (Section 2). We then describe the details of the dataset and describe the outcomes and explanatory variables used in the analysis (Section 3). In Section 4, we describe our empirical strategy for detecting correlations between perceived COVID-19 risk and food insecurity and understanding the channels underlying the observed relationships. The main findings are synthesized in Section 5, followed by a discussion of the broader implications for future research.

COVID-19 AND FOOD INSECURITY

National and sub-national policy responses to the pandemic can exacerbate access to food through their impact on price volatility. For example, restrictions on internal and international trade in Ethiopia rendered the retail prices of some fruit and vegetables more volatile than usual (Hirvonen, 2020; Hirvonen et al., 2020b). Reductions in freight services and restrictions on inter-state transportation hit long-distance food supply chains the hardest in India, by compromising the availability of perishable goods (Mahajan & Tomar, 2020). Households that depend on markets to purchase foods are often more severely impacted (Aggarwal et al., 2020; Amare et al., 2020; Ceballos et al., 2020; Egger et al., 2022, 2021b; Kansiime et al., 2021; World Food Program, 2020).

COVID-19 policies affect food insecurity through their effect on household livelihoods as well. Lockdowns and mobility restrictions are often imposed by the state in high population-density areas, where the threat of transmission is the greatest. This further jeopardizes employment opportunities, wages, and disposable income (Abay et al., 2020; Amare et al., 2020; Lynda et al., 2020). Cash transfer programs, such as those in South Africa, Zimbabwe, and Ethiopia, have served to alleviate constraints on consumption, particularly among those residing in rural and remote areas (Abay et al., 2020; Aggarwal et al., 2020; Arndt et al., 2020; Kesar et al., 2021; World Bank and Zimbabwe National Statistics Agency, 2020). However, failure to deliver the full amount of rations allocated to recipients and other shortcomings raise concerns over how effectively these programs can continue to function under the immense strain of COVID-19 (Saxena et al., 2020).

Vulnerability to food insecurity is also contingent on demographic and geographic factors. The dominant narrative declares urban households suffer the greatest losses from the disruption of food systems given their reliance on food purchases (Adjognon et al., 2020; Aggarwal et al., 2020; Egger et al., 2022, 2021b; Heady et al., 2020; Hirvonen et al., 2020a; Kesar et al., 2021; Mahmud & Riley, 2021). In addition, workers in specific occupations may face constraints on their own purchasing power as pandemic policies restrict firm operations and the demand for nontradeable goods and services declines during a local recession. Employment opportunities have diminished in sectors, which require personal, face-to-face interactions, such as those in manufacturing, service, construction, and small, nonfarm business (Amare et al., 2020; Kesar et al., 2021). Effects are more pronounced for unskilled workers, who typically engage in the informal sector and likely given the short-term nature of their wage contracts (Amare et al., 2020; Jassens et al., 2021; Kansiime et al., 2021; Kesar et al., 2021; Mahmud & Riley, 2021; World Food Program, 2020). Unskilled workers also possess attributes, which can interfere with the job search, such as having a higher dependency ratio, lower educational attainment, and a lack of financial capital (Abate et al., 2020; Amare et al., 2020; Arndt et al., 2020; Balana et al., 2020; Elsahoryi et al., 2020; Hirvonen, 2020; Josephson et al., 2020; Kundu et al., 2020; World Food Program, 2020; Ibukun et al. 2021; Kansiime et al., 2021; Lynda et al., 2020; Mahmud & Riley, 2021; Pakravan-Charvadeh et al., 2021).

Our main objective is to evaluate the extent vulnerabilities in food access and income were widespread within countries, and whether they continued to persist a year after the inception of the pandemic. As the number of COVID cases increased over time, constraints on income may have been added as household members contract the virus and their labor productivity dwindle. On the other hand, many initial measures to protect populations from transmission were relaxed over time potentially augmenting employment opportunities for household members. For example, school closures were eradicated in most contexts at the time of our survey (see Figure A1 in the online appendix), potentially offering women a re-entry point into the labor market. Our empirical analysis will shed light on how these opposing forces influenced the overall correlation between COVID-19 risk and food insecurity 1 year into the pandemic in Bangladesh, Kenya, and Nigeria.

DATA

We initiated a longitudinal study in Bangladesh, Kenya, and Nigeria during the pandemic.[1] The first and second round surveys were administered in October through December 2020 and April 2021, respectively.[2] The following information was collected over the mobile phone from individual men and women in each country: demographic characteristics, their perceived COVID-

19 risk and exposure; metrics on mental health and access to health services; their time use and employment; as well as their assessments on household food security, decision-making, assets, social support, and coping strategies (round 2 only). In the initial round, we randomly surveyed 1822 individuals in Bangladesh (914 men and 908 women), 2038 individuals in Kenya (742 men and 1296 women), and 1969 individuals in Nigeria (823 men and 1146 women). The final samples consist of 3544 person-rounds in Bangladesh, 3685 person-rounds in Kenya, and 3582 person-rounds in Nigeria. The samples used in the analysis are unbalanced: 95% of men and 94% of women were surveyed in both rounds in Bangladesh; 83% of men and 80% of women were surveyed in both rounds in Kenya; and 85% of men and 79% of women were surveyed in both rounds in Nigeria. We describe how attrition is accounted for in our descriptive and regression analysis when describing the survey weights.

