



## COVID-19 and food security: Panel data evidence from Nigeria

Mulubrhan Amare<sup>a</sup>, Kibrom A. Abay<sup>b,\*</sup>, Luca Tiberti<sup>c</sup>, Jordan Chamberlin<sup>d</sup>

<sup>a</sup> International Food Policy Research Institute, United States

<sup>b</sup> International Food Policy Research Institute, Egypt

<sup>c</sup> University of Laval and Partnership for Economic Policy (PEP), Canada

<sup>d</sup> International Maize and Wheat Improvement Center, Kenya

### ARTICLE INFO

#### JEL Codes:

I12  
O13  
Q18  
Q12

#### Keywords:

COVID-19  
Coronavirus  
Pandemic  
Welfare  
Labor market participation  
Sub-Saharan Africa

### ABSTRACT

This paper combines pre-pandemic face-to-face survey data with follow up phone surveys collected in April-May 2020 to examine the implication of the COVID-19 pandemic on household food security and labor market participation outcomes in Nigeria. To examine these relationships and implications, we exploit spatial variation in exposure to COVID-19 related infections and lockdown measures, along with temporal differences in our outcomes of interest, using a difference-in-difference approach. We find that households exposed to higher COVID-19 case rates or mobility lockdowns experience a significant increase in measures of food insecurity. Examining possible transmission channels for this effect, we find that the spread of the pandemic is associated with significant reductions in labor market participation. For instance, lockdown measures are associated with 6–15 percentage points increase in households' experience of food insecurity. Similarly, lockdown measures are associated with 12 percentage points reduction in the probability of participation in non-farm business activities. These lockdown measures have limited implications on wage-related activities and farming activities. In terms of food security, households relying on non-farm businesses, poorer households, and those living in remote and conflicted-affected zones have experienced relatively larger deteriorations in food security. These findings can help inform immediate and medium-term policy responses, including social protection policies aiming at ameliorating the impacts of the pandemic.

### 1. Introduction

The COVID-19 pandemic is ravishing local, national, and global economies. In addition to the direct health impacts, the pandemic is having widespread effects on employment, poverty, food security, nutrition, education and health, and the overall functioning of food systems (Barrett, 2020; Devereux et al., 2020; Swinnen, 2020; GAIN, 2020). The pandemic is destabilizing supply chains and creating instability in food supply and food prices (Zurayk, 2020; Torero, 2020; Reardon et al., 2020a; Reardon et al., 2020b; Ihle et al., 2020; Akter, 2020; FAO, 2020). The World Bank's recent forecasts show that, globally, the pandemic is likely to push 49 million people into extreme poverty in 2020 (World Bank, 2020a).<sup>1</sup> More than 45 percent (23 million people) of these people are in Sub-Saharan Africa, implying that the region will be hit hardest in terms of increased extreme poverty. The

United Nations World Food Program (WFP) estimates that the number of people globally facing acute food insecurity would almost double by the end of 2020 (about 135 million people before the crisis), due to income and remittance losses, and disruption of food systems associated with the pandemic (WFP, 2020a; WFP, 2020b).

This paper examines the implication of the spread of the coronavirus pandemic and associated governmental lockdown measures on households' food security and labor market participation in Nigeria. Nigeria is an interesting case study, as about 83 million people were already living below the national poverty line (World Bank, 2020a). According to the recent World Bank projections, Nigeria is predicted to be one of the three countries with the highest increase in the number of poor people.<sup>2</sup> About 5 million Nigerians are projected to be pushed into poverty because of the COVID-19 pandemic and associated mobility restrictions and lockdown measures (World Bank, 2020a; IMF, 2020). Food insecurity has

\* Corresponding author.

E-mail address: [k.abay@cgiar.org](mailto:k.abay@cgiar.org) (K.A. Abay).

<sup>1</sup> The share of the world's population living on less than \$1.90 per day is projected to increase from 632 million to 665 million people (World Bank, 2020a).

<sup>2</sup> The three countries with the largest change in the number of poor are estimated to be India (12 million), Nigeria (5 million) and the Democratic Republic of Congo (2 million) (World Bank, 2020a).

<https://doi.org/10.1016/j.foodpol.2021.102099>

Received 20 August 2020; Received in revised form 29 April 2021; Accepted 4 May 2021

Available online 16 May 2021

0306-9192/© 2021 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

been a major longstanding challenge in Nigeria, as reflected by Nigeria's high Global Hunger Index (GHI), low Food Consumption Score<sup>3</sup> (FCS), and high-calorie deficiency (Global Hunger Index, 2019). Disruptions in domestic economic activities and international food markets are very likely to affect the food security of Nigerian households through various channels (Ericksen, 2008; Barrett et al., 2019; Arndt et al., 2020; Devereux et al., 2020; Baldwin and Weder di Mauro, 2020; Haddad et al., 2020; Béné, 2020; Obi et al., 2020). In addition, the availability of a large nationally representative panel of households observed before and after the pandemic makes Nigeria an ideal setting for an empirical examination of some of the short-term effects of the coronavirus pandemic.

In addition to examining the overall implication of the pandemic and government lockdowns on household food security outcomes, this research also aims to shed light on some of the specific pathways which mediate such welfare outcomes, focusing in particular on disruptions in household economic activities. Lockdowns and social distancing measures associated with the pandemic are widely understood to have potentially serious adverse effects on incomes, through reduced economic activity and attenuated livelihood options (Devereux et al., 2020; Barrett, 2020; Reardon et al., 2020b). In Nigeria, recent estimates have indicated that the economy will have contracted by 3.5 to 5 percent in 2020, during the period in which the government imposed restrictions on economic activities and mobility (World Bank, 2020c; IMF, 2020; Andam et al., 2020). In this study, we examine the implication of the spread of the pandemic and associated lockdown measures on household-level labor market participation and economic activity outcomes, key pathways by which food security outcomes are mediated.

The effects of the pandemic are expected to differ both by geography and type of household, with preexisting vulnerabilities to food security likely to be magnified (Amjath-Babu et al., 2020; Béné, 2020; Devereux et al., 2020; Ravallion, 2020; Mobarak and Barnett-Howell, 2020). Nigeria has significant longstanding geographical variation in poverty and food insecurity – more than 75 percent of poor Nigerians live in the north of the country – and the pandemic is likely to disproportionately exacerbate food insecurity in those already fragile and conflict-affected zones (World Bank, 2020b, 2020c). Poorer households in both rural and urban areas are more likely to be affected by the pandemic (Ericksen et al., 2010; Ravallion, 2020; Mobarak and Barnett-Howell, 2020). As the spread of the pandemic initiates in urban areas, government responses, including mobility restrictions and lockdowns, will likely be most intense in urban areas and may affect urban residents more directly than rural households in the short term. However, the impact of the pandemic is also expected to vary across livelihood options, with those activities that require face-to-face interactions likely to experience a significant loss in demand (e.g., Abay et al., 2020a; Baldwin and Weder di Mauro, 2020). We thus explore potential differential implications along these dimensions, including livelihood strategies and options.

To address these questions, we combine pre-pandemic face-to-face surveys with post-pandemic phone surveys and primary data on states' infections and lockdown measures, exploiting spatial variation in exposure to COVID-19 cases along with temporal changes in various food security indicators within a difference-in-difference framework. By comparing before- and post-outbreak food security outcomes of households with different exposure to the pandemic, we quantify some of the key overall and differential welfare effects of the pandemic. We also examine the role of state-level government responses, in the form of lockdowns and associated mobility restrictions. Because our study relies on observational data, we need to be cautious in our causal identification claims. A main concern is that there might exist potential, time variant, omitted correlates of food security and infections/lockdown measures (e.g., distance to food market, health facilities, and nutrition

programs). However, given the very short time span between pre-COVID-19 data and the outbreak of the pandemic (about 12 months), such variables are unlikely to change significantly over this period. Hence, as discussed below, our household fixed effects approach addresses the most significant sources of potential endogeneity, and the conditional relationships we identify are plausibly interpreted as impacts.

We find that those households exposed to higher COVID-19 cases or more strict government measures experience significant increase in food insecurity indicators. We also document significant reductions in labor market activities in those areas most affected by the spread of the pandemic and lockdown measures. For instance, doubling of the number of confirmed cases is associated with 3 percentage points increase in households' food insecurity experience and 2–4 percentage points reduction in major economic activities. State-level lockdown measures increased households' experience of food insecurity by 6–15 percentage points and reduced non-farm business activities by 12 percentage points. These results remain consistent across alternative indicators of food insecurity and labor market participation. We also document important differential implications across various economic activities and households. For instance, state-level lockdown measures are more disruptive of non-farm business activities, while wage-related activities appear to be less affected. Similarly, poorer households and those households living in remote and conflict-affected zones are more strongly affected than wealthier and less-remote households.

The literature evaluating early impacts of the pandemic on food security in developing countries is still incipient, but has already generated some important evidence, finding negative impacts of the pandemic on food security outcomes (e.g., Abay et al., 2020b; Adjogon et al., 2020; Aggarwal et al., 2020; Ceballos et al., 2020; Hirvonen et al., 2021a; Kansime et al., 2020; Mahmud and Riley, 2020). It is important, however, to continue building this evidence base across different geographical and economic contexts, in order to better understand how these impacts play out in different settings and for different populations. Using nationally representative household survey data from Nigeria, the most populous country in Africa, this paper contributes new evidence on the implication of the spread of the pandemic and associated lockdown measures on food security as well as labor market and economic activities of urban and rural households. These findings may inform immediate and medium-term policy responses. For instance, our findings can inform social protection policies aiming at weathering the impacts of the pandemic, which rely heavily on effective targeting strategies. This is particularly imperative for governments like Nigeria, which has limited fiscal space and competing needs for post-COVID-19 recovery investment. The evidence that government responses, such as lockdowns and other mobility restrictions, have disproportionately large negative impacts on poorer households is consistent with arguments made by those who are critical of such policies for low- and middle-income countries (e.g., Ravallion, 2020; Mobarak and Barnett-Howell, 2020; Bargain and Aminjonov, 2020).

