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COVID-19 Severity and Food Insecurity: Evidence from Pakistan

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Abstract: COVID-19 caused serious food disruptions worldwide and raised food insecurity levels. To further understand how COVID-19 impacted food insecurity, this study used nationally representative data from Pakistan to examine the effect of negative COVID-19 shock on food insecurity and its heterogeneity across different income groups. COVID-19 shock was quantified by a subjective measure based on self-reported exposure to the severity of COVID-19. We found that households struck severely by COVID-19 were about 26% more likely to report a lack of healthy food, almost 35% more likely to skip a meal, around 33% more likely to run out of food, and around 20% more likely to go without food for one whole day in comparison to the households unexposed to the severe COVID-19 shock. Furthermore, households affected by severe COVID-19 shock, especially those in the lower income quartiles, faced acute food insecurity. We constructed two additional proxies for this negative COVID-19 shock based on the objective assessment of income loss due to the lockdown measures in Pakistan to examine the robustness of the findings, and they also led to similar outcomes. Overall, the findings suggested that poorer and COVID-19-stricken households faced severer food insecurity and required urgent support.

Keywords: food insecurity; Pakistan; COVID-19; income

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1. Introduction

COVID-19 has caused serious disruptions in regional and global food chains, increased food price volatility, and raised serious concerns regarding food insecurity, specifically in underdeveloped economies [1–4]. The pandemic is projected to severely impact food insecurity and double the number of people facing acute hunger unless relevant policies are envisaged and proactively implemented to combat the rapidly growing crisis [5]. Pakistan's food security like many other developing economies is also strongly challenged by the ongoing pandemic; currently, almost 25% of Pakistan's population is placed below the national poverty line while about 40% is categorized as multidimensionally poor [6]. Alarmingly, 20 to 30% of Pakistan's population experiences some sort of food insecurity and approximately 36 million people are persistently experiencing acute food insecurity [6]. Pakistan's fragile economic situation and acute poverty necessitate a comprehensive investigation as to how the pandemic and its associated lockdowns have influenced food security challenges and to what extent these challenges have disproportionately impacted people belonging to different income groups. Such an analysis can provide necessary and relevant information regarding the dynamics and scale of food insecurity and can subsequently guide public policies to tackle the latest food insecurity issues in Pakistan.

The ongoing pandemic can influence food security within a country through at least four different channels. First and foremost, virus contraction or fear of virus contraction can negatively influence labor activities, leading to reduced domestic incomes as well as foreign remittances. Second, lockdowns imposed by governments to tackle the surge in virus cases can lead to a reduction in domestic production, reduced labor demand,

and difficulty to commute for work purposes, specifically for jobs that require exiting the house. All these factors combined can lead to a reduction in incomes [7–9]. Third, food supply chain disruptions can lead to reduced food accessibility [10,11]. Lastly, because of disruptions in food supplies, the prices of food can increase and subsequently enhance food security problems specifically for poor people [3,12]. The early evidence from Pakistan also showed that food prices during the pandemic increased in rural (13.73% increase) as well as urban areas (10.94% increase) [6]. The post-pandemic evidence from India, Myanmar, and Vietnam also offered support that job loss, food expenditure, as well as the availability of some food items were disproportionate across rural and urban regions [13]. On top of the pandemic-driven factors, food security in Pakistan is further challenged by a slower average growth of agriculture in the last decade as compared to its performance in the 2000s [14]. The recent locust attack also damaged the agricultural output and incomes specifically in rural areas, and it is expected to push 34,000 households in the Punjab, Sindh, and Balochistan provinces towards food insecurity [14].

The aforementioned pandemic-driven factors and co-occurrence of agricultural challenges have called for a thorough investigation of how the onset of the COVID-19 pandemic has influenced food security in Pakistan, where a large number of people already live below the poverty line. Even households with relatively higher incomes can suffer from mild food insecurity because of a lack of food availability or a hyper-increase in food prices due to lockdowns. Therefore, a systematic examination of food security, dependent on the income status of households, is important to understand the COVID-19-induced food security challenges in Pakistan. Such an understanding on the one hand can dissect the nature and severity of food security challenges among different income groups in the country, and on the other hand, help in formulating relevant and targeted policies to effectively combat food insecurity without putting much burden on the scarce resources of the country. Considering the scale of the socioeconomic and health impacts of food insecurity in the already stressed economy of Pakistan, from an academic as well as policy perspective, this paper examines how the severity of COVID-19 in a household and the associated reduction in income impacted food insecurity at the household level in Pakistan.

The existing empirical studies focusing on food insecurity post-pandemic in Pakistan are scarce. Shahzad et al. [15] elicited information from 370 respondents from the Punjab province through the internet. The authors reported acuter food insecurity in urban as compared to rural areas. Their study however drew conclusions based on a relatively small sample size only from the Punjab province and the data collection process left out those respondents who did not have access to the internet, and therefore, were most probably poorer and exposed to a higher risk of food insecurity.

Another study by the Asian Development Bank with 410 farmers in the Sindh province found that approximately 58% of respondents were facing food insecurity issues [16]. Their study however informed our understanding of the food insecurity challenges only of farmers in the Sindh province. Ali et al. [17] examined the socioeconomic effects of the pandemic primarily in the Gilgit-Baltistan region based on 367 observations collected through the internet. The authors found that 78% of respondents were affected by food shortages. The results however were non-representative of the whole country.

Several other studies [18–20] only offer theoretical discussions on food insecurity and relevant policies to combat it in Pakistan. Other studies examined the changes in food prices in Pakistan due to the pandemic [21–23], effects of virus cases on food insecurity [24], negative influence of the pandemic on incomes [25], possible causes of food insecurity [26,27], and gap in food insecurity across male- and female-headed households in Pakistan [28].

To the best of our knowledge, no existing study used country-level household data to analyze the severity of food security linked to negative COVID-19 shock as well as negative income shock in Pakistan. As discussed earlier, studying COVID-19's severity and its associated negative income shock is vital to better understanding the regional dynamics of food security and subsequently formulating data-driven policies for combating this issue. Therefore, an important gap exists in Pakistan's food security literature in a post-pandemic

context and calls for further research. To fill this aforementioned gap, this study used nationally representative data from the Pakistan Bureau of Statistics (PBS) to examine the impact of COVID-19 severity as well as reduced incomes on four different indicators of food security over four months (April–July 2020), when COVID-19 was acute in Pakistan. Furthermore, this paper also examines if the impact of COVID-19 on food security varied across households belonging to different income quartiles in Pakistan. The first food security indicator elicits information about a lack of healthy and nutritious food while the second indicator examines if any member of a household skipped a meal due to lack of money or other resources. The third indicator examines whether a household ran out of food while the last indicator examines whether any member of a household went without food for a whole day due to lack of money or other resources. These food insecurity measures are a part of the Food Insecurity Experience scale (FIES) developed by the Food and Agriculture Organization (FAO) [29]. The FIES is a standard scale used across the world for measuring the extent of food insecurity.