The implementation partner and survey sampling frame differed by country. In Bangladesh, the BRAC James P Grant School of Public Health managed the survey and drew the sample from an existing household survey, the Bangladesh National Nutrition Services Survey (BRAC James P Grant School of Public Health and National Nutrition Services, 2019). The sampling frame rendered analysis representative at the division level. A total of 16 districts were included in the dataset—two were randomly sampled from each of the eight divisions. The Kenya and Nigeria samples were acquired through random digital dial (RDD) phone surveys through the assistance of Innovations for Poverty Action (IPA). Cellphone numbers were purchased from a third party and randomly called by the enumerators to build a sample of respondents. Quota sampling by gender was enforced in both RDD countries. Survey costs permitted the sampling of 2000 individuals, where we agreed to target 1200 women and 800 men interviews. We further divided the cells for quota sampling by region (north vs. south) and age (18–25 years old, 25–44 years old, and >44 years old) in Nigeria to guarantee representation along these dimensions. We had adopted this strategy as we had been concerned that women in northern regions and of marital age would be underrepresented due to distortions in telecommunications access and gendered norms around ownership and use of cellphones.

Outcomes and explanatory variables

We analyze household food insecurity as reported by the respondents during the pandemic in Bangladesh, Kenya, and Nigeria.[3] We use the information from six survey questions to construct three food insecurity outcomes. First, we create a binary dependent variable, assigning a value of one to individuals who reported that their household did not have enough food or money to buy food in the last 7 days, and zero otherwise. Second, for those who indicated they were food insecure based on the first question, we created a composite index from the responses to five subsequent questions related to their consumption patterns. The values of the index range from 0 to 1, where higher values signify greater intensity of food insecurity.[4] Third, we created a binary dependent variable based on the composite index on food insecurity, where observations in the 75th percentile distribution were assigned a value of one, and zero otherwise. We chose this threshold to represent the proportion of people experiencing extreme food insecurity.

We focus on correlating food insecurity with personal knowledge of someone having COVID-19. One's personal knowledge of who is infected with COVID-19 within their network clearly reflects a perceived (rather than objective) form of risk. This aspect of risk remains an important variable to consider, as it is likely to affect the decision-making of respondents and

their households. In our study, respondents were asked to consider themselves, other household members living in the same household, household members living outside of the household, friends in the same community, friends living outside of the same community, or other forms of acquaintanceship when answering this question. Our measure of COVID-19 risk is binary, where a value of one is assigned to the person who indicated that she/he personally knew of anyone that has or had the coronavirus, and zero otherwise. COVID-19 risk varies over time, as we ask this question both in the first and second rounds of the survey. In Figure A2 in the online appendix, we illustrate the type of relationships the respondent has with the persons they consider to be infected conditional on reporting that they know someone is infected with COVID-19. In all countries, the majority of the respondents claiming to know an infected person are referring to a friend in their community or outside of their community. Few are claiming to have been infected themselves or have a household member that is infected. Thus, this measure likely reflects the perceived risk within one's social network, much of it originating within one's own community.

While this measure captures perceived risk (rather than objective risk), there are a few indications that the measure of perceived risk may in fact be correlated with a measure of objective risk. First, the reporting of risk in urban areas is consistently higher (see Figure A3 in the online appendix). Second, the proportion of people in a region stating that they know someone infected with COVID-19 is positively correlated with the reported cases at the subnational level in Bangladesh and Kenya (Figures A4 and A5 in the online appendix). In Nigeria, the number of cases reported by official sources is much lower than in the other two countries. Moreover, the association between the proportion of people reporting to know someone with COVID-19 in a state and the total additional cases in March 2021 is slightly negative (see Figure A5 in the online appendix). Data quality likely interferes with our ability to accurately reflect the number of cases by state and estimate a precise relationship, since we might erroneously assume zero additional cases on days left undocumented by the source.

In spite of the fact that our measure of perceived risk is positively correlated with objective risk, the explanatory variable potential may be endogenous. We recognize that individual knowledge of cases may be correlated with unobserved characteristics, such as labor force participation, ownership of a mobile phone, or even the respondent's propensity to communicate and maintain relationships with family members and friends. An appropriate instrumental variable for perceived risk might stem from an epidemiological model using a combination of objective measures of the infection rate, contact rate, and cases at the community level (Mueller et al., 2021). Reliable data sources for these measures in all three countries remain unavailable. This limitation, however, motivates the focus of the correlations between food insecurity and perceived risk of infection in this paper.

We estimate the correlates of food insecurity with COVID-19 risk using regression analysis.[5] We also consider two additional sets of outcomes based on the information collected in the Round 2 shocks module, as a way to evaluate, which pathways contribute to the worsening of food insecurity during the pandemic. The first set of outcomes are used to identify the potential source of food insecurity. Specifically, we ask whether the respondent's household has been affected by any of the following shocks in the last 12 months (3 months in Bangladesh): job loss; nonfarm business closure; disruption of farming, livestock, and fishing activities; an increase in price of major food items consumed; an illness or injury of a household member; or the death of a household member. Based on the responses to these questions, we create six additional binary outcomes where a value of one is assigned if the

person responds yes to each of the questions, and zero otherwise. This allows us to summarize the source of economic stress generated by the pandemic.