The remainder of this paper is organized as follows. Section 2 provides a conceptual discussion on potential mechanisms through which the pandemic could affect food security. Section 3 describes the context and data. Our empirical strategy is presented in Section 4. Section 5 presents estimation results and associated discussions, while Section 6 provides concluding remarks.

## 2. COVID-19 and food security

There are at least four mechanisms through which the coronavirus pandemic may affect household food security. First, contractions by the virus or fear of contracting the virus could reduce income-generating activities. This applies both to local sources of income as well as international sources of income, including remittances. For instance, remittances which are usually shown to be important for maintaining food security during food crises (Obi et al., 2020) are likely to shrink because

<sup>3</sup> FCS is a composite score constructed based on dietary diversity, food frequency, and relative nutritional importance of different food groups.

of the pandemic (e.g., Breisinger et al., 2020; Diao and Mahrt, 2020). Second, government restrictions meant to slow the spread of the pandemic, including mobility restrictions and lockdown measures, are disrupting livelihood activities, and hence reducing household incomes (Abay et al., 2020b; Arndt et al., 2020; World Bank, 2020a). Third, disruptions in food systems and food supplies can limit access to food (e.g., Aggarwal et al., 2020; Hirvonen et al., 2021b; Mahajan and Tomar, 2021). Fourth, disruptions in food systems and value chains can trigger food price increases, limiting affordability of foods (e.g., von Braun et al., 2014; Devereux et al., 2020). For example, early findings by Hirvonen et al. (2021b) show that the pandemic led to significant but heterogeneous increases in food (vegetable) prices in Ethiopia.

However, empirical evidence on the magnitude of the impact of the coronavirus pandemic on the above mechanisms remains scant, partly because the pandemic is still unfolding, and detailed household survey data are not yet available. This study aims to examine the implication of the spread of the pandemic and associated lockdown measures on labor allocation to different economic activities, as well as ultimate food security outcomes of households. Nigeria is highly susceptible to income shocks and food insecurity associated with the spread of the pandemic. Furthermore, national and state-level lockdowns and mobility restrictions are disrupting major economic activities, including local businesses. These restrictions are affecting food transportation within the country, with clear implications for food supply. There are indications that Nigeria's domestic and international food supply chains are being disrupted, food prices are increasing, and informal sector unemployment rates are likely to be increasing (GAIN, 2020).<sup>4</sup> All these effects are likely to generate significant repercussions for food insecurity, particularly in poorer and vulnerable households (Ericksen et al., 2010; Tendall et al., 2015; Gilligan, 2020).

### 3. Context, data and descriptive results

#### 3.1. Context

Nigeria is Africa's most populous country, characterized by high poverty rates, a large informal sector economy, high dependence on imported staples, and high exposure to food price volatility (Benson et al., 2020). The country experiences significant seasonal and spatial food price fluctuations due to weather shocks to agricultural production, limited access to markets and infrastructure, and global food price volatility on imported staple foods (Amare et al., 2018).<sup>5</sup> Nigeria is one of the few African countries that first recorded COVID-19 cases and hence among those African countries who experienced significant economic disruptions because of the pandemic. The first COVID-19 case in Nigeria was recorded on February 27, and by late June, the number of confirmed cases passed the 30,000 mark (NCDC, 2020).<sup>6</sup> As part of the measures to contain the spread of the pandemic, federal and state-level governments have introduced social distancing and mobility restrictions in March 2020 (FMBNP, 2020). The federal government closed all schools in mid-March, and several states and local authorities introduced bans on public and social gatherings. By late March, the Nigerian government closed its land and air borders to all travelers and suspended passenger rail services within the country (Ogundele, 2020; NCDC, 2020). Furthermore, the federal government announced fiscal and stimulus measures, amounting up to 50 billion Naira to support

households, and small and medium-scale enterprises affected by the COVID-19 pandemic (FMBNP, 2020).

Nigeria's lockdown and mobility restrictions were mostly introduced by federal and state-level governments. Starting from March 29, 2020, federal and state governments announced lockdown measures and strict mobility restrictions for some states such as Abuja FCT, Lagos, Ogun, Kano, Delta, Ekiti, Kano, Kaduna, Kwara, and Taraba states.<sup>7</sup> Lockdown measures in other states were introduced by state governments independently of the federal government, including in Akwa Ibom, Borno, Osun, and Rivers. In most cases, the lockdowns remained in force for about 5–8 weeks. These measures restricted movement of residents and led to the closure of business operations, and the closure of regional borders linking lockdown areas with the rest of the country.

#### 3.2. Data and descriptive results

In this study, we combine data from a pre-COVID-19 face-to-face survey with post-COVID-19 phone survey data. These surveys are part of the World Bank's Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) and are collected in collaboration with the Nigerian Bureau of Statistics (NBS). The LSMS-ISA data for Nigeria, also known as General Household Survey-Panel (GHS-P) include four rounds collected in 2010–11, 2012–13, 2015–16 and 2018–19.<sup>8</sup> The data are nationally representative, and they provide detailed information on employment, income, food, and nutrition security indicators.

Following the onset of the COVID-19 pandemic, the LSMS-ISA program initiated tracking of national samples of households that had been interviewed during the latest rounds of the LSMS-ISA surveys using phone surveys.<sup>9</sup> Among the total sample of households (4,976) interviewed in the most recent round (post-harvest January/February visit) of the GHS-P survey in 2019, 4,934 (99.2%) provided at least one phone number. Out of the full sample of households with phone numbers, a random sample of 3,000 households was selected for the phone survey, to collect a complete sample of 1800 households that enable statistical monitoring of monthly changes in key outcomes of interest. Out of these 3,000 households prepared for phone survey, 69 percent of sampled households were successfully contacted, and among these, 94 percent (1,950) households were fully interviewed (NBS and World Bank, 2020). The final sample for the phone survey consists of these 1,950 households, and they are expected to be contacted in subsequent rounds of the survey. To create a balanced panel across rounds, we merged these households with the previous round (2019) and kept those households with complete information in both rounds, resulting in a total of 1882 households in our sample.

To adjust for potential systematic attrition in the phone survey and construct nationally representative statistics, one must construct and apply appropriate sampling weights. The LSMS-ISA team constructed the sampling weights using the weights for the GHS-Panel as the basis, with further adjustment for attrition in the phone survey. The weights for the final sample of households from the phone survey were calculated in several stages, and readers are referred to NBS and World Bank (2020). These weights are shown to sufficiently ensure comparable

<sup>4</sup> For example, the cost of rice in retail markets soared by more than 30% in March alone (Bloomberg: Key Food Prices Are Surging After Virus Upends Supply Chains: <https://news.bloomberglaw.com/international-trade/key-food-prices-are-surging-after-virus-upends-supply-chains>)

<sup>5</sup> Nigeria imported 2.4 million metric ton of rice in 2019/2020. Nigeria spent more than USD 4.1 billion on food import (NBS and World Bank, 2020).

<sup>6</sup> The Nigerian Centre for Disease Control (NCDC) is responsible for overall management of testing, isolation, and treatment of COVID-19 patients.

<sup>7</sup> In addition to lockdown measures, federal and state government implemented different measures includes: (i) travel bans which includes restricted entry into the country for travelers from high-risk countries; closure of two main international airports; suspension of all railway passenger services in the country; closure of all air and land borders. (ii) closure of schools and religious institutions. (iii) Bans on public and social gatherings across all states in Nigeria. (iv) Curfew hours which restrict movement of people.

<sup>8</sup> While the first three rounds following similar households the latest (2018–19) round covers a highly refreshed sample of households.

<sup>9</sup> These phone surveys have been (are being) conducted in Ethiopia, Malawi, Nigeria, Tanzania, and Uganda.

distribution of observable characteristics from the GHS-P and the phone survey (NBS and World Bank, 2020).

In this paper, we use the first round of the phone survey (the only available at the time of writing), which was administered in April-May 2020.<sup>10</sup> The LSMS-ISA phone surveys are planned to be monthly surveys and hence are high-frequency surveys. These high-frequency phone surveys covered topics including (1) knowledge regarding the spread of COVID-19; (2) prices and access to food and non-food necessities; (3) employment and income losses; (4) food insecurity; and (5) subjective wellbeing. We are more interested in those outcomes, which can be observed in the face-to-face (pre-COVID-19) and phone (post-COVID-19) surveys. Since both the pre-and post-COVID-19 data contain important information on households' participation in economic activities and food insecurity experience, we can examine the patterns and dynamics of food insecurity and labor allocation along multiple periods. As we discuss below, we are particularly interested in examining potential implications on food insecurity and disruptions in economic activities, which are both measured in similar ways across rounds.

Table 1 presents weighted summary statistics of selected variables used in our analysis. For comparison purposes, we report summary statistics for those variables observed in both rounds which are not expected to change significantly across rounds or because of COVID-19. The observable household characteristics that are observed for both rounds are very similar. This is encouraging for our analysis as most of these household characteristics are not expected to change in such a short period significantly. About 18 percent of our sample are female headed in the 2019 round, while the corresponding figure for the 2020 round is 19 percent. We also show other pre-pandemic variables which are used to capture heterogeneous effects across the population.

### 3.3. Definition of variables and descriptive results

#### 3.3.1. Outcome variables

**Food insecurity indicators:** We measure food insecurity using three

**Table 1**  
Descriptive results of key explanatory variables.

	Pre-COVID-19 (2019)	Post-COVID-19 (2020)
Male headed households	0.82(0.37)	0.81(0.36)
Age of head (years)	49.68(14.88)	49.40(14.24)
Education of head (years)	8.21(5.89)	8.81(5.93)
Family size (number)	6.33(3.84)	5.89(3.32)
Value of assets (PPP USD)	1678.41(3370.92)	NA
Urban households	0.39(0.49)	NA
Poor households (poorest asset tercile = 1)	0.20(0.40)	NA
Households living in North East Nigeria	0.17(0.38)	NA
Distance to main road (km)	5.37(6.05)	NA
Livelihood (income) sources during the last 12 months <sup>a</sup>		
Farming /agriculture	0.77(0.42)	NA
Non-farm business	0.64(0.48)	NA
Wage employment	0.34(0.47)	NA
Remittances and assistances	0.26(0.44)	NA
No. observations	1,882	1,882

*Notes:* This table presents descriptive statistics associated with our final sample. Values out of parenthesis are means while values in parenthesis are standard deviations. NA stands for "Not Available".