The analysis of the aforementioned indicators revealed worrying outcomes. The households severely affected by COVID-19 shock (subjectively or objectively measured) had acuter food security issues on average, across all four indicators. Importantly, in comparison with the households belonging to the top income quartile, households in all three lower income quartiles reported acuter food security challenges. This indicates that the food security of households even with relatively higher incomes was severely affected and highlights the scale of problems created by the pandemic.

The findings in this paper offer important insights that can help policymakers formulate relevant interventions primarily targeting COVID-19-affected households, those with reduced incomes due to the COVID-19 lockdowns, and households in the lower income quartiles. These targeted interventions can provide help to the most deserving ones and at the same time ensure homogeneous access to necessary food items. On an academic level, these findings contribute to the rapidly expanding pandemic literature examining food security in other countries. Some of these works include by Kang et al. [13] for the Asia Pacific region, Nwaka et al. [30] and Ibukun and Adebayo [31] for Nigeria, Houessou et al. [32] for Benin, Kundu et al. [33] for Bangladesh, Niles et al. [34] and Ahn and Norwood [35] for the United States, and Mueller et al. [36] for Bangladesh, Kenya, and Nigeria. Importantly, the current work examines food insecurity based on nationally representative data and therefore makes an important contribution to the literature based on extensive data collected systematically.

The rest of this study is organized as follows. Section 2 offers details regarding the emergence and progression of COVID-19 and lockdown restrictions in Pakistan. Section 3 reports details, definitions, and summary statistics of the data. Section 4 discusses the regression results while the last section concludes this paper with some policy recommendations.

2. Context

Pakistan is the fifth most populated country in the world with approximately 252 million people [37]. More than half of Pakistan's population (approximately 62%) still resides in rural areas [38], and subsequently, agriculture employs about 37% of the workforce and contributes 23% to the GDP of the country [39]. Pakistan is one of the first South Asian countries to report COVID-19 cases but managed the virus outbreak relatively better as compared to some of its neighboring countries. For example, every week in September 2020, more people died in India due to COVID-19 (about 6500 deaths) as compared to the cumulative deaths for the entire first nine months of the pandemic in Pakistan [40]. Overall, Pakistan managed both infections and deaths due to COVID-19 significantly better than India.

Generally, food is supplied through grain, vegetable, and fruit markets in most cities and towns in Pakistan. Shopkeepers from surrounding areas come to these markets frequently, purchase food, take it back, and sell it at their local shops. Most of these food markets have basic facilities, not technologically well equipped (very different from

supermarkets in the developed countries). Unlike some of the developed countries like the United States, there is no federally administered food assistance program in Pakistan. Therefore, during crises, people with insufficient food rely on social assistance and social networks to obtain necessary food items for survival.

As reported earlier, almost 25% of Pakistan's population is placed below the national poverty line while about 40% is categorized as multidimensionally poor [6]. Moreover, 20 to 30% of Pakistan's population experiences some sort of food insecurity while it is estimated that about 36 million people persistently face acute food insecurity [6]. The prevalence of acute poverty is a major reason behind food insecurity in Pakistan. Along with poverty, a decline in the average growth of agriculture in the last decade [14] has also led to a disparity between the demand and supply of basic food items and eventually contributed to the challenges of food insecurity in Pakistan.

The food security data used in this study focused on the food security information for April–July 2020 (COVID-19 was acute, and lockdowns were implemented in several parts of Pakistan), and therefore it was expedient to have a quick glance at the timeline of COVID-19 related events in Pakistan around the aforementioned time frame. Table 1 documents important and relevant events based on the information collected from the news [41] and from the work of Umer and Khan [42] (Table 1 in Umer and Khan's [42] work).

Table 1. Timeline of COVID-19-related events in Pakistan.

Date	Event
26 February 2020	The first case of COVID-19 was identified among travelers from Iran.
13 March 2020	The first locally transmitted COVID-19 case was reported in Sindh province's Karachi City, and borders with neighboring Afghanistan and Iran were closed for two weeks. Moreover, academic institutes across Pakistan were closed until the 5 April.
18 March 2020	The first death due to COVID-19 was recorded.
21 March 2020	The provincial governments of Punjab and Sindh imposed lockdowns. Most international flights were suspended to control the influx of the virus.
23 March 2020	Partial lockdown was imposed by the KPK government.
24 March 2020	Lockdown was enforced by the Balochistan government.
9 May 2020	All provinces partially eased lockdowns for outdoor patient departments, businesses, and small markets.
18 May 2020	Limited economic activities were allowed, with shopping malls to open on Saturdays and Sundays only.
22 June 2020	Inbound international flights were partially restored.
15 July 2020	International airlines made the COVID-19 test compulsory for travelers from Pakistan.
16 July 2020	Lockdowns were extended for one month by the Sindh government.

The first COVID-19 case was reported in Pakistan on the 26 February 2020. Soon afterwards, the virus spread relatively quickly through local transmission channels. By the 31 July, the total number of confirmed cases rose to 279,146 and total deaths were 5970 with a death rate of around 2% (source: Government of Pakistan. https://covid.gov.pk/stats/pakistan, accessed on 26 October 2024). From the 21 March, Punjab and Sindh imposed lockdowns while KPK and Balochistan followed soon afterwards. Complete or partial lockdowns continued across the country until the 9 May, and later, economic activities restarted on a small scale with the observance of preventive measures.

3. Data Details

In this study, we used secondary data from the Pakistan Bureau of Statistics (PBS) (the data are available publicly at Pakistan Bureau of Statistics website: https://www.pbs.gov.pk/content/microdata-covid-19, accessed on 26 October 2024). The PBS implemented a special survey using electronic tablets from the 20 October 2020 to 5 November 2020 to evaluate the impact of COVID-19 on socioeconomic outcomes, with a nationally representative sample of 6000 households. The survey sample had 70% urban and 30% rural representation primarily because the spread of COVID-19 and its effects were higher in urban areas. The survey questions and methodology were finalized by consultations with the FAO, Ministry of Planning Development & Special Initiatives (PD&SI), UNDP, WHO, and World Bank. Households were selected using two-stage stratified random sampling. In the first stage, 349 urban and 151 rural primary sampling units (PSUs) were selected using a random sampling proportional size methodology. In the second stage, 12 households from every PSU were randomly selected, giving a final sample of 6000 households.

The survey had eight main sections that elicited demographic details of each household, information about COVID-19's impact on employment and income, food security and health services, obtaining assistance from social protection programs, coping strategies during COVID-19, steps taken to mitigate it, and household assets. The outcome variables capturing food insecurity were obtained from Section D of the survey. The main explanatory variables measuring the severity of COVID-19 were obtained from Section G (Subjective Measures) and Sections B and C (Objective Income-Based Measures). Further details about these variables are provided below (the complete survey is available online at the PBS website: https://www.pbs.gov.pk/sites/default/files//other/covid/PBS_COVID-19_QUESTIONNAIRE.pdf, accessed on 26 October 2024).