The second set of outcomes attempts to measure the relative flexibility of households to cope with the pandemic through their abilities to leverage social capital, diversify income, liquidate assets, or access credit. Six binary outcomes were used to characterize whether the household adopted a particular coping strategy irrespective of the type of shock that affected it in the last 12 months (3 months in Bangladesh). The six variables were whether the respondent claims the household to have: (1) sold their assets, (2) engaged in additional income-generating activities, (3) received assistance from friends, family, a women's group or savings group, or an NGO (Non-Governmental Organization); (4) reduced their food consumption; (5) reduced their non-food consumption; and (6) relied on savings or credit. Analyzing these outcomes in tandem allows us to observe whether households facing increased risk of COVID-19 are more likely limited to dietary and consumption adjustments to cope with the shock.[6]

Survey weights

Our analysis uses the sampling weights to adjust for selection bias inherent in the RDD sample and attrition bias driven by our inability to resurvey all baseline respondents. The sampling weights were constructed by IPA for Bangladesh, Kenya, and Nigeria surveys using nationally representative surveys collected by the respective governments (2016 Bangladesh Household, Income, and Expenditure Survey, 2016 Kenya Integrated Household Budget Survey, the 2019 Kenya Population and Housing Census, and the 2018–2019 Nigeria General Household Panel Survey). Weights were designed to adjust for the representation of individuals by gender, age, region, and phone ownership following the approach adopted by the World Bank (World Bank, 2020). Within-cell post-stratification weights are constructed for the baseline surveys in all countries and then top-coded at the 99th percentile (World Bank, 2020). In Bangladesh, the baseline weights are used for both rounds. In Kenya and Nigeria, an attrition correction factor was derived based on the response rate within demographic group bins in the second round (Kastelic et al., 2020). Panel weights are, therefore, constructed for the Kenya and Nigeria data, where the second round uses the baseline weights adjusted by the attrition correction factor with an additional top-coding at the 99th percentile. The baseline weights (in the Bangladesh analysis) and the panel weights (in the Kenya and Nigeria analysis) are then applied using inverse probability weighting when calculating descriptive statistics or estimating regressions.[7]

Descriptive statistics for the samples are provided in the online appendix (Table A2). To give perspective on the representation of the sample, we compare the educational attainment rates collected by the United Nations and from our sample. The upper secondary school completion rate in Bangladesh, Kenya, and Nigeria is officially 29%, 41%, and 49%, respectively (UNICEF, 2021). Our sample, in comparison, reports the equivalent statistic for Bangladesh but indicates our RDD sample in Kenya and Nigeria is much more educated (see online appendix). Mobile phone ownership has been shown to be more prevalent in these countries among those with upper secondary education levels (Pew Research Center, 2018). While the sampling weights adjust downward the secondary school completion statistics in Kenya and Nigeria, they clearly do not entirely correct for these discrepancies. Thus, our sample is likely to over-represent older individuals given the eligibility criterion of 18 years of age, but may also skew representation in other dimensions due to disparities in mobile phone access and cellphone coverage in Kenya and Nigeria.

Descriptive statistics

We first describe the state of food insecurity and exposure to COVID-19 risk by country of the respondent. Half of respondents in Kenya and Nigeria report being food insecure, relative to 20% of respondents in Bangladesh (Table 1). Among those who report food insecurity in the last 7 days, we observe that Bangladesh has the lowest composite index value of 0.26. The food insecurity composite index is 54 (69)% greater in Kenya (Nigeria) than Bangladesh (Table 1). We contrast the prevalence of food insecurity across the three countries with the reported familiarity of a person infected by COVID-19. On average, Kenya has the highest proportion of people who report knowing someone that is infected with the virus (27%) followed by Bangladesh (16%) and then Nigeria (11%) (Table A2 in online appendix).

We next characterize, which aspects of the pandemic might contribute to food insecurity. Figure 1 summarizes the proportion of respondents reported to have lived in a household where at least one member experienced a job loss, a business closure, a disruption of agricultural activities, price inflation, an illness or injury of a family member, or death of a family member. The statistics featured in Figure 1 illustrate how different realizations of the pandemic manifested across countries. The majority of men and women report high incidence of exposure to price inflation in all three countries. However, the proportion of respondents living in households with a member who lost their job or closed their business appears to be greater in Kenya than in the other settings. Illnesses also are more prevalent among households in Kenya, while incidence of death among household members appears quite small in all countries.

