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# The double burden of COVID-19 and a major volcanic eruption on local food production and food security in a Small Island Developing State

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**Introduction:** Small Island Developing States have disproportionately high food insecurity rates, related to complex challenges and vulnerabilities. The COVID-19 pandemic highlighted that within these settings, crises often overlap. We aimed to assess the impact of the concurrent COVID-19 pandemic and volcanic eruption on food production and security in St. Vincent and the Grenadines (SVG).

**Methods:** An interpretive mixed-methods study was conducted among a convenience sample of consenting adults  $\geq 18$  years from 100 households in SVG through a cross-sectional survey and participant interviews (10 households) between September 2021 and March 2022. Food insecurity prevalence over the past year was assessed using the Food Insecurity Experience Scale (FIES; Rasch modeling) and impacts to livelihoods from the pandemic and volcanic eruption was assessed using an adapted Caribbean COVID-19 Food Security and Livelihoods Impact Survey (Caribbean COVID-19 FS&L Survey). Data were analyzed using logistic regression.

**Results:** During the pandemic, 59% of the participants reported decreased income, 63% had no access to markets, 81% had no access to food aid; 34% of the participants had a change in food sources, and 81% reported that food production was negatively impacted by the volcanic eruptions, of which 68% reported decreased food production. The interviews highlighted that access to markets were restricted by fear of leaving home and contracting the COVID-19 virus, and participants who received food aid stated that the number of items were not sufficient for larger families. Almost half of the participants were severely food insecure [48% (95% C.I. 31.2,57.8)]; almost two thirds were moderately to severely food insecure [64% (95% C.I. 50.0, 74.2)]; mean FIES score 5.31 (95% C.I. 5.0,5.6). After adjusting for gender, age, education, and household size, moderate to severe food insecurity was associated with no access to food aid during the pandemic and post-eruptions (odds ratio 3.7; 95% confidence interval 1.5, 9.1;  $p = 0.004$ ).

**Conclusion:** Food insecurity rates were high during the COVID-19 pandemic, exacerbated by volcanic eruptions and insufficient access to food aid. Our results suggest the need for the development of strategies and interventions aimed at increasing the resilience of food systems to mitigate the effects of future disasters.

#### KEYWORDS

food security, natural disaster, COVID, backyard gardening, Small Island Developing State

## 1 Introduction

The COVID-19 pandemic highlighted that we are now living in a time where crises overlap. Underpinned by a complex global supply chain, food security is often the first way in which populations experience the direct consequences of crises (Schmidhuber and Tubiello, 2007; INDDEx, 2020; United Nations, 2022). Small Island Developing States (SIDS), a group of 57 island states located mainly in the Caribbean and Pacific Oceans are particularly vulnerable to food insecurity, a multidimensional concept associated with limited access, availability, stability, and utilization of safe and nutritious food (Schmidhuber and Tubiello, 2007; SAMOA, 2017; INDDEx, 2020; United Nations, 2022; FAO, 2023). Food insecurity in SIDS is related to a unique set of challenges and vulnerabilities (SAMOA, 2017; FAO, 2023). On a broad scale this includes geographic isolation, national economic challenges associated with limited natural resources, and vulnerability to environmental issues brought on by climate change, such as extreme weather events and natural disasters (including floods, earthquakes, volcanic eruptions, hurricanes, and drought) (Schmidhuber and Tubiello, 2007; FAO, 2023). These challenges are further compounded by the development trajectories of SIDS, such as high rates of internal migration from urban to rural areas related to urbanization and modernity, which have distanced many from agricultural systems, decreasing agricultural production (SAMOA, 2017; FAO, 2023). These issues have led to increasing rates of food imports and dependence on global food chains for access to safe and nutritious food (SAMOA, 2017; The Economist Group, 2022; FAO, 2023). For example, in the Caribbean and Pacific SIDS, more than US\$5 billion yearly is spent on imported food (SAMOA, 2017; FAO, 2023). As such global food chains amplify the impact of local crises regarding food supply (SAMOA, 2017; FAO, 2023).

Data from the Food and Agriculture Organization (FAO) highlights that the prevalence of severe food insecurity (20.4%) and moderate to severe food insecurity (46.8%) in SIDS was double the global average (11.1 and 29.5% respectively) between 2020 and 2022 (FAO, 2023). Indicators of hunger also remain high in SIDS settings, where the prevalence of undernourishment was 15.3%, the prevalence of wasting and stunting for children <5 years old was 4.1 and 21.1% respectively, and the prevalence of anemia in women (15–49) was 29.2% in 2020 to 2022 (FAO, 2023). The Global Food Security Index (GFSI) (The Economist Group, 2022), a measure of the four key pillars of food security indicates that in 2022, the top 10 performing countries including Finland, Ireland, and Norway, had a GFSI of 78.7 to 83.7 (score out of 100), compared to 45.1 and 38.5 in Guinea and Haiti (The Economist Group, 2022). Including indicators such as undernourishment, child stunting, wasting, and mortality

(The Economist Group, 2022), the Global Hunger Index (GHI) is a key measure of hunger. In 2022 the global score was 18.2 and although the GHI score is  $\leq 10$  in most Caribbean and Pacific SIDS where data is available, here we do see some SIDS scoring much higher than average including Solomon Islands (19.4), Papua New Guinea (26.5), Timor-Leste (30.6), and Haiti (32.7) (Von Grebmer et al., 2022).

