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Effect of COVID-19 pandemic on household food insecurity: evidence from the United Arab Emirates

Beshir M. Ali
Business Economics Group, Wageningen University and Research, Wageningen, Netherlands
Ioannis Manikas
Faculty of Agrobiology, Food and Natural Resources, Czech University of Life Sciences Prague, Praha, Czech Republic, and
Balan Sundarakani
University of Wollongong in Dubai, Dubai, United Arab Emirates

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Abstract

Purpose – The objective of this study was to measure the prevalence and severity of food insecurity in the United Arab Emirates (UAE) during May 2021 to June 2022, and to assess the impact of the COVID-19 pandemic on household food insecurity.

Design/methodology/approach – This study measured the prevalence of household food insecurity in UAE during May 2021 to June 2022 by employing FAO's Food Insecurity Experience Scale (FIES). The impact of the COVID-19 pandemic on household food security was evaluated by employing a truncated regression model, using survey data from 504 respondents.

Findings – About 34% of the households were found to be food secure. About 22% of them experienced moderate or severe food insecurity (i.e. have eaten less than they thought should have) whereas almost none have experienced severe food insecurity during the sample period. The truncated model results show that households' region of residence, livelihood source, education level, income and number of elderlies have a significant association with the probability of experiencing food insecurity. The pandemic-induced unemployment and disruptions in physical access to food positively associated with the probability of experiencing food insecurity.

Social implications – It is critical to regularly monitor households' food security status, and design strategies that explicitly consider the food security status of UAE's significant expat population; most of whom are migrant manual labourers earning low wages, are less job-secured and have poorer access to health care.

Originality/value – Although several studies assessed the impact of the pandemic on food security in different countries, there is a lack of studies assessing the impact of the pandemic on food security in the import-dependent Gulf Cooperation Council (GCC) countries, whose food security might be severely impacted due to the COVID-19-induced global food supply chain disruptions. Our application of the truncated regression model also contributes to the food security literature.

Keywords Coronavirus, FIES, Food insecurity, Food security measurement, Pandemic, United Arab Emirates

Paper type Research paper

1. Introduction

The COVID-19 pandemic has caused about 7 million deaths and 776 million confirmed cases worldwide since its outbreak in late 2019 (WHO, 2024). Sparking fears of anticipated

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economic crisis and recession, the pandemic has also disrupted supply chains leading to panic-buying and stockpiling of food products, soaring demand for medical supplies, decreasing demand for manufactured products, and disruption of production and distribution networks following from the restrictive measures implemented by countries to slowdown the spread of the virus (Nicole *et al.*, 2020). The COVID-19 outbreak has especially exposed the vulnerability of the food systems of import-dependent countries to global food supply chain disruptions. Following the outbreak of COVID-19, several countries put restrictions on export of agri-food products (Koppenberg *et al.*, 2021), which might have raised food insecurity in import-dependent countries.

The economic difficulties caused by the pandemic and the subsequent restrictive measures adopted by nations reduced households' economic and physical access to food (Fang *et al.*, 2022). The pandemic-induced job losses and declining incomes might make (nutritious) food unaffordable, particularly for poorer households. Extremely, food may be unavailable in some areas as a result of the disruptions and breakdowns of logistics, marketing and trading systems, all leading to a rise in food insecurity (FAO, 2020). The Gulf Cooperation Council (GCC) countries such as the United Arab Emirates (UAE) are water insecure (physical) and food deficient (Hassen and El Bilali, 2019), and subsequently up to 90% of their domestic food requirements are covered through imports (EIU, 2021). Food security in these countries remains prone to disruptions in global food supply chains (Ali *et al.*, 2022).

Several studies reported that the COVID-19 pandemic has adversely affected food security (Ahn and Norwood, 2021; Béné *et al.*, 2021; Bukari *et al.*, 2022; Gundersen *et al.*, 2021; John-Henderson *et al.*, 2022; Mishra and Rampal, 2020; Restrepo *et al.*, 2021; Ziliak, 2021). Most of these studies were conducted within the first year of the pandemic (in 2020) and thereby assessed the impact of the pandemic on food security during the early stage of the pandemic, where stricter restrictions were applied by authorities to curb the spread of the virus (e.g. mobility restrictions and lockdowns). Accordingly, these studies assessed during pandemic impacts, and do not addressed post pandemic impacts on food security. Béné *et al.* (2021), for example, examined the impact of the pandemic on the four food security dimensions and concluded that the accessibility dimension has been severely impaired globally compared to the other dimensions whereas the availability dimension was less affected. Bukari *et al.* (2022) assessed the impacts of the pandemic on households' food insecurity in Ghana, and reported that the food insecurity levels experienced by households who lost their jobs due to pandemic is higher by 29-percentage points compared to households who did not lose jobs. John-Henderson *et al.* (2022) examined the impact of the COVID-19 pandemic on food security in the Blackfeet American Indian Tribal Community by using a four-month longitudinal data over August 2020 to November 2020. They found that 79% of the respondents experienced increased food insecurity. Ahn and Norwood (2021) reported that the percent of food insecure American households with children in Spring 2020 was higher by 3-percentage points than it was in 2016 and 2017.

Although several studies assessed the (during) impact of the pandemic on food security in different regions of the world, there are no studies that examined for the GCC countries, whose food security might be severely impacted due to their high food import dependency and the subsequent COVID-19-induced global food supply chain disruptions (Ali *et al.*, 2022). Therefore, the objective of this study was to assess the impact of the COVID-19 pandemic on household food security in the UAE. The specific objectives are:

(1) Measuring the prevalence and severity of food insecurity in the UAE during the past 12 months (April/May 2021 to May/June 2022),

(2) Understanding how the COVID-19 pandemic affected households' food insecurity levels, and

(3) Analysing the demographic and socioeconomic determinants of prevalence and severity of household food insecurity, and

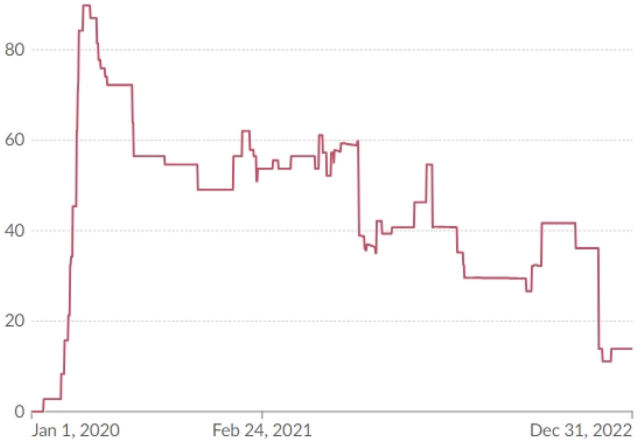
(4) Assessing the associations between the degree of experiencing food insecurity and households' coping strategies for reducing the impact of the COVID-19 pandemic on their food security.