Finally, we evaluate whether the availability of formal and informal mechanisms to cope with the economic inactivity and increased health risks might explain differences in the vulnerability to the pandemic. Figure 2 focuses on six common coping strategies: selling household assets, engaging in another income-earning activity, receiving some type of assistance from friends or outside organizations, reducing food consumption, reducing nonfood consumption, or getting access to credit or using household savings. The propensity to engage in a coping strategy and the type of coping strategy practiced varies by country. In Bangladesh, the common coping strategies appear to be receiving a loan or using savings, in addition to receiving formal or informal assistance. In contrast, Kenyans and Nigerians tend to seek other income opportunities or reduce their overall food consumption. We next explain how we will use a regression framework to examine whether respondents with a greater perceived exposure to COVID-19 undergo greater food insecurity, report greater vulnerability to job loss, and are more likely to adjust their own consumption than partake in auxiliary coping strategies.

TABLE 1 Summary statistics of the food insecurity outcomes

	Bangladesh	Kenya	Nigeria
Household food insecurity within 7 days	0.20	0.50	0.50
N	3544	3685	3582
Food insecurity composite index	0.26	0.40	0.44
In 75th percentile of the composite index distribution	0.22	0.22	0.23
N	679	1707	1803

Note: 166 and 2 observations in Kenya and Nigeria were dropped from the computation of the food insecurity composite index due to missing values.

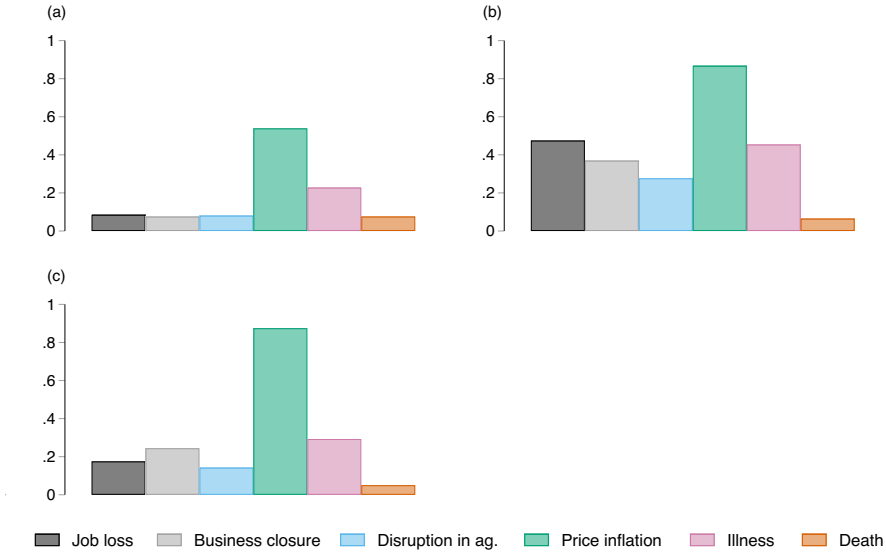

FIGURE 1 Legend on next page.

EMPIRICAL STRATEGY

We apply a linear regression model to explore whether COVID-19 risk is positively associated with food insecurity:

$$y_{it} = \alpha + \beta_t + \gamma X_i + \delta C_{it} + \varepsilon_{it}. \quad (1)$$

We estimate (Equation 1) using three dependent variables: a food insecurity indicator (available for the whole sample), a composite food insecurity index, and an indicator for being in the 75th percentile of the distribution of the composite food insecurity index (available for those who indicate being food insecure). The explanatory variables implicit in vector X are indicators for sex, primary school, secondary school, and post-secondary school attendance/completion, age, age square, whether the individual is married, the total number of children, asset wealth, and whether the individual lived in an urban location at baseline. One time-varying variable for exposure to COVID-19 risk is also included in all regressions, as well as a survey round fixed effect β_t to control for seasonality. All standard errors are clustered at the regional level (district for Bangladesh, county for Kenya, and state for Nigeria).[8]

Our main objective is to illustrate whether the correlation between perceived COVID-19 risk and food insecurity is positive $\delta > 0$. To gauge why respondents may be more vulnerable (and less resilient) to the pandemic, we also estimate a version of (Equation 1) using the cross-sectional shock and coping strategy outcomes collected in Round 2. We focus on whether the respondent reports a job loss or nonfarm business closure in the household. These shocks are

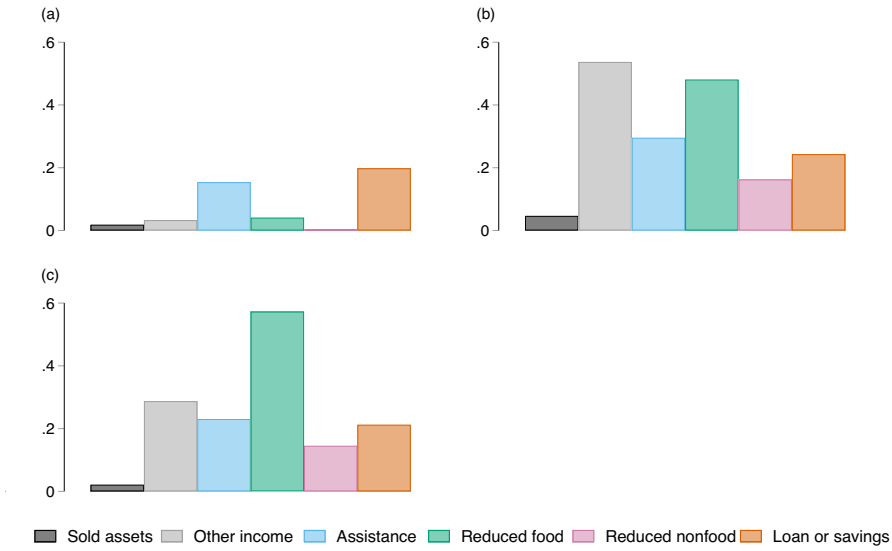

FIGURE 2 Legend on next page.