The level of dependence experienced by SIDS on food imports, particularly exposes them to food price volatility and global and regional food crises (FAO, 2023). The pathways and extent to which these crises impact food security vary according to sociodemographic factors, such as socioeconomic status, gender, household size, occupation, education, and income (Bashir and Schilizzi, 2013; Shuvo et al., 2022; Halliday et al., 2023). Of these, household income is widely regarded as the major factor impacting food security since it interacts directly with access by determining purchasing power or ability to afford safe and nutritious food (Bashir and Schilizzi, 2013; Shuvo et al., 2022). Other important pathways in which crises impact food security on the household level include availability and utilization (Bashir and Schilizzi, 2013; Shuvo et al., 2022). Food availability relates to two broad categories, purchased food and own food production. Purchased food refers to food obtained through formal and informal shops such as supermarkets, wholesalers, small food stalls, markets, and butchers, as well as those supplemented (food aid) (Bashir et al., 2012; Bashir and Schilizzi, 2013; Shuvo et al., 2022). It also takes into consideration factors impacting food adequacy and shortages, particularly in reference to fresh fruits, vegetables, and meats (Shuvo et al., 2022; Halliday et al., 2023). However, although economic status mainly impacts household food security, SIDS are known to have high poverty and unemployment rates, with an average multidimensional poverty index (MPI) of 47.5% based on a \$1.90 a day poverty rate (United Nations, 2022). Though, some countries within the Caribbean such as Bahamas are considered to have low rates (9.3%), there are high rates within other countries such as Belize (41.0%) and Haiti (58.7%) (United Nations, 2022). Within the Pacific region, poverty rates range from 12.7% (Vanuatu) to 35.2% (Fiji), with the highest rates among SIDS off the west coast of Africa with 66.2% in São Tomé e Príncipe and 69.3% in Guinea-Bissau (United Nations, 2022). Unemployment rates among youths within SIDS are higher than the global average (5.5%) (Haynes et al., 2020).

SIDS are currently at the nexus of food insecurity challenges and environmental issues, while an additional major shock, the COVID-19 pandemic, exacerbated food insecurity (Béné, 2020; Connell et al., 2020). Globally, there has been more than  $\frac{3}{4}$  billion cases, with millions of related deaths (Hickey and Unwin, 2020). Within the Caribbean region there has been over a million cases, with deaths

confirmed in the tens of thousands (Coronavirus Update, 2023). At the beginning of the pandemic, the lack of an effective vaccine and other effective medical interventions caused governments around the world, including those of SIDS, to temporarily close institutions and employ several non-pharmaceutical interventions (NPIs) such as physical distancing measures, curfews, and lockdowns (COVID-19 Situation in CARICOM, 2023). Though these measures were necessary to control the spread of the virus, they negatively impacted employment rates through job loss and business closure (Bonaccorsi et al., 2020). Hence an assumption at this time was that local food systems would be strengthened, through increased self-sufficiency farming, related to financial pressures, these measures deepened vulnerability among millions of small local food producers and agricultural workers, particularly women (Bonaccorsi et al., 2020; Leal Filho et al., 2020). For those of low socioeconomic status, and those whose earnings solely covered expenses, the means of securing food became a greater issue (Bonaccorsi et al., 2020; Leal Filho et al., 2020). SIDS with limited economic capacities to cope with these sudden additional risks were particularly vulnerable. This includes SIDS within the Caribbean and Pacific region who mainly depend on the tourism industry, which relies on developed agricultural systems and food exports as major drivers for economic activity (Haynes et al., 2020). A knock-on effect of this has been loss of markets for farmers that normally supply hotels, restaurants, and other food places with fresh produce (Haynes et al., 2020). In general, furlough, coupled with further increase in food prices related to the pandemic, contributed to increased risk of regression related to the progress made on achieving targets associated with hunger and poverty from the Sustainable Development Goals (Bonaccorsi et al., 2020; Leal Filho et al., 2020; Murphy et al., 2020).

St. Vincent and the Grenadines (SVG), a middle-income SIDS within the Caribbean was one of the countries that faced concurrent crises. In addition to challenges faced from the COVID-19 pandemic, an extra challenge came from renewed volcanic activity from La Soufrière volcano (Murphy and Guariguata, 2020), putting local food production under great pressure (Murphy and Guariguata, 2020; Caricom Today, 2021). Given the need to understand the impact of overlapping crises (IFRC, 2021; Watts et al., 2021) as experienced in SVG, we set out to study the joint effects of COVID-19 and a volcanic eruption on local food production and food security in this setting. As far as we are aware, this is the first study from this setting to explore these relationships concurrently, and one of the very limited number of studies to look at impact of COVID-19 on local food production and food security in a middle-income SIDS.

