# Perceived Effects of COVID-19 Pandemic on Food Security in Southeast Nigeria

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The present study evaluated the perceived effects of the COVID-19 Pandemic on food security in Southeast Nigeria. A multi-stage random technique was used to select 209 households. Data for the study were collected with the aid of a structured questionnaire and were analyzed using descriptive statistics, $z$-test, food security model, and Tobit regression model. Results showed that the mean household size was 9.6 persons, which indicates a large household size. The percentage rate of food consumption of the households before the Pandemic was higher relative to the COVID-19 event. Again, exorbitant prices of food materials were noticed during the COVID-19 as compared to the period before the Pandemic. About 10.5% of the households met the minimum food requirements as proposed by World Health Organization (WHO), and Food and Agriculture Organization (FAO) as against the majority of 76.1%. The three dimensions of food security which include availability, accessibility, and utilization were interposed by a number of factors, such as artificial scarcity, and an increase in food prices. Furthermore, social distancing and lockdown imposition were COVID-19 determinants of the food security status of households in the Southeast Nigeria. About 24% of the households were food-secured compared to 76% that were insecured during the Pandemic. Robust and effective food and agricultural policy formulations and implementations were recommended in Southeast Nigeria.

Keywords: COVID-19, effects, food security, pandemic, Southeast, Tobit model

## INTRODUCTION

### Background and Rationale

The corona virus disease 2019 (COVID-19) is a global health Pandemic that shut down the whole countries of the world (FAO, 2021). Earlier, human coronavirus (HCoVs) had long been in existence causing "common cold" in healthy people and it was considered an inconsequential pathogen due to its minor effects (FAO, 2020a). The advent of the twenty first century brought in two highly pathogenic HCoVs, namely severe acute respiratory syndrome coronavirus (SARS–CoV), and Middle East respiratory syndrome coronavirus (MERS–CoV), which emerged from animal reservoirs causing a global epidemic with alarming morbidity and mortality (Paules et al., 2020; Sallent, 2020). The recent COVID-19 which broke out in Wuhan, China in December 2019 is classified as another zoonotic pathogen human coronavirus (United Nations, 2020a; WHO, 2020a). On February 11, 2020, the International Committee on Taxonomy of Viruses (ICTV) announced the new COVID-19 as "severe acute respiratory syndrome coronavirus 2 (SARS–CoV2)" (United Nations, 2020b; WHO, 2020a). As of May 15, 2020, globally, 4,307,287 cases were confirmed

and 295,101 deaths had been recorded in more than 216 countries and territories (UNCTAD, 2020b; WHO, 2020b). Nigeria recorded her first case of COVID-19 in February 2020 (NCDC, 2020a,b) and by March 23, 2020, federal schools in Nigeria were mandated to close as a result of the escalating spread of COVID-19 and by March 30, 2020, the commercial state hub in Nigeria such as Lagos, Abuja; the capital city and Ogun state in Nigeria were placed under lockdown to contain the spread (NCDC, 2020b). Subsequently, the majority of the states joined the lockdown as soon as the directive was given by the Federal Government of Nigeria. As of May 14, 2020, Nigeria had recorded 5,162 confirmed cases and 167 deaths (De-Wit et al., 2016; Johns, 2020; UNCTAD, 2020a; World Bank, 2020b). According to International Monetary Fund (IMF, 2020), the COVID-19 crisis is reported to have a crippling effect on the global economy. It is tagged a global phenomenal threat, ranging from ill-health, food insecurity, economic shocks and setbacks, economic stagnation, human depression, poor social interaction, stagnant agricultural production, limited housing, limited education service delivery, and border closures (Devereux et al., 2020; Laborde et al., 2020; Vanapalli et al., 2020; Waltenburg et al., 2020). Consequently, Southeast Nigeria had its share of the adverse impacts of the COVID-19 Pandemic (Ogunji et al., 2021; Uche et al., 2021). This is because the region was neither prepared nor armed to absorb the initial shock orchestrated by the Pandemic (Mbachu et al., 2020; Uche et al., 2021). Southeast Nigeria was thrown into learning by doing *ad-hoc* measures to contain the virus spread, and as a result of the Nigerian government's enforcement of several COVID-19 measures such as lockdown, stay at home, social distancing, quarantine, banning large–private and public gathering, and crowded transportations (Ekoh et al., 2021; Ogunji et al., 2021; Uche et al., 2021). Despite these measures, the COVID-19 Pandemic kept raging as confirmed cases in Southeast Nigeria continue to rise arbitrarily. As of March 18, 2022, the number of confirmed cases had risen to 12,569 and death cases to 172 (NCDC, 2022). The lockdown measures adopted in Southeast Nigeria focused largely on flattening the COVID-19 epidemic curve; however, food supply and agricultural production which are the hub of the Southeast Nigeria suffered the most as food crop farmers were sent off their farms as a result of the sudden lock down imposed by the government and this singular act worsened economic activities; more especially, food production in the region (Egwue et al., 2020; Adebowale et al., 2021). As the lockdown continued, food and other livestock goods were equally restricted from entering the Southeast Nigeria from other neighboring states due to border closure (Agbugba, 2020a; Uche et al., 2021). This development further heightened food insecurity in the region causing severe pains and created a huge food supply-demand gap (Ohiaa et al., 2020; Obayelu et al., 2021; Uche et al., 2021). The issue of lockdown without an alternative source of food supply and provisions constituted major economic problems and food security challenges in the Southeast region (Arouna et al., 2020; Egwue et al., 2020; United Nations World Food Programme, 2020; Ekoh et al., 2021). Although the lockdown was meant to contain the spread of the coronavirus disease in the short-run, its long-run effects exacerbated food security

situation in Southeast Nigeria making the region vulnerable to chronic starvation, malnutrition, food inadequacy, food shortage, low food supply, and persistent poverty (Adebowale et al., 2021; Uchechukwu et al., 2022). Until now, the region is yet to come out from the negative impacts and shocks of COVID-19 Pandemic. However, food security is the ability to meet target consumption levels on a year-to-year basis. It is said to exist when every households have sufficient access to food to meet their dietary needs for a productive and healthy life (Headey and Martin, 2016; FAO, 2018; Oleribe et al., 2020; United Nations, 2020a; Worstell, 2020) but such was not the case in Southeast Nigeria as the COVID-19 Pandemic introduced intense food scarcity, excruciating hunger, pain, and food deficit. With rising population growth in Southeast Nigeria, food crop production is yet to keep pace with meeting domestic food demands (FAO, 2020a; United Nations, 2020b; Ogunji et al., 2021). This had equally aggravated food security and ushered in food insecurity in the Southeast region.

Earlier, several empirical studies had looked at the food security situations in Nigeria, (Babatunde et al., 2007; Agada and Igbokwe, 2015; Ahmed et al., 2015) examined the factors influencing food security and its coping strategies. Akukwe (2019) evaluated household food security and its determinants, while Egwue et al. (2020) and Agbawodikeizu et al. (2021) investigated food insecurity of rural households during COVID-19 and the impact of COVID-19 Pandemic on economic activities and well-being of older adults in Southeast Nigeria. Amongst these studies, none had assessed the perceived effect of COVID-19 Pandemic on individual household food security with reference to COVID19 determinants, recommended food consumption, calorie in-takes, and food sources of individual households before and after the Pandemic. More so, no study had examined the true state of COVID-19 determinants on individual food secured households and food insecured households in Southeast Nigeria, hence the true essence of this study. This study filled the gap in knowledge by providing an objective assessment of the true picture of COVID-19 Pandemic on food security in the Southeast Nigeria.

## Objectives of the Study

The broad objective of the study is to access the perceived effect of the COVID-19 Pandemic on food security in Southeast Nigeria. Hence, the specific objectives include:

i.   To describe the standardized food groups/classifications
ii.  To identify the demographic characteristics of the sampled households
iii. To ascertain the food groups consumed before and during the Pandemic
iv.  To determine the food prices before and during the Pandemic
v.   To determine the minimum food requirements, source of food delivery, and availability of food during COVID-19 Pandemic
vi.  To isolate the factors affecting food availability, accessibility, and use during the Pandemic
vii. To estimate the perceived effect of COVID-19 determinants on food security status of households in Southeast Nigeria