3.1. Outcome Variables: Food Insecurity Indicators

The food insecurity in this study was examined based on four different indicators that are frequently used by international organizations (such as the FAO) as well as studies examining food security post-pandemic (a recent example is in [3]). The survey implemented in Pakistan had eight questions that closely followed the food insecurity elicitation mechanism (FIES measures) proposed by Cafiero et al. [43]. We did not use all eight questions but rather focused on the four important ones in this study which primarily covered essential food insecurity experiences. The four indicators were used to gather information regarding food insecurity experience spread over four months (April 2020–July 2020). The first indicator examined whether any household member was unable to eat healthy and nutritious food while the second indicator examined whether any household member skipped a meal due to a lack of money or other resources. The third indicator asked if the household ran out of food while the last indicator asked if any household member did not have food for the whole day due to a lack of money or other resources. Table 2 provides a summary of all four outcome variables.

Approximately 61% of respondents reported a lack of healthy food, almost 30% reported skipping a meal, around 23% of households ran out of food, while around 12% went without food for one whole day. Overall, mild food insecurity (a lack of healthy food) appeared to be more profound while acute food insecurity (going without food for the whole day) was less severe.

Table 2. Descriptive statistics of outcome variables.

Food Insecurity Indicator	Observations	Mean
1: Unable to eat healthy food (1/0)	5413	0.606
2: Skipped meal (1/0)	5384	0.296
3: Ran out of food (1/0)	5291	0.228
4: Did not eat for a whole day (1/0)	5286	0.123

Note: The outcome variables were measured at the household level over a period of four months (April–July). All four outcome variables were binary and took a value of 1 if the respondent experienced food insecurity and zero otherwise. Some respondents either did not know or refused to answer these questions and they were excluded from the analysis.

3.2. Primary Explanatory Variables and Controls

The primary explanatory variable was COVID-19 shock, which captured the COVID-19 severity experienced at a household level measured in the survey through the following subjective question:

How severely has your household been affected by COVID-19?

(a) Not at all affected (28.46%);
(b) Mildly affected (27.70%);
(c) Moderately affected (22.54%);
(d) Highly affected (17.38%);
(e) Severely affected (3.92%).

The number of observations in the cases of "Highly affected" and "Severely affected" households was relatively smaller as compared to the other three choices. Therefore, a possible solution suggested by existing studies is to merge these adjacent categories to improve the distribution of data [42,44–47]. Moreover, DiStefano et al. [45] showed that merging categories of the Likert scale with a low number of observations improved the precision of the estimated parameters. Linacre [46] argued that the response to survey questions in the case of socially acceptable behaviors could pivot around certain categories of the Likert scale. In the current case, households could respond to the COVID-19 question with their response skewed towards unaffected or moderately affected categories to avoid the social stigma of infections. Therefore, Linacre [46] suggested combining these categories together. Following these existing studies, we constructed a binary variable to measure COVID-19 severity by combining the first three categories into one group (not severely affected) and the last two categories into another group (severely affected; approximately 21%).

As our main proxy for COVID-19 shock was deduced from a subjective question, it was important to scrutinize the stability of our findings. Therefore, to check the robustness of our findings, we constructed two additional variables based on the objective information as possible proxies for COVID-19 shock. The first proxy consisted of binary information capturing whether a household experienced income reduction (approximately 54%) due to the COVID-19 lockdowns or not, while the last proxy was a continuous variable based on the number of members in a household with reduced income due to the lockdowns. As COVID-19 and to a large extent related lockdowns were close to exogenous shocks, our proxies for negative COVID-19 shock were less likely to be biased.

As food insecurity information in the survey was elicited at the household level, we used household-level controls or constructed them from the available data where possible (for example, HH monthly income, average age of HH members). We controlled for family size and the average age of household members, and these variables indirectly considered both young (including students) and elderly members in a household. Moreover, students and elderly people are generally uninvolved in income-generating activities in Pakistan. Therefore, even if these members were underemployed before the pandemic, they were more likely to remain in the same situation and cause no significant change to household-level income. Further details about the primary explanatory variables and main controls are reported in Table 3 while the list of other controls which included the residence type,

cooking and lighting fuel, and drinking water source are reported in Appendix A for brevity reasons.

The survey did not have information about whether households suffering from food insecurity were able to access food-based assistance primarily because there was no federally run food assistance program in Pakistan. However, the survey had information about social protection benefits received during COVID-19 (April–July 2020). We controlled for these social protection benefits through the binary variable "Social assistance" in Table 3.

Table 3. Data summary for primary controls (n = 5506).

Variable	Mean	Standard Deviation	Min–Max Values
COVID-19 Severity Proxies			
HH severely affected by COVID-19 (1 = Yes)	0.21		0–1
HH member income reduced by lockdown (1 = Yes)	0.54		0–1
Number of HH members with reduced income by lockdown	0.76	0.90	0–7
Household Controls			
Average family size	5.57	2.70	1–35
Average age of HH members (Years)	26.03	10.53	8.25–85
Ln (Monthly HH income) [Labor + rental income + remittances + social security]	5.29	4.64	0–15.73
Social assistance (1 = Yes)	0.40		0–1
Average rooms in house	2.55	1.43	1–15
Internet connection	0.25		0–1
Own computer (1 = Yes)	0.12		0–1
Own agricultural land (1 = Yes)	0.12		0–1
Own generator (1 = Yes)	0.04		0–1
Own house (1 = Yes)	0.61		0–1

HH = Household. For the "Own house" dummy variable, the number of observations was 5504.

3.3. Empirical Analysis

To explore the effects of COVID-19 severity and income on food insecurity, we used the following two specifications:

$$Y_i = \beta_0 + \beta_1 \, Covid\ Severity_{\ i} + \beta_{2k} \, X_i + \gamma_j + \epsilon_{ij} \quad (1)$$

$$Y_i = \beta_0 + \beta_\gamma \, Covid\ Severity_{\ i} + \sum_{Z=1}^{3} \beta_Z \, (Covid\ Severity_{\ i} \times Income\ Quartile_{iZ}) + \beta_{4k} \, X_i + \gamma_j + \epsilon_{ij} \quad (2)$$

where Y_i in both Equations (1) and (2) is the value of the food insecurity indicator for the household i in the primary sampling unit (PSU) j. A PSU is a small enumeration block or a village that was randomly selected for the survey from a population of all the PSUs in each province of the country so that the sample was nationally representative. In total, there were 500 PSUs in the data (349 urban and 151 rural areas) and the average number of households surveyed within a PSU was 12. The main independent variable of interest in Equation (1) was $Covid\ Severity_{\ i}$, measured by the COVID-19 severity proxies (reported in Table 3). A positive and significant value of β_1 of the main explanatory variable would mean that food insecurity was severe among households affected by COVID-19 as compared to the unaffected ones. The main coefficient in Equation (2) was β_Z, which captured the effect of COVID-19 severity (subjective measure) on food insecurity across the three lower income quartiles in comparison to households in the top income quartile. Z represents the income quartile of the household with the top quartile treated as the base category in regressions. A positive and significant value of β_Z would mean that food insecurity was severer among households affected by COVID-19 and in the lower three income quartiles as compared to the affected households in the top income quartile.