## 2 Materials and methods

### 2.1 Design, setting and participants

Our study site was SVG which experienced a major eruption of the La Soufrière volcano during the height of the COVID-19 pandemic (Murphy and Guariguata, 2020; Caricom Today, 2021). SVG has a population of approximately 109,000, a land area of 400 km<sup>2</sup>, and poverty rates of 30% (Food and Agriculture Organization, 2016; NCD Risk Factor Collaboration, 2020). This country was chosen since it is one of the study sites for the Intervention Co-creation to Improve Community-based Food Production and

Household Nutrition in Small Island Developing States (ICoFaN) project, funded and coordinated from the United Kingdom (United Kingdom). ICoFaN aims to improve household diet and nutrition in SIDS including SVG, Fiji and Haiti. The ICoFaN project builds on the Community Food and Nutrition (CFaH) project conducted within this setting (Bashir and Schilizzi, 2013), due to connections that the research team has with the Ministry of Health and a local non-governmental organization (NGO), Richmond Vale Academy (RVA). The RVA was chosen to implement a community backyard garden intervention based on their experience in facilitating sustainable and ecological courses including organic farming and backyard gardening, and a holistic nutrition-based approach to the use of local products.

Although La Soufrière had not erupted within the past four decades, it was deemed active in December 2020 and the eruption occurred on April 9th, 2021, and continued over the following days, sending ash plumes up to 10 km in the sky (Murphy and Guariguata, 2020). In October 2021, the International Federation of Red Cross, and Red Crescent Societies (IFRC), published a press release, stating that although 6 months had elapsed since the eruptions, some persons were yet to return home, and some were still in dire need of financial support, since the eruptions affected their livelihoods (Caricom Today, 2021). We therefore aimed to assess the impact of the concurrent COVID-19 pandemic and associated restrictions and La Soufrière's volcanic eruption on local food production and security in SVG, using survey data from data collection carried out between September 2021 and March 2022. Food insecurity was measured using the FIES and the Caribbean COVID-19 FS&L Survey along with participant interviews to gain a deeper insight of quantitative findings.

We conducted a cross-sectional quantitative survey and a series of repeated qualitative interviews. Study areas, situated within rural settings (Figure 1), were selected in consultation with RVA. There was a total of 13 communities, three highlighted on the map and small communities in between. Participants were eligible based on their willingness to participate, if they were citizens or residents of SVG, if they had prior gardening experience and if they had lost their gardens due to the impact of the La Soufrière eruptions. A convenience sample of 177 adults 18 years and older from 100 households of one to four members were included. To ensure the largest possible participation in the intervention, and due to the pre-existing relationship with RVA, convenience sampling was used to recruit participants. To this end, RVA assisted in the selection of participants that would have participated in the wider project (backyard garden intervention). Participants were chosen from rural areas (North Leeward) as those are the areas that most of the local food production/subsistence farming is done.

### 2.2 Data collection

Of the 100 families that took the survey, 10 families were sampled for monthly open-ended repeat interviews over a six-month period, conducted with one family member in charge of household food production or food preparation (Figure 2). These families were purposely chosen by RVA based on their willingness to participate. Interviewees consisted of nine females and one male (household size of 3–4), one female was in her early



FIGURE 1  
Study map [Source: Google maps].

thirties while the others were 45–55 years old. Eight of the female participants were unemployed with six selling items grown in their garden for income, and the male participant worked as a fisherman and laborer.