<sup>a</sup> We note that households were asked to mention multiple sources of livelihood and hence choices are not mutually exclusive.

*Source:* Authors' calculations based on Nigeria LSMS-ISA 2019 and 2020 rounds. Sample weights have been applied.

<sup>10</sup> The outcomes and information from 2019 were collected during January and February 2019.

indicators, capturing households' experience of food insecurity. In both rounds, households' food insecurity experiences are elicited using the self-reported experience of hunger and food shortage in the last 30 days (Hoddinott, 1999; Carletto et al., 2013; Bellemare and Novak, 2017). The first indicator asks if a household head or any other adult in the household had to *skip a meal* because there was not enough money or other resources to get food. The second indicator measures whether the household has *run out* of food and takes a value of 1 if the household ran out of food because there was not enough money or other resources to get food. The third indicator takes a value of 1 if the household or any other adult in the household *went without eating for a whole day* because of a lack of money or other resources.

These three indicators of food insecurity are strongly correlated with one another. Thus, we also employ principal component analysis (PCA) to construct an index of food insecurity. This index, which is standardized across each wave to capture seasonality in food security outcomes, is a linear combination of the three indicators of food insecurity experience. We use all four measures (i.e., the three binary indicators and the composite index) in our analysis.<sup>11</sup>

**Labor market participation:** The 2019 and 2020 surveys collected information on households' participation in income-generating activities over the last seven days. The major income-generating activities include farming, non-farm business, and wage-related activities. We thus can quantify changes in labor allocations across rounds. We define an indicator variable for *farming activities*, which takes a value of 1 if the household head or any member of the household worked on a household farm growing crops, raising livestock, or fishing, and 0 otherwise. Similarly, we define an indicator variable for *non-farm business*, which takes a value of 1 if the household head or any member of the household operated family business and zero otherwise. Both farm and non-farm activities are observed at the household level. We also generate an indicator variable for participation in *wage-related activities* (observed at the individual level), which assumes a value of 1 if the household head or any other member of the household did work wage job, either at their place of work or from home, and 0 otherwise. We also generate an indicator variable for participation in *any economic activity* which assumes a value of 1 if the household head or any member of the household participated in any of the above economic activities, and zero otherwise. Because of this, our estimations aim to quantify the implication of the pandemic at the extensive margin of labor market participation.

Table 2 reports key outcome variables: households' food security and labor market participation rates in both rounds. The results in Table 2 show significant increases in all food insecurity indicators. For example, households' food insecurity experiences, as measured by incidence of skipping a meal, running out of food, and going without eating in the last 30 days have increased by 47, 32, and 20 percentage points, respectively. We note that seasonality may also contribute to some of these increases as the pre-pandemic survey was collected in January and February 2019 while the post-pandemic survey was collected in April and May 2020. To control for potential seasonality effects, we standardize the aggregate food insecurity index for each wave to have a mean of zero and standard deviation of one. Our empirical estimations explore whether these changes and increases in food insecurity can be attributed to the spread of the COVID-19 pandemic and associated mobility restrictions. On the other hand, participation in income-

<sup>11</sup> We note these three questions used to measure food insecurity are a subset of the full Food Insecurity Experience Scale (FIES) commonly employed to measure food insecurity experience in large surveys (Cafiero et al. 2018). For the specific rounds we are using, the LSMS-ISA survey for Nigeria includes only these indicators, those which are believed to be the most important indicators of severe food insecurity. Although these three indicators may not capture all domains of food security situation (e.g., food quality), these indicators can show potential dynamics in the food security situation, especially in contexts where food availability and shortages are acute, such as in Nigeria.

**Table 2**  
Descriptive results of key outcome variables.

Key outcomes	Pre-COVID-19 (2019)	Post-COVID-19 (2020)	Difference test
<i>Food security indicators</i>			
Skip a meal (0/1)	0.26	0.73	0.47***
Run out of food (0/1)	0.25	0.57	0.32***
Went without eating for a whole day (0/1)	0.05	0.24	0.20***
<i>Labor market participation</i>			
Work in any activity	0.93	0.67	-0.25***
Farm activities	0.65	0.45	-0.19***
Non-farm business activities	0.58	0.37	-0.21***
Wage employment	0.26	0.12	-0.14***
No. observations	1,882	1,882	

*Notes:* Food security indicators are measured as household-level responses to a question that elicits food insecurity experienced in the last 30 days. The food insecurity index is constructed using principal component analysis. Labor market participation indicators take a value of 1 if any adult member of the household reported labor allocation for that category of activity within the last 7 days.

*Source:* Authors' calculations based on Nigeria LSMS-ISA 2018–19 and 2020 rounds. Values are weighted using the sampling weights discussed above.

generating activities significantly reduced in the post-COVID-19 round.

Households were also asked about the impact of the pandemic on major livelihood sources. These are self-assessed subjective indicators, but they can provide suggestive evidence on the differential sectoral (livelihood) impacts of the pandemic, which can complement our forthcoming difference-in-difference estimations. Households were asked for major sources of livelihood in the last 12 months and changes in associated income since the outbreak of COVID-19. As shown in Fig. 1, 72 percent of households reported reduction in farming income while 84 percent of households reported a reduction in income from non-farm businesses. About half of the households in our sample report reductions in wage-related incomes. These suggest that non-farm businesses are the most affected, and wage-related activities are relatively least affected. This is not surprising as some wage-related activities are likely to be under formal contractual agreements, and some of these activities may be performed remotely and hence less affected by mobility restrictions.

### 3.3.2. Key explanatory variables: state-level COVID-19 cases and government lockdowns

We compiled the COVID-19 cases and lockdown measures from the Nigerian Centre for Disease Control (NCDC) (NCDC, 2020; IFPRI, 2020). As our post-COVID-19 survey was fielded in April and May 2020, we extract confirmed COVID-19 cases until the end of May 2020. We compile government measures based on policy announcements by Federal and State Governments of Nigeria (FGN, 2020a; 2020b; NCDC, 2020). We focus on the strictest mobility restrictions, defining an indicator variable that takes a value of 1 for those states introducing lockdown measures to contain the spread of the virus, while those states which did not introduce lockdown measures take a value of 0.<sup>12</sup> The timing and length of lockdowns vary across states. As our post-COVID-19 survey was fielded in April and May 2020 and our food security questions elicit food shortage experiences in the last 30 days we consider lockdown measures introduced between March 28 to May 15, which resulted in 17 states out of the total 37 states in Nigeria (see Fig. 2). Thus, our main explanatory variables of interest are the number of COVID-19 cases and an indicator variable for those states who

<sup>12</sup> Nigeria has 36 states and one federal territory (the Federal Capital Territory). For simplicity, we refer to all these as 37 states. All states are included in the analysis.

introduced lockdown measures to contain the spread of the pandemic.<sup>13</sup> The number of COVID-19 cases may underestimate the true rate of infections in most Nigerian states because of limited testing capacity, generating some form of non-classical measurement error which could correlate with our outcomes of interest.<sup>14</sup> However, it is worth noting that what matters for household and state-level responses are actually confirmed cases and not the actual unknown infection rates. Furthermore, the use of alternative indicators, COVID-19 cases and lockdown measures, can help triangulate and probe our results.

The lockdown measures restrict movement of people and vehicles except for health personnel, fire service, security personnel, power and water supply agencies, pharmaceutical and medical services. We note that, although lockdown policies involve similar mobility restrictions, their implementation and stringency are likely to vary across states, which may introduce heterogeneity in the impact of these mobility restrictions.

The average state-level COVID-19 cases (at the end of May) is 222, and 46 percent of the states have imposed lockdown restrictions in the period March 28 through May 15. Fig. 2 presents the geographic distribution of confirmed COVID-19 cases and lockdown interventions (measured at the state levels) across states in Nigeria. As expected, federal and state-level governments are likely to introduce lockdown measures with increasing confirmed COVID-19 cases. However, some states with a high level of COVID-19 cases have abstained from introducing lockdown measures while some other states with low COVID-19 cases have announced lockdown measures. We exploit these variations in some of our estimations.

### 3.3.3. "Heterogeneity" variables

To better understand the differential implications of COVID-19 cases and associated lockdown measures on households' food security and labor market participation rates, we employ baseline characteristics of households to differentiate "vulnerable" households and livelihoods. As the impacts of the pandemic are likely to vary across households, we aim to uncover heterogeneous relationships across various groups, especially those deemed to be vulnerable households and regions. The availability of baseline surveys allows us to estimate the implication of the pandemic across various socioeconomic groups and regions. For instance, we explore potential differential implications across rural and urban households as well as across poor and non-poor households. We also classify households in remote and more accessible areas as well as across households living in conflicted affected and other states. We also construct indicators of household sources of livelihood in the past twelve months, including farming/agriculture, non-farm business, wage employment, and remittances and assistances. We then estimate heterogeneous responses across livelihood options.

## 4. Empirical strategy

To explore the effect of the coronavirus pandemic on households' food insecurity (our main outcome of interest) as well as labor market participation, we exploit spatial variations in the spread of the pandemic across states in Nigeria, along with the temporal variations in our outcomes of interest. We specifically estimate the following fixed effects specification to investigate the effect of the pandemic:

$$Y_{ht} = \alpha_h + \alpha_0 Post_t + \alpha_1 Cases_s * Post_t + \varepsilon_{ht} \quad (1)$$

where  $Y_{ht}$  stands for food insecurity and labor market outcomes for each household  $h$  and round  $t$ .  $\alpha_h$  captures household fixed effects,  $Cases$

<sup>13</sup> We also construct an indicator variable assuming a value of 1 for states above the median confirmed COVID-19 case and 0 for those states below the median COVID-19 case in our sample.