**FIGURE 1 |** Structural framework, food security, and COVID-19 pandemic. Source: Munonye, 2022.
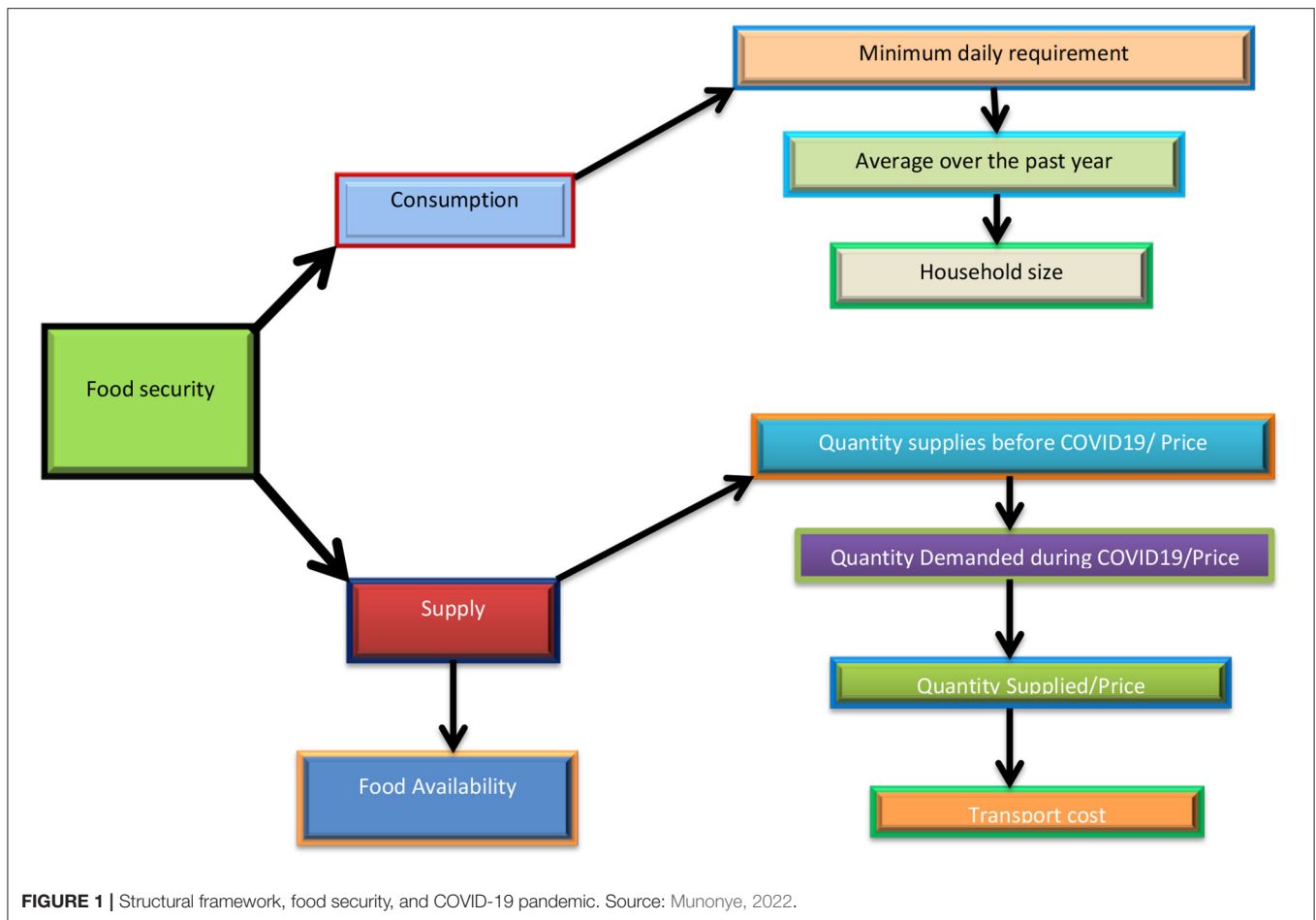
viii. To estimate the food security indices of households during COVID-19.

## MATERIALS AND METHODS

### Study Design

The study was designed to elicit detailed information from the sampled respondents who were selected using a multi-stage sampling technique. Information on the specific objectives of the study was collected using the data instrument (questionnaire) which was administered in person. The data collected were analyzed using both descriptive and inferential statistics (percentage, mean, z-test, Tobit model, and food security model). The study was structured into five stages: Introduction, Materials and methods, Results, Discussion, and Conclusion.

### Setting

#### Description of the Study Area

The study area is the Southeast geopolitical zone of Nigeria. Nigeria is divided into six geo-political zones—North-central, North-east, North-west, South-east, South-south, and South-west.

Southeast zone is made up of five states: Abia, Anambra, Ebonyi, Enugu, and Imo. This zone is also known as Igboland

because it is largely dominated by the Igbo-speaking tribe of Nigeria. The zone is bounded on the north by Kogi and Benue States, on the east by Cross River State, on the south by Akwa Ibom and Rivers States, and on the west by Delta and Edo States. According to the National Bureau of Statistics, the 2016 population estimate of the area was 21,955,414 persons (NBS, 2017). The vegetation of the area is predominantly rainforest, which supports the cultivation of food crops, such as rice, maize, yam, cassava, oil palm, cowpea, sweet potato, cocoyam, plantain, banana, melon, bambara nut, breadfruit, groundnut, and various vegetables and fruit trees. The people of the region largely engage in farming and trading activities, as well as in other occupations, such as civil service, corporate businesses, etc. The region has divergent beliefs, perceptions, and attitudes about food and nutritional practices, especially during COVID-19. Data was collected for a period of 6 months starting from January to June 2021. Structural framework of food security and Covid 19 and geographical map of Nigeria showing the Southeast regions were shown in **Figures 1**, **2** respectively.

### Data Collection

The questionnaire was developed by the researchers and used as a survey instrument for data collection. It was prepared following the recommendations of FANTA (2020), FAO (2020a), WHO
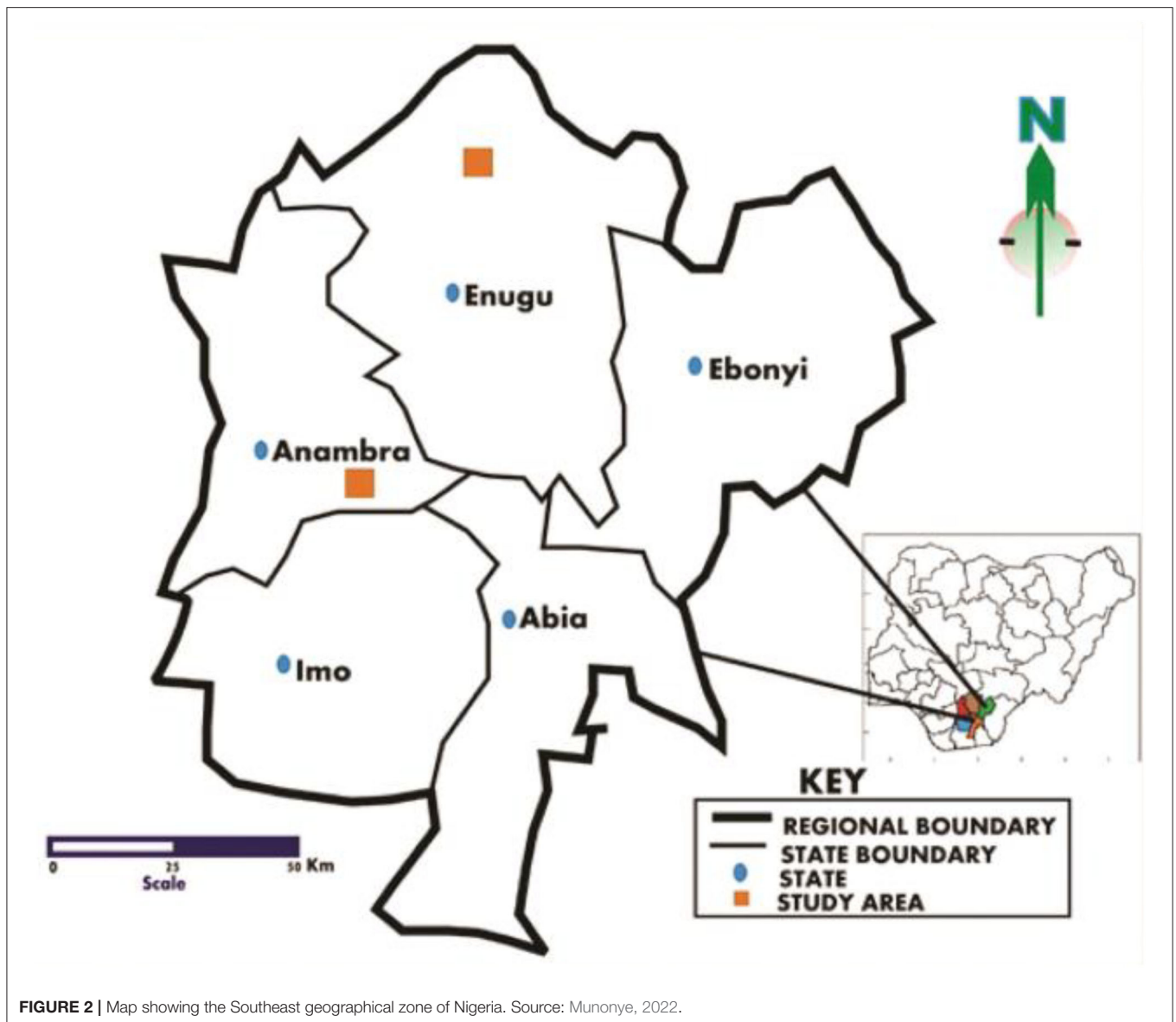
**FIGURE 2 |** Map showing the Southeast geographical zone of Nigeria. Source: Munonye, 2022.