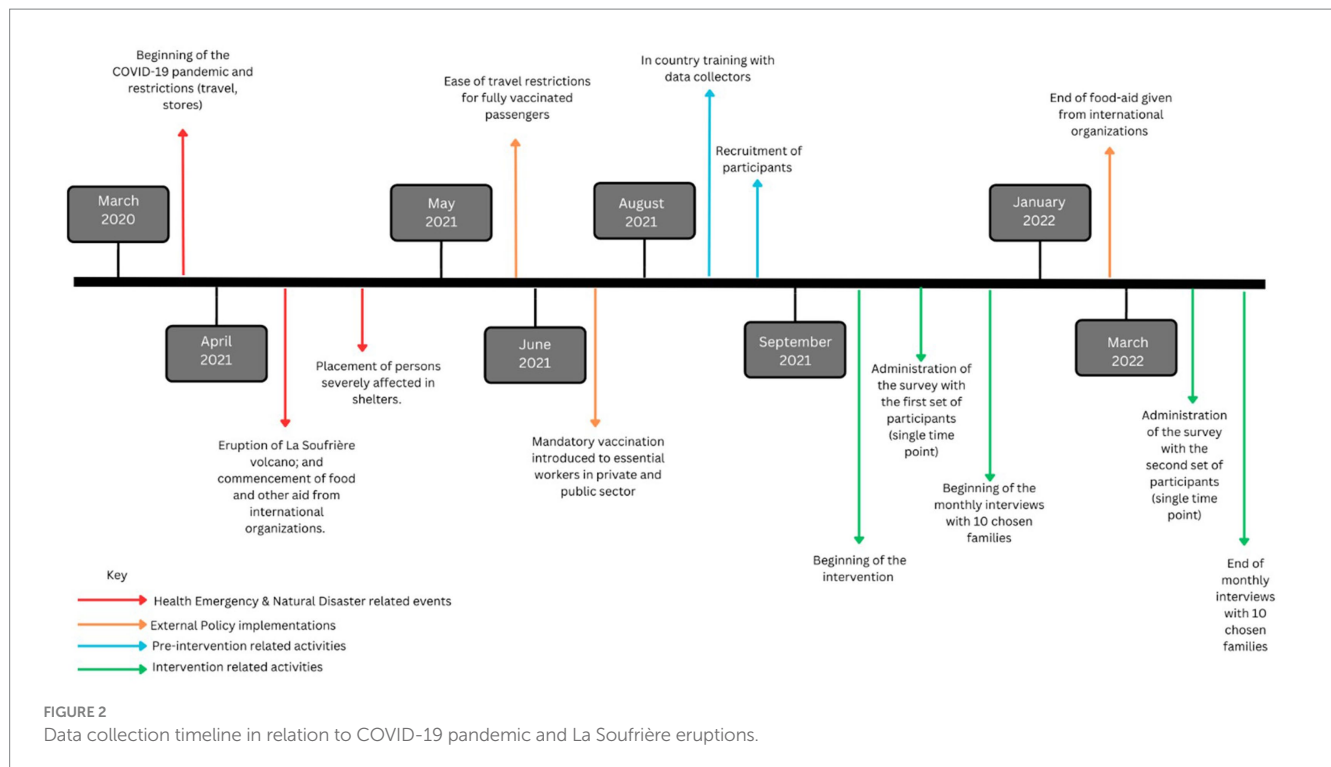
## 2.3 Data collection tools

### 2.3.1 Quantitative survey

The survey was developed within REDCap, an encrypted application, and was administered by trained data collectors who attended a four-day workshop entailing the use of the REDCap mobile application, specifics of the project and the survey. Data

derived from the survey were aggregated through REDCap. Data collectors were cautioned and trained in accordance with the country-specific COVID-19 protocols and were given KN95 masks for themselves and participants as well as individual hand-sanitizers. Data files were uploaded to and stored on a password protected computer and backed up on an encrypted external hard drive. To ensure confidentiality, only the investigators were given access to the nonaggregate data. The survey was tested for clarity of language, readability, and contextual aspects before being administered.

The survey encompassed the FIES, COVID-19 module, developed by the FAO, and aspects of the Caribbean COVID-19 FS&L Survey, developed by the World Food Program and FAO



(Cafiero et al., 2018; Food and Agriculture Organization of the United Nations, 2020; World Food Programme, 2020). Section 1, demographics, was adapted from the Caribbean COVID-19 FS&L Survey, which originally asked questions on age, gender, and household size, but was modified/expanded to include education level, and socioeconomic status. Section 3, livelihoods included questions related to impact of COVID-19 on livelihoods, main reason for disruptions to livelihoods, and expected future impact of COVID-19 to livelihoods (see Annex 1) and Section 4, food sources was based on the COVID-19 FS&L Survey (a tool originally encompassing 15-questions related to the impact of the COVID-19 pandemic on access to markets, livelihoods, and food security) which we modified to capture more in depth information related to impact on food sources, as well as own food production with a particular focus on home gardening, due to our study objective. Several questions related to home-gardening were developed considering the Transtheoretical model (pre-contemplation, contemplation, preparation, action, and maintenance), to assess if there were differences in relation to starting and maintaining backyard gardens pre and during COVID-19. For example we asked about household engagement in food production pre COVID-19, and since COVID-19 began, specifically asking how long it took for persons to start producing their own food after their initial thought, how difficult it was to start, if they maintained food production activities, how difficult it was to maintain food production activities and if they continued despite their country's COVID-19 related restrictions. Within Section 4, a sub-section was developed which included questions related to the impact of the La Soufrière volcanic eruption (see Annex 1). These questions assessed if there was any impact to own food production, access to food sources, or shopping behavior. Section 5, food security, utilized the FIES COVID-19 module (see Annex 1 and description below).

### 2.3.2 Food insecurity experience scale COVID-19 module

The FIES, developed by the FAO, is a tool that can be utilized at both the individual and household level. For this study, we utilized the individual level. It is the only food security assessment tool that ensures a global comparability of the measures. It is used to produce food insecurity prevalence estimates in the context of monitoring the SDG Target 2.1. Typically, the FIES survey module comprises of eight questions that are based on food-related behaviors as well as experiences associated with challenges in accessing food due to resource-related constraints. "These eight questions are intended to reveal conditions that cover a range of severity and the FIES analytic protocol (based on Rasch modeling) makes it possible to transform the qualitative information collected ("yes/no" answers) into quantitative, rigorous measures of food insecurity severity, allowing for categorization of respondents into classes of moderate as well as severe food insecurity" (Cafiero et al., 2018; Food and Agriculture Organization of the United Nations, 2020).