<sup>14</sup> The implications of such correlated non-classical measurement error are ambiguous (e.g., Abay et al., 2019).

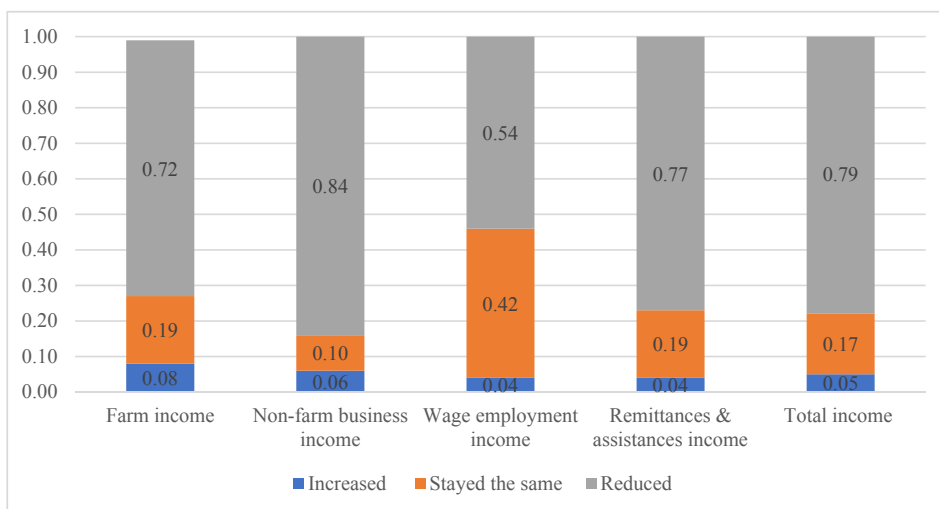


Fig. 1. Changes in income by sources since the outbreak of the pandemic.

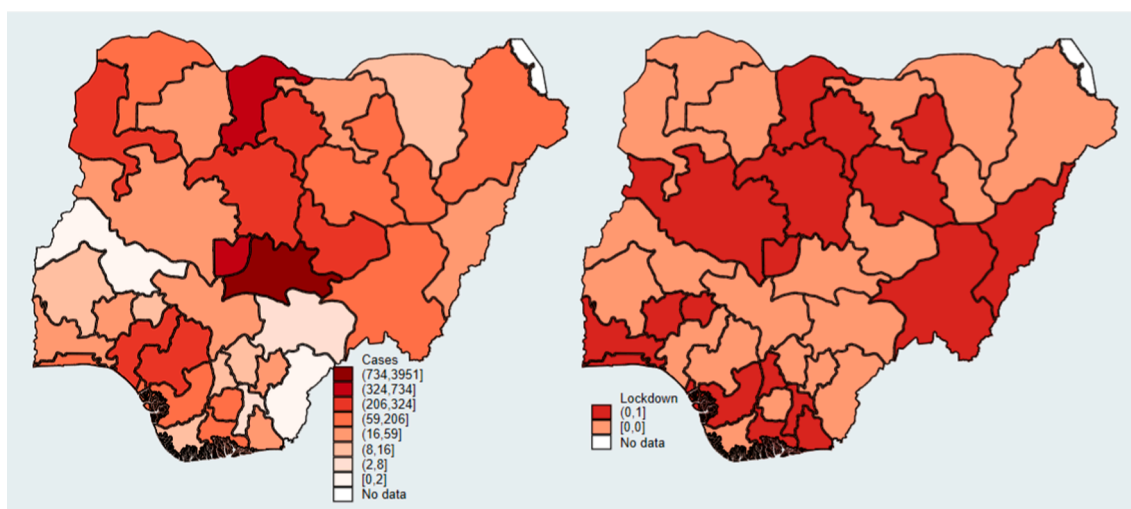


Fig. 2. Confirmed COVID-19 cases and Lockdown restrictions by states. Source: Federal Government of Nigeria (2020) and Nigeria Center for Disease Control (NCDC, 2020).

represent the number of confirmed COVID-19 cases for each state.  $Post_t$  is a dummy variable, assuming a value of 1 for the post-COVID-19 round and 0 for the pre-COVID-19 round. The parameter associated with this round dummy captures aggregate trends in food security and labor market outcomes. This variable also captures aggregate potential differences in our outcomes of interest driven by differences in survey methods (face-to-face or phone survey).  $\epsilon_{ht}$  is an error term that is assumed to be uncorrelated with COVID-19 cases, at least conditional on household fixed effects and state-level policy responses. The household fixed effects in Eq. (1) capture time-invariant heterogeneities across households. The specification in Eq. (1) is a standard difference-in-difference approach, except that our treatment intensity variable is continuous.

Our identifying variation in Eq. (1) comes from a combination of spatial variations in COVID-19 cases and temporal variations in our outcome of interest. The interaction term, between COVID-19 cases and post-COVID-19 round dummy, captures differential temporal evolution in our outcome of interest across states with varying exposure to the pandemic. We hypothesize that those states experiencing a higher intensity of the pandemic are more likely to witness a higher reduction in labor market participation and a higher increase in food insecurity. Thus, the estimation in Eq. (1) entails comparing the temporal evolution

of food security and labor market outcomes for those states with high and low exposure to the pandemic.

Potential temporal variations in food security and labor market participation rates are likely to be driven by both government responses to the pandemic as well as household-level responses associated with precautionary measures to reduce the contraction of the virus. The economic repercussions of the pandemic are expected to vary depending on individuals' precautionary measures and state-level government responses (Abay et al., 2020a; Koren and Petó, 2020). In line with this, various states in Nigeria have imposed alternative forms of restrictions and lockdowns, which are likely to affect individuals' mobility and hence the labor market and food security outcomes. To explore the differential and compounding effect of these lockdown measures, we estimate the following fixed effects specification:

$$Y_{ht} = \alpha_h + \beta_0 Post_t + \beta_1 lockdown_s * Post_t + \epsilon_{ht} \tag{2}$$

where  $lockdown_s$  now stands for a dummy variable indicating for the introduction of lockdown measures to contain the spread of the

pandemic.<sup>15</sup>  $\epsilon_{ht}$  is an error term that captures other unobservable factors. In some of our specifications, we further interact the spread of the pandemic with lockdown measures. However, the breadth and implementation of these lockdown measures are likely to vary across states. Thus, although such an exercise can give us some latitude to identify the relative impacts of the spread of the pandemic and government-induced restrictions, such results can only provide suggestive evidence.

The implications of the pandemic are likely to vary across households with varying socioeconomic status, livelihood options, and underlying conditions. We, thus, aim to uncover the potential differential implications across various groups of households. In particular, the impacts of the pandemic are expected to be higher among those households and regions deemed to be vulnerable, including poor households and those living in conflict-affected and remote zones. Using baseline information on households' residence, socioeconomic status, and livelihood options, we quantify the differential implications of the pandemic on households' food security and labor market participation using the following empirical specification:

$$Y_{ht} = \alpha_h + \delta_0 Post_t + \delta_1 Cases * Vulnerable_h * Post_t + \varphi_{ht} \tag{3}$$

where  $Vulnerable_h$  is a binary indicator of vulnerability,  $\varphi_{ht}$  is an idiosyncratic error term, and all other terms are defined as above. Our vulnerable group of households includes poorer, urban households and those living in remote and conflict-affected zones and neighborhoods.  $\delta_1$  in Eq. (3) capture differential trends in food security and labor market outcomes across those households deemed "vulnerable" and others, which can be attributed to the spread of the pandemic and associated lockdown restrictions.

We also examine potential differential implications across households with varying exposure to the pandemic because of their livelihood strategies and sectoral engagement in labor markets. For example, some sectors are likely to experience a disproportionately higher impact associated with social distancing and lockdown measures. For example, several recent economywide analyses of the impact of the pandemic show that services are the most affected sectors (e.g., Breisinger et al., 2020). Abay et al. (2020a) show that those sectors and services involving face-to-face interactions experience much higher loss in demand for services, while those services meant to substitute personal interactions (e.g., ICT services) enjoy a significant boost in demand. Traditional small non-farm businesses in Africa are likely to involve personal interactions and hence may be more affected than those activities that can be performed remotely. Similarly, rural activities might be less prone to the spread of the pandemic and associated lockdown measures for several reasons. First, the spread of the pandemic is likely to be higher among urban areas. Second, government responses and restrictions are expected to be stricter and more intense among urban areas. Third, urban food systems and value chains are likely to be more affected by short-term shocks than rural livelihoods. We thus estimate the following empirical specification to quantify the differential implications of the pandemic across livelihood options:

$$Y_{ht} = \alpha_h + \gamma_0 Post_t + \gamma_1 Cases * Livelihood_h * Post_t + \omega_{ht} \tag{4}$$

where all notations except "Livelihood" are as defined above.  $\omega_{ht}$  is an idiosyncratic error term. As shown in Table 1, households' livelihood options and sources of income in our sample include farming, non-farm business, wage-employment, and remittances and transfers.

To account for systematic non-response in the post-COVID-19 phone survey, we weighted all our estimates by the sampling weight associated

with the LSMS-ISA phone survey data.<sup>16</sup> This weighting procedure enables recovering unbiased and representative statistics under the assumption that data are "missing at random" conditional on some observable factors that are accounted in the construction of weights (e.g., Wooldridge, 2007; Korinek et al., 2007). Households living in the same enumeration area (EA) are likely to experience similar observable and unobservable shocks and services. Thus, we cluster standard errors at EA level. Even after tackling these shortcomings, we remain cautious in our causal identification claims. Although the fixed effects estimations capture time-invariant heterogeneities, we may still have some time-variant omitted factors that may affect both food security and the spread of the pandemic or associated lockdown measures.