The vector X_i in both equations was a large set of household-level controls that were related to the food security of a household, and thus controlling them helped in reducing the bias in β_1 and β_Z. γ_j represents the PSU fixed effects and was meant to control for the heterogeneity caused by differences in location such as rural/urban, distance to the nearest city or market, etc. The likelihood of bias in β_1 was small because of the fact that COVID-19 shock to a household could be taken as exogenous and thus not likely to be related to a variable that was not included in the regression. Therefore, we could interpret the β_1 coefficient as a causal effect rather than a mere correlational effect. ϵ_{ij} represents the random error term in both equations and these equations were estimated with the help of OLS regressions. Even though our outcome variables were binary, we preferred OLS over logit because the interpretation of OLS coefficients was intuitive and easier as compared to the logit model [48]. However, as a robustness check, we also reported the outcomes from the logit regressions in the Supplementary Materials.

4. Results

This section is organized into three subsections. First, national-level outcomes of the impact of COVID-19 shock (either subjective or objective) are reported. Afterwards, the findings based on the classification of households based on their income quartile are discussed. Lastly, additional checks performed to examine the robustness of the main findings are discussed.

4.1. COVID-19 Severity and Food Insecurity Outcomes

The results obtained for the various estimations of Equation (1) are reported in Table 4. For brevity reasons, we report the results for our main explanatory variables in the main text and report the complete results with all controls in the Supplementary Materials in Tables S1–S3. The results indicated that households that self-reported to be severely affected by COVID-19 (subjective proxy for COVID-19 severity, Table 4, Panel A) and those that reported that any member of the household experienced reduced income (Table 4, Panel B), as well as a number of household members who experienced reduced income (Table 4, Panel C) due to lockdown, experienced more food insecurity as per all four food insecurity indicators in comparison with those who remained unaffected by COVID-19, *ceteris paribus*. As per the results of Panel A, if a household faced severe COVID-19-related shock, then it was 26.4 percent more likely to have lower access to healthy food, 34.6 percent more likely to skip a meal, 32.9 percent more likely to run out of food, and 20.3 percent more likely to go without food for a whole day. Likewise, if a household faced income reduction as a consequence of the pandemic (Panel B), then it was 21.1 percent more likely to have lower access to healthy food, 11 percent more likely to skip a meal, 8.6 percent more likely to run out of food, and 3 percent more likely to go without food for a whole day. Similar results were observed in the case where we used the number of households with reduced income due to COVID-19 (Panel C). Overall, irrespective of the COVID-19 severity proxy, these results provide robust evidence that COVID-19-affected households were also badly stuck in the food insecurity nexus.

Table 4. COVID-19 severity and food insecurity.

	Lack of Healthy Food	Skipped a Meal	Ran Out of Food	Went Without Food the Whole Day
Model No.	**[1]**	**[2]**	**[3]**	**[4]**
	Panel A			
HH affected by COVID-19 (Base: No)	0.264 ***	0.346 ***	0.329 ***	0.203 ***
	(0.017)	(0.021)	(0.022)	(0.019)
PSU fixed effects	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	5411	5382	5289	5284
R-squared	0.515	0.495	0.492	0.476
	Panel B			
HH reported income reduction (Base: No)	0.221 ***	0.110 ***	0.086 ***	0.030 ***
	(0.016)	(0.014)	(0.014)	(0.010)
PSU fixed effects	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	5411	5382	5289	5284
R-squared	0.516	0.445	0.435	0.439
	Panel C			
No. of HH members with reduced income (Base: No)	0.099 ***	0.045 ***	0.030 ***	0.010 *
	(0.009)	(0.008)	(0.007)	(0.006)
PSU fixed effects	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	5411	5382	5289	5284
R-squared	0.506	0.441	0.431	0.438

PSU = Primary sampling unit. PSUs represent either a rural or urban area from which households were randomly selected for the survey. In total, there were 500 PSUs in the data, of which 349 PSUs were urban while 151 were rural areas. Robust standard errors clustered around PSUs are in parentheses. *** $p < 0.01$, * $p < 0.10$.

4.2. Income Quartile-Based Outcomes

While the above estimates held for the entire sample, we could also expect the results to differ across different income quartiles because poorer households were more likely to face food insecurity as compared to richer households. We divided households into four income quartiles based on the total household income prior to COVID-19 and prior to the lockdown, i.e., during January–March 2020. A possible issue in this classification is that pre-lockdown employment and hence income could be correlated with post-lockdown employment and income. However, as we did not have time-series data to examine this serial correlation, we primarily relied on the subjective measure of COVID-19 severity, which was less likely to be correlated with the pre-lockdown and pre-COVID-19 incomes. Table 5 contains the results for the heterogenous effects of COVID-19 severity across various income quartiles for primary variables, while the complete results are in the Supplementary Materials in Table S4. We also report the results obtained from the interactions of objective measures of COVID-19 severity and income quartiles in the Supplementary Materials in Tables S5 and S6 for interested readers.

For the subjective COVID-19 severity proxy (Table 5), we found that in comparison to households belonging to the 4th (top) income quartile, the households in lower income quartiles reported significantly higher food insecurity issues for almost all four indicators, ceteris paribus. However, the results of the COVID-19 severity proxy interacted with income quartiles, showing significant results only for the 1st quartile income group; the households in the first income quartile severely affected by COVID-19 reported acuter food insecurity as measured by the third (ran out of food) and fourth (went without food whole day) indicators of food insecurity, which were comparatively more severe measures of food insecurity (Table 5, variable: "COVID-19 severity × 1st quartile", models 3 and 4). Specifically, severely affected households in the 1st income quartile are 17.3% more likely to run out of food and 12.7% more likely to go without food for a whole day. Tables S5 and

S6 contain the quartile-wise heterogeneity results for the other two proxies for the severity of COVID-19 shock, i.e., any member of a household who faced reduced income, and the number of household members facing reduced income due to the pandemic, respectively. The results in both appendices revealed that as compared to the fourth-quartile households, first-quartile households faced more severe food insecurity, especially in the case of the third (ran out of food) and fourth (went without food for the whole day) food proxies. These results corroborate our expectations that the COVID-19 pandemic increased food insecurity among poorer households.

Table 5. COVID-19 severity and income disparity's effects on food insecurity (subjective measure of COVID-19 severity interacting with income quartiles).