The adapted module (developed by the FAO during the height of the COVID-19 pandemic) that we used has been modified from the typical FIES survey module to respond to the challenge of measuring and monitoring food insecurity in the context of the COVID-19 pandemic, while preserving all the desirable properties in terms of food security measurement rigor and reliability. Each FIES question is asked with reference to the previous 12 months, to allow for an annual food insecurity prevalence rate to be produced as is typically done for SDG monitoring, with follow-up questions intended to capture the extent to which the respondent associates their experiences specifically with the COVID-19 crisis. All questions are then asked with reference to the past 30 days in order to assess recent food insecurity, with the last three questions also collecting information on the frequency of experiences, which is useful to further discriminate

within severe food insecurity, making it possible to also produce the Household Hunger Score indicator, if the FIES is administered at the household level. This extended version of the FIES is particularly relevant to the context of the COVID-19 pandemic, since prevalence of severe food insecurity is expected, during global emergencies (Cafiero et al., 2018; Food and Agriculture Organization of the United Nations, 2020).

The eight main questions asked for the FIES COVID-19 module included – (1) Was there a time when you were worried you would not have enough food to eat because of a lack of money or other resources? (2) Was there a time when you were unable to have a healthy and nutritious diet because of a lack of money or other resources? (3) Was there a time when you ate the same food items over and over because of a lack of money or other resources? (4) Was there a time when you had to skip a meal because there was not enough money or other resources to get food? (5) Was there a time when you ate less than you thought you should because of a lack of money or other resources? (6) Was there a time when you ran out of food because of a lack of money or other resources? (7) Was there a time when you were hungry but did not eat because there was not enough money or other resources for food? (8) Was there a time when you went without eating for a whole day because of a lack of money or other resources? All questions used a 12 month timeframe. If the answer to any of the eight questions was yes, they were then asked if this was specifically due to the COVID-19 crisis, and if it also occurred within the past 30 days. For the last three main questions, participants were asked on frequency of occurrence within the past 30 days (See Annex 1-Questionnaire) (Cafiero et al., 2018; Food and Agriculture Organization of the United Nations, 2020).

The Rasch model provides a set of statistical tools to assess the suitability of a set of questions within a survey for constructing a measurement scale and for comparing the scale's performance across several populations. Rasch analysis was performed using algorithm ("RM weights") developed by FAO for use in the R software package. For robust parameter estimation, and to have confidence in the statistical validation of FIES data, a sufficient number of complete non extreme cases is needed (scored from 0 to 8). As a rule of thumb, less than 100 would be considered insufficient and between 100 and 300 would allow provisional estimation and validation (Cafiero et al., 2018; Food and Agriculture Organization of the United Nations, 2020).

### 2.3.2.1 Caribbean COVID-19 food security and livelihoods impact survey

The Caribbean COVID-19 Food Security and Livelihoods Impact Survey was developed by the FAO and World Food Program, launched by CARICOM to rapidly gather data on impacts to livelihoods, food security and access to markets (World Food Programme, 2020).

### 2.3.3 Qualitative interviews

The qualitative component of the survey aimed to gain in-depth and contextual insight on the impact of COVID-19 and the La Soufrière eruption on own food production. An open-ended semi-structured interview guide with prompts was adapted from a tool used in a previous project, in a similar setting. Focused on participants' perceived barriers and facilitators of food production, including "Can you explain the main reasons that you engage in food production activities? Describe the major challenges that you are facing or will face with regards to food production? Describe the main use of the

foods that you normally produce? Can you explain how food production have been affected by the recent volcanic eruption/ COVID-19?" Individual interviews were conducted that lasted between 35 and 80 min. Consent was obtained by each participant to begin and record the interviews. A contact summary sheet which summarizes the main points of each interview and if any new topics were discussed was completed immediately after each interview. The interviews were audio recorded and transcribed verbatim. Transcripts were de-identified and reviewed for accuracy before coding began. Accuracy was determined by randomly choosing parts of the transcripts and listening to the audio while reading the transcript. If a mistake was made in the random checks the entire transcript was reviewed.

## 2.4 Ethical approval

Ethical approval was gained from the Institutional Review Board, The University of the West Indies, Cave Hill Campus, Barbados for both parts of the study. IRB No. 201101-B and IRB No. 210205-A. Approvals were also gained by SVG, Ministry of Health. Written informed consent was provided by all participants before participating in the survey and verbal consent was provided by participants before the interviews were conducted.

## 2.5 Analysis

### 2.5.1 Statistical analysis

Data from the cross sectional survey were described using frequencies (n) and percentages (%) to provide a descriptive overview of the sample participants. Bivariate associations between food insecurity and sociodemographic characteristics, food production and sociodemographic characteristics, food insecurity and access to food aid, food insecurity and access to markets, food insecurity and food source, food insecurity and impact on food production (COVID-19), and food insecurity and the impact on food production (volcanic eruption) were examined using Pearson chi squared tests.

Multivariable logistic regressions were conducted to test associations between the dependent variable - food insecurity (moderate to severe, and severe) and independent variables: COVID-19 (food aid (access or no access), food source (change or no change); food production (increase or not), and Volcanic eruption (impact of food production (yes or no), impact of food sources (yes or no); impact on shopping behaviour (yes or no). A total of 12 independent models were fitted. Six in the context of COVID-19, related to both moderate to severe food insecurity and severe food insecurity on (i) access food aid, (ii) change in food source, and (iii) change in food production. Six in the context of the volcanic eruption related to both moderate to severe food insecurity and severe food insecurity on (i) effect on food production, (ii) effect on way food is sourced, and (iii) change in food source. These models were adjusted for gender, age, education, and household size due to the fact that these variables are known confounders. T tests were done to test differences in food production pre and during COVID-19. A *p*-value of <0.05 was considered statistically significant. All data was analysed using Stata (version 17, StataCorp, College Station, TX, USA) and R.