## 5. Results and discussion

### 5.1. Food security outcomes

In this section, we present estimation results for Eqs. (1) and (2), which indicate how food security outcomes have varied with state-level infection rates and associated lockdown measures. Table 3 shows the implications of the spread of the pandemic on food security outcomes, measured as binary indicators of food insecurity experience. The number of reported COVID-19 cases for each state are transformed using an inverse hyperbolic sine transformation, to accommodate those few states with zero reported cases.<sup>17</sup> The interaction between COVID-19 cases and the post-COVID-19 dummy captures the temporal variation in the evolution of our outcomes of interest associated with varying exposure to the spread of the pandemic. A positive and significant coefficient shows that states registering higher numbers of COVID-19 cases are likely to experience greater increases in the probability of food insecurity, relative to the pre-COVID-19 period. The coefficients in Table 3 show that doubling the number of COVID-19 cases is associated

**Table 3**  
State-level COVID-19 cases and household food security outcomes.

	(1) Skip a meal	(2) Ran out of food	(3) Went without eating for a whole day	(4) Food insecurity index
Post dummy (2020 round)	0.393*** (0.050)	0.230*** (0.043)	0.105** (0.041)	0.642*** (0.093)
COVID-19 cases*Post	0.031** (0.015)	0.033*** (0.012)	0.031** (0.013)	0.078*** (0.028)
Household fixed effects	Yes	Yes	Yes	Yes
R-squared	0.39	0.22	0.15	0.37
No. observations	3764	3764	3764	3764

Notes: All estimation results are adjusted by sampling weights accounting for systematic non-response in the phone survey. The number of confirmed COVID-19 cases are transformed using an inverse hyperbolic sine transformation to accommodate one state with zero case. Standard errors, clustered at EA level, are given in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Source: Authors' calculations based on Nigeria's LSMS-ISA 2018–19 and 2020 rounds.

<sup>16</sup> A discussion on the construction of these sampling weights is given in NBS and World Bank (2020).

<sup>17</sup> As we have large positive values of COVID-19 cases for most states, such a transformation is expected to be innocuous (e.g., Bellemare and Wichman, 2020).

<sup>15</sup> We note that as the number of COVID-19 cases are strongly correlated with government responses to the pandemic, we cannot control for both COVID-19 cases and government measures in the same specification.

with a 3-percentage points increase in the probability that a household ran out of food or skipped a meal in the last 30 days.<sup>18</sup> Similarly, an increase in the number of COVID-19 cases is associated with a significant increase in the aggregate food insecurity index. The magnitude of the estimate is plausible for the population as a whole, although we would expect significant heterogeneities across different types of households and contexts, an empirical question we address in the next section.

The relationships and estimates shown in Table 3 are likely to be compounded by national and state-level government responses to the pandemic, which included social distancing and mobility restrictions as well as partial and complete lockdown measures. We thus estimate the empirical specification in Eq. (2) to quantify the implication of variations in state-level responses to the pandemic. We mainly focus on the strictest mobility restrictions and hence generate an indicator variable for states introducing lockdown measures. We then compare temporal evolutions in food security outcomes across states with and without lockdown measures. Table 4 generally shows that lockdown measures increase food insecurity. For example, we find that state-level lockdowns increase the probability that a household skips a meal in the last 30 days by 15 percentage points.

To jointly examine the effects of infection rates and lockdowns, we also interact the indicator variables for the spread of the pandemic with lockdown measures. To facilitate this, we construct an indicator variable assuming a value of 1 for states above the median confirmed COVID-19 case and 0 for those states below the median COVID-19 case in our sample. Interacting these indicators gives us four groups: high COVID-19 cases with lockdown, high COVID-19 cases without a lockdown, low COVID-19 cases with lockdown, and low COVID-19 cases without lockdown. The estimation results are shown in Table 5. As expected, households in states recording high COVID-19 cases and with lockdown measures are hit hardest and hence experience the greatest increase in food insecurity. Coefficient estimates suggest that both the spread of the pandemic as well as government-induced lockdown measures are associated with increased food insecurity. However, the former seems to dominate.

**Table 4**  
Governmental pandemic responses and household food security outcomes.

	(1) Skip a meal	(2) Ran out of food	(3) Went without eating for a whole day	(4) Food insecurity index
Post dummy (2020 round)	0.421*** (0.031)	0.297*** (0.032)	0.171*** (0.024)	0.775*** (0.068)
Lockdown*Post	0.146*** (0.041)	0.075* (0.042)	0.063* (0.037)	0.234*** (0.087)
Household fixed effects	Yes	Yes	Yes	Yes
R-squared	0.41	0.27	0.19	0.37
No. observations	3764	3764	3764	3764

Note: Dependent variables are as defined in Table 2. All estimations are adjusted by sampling weights accounting for non-response in the phone survey. Lockdown is an indicator variable taking a value of 1 for those states which introduced lockdown measures to contain the spread of the virus. Standard errors, clustered at EA level, are given in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: Authors' calculations based on Nigeria LSMS-ISA 2018–19 and 2020 rounds.

<sup>18</sup> We note that, as the spread of the pandemic remains fast globally, doubling of COVID-19 cases takes only a few weeks (in some cases less than a week) in many countries, including in Nigeria.

**Table 5**  
COVID-19 cases, government responses and household food security outcomes.

	(1) Skip a meal	(2) Ran out of food	(3) Went without eating for a whole day	(4) Food insecurity index
Post dummy (2020 round)	0.404*** (0.042)	0.241*** (0.040)	0.118*** (0.034)	0.669*** (0.087)
High COVID-19 cases*Lockdown	0.209*** (0.052)	0.174*** (0.053)	0.126** (0.052)	0.434*** (0.111)
High COVID-19 cases*No-lockdown	0.037 (0.063)	0.121* (0.062)	0.113** (0.051)	0.230* (0.133)
Low COVID-19 cases*Lockdown	0.052 (0.062)	0.027 (0.057)	0.090 (0.076)	0.109 (0.120)
Household fixed effects	Yes	Yes	Yes	Yes
R-squared	0.42	0.26	0.16	0.38
No. observations	3764	3764	3764	3764

Note: “High” and “Low” COVID-19 cases are defined as above and below the median confirmed values in our sample, respectively. Lockdown stands for indicator variables for those states who introduced lockdown measures to contain the spread of the virus. All estimations are adjusted by sampling weights for accounting non-response in the phone survey. Standard errors, clustered at EA level, are given in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: Authors' calculations based on Nigeria LSMS-ISA 2018–19 and 2020 rounds.

### 5.2. Labor market participation outcomes

Reduction in household income is one of the most important mechanisms through which the COVID-19 pandemic can affect food insecurity. Results in Table 6 show the implication of the spread of the pandemic on labor market participation rates. As expected, the spread of the pandemic is associated with a significant reduction in economic activity. The interaction term in column 1 of Table 6 shows that doubling the number of COVID-19 cases is associated with a 2-percentage point reduction in the probability of participation in any economic activity (in the last seven days). The second column presents its implication on-farm activities, while the third and fourth columns report similar estimates for non-farm business and wage-related activities. Overall, these results imply that households in areas with a higher

**Table 6**  
COVID-19 cases and labor market participation outcomes.

	(1) Working any activity	(2) Farm activities	(3) Non-farm business	(4) Wage employment
Post dummy (2020 round)	-0.222*** (0.033)	-0.093** (0.047)	-0.210*** (0.048)	-0.081* (0.042)
COVID-19 cases*Post	-0.015** (0.007)	-0.041*** (0.015)	-0.017 (0.016)	-0.017 (0.015)
Household fixed effects	Yes	Yes	Yes	Yes
R-squared	0.54	0.18	0.22	0.26
No. observations	3764	3764	3764	3764

Note: All estimations are adjusted by sampling weights for accounting non-response in the phone survey. The number of confirmed COVID-19 cases is transformed using inverse hyperbolic sine transformation to keep zero cases for few states. Standard errors, clustered at EA level, are given in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: Authors' calculations based on Nigeria LSMS-ISA 2018–19 and 2020 rounds.



degree of exposure to the pandemic have experienced significant reductions in economic engagement.

Similar to the food security results, the results shown above are likely to be compounded by government lockdown measures. Table 7 shows that lockdowns limit economic activities and hence households' participation in labor market activities. Interestingly, state-level lockdown measures are associated with larger reductions in non-farm business activities. As expected, wage-related activities appear to be less affected by state-level lockdown measures, perhaps due to the following important reasons. First, wage-related activities may still be operated remotely and hence individuals can continue working remotely (e.g., Dingel and Neiman, 2020). Second, individuals engaged in wage-related activities are likely to have formal contracts and hence less likely to lose their job in short notice. For instance, more than half of the wage employees in our data are employed in government and non-governmental organizations, which are less likely to fire employees but allow employees operate some of their functions in some form. These findings are consistent with global evidence on the differential sectoral impact of the pandemic (e.g., Dingel and Neiman, 2020; Abay et al., 2020a).

### 5.3. Differentiating outcomes across sub-populations

#### 5.3.1. Differentiating outcomes across household types and geography

The effects of the coronavirus pandemic are likely to vary across households due to differences in underlying conditions and exposure to the pandemic. For instance, urban households are likely to experience higher exposure to the pandemic, and hence they are likely to experience reductions in economic activities. Similarly, poorer households and those in remote areas and conflict zones could see further deterioration in food security because of disruptions in local and national transportation systems and markets. Such heterogeneous impacts may also vary by type of outcome. For instance, while urban households are likely to experience reductions in economic activities, poorer and remotely located households may be more likely to face food security challenges. For this purpose, we define indicator variables for urban and poor households, those in remote areas (those households located above the median distance to main road), and those in conflict-affected areas. These variables are interacted with state-level COVID-19 cases and lockdown indicators to explore potential differential implications across households.