indicative of how income-constrained households become when exposed to a greater intensity of COVID-19 risk. If we find $\delta > 0$ when using these shock outcomes, then we can triangulate that the food insecurity may have stemmed from household constraints on liquidity that arise in risky locales. A second set of outcomes are analyzed to characterize whether respondents are less resilient due to an inability to access informal mechanisms that alleviate some of the constraints imposed by the pandemic. We focus on four coping strategy outcomes: engagement in additional income-generating activities, receipt of assistance, reductions in food consumption, and reliance on savings or credit. We anticipate $\delta > 0$ will be positive for respondents that lack alternatives to smooth income, when the dependent variable reduced their food consumption. The direction of the effects on engaging in additional income-generating activities will likely vary by the opportunities that avail from the expansion of the labor demand for essential workers as well as the extent work closures disrupted the labor markets in each country.

RESULTS

We divide the results into two sub-sections. First, we present the correlations between our measure of COVID-19 risk and food insecurity. Second, we study similar relationships between risk, reported job loss, and coping strategies to identify the potential sources of vulnerability in the pandemic.

TABLE 2 Relationships between food insecurity outcomes and COVID-19 risk

	Bangladesh	Kenya	Nigeria
Household food insecurity within 7 days	0.05** (0.02)	−0.03 (0.02)	−0.07* (0.04)
N	3544	3685	3582
Food insecurity composite index	0.03 (0.02)	0.03* (0.01)	−0.05 (0.03)
In 75th percentile of the composite index distribution	0.05 (0.04)	0.06* (0.03)	−0.05 (0.06)
N	679	1707	1803

Note: All parameter estimates and standard errors for each regression presented here are displayed in the online Appendix (Tables A3-A5).
***$p < 0.01$. **$p < 0.05$. *$p < 0.1$.

TABLE 3 Relationships between self-reported shocks, coping strategies, and COVID-19 risk

	Bangladesh	Kenya	Nigeria
Job loss	0.03 (0.02)	0.02 (0.02)	0.09* (0.05)
Business closure	0.03 (0.02)	0.06*** (0.02)	0.11** (0.05)
Engage in other activities	0.02 (0.02)	0.04 (0.03)	0.03 (0.08)
Received assistance	0.03 (0.03)	0.09*** (0.03)	0.03 (0.05)
Reduced food consumption	0.02 (0.02)	0.07** (0.02)	−0.02 (0.05)
Acquired loan or used savings	0.10** (0.04)	0.02 (0.02)	0.11** (0.04)
N	1722	1647	1613

***$p < 0.01$. **$p < 0.05$. *$p < 0.1$.

COVID risk and food insecurity

We provide the estimates of the COVID-19 risk parameter and their associated standard errors from all specifications in Table 2. All parameter estimates and standard errors are included in the Appendix (Tables A3–A5). Knowing at least one person infected with COVID-19 raises the probability of being food insecure by 5 percentage points in Bangladesh and reduces the probability of being food insecure by 7 percentage points in Nigeria. There is no statistically significant correlation between COVID-19 risk and food insecurity in Kenya. When restricting the focus to the food insecure population, we, however, observe risk is positively correlated with the intensity of food insecurity in Kenya. For example, men and women are 6 percentage points more likely to live in households that experience extreme food insecurity when knowing at least one infected person.

The patterns of food insecurity in response to risk are quite divergent in Nigeria relative to those in the other countries. One possible explanation is the sampling weights are inadequately correcting for discrepancies in the RDD sampling frame. To assess the validity of this claim, we checked the sensitivity of our results to the exclusion of the sampling weights (Table A6 in the online appendix). A few findings persist irrespective of the use of sampling weights. First, food insecurity remains positively correlated with knowing an infected person for the pooled sample

TABLE 4 Relationships between food insecurity incidence and COVID-19 risk, by marital status and headship