## 2.5.2 Thematic analysis

A thematic analysis was undertaken for the qualitative data of 60 transcripts collected over a 6-month period from 10 families (Tuckett, 2005; Alhojailan, 2012). A codebook with a list of codes and definitions was developed by one team member (EA) using information from the contact summary sheets, field notes and transcripts. Codes were reviewed by another team member (MM), until unanimous agreement was reached. Codes were then refined in Atlas Ti22, by utilizing the codebook and individually going through transcripts and redefining codes or adding similar codes that were related but could stand alone. Themes were then derived from semantic linkages between codes (which highlights relationships between codes) or those reoccurring (specific topics that were brought up by participants repeatedly).

## 2.5.3 Mixed-method analysis

Quantitative and qualitative data were analyzed simultaneously to allow for data comparison. Within this study, higher priority was given to the quantitative component since there was more emphasis on the quantitative data collection and analysis (Dawadi et al., 2021). The longitudinal qualitative data provided an understanding of trends over time, and thus added important context to the data collected as part of the cross sectional survey.

# 3 Results

## 3.1 Demographics

Table 1 presents a descriptive overview of our survey participants. A total of one hundred and seventy-seven ( $n = 177$ ) adults completed the survey. Almost one third (31%) of the participants were 50–64 years old, almost two thirds (64%) were female, and almost half (47%) had only completed a primary school level education. Most participants (62%) resided in a household of more than four members, almost a third were never married (30%) and more than a third (37%) were self-employed before the pandemic, with almost a third (33%) having their own business. Most participants reported that they were responsible for food preparation in their home (53%) (Table 1).

### 3.1.1 Shocks to income and employment

Participants were asked to remember/recall their income before and during the COVID-19 pandemic (difference was calculated based on these figures). The percentage of persons earning less than 2000 XCD (740 USD) monthly (average salary), increased during the pandemic by 8%, and those earning more than 2000 XCD decreased by 10% (Supplementary Table S1). There were no significant differences among those with a decrease in income in relation to gender, age, education status or household size (Table 2). However, most persons with a decreased income were female, completed primary level education or less, were aged 18–39 and lived in a household of 4 to 5 persons (Table 2). Over half of the participants ( $n = 106$ , 59%) reported that there was a change in household income since the beginning of the COVID-19 pandemic, with  $n = 92$ , 53% reporting that they experienced a salary decrease. A total of  $n = 49$ , 43% of those employed reported that the COVID-19 pandemic affected their employment status with the

majority reporting that the pandemic led to a decrease in job hours ( $n = 27$ , 54%; Table 3).

Providing insight on trends over time, the qualitative data highlights the impacts of COVID-19 and impacts of the volcanic eruption. Regarding the COVID-19 pandemic, the data from the interviews provided insight into the experience of participants during the COVID-19 pandemic, particularly related to employment. A specific issue raised was the mandatory vaccination that had been introduced by the Government and enforced by employers for some occupations including teachers and police officers. Despite financial pressure, vaccine hesitancy remained persuasive for some, with some choosing to forego employment to avoid taking the vaccines. Other financial burdens related to the pandemic included loss of employment or decreased job hours related to closure of businesses, specifically those within the tourism industry.

“They say you have to take your jab, take your jab or no job. They do not want to make it mandatory for Vincentians but honestly, I do not think I’m going to take it. People should have choice they are not supposed to tell if you do not take it, you have a choice.” CS1I2.

“People do not want to take the vaccine. I think they are having a protest either today or tomorrow or something with teachers, cause the government making it mandatory for teachers and police and all those kinds of people...I know Covid is impacting a lot of people with their jobs cause a lot of people lost their jobs and stuff because of Covid, because some business has closed so they do not have no work and I know for some in the tourist industry, some of the sites are not operating if somebody say I might be working...when people come visit, and it’s not open. Yeah, and there are people employed there.” 232–467 CS2I3.

Stratification by sex highlighted that  $n = 34$ , 69% of those whose jobs were affected were female (no significant association). Interviews conducted with women (mothers) explained that this was largely due to school-related stay at home orders which increased burdens on mothers, specifically those who were self-employed since they now had to provide cooked meals for their children as there was no access to school-feeding programs, as well as accommodate online schooling.

“Unless there is a spike in the school and stuff like that, let the children go to school. I do not think anything has been geared toward kids who are at home...You will find pockets of people like that who are dependent on the school meal. I do not know how much of people, but you will have that because you have some people who are seriously in need.” 101–112 CS2I4.

### 3.1.2 Changes in food sources

Forty percent of participants stated that their ability to secure necessities was affected by the COVID-19 pandemic. Of these, 61% were female, 41% completed primary level education or less, 60% resided in a household with four or more people and 74% earned less than 2000 XCD during the pandemic significant associations between ability to secure necessities and household size ( $p = 0.041$ ) and income ( $p = 0.037$ ). Their ability to secure necessities were mainly affected by

TABLE 1 Demographic characteristics.