(2020a) and on dietary and nutrient food contents required for each household. The questionnaire was administered in person to the 240 selected households in Anambra, Ebonyi, and Enugu States, respectively. The researchers guided the filling of the questionnaire to ensure total compliance from the households (respondents). However, out of the 240 distributed questionnaires, only 209 were found useful for data analysis. This was based on sufficient information regarding the core objectives of the study. Others were voided due to errors and insufficient data. Data collected were carefully sorted out, standardized, coded, and entered in an excel spreadsheet for data analysis using descriptive and inferential statistics. Moreover, before the actual data collection, the first pilot survey was conducted using 20 households to determine the effectiveness of the questionnaire in terms of reliability. This action was repeated again, after 1 month. The test-retest

reliability of the questionnaire yielded a correlation coefficient of 0.80 and was significant at 1 and 5% levels. This shows the overall reliability and suitability of the questionnaire for actual data collection. Items included in the final instrument were as follows:

- Demographic characteristics of the households estimated using mean and percentage.
- Different food categories consumed before and during the Pandemic, scored using frequency; that is the number of occurrences of respondents per food category.
- Food prices of commodities before and during the Pandemic. Respondents were asked to input the actual food prices or food cost per commodity listed and the mean value determined.
- Sources of food delivery, scored using the frequency
- Availability of food, scored using the frequency

- Factors affecting food availability, accessibility, and use, scored using the frequency
- Determinants of food security status of households, scored using binary numbers.

## Sampling Technique (Participants)

The study was a cross-sectional study, and its eligibility criteria were based on the true experience and encounter of the households with COVID-19 Pandemic. The study adopted purposive and multi-stage sampling techniques. In the first stage, three states out of the five states in Southeast Nigeria were purposively picked due to worsening food security situations in the states orchestrated by COVID-19 as depicted by the National Food Council of Nigeria. The states were Anambra, Enugu, and Ebonyi. In the second stage, two local government areas mostly affected by the COVID-19 Pandemic according to regional reports of the National Food Council of Nigeria were purposively selected from each of the states, giving a total of six local government areas. In the third stage, two communities were randomly selected from the local government areas resulting in a total of 12 autonomous communities across the states. In the fourth stage, with the help of the community leaders, 20 households (respondents) were randomly picked across the selected communities, giving a sample size of 240 households.

## Variables Used in the Study

The variables used in the study were identified and defined in the following section.

### Demographic Factors Such as

Age of households (Years)
Number of males (Number)
Number of females (Number)
Male-headed household (Percentage)
Female-headed household (Percentage)

### Food Groups Consumed and Food Prices

Cereals/grains
Fish and seafood
Root/tubers and plantain
Vitamin a rich fruits and vegetables
Other fruits and vegetables
Milk and milk products
Oil/fats
Meat (organ and fresh meat)
Edible insects
Seeds and pulses/nuts
Sugar/honey
Eggs
Miscellaneous (spices, condiments, etc.)
**Note:** Respondents were asked to indicate the food groups consumed and food prices before and during the Pandemic.

### Food Requirements

Minimum food requirements
Source of food delivery
Availability of food during COVID-19 Pandemic.

**Note:** Respondents were asked to indicate their minimum food requirements, source of food delivery, and availability during the Pandemic.

### Factors Affecting Food Availability, Accessibility, and Use During the Pandemic

Artificial scarcity
Increase in food price
Lockdown policy
Panic purchase
Lack of storage facilities
Lack of electricity supply
Low income
Lack of employment
Family size
Climate change
Poor government policy
Labor reduction.
**Note:** Respondents were asked to indicate the variable factors applicable to them.

### Variable Determinants of COVID 19

$X_1$ = Social distancing (Observed = 1, 0 = otherwise)
$X_2$ = Lockdown imposition (Observed = 1, 0 = otherwise)
$X_3$ = On-line orders (Yes = 1, 0 = otherwise)
$X_4$ = Increase in disease spread (High = 1, 0 = otherwise)
$X_5$ = Government policy on food market closure (Observed = 1, 0 = otherwise)
$X_6$ = Loss of jobs (Yes = 1, 0 = otherwise)
$X_7$ = Low income (Yes = 1, 0 = otherwise)
$X_8$ = Household size (No. of persons)
$X_9$ = Panic purchase (Yes = 1, 0 = otherwise)
$X_{10}$ = Increase in food prices (Yes = 1, 0 = otherwise)

### Food Index Variables

Percentage of households
Number of households
Mean of household size
Mean food security index/standard deviation
Mean household's daily calorie intake (kcal)
Mean households per capita daily calorie intake (kcal)
Food insecurity gap index
Food surplus gap index
Food surplus/insecurity gap index
Headcount ratio
**Note:** Measured in percentages, numbers, mean, and food security indices.

## Data Source and Measurement

Demographic factors or characteristics of the households were sourced from field survey report 2021 and were measured using descriptive statistics. Food groups consumed and food prices were sourced from field survey report 2021 and were measured using descriptive and Z-test statistics. Food requirements were sourced from field survey report 2021 and were measured using descriptive statistics. Factors affecting food availability, accessibility, and use during the Pandemic were sourced from

field survey report 2021 and were measured using descriptive statistics. COVID-19 variable determinants were sourced from field survey report 2021 and were measured using Tobit regression model. Food index variables were sourced from field survey report 2021 were measured using both descriptive statistics and food security model.

## Bias

In accessing the effect of COVID-19 Pandemic on food security in Southeast Nigeria, the researchers carefully followed up on the household respondents in filling the data instrument (questionnaire) to ensure the correctness and ascertain the appropriateness of the data information provided in order to eliminate potential errors and/ or human induced bias.

## Study Size

Initially, the researchers randomly selected 240 household respondents using multi-stage sampling technique. However, after careful examination of the data instrument, only the respondents from 209 households were finally used for the study based on the correctness and appropriateness of the data provided, which were carefully certified by the researchers for data analysis. The selected households were picked from the three states in Southeast Nigeria namely Enugu, Anambra, and Ebonyi.

## Quantitative Variables

The variables used in this study were quantified and handled using food security index model and Tobit regression model.

The food security index model was proposed by Marion (2010) and adopted by Otu et al. (2014) and Saleh and Mustafa (2018). The model seeks to ascertain the household daily per capita calorie intake vs. the recommended daily per capita calorie requirements of households. The food security index model is specified as follows;

$$\text{FS}_I = \frac{H_{DPCCI}}{R_{DPCCR}} - - - - - - \quad (1)$$

Where

$\text{FS}_I$ = Food security index

$H_{DPCCI}$ = Household's daily per capita calorie intake

$R_{DPCCR}$ = Recommended daily per capita calorie requirement.

Furthermore, the food insecurity gap index (FIGi), food surplus gap index (FSGi), and the headcount ratio (HCR) of the food security were calculated for the sample households based on the food security index. The food insecurity gap measures the extent to which food in-secured households on average fall below the food security line and the food surplus gap measures the extent to which food secured households exceeded the food security line. The headcount index measures the percentage of the sampled households that are food insecured or secured. The HCR, food insecurity gap, and food surplus gap were also projected by Marion (2010) and are defined as follows:

$$\text{Hf}_i = \frac{X}{Z} - - - - \quad (2)$$

$$\text{Hf}_s = \frac{y}{Z} - - - - \quad (3)$$

$$\text{FIG}_i = \frac{1}{X} \sum_{i}^{X} = 1 \; where \; D_i = \frac{C_{i-R}}{R} - - - - \quad (4)$$

$$\text{FSG}_i = \frac{1}{Y} \sum_{i}^{Y} = 1 \; where \; D_i = \frac{C_{i-R}}{R} - - - - \quad (5)$$

Where;

Hfs = Headcount index for food secured households
Hfi = Headcount index for food insecured households
$\text{FIG}_i$ = Food insecurity gap index
$\text{FSG}_i$ = Food surplus gap index
X = Number of food insecured households
Z = Total number of households in the sample
Y = Number of food secured households
$D_i$ = Daily per capita calorie deficiency or surplus for ith households
$C_i$ = Daily per capita calorie consumption of food item for ith households
R = recommended daily per capita calorie requirement.

The recommended minimum daily calorie requirement per adult equivalent of 2,100 kcal by WHO (2020c) and the United States Committee on International Nutrition (USCIN, 2020), 1,800 kcal by FAO (2020b), and National Average Calorie Requirement of 2,700 Kcal (Babatunde et al., 2007) were used as baselines in defining the food security line for the study. Hence, households that are below the food security line are classified as food insecured households, while those households that are above are classified as food-secured households. Again, households' daily per capita calorie consumption was estimated using the food nutrient composition table as shown in **Table 1**. This involves a comprehensive list of standardized food groups and/or classifications consumed in Nigeria. The calories were calculated from the energy values of various food components which were converted into kilograms. The estimated daily calorie (energy) supply of the households was divided by the household size adjusted for adult equivalents using the consumption factor for age–sex categories. The food security model was used to determine the distribution of food security indices of households during COVID-19 Pandemic in Southeast Nigeria.