	Total	Female respondents	Male respondents	*t* statistic *p*-value
Panel A: Bangladesh				
Model 1				
COVID risk × unmarried	−0.08* (0.04)	0.01 (0.05)	−0.36*** (0.11)	0.01
COVID risk × married	0.08*** (0.02)	0.07* (0.04)	0.09*** (0.02)	0.61
Model 2				
COVID risk × not head	−0.02 (0.03)	0.03 (0.03)	−0.30 (0.08)***	0.00
COVID risk × head	0.08 (0.02)***	0.06 (0.05)	0.08 (0.02)***	0.67
N	3544	1758	1786	
Panel B: Kenya				
Model 1				
COVID risk × unmarried	−0.01 (0.03)	−0.03 (0.04)	0.0 (0.04)	0.26
COVID risk × married	−0.04 (0.03)	−0.0 (0.04)	−0.03 (0.04)	0.71
Model 2				
COVID risk × not head	−0.03 (0.03)	−0.06 (0.03)*	0.17 (0.06)***	0.00
COVID risk × head	−0.03 (0.03)	0.01 (0.05)	−0.04 (0.03)	0.40
N	3685	2328	1357	
Panel C: Nigeria				
Model 1				
COVID risk × unmarried	0.01 (0.05)	−0.03 (0.08)	0.03 (0.07)	0.48
COVID risk × married	−0.11** (0.05)	−0.12* (0.06)	−0.08 (0.08)	0.75
Model 2				
COVID risk × not head	−0.07 (0.06)	−0.08 (0.07)	0.03 (0.09)	0.32
COVID risk × head	−0.08 (0.06)	−0.13 (0.11)	−0.07 (0.07)	0.67
N	3582	2057	1525	

Note: COVID risk = Know people infected with COVID-19. Models 1 and 2 have the same explanatory variables in Table 2, with a few exceptions. Both models replace the COVID risk variable from Table 2 with the two interacted variables presented in this table, and add an explanatory variable indicating whether the respondent was the household head in Round 1. To compare the risk effects on the food insecurity of men and women, we perform a *t*-test, which assesses whether the correlation's magnitude differs across samples. The *t* statistic is computed from a version of model (Equation 1) that includes variables that interact the gender indicator with all other explanatory variables in the model using the pooled sample. We report all *p*-values for the *t* statistics on the interacted variables.
***$p < 0.01$. **$p < 0.05$. *$p < 0.1$.

of men and women in Bangladesh and that correlation is statistically significant. Second, men and women, who report living in households that are food insecure in Kenya, are more likely to experience levels of food insecurity in the upper quartile of the distribution. Third, the negative effect of knowing an infected person on the food insecurity of the pooled sample of men and women remains robust in Nigeria, but the magnitude of the effect dampens.

TABLE 5 Relationships between food insecurity index outcomes and COVID-19 risk, by marital status and having children

	Total	Female respondents	Male respondents	*t* statistic *p*-value
Panel A: Kenya				
Index, Model 1				
COVID risk × unmarried	0.03 (0.02)	0.04* (0.02)	−0.02 (0.04)	0.20
COVID risk × married	0.03 (0.02)	0.04* (0.02)	0.00 (0.03)	0.29
Index, Model 2				
COVID risk × not head	0.03 (0.02)	0.04 (0.02)*	−0.04 (0.04)	0.08
COVID risk × head	0.02 (0.02)	0.03 (0.03)	0.00 (0.03)	0.56
High index value, Model 1				
COVID risk × unmarried	0.07 (0.05)	0.07 (0.06)	0.08 (0.08)	0.98
COVID risk × married	0.05 (0.04)	0.10* (0.05)	−0.01 (0.05)	0.13
High index value, Model 2				
COVID risk × not head	0.08 (0.05)	0.10 (0.05)*	0.00 (0.07)	0.20
COVID risk × head	0.03 (0.04)	0.04 (0.07)	0.01 (0.05)	0.78
N	1707	1170	537	
Panel B: Nigeria				
Index, Model 1				
COVID risk × unmarried	−0.01 (0.05)	−0.05 (0.07)	0.02 (0.06)	0.38
COVID risk × married	−0.08* (0.04)	−0.11* (0.06)	−0.06 (0.04)	0.41
Index, Model 2				
COVID risk × not head	−0.06 (0.05)	−0.09 (0.06)	−0.00 (0.08)	0.36
COVID risk × head	−0.05 (0.04)	−0.11 (0.09)	−0.04 (0.04)	0.44
High index value, Model 1				
COVID risk × unmarried	0.04 (0.09)	−0.08 (0.15)	0.14 (0.10)	0.22
COVID risk × married	−0.11 (0.07)	−0.13 (0.10)	−0.11 (0.07)	0.88
High index value, Model 2				
COVID risk × not head	−0.01 (0.07)	−0.08 (0.10)	0.13 (0.13)	0.23
COVID risk × head	−0.10 (0.07)	−0.27 (0.11)**	−0.07 (0.06)	0.10
N	1803	1053	750	

Note: COVID risk = Know people infected with COVID-19. Models 1 and 2 have the same explanatory variables in Table 2, with a few exceptions. Both models replace the COVID risk variable from Table 2 with the two interacted variables presented in this table, and add an explanatory variable indicating whether the respondent was the household head in Round 1. To compare the risk effects on the food insecurity of men and women, we perform a *t*-test, which assesses whether the correlation's magnitude differs across samples. The *t* statistic is computed from a version of model (Equation 1) that includes variables that interact the gender indicator with all other explanatory variables in the model using the pooled sample. We report all *p*-values for the *t* statistics on the interacted variables.

***$p < 0.01$. **$p < 0.05$. *$p < 0.1$.

Potential causes of food insecurity

In this section, we try to identify what constrained households from buffering against the local economic shock experienced by an increase in COVID-19 risk and potentially the weakening of

the informal networks and institutions for coping. We report the parameter and standard error of the COVID-19 variable estimated in Equation (1) for six self-reported shock and coping strategy outcomes in Table 3.