	Lack of Healthy Food	**Skipped a Meal**	**Ran Out of Food**	**Went Without Food the Whole Day**
Model No.	**[1]**	**[2]**	**[3]**	**[4]**
HH affected by COVID-19 (Base: No)	0.281 ***	0.301 ***	0.235 ***	0.137 ***
	(0.038)	(0.044)	(0.044)	(0.039)
Income quartile (Base: 4)				
1st quartile	0.189 ***	0.108 ***	0.060 ***	0.047 ***
	(0.025)	(0.020)	(0.018)	(0.014)
2nd quartile	0.160 ***	0.075 ***	0.046 ***	0.031 **
	(0.024)	(0.019)	(0.016)	(0.012)
3rd quartile	0.095 ***	0.057 ***	0.020	0.024 **
	(0.021)	(0.016)	(0.014)	(0.010)
COVID-19 severity (Yes) × Income quartiles (Base: Quartile 4)				
COVID-19 severity × 1st quartile	−0.060	0.065	0.173 ***	0.127 ***
	(0.043)	(0.050)	(0.050)	(0.043)
COVID-19 severity × 2nd quartile	−0.047	0.046	0.059	0.050
	(0.043)	(0.055)	(0.052)	(0.045)
COVID-19 severity × 3rd quartile	0.014	−0.017	0.013	−0.011
	(0.047)	(0.051)	(0.054)	(0.043)
PSU fixed effects	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	5411	5382	5289	5284
R-squared	0.526	0.501	0.500	0.484

PSU = Primary sampling unit. PSUs represent either a rural or urban area from which households were randomly selected for the survey. In total, there were 500 PSUs in the data, of which 349 PSUs were urban while 151 were rural areas. Robust standard errors clustered around PSUs are in parentheses. *** $p < 0.01$, ** $p < 0.05$.

4.3. Robustness Checks

As the four food insecurity measures used in this study captured different dimensions of the same reality, they could be correlated to each other. A pairwise correlation analysis revealed that the four indicators indeed had positive and significant correlations ($p < 0.01$) among themselves (output in the Supplementary Materials in Table S7). Therefore, as a robustness check, following recent work on food insecurity by Amare et al. [3], we performed principal component analysis (PCA) to construct a food insecurity index based on a linear combination of four food insecurity indicators. The regression analysis with the food insecurity index as the dependent variable and the primary explanatory variable are reported in Table 6, while complete results are available in the Supplementary Materials in Table S8. This analysis also revealed that food insecurity was acuter among households struck with either subjective or objective (based on income information) COVID-19 shock.

Using the food insecurity index as the dependent variable, we also examined how COVID-19 severity interacted with households belonging to different income quartiles. The results for the subjective measure of COVID-19 severity (Table 7) showed that in comparison to the fourth income quartile, households in the lower income quartiles faced acute food insecurity, supporting the earlier findings in Table 5. However, we did not find any significant coefficients for the interaction terms (the primary results are in Table 7 while

complete results are in the Supplementary Materials, Table S9, model 1). Similarly, for the objective measures of COVID-19 severity, the results (reported in Table S9, models 2 and 3) supported the earlier findings reported in Tables S5 and S6. Overall, the results obtained by using the food insecurity index were almost similar to the earlier findings.

Table 6. COVID-19 severity and food insecurity (PCC analysis). (All three COVID-19 severity measures are reported).

	PCC	**PCC**	**PCC**
Model No.	**[1]**	**[2]**	**[3]**
HH affected by COVID-19 (Base: No)	0.766 ***		
	(0.049)		
Any HH member reported income reduction (Base: No)		0.240 ***	
		(0.032)	
No. of HH members with reduced income			0.096 ***
			(0.018)
PSU fixed effects	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Observations	5182	5182	5182
R-squared	0.504	0.453	0.449

PSU = Primary sampling unit. PSUs represent either a rural or urban area from which households were randomly selected for the survey. In total, there were 500 PSUs in the data, of which 349 PSUs were urban while 151 were rural areas. Robust standard errors clustered around PSUs are in parentheses. *** $p < 0.01$.

Table 7. COVID-19 severity and food insecurity (PCC analysis). (Subjective COVID-19 severity measure interacting with income quartiles).

	PCC
Model #	**[1]**
Income quartile (Base: 4)	
1st quartile	0.228 ***
	(0.045)
2nd quartile	0.152 ***
	(0.043)
3rd quartile	0.129 ***
	(0.037)
HH affected by COVID-19 (Base: No)	0.665 ***
	(0.098)
HH affected by COVID-19 (Yes) × Income quartiles (Base: Q4)	
HH affected by COVID-19 × 1st quartile	0.145
	(0.112)
HH affected by COVID-19 × 2nd quartile	0.114
	(0.122)
HH affected by COVID-19 × 3rd quartile	−0.047
	(0.115)
PSU fixed effects	Yes
Controls	Yes
Observations	5182
R-squared	0.509

PSU = Primary sampling unit. PSUs represent either a rural or urban area from which households were randomly selected for the survey. In total, there were 500 PSUs in the data, of which 349 PSUs were urban while 151 were rural areas. Robust standard errors clustered around PSUs are in parentheses. *** $p < 0.01$.

We also examined whether COVID-19 shock had a different impact on the food security of urban and rural households. However, we did not find significant differences. The output is in the Supplementary Materials in Tables S10–S12. As outcome variables are binary in nature, we also conducted logistic regressions as a robustness check. For brevity

reasons, we focused only on the main variable for measuring COVID-19 severity (subjective measure). The findings from the logistic regressions were also similar to those reported in Tables 4 and 5 (main variable: HH affected by COVID-19). We provide these additional analyses in the Supplementary Materials in Tables S13 and S14.

5. Discussions and Conclusions

COVID-19 has increased food insecurity in most parts of the world and Pakistan is no exception. Pakistan's fragile economy, weak governance, and large share of poor populations necessitated an investigation into pandemic-driven food security challenges to better understand the spread of food insecurity and subsequently formulate relevant policies. Therefore, in this study, we used nationally representative data collected during pandemic (i.e., in October and November 2020) by the Pakistan Bureau of Statistics to study the impact of COVID-19 severity on food security using four indicators. Our main proxy for COVID-19 shock used the subjective evaluation of the COVID-19 severity reported by households. In addition, we also used the loss in household income (binary variable) and number of household members reporting income loss (count variable) due to COVID-19 lockdowns as possible objective proxies for COVID-19 severity.

Our analysis showed that households severely affected by COVID-19 shock (either subjective or objective) faced relatively acuter food insecurity issues in Pakistan, whether it was a lack of healthy food, skipping a meal, running out of food, or going without food for a whole day. Moreover, the income-based analysis revealed that these issues were relatively more prevalent among poorer households. We also examined how COVID-19 severity interacted with income quartiles and found that households reporting a severe COVID-19 shock (measured subjectively) only in the lowest income quartile experienced acute food insecurity (i.e., ran out of food and went without food for a whole day) in comparison to those in the top income quartile.

Our findings showed that food insecurity (all four measures) worsened for those severely impacted by COVID-19, which coincided with previous studies from Pakistan [15–17]. However, all previous studies used a very small sample (sample sizes ranging from 367 to 410 observations). Therefore, the findings from the previous studies were not generalizable. The current findings based on a nationally representative sample offer a concrete picture of food insecurity problems due to the severity of COVID-19, and these findings can be generalized to the whole country as well. The negative impact of the COVID-19 severity on food insecurity observed in the current study also coincided with similar findings from other developing South Asian countries including Bangladesh [49–51] and India [52–54]. This indicates that COVID-19 and lockdowns impacted Pakistan and surrounding developing countries in a similar manner, providing an acute picture of food insecurity during the global pandemic.