Tobit regression model was proposed by James (1958) and had been used by many (Mazibuko and Antwi, 2019; Yang et al., 2019; Amore and Murtinu, 2021) in estimating censored or truncated continuous variables. Tobit regression model is explicitly expressed as follows:

$$Y = X_i B + U_i - - - - \quad (6)$$

Where

Y = a latent unobservable variable
B = Vector of unknown coefficients
$U_i$ = Error term assumed to be independently distributed with mean zero and constant variance

**TABLE 1 |** Standardized food groups/classifications.

| Food group | Examples |
| --- | --- |
| Cereals/grains | Corn/maize, rice, sorghum, millet or any other grains or foods made from these (e.g., bread, corn flakes, golden morn, noodles, spaghetti, pap, agidi, or other grain products) |
| Roots, tubers, and plantain | Potatoes, yam, cassava, cocoyam, plantain, or other foods made from these roots and tuber (e.g., garri, tapioca, fufu, plantain chips, potato chips) |
| Vitamin a rich vegetables and fruits | Banana, papaya, mango, carrot, palm fruit, red/yellow sweet pepper |
| Other fruits and vegetables | Garden egg, fresh and canned tomatoes, African pear, avocado pear, pineapple, apple, watermelon, African star apple, ube mgba, guava, soursop, orange, cucumber, grape, cabbage, lettuce, green, spinach, pepper fruit, waterleaf, onion, garlic, ginger, scent leaf, bitter leaf, okazi, oha, coconut, pumpkin leaf, okra, garden egg leaf, date, wild fruits, and fruit juice. |
| Meats, organs, and edible insects | Beef, pork, mutton, chevon, goat, game, turkey, guinea fowl, chicken, duck, other birds, insects (termites, locust, crickets), snail, liver, kidney, intestine, heart, or other organ meats or blood-based foods |
| Eggs | Eggs from chicken, duck, guinea fowl or any other egg |
| Fish and seafood | Fresh, frozen or dried fish, crayfish, crab, shellfish, and other sea foods |
| Pulses, nuts, and seeds | Beans, groundnut, melon, walnut, cowpea, tiger nut, soybean, cashew nut, bambara nut, oil bean, breadfruit, jackfruit, akidi, palm kernel nut, pigeon pea, or foods made from these (e.g., moi-moi, akara, peanut butter) |
| Milk and milk products | Milk, yogurt |
| Oil and fat | Margarine, butter, vegetable oil, bleached palm oil, groundnut oil, olive oil, etc. |
| Sugar/honey | Sugar, sugar cane, honey, ice cream, chocolates, candies, sweet, chewing gum, cookies, and cakes |
| Miscellaneous | Black pepper, salt, condiments (Onga, Maggi cube, Royco cube, Knor, Ajinomoto, Vedan) hot sauce, Uda, Uziza seed and other local spices, beverages, alcohol, etc. |

*Source: FANTA (2020), FAO (2020a), and WHO (2020b).*

$X_i$ = Vector of independent variables.

If data for the dependent variable is above the limiting factor, zero, in this case, Y is observed as a continuous variable. If Y is at the limiting factor, it is held at zero. This relationship is presented mathematically in the following two equations:

$$Y_i = X_i\beta + u_i \text{ if } X_i\beta + u_i > 0 \qquad (7)$$

$$Y_i = 0 \text{ if } X_i\beta + u_i \leq 0 \qquad (8)$$

i =1, 2, ————–N
Where
    N = the number of observations
    $Y_i$ = the dependent variable
    $X_i$ = the vector of independent variables
    $\beta$ = the vector of unknown coefficients
    $u_i$ = the error term.

Equations 8 and 9 represent a censored/truncated distribution. The model assumes that there is an underlying stochastic index equal to $(X_i\beta + u_i)$ which is observed only when it is positive and hence qualifies as an unobserved, latent variable. The Tobit model is used to estimate the expected value of $Y_i$ as a function of a set of explanatory variables $(X_i)$ weighted by the probability that $Y_i > 0$ (James, 1958). It estimates the probability of an outcome in which the dependent variable follows a continuous normal distribution of the event occurring; in this case, the dependent variable $(FS_I)$ is the probability of an event outcome that is different from having either 0 or 1 (just as it occurs in the use of Probit or Logit regression estimates). Thus, the dependent variable $(FS_I)$ was a continuous occurring variable with 0 and 1 occurring at extreme limits. Hence, the data set involves observations that are continuous but excludes any value that is outside the extreme values, 0 or 1. However, the use of continuous dependent variables with extreme limits of this nature gave rise to some censored or truncated values, which are more compatible with Tobit estimations. Hence, this informed the use of Tobit model in estimating the perceived effect of COVID-19 determinants on food security status of households in Southeast, Nigeria. Moreover, substituting Y in equation (7) above with $(FS_I)$, the Tobit model is specified as follows:

$$FS_I = X_i B + U_i ----- \qquad (9)$$

Where
    $FS_I$ = Estimated food security index of ith households
    B = Vector of unknown coefficients
    $U_i$ = Error term, assumed to be independently distributed with mean zero and constant variance
    $X_i$ = Vector of independent variables, which includes the following:
    $X_1$ = Social distancing (Observed = 1, 0 = otherwise)
    $X_2$ = Lockdown imposition (Observed = 1, 0 = otherwise)
    $X_3$ = On-line orders (Yes = 1, 0 = otherwise)
    $X_4$ = Increase in disease spread (High = 1, 0 = otherwise)
    $X_5$ = Government policy on food market closure (Observed = 1, 0 = otherwise)
    $X_6$ = Loss of jobs (Yes = 1, 0 = otherwise)
    $X_7$ = Low income (Yes = 1, 0 = otherwise)
    $X_8$ = Household size (No. of persons)
    $X_9$ = Panic purchase (Yes = 1, 0 = otherwise)
    $X_{10}$ = Increase in food prices (Yes = 1, 0 = otherwise).

## Statistical Methods

The statistical methods employed in this study were descriptive statistics and Z-test statistics. The descriptive statistics includes the frequency counts, percentage, standard deviations, and mean estimates.

The Z-test, statistic was propounded by Carl (1777–1855) and was adopted by Ryeji et al. (2018). The Z-test was used to test the statistical significance differences in mean households for ith food consumed/prices before and during the Pandemic. The Z-test is expressed as:

$$Z = \frac{X_1 - X_2}{\sqrt{\frac{SD_1}{n_1} + \frac{SD_2}{n_2}}} \quad ------ \quad (10)$$

Where;

$Z$ = Z-test statistic

$X_1$ = Mean household distribution of ith food consumed/prices before the Pandemic

$X_2$ = Mean household distribution of ith food consumed/prices during the Pandemic

$SD_1$ = Standard deviation distribution of ith food consumed/prices before the Pandemic

$SD_2$ = Standard deviation distribution of ith food consumed/prices during the Pandemic

$n_1$ = Total number of households for ith food consumed/prices before the Pandemic

$n_2$ = Total number of households for ith food consumed/prices during the Pandemic.

## RESULTS

### Participants

The researchers made use of 209 household respondents who were carefully selected and were confirmed eligible for inclusion in the study.

## DISCUSSION

### Key Results

The food groups were structurally categorized into 12 groups and/or classifications consequent upon Objective I, which describes the standardized food groups/classifications.

The demographic characteristics showed that the households had a mean age of 49 years, household size of 9.6 persons, mean numbers of males and females households were 5.1 and 4.5 persons, and percentage of the male- and female-headed households were 82 and 18, respectively. This is consequent upon Objective II, which identifies the demographic characteristics of the sampled households.

The food groups consumed before and during the Pandemic showed that majority of the households attested to the fact that foods were consumed more before the Pandemic than during the Pandemic due to the ugly impact of COVID-19 and this is consequent upon Objective III, which ascertains the food groups consumed before and during the Pandemic.

The food prices before and during the Pandemic showed that the majority of the households indicated that foods prices were higher during the Pandemic relative to before the Pandemic due to the negative impact of COVID 19 and this is consequent upon Objective IV, which determines the food prices before and during the Pandemic.

The minimum food requirements, source of food delivery, and availability of food during COVID-19 Pandemic showed that the majority of the households did not meet the minimum food requirements as recommended by FAO, WHO, and FANTA. The majority sourced foods *via* online orders and home deliveries, while food materials were not readily available due to lockdown and border closures. This is consequent upon Objective V, which determines the minimum food requirements, source of food delivery, and availability of food during the COVID-19 Pandemic.

The factors affecting food availability, accessibility, and use during the Pandemic showed that a good number of factors, such as artificial scarcity, increase in food prices, lockdown, panic purchase, lack of storage facilities, etc. influenced the food security of the households during the COVID-19 Pandemic. This is consequent upon Objective VI, which isolates the factors affecting food availability, accessibility, and use during the Pandemic.

The estimated COVID-19 determinant of food security status of the households showed that lockdown imposition, increase in disease spread, Government policy, loss of jobs, low income, and household size were important significant COVID-19 determinants of food security status of the households in Southeast Nigeria. This is consequent upon Objective VII, which estimates the perceived effect of COVID-19 determinants of the food security status of households in Southeast Nigeria.

The food security indices of households during COVID-19 showed that 24.4% of the households were food secured while 75.6% were food insecured. The food secured households had an estimated food security index of 4.59 while food insecured households had a 1.21 index. The FSGi indicated a high index value of 2.10 for food secured households and a marginal index of 0.99 for insecured households. This is consequent upon Objective VIII, which estimates the food security indices of households during COVID-19.