In Bangladesh, households who perceived, there was a risk of COVID-19 in their network were more likely to report being food insecure. There are no apparent differences in household vulnerability to income loss among those with heightened risk. However, households with increased risk were 10 percentage points more likely to report acquiring a loan or using savings. Such outlets for smoothing consumption may have protected the food-insecure households from realizing a greater intensity of food insecurity.

In Nigeria, households were less likely to be food insecure when there was a perceived threat of COVID-19 within their personal networks. Table 3 indicates that, if anything, households that perceived being exposed to COVID-19 were more inclined to job loss and business closures. As in Bangladesh, the ability to acquire loans or the ability to draw from savings is what might have protected households in Nigeria from experiencing food insecurity. The findings in Table 3 indicate that those who knew someone in their network with COVID-19 were 11 percentage points more likely to acquire a loan or draw on their savings.

Finally, in Kenya, households were more likely to be under extreme food insecurity when exposed to someone who was infected with COVID-19. According to the results in Table 3, this may have been attributed to the income lost from business closures. Male and female respondents in Kenya were 6 percentage points more likely to report a business closure in the household with increased risk. Yet, households with increased risk were also 9 percentage points more likely to receive assistance. This may have effectively ameliorated households from becoming food insecure in risky areas. However, there were still vulnerable households reporting to have reduced food consumption, perhaps because whatever assistance they might have received was insufficient to compensate for the loss in income. Among food insecure households, relying on dietary adjustments to cope with the pandemic may be responsible for why households in higher risk areas exhibit extreme levels of food insecurity.

DISCUSSION

The existing literature suggests deleterious impacts of the pandemic on the food security of households in Bangladesh and Kenya. In Bangladesh, knowing someone with COVID-19 in your network increases the tendency of being in a food-insecure household by 5 percentage points. In Kenya, it increases the likelihood of being in the upper quantile of the food insecurity index distribution by 6 percentage points, conditional on already being food insecure.

The main question becomes whether there were opportunities that the Nigerian government provided in the background that created an environment where households with moderate exposure to COVID-19 might have experienced lower incidence of food insecurity relative to households with low exposure to COVID-19. Devereux (2021) notes several possibilities. First, not only were stipends increased to existing beneficiaries of cash transfer programs to compensate for the income loss during lockdowns, but eligibility of the National Social Safety Nets Project expanded. Second, there were other subsidies given to vulnerable households, such as food vouchers during school closures as a substitute for school feeding. Although, we were unable to detect a positive effect of COVID-risk on the propensity to receive assistance, it is possible that the culmination of these programs might have created enough disposable income among vulnerable households to protect themselves from becoming food insecure. Another important

policy that might explain the positive effect on the tendency to save among Nigerian households with moderate exposure to COVID-19 is the debt relief program that targeted enterprises, who were given a 3-month respite on loan repayments (Devereux, 2021). The creation of the aforementioned new mechanisms for food-insecure households to smooth consumption might explain why food insecurity was lower in riskier areas, particularly if riskier areas were more likely to experience lockdowns and benefit from the suite of programs offered by the Nigerian government.

What remains relatively understudied is whether these experiences are realized equally across the genders. The current studies that have disaggregated the effects of the pandemic on food security by the gender of the household head are inconclusive. Female-headed households in Senegal (Barooah et al., 2020), Ethiopia, Nigeria, Malawi, and Uganda (Josephson et al., 2020) have a higher prevalence of food insecurity than male-headed households. However, there are other case studies, which find that there are no differential impacts on female-headed households (Abate et al., 2020; de Brauw et al., 2020; Hirvonen et al., 2020a; Mahmud & Riley, 2021). Because women face exceptional constraints on their labor participation and time use during pandemics (Wenham et al., 2020), additional studies are necessary to determine the consequences of the pandemic on their food security status as well as identify the source of the problem to better target their needs in the design of future humanitarian programs.

Our food insecurity measure, which is measured at the household level is unlikely to correspond with the individualized experiences of our male and female respondents. While recognizing these limitations, we did estimate two additional specifications stratifying by gender, which replace the COVID risk variable in Equation (1) with two variables: (i) whether the respondent was unmarried interacted with COVID risk and married interacted with COVID risk, and (ii) whether the respondent was not the household head interacted with COVID risk and the household head interacted with COVID risk. Building upon our main findings using the pooled sample, we witness that women who are not household heads may be more vulnerable to food insecurity at the extensive and intensive margins in Bangladesh and Kenya than their male counterparts. For example, among respondents facing COVID risk, nonhead males are 30 percentage points *less* likely to be food insecure compared to nonhead females who are 3 percentage points *more* likely to be food insecure (Table 4). Similarly, nonhead males in Kenya are 1 percentage point *less* likely to be extremely food insecure compared to nonhead females who are 10 percentage points *more* likely to be extremely food insecure (Table 5). These gendered differences are statistically significant at the 1% and 13% critical levels in Bangladesh and Kenya, respectively. Unfortunately, we are unable to differentiate whether these reflect the disparities by the sex of the respondent or variation in the accuracy of responses by gender.