Results, presented in Table 8, show that poor households and those households living in remote areas and conflict-affected North-East Nigeria (Yobe, Borno, Bauchi, Gombe, Taraba, and Adamawa States) are more likely to experience further deterioration in food security. These

**Table 7**  
Government pandemic responses and labor market participation outcomes.

	(1) Working any activity	(2) Farm activities	(3) Non-farm business	(4) Wage employment
Post dummy (2020 round)	-0.265*** (0.022)	-0.176*** (0.029)	-0.317*** (0.030)	-0.121*** (0.020)
Lockdown*Post	-0.051** (0.021)	-0.089** (0.044)	-0.121*** (0.043)	-0.022 (0.034)
Household fixed effects	Yes	Yes	Yes	Yes
R-squared	0.54	0.14	0.19	0.25
No. observations	3764	3764	3764	3764

Note: All estimations are adjusted by sampling weights for accounting non-response in the phone survey. Lockdown stands for indicator variables for those states who introduced lockdown measures to contain the spread of the virus. Standard errors, clustered at EA level, are given in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Source: Authors' calculations based on Nigeria LSMS-ISA 2018–19 and 2020 rounds.

**Table 8**

COVID-19 cases, governmental responses, and household food security outcomes, with household type and geography interactions.

Panel A: COVID-19 cases and household food security outcomes				
	(1) Skip a meal	(2) Ran out of food	(3) Went without eating for a whole day	(4) Food insecurity index
Post dummy (2020 round)	0.481*** (0.024)	0.321*** (0.025)	0.184*** (0.020)	0.830*** (0.042)
COVID-19 cases*Urban*Post	0.007 (0.013)	0.012 (0.013)	0.017 (0.014)	0.027 (0.028)
COVID-19 cases*Remote*Post	0.014 (0.011)	0.031*** (0.010)	0.022** (0.010)	0.059** (0.023)
COVID-19 cases*Asset poor tercile*Post	0.037*** (0.013)	0.022* (0.012)	0.027* (0.016)	0.067** (0.029)
COVID-19 cases*North East Zone*Post	0.021* (0.011)	0.000 (0.012)	0.034* (0.018)	0.039* (0.020)
Household fixed effects	Yes	Yes	Yes	Yes
R-squared	0.41	0.25	0.15	0.36
No. observations	3764	3764	3764	3764
Panel B: Governmental lockdown measures and household food security outcomes				
Post dummy (2020 round)	0.481*** (0.023)	0.325*** (0.024)	0.192*** (0.020)	0.865*** (0.049)
Lockdown*Urban*Post	0.044 (0.054)	0.041 (0.051)	0.053 (0.056)	0.107 (0.105)
Lockdown*Remote*Post	0.093** (0.039)	0.056 (0.041)	0.060 (0.045)	0.167** (0.085)
Lockdown*Asset poor tercile*Post	0.226*** (0.053)	0.135* (0.069)	0.111 (0.083)	0.392*** (0.142)
Lockdown*North East Zone*Post	0.019* (0.010)	0.022 (0.050)	0.136* (0.076)	0.033* (0.017)
Household fixed effects	Yes	Yes	Yes	Yes
R-squared	0.41	0.25	0.15	0.36
No. observations	3764	3764	3764	3764

Note: All estimations are adjusted by sampling weights for accounting non-response in the phone survey. The number of confirmed COVID-19 cases is transformed using inverse hyperbolic sine transformation to keep zero cases for few states. Lockdown stands for indicator variables for those states who introduced lockdown measures to contain the spread of the virus. Standard errors, clustered at EA level, are given in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Source: Authors' calculations based on Nigeria LSMS-ISA 2018–19 and 2020 rounds.

findings hold both in Panel A (using COVID-19 cases) and Panel B (using lockdown measures) of Table 8. On the other hand, although urban households reduce economic activities (as we show in Table 9), they do not suffer from disproportionately higher reductions in food security. This finding is probably because of better underlying food security and improved access to markets. On the other hand, poorer households experience significant increases in all indicators of food insecurity. Consistent with this argument, Bargain and Aminjonov (2020) use Google mobility data and document that mobility reductions are relatively smaller in poor neighborhoods in developing countries, possibly because poorer households in such settings are less able to afford the costs of reduced mobility in compliance with government restrictions.

The results in Table 9 provide differential relationships and implications of the spread of the pandemic and associated lockdown measures on households' labor market participation and economic activities. These results indicate that urban households and those households located in remote areas and conflict-affected areas of North East Nigeria are likely to experience significantly larger reductions in economic

**Table 9**  
COVID-19 cases, governmental responses, and labor market participation outcomes, with household type and geography interactions.

Panel A: COVID-19 cases and labor market participation outcomes				
	(1) Working any activity	(2) Farm activities	(3) Non-farm business	(4) Wage employment
Post dummy (2020 round)	-0.259*** (0.018)	-0.274*** (0.023)	-0.235*** (0.027)	-0.108*** (0.020)
COVID-19 cases*Urban	-0.041** (0.020)	-0.069*** (0.018)	-0.033** (0.014)	-0.027*** (0.010)
COVID-19 cases*Remote	-0.020** (0.008)	-0.037*** (0.012)	-0.024** (0.012)	-0.009 (0.012)
COVID-19 cases*Asset Poor	-0.000 (0.011)	-0.040*** (0.013)	-0.008* (0.005)	0.011 (0.009)
COVID-19 cases*North East Zone	-0.014* (0.008)	-0.065*** (0.016)	-0.047*** (0.014)	-0.015 (0.016)
Household fixed effects	Yes	Yes	Yes	Yes
R-squared	0.22	0.14	0.15	0.08
No. observations	3764	3764	3764	3764
Panel B: Government lockdown measures and labor market participation outcomes				
Post dummy (2020 round)	-0.263*** (0.017)	-0.238*** (0.023)	-0.263*** (0.025)	-0.115*** (0.018)
Lockdown*Urban*Post	-0.042* (0.025)	0.159** (0.078)	0.006 (0.055)	-0.118*** (0.042)
Lockdown*Remote*Post	-0.043 (0.033)	-0.124*** (0.045)	-0.086* (0.047)	-0.043 (0.044)
Lockdown*Asset poor tercile*Post	-0.031 (0.050)	-0.158*** (0.055)	0.087 (0.062)	0.078** (0.039)
Household fixed effects	Yes	Yes	Yes	Yes
R-squared	0.22	0.14	0.15	0.08
No. observations	3764	3764	3764	3764

Note: All estimations are adjusted by sampling weights for accounting non-response in the phone survey. The number of confirmed COVID-19 cases is transformed using inverse hyperbolic sine transformation to keep zero cases for few states. Lockdown stands for indicator variables for those states who introduced lockdown measures to contain the spread of the virus. Standard errors, clustered at EA level, are given in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Source: Authors' calculations based on Nigeria LSMS-ISA 2018–19 and 2020 rounds.

activities. For example, urban households are more likely to experience higher reduction in economic activities, despite significant variations across various types of economic activities. Households in urban areas reduce non-farm business and wage-related activities while increasing farm activities. This implies that the pandemic can also lead to the reallocation of labor resources across alternative economic activities and sectors of economies. Similarly, households in remote areas and those in conflicted-affected areas are disproportionately affected by the COVID-19 crisis and hence reduce all forms of economic activities. These patterns are consistently observed when using both COVID-19 cases and lockdown measures to capture the spread of the pandemic.

### 5.3.2. Differentiating outcomes across livelihood orientations

In this section, we explore potentially heterogeneous implications of the pandemic across households with varying livelihoods and sources of incomes. Several studies from developed countries, where administrative and transaction-level data are available, show that the pandemic has had heterogeneous impacts on different livelihood activities and sectors. For instance, livelihoods and sectors that can operate on a remote basis with limited personal interactions or those functionally dependent on the internet are likely to be less affected, relative to those

involving personal interactions (Dingel and Neiman, 2020; Abay et al., 2020a). Similarly, some livelihood options and sectors are likely to experience a relatively higher disruption in economic activities. For instance, government-imposed mobility restrictions often disrupt supply chains, which may prove most challenging for small businesses with smaller stock. Thus, those households relying on non-farm business activities are likely to experience disproportionately higher impacts associated with disruptions in value chains caused by the pandemic and related mobility restrictions. Although not many rural activities in Nigeria are functionally dependent on the internet, some activities can be operated without many personal interactions with others and hence may be relatively less prone to these restrictions and lockdown measures.

We hypothesize that households relying on alternative livelihood options and economic sectors may be relatively more resilient to the shocks associated with pandemic. For instance, as shown in Fig. 1 and Table 6, those households relying on non-farm businesses, witness the highest reduction in income and economic activities. On the other hand, wage-related activities and income sources are least affected by lockdown measures (Fig. 1 and Table 6). The estimations in Table 10 probe these relationships further to explore heterogeneous implications across households' livelihood and income sources.

The results in Table 10 consistently show that those households relying on on-farm activities and non-farm businesses experience a significant increase in food insecurity associated with the spread of the pandemic and associated lockdowns. Those households relying on wage employment, and remittances and assistance income are not significantly affected by the pandemic and associated lockdowns. This is consistent with the self-assessed evidence from Fig. 1. This is not surprising as some wage-related activities may still be operated remotely, or individuals engaged in wage-related activities have longer-term contracts or savings that they can draw on during crises of this type.

## 6. Concluding remarks

We have employed recent nationally representative data from Nigeria to explore the ways in which the COVID-19 pandemic has affected both urban and rural households' food security outcomes. Our analysis suggests that the spread of the pandemic, as well as governmental mobility restrictions (i.e., lockdowns), have both had significant influences on food security outcomes reported by households in our sample. Furthermore, our analysis suggests that household labor market participation is a key intermediate channel through which food security outcomes are mediated. We do not have enough information to relate lockdown restrictions to the avoided (or delayed) number of new cases, and so cannot directly speak to the tradeoffs that government lockdown policies imply. However, our analysis indicates that there are measurable food insecurity costs associated with infection rates, as well as the restrictions designed to contain the spread of the pandemic. State-level lockdown measures are associated with a 12-percentage points reduction in the probability of participation in non-farm business activities and 6–15 percentage points increase in food insecurity experience. Our finding that government-imposed lockdowns are associated with increased food insecurity is consistent with a recent review of grey literature indicating that the main food security impacts of the pandemic have been through lockdown and mobility restrictions, with direct effects operating through income losses and reduced purchasing power, with such effects being particularly acute for the poorest households (Béné, 2020). Our findings are directly relevant to the debate on the aggregate social welfare and economic impacts of lockdown restrictions in low-and-middle-income countries, which recently has come under some criticism (e.g., Ravallion, 2020, Mobarak and Barnett-Howell, 2020, Bargain and Aminjonov, 2020).