Our findings showed that poorer households severely affected by COVID-19 (those in the lower income quartile) had acute food insecurity problems, which correlated with prior expectations that food security issues of poor households were more sensitive to COVID-19 and lockdowns [3]. Other studies from Pakistan [15,19] also reported that low-income households had acuter food insecurity due to lockdowns. It is important to acknowledge that the results were based on cross-sectional data that captured only short-term disruptions in the food security nexus in Pakistan. The outcomes may vary in the long run if the fruits of both micro- and macro-level interventions by the government trickle down to poorer households, as more households adapt to the unprecedented socioeconomic environment in a post-pandemic world, and possibly, as the situation worsens due to the spread of new variants of COVID-19. Nevertheless, the short-term income loss (reported by approximately 54% of households) due to lockdowns can have long-term effects as well because a reduction in income can have negative spillover effects on the health and productivity of households, agricultural inputs, and investments in the schooling of children [3].

Our empirical analysis can lead to several policy implications. First, as expected, poorer households were entangled in a severe food insecurity nexus and required urgent

help. Therefore, both government and non-government organizations can develop interventions to target subpopulations of poorer and severely affected COVID-19 households to effectively mitigate food insecurity of the most vulnerable ones at least in the short to medium terms. Some of the possible interventions can be either direct food transfers through district governments or subsidies on necessary food items by provincial governments. Similarly, non-governmental organizations can also provide food directly to poor households and finance it through charity donations.

Second, almost 54% of the respondents reported a decrease in household income due to lockdowns. The impacts of reduction in incomes are more likely to appear in other domains including health and schooling at least for poorer subpopulations. Therefore, an expansion in the social safety nets (such as the Benazir Income Support Program and Ehsas Program) to address the aforementioned possible vulnerabilities and mitigate their exacerbation is essential for ensuring welfare in the long run [3,55]. In the short run, one-time cash transfers to poor households through provincial governments can also help in mitigating food insecurity in Pakistan.

Lastly, some of the limitations of this study are discussed here. First, the data used in this study had food security measured at the household level and therefore intrahousehold differences in food security could not be observed. Second, this study was based on cross-sectional data and therefore food security patterns over time could not be examined. Third, we examined food security with the help of four critical measures. We did not use other food security measures available in the data because we expected the four critical measures to provide sufficient insights into the food security problems of people in the context of Pakistan. However, the analysis of other indicators might reveal additional insights regarding other domains of food security.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/covid4110121/s1. Table S1: COVID-19 Severity and Food Insecurity (Proxy: Subjective Measure of COVID-19 Severity); Table S2: COVID-19 Severity and Food Insecurity (Proxy: Decreased Income of any HH member due to COVID-19 lockdown); Table S3: COVID-19 Severity and Food Insecurity (Proxy: Number of HH reporting Decreased Income due to COVID-19 lockdown); Table S4: COVID-19 Severity and Income Disparity's Effect on Food Insecurity (Subjective Measure of COVID-19 Severity Interacted with Income Quartiles); Table S5: COVID-19 Severity and Income Disparity's Effect on Food Insecurity (Decreased Income of any HH member Interacted with Income Quartiles); Table S6: COVID-19 Severity and Income Disparity's Effect on Food Insecurity (Number of HH reporting Decreased Income Interacted with Income Quartiles); Table S7: Pairwise Correlations Among Food Insecurity Indicators; Table S8: COVID-19 Severity and Food Insecurity (PCC Analysis) (All three COVID-19 severity measures reported); Table S9: COVID-19 Severity and Food Insecurity (PCC Analysis) (All three COVID-19 severity measures interacted with Income Quartiles); Table S10: COVID-19 Severity and Regional Disparity in Food Insecurity (Subjective Measure of COVID-19 Severity Interacted with Household Location); Table S11: COVID-19 Severity and Regional Disparity in Food Insecurity (Decreased Income of any HH member Interacted with Household Location); Table S12: COVID-19 Severity and Regional Disparity in Food Insecurity (Number of HH reporting Decreased Income Interacted with Household Location); Table S13: COVID-19 Severity and Food Insecurity (Logit Regressions) (Proxy: Subjective Measure of COVID-19 Severity); Table S14: COVID-19 Severity and Income Disparity's Effect on Food Insecurity (Logit Regressions) (Subjective Measure of COVID-19 Severity Interacted with Income Quartiles).

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Appendix A. Data Summary for All Explanatory Variables

Variable	Observations (%age)	Mean (SD)	Min–Max Values
COVID-19 Severity Proxies			
HH severely affected by COVID-19 (1 = Yes)	5506	0.21 (0.41)	0–1
HH member income reduced by lockdown (1 = Yes)	5506	0.55 (0.50)	0–1
Number of HH members with reduced income by lockdown	5506	0.77 (0.91)	0–7
Household Controls			
Family Size	5506	5.57 (2.70)	1–35
Average age of HH members (Years)	5506	26.03 (10.53)	8.25–85
Ln (Monthly HH income) [Labor + Rental income + Remittances + Social Security]	5506	5.29 (4.64)	0–15.73
Social Assistance	5506	0.40 (0.49)	0–1
Residence Type	5506		
Personal residence (not self-hired)	3908 (70.98%)		
Personal residence (self-hired)	223 (4.05%)		
On rent	925 (16.80%)		
On subsidized rent	82 (1.49%)		
Rent free	368 (6.68%)		
Average rooms in house	5506	2.55 (1.43)	1–15
Type of Cooking Fuel	5506		
Firewood	1825 (33.15%)		
Gas	2955 (53.67%)		
LPG + Kerosene Oil	444 (8.06%)		
Electricity	16 (0.29%)		
Dung Cake	161 (2.92%)		
Crop Residue	66 (1.20%)		
Charcoal/Coal	25 (0.45%)		
Others	14 (0.25%)		
Type of Lighting Fuel	5506		
Electricity	5098 (92.59%)		
Solar Energy	194 (3.52%)		
Gas	23 (0.42%)		
Kerosene oil/Diesel/Petrol	7 (0.13%)		
Firewood	61 (1.11%)		
Candle	61 (1.11%)		
Others	62 (1.13%)		
Type of Drinking Water	5506		
Piped water	1605 (29.15%)		
Hand Pump	900 (16.35%)		
Bore hole (motor pump)/Tube well	1306 (23.72%)		
Open well	71 (1.29%)		
Closed well	40 (0.73%)		
Spring (protected)	44 (0.80%)		
Spring (unprotected)	40 (0.73%)		
Pond/canal/river/stream	159 (2.89%)		
Bottled water	287 (5.21%)		
Tanker/truck/water bearer	445 (8.08%)		
Filtration plant	555 (10.08%)		
Others	54 (0.98%)		
Internet connection	5506	0.25 (0.43)	0–1
Own computer (1 = Yes)	5506	0.12 (0.33)	0–1
Own agricultural land (1 = Yes)	5504	0.12 (0.33)	0–1
Own residential/commercial plot (1 = Yes)	5504	1.93 (0.23)	0–1
Own generator (1 = Yes)	5506	0.04 (0.18)	0–1
Own house (1 = Yes)	5504	0.61 (0.49)	0–1

HH = Household.