	Male ( <i>n</i> = 63)	Female ( <i>n</i> = 114)	Total
Variable	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)
Age			
18–34	13 (21)	30 (26)	43 (24)
35–49	16 (25)	37 (32)	53 (30)
50–64	22 (35)	32 (28)	54 (31)
65 and up	12 (19)	15 (13)	27 (15)
Education			
Primary level/less	34 (54)	47 (42)	81 (46)
Secondary level	17 (27)	46 (41)	63 (36)
Technical/Vocational	2 (3)	7 (6)	9 (5)
Tertiary level	6 (10)	11 (10)	17 (10)
Prefer not to say	4 (6)	2 (2)	6 (3)
Household size			
One	10 (16)	7 (6)	17 (10)
Two	10 (16)	16 (14)	26 (15)
Three	4 (6)	21 (19)	25 (14)
Four to five	18 (28)	34 (30)	52 (29)
More than five	22 (34)	35 (31)	57 (32)
Employment status			
Employed full time	12 (19)	22 (19)	34 (19)
Employed part time	7 (11)	8 (7)	15 (8)
Self employed	26 (41)	40 (35)	66 (37)
Unemployed	12 (19)	35 (31)	47 (27)
Student	1 (2)	3 (3)	4 (2)
Retired	5 (8)	3 (3)	8 (5)
Other	1 (2)	2 (2)	3 (2)
Main source of income (multiple response)			
Regular salary	14 (22)	24 (21)	38 (17)
Daily paid	18 (28)	22 (19)	40 (18)
Own business	25 (39)	47 (42)	72 (33)
Petty trade	4 (6)	8 (7)	12 (5)
Remittances from abroad	0 (0)	4 (3)	4 (2)
Support from family/friends	6 (9)	21 (19)	27 (12)
Government assistance	5 (8)	8 (7)	13 (6)
Assistance from (i.e., UN)	1 (2)	1 (1)	2 (1)
Other	3 (5)	8 (7)	11 (5)
Marital status			
Never married	17 (27)	36 (32)	53 (30)
Currently married	20 (32)	28 (25)	48 (27)
Separated /Divorced	6 (10)	11 (10)	17 (10)
Widowed	1 (2)	5 (4)	6 (3)
Cohabiting	9 (14)	8 (7)	17 (10)
Visiting Partner	8 (13)	15 (13)	23 (13)
Refuse to answer	2 (3)	10 (9)	12 (7)
Responsible for food preparation			
Myself	18 (29)	75 (66)	93 (53)
Relative	17 (27)	28 (25)	45 (26)
Cohabiting partner	25 (40)	10 (9)	35 (20)
Other non-relative	2 (3)	1 (1)	3 (2)



TABLE 2 Decreased income due to the impact of COVID-19.

Characteristics	Yes <i>n</i> (%)	No <i>n</i> (%)	Total <i>n</i> (%)
<b>Gender</b>			
Male	8 (47)	31 (34)	39 (36)
Female	9 (53)	60 (66)	69 (64)
<b>Education</b>			
Primary level/less	8 (47)	41 (45)	49 (45)
Secondary	6 (35)	37 (41)	43 (40)
Technical/Vocational	1 (6)	7 (8)	8 (7)
Tertiary	2 (12)	4 (4)	6 (6)
Prefer not to say	0 (0)	2 (2)	2 (2)
<b>Age</b>			
18–39	6 (35)	24 (26)	30 (28)
40–49	5 (29)	23 (25)	28 (26)
50–59	5 (29)	20 (22)	28 (23)
60+	1 (6)	24 (26)	28 (23)
<b>Household size</b>			
1	1 (6)	10 (11)	11 (10)
2	4 (24)	20 (22)	24 (22)
3	3 (18)	13 (14)	16 (15)
4 to 5	6 (35)	25 (27)	31 (29)
More than 5	3 (18)	23 (25)	26 (24)

reduced or no market (41%) or concern for leaving home (14%) (Table 3).

Sixty-three percent of participants reported that they had no access to markets during the COVID-19 pandemic (Table 4). Sixty two percent were female, similar to the proportion (64%) in the overall sample, and 50% were older than 50, compared to 46% in the overall sample ( $p=0.048$ ). There was no association with educational level. Of the 111 persons who had no access to markets during COVID-19,  $n=78$ , 74% stated that their ability to secure things were disrupted by the pandemic. This was primarily related to restriction of store opening hours (23%), transportation limitations (22%) and similar to reasons why persons were unable to secure necessities, several persons were concerned about leaving their home (19%). The qualitative data showed that persons were mainly afraid of leaving their homes due to contracting COVID-19. This was heard mostly among those that were unvaccinated or had personal theories of the vaccine and its causes.

“The negative is that people will not want to go out or to leave their home to buy seeds to buy meat and herbs that they do not have. It’s kind of scary to go outside to mingle in Kingstown especially on a Friday.” 200–202 CS1I2.

“It is and I think the most that we can do is to make sure that we are safe and our family and immediate friends and what not are safe and if everybody think like that I think everybody would

TABLE 3 Impact of COVID-19 on socioeconomic status and livelihoods.