As the survey was conducted during June/July 2022, the sample period refers to the months between April/May 2021 and May/June 2022. During this period, the number of confirmed COVID-19 cases and the case fatality rate were high, and new variants of the virus were detected in the UAE (Chen *et al.*, 2024). Subsequently, the UAE government's response to the pandemic was strict during this period (though not as strict as during the early months of the pandemic) (Figure 1), as reflected by the Government Stringency Index (Hale *et al.*, 2021; Mathieu *et al.*, 2020). The Stringency Index is a composite index, published by the Oxford COVID-19 Government Response Tracker, comprising of nine response indicators: closures of schools, workplace and public transport, stay-at-home requirements, public information campaigns, restrictions on internal movements and public gatherings, cancellation of public events and international travel controls (Hale *et al.*, 2021). Although the pandemic was not over during the time of the data collection, the analysis resembles to a post-pandemic impact assessment since respondents were asked about their food insecurity experiences during the past (pandemic) year. Relying on a sample period of the past 12 months, the present study aimed at understanding how the pandemic affected households' food insecurity during that period (i.e. an ex-post impact assessment).

2. Materials and methods

2.1 Measuring food insecurity

Food security measurement, by applying valid and reliable indicators, is critical for analysing and monitoring citizens' food security status. However, measuring food security is challenging due to the complexity and evolving nature of its operational concept in relation to its multiple dimensions and components (Maxwell, 1996; Smith *et al.*, 2017a), and as it involves a *continuum of situations* invalidating binary indicators that assign households into "food secure" and "food insecure" classes (Izraelov and Silber, 2019). Subsequently, the estimates of the prevalence and severity of food insecurity in the literature are inconsistent and inconclusive due to the lack of standardisation of the food security indicators applied (Smith *et al.*, 2017a). To circumvent the limitations of food security measurement, FAO proposed the Food



Source(s): Mathieu *et al.* (2020)

Figure 1. UAE government's COVID-19 stringency index, rescaled to a value from 0 to 100 (100 = strictest)

Insecurity Experience Scale (FIES) measure (FAO, 2016). The FIES indicator measures the prevalence and severity of food insecurity, and allows for monitoring global food insecurity. It has been applied in more than 140 countries worldwide since 2014, and is adopted by the United Nations for monitoring global food security progresses towards *Target 2.1* of *SDG2*.

The FIES is constructed using survey data from an 8-item questionnaire, referred to as Food Insecurity Experience Scale Survey Module (FIES-SM; Table 1). The FIES-SM questions, referring to a recall period of 12 months, reflect a respondent's experiences and behaviours when faced with lack of money or other resources to meet their basic food requirements. These experiences include worrying about running out of food, compromising on quality and variety of food, reducing meal sizes or skipping meals, and experiencing hunger. The prevalence and severity rates of food insecurity at respondent level are then derived from the dichotomous responses (yes/no) to the eight questions, by applying Item Response Theory, specifically the single-parameter logistic Rasch measurement model (Nord, 2014). Rasch model (Fischer and Molenaar, 2012; Rasch, 1993) allows assessing and combining individual's responses to the 8-questions, and measuring the severity of food insecurity experienced by a respondent as a latent variable (Nord, 2014).

The Rasch model assumes an underlying continuum of food insecurity severity scale for locating both items (questions) making up the scale and the households responding to the items (Nord, 2014). According to the single-parameter Rasch model, the probability of a household providing an affirmative response for a specific item/question depends on the relative severity levels of the household's food insecurity and the severity of the item/question. Specifically, the model assumes that the log-odds of a household providing an affirmative response for a specific item is proportional to the difference between the level of severity of the household's food insecurity condition and the item's severity (Cafiero *et al.*, 2018b). Let x_{ij} represents the response provided by respondent i to question j (where $x_{ij} = 1$ if a respondent provided a "Yes" response and $x_{ij} = 0$ for the "No" responses), then a random effect logit model can be specified as Cafiero *et al.* (2018b):

Table 1. The household version of the food insecurity experience scale survey module

No.	Short reference	Question wording
1	WORRIED	During the last 12 MONTHS, was there a time when you were worried that you or any household member would not have enough food to eat because of a lack of money or other resources?
2	HEALTHY	Still thinking about the last 12 MONTHS, was there a time when you or any household member were unable to eat healthy and nutritious food because of a lack of money or other resources?
3	FEWFOODS	Was there a time when you or any household member ate only a few kinds of foods because of a lack of money or other resources?
4	SKIPPED	Was there a time when you or any household member had to skip a meal because there was not enough money or other resources to get food?
5	ATELESS	Still thinking about the last 12 MONTHS, was there a time when you or any household member ate less than you thought you or any household member should because of a lack of money or other resources?
6	RANOUT	Was there a time when your household ran out of food because of a lack of money or other resources?
7	HUNGRY	Was there a time when you or any household member were hungry but did not eat because there was not enough money or other resources for food?
8	WHOLEDAY	During the last 12 MONTHS, was there a time when you or any household member went without eating for a whole day because of a lack of money or other resources?