References

1. Akter, S. The impact of COVID-19 related 'stay-at-home' restrictions on food prices in Europe: Findings from a preliminary analysis. *Food Secur.* **2020**, *12*, 719–725. [CrossRef] [PubMed]
2. Ihle, R.; Rubin, O.D.; Bar-Nahum, Z.; Jongeneel, R. Imperfect food markets in times of crisis: Economic consequences of supply chain disruptions and fragmentation for local market power and urban vulnerability. *Food Secur.* **2020**, *12*, 727–734. [CrossRef] [PubMed]
3. Amare, M.; Abay, K.A.; Tiberti, L.; Chamberlin, J. COVID-19 and food security: Panel data evidence from Nigeria. *Food Policy* **2021**, *101*, 102099. [CrossRef]
4. Zurayk, R. Pandemic and food security: A view from the Global South. *J. Agric. Food Syst. Community Dev.* **2020**, *9*, 17–21. [CrossRef]
5. World Food Programme (WFP). COVID-19 Will Double Number of People Facing Food Crises Unless Swift Action Is Taken. Media Release. 2020. Available online: https://www.wfp.org/news/covid-19-will-double-number-people-facing-food-crises-unless-swift-action-taken (accessed on 26 October 2024).
6. FAO. National Agrifood Systems and COVID-19 in Pakistan: Effects, Policy Responses, and Long-Term Implications. 2020. Available online: https://www.fao.org/3/cb1343en/CB1343EN.pdf (accessed on 26 October 2024).
7. Arndt, C.; Davies, R.; Gabriel, S.; Harris, L.; Makrelov, K.; Robinson, S.; Levy, S.; Simbanegavi, W.; van Seventer, D.; Anderson, L. COVID-19 lockdowns, income distribution, and food security: An analysis for South Africa. *Glob. Food Secur.* **2020**, *26*, 100410. [CrossRef]
8. Breisinger, C.; Raouf, M.; Wiebelt, M.; Kamaly, A.; Karara, M. *Impact of COVID-19 on the Egyptian Economy: Economic Sectors, Jobs, and Households*; International Food Policy Research Institute: Washington, DC, USA, 2020; Volume 6.
9. Obi, C.; Bartolini, F.; D'Haese, M. International migration, remittance and food security during food crises: The case study of Nigeria. *Food Secur.* **2020**, *12*, 207–220. [CrossRef]
10. Hirvonen, K.; Minten, B.; Mohammed, B.; Tamru, S. Food prices and marketing margins during the COVID-19 pandemic: Evidence from vegetable value chains in Ethiopia. *Agric. Econ.* **2021**, *52*, 407–421. [CrossRef]
11. Mahajan, K.; Tomar, S. COVID-19 and supply chain disruption: Evidence from food markets in India. *Am. J. Agric. Econ.* **2021**, *103*, 35–52. [CrossRef]
12. Devereux, S.; Béné, C.; Hoddinott, J. Conceptualising COVID-19's impacts on household food security. *Food Secur.* **2020**, *12*, 769–772. [CrossRef]
13. Kang, Y.; Baidya, A.; Aaron, A.; Wang, J.; Chan, C.; Wetzler, E. Differences in the early impact of COVID-19 on food security and livelihoods in rural and urban areas in the Asia Pacific Region. *Glob. Food Secur.* **2021**, *31*, 100580. [CrossRef]
14. ADB. Islamic Republic of Pakistan: Strengthening Food Security Post COVID-19 and Locust Attacks. 2020. Available online: https://www.adb.org/sites/default/files/project-documents/54319/54319-001-tar-en.pdf (accessed on 26 October 2024).
15. Shahzad, M.A.; Qing, P.; Rizwan, M.; Razzaq, A.; Faisal, M. COVID-19 pandemic, determinants of food insecurity, and household mitigation measures: A case study of Punjab, Pakistan. *Healthcare* **2021**, *9*, 621. [CrossRef] [PubMed]
16. Yamano, T.; Sato, N.; Arif, B.W. *Impact of COVID-19 and Locust Swarms on Farm Households in Sindh, Pakistan: Analysis of Data from a Cross-Sectional Survey*; Asian Development Bank: Mandaluyong, Philippines, 2020. Available online: https://www.adb.org/sites/default/files/publication/643406/covid-19-locust-swarms-farm-households-pakistans.pdf (accessed on 26 October 2024).
17. Ali, A.; Ahmed, M.; Hassan, N. Socioeconomic impact of COVID-19 pandemic: Evidence from rural mountain community in Pakistan. *J. Public Aff.* **2021**, *21*, e2355. [CrossRef] [PubMed]
18. Mamun, M.A.; Ullah, I. COVID-19 suicides in Pakistan, dying off not COVID-19 fear but poverty?—The forthcoming economic challenges for a developing country. *Brain Behav. Immun.* **2020**, *87*, 163–166. [CrossRef] [PubMed]
19. Ubaid-ur-Rehman, H.; Asghar, W.; Khalid, N. Food security challenges for Pakistan during COVID-19 pandemic: An overview of the response plan. *World Food Policy* **2021**, *7*, 82–89. [CrossRef]
20. Udmale, P.; Pal, I.; Szabo, S.; Pramanik, M.; Large, A. Global food security in the context of COVID-19: A scenario-based exploratory analysis. *Prog. Disaster Sci.* **2020**, *7*, 100120. [CrossRef]
21. Kim, K.; Kim, S.; Park, C.Y. Food Security in Asia and the Pacific Amid the COVID-19 Pandemic. ADB Brief No. 139. 2020. Available online: https://www.adb.org/sites/default/files/publication/611671/adb-brief-139-food-security-asia-pacific-covid-19.pdf (accessed on 26 October 2024).
22. Rasheed, R.; Rizwan, A.; Javed, H.; Sharif, F.; Zaidi, A. Socio-economic and environmental impacts of COVID-19 pandemic in Pakistan—An integrated analysis. *Environ. Sci. Pollut. Res.* **2021**, *28*, 19926–19943. [CrossRef]
23. Xu, Z.; Elomri, A.; El Omri, A.; Kerbache, L.; Liu, H. The compounded effects of COVID-19 pandemic and desert locust outbreak on food security and food supply chain. *Sustainability* **2021**, *13*, 1063. [CrossRef]
24. Erokhin, V.; Gao, T. Impacts of COVID-19 on trade and economic aspects of food security: Evidence from 45 developing countries. *Int. J. Environ. Res. Public Health* **2020**, *17*, 5775. [CrossRef]
25. Workie, E.; Mackolil, J.; Nyika, J.; Ramadas, S. Deciphering the impact of COVID-19 pandemic on food security, agriculture, and livelihoods: A review of the evidence from developing countries. *Curr. Res. Environ. Sustain.* **2020**, *2*, 100014. [CrossRef]
26. Inegbedion, H.E. COVID-19 lockdown: Implication for food security. *J. Agribus. Dev. Emerg. Econ.* **2021**, *11*, 437–451. [CrossRef]
27. Mardones, F.O.; Rich, K.M.; Boden, L.A.; Moreno-Switt, A.I.; Caipo, M.L.; Zimin-Veselkoff, N.; Alateeqi, A.M.; Baltenweck, I. The COVID-19 pandemic and global food security. *Front. Vet. Sci.* **2020**, *7*, 578508. [CrossRef] [PubMed]