### Limitations

The study experienced constraints on the part of following up respondents of the 240 households regarding the filling of the data instruments. In some cases, the respondents of the households were absent on visits of the researchers thus making it a tedious exercise for the researchers who painstakingly revisited the respondents of the households on several occasions to monitor and ensure the genuineness of the data instruments.

### Interpretations

The standardized food group/classification is presented in **Table 1.** This is sequel to the recommendations of WHO (2020a), FAO (2020a), and FANTA (2020) on dietary and nutrient food contents for each household. They were of the opinion that each household should integrate these groups of food into their meal consumption on daily/weekly bases to ensure adequate calorie intake, good healthy living, and

**TABLE 2 |** Demographic characteristics of the households.

| Variable | Mean/% | Standard deviation |
|---|---|---|
| Age | 48.8 | 12.30 |
| Household size | 9.6 | 2.96 |
| Number of males | 5.1 | 1.56 |
| Number of females | 4.5 | 1.64 |
| Male headed household | 81.8% | 0.67 |
| Female headed household | 18.2% | 0.37 |
| Sample size | 209 | |

*Source: Field survey data, 2021.*

be immune against infectious germs and diseases that attack the human body (Ahmed et al., 2015). Furthermore, these groups of foods reflect the dietary quality and balanced rations needed by every household for health sustenance, tissue growth, and general body development. Each household is expected to meet these food requirements as stipulated. From **Table 1**, the various classes of foods include "cereals/grains, fish and seafood, root/tubers and plantain, seeds/pulses/nuts, vitamin A-rich fruits and vegetables, other fruits and vegetables, milk and milk products, oil/fats, meat (organ and flesh meat) and edible insects, sugar/honey, eggs, and miscellaneous food (spices, condiments, and beverages)."

The demographic characteristic of the household is presented in **Table 2**. The mean age of the households was 49 years, with a high standard deviation of 12.30; this implies that the respondents sampled during the period of COVID-19 Pandemic were more of the young and energetic group. Having been incarcerated indoors as a result of the COVID-19 Pandemic, the young and energetic people put pressure on the available and limited household foods. As they were young, they consumed more food relative to the aging members of the family (Kiramat et al., 2022). The mean household size was 9.6 persons; this means that the household size of the respondents was relatively large, and this could have serious food security implications as large families found it difficult to cope with the available food during the Pandemic that caught the world unawares (Osuji et al., 2017; Egwue et al., 2020). The mean numbers of males and females were 5.1 and 4.5 persons per household; this implies the number of males and females per household who were impacted by the COVID-19 Pandemic. More so, this further means that there are more males relative to the females in a household and this posed a big challenge to household food security during the COVID-19 Pandemic, as male folks were considered to consume more food than the female folks (Agada and Igbokwe, 2015). The percentage of the male and female-headed households were 82 and 18, respectively; this implies that the male-headed household outnumbered the female-headed household with over 456%. This further shows that the household responsibilities were shouldered by men in providing for their families even during the COVID-19 Pandemic (Agbugba, 2020a). The COVID- 19 Pandemic interfered with this responsibility as the majority of the male-headed households were basically indoors and could not source food and other domestic family needs and thus affecting their food intake (Ekoh et al., 2020b).

The food groups consumed before and during the Pandemic is presented in **Table 3**. The Table reveals that various foods were consumed before and during the Pandemic. About 82% of the households consumed cereals/grains before the Pandemic relative to the low consumption rate of 60.3% during the Pandemic. This implies that COVID-19 Pandemic negatively lowered food consumption in the Southeast zone of Nigeria due to incessant lock downs and indoor incarcerations (Egwue et al., 2020). Cereals/grains refer to staple food crops, such as rice, wheat, maize, guinea corn, etc., mostly eaten by over 80% of households in Nigeria (Mulubrhan et al., 2020). This indicated the high consumption rate recorded across the respondents both before and during the Pandemic. More of fish and seafood were consumed before the Pandemic with over 187% of the households. Fish and seafood are protein-rich food materials which are needed by each household in bodybuilding, tissue growth, and development (Akukwe, 2019). The impact of the COVID-19 situation which occurred suddenly deprived majority of the households from accessing the food material partly because of the forceful incarceration of the fishermen who were barred from fishing and also due to the unavailability of the food materials due to lockdown which prevented the smooth supply and delivery of such food materials by fish merchandise (Ohiaa et al., 2020). About 57% of the households consumed root/tubers and plantain, during the Pandemic which was far less than 74.2% of the households who consumed more of root/tubers and plantain before the Pandemic. This group of food refers to cassava, yam, coco-yam, plantain, etc. The COVID-19 Pandemic dealt with these food crops in the sense that farmers were constrained from visiting their farms to carry out their agricultural activities which brought about increased hunger, starvation, malnutrition, food shortage, low food supply, and poor food accessibility during the COVID-19 Pandemic (FAO, 2020a). In addition, most farmlands were rendered idle and unproductive due to the inability of the farmers to carry out their occupational operations (Arouna et al., 2020). Vitamin A-rich fruits and vegetables had an increasing consumption rate of over 167% before the Pandemic; this implies that more than 47.8% households consumed these food materials before the Pandemic relative to the 28.7% that consumed the food materials during the Pandemic. Other fruits and vegetables were equally consumed more before the Pandemic than during the Pandemic. These fruits and vegetables are very rich in minerals and vitamins required for body growth, bone formations, and tissue developments. About 49.3% of the households consumed milk and milk products before the Pandemic as compared to a minority of 24.9% during the Pandemic; these are products derived from farm animals both in raw or processed forms, such as extracted milks, processed milks, yogurts, etc. (Barrett, 2020; Yaffe-Bellany and Corkery, 2020). These set of food products are proteinous in nature and needed for body and organ development. The COVID-19 Pandemic impeded animal husbandry where such food products are got from and rendering breeders of livestock comatose (Barrett, 2020). Oil/fats were also consumed more before the Pandemic by 56% of the households

| Food groups | Frequency/(Percentage) | | | |
|---|---|---|---|---|
| | Before the Pandemic | During the Pandemic | Z-test | P-values |
| Cereals/grains | 171 (81.8) | 126 (60.3) | 4.8532 | <0.00001*** |
| Fish and seafood | 146 (69.9) | 78 (37.3) | 6.66692 | <0.00001*** |
| Root/tubers and Plantain | 155 (74.2) | 119 (56.9) | 3.7054 | 0.0002*** |
| Vitamin a rich fruits and vegetables | 100 (47.8) | 60 (28.7) | 4.0251 | <0.0001*** |
| Other fruits and vegetables | 120 (57.4) | 89 (42.6) | 3.0325 | <0.00244*** |
| Milk and milk products | 103 (49.3) | 52 (24.9) | 5.1643 | <0.0001*** |
| Oil/fats | 117 (56.0) | 90 (43.0) | 2.6413 | <0.0083** |
| Meat (organ and fresh meat) | 135 (64.6) | 79 (37.8) | 5.4797 | <0.0001*** |
| Edible insects | 48 (23.0) | 32 (15.3) | 1.9893 | <0.0466* |
| Seeds and pulses/nuts | 111 (53.1) | 70 (33.5) | 4.0472 | <0.0001*** |
| Sugar/honey | 105 (50.2) | 43 (20.6) | 6.3411 | <0.0001*** |
| Eggs | 105 (50.2) | 62 (29.7) | 4.294 | <0.0001*** |
| Miscellaneous (spices, condiments, etc) | 107 (51.2) | 77 (36.8) | 2.9559 | <0.00308** |

*Source: Field survey data, 2021. Significance at 1\*, 5\*\*, and 10%\*\*\*.*

as against the 43% consumption during the Pandemic. These food materials include margarine, butter, vegetable oil, bleached palm oil, groundnut oil, etc. They are known for muscle development, body formation, and tissue enhancement. **Table 3** further shows an increasing 171% in meat consumption before the Pandemic; this implies that greater percentage of the households consumed more meat products before the Pandemic than during the Pandemic. This is also as a result of the COVID-19 situation that grounded animal husbandry in the Southeast Nigeria (Uche et al., 2021). Edible insects, such as termites, locust, and crickets were consumed more before the Pandemic than during the Pandemic; this refers to victual insects usually substituted in most times for their nutritional content capacities needed by the body for maximum growth and development. About 53.1% of the households consumed seeds and pulses/nuts before the Pandemic as against 34% during the Pandemic. These seeds and nuts include beans, groundnut, melon, walnut, cowpea, tiger nut, etc. Sugar/honey and eggs had an increasing consumption rate of 50% before the Pandemic with less than 22 and 31% of the households during the Pandemic; this implies a high consumption rate over these food groups before the Pandemic. Other miscellaneous foods (spices, condiments, etc.) were consumed by less than 37% of the households during the Pandemic which represents 72% less of consumption rate during the COVID-19 Pandemic. The COVID-19 Pandemic negatively influenced the food consumption rates during the Pandemic as lesser food categories were evidently consumed as shown in **Table 3**. This was obviously due to the frequent and total lockdowns imposed by both the federal and state governments in the Southeast zone of Nigeria which grounded all economic and agricultural activities leading to epileptic food supply, food shortages, low food quality, and higher food prices (Young and Crush, 2019; Oleribe et al., 2020). The lockdown experienced in the Southeast region coupled with other Covid-19 logistics adversely impacted on the provision of the needed food

categories by different households. According to Ogunji et al. (2021), lockdowns arising from COVID-19 triggered a massive food recession and major disruptions in food value chains across the Southeast region in Nigeria. Furthermore, the Z-test statistics carried out indicated higher significance levels showing that the food consumption of the household before the COVID-19 Pandemic significantly differs from that consumed during the Pandemic; that is, the households were much better off with respect to food consumption before the Pandemic than during the Pandemic. This assertion validated the fact that COVID-19 Pandemic negatively grounded food security in the Southeast region of Nigeria.