Source(s): FAO (2016)

$$\rho \equiv Prob(x_{ij}=1) = e^{(\theta_i-\gamma_j)} \Big/ \left(1+e^{(\theta_i-\gamma_j)}\right) \iff ln\left(\rho/(1-\rho)\right) = \theta_i - \gamma_j \quad (1)$$

where $p = Prob(x_{ij}=1)$ measures the probability that household i at a severity level θ_i will provide an affirmative response to question j at severity-level γ_j, and e is the base of the natural logarithms. The severity-level of each item (γ_j) vary as, for example, the first question is less severe than the last question (Table 1). Subsequently, the probability of providing an affirmative response by a household to the less severe items is greater than the probability of affirming to the more severe items. The latent variable θ_i measures the severity of food insecurity experienced by household i, thereby captures the position of the respondent on the food insecurity severity scale (Cafiero *et al.*, 2018b). This latent severity of food insecurity experienced by each respondent (θ_i), and the severity of each item (γ_j, Table 1) are estimated by applying maximum likelihood methods, providing a continuous interval measure of severity of food insecurity.

The maximum likelihood estimation of the Rasch model provides various statistics to assess the consistency of the data with the Rasch model assumptions (Cafiero *et al.*, 2018a). These statistics include item-fit statistics, correlations among items, and a reliability measure of the scale. The item infit statistic is used to assess the consistency with the assumption of equal discrimination of the 8-FIES items (Cafiero *et al.*, 2018a). The infit statistic is "an information-weighted chi square-type statistic that compares observed with expected misfit of each item". Infit statistic values between 0.7 and 1.3 are consistent with the assumption of equal discrimination. The conditional independence of household's responses to the 8-FIES items is assessed by checking the correlations among residuals of the FIES items (Cafiero *et al.*, 2018a). The computed matrix of correlations can be used to detect the presence of any residual structure, e.g. higher correlations imply interdependence between items. The reliability measure of the scale provides the "proportion of total variance in the population that is accounted for by the measurement model" (Cafiero *et al.*, 2018a). Rasch reliability score of greater than 0.70 for a scale comprising of eight items implies a reasonably good model fit, and small measurement errors in the national-level prevalence estimates compared with sampling errors (Cafiero *et al.*, 2018a).

Based on the estimation of the prevalence of food insecurity using FIES, households are commonly assigned into the two food insecurity severity classes (*Moderate or severe food insecurity*, and *Severe food insecurity*) following FAO's predefined global FIES reference scales (threshold), termed to as FIES Global Standard Scale (FIES-GSS). The moderate or severe food insecurity threshold corresponds to the severity of the "*ATELESS*" item whereas the threshold for the severe food insecurity corresponds to the severity of the "*WHOLEDAY*" item (Cafiero *et al.*, 2018a). Accordingly, households that are classified as moderately or severely food insecure are those that have typically eaten less than they thought they should have at some point in time during the past 12 months, and have even experienced severe conditions like hunger at times. Similarly, those households that are classified as severely food insecurity are those that have spent a whole day without eating at some point in time during the past year. In this study, we assigned households into (1) moderate or severe food insecurity class if the sum of the affirmative responses is equal to or above the moderate FIES-GSS threshold; and (2) severe food insecure class if the sum of the affirmative responses is equal to or above the severe FIES-GSS threshold. Besides assigning households into the two food insecurity severity classes based on the sum of affirmative responses, we derived a *Food Insecurity Score* (FIS) for each household by taking both the severity of the FIES items, and the severity of household's experience of food insecurity into account (see Section 2.3 and Section 3.3.1 for details).

Although the FIES indicator has been applied in more than 140 countries around the world to measure and monitor food insecurity, it has not been used in the UAE. This study applied FIES to measure the prevalence and severity of household level food insecurity in the UAE.

We used the modified 8-item questions reflecting a household's (instead of an individual's) experiences and behaviours when faced with lack of money or other resources to meet their basic food needs (Table 1). To analyse the collected data, we used the customised R-based statistical software program, which was developed by Cafiero *et al.* (2018b) for estimating the prevalence and severity of food insecurity. The program also allows producing a number of additional useful statistics to analyse FIES survey data such as food insecurity prevalence by respondent characteristics (e.g. gender, region and income).

2.2 Data

Online surveys were used to collect the required data for addressing the objectives of the study. The survey was administered by a survey agent "Surview Research & Consulting" (https://surview.ae/). The questionnaire consisted of three main parts: (1) socio-demographic characteristics (e.g. gender, education, income, share of income spent on food), (2) The household-version of the Food Insecurity Experience Scale Survey Module comprising of the 8-item FIES questions (Table 1), (3) questions assessing the impact of the COVID-19 pandemic on household's food security and consumption behaviour including household's coping strategies to mitigate the impact of the pandemic on their food security. In addition, participant information sheet and a consent form were included in the introductory part of the questionnaire. Prior to distributing the survey, the participant information sheet and the consent form, which safeguard the ethical aspects of this study (e.g. data storage, privacy and potential risks to respondents), were reviewed and approved by the Human Research Ethics Committee (Ethics Number: 2022/076).

The survey was implemented in the Surview survey platform and distributed online, where an Arabic translation (of the English version) was also provided. Data were collected in June and July 2022. After the first advertisement of the survey at the beginning of June 2022, a follow-up email was sent out to consumers in mid-June 2022 to remind them to fill up the questionnaire. In total, 504 fully completed responses were obtained. Table 2 presents the description of variables.