28. Shahbaz, P.; Haq, S.U.; Khalid, U.B.; Boz, I. Gender-based implications of the COVID-19 pandemic on household diet diversity and nutritional security in Pakistan. *Br. Food J.* **2022**, *124*, 951–967. [CrossRef]
29. FAO. Food Insecurity Experience Scale (FIES). 2018. Available online: https://www.fao.org/policy-support/tools-and-publications/resources-details/en/c/1236494/ (accessed on 26 October 2024).
30. Nwaka, I.D.; Akadiri, S.S.; Uma, K.E. Gender of the family head and food insecurity in urban and rural Nigeria. *Afr. J. Econ. Manag. Stud.* **2020**, *11*, 381–402. [CrossRef]
31. Ibukun, C.O.; Adebayo, A.A. Household food security and the COVID-19 pandemic in Nigeria. *Afr. Dev. Rev.* **2021**, *33*, S75–S87. [CrossRef]
32. Houessou, M.D.; Cassee, A.; Sonneveld, B.G. The effects of the COVID-19 pandemic on food security in rural and urban settlements in Benin: Do allotment gardens soften the blow? *Sustainability* **2021**, *13*, 7313. [CrossRef]
33. Kundu, S.; Al Banna, H.; Sayeed, A.; Sultana, M.S.; Brazendale, K.; Harris, J.; Mandal, M.; Jahan, I.; Abid, M.T.; Khan, S.I. Determinants of household food security and dietary diversity during the COVID-19 pandemic in Bangladesh. *Public Health Nutr.* **2021**, *24*, 1079–1087. [CrossRef]
34. Niles, M.T.; Bertmann, F.; Belarmino, E.H.; Wentworth, T.; Biehl, E.; Neff, R. The early food insecurity impacts of COVID-19. *Nutrients* **2020**, *12*, 2096. [CrossRef]
35. Ahn, S.; Norwood, F.B. Measuring food insecurity during the COVID-19 pandemic of spring 2020. *Appl. Econ. Perspect. Policy* **2021**, *43*, 162–168. [CrossRef]
36. Mueller, V.; Grépin, K.A.; Rabbani, A.; Navia, B.; Ngunjiri, A.S.; Wu, N. Food insecurity and COVID-19 risk in low-and middle-income countries. *Appl. Econ. Perspect. Policy* **2022**, *44*, 92–109. [CrossRef]
37. US Government. U.S. and World Population Clock. Available online: https://www.census.gov/popclock/world/pk (accessed on 26 October 2024).
38. World Bank. Rural Population (% of total population)—Pakistan. 2018. Available online: https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=PK (accessed on 26 October 2024).
39. FAO. FAO in Pakistan. 2024. Available online: https://www.fao.org/pakistan/our-office/pakistan-at-a-glance/en/ (accessed on 26 October 2024).
40. The Economist. Is Pakistan Really Handling the Pandemic Better than India? 2020. Available online: https://www.economist.com/asia/2020/09/30/is-pakistan-really-handling-the-pandemic-better-than-india (accessed on 26 October 2024).
41. The Express Tribune. 2020, the Year Everything Changed: A Timeline. 2020. Available online: https://tribune.com.pk/story/2276558/2020-the-year-everything-changed-a-timeline (accessed on 26 October 2024).
42. Umer, H.; Khan, M.F. COVID-19 and intra-household financial coping strategies in Pakistan. *Int. J. Disaster Risk Reduct.* **2024**, *114*, 104908. [CrossRef]
43. Cafiero, C.; Viviani, S.; Nord, M. Food security measurement in a global context: The food insecurity experience scale. *Measurement* **2018**, *116*, 146–152. [CrossRef]
44. Umer, H. Does pro-sociality or trust better predict staying home behavior during the COVID-19? *J. Behav. Exp. Econ.* **2022**, *100*, 101926. [CrossRef] [PubMed]
45. DiStefano, C.; Shi, D.; Morgan, G.B. Collapsing categories is often more advantageous than modeling sparse data: Investigations in the CFA framework. *Struct. Equ. Model. A Multidiscip. J.* **2021**, *28*, 237–249. [CrossRef]
46. Linacre, J.M. Optimizing rating scale category effectiveness. *J. Appl. Meas.* **2002**, *3*, 85–106.
47. Muis, K.R.; Winne, P.H.; Edwards, O.V. Modern psychometrics for assessing achievement goal orientation: A Rasch analysis. *Br. J. Educ. Psychol.* **2009**, *79*, 547–576. [CrossRef]
48. Horrace, W.C.; Oaxaca, R.L. Results on the bias and inconsistency of ordinary least squares for the linear probability model. *Econ. Lett.* **2006**, *90*, 321–327. [CrossRef]
49. Das, S.; Rasul, M.G.; Hossain, M.S.; Khan, A.R.; Alam, M.A.; Ahmed, T.; Clemens, J.D. Acute food insecurity and short-term coping strategies of urban and rural households of Bangladesh during the lockdown period of COVID-19 pandemic of 2020: Report of a cross-sectional survey. *BMJ Open* **2020**, *10*, e043365. [CrossRef]
50. Ahmed, F.; Islam, A.; Pakrashi, D.; Rahman, T.; Siddique, A. Determinants and dynamics of food insecurity during COVID-19 in rural Bangladesh. *Food Policy* **2021**, *101*, 102066. [CrossRef]
51. Shuvo, S.D.; Hossain, M.S.; Riazuddin, M.; Mazumdar, S.; Roy, D. Factors influencing low-income households' food insecurity in Bangladesh during the COVID-19 lockdown. *PLoS ONE* **2022**, *17*, e0267488. [CrossRef]
52. Jaacks, L.M.; Veluguri, D.; Serupally, R.; Roy, A.; Prabhakaran, P.; Ramanjaneyulu, G.V. Impact of the COVID-19 pandemic on agricultural production, livelihoods, and food security in India: Baseline results of a phone survey. *Food Secur.* **2021**, *13*, 1323–1339. [CrossRef]
53. Jeyakumar, A.; Dunna, D.; Aneesh, M. Loss of livelihood, wages, and employment during the COVID-19 pandemic in selected districts of Chhattisgarh in India, and its impact on food insecurity and hunger. *Front. Public Health* **2022**, *10*, 810772. [CrossRef] [PubMed]

54. Makkar, S.; Manivannan, J.R.; Swaminathan, S.; Travasso, S.M.; John, A.T.; Webb, P.; Kurpad, A.V.; Thomas, T. Role of cash transfers in mitigating food insecurity in India during the COVID-19 pandemic: A longitudinal study in the Bihar state. *BMJ Open* **2022**, *12*, e060624. [CrossRef] [PubMed]
55. Béné, C. 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. *Food Secur.* **2020**, *12*, 805–822. [CrossRef] [PubMed]