The food prices before and during the Pandemic is presented in **Table 4**. The table reveals that the prices of food materials before the Pandemic was obviously lower relative to the high and exorbitant prices obtained during the Pandemic; for instance, the price of cereals/grains soared higher during the Pandemic as compared with the price before the Pandemic. The exorbitant price could be because of the demands on cereals/grains since they are majorly staple food consumed regularly by over 80% of the populace in Southeast Nigeria (Mbachu et al., 2020; Ogunji et al., 2021). These food materials are energy giving foods required by every household. Fish and seafood had over 62.2% increases in price during the Pandemic; this is due to the lockdown effects that crippled the fishing business and made fishermen to compulsory retire (Adebowale et al., 2021). Root/tubers and plantain were less than N33, 000 before the Pandemic as against over N76, 000 estimated during the Pandemic; this could also be because of higher demands placed on this food category especially cassava, yam, plantain, etc. They are mostly eaten in their raw form or processed into flour which could be on high demands during the Pandemic (UNSCN, 2020). Vitamin A-rich fruits and vegetables and other fruits and vegetables had the same triple effects on prices during the Pandemic than before the Pandemic; there is over 33.5 percentage

**TABLE 4 |** Food prices before and during the Pandemic.

| Food groups | Food prices Mean (N) | | | |
|---|---|---|---|---|
| | Before the Pandemic | During the Pandemic | Z-test | P-values |
| Cereals/grains | 5492.86 | 9610.71 | 4.144 | 0.000*** |
| Fish and seafood | 4672.30 | 7506.08 | 2.225 | 0.029** |
| Root/tubers and plantain | 3206.80 | 7756.31 | 2.918 | 0.004** |
| Vitamin a rich fruits and vegetables | 2618.80 | 6493.00 | 2.271 | 0.210** |
| Other fruits and vegetables | 2131.82 | 7688.64 | 3.211 | 0.002*** |
| Milk and milk products | 4080.54 | 8381.61 | 4.150 | 0.000*** |
| Oil/fats | 3210.71 | 5054.29 | 5.641 | 0.400*** |
| Meat (organ and fresh meat) | 3858.11 | 6389.86 | 4.091 | 0.002*** |
| Edible insects | 3111.22 | 5642.33 | 2.149 | 0.064** |
| Seeds and pulses/nuts | 3158.82 | 6284.31 | 3.998 | 0.300*** |
| Sugar/honey | 2690.98 | 6801.37 | 3.438 | 0.001*** |
| Eggs | 3302.71 | 7068.64 | 1.921 | 0.192* |
| Miscellaneous (spices, condiments, etc.) | 3172.00 | 5956.67 | 1.557 | 0.125* |

*Source: Field survey data, 2021. Significance at 1*, 5**, and 10%***.*

increase in these food prices during the Pandemic; the high prices could be due to the medical advice for people to consume more of fruits and vegetables rich in Vitamin A (WFP, 2020). The essence was to build up body immune systems as to guard the body against contacting the dreaded coronavirus and other infectious diseases (UNSCN, 2020). This probably attracted the higher increases in prices during the Pandemic. Milk and milk products had a double increase in price during the Pandemic; this could be due to their protein contents heavily required for body build and nourishment during the Pandemic. Oil/fats equally doubled its price during the Pandemic; this could be a result of higher demands on domestic cooking which cannot be varied (UNDP, 2020). Meat (organ and fresh meat) had over 60% increase in price during the COVID-19 Pandemic; this increase in price could be as a result of limited meat shop sellers who took good advantage of the closed meat markets and other market where meats are sold to inflate their meat prices. This was sequel to the lockdown imposed by the governments which affected markets and other wholesale and retail shops (UNDP, 2020). Edible insects were equally sold at a higher price during the Pandemic relative to before the Pandemic. The price of seeds and pulses/nuts and sugar/honey were higher during the Pandemic than before the Pandemic; thus, these food categories doubled in their prices due to higher demands on them. Eggs and other miscellaneous food materials were also doubled in their prices, especially eggs which had a percentage price increase of about 47% during the Pandemic. The respondents reported buying eggs at prices higher than the usual price before the Pandemic. This arose as a result of the lockdown imposition across the Southeast zone which ultimately grounded poultry production and as a result of this, egg sellers, who were able to smuggle in eggs, sold eggs at exorbitant prices relative to their former price (Uche et al., 2021). Eggs are important food materials rich in protein required by every household during the Pandemic for healthy living and maximum growth, especially in children

(UNDP, 2020). The overall implication of the result showed that food prices were relatively low before the Pandemic but during the Pandemic, prices of food items soared rapidly. The high prices of food materials during the Pandemic evidently benefited the marketers or sellers on the short-run chain; they made reasonable sales and profits arising from the lockdown escapade that brought the entire Southeast Nigeria to a sudden halt. No doubt, the COVID-19 Pandemic worsened food security in the Southeast Nigeria *via* uncertainty in food access and inadequate food supply chain thus creating a huge deficit–supply gap (Ogunji et al., 2021). Demands for available food increased tremendously and could not meet up with the supply; this resulted in the shortage of food supply in the long-run and induced higher food prices experienced in Southeast Nigeria (Oleribe et al., 2020). Furthermore, the Z-test statistics gave an overall significance value, indicating that a significant difference exists in food prices before the Pandemic and during the Pandemic. That is, the food prices before the Pandemic differs greatly from the food prices during the Pandemic.

Minimum food requirements, source of food delivery and availability of food during COVID-19 Pandemic is presented in **Table 5**. From the table, it is understood that about 10.5% of the respondents met the minimum food requirements according to the reports from WHO (2020a), FAO (2020b), and FANTA (2020). This assertion was observed during the period of data collection from the households in view of the groups of food consumed during the Pandemic. It was further observed that these minorities of households were able to access the available dietary and nutritional food materials to meet the minimum food requirements. This resulted in panic purchasing of available food materials, which made households stockpile foodstuff (Worstell, 2020; Adebowale et al., 2021). This was done to avert possible hunger, starvation, malnutrition, etc. during the COVID-19 Pandemic. Again, 76.1% of the households had a no response to the minimum food requirements implying that they were not able

**TABLE 5 |** Minimum food requirements, source of food delivery, and availability of food during COVID-19 Pandemic.

| Variables | Frequency | Percentage |
|---|---|---|
| **Meeting minimum food requirements during COVID-19** | | |
| Yes | 22 | 10.5 |
| No | 159 | 76.1 |
| No response | 28 | 13.4 |
| Total | 209 | 100 |
| **Sources of food delivery during the Pandemic** | | |
| Visit available markets, stores, shops, etc. | 96 | 45.9 |
| Online orders/Home delivery services | 113 | 54.1 |
| Total | 209 | 100 |
| **Availability of food during the Pandemic** | | |
| Readily available | 69 | 33 |
| Not available | 115 | 55 |
| No response | 25 | 12 |
| Total | 209 | 100 |

*Source: Field survey data, 2021.*

**TABLE 6 |** Factors affecting food availability, accessibility, and use during the Pandemic.

| Factors | Frequency | Percentage |
|---|---|---|
| Artificial scarcity | 125 | 59.8 |
| Increase in food price | 179 | 85.6 |
| Lockdown policy | 134 | 64.1 |
| Panic purchase | 63 | 30.1 |
| Lack of storage facilities | 119 | 56.9 |
| Lack of electricity supply | 65 | 31.1 |
| Low income | 134 | 64.1 |
| Lack of employment | 101 | 48.3 |
| Family size | 64 | 30.6 |
| Climate change | 56 | 26.8 |
| Poor government policy | 115 | 55.0 |
| Labor reduction | 92 | 44.0 |