2.3 Bootstrap-truncated regression

In this study, we followed a two-stage analysis. First, we estimated the *Food Insecurity Scores* (as described below), which measure the degree of prevalence and severity of household food insecurity in the UAE. The range of the food insecurity score lies between 0 (representing that a household is food secure) and 1 (representing that a household is severely food insecure). In the second stage, we applied a bootstrap-truncated regression to analyse the determinants of the prevalence and severity household food insecurity. The bootstrap-truncated regression for analysing the association between households' degree of food insecurity and determinants of food insecurity including household characteristics can be given by:

$$Y_i = X_i'\beta + \varepsilon_i \tag{2}$$

where Y_i is the dependent variable measuring food insecurity (i.e. the *Food Insecurity Score*); X_i' refers to a vector of household's demographic, socioeconomic, and COVID-19-related characteristics, and ε_i is the error term. This second stage bootstrap-truncated regression does not measure the effects of the causes of food insecurity. It rather shows the association between the degree of prevalence of household food insecurity and the determinants. Unlike Smith *et al.* (2017a) who defined a binary dependent variable by classifying households into two food insecurity categories (i.e. moderate or severe, and severe food insecurity) based on the sum of affirmative responses relative to FAO's global reference food insecurity thresholds, in this study, we derived a continuous interval *Food Insecurity Score* for household i (FIS_i) as a weighted average of the responses to the 8-item FIES questions:

Table 2. Description of variables used in the analysis

Variable name	Description	Measurement
Moderate or severe food insecurity	Binary variable: a household is moderately or severely food insecure if the sum of the affirmative responses is equal to or above the moderate or severe FIES-GSS threshold (i.e. 4, see Section 3.2)	Logistic Rasch measurement model; see Section 2.1
Severe food insecurity	Binary variable: a household is severely food insecure if the sum of the affirmative responses is equal to or above the severe FIES-GSS threshold (i.e. 7, See Section 3.2)	Logistic Rasch measurement model; see Section 2.1
Food insecurity score	The probability of a household being food insecure	Equation (3), see Section 2.3
Region	Emirati of the household's residence	Four dummies (Reference: Dubai): 1 = Abu Dhabi, 0 = Otherwise; 1 = Sharjah, 0 = Otherwise; 1 = Ajman, 0 = Otherwise; 1 = Umm Al-Quwain, Fujairah, and Ras Al Khaimah, 0 = Otherwise
Age	Age of the household head in years	Years
Education	Education level of the household head	Three categories: 1 = Primary sch., 2 = High sch., 3 = Higher education
Number of adults	Number of adults (15–59 years old) in the household	Number
Number of children	Number of children in the household (≤14 years old)	Number
Number of elderlies	Number of elderlies in the household (≥60 years old)	Number
Food purchasing place	Commonly used purchasing food place	Three categories: 1 = Supermarket; 2 = Open market, 3 = Other markets
Income	Annual joint household income in AED	5-point scale: 1 = <50,000 to 7 = >500,000 AED
Expenditure	Percentage of household income spent on food	7-point scale: 1 = <5% to 7 = >55%
Expat	Whether a respondent is expat or not	1 = Expat; 0 = Emirati
Main source of livelihood	Main source of livelihood or employment of the household	Four dummies (Reference: Private sector employment): 1 = Public sector, 0 = Otherwise; 1 = Own business, 0 = Otherwise; 1 = Daily labour, 0 = Otherwise; 1 = Agriculture, 0 = Otherwise
COVID-19- related variables		
Financial access	The extent to which the pandemic adversely affected household's ability to earn/get money or other resources for acquiring food	7-point scale: 1 = did not affect at all to 7 = Strongly affected
Physical access	The mobility restrictions, lockdowns or any other measure implemented by authorities negatively affected household's physical access to food	7-point scale: 1 = Strongly disagree to 7 = Strongly agree
Job loss	Whether a household member lost his/her job involuntarily due to the pandemic or not	1 = Yes, 0 = No

(*continued*)

Table 2. Continued

Variable name	Description	Measurement
Food price increase	Increase in the price of household's usual food items	7-point scale: 1 = Strongly disagree to 7 = Strongly agree
Exposed to unsafe food	Households were forced to increased risk of consumption of unsafe food due to reduced access to their usual/ traditional food suppliers/outlets	7-point scale: 1 = Strongly disagree to 7 = Strongly agree
Increase domestic violence	A household experienced increased domestic violence and/or increased tension	7-point scale: 1 = Strongly disagree to 7 = Strongly agree
Risk of COVID-19 exposure	The adopted coping strategies to satisfy the household's food requirements increased the risk of exposure to COVID-19	7-point scale: 1 = Strongly disagree to 7 = Strongly agree
Coping strategies to COVID-induced food insecurity		
Ate cheaper food	Households were forced to shift to cheaper food items	7-point scale: 1 = Strongly disagree to 7 = Strongly agree
Reduced diet diversity	Households reduced their diet diversity (i.e. forced to eat fewer food items compared to their usual consumption basket) due to the pandemic	7-point scale: 1 = Strongly disagree to 7 = Strongly agree
Ate less nutritious food	Households forced to eat fewer and/or less nutritious food items, compared to their usual consumption of nutritious food items	7-point scale: 1 = Strongly disagree to 7 = Strongly agree
Ate less-preferred food	COVID-19 forced the household to eat less-preferred food	1 = Yes; 0 = No
Spent savings on food	COVID-19 forced the household to spend savings on food	1 = Yes; 0 = No
Borrowed food/ money from friends/ relatives	COVID-19 forced households to borrow food/money from friends and relatives	1 = Yes; 0 = No
Sold household assets	COVID-19 forced the household to sell household assets such as animals, furniture, jewellery, vehicles	1 = Yes; 0 = No

Source(s): Authors' work

$$FIS_i = S_1{*}WORRIED_i + S_2{*}\text{HEALTHY}_i + S_3{*}\text{FEWFOODS}_i + S_4{*}\text{SKIPPED}_i + S_5{*}\text{ATELESS}_i + S_6{*}\text{RANOUT}_i + S_7{*}\text{HUNGRY}_i + +S_8{*}\text{WHOLEDAY}_i \quad (3)$$

where $S_1, \ldots, S_8$ represent the relative severity weights of the eight food insecurity items. This approach of measuring food insecurity accounts for both the severity of the eight items and the severity of a household's food insecurity situation (i.e. the sum of the raw score). The relative severity weights ($S_1, \ldots, S_8$) are derived from the severity score estimates of the maximum likelihood method of the Rasch model (see Section 3.3.1). Unlike the food insecurity prevalence rates based on raw scores, the FISs account for both the severity of each FIES item and the severity of food insecurity experienced by each respondent. The food insecurity prevalence rates based on raw scores do not account for the severity of the FIES items. However, the experience of food insecurity is expected to be severe for those households that provide affirmative responses to the more severe FIES items (although the raw scores remain the same). In short, in this study, the FISs provide estimates of both the severity and prevalence of food insecurity whereas the measures of food insecurity based on the raw scores provide only the food insecurity prevalence rates.