Our analysis also indicates that the implication and effects of the pandemic vary considerably across household types and geographic contexts. Most of our results accord with prior expectations. For

**Table 10**  
COVID-19 cases, governmental responses, and household food security outcomes, with livelihood orientation category interactions.

Panel A: COVID-19 cases and household food security outcomes				
	(1) Skip a meal	(2) Ran out of food	(3) Went without eating for a whole day	(4) Food insecurity index
Post dummy (2020 round)	0.419*** (0.037)	0.260*** (0.036)	0.182*** (0.033)	0.729*** (0.078)
COVID-19 cases*Farming	0.028** (0.012)	0.029** (0.012)	0.007 (0.011)	0.062** (0.025)
COVID-19 cases*Non-farm business	0.021** (0.011)	0.022** (0.011)	0.020** (0.009)	0.053** (0.021)
COVID-19 cases*Wage employment	-0.028** (0.012)	-0.005 (0.011)	-0.021** (0.010)	-0.035 (0.021)
COVID-19 cases*Remittances and assistances	0.001 (0.012)	0.013 (0.013)	-0.001 (0.011)	0.017 (0.025)
Household fixed effects	Yes	Yes	Yes	Yes
R-squared	0.41	0.25	0.14	0.37
No. observations	3764	3764	3764	3764
Panel B: Government lockdown measures and household food security outcomes				
Post dummy (2020 round)	0.421*** (0.028)	0.293*** (0.029)	0.179*** (0.022)	0.773*** (0.062)
Lockdown*Farming* Post	0.177*** (0.041)	0.101** (0.042)	0.054 (0.038)	0.288*** (0.088)
Lockdown*Non-farm business* Post	0.123*** (0.043)	0.076* (0.042)	0.081** (0.035)	0.224*** (0.084)
Lockdown*Wage employment* Post	-0.064 (0.058)	0.002 (0.060)	-0.078 (0.049)	-0.075 (0.116)
Lockdown*Remittances and assistances*Post	0.058 (0.049)	0.068 (0.059)	-0.048 (0.051)	0.116 (0.110)
Household fixed effects	Yes	Yes	Yes	Yes
R-squared	0.41	0.24	0.15	0.36
No. observations	3764	3764	3764	3764

Note: All estimations are adjusted by sampling weights for accounting non-response in the phone survey. The number of confirmed COVID-19 cases is transformed using inverse hyperbolic sine transformation to keep zero cases for few states. Lockdown stands for indicator variables for those states who introduced lockdown measures to contain the spread of the virus. Standard errors, clustered at EA level, are given in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Source: Authors' calculations based on Nigeria LSMS-ISA 2018–19 and 2020 rounds.

example, the food security outcomes of poorer households, and those living in conflict-affected areas are most sensitive to the spread of the pandemic and associated lockdown measures: lockdown measures appear to be most disruptive of non-farm business activities, and those households relying on these activities experience the highest reductions in income and increases in food insecurity. Lockdown measures have weaker implications on wage-related activities.

It is important to note that the current analysis is examining short-term implications of the pandemic, i.e., those occurring during the first 3 months of significant disruption. It is possible that the estimated elasticities of food insecurity and economic engagement to the spread of the pandemic and lockdowns may change over time. Nevertheless, income deterioration experienced by households soon after the outbreak of the pandemic may have longer-term effects because of potential impacts on agricultural inputs, health care, schooling and other investments in the coming months. Our results align with other analysis which has underscored the urgency of effective social safety net

expansion to address such exacerbated vulnerabilities and mitigate against longer term welfare deteriorations (Amjath-Babu et al., 2020; Bénéd, 2020).

We acknowledge some limitations to this study. First, our phone survey data do not allow us to observe detailed intrahousehold consumption patterns, nor patterns over alternative time scales.<sup>19</sup> Future data collection efforts may address such limitations with more detailed intrahousehold consumption questions, measured over different periods. Second, our food security measures were based on a few critical questions capturing the most severe food insecurity, rather than the full set of questions forming the Food Insecurity Experience Scale (FIES) (Caffero et al., 2018). In the context of Nigeria, these questions are expected to reasonably capture households' food security status, but a full set of FIES questions may generate additional insights on various domains of food insecurity. Thus, comparisons of our results with those of other studies of food security impacts should consider possible differences in outcome indicator construction. Finally, we must acknowledge that this is an observational study, and as such we do not have the privilege of observing randomized variation in state-level pandemic infection rates or associated lockdown measures. We acknowledge potential concerns that infection counts and/or lockdown responses may be correlated with other unobserved factors influencing food security. However, such correlations would likely have to do with factors which are effectively time-invariant, i.e., changing very slowly over time, and not over the relatively short term of our study. This suggests that our reliance on fixed effects estimation to address unobserved time-invariant sources of bias is a valid strategy to address such concerns.<sup>20</sup> As with any observational study, our claims for causal identification are made with circumspection.

Our analysis contributes new empirical data on the pandemic's welfare consequences at a point where there is an abundance of conceptual papers and opinion pieces but still relatively scant empirical evidence on actual impacts, particularly in developing countries. One of the policy implications of our study is the need to address social safety nets in rural areas as well as urban areas, which have been the focus of much of the discussion in the region to date (Abay et al., 2020b; Gentilini et al., 2020; Gilligan, 2020; Devereux et al., 2020). Our findings can inform immediate and medium-term social protection policies as well as help governments and international donor agencies improve their targeting strategies to identify the most impacted sub-populations. For example, Abay et al. (2020b) find that the productive safety net program (PSNP) in Ethiopia significantly mitigates the adverse effect of the COVID-19 pandemic. Further empirical analysis across a wider variety of national policy and economic contexts in the region may further clarify such relationships and the policy lessons they imply.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgements

This paper has been prepared as an output of the Nigeria Strategy Support Program, managed by the International Food Policy Research

<sup>19</sup> Longer phone surveys are likely to suffer from response fatigue (Abay et al., 2021).

<sup>20</sup> A related concern is with potential bias arising from non-random phone-survey participation. This sample is based on those households in the pre-COVID-19 round who provided a valid phone number. While this condition could generate selection bias in some contexts, we note that 99.2% of the sample provided such numbers, providing some reassurance that this is not a major identification threat to our analysis.

Institute (IFPRI) and supported by the United States Agency for International Development (USAID). The research presented here was also funded by and conducted as part of the CGIAR Research Program on Policies, Institutions, and Markets (PIM), which is led by IFPRI. Abay and Tiberti acknowledge support from the Partnership for Economic Policy (PEP), which is financed by the Department for International Development (DFID) of the United Kingdom (UK Aid) and the International Development Research Centre (IDRC) of Canada. We received constructive comments from two anonymous reviewers, which significantly improved the paper.