*Source: Field survey data, 2021.*

to meet the minimum food requirements as specified basically due to the sudden emergence of the COVID-19 Pandemic which swept the whole world off their feet (WHO, 2020c).These groups of households reported making use of any available food at their disposals in satisfying their domestic food needs during the Pandemic and thus, did not bother meeting the minimum food requirements as specified. That is, they were of less concern to minimum food requirements owing to the negative effects of COVID-19 in term of food shortage and unavailability in Southeast Nigeria (Akukwe, 2019; Ekoh et al., 2021). However, 13.4% of the households gave a zero response to the minimum food requirements, implying that they were neither here nor there, regarding the minimum food requirements. They were speechless and dumbfounded due to the biting impact of COVID-19 Pandemic which impaired the food security of their households. About 45.9% of the households sourced their foods *via* available markets, opened stores, shops, etc. This was because the Covid-19 Pandemic led to the closing and shutting down of major markets, stores, shops, etc. across the southeast region whose aim was to avert the possible spread of the COVID diseases which was presumed to spread *via* close contacts with infected persons (WFP, 2020b). This singular act limited the number of available markets, stores, etc. Online orders/home delivery services was used by 54.1% of the households; this became an alternative to the physical buying and selling in the opened markets, shops, and stores as majority of the households resulted to online ordering of domestic foods, since they were not allowed to visit the open markets due to the COVID-19 lock down that greeted the entire Southeast region of the country (Mbachu et al., 2020). The online ordering request commands available foods to be delivered at doorstep under strict compliance with COVID-19 protocols put by the government (WFP, 2020a). Indeed, the online ordering was a source of relief to most homes that were suffering from food shortage and scarcity. Again, less than 55% of the households opined that food was not readily

available during the Pandemic due to evidential reasons, such as the lockdown syndrome, the spread of COVID disease, ban on movements, grounding of agriculture, etc. (Torero, 2020). Due to the lockdown, vehicle movements were restricted in the Southeast zone, and this further restricted the movement of food materials across the Southeast zones (Uchechukwu et al., 2022). Furthermore, agriculture which happens to be the main stay of food production was grounded to pieces as the farmers failed to visit their farmlands due to the lockdown and the government's ban on movement due to the spread of COVID-19 disease (Terazono and Munshi, 2020). On the contrary, about 33% of the households gave a positive response toward food availability, implying that foods were readily available precisely on demands or online ordering and/or available markets (Barrett, 2020). They reported that they were able to access available food, though in limited quantity, due to available funds or capital. About 12.0% of respondents declined answers on food availability. Again, they were dumbstruck on the prevalence of the COVID-19 Pandemic ravaging the Southeast zones and other parts of the country.

Factors affecting food availability, accessibility, and use during the Pandemic is presented in **Table 6**. The table reveals that 60% of the households opined that artificial scarcity affected food availability, accessibility, and use during the Pandemic; this means that the COVID-19 Pandemic created some form of artificial scarcity in the sense that some of the marketers or goods sellers took good advantage of the period and hoarded their wares, making it look scarce with an ulterior motive of making excess profits at sales (Agbawodikeizu et al., 2021).This attitude of the sellers or marketers really affected food availability, accessibility, and use during the Pandemic. About 86% of the households attested that increase in food prices hugely influenced negatively the three dimensions of food security (food availability, accessibility, and use) during the Pandemic; this implies that the COVID-19 Pandemic initiated increase in prices of food materials due to the total lockdowns imposed by the government that clapped down markets and other sources of food vendors thereby initiating artificial scarcity leading to increase

in food prices of food materials (Oginni et al., 2020). About 64.1% of the households indicated that the lockdown policy embarked on by the government as an alternative measure to flatten the COVID-19 epidemic curve and curtail the spread of the coronavirus affected food availability, accessibility, and use during the Pandemic. This means that the lockdown policy led to the closure of open markets, shops, stores, and impeded vehicular movement of goods and products into the Southeast regions thereby threatening food security in the zone (Ohiaa et al., 2020). Panic purchase was testified by 30.1% of the households; this factor affected the availability, accessibility, and use of food during the Pandemic (Ekoh et al., 2021). In a bid to defeat hunger, starvation, and malnutrition during the Pandemic, out of panic, people purchased expired food products without checking or confirming their expiration regarding the dates, which they eventually did not consume or made use of during the Pandemic. Lack of storage facilities was reported by 57% of the households; this implies that storage facilities that were inadequate due to the lockdown imposition affected the availability, accessibility, and use of food during the Pandemic (Ekoh et al., 2021). Lack of electricity supply was also attested by 31.1% of the households; this factor worsened the storage and preservation of perishable items. thus affecting the availability, accessibility, and use of food during the Pandemic (Uchechukwu et al., 2022). About 64.1% of the households indicated low income; it was generally obvious and true that the COVID-19 Pandemic induced low capital since people's jobs and source of earnings were hugely interrupted resulting from the lockdown (Agbawodikeizu et al., 2021). As a result, incomes were affected, and this negatively influenced food security in the Southeast region. Lack of employment was reported by 48.3% of the respondents; similarly, the COVID-19 Pandemic heavily led to massive loss of jobs across the Southeast Nigeria. Majority of the private companies and business enterprises begun the act of laying off their staff due to the biting impacts of the Pandemic as the companies were not able to sustain their salaries and other allowances; this back drop bankrupts the affected staff and impeded their food accessibility and use during the Pandemic (UNDP, 2020). Family size was reported by less than 32% of the respondents, in truth, families with large households felt the seriousness of the Pandemic, as they were not able to cope during the Pandemic (Aven and Bouder, 2020). Climate change was also attested to and evidently affected food availability, accessibility, and use during the Pandemic. Alterations in weather and seasonal changes affected farm production (Uche et al., 2021), which transited to food shortage and supply during the Pandemic. Poor government policy and labor reduction were reported by over 90% of the households; this means that lockdown policy of the government without adequate and proper food provisions largely affected food availability, accessibility, and use during the Pandemic (Agbugba, 2020a). The government perceived the lockdown as an alternative measure without seeing the negative side effects on food security in the Southeast region of Nigeria.

The estimated COVID-19 determinant of food security status of households in Southeast Nigeria is presented in **Table 7**. The log-likelihood value of 176.990 was highly significant at

1% level, implying that the COVID-19 variables significantly declined food security in the Southeast zone of Nigeria. The high value estimated on Pseudo ($R^2$) indicated the fitness of the model. The coefficient of social distancing, online orders, and panic purchasing were not significant even at a 10% probability level. The coefficient of lockdown imposition was significant and negative; this implies that an increase in lockdown imposition by the government declined the food security in the zone. This is true due to the effects of the lockdown imposition shut-down open markets and other marketing outlets where food materials could be sourced leading to food deficit and shortage (Ekoh et al., 2020a). The increase in disease spread coefficient was significant at a 1% level and negative; this implies that food security (availability, accessibility, and utilization) worsened as the coronavirus disease spreads rapidly. This was evidently true because the Southeast zone experienced increase in the virus spread, and this hugely affected food availability, accessibility, and use during the Pandemic (Uche et al., 2021). The coefficient of government policy was significant at 1% level and negative; this implies that increase in poor policies of government decreased the food security in the Southeast zone of Nigeria. This was on the bases of immature and sudden measures (policy) to curtail the spread of the coronavirus. These policies (lock-down, closing of food markets, shops, stores, closing of abattoirs, ban on vehicular movement, etc.) were sudden policies that crippled food security in the Southeast Nigeria Agbugba (2020b).Coefficient of loss of jobs was significant at 1% level and negative; this implies that food security aggravated in the Southeast zone due to increased loss of jobs. The COVID-19 period led to a massive loss of jobs in the Southeast zone, especially by private multinational and other private companies (Altieri and Nicholls, 2020; Mbachu et al., 2020; Torero, 2020), and this basically affected the income of workers and thus, translated to food deficit in the zone. The coefficient of low income was significant at 10% level and negative; this implies that the increase in the low income of the respondents exacerbated food security in the zone, the Pandemic period led to massive job losses and shut-down of businesses which affected the income of the populace, and this made it difficult to access or purchase food materials during the Pandemic (UNDP, 2020). The coefficient of household size was significant at a 5% level and negative; this implies that food security in Southeast Nigeria was exacerbated with an increase in the household size. Families with large household sizes found it extremely difficult to cope during the Pandemic, as the available food materials were limited and insufficient to satisfy their domestic food needs (Adebowale et al., 2021). The coefficient of increase in food prices was significant at 1% level and negative; this implies that food security in Southeast Nigeria got worsened with increased food prices. The sudden and imminent lockdown and closure of markets, shops, mini stores, had tremendous effects on food prices, as it doubled the usual market price (Devereux et al., 2020). This stems partly from the creation of artificial scarcity by marketers and partly from government inabilities to provide alternative measures to cushion the negative effects of their actions and policies. An increase in food prices was the major factor as averred by the respondents because it affected the three pillars of food security dimensions (availability,

**TABLE 7 |** Estimated COVID-19 determinants of food security status of households in Southeast Nigeria.

| Variables | Parameters | Coefficients | t-values | Std. Error |
|---|---|---|---|---|
| Constant | $b_0$ | −0.8499 | −2.8194** | 0.3014 |
| Social distancing | $b_1$ | −4.9160 | −1.4466ns | 3.3983 |
| Lockdown imposition | $b_2$ | −0.8414 | −4.0494*** | 0.2077 |
| On-line orders | $b_3$ | 0.6635 | 1.4584ns | 0.4549 |
| Increase in disease spread | $b_4$ | −0.7769 | −4.8474*** | 0.1602 |
| Government policy | $b_5$ | −4.8314 | −4.8470*** | 0.9967 |
| Loss of jobs | $b_6$ | −3.6436 | −3.9138*** | 0.9309 |
| Low income | $b_7$ | −0.8847 | −1.6577* | 0.5337 |
| Household size | $b_8$ | −4.9674 | −2.4994** | 1.9874 |
| Panic purchase | $b_9$ | 0.8978 | 1.0953ns | 0.8197 |
| Increase in food prices | $b_{10}$ | −0.0394 | −4.4986*** | 0.0088 |
| Log likelihood | | −176.990** | | |
| Pseudo ($R^2$) | | 0.8999 | | |
| N | | 209 | | |

*Source: Field survey data, 2021. Significance at 1\*, 5\*\*, and 10%\*\*\* levels.*

accessibility, and usability). Food availability was affected due to prohibitions on movement and closure of informal food markets to observe social distancing and to curtail the spread of the virus. Food access was threatened by high food prices and affected households with relatively low income (World Bank, 2020a). These high prices made retailers to have profiteered from panic purchases.