To analyse the determinants of food insecurity, we borrowed the two-stage estimation approach that has widely been applied in the efficiency and productivity literature (Simar and Wilson, 2007). In efficiency analysis, technical efficiency scores are estimated by using Data Envelopment Analysis technique in the first stage. Then, in the second stage, the marginal effects of the environmental (explanatory) variables on technical efficiency scores are estimated by applying the bootstrap-truncated regression technique. Simar and Wilson (2007) proposed the bootstrap-truncated regression analysis to overcome the two common issues of the two-stage efficiency analysis: the serial correlations of technical efficiency estimates, and the truncated nature of the underlying data generating process of the efficiency scores (note that like the food insecurity scores the efficiency scores lie between 0 and 1). As Simar and Wilson (2007) argued the efficiency scores computed in the first stage are serially correlated, and the environmental variables are correlated with the error term of the second-stage model. Subsequently, the second stage estimates will be biased if one applies the conventional methods of estimation. Similarly, the environmental variables affecting a household's food security status are expected to be correlated with the error term of the second-stage model (Equation (2)). Also, as the food insecurity scores are truncated at 0 (fully food secure) and 1 (fully food insecure), the bootstrap-truncated regression is an appropriate technique for estimating the marginal effects of determinants of food insecurity.

The literature suggests that several factors explain the degree of prevalence and severity of household food insecurity. In the model, we included three classes of factors: (1) standard determinants of food insecurity such as income and education, (2) COVID-19 pandemic-related factors such as *pandemic-induced disruptions in access to food outlets* and *job loss*, and (3) household coping strategies for reducing the impact of the COVID-19 pandemic on their food security such as *spending savings on food, borrowing food/money from friends/relatives* and *selling household assets for acquiring food*.

An increase in household income reduces the share of income spent on food, allowing households to afford (diverse and nutritious) food (Banerjee and Duflo, 2008). Moreover, increased income enable households to consume other complementary products that enhance household's well-being such as quality education and health insurance (Barrett, 2002), which ultimately improve food security. Omidvar *et al.* (2019), for example, reported that income, education level and personal health index are the main determinants of individual level food insecurity in the Middle East and North Africa (MENA) region. A household's severity of food insecurity is associated with "temporary unemployment, episodes of ill health, or other recurring adverse events" as food insecurity is often a seasonal issue (Barrett, 2010). Accordingly, we included job loss and risk of exposure to COVID-19 in the model as explanatory variables of household food insecurity (Equation (2)). Pandemic-induced job loss may raise food insecurity, specifically in low-skill households (Barrett, 2010). Unemployment not only leads to a decrease in income but also impacts individual's psychological wellbeing, which adversely affect a household's food security. In this regard, we included the household's main source of livelihood or employment as one of the determinants. Furthermore, we included "*expat*" (i.e. whether a respondent is expat or national) as an explanatory variable of food insecurity. The GCC countries are home to a significant percentage of foreign workers, accounting for, on average, about 76% of the total employed labour in 2020, and about 52% of the total population (NSI, 2022a, b). Unlike expats in the western countries, these foreign workers are migrant manual labourers earning lower wages, are less job-secured and have poorer health care access than citizens (El-Saharty and Liu, 2021; GIJN, 2021). Following the literature (Omidvar *et al.*, 2019; Smith *et al.*, 2017a, b), we have also included other demographic and socio-economic variables, COVID-19-related factors and coping strategies (Table 2). Although some of the FIES questions imply coping strategies, we have included more (direct) coping strategies that households would apply for reducing the impact of the COVID-19 pandemic on their food security. As coping strategies, households may spend their savings on food, borrow money/food from relatives/friends and/or sell/exchange their assets for food.

3. Results and discussion

3.1 Descriptive statistics

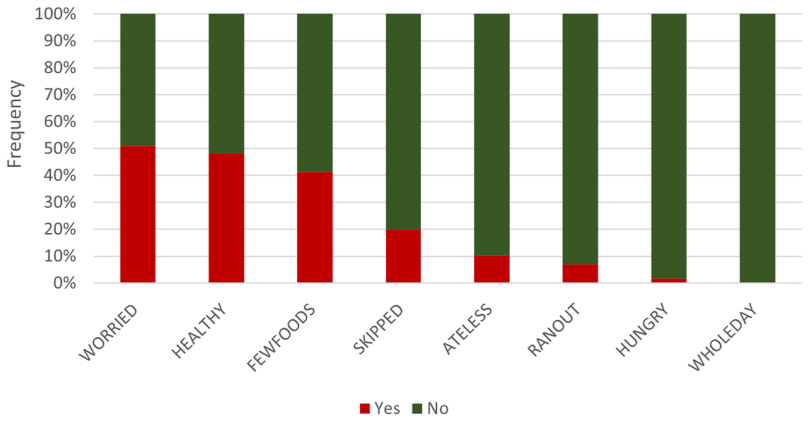
Table 3 summarises the descriptive statistics of the 504 fully completed responses. More than half of the respondents (55%) are from Dubai. Only 10% of the households are Emirati (the remaining being expats), which seems a good representative of the residents of UAE. The majority of the household heads completed higher education (67%) (Table 3).