A strong theme that resonates in this special issue is the extent to women face additional vulnerabilities in various aspects of the food system, for example, in research and development in the United States (Hilsenroth et al., 2022) as well as in the informal sector in LMICs (Egger et al., 2022). Future research should better identify, which demographic groups, including women, are particularly vulnerable to food insecurity and the source of such disparities. Furthermore, it remains unclear whether the job loss and business closures were in result of factors related to the supply or demand of labor. Social distancing and risk averting behavior could have weakened the formal or informal childcare options, which enabled women to engage in the labor force. School closures might have driven women to reduce their labor supply to supervise the educational progress of their children, while lockdowns might have suspended activities in specific sectors that employ women. The source of the vulnerability is important to

inform policies that aim to retain women and other demographic groups in the labor market as well as protect them from malnutrition.

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ENDNOTES

[1] The project was commissioned to Simon Frasier University by the Bill and Melinda Gates Foundation to investigate the deleterious impacts of pandemic on women's economic and social empowerment. The study was authorized through an Institutional Review Board at Simon Frasier University (SFU) with an authorization agreement between Simon Frasier University and Arizona State University (ASU) (FWA 00009102; IRB Registration Number: IRB00000128). While there are several collaborators and institutions involved in the project, in addition to SFU and ASU, the other principal investigators of the project are affiliated with Hong Kong University, Johns Hopkins, and the London School of Economics and Political Science.

[2] Our first round coincides with the lean season in Kenya (August–November) and was conducted after the lean season of Bangladesh (September–November) and Nigeria (June–August). The second round of interviews overlaps with the harvesting of boro rice in Bangladesh, the main "long-rain" season in Kenya, and the end of the dry season in northern Nigeria and the wet season in central and southern Nigeria (April–October).

[3] The questionnaire was designed to be completed in 30–45 min. The expected duration of the interview included the verbiage required to obtain consent, where the length of the consent form varied considerably across countries. Given the interest to cover a wide scope of well-being outcomes, we limited the number of food security questions included in the questionnaire to six. We borrowed the framing of the questions from the Demographic and Health Surveys (Kenya National Bureau of Statistics and ICF International, 2014).

[4] We describe how the index is constructed in Section 1 of the Appendix. We dropped 166 and 2 observations in the Kenya and Nigeria sample, respectively, because they were missing information required to compute the values for the index.

[5] Time-invariant indicators collected in the first round are also included as explanatory variables, which document whether the highest level of education attended (or completed, in the case of Bangladesh) is primary school, secondary school, or post-secondary school; her/his age and age squared; whether she/he is married; the total number of pre-primary school-aged children in the household; an asset index (0–100); and a binary variable for whether the person lives in an urban location. Seasonality is incorporated by including an indicator for whether the survey was conducted in Round 2 in the empirical model. With respect to the asset index, we construct a standardized principal component index using the approach in Filmer and Pritchett (2001) and the following variables: whether the household has finished walls and floors, electricity, a radio, a fan, an electric iron, a television, a refrigerator, and a smartphone.

[6] As noted, the Bangladesh shock module possessed a shorter recall period in the shocks module than applied in Kenya and Nigeria. Respondents in Bangladesh are also asked to reflect upon shocks that are brought on by

the pandemic. The shorter recall period and conditionality of COVID-induced shocks are likely to affect the prevalence of reporting each type of shock and our ability to generalize across countries. An additional difference of the shock module in the Bangladesh survey is that when each person was asked whether she/he experienced a specific shock, they were allowed to answer (1) yes, (2) no, and (3) not applicable, whereas the other two countries were only given the first two choices. For comparability, we assume a response of (3) is equivalent to (2) in Bangladesh. Evaluating the response rate of option (3) suggests this may be sensible. Approximately, 30% of the sample is inclined to report not applicable to shocks like job loss and nonfarm business closure, perhaps because they or other household members are unemployed or do not possess a nonfarm business. In contrast, approximately 1% of the sample indicated not applicable for shocks that would affect everyone, for example, price inflation.

[7] The absence of panel weights in Bangladesh may be less of an issue if there are relatively few differences in the demographic and wealth characteristics among tracked and nontracked respondents. To understand how different the respondents are by tracking status, we estimate a linear probability model, using a binary dependent variable that reflects tendency to remain in the sample. We include a set of baseline individual and household characteristics as explanatory variables in the model (described in Table A1 in the online appendix). The results suggest that respondents that have completed a secondary and post-secondary education are slightly more likely to be resurveyed. These effects are statistically significant at the 10% critical level. All other covariates remain uncorrelated with the retention of respondents in the sample in Bangladesh.

[8] We cluster at these geographic levels as they represent administrative units consistently and of similar magnitude across contexts. We believe it is important to cluster the standard errors at this level of aggregation because local governments are imposing lockdowns and enforcing other policies that affect the livelihood portfolios and infrastructure of respondents. We lack sufficient data to evaluate how sensitive our inferences are to more disaggregate levels of clustering (Abadie et al., 2017), and recognize that, in result, our inferences based on the hypothesis testing may be on the conservative side.

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