The food security index of households during COVID-19 is presented in **Table 8**. The result shows that 24.4% of the households were food secured during COVID-19 Pandemic as against 75.6% that were not secured. This implies that a lesser number of the households were food secured while the majority of the households were not secured. The former could be due to the food accessibility, availability, and utilization as against the latter (Ogunji et al., 2021). Similarly, the total number of food-secured households was 51 relative to 158 insecured households; this means households in Southeast Nigeria had an increasing percentage of about 309.8% in food insecurity during the Pandemic; this may be due to the lockdown imposed in the states that shut down the economy of the Southeast Nigeria (Uchechukwu et al., 2022). The mean household size of food secured, and insecured households were 4.4 and 6.6, respectively; this implies a serious implication for food security in the zone (Agbawodikeizu et al., 2021). Food insecured households had approximately 6 persons per household and were worse-off during the COVID-19 Pandemic; this was due to their inability to access adequate and sufficient food materials needed to meet their domestic demands (UNDP, 2020). The food secured households had an estimated mean food security index of 4.59 relative to 1.21 obtained from the food insecured households. This means that food secured households had a higher mean food security index in comparison with the food insecured households with a lower food security index. The low food security index could result from the inability of the households to cope with the biting effects of the COVID-19 Pandemic and the limited food materials during the Pandemic due to the lockdown

imposition and closure of markets experienced in the Southeast Nigeria (Ekoh et al., 2020a,b). This further implies an upward percentage increase of 379.3% in food insecurity in the Southeast Nigeria. The mean household daily calorie intake (kcal) of food secured and insecured households were 15,512.07 and 1,422.06, respectively, in addition to the mean household per capita daily calorie intake (kcal) estimated at 19,104.41 and 1,270.94 for food secured and insecured households. Here, the average daily calorie intake cum per capita daily calorie intake for food secured households were 15,512.07 and 19,104.41 kcal, which were higher than the recommended minimum daily calorie requirement of 2,100 kcal by (WHO) and (USCIN), 1,800 kcal by (FAO) and the national average calorie requirement of 2,700 kcal, signifying the maximal food security. While the average daily calorie intake cum per capita daily calorie intake for food insecured households were 1,422.06 and 1,270.94 kcal, respectively, which were lower than the recommended minimum daily calorie requirement of 2,100 kcal by WHO and USCIN) 1,800 kcal by (FAO), and the national average calorie requirement of 2,700 kcal, signifying a shortfall in the food security in Southeast Nigeria. These results further imply that the food secured households met the recommended calorie intake of 2,100 kcal by WHO and (USCIN, 1,800 kcal by FAO and the national average calorie requirement of 2,700 kcal, per capita per day as against the food insecured households that were unable to meet the recommended daily per capita calorie requirements of 2,100 kcal by WHO and USCIN, 1,800 kcal by FAO and national average calorie requirement of 2,700 kcal, during the COVID−19 Pandemic experienced in the Southeast Nigeria. This further indicated that a greater percentage of the households, 76%, were food insecured during the COVID-19 Pandemic. The reason for this variance still revolves around the sudden lockdown policy of the government that grounded every economic activity, for instance, food production and distribution in the Southeast Nigeria (Oginni et al., 2020). The FIGi gave estimated values of 0.89 and 3.98 for food secured and insecured households, respectively; this implies that food secured

| Food security indices | Food secured households | Food in-secured households | Pooled |
|---|---|---|---|
| Percentage of households | 24.4 | 75.6 | 100 |
| Number of households | 51 | 158 | 209 |
| Mean of household size | 4.4 | 6.6 | 11.0 |
| Mean food security index/ Std. Dev. | 4.59/(3.47) | 1.21/(0.98) | 5.8/(4.45) |
| Mean households daily calorie intake (kcal) | 15512.07 | 1422.06 | 16934.13 |
| Mean households per capita daily calorie intake (kcal) | 19104.41 | 1270.94 | 20375.35 |
| Food insecurity gap index | 0.89 | 3.98 | 4.87 |
| Food surplus gap index | 2.10 | 0.99 | 3.09 |
| Food surplus/insecurity gap index | 2.36 | 0.24 | 2.6 |
| Head count ratio | 0.28 | 0.97 | 1.27 |

*Source: Field survey data, 2021.*

households had a marginal insecurity gap index as against food insecured households with a high prevalence index of 398%. Again, the FSGi indicated a high index value of 2.10 for food secured households and a marginal index of 0.99 for insecured households, meaning that the food secured households were able to access and utilized food materials during the COVID-19 Pandemic relative to the latter. The FSGi/FIGi which measure the extent of deviation from the food security line shows that food secure households exceeded the calorie requirement by 236%, while the food insecured households fell short of the calorie requirement by 24%. This shows a wide margin between the food secured and food insecured households in the Southeast Nigeria. The wide margin connotes the preponderance of the COVID-19 Pandemic in the zone (Uchechukwu et al., 2022). The result further revealed a HCR of 0.28 for food secured households and 0.97 for food insecured households; this implies that about 28% of the households were food secured and 97% were food insecured.

## Generalizability

The study proved that the ongoing COVID 19 Pandemic worsened food security status of households in the Southeast region with an emphasis on the estimated food security indices of households in Southeast Nigeria.

## CONCLUSION

The findings of the study revealed that the food security situation in the Southeast, Nigeria during the COVID-19 Pandemic deteriorated and led to hunger, malnutrition, excruciating poverty, starvation, and food insecurity. The study showed that the mean household size was 9.6 persons; this means that the household size of the respondents was relatively large and this had serious food security implications as large families found it very difficult to cope with the available food during the Pandemic that caught the world unawares. About 82% of the households consumed cereals/grains before the Pandemic relative to the low consumption rate of 60.3% during the Pandemic. This suggests that COVID-19 Pandemic negatively lowered food consumption in the Southeast zone of Nigeria due to incessant lockdowns and indoor incarcerations. Cereals/grains refer to staple food crops, such as rice, wheat, maize, guinea corn, etc., mostly eaten by over 80% of households in Nigeria. This no doubt indicated the high consumption rate estimated across the households both before and during the Pandemic. The lockdown experienced in the Southeast region coupled with other COVID-19 logistics adversely impacted the provision of the needed food categories by different households. It triggered a massive food recession and major disruptions in food value chains across the Southeast region of Nigeria. Again, the prices of food materials before the Pandemic were obviously lower relative to the high and exorbitant prices obtained during the Pandemic; for instance, the prices of most staple foods soared higher during the Pandemic as compared with the price before the Pandemic. The exorbitant price could be as a result of its demands since they are majorly consumed regularly by over 80% of the populace in Southeast Nigeria. Again, the majority of the households, i.e., 76.1%, had a no response to the minimum food requirements implying that they were not able to meet the minimum food requirements as specified by WHO, FAO, and FANTA basically due to the sudden emergence of the COVID-19 Pandemic which swept the whole world off their feet. A good number of factors, such as artificial scarcity, increase in food prices, lockdown policy, panic purchase, lack of storage facilities, lack of electricity supply, low income, etc., affected the three dimensions of food security which include availability, accessibility, and utilization. Furthermore, social distancing, lockdown imposition, online orders, increase in disease spread, government policy, loss of jobs, low income, household size, etc., were recognized as COVID-19 determinants of food security status of households in Southeast Nigeria. About 24% of the households were food secured compared to 76% that were insecured during the Pandemic. The FSGi/FIGi which measure the extent of deviation from food security line shows that food secured households exceeded the calorie requirement by 236%, while the food insecured households fell short of the calorie requirement by 24%. This shows a wide margin between the food secured and food insecured households in the Southeast Nigeria.

# RECOMMENDATIONS

The study recommended the following based on its findings.

1. Robust and effective policy formulations and implementations regarding food production in the Southeast Nigeria.
2. Revitalization and rejuvenation of the agricultural sector which is the primary source of food production in Nigeria by deployment of modern agrotechnologies to replace crude implements which induce fatigues.
3. Supply of agricultural incentives, such as land provision, improved seedlings, agrochemicals, soft agricultural -loans, etc. These incentives would no doubt motivate the poor household farmers to full scale-up-agricultural production.
4. Massive job creation and provision to cushion the effects of job losses during the COVID-19 Pandemic will enhance the financial capacity of the populace to access and meet domestic food requirements.

5. Childbirth in Nigeria should be regulated to allow for household heads to provide adequately for their families; this is because large families were the major hit by the COVID-19 Pandemic.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

Ethics review and approval/written informed consent was not required as per local legislation and institutional requirements.

## AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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