The frequency of household responses to the 8-item FIES questions is presented in Figure 2. About half of the respondents stated that they were worried about running out of food

Table 3. Descriptive statistics of variables ($N = 504$)[a]

Variable	Unit	Mean	Std. Dev
Moderate or severe food insecurity[b]	Decimal	0.21	0.41
Food insecurity score[c]	Decimal	0.17	0.20
Region (reference: *Dubai*)			
Abu Dhabi	Dummy variable	0.14	0.35
Sharjah	Dummy variable	0.19	0.39
Ajman	Dummy variable	0.07	0.25
Others (the other three emirates)	Dummy variable	0.05	0.22
Age	Years	49.80	9.03
Expat	1 = Expat; 0 = Emirati	0.90	0.29
Education	Three categories	2.63	0.57
Number of adults (15–59 Years old)	Number	3.23	1.64
Number of children	Number	2.70	1.47
Number of elderlies	Number	0.79	0.80
Food purchasing place	Three categories	1.16	0.48
Income	Scale 1–5	1.45	0.67
Expenditure	Scale 1–7	2.64	0.94
Main source of livelihood (reference: *private sector*)			
Public sector employment	Dummy variable	0.07	0.25
Own business	Dummy variable	0.27	0.45
Daily labour	Dummy variable	0.15	0.36
Agriculture	Dummy variable	0.02	0.15
COVID-19-related variables: The pandemic			
Reduced financial access to food	Scale 1–7	4.25	1.93
Reduced physical access to food	Scale 1–7	4.44	1.52
Led to job loss	1 = Yes; 0 = No	0.59	0.49
Led to increased food price	Scale 1–7	4.23	1.52
Exposed to unsafe food	Scale 1–7	4.26	2.15
Led to increased domestic violence	Scale 1–7	3.64	2.13
Coping strategies raised COVID-19 exposure	Scale 1–7	4.03	1.81
Coping strategies to COVID-induced food insecurity			
Ate cheaper food	Scale 1–7	4.63	1.41
Reduced diet diversity	Scale 1–7	3.64	2.02
Ate less nutritious food	Scale 1–7	3.82	2.12
Ate less-preferred food items	1 = Yes; 0 = No	0.32	0.47
Spent savings on food	1 = Yes; 0 = No	0.28	0.45
Borrowed food/money from friends/relatives	1 = Yes; 0 = No	0.18	0.38
Sold household assets	1 = Yes; 0 = No	0.11	0.31

Note(s): [a]Refer to Table 2 for the description of variables and measurement
[b]A household is moderately or severely food insecure if the sum of the affirmative responses is equal to or above 4 (i.e. the moderate or severe FIES-GSS threshold, see Section 3.2 below)
[c]Food insecurity score refers to the weighted average of the affirmative responses to the 8-item FIES questions (i.e. derived by following Equation (3), see Section 3.3.1 below)
Source(s): Authors' work



Source(s): Authors' own work

Figure 2. Frequency of responses for the food insecurity experience scale survey module ($N = 504$)

at some point during the past 12-months because of lack of money or other resources for acquiring food whereas about 48% of them were unable to eat healthy and nutritious food during the same period for the same reason. However, almost all the respondents have not experienced severe food insecurity during the past year. Only a single respondent provided an affirmative response for the "WHOLEDAY" item while nine respondents (i.e. less than 2% of the sample) provided an affirmative response to the "HUNGRY" item.

3.2 Prevalence and severity of food insecurity

We have initially estimated the Rasch model based on the responses to the 8-item FIES questions. However, the infit statistic showed that the "WHOLEDAY" item does not fit the latent construct of severity of food insecurity. As a result, we estimated the Rasch model by using responses to the 7-items, by excluding the "WHOLEDAY" item [1]. Table 4 summarises the item parameter severities, the infit statistics, and the severity of the households' food insecurity together with the standard errors. The indicators of model goodness of fit show that the maximum likelihood model estimates are consistent with the Rasch model assumptions. The item fit statistics are within the acceptable range of 0.70 and 1.30. Similarly, the Rasch reliability score of 0.74 (which is greater than 0.70) implies that the constructed scale for measuring food insecurity from the seven items is reliable. The residual correlations among the seven FIES items are close to zero.

The thresholds for moderate or severe food insecurity, and severe food insecurity for the UAE are around 4 and 7, respectively (Table 4). These imply that UAE households that experienced moderate or severe food insecurity have eaten less than they thought they should at some point during the past 12 months due to lack of adequate resources for acquiring food, and have even experienced severe conditions like hunger at times. Similarly, those households who experienced severe food insecurity have spent a whole day without eating at some point during the past year. The results show that about 34% of the respondents were found to be food secure (Table 4). However, about 22% of the respondents experienced moderate or severe food insecurity during the past year whereas almost no one has experienced severe food insecurity. In other words, about 22% of the respondents have raw scores of greater than or equal to 4 whereas almost none have spent a whole day without eating at some point during the past year because of lack of adequate resources to acquire food. Our findings in line with the estimates of FAO *et al.* (2022) that the global prevalence of moderate or severe food insecurity has increased from about 25% in 2019 to about 30% in 2020 and 2021 (FAO *et al.*, 2022). Our

Table 4. Prevalence and severity of household food insecurity in the UAE

Items	Item severity		Infit		% affirmative response on non-extreme sample[a]	Severity of household food insecurity			% affirmative responses on complete sample[b]
	Mean	SE	Statistic	SE		Raw score	Severity	SE	
WORRIED	−2.92	0.16	0.81	0.07	77.34	0	−4.26	1.55	34.13
HEALTHY	−2.69	0.16	1.39	0.07	73.11	1	−3.34	1.22	18.85
FEWFOODS	−2.08	0.16	0.74	0.08	62.54	2	−2.06	1.11	14.29
SKIPPED	0.24	0.19	1.15	0.12	30.21	3	−0.74	1.19	11.31
ATELESS	1.54	0.21	0.98	0.12	15.41	4	0.65	1.15	11.90
RANOUT	2.14	0.23	0.96	0.14	10.27	5	1.94	1.14	6.75
HUNGRY	3.78	0.38	0.95	0.29	2.42	6	3.40	1.32	2.58
						7	4.45	1.55	0.20
Rasch reliability									0.74
Moderate or severe food insecurity prevalence rate									22.44%
Severe food insecurity prevalence rate									0.02%

Note(s): [a]Percentage of affirmative responses based on the non-zero raw score sample ($N = 331$), i.e. excluding fully food secure respondents. [b]Percentage of affirmative responses based on the complete sample ($N = 504$)
Source(s): Authors' work

estimate of the prevalence of moderate or severe food insecurity (22%) is also lower than the average estimate for Western Asia region (34% in 2021) (FAO *et al.*, 2022). This difference is expected as the UAE is more food secure than most of the Western Asia countries, and the 2022 estimate is also expected to be lower than the 2021 estimate following from the economic recovery from the pandemic during the first-six months of 2022.