## References

- Abay, K.A., Abate, G.A., Barrett, C.B., Bernard, T., 2019. Correlated non-classical measurement errors and 'Second Best' policy inference: The case of the inverse size-productivity relationship in agriculture. *J. Dev. Econ.* 139, 171–184.
- Abay, K.A., Tafere, K., Woldemichael, A., 2020a. Winners and Losers from COVID-19: Global Evidence from Google Search (English). Policy Research working paper; no. WPS 9268; COVID-19 (Coronavirus). World Bank Group, Washington, D.C..
- Abay, K.A., Berhane, G., Hoddinott, J., Tafere, K., 2020b. COVID-19 and Food Security in Ethiopia: Do Social Protection Programs Protect? IFPRI Discussion Paper.
- Abay, K.A., Berhane, G., Hoddinott, J., Tafere, K., 2021. Assessing Response Fatigue in Phone Surveys: Experimental Evidence on Dietary Diversity in Ethiopia (English). Policy Research working paper; no. WPS 9636. World Bank Group, Washington, D.C.
- Adjognon, S.G., Bloem, J., Sanoh, A., 2020. The coronavirus pandemic and food security: Evidence from West Africa. Policy Research Working Paper 9474.
- Aggarwal, S., Jeong, D., Kumar, N., Robinson, J., Spearot, S., 2020. Did COVID-19 market disruptions disrupt food security? Evidence from households in rural Liberia and Malawi. Tech. rep., National Bureau of Economic Research.
- Akter, S., 2020. The impact of COVID-19 related 'stay-at-home' restrictions on food prices in Europe: findings from a preliminary analysis. *Food Security*, 1–7.
- Amare, M., Jensen, N.D., Shiferaw, B., Cisse, J.D., 2018. Rainfall shocks and agricultural productivity: Implication for rural household consumption. *Agric. Syst.* 166, 79–89.
- Amjath-Babu, T., Krupnik, T., Thilsted, S., McDonald, A., 2020. Key indicators for monitoring food system disruptions caused by the COVID-19 pandemic: Insights from Bangladesh towards effective response. *Food Security* 1–8.
- Andam, K., Edeh, H., Oboh, V., Pauw, K., Thurlow, J., 2020. Impact of COVID-19 on Production, Poverty and Food Systems. International Food Policy Research Institute (IFPRI), Washington, D.C.
- Arndt, C., Davies, R., Gabriel, S., Harris, L., Makrelou, K., Robinson, S., Anderson, L., 2020. Covid-19 lockdowns, income distribution, and food security: An analysis for South Africa. *Global Food Security* 26.
- Baldwin, R., Weder di Mauro, B., 2020. Mitigating the COVID Economic Crisis. Centre for Economic and Policy Research, London.
- Bargain, O., Aminjonov, U., 2020. Between a Rock and a Hard Place: Poverty and COVID-19 in Developing Countries. IZA DP No. 13297.
- Barrett, C.B., 2020. Actions now can curb food systems fallout from COVID-19. *Nature Food* 1–2.
- Barrett, C., Reardon, T., Swinnen, J., Zilberman, D., 2019. Structural Transformation and Economic Development: Insights from the Agri-food Value Chain Revolution. Working Paper, Dyson School of Applied Economics and Management, Cornell University.
- Bellemare, M.F., Novak, L., 2017. Contract farming and food security. *Am. J. Agric. Econ.* 99(2), 357–378.
- Bellemare, M.F., Wichman, C.J., 2020. Elasticities and the inverse hyperbolic sine transformation. *Oxford Bull. Econ. Statistics* 82 (1), 50–61.
- Benson, T., Amare, M., Ogunniyi, A., 2020. The relative commercial orientation of smallholder farmers in Nigeria: Household and crop value-chain analyses. NSSP Working Paper 66. International Food Policy Research Institute (IFPRI), Washington, DC.
- Béné, C., 2020. Resilience of local food systems and links to food security—A review of some important concepts in the context of COVID-19 and other shocks. *Forthcoming in Food Security*.
- Breisinger, C., Abdelatif, A., Raouf, M., Wiebelt, M., 2020. COVID-19 and the Egyptian economy: Estimating the impacts of expected reductions in tourism, Suez Canal revenues, and remittances. International Food Policy Research Institute (IFPRI): Regional Program Policy Note 06.
- Cafiero, C., Viviani, S., Nord, M., 2018. Food security measurement in a global context: The food insecurity experience scale. *Measurement* 116, 146–152.
- Carletto, C., Zezza, A., Banerjee, R., 2013. Towards better measurement of household food security: Harmonizing indicators and the role of household surveys. *Global Food Security* 2 (1), 30–40.
- Ceballos, F., Kannan, S., Kramer, B., 2020. Impacts of a national lockdown on smallholder farmers' income and food security: Empirical evidence from two states in India. *World Dev.* 136.
- Devereux, S., Béné, C., Hoddinott, J., 2020. Conceptualizing COVID-19's impacts on household food security. *Food Security* 1–4.
- Diao, X., Mahrt, K., 2020. Assessing the Impacts of COVID-19 in Myanmar on Household Incomes and Poverty Due to Declines in Remittances. Myanmar Strategy Support Program Policy Note 06. International Food Policy Research Institute, Yangon.
- Dingel, J.L., Neiman, B., 2020. How many jobs can be done at home? *J. Public Econ.* 189, 104235.
- Ericksen, P.J., 2008. Conceptualizing food systems for global environmental change research. *Global Environ. Change* 18, 234–245.
- Ericksen, P.J., Bohle, H.-G., Stewart, B., 2010. Vulnerability and resilience of food systems. *Food Security and Global Environmental Change*. Earth scan, London & Washington DC: 67–77.
- FAO, 2020. National Policy Responses to Limit the Impact of COVID-19 on Food Markets. Food Policy and Market Developments. Rome, Italy: Food and Agriculture Organisation of the United Nations (FAO). 2020.
- FGN, 2020a. Address By His Excellency Muhammadu Buhari, President of the Federal Republic of Nigeria, on the COVID-19 Pandemic, 29th March 2020. Abuja, Nigeria: Federal Government of Nigeria (FGN).
- FGN, 2020b. Address by His Excellency Muhammadu Buhari, President of the Federal Republic of Nigeria, on the Extension of the COVID-19 Pandemic Lockdown, State House. Federal Government of Nigeria (FGN), Abuja, Nigeria.
- FMBNP (Federal Ministry of Budget and National Planning), 2020. Ministerial Press Statement on Fiscal Stimulus Measures in Response to the COVID-19 Pandemic & Oil Price Fiscal Shock. FMBNP, Abuja, Nigeria.
- GAIN, 2020. Impact of COVID-19 on Food Systems: A Situation Report, Edition 3. May 13, 2020. Global Alliance for Improved Nutrition, Geneva, Switzerland.
- Gentilini, U., Almenfi, M., Dale, P., Lopez, A.V., Zafar, U., 2020. Social Protection and Jobs Responses to COVID-19: A Real-Time Review of Country Measures. Working paper.
- Gilligan, D., 2020. Social safety nets are crucial to the COVID-19 response. Some lessons to boost their effectiveness. International Food Policy Research Institute Blog.
- Global Hunger Index, 2019. The Challenge of Hunger and Climate Change: The Challenge of Hunger and Climate Change. International Food Policy Research Institute, Washington, DC, WHH (Welthungerhilfe), Bonn, and Concern Worldwide, Dublin.
- Haddad, L., Fanzo, J., Godfrey, S., Hawkes, C., Morris, S., Neufeld, L., 2020. The COVID-19 crisis and food systems: Addressing threats, creating opportunities.
- Hirvonen, K., de Brauw, A., Abate, G.T., 2021a. Food Consumption and Food Security during the COVID-19 Pandemic in Addis Ababa. *Forthcoming. Am. J. Agric. Econ.*
- Hirvonen, K., Mohammed, B., Minten, B., Tamru, S., 2021a. Food marketing margins during the COVID-19 pandemic: Evidence from vegetables in Ethiopia. *Forthcoming, Agricultural Economics*.
- Hoddinott, J., 1999. Choosing outcome indicators of household food security. International Food Policy Research Institute, Washington, DC.
- IFPRI, 2020. COVID-19 Policy Response (CPR) Portal. <https://www.ifpri.org/project/covid-19-policy-response-cpr-portal>.
- Ihle, R.O., Rubin, D., Bar-Nahum, Z., Jongeneel, R., 2020. Imperfect food markets in times of crisis: economic consequences of supply chain disruptions and fragmentation for local market power and urban vulnerability. *Food Security* 12, 727–734.
- IMF, 2020. Nigeria: Request for Purchase Under the Rapid Financing Instrument. International Monetary Fund Country Report No. 20/142, Washington, D.C. 20090.
- Kansime, M., Tambo, J., Mugambi, I., Bundi, M., Kara, A., Owuor, R., 2020. COVID-19 implications on household income and food insecurity in Kenya and Uganda: Findings from a rapid assessment. *World Dev.* 137.
- Koren, M., Petó, R., 2020. Business disruptions from social distancing. The Centre for Economic Policy Research (CEPR), COVID Economics vetted and real-time papers. Issue 2 April 8, 2020.
- Korinek, A., Mistiaen, J.A., Ravallion, M., 2007. An econometric method of correcting for unit nonresponse bias in surveys. *J. Econometr.* 136 (1), 213–235.
- Mahmut, M., Riley, E., 2020. Household response to an extreme shock: Evidence on the immediate impact of the COVID-19 lockdown on economic outcomes and wellbeing in rural Uganda. Working Paper.
- Mohamed, A., Barnett-Howell, Z., 2020. Poor countries need to think twice about social distancing. *Foreign Policy*.
- Mahajan, K., Tomar, S., 2021. COVID-19 and Supply Chain Disruption: Evidence from Food Markets in India. *Am. J. Agric. Econ.* 103 (1), 35–52.
- NBS and World Bank, 2020. Nigeria COVID -19 National Longitudinal Phone Survey (COVID -19 NLPS).
- NCDC, 2020. First Case of Corona Virus Disease Confirmed in Nigeria. Abuja, Nigeria: Nigeria Centre for Disease Control (NCDC). Downloaded on June 27th 2020.
- Obi, C., Bartolini, F., D'Haese, M., 2020. International migration, remittance and food security during food crises: the case study of Nigeria. *Food Security* 12, 207–220.
- Ogundele, K., 2020. Updated: FG Places Travel Ban on China, Italy, US, UK, Nine Others. The Punch, March 18, 2020.
- Ravallion, M., 2020. Pandemic policies in poor places. Center for Global Development, Washington DC.
- Reardon, T., Bellemare, M.F., Zilberman, D., 2020a. How COVID-19 May Disrupt Food Supply Chains in Developing Countries. *Int. Food Policy Res. Institute Blog*.
- Reardon, T., Mishra, A., Nuthalapati, C.S.R., Bellamare, M.F., Zilberman, D., 2020b. COVID-19's disruption of India's transformed food supply chains. *Econ. Polit. Weekly* 55 (18).
- Swinnen, J., 2020. Will COVID-19 Cause Another Food Crisis? An Early Review, Issue Post, April 10, 2020. International Food Policy Research Institute, Washington, DC.
- Tendall, D.M., et al., 2015. Food System Resilience: Defining the Concept. *Global Food Security*. 6, 17–23.
- Torero, M., 2020. Without food, there can be no exit from the pandemic: Countries must join forces to avert a global food crisis from COVID-19. *Nature* 580, 588–589.
- von Braun, J., Algieri, B., Kalkuhl, M., 2014. World Food System Disruptions in the Early 2000s: Causes, Impacts and Cures. *World Food Policy* 1 (1), 1–22.
- WFP, 2020a. COVID-19 Will Double Number of People Facing Food Crises Unless Swift Action is Taken. Press Release, April 21, 2020. World Food Program, Rome.

- WFP, 2020b. WFP Global Response to COVID-19: June 2020. World Food Program, Rome.
- Wooldridge, J.M., 2007. Inverse Probability Weighted Estimation for General Missing Data Problems. *J. Econometr.* 141 (2), 1281–1301.
- World Bank, 2020a. The impact of COVID-19 (Coronavirus) on global poverty: Why Sub-Saharan Africa might be the region hardest hit. *Data Blog*.
- World Bank, 2020b. Gender Dimensions of the COVID-19 Pandemic. The World Bank, Washington, D.C.
- World Bank, 2020c. Nigeria Development Update: Nigeria in Times of COVID-19: Laying Foundations for a Strong Recovery. World Bank, Washington DC.
- Zurayk, R., 2020. Pandemic and Food security. *J. Agric. Food Sys. Community Dev.* 9 (3), 1–5.