3.3 Determinants of household food insecurity

3.3.1 Estimation of the food insecurity score. To analyse the determinates of food insecurity, first, we estimated FIS for each respondent, following Equation (3). The average FIS is 0.174 for the UAE respondents (Table 3). This implies that there is a 17.4% likelihood that a household to be food insecure in the UAE.

Table 5 provides the estimation results of the truncated model (Equation (2)). The Wald chi-square statistic measure of the model goodness of fit indicates that the included explanatory variables of the model are jointly significant in explaining the variations in the food insecurity score. The regression results are discussed below.

3.3.2 Socio-economic determinants. The truncated regression results show that the severity and prevalence of household food insecurity in Dubai is higher compared to the food insecurity situation in Sharjah and Ajman. Specifically, the food insecurity scores (FISs) in Sharjah and Ajman are, respectively, lower by 10.3- and 16.4- percentage points than the FIS of Dubai, other things being constant (Table 5), implying that the probability of experiencing food insecurity is higher in Dubai than in Sharjah and Ajman. This might be due to the fact that the majority of the sample respondents were from Dubai, and they are mostly migrant labourers.

The source of household's livelihood is found to have a significant association with the severity of food insecurity. Households earning their main livelihood from daily labour are more food insecure than those who earn their livelihood from private sector employment. *Ceteris paribus*, the FIS of "daily labourers" is greater by about 19-percentage points than the FIS of those who earn their main income from private sector employment (Table 5). This is in line with the literature that migrant labourers in the GCC countries usually earn lower wages, have poorer access to health care and are less job-secured (Chen *et al.*, 2024). On the other hand, households who earn their livelihood from public sector employment are less food insecure than those who earn from private sector employment.

Table 5. Truncated regression estimation results for the determinants of household-level food insecurity

Food insecurity score	Coefficient	Bootstrap SE[a]	95% CI	
Region (reference: Dubai)				
Sharjah	−0.103***	0.040	−0.181	−0.024
Abu Dhabi	−0.020	0.051	−0.120	0.080
Ajman	−0.164***	0.059	−0.279	−0.049
Others[b]	−0.068	0.061	−0.188	0.053
Main source of livelihood (Ref.: Private sector)				
Public sector employment	−0.112*	0.067	−0.244	0.020
Agriculture	−0.077	0.090	−0.253	0.100
Daily labour	0.187***	0.053	0.083	0.291
Own business	−0.072	0.048	−0.165	0.022
Expat	0.042	0.138	−0.229	0.313
Number of children (0–14 Years old)	−0.002	0.009	−0.021	0.016
Number of adults (15–59 Years old)	−0.011	0.009	−0.027	0.006
Number of elderlies (≥60 Years old)	0.041**	0.018	0.005	0.077
Age	−0.001	0.001	−0.003	0.002
Education	−0.079***	0.029	−0.135	−0.023
Food purchasing place	−0.002	0.033	−0.066	0.063
Income	−0.095***	0.030	−0.154	−0.035
Expenditure	0.014	0.015	−0.014	0.043
COVID-19-related variables				
Limited financial access	0.003	0.010	−0.016	0.022
Disruption in access to food outlets	0.017**	0.009	0.000	0.035
Job loss	0.081***	0.032	0.019	0.144
Risk of COVID-exposure	−0.012	0.009	−0.029	0.006
Food price increase	−0.013	0.010	−0.033	0.008
Exposed to unsafe food	0.005	0.010	−0.015	0.025
Increased domestic violence	−0.007	0.010	−0.027	0.012
Coping strategy to COVID-19-induced food insecurity				
Ate cheaper food	−0.042	0.043	−0.126	0.041
Ate less preferred food	0.045*	0.028	−0.009	0.099
Reduced diet diversity	−0.048***	0.015	−0.076	−0.019
Ate less nutritious food	0.035***	0.013	0.009	0.061
Spent saving	−0.015	0.028	−0.069	0.039
Borrowed food/money from friends/relatives	−0.010	0.035	−0.079	0.059
Sold assets	−0.013	0.037	−0.086	0.060
Constant	0.528***	0.202	0.132	0.923
Error component and model fit				
Sigma	0.168***	0.011	0.145	0.190
Log likelihood	241.890			
Wald χ^2 (31)	305.940***			
Number of observations	331.000			

Note(s): [a]Estimation based on 1,000 replications. [b]Refers to the other three emirates: Ras Al Khaimah, Fujairah and Umm Al-Quwain
***, **, * Significant at critical levels of 1, 5 and 10%, respectively
Source(s): Authors' work

Education is found to have a negative association with household's food insecurity status; where households headed by individuals with higher levels of education are expected to have a lower probability of experiencing food insecurity. Specifically, a one-unit increase in household's head education level (over the 3-point scale) is associated with about an 8-percentage point lower FIS. These results are in line with the literature (Bukari *et al.*, 2022;

Omidvar *et al.*, 2019; Smith *et al.*, 2017a, b). For example, Smith *et al.* (2017b) reported that, other things being equal, globally, having a college degree is associated with about a 15- and 5-percentage points lower probability of experiencing food insecurity, compared to having only an elementary and a secondary education, respectively. Similarly, Bukari *et al.* (2022) reported that, compared to those households without formal education, completing a tertiary, secondary and primary education is associated with about a 6-, 4- and 3-percentage points lower probability of experiencing food insecurity in Ghana, respectively.

Households with higher levels of income are associated with a lower probability of experiencing food insecurity. A one-unit increase in income is associated with a 9.5-percentage point lower FIS. Similarly, Smith *et al.* (2017b) found that a 10% increase in income in high income countries is associated with a 0.6-percentage point lower probability of experiencing food insecurity. Also, Omidvar *et al.* (2019) reported that income is one of the main determinants of food insecurity in the MENA region. Increase in household income decreases the share of income spent on food (Banerjee and Duflo, 2008), allowing households to afford food thereby reducing food insecurity. Higher income enables households to consume other complementary products that enhance the household's well-being such as quality education and health insurance (Barrett, 2002).

Households with more elderlies are associated with a higher probability of experiencing food insecurity whereas the number of children does not have a significant association with food insecurity. Similarly, Ziliak (2021) reported that food insufficiency among the elderlies increased by 75%, from 2.8% in 2019 to 4.9% in July 2020, during the pandemic. Consistent with the findings of Smith *et al.* (2017b) for upper-middle- and high-income countries, the number of adults does not have a statistically significant association with the probability of experiencing food insecurity. However, Smith *et al.* (2017b) reported that the number of children has a negative association with a household's probability of experiencing food insecurity across the different economic development levels.

Although we hypothesised "expat" (i.e. whether a respondent is expat or national) to have a positive association with the severity and prevalence of household food insecurity, the truncated regression results (Table 5) showed that being an expat does not have a statistically significant association with food insecurity. This lack of statistical variation is due to the small number of responses from the nationals; where 90% of the respondents were expats. Also, the other sociodemographic explanatory variables (age of the household head, food purchasing place, and share of income spent on food) do not have a statistically significant association with food insecurity in the UAE during the sample period.

3.3.3 Impact of COVID-19 pandemic on food insecurity. From the seven pandemic-related explanatory variables, *pandemic-induced disruptions in access to food outlets* and *job loss* were found to have a positive association with experiencing food insecurity. Other things being equal, a unit increase in *Disruption in access to food outlets* was associated with a 2-percentage point increase in FIS. This is in line with the findings of Béné *et al.* (2021) that the COVID-19 pandemic has severely impaired food access.

Ceteris paribus, the severity and prevalence of food insecurity experienced by unemployed households was higher by 8-percentage points than those households who did not lose their job. This is in line with the literature in different contexts (Bukari *et al.*, 2022; Gundersen *et al.*, 2021; Mishra and Rampal, 2020; Restrepo *et al.*, 2021). Restrepo *et al.* (2021) reported that households who lost their jobs over April to June 2020 due to COVID-19 induced business closures were 10% more likely to face lack of adequate food compared with households who did not lose their jobs. Similarly, Gundersen *et al.* (2021) argued that "projected increases in unemployment" is the main source of "projected increase in food insecurity" in the US during the COVID-19 outbreak. In this regard, Barrett (2010) noted that a household's severity of food insecurity is associated with "temporary unemployment, episodes of ill health, or other recurring adverse events" as experienced during the pandemic. Next to losing family members to the virus, households' losses of jobs and income were noted as the major direct

consequences of the COVID-19 pandemic (see, for example, Béné *et al.* (2021) for more specific cases of extents of job and income losses).

The results further show that the other COVID-19-related explanatory variables do not have a statistically significant association with the severity and prevalence of household food insecurity in the UAE. The pandemic-induced *reductions in financial access to food* and increased *exposure to unsafe food* have the expected signs as reductions in economic access to food and compromised food safety adversely affect the accessibility and utilisation dimensions, respectively. On the other hand, households' exposure to *increased price* and *increased risk of exposure to COVID-19* while acquiring food have negative association with food insecurity. These could be due to the fact that households might maximised their (physical) access to food at the expense of affordability (increased price) and utilisation (health risk).

3.3.4 Coping strategies. Three of the seven coping strategies (i.e. *Ate less preferred food, Reduced diet diversity,* and *Ate less nutritious food*) were found to have a significant association with the severity and prevalence of household food insecurity. *Ceteris paribus*, the severity and prevalence of food insecurity experienced by those households who ate less preferred food as a result of the pandemic-induced hardships was greater by about 5-percentage points compared to the food insecurity experienced by those who did not eat less preferred food. Similarly, other things being equal, the severity and prevalence of food insecurity experienced by those households who ate less nutritious food as a result of the pandemic-induced hardships was greater by about 4-percentage points compared to the level of food insecurity experienced by those who did not eat less nutritious food.

Reducing diet diversity helped UAE households to minimise their households' experience of food insecurity during the sample period. The severity and prevalence of food insecurity experienced by those households who reduced their diet diversity (i.e. ate fewer food items) as a result of the pandemic-induced hardships was lower by about 5-percentage points compared to the level of food insecurity experienced by those who did not reduce their diet diversity. This is in line with the findings of Vaitla *et al.* (2017) that copying strategies with high degree of reliance on unusual foods and homogenous but adequate foods (e.g. from food aid) could reduce diet diversity while the adequate supply of the less diverse food enable households to reduce the experience of severe food insecurity.

4. Conclusions

Food security in import-dependent countries is prone to food supply chain disruptions. We measured the prevalence of food insecurity in UAE during the pandemic, and assessed the impact of the pandemic on the prevalence and severity of food insecurity by employing a truncated regression model. Results show that about 34% of the respondents were found to be food secure. On the other hand, about 22% of the respondents experienced moderate or severe food insecurity during the sample period whereas almost no one has experienced severe food insecurity. The truncated model results show that households' region of residence, source of livelihood, education level, income and number of elderlies were found to have a significant association with the probability of experiencing food insecurity. The pandemic-induced unemployment and disruptions in physical access to food showed positive association with probability of experiencing food insecurity. The results of this study, particularly the rise in the prevalence of household food insecurity and the positive associations between experiencing food insecurity, and the pandemic-induced job losses and disruptions in physical access to food, imply that policymakers should effectively implement formulated strategies like the National Food Security Strategy 2051 to enhance the sustainability and resilience of UAE's food supply chains. Moreover, it is critical to regularly monitor households' food security status as done annually in other high-income countries. Designed strategies should explicitly consider the food security status of the significant expat population of the country, who usually earn less wages and have poorer access to health care.

Note

1. Note that in the survey, only one respondent provided an affirmative response to the "WHOLEDAY" item (Figure 2).

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Corresponding author
Beshir M. Ali can be contacted at: beshir.ali01@gmail.com