Variable	<i>n</i> (%)
<b>Change in household income</b>	
Decreased hours/salary	92 (53)
Increased hours/salary	4 (2)
Alternative income	8 (5)
No change	71 (41)
<b>COVID-19 affected employment</b>	
No	66 (57)
Yes	49 (43)
<b>How COVID-19 affected employment</b>	
I lost my job	5 (10)
I was put on temporary leave	5 (10)
Job hours decreased	27 (54)
Job hours increased	2 (4)
Other	11 (22)
<b>Ability to secure necessities affected by COVID-19</b>	
No	107 (60)
Yes	70 (40)
<b>Reasons ability was affected</b>	
Reduced demand	38 (26)
No market	22 (15)
Transport limitations	16 (11)
Decreased food imports	12 (8)
Movement restrictions	8 (5)
Means unavailable	10 (7)
Necessities too expensive	13 (9)
Concern leaving house	21 (14)
Decreased demand for good or services	4 (3)
Other	2 (1)

be alright but sadly people do not you know people be like “it’s me and me alone” (laughs). But the thing is right, I was home and not going anywhere, but I live in a community where we mingle a lot in the area and they have some young people who just do not care. They will go out the road, they will mingle with whoever and they could bring it to you. You ain’t going nowhere to look for it but somebody bringing it to you” 232–467 CS2I3.

Participants highlighted that during the beginning of the pandemic there were major issues related to food availability. Almost a third (31%) stated that fresh food items such as eggs, meat, milk, fruits, and vegetables were either not available or only available sometimes, and 23% stated that basic food items such as bread, rice, and cereals were not available or only available sometimes. Most participants (71%) noted an increase in food costs at the beginning of the pandemic and more than half (55%) stated that they changed their food shopping behavior since the start of the COVID-19 pandemic. Participants reported that shopping behavior changed by purchasing smaller food quantities (34%),

TABLE 4 Impact of COVID-19 on access to markets and food aid.

Variable	n (%)
Access to markets during COVID-19	
No	111 (63)
Yes	65 (37)
Reasons unable to access markets	
Market/stores were closed	13 (9)
Opening hours restriction	32 (23)
Transport limitation	31 (22)
Decreased food importation	8 (6)
Movement restrictions	14 (10)
Security concerns	2 (1)
Concern about leaving home	26 (19)
Unwell adult members	2 (1)
Members of household quarantining	4 (3)
Other	6 (4)
Availability of fresh items	
Always available	105 (59)
Partially/sometimes available	53 (30)
Not available	2 (1)
Don't know	17 (10)
Availability of basic food items	
Always available	125 (71)
Partially/sometimes available	37 (21)
Not available	1 (1)
Don't know	14 (8)
Change in food costs beginning COVID-19	
Food price increased	124 (70)
Food have decreased	7 (4)
No changes	46 (26)
Change in shopping behavior since COVID-19	
No	80 (45)
Yes	97 (55)
How shopping behavior changed	
Bought larger quantities	12 (5)
Bought smaller quantities	76 (34)
Bought cheaper foods	54 (24)
Bought more expensive foods	1 (1)
Bought less preferred foods	33 (15)
Bought more preferred foods	10 (4)
Went to different stores/markets	25 (11)
Bought different food brands	14 (6)
Access to food aid during COVID-19 pandemic	
No	147 (84)
Yes	29 (16)
Who provided food aid	
Non-governmental aid	6 (19)
Governmental aid	18 (58)
Church, school, community center	5 (16)

(Continued)

TABLE 4 (Continued)

Variable	n (%)
Other	2 (6)
Type of food aid	
Food card/check	2 (4)
Dried goods	25 (47)
Canned goods	17 (32)
Poultry	1 (2)
Dairy	1 (2)
Oils/Fats	6 (11)
Seeds/Seedlings	1 (2)

purchasing cheaper foods (24%), or purchasing less preferred foods (15%) (Table 4).

Most participants (84%) also reported that they did not have access to food aid during the pandemic. Those with access ( $n = 29$ , 16%) were mainly female (69%), who completed primary school level or less (45%) (no significant associations). Notably there were no one over 69 years old who had access to food-aid. For those with access, more than half (58%) reported that food aid was gained from the government and 19% reported that the food aid was gained from a non-governmental organization. Dried goods and canned goods were the most prominent type of food aid reported (47 and 32%). However, the qualitative data highlighted that participants had knowledge that most food provided was processed and highlighted some suggestions to improve the system (Table 4).

“Not people with large families it would not be enough. They only give certain types of aid, like you get macaroni, corn beef and rice, flour, and sugar.” 118 CS2I2.

“I find you could at least get some cod, some salt... fish, yea. I noticed fish, they do not really, you know most likely they put the tin stuff, like sardines. I find sometimes they could do the food box with some dasheen and tannia like what they do at the center, like they do that do the food box, the grocery box this month and next month you do a vegetable box, a food box.” 97–101 CS6I1.

“I think it's good, it's very good but just need some, I do not like the part where they pick and choose; to me they pick and choose who to give, you know, they do not, I think people should be giving you, if good for it, they give it to you. They, but these people down here, they watch you and say oh you ain't going to want because you know, that's, stuff like that. They pick out who to give. If you go by the, if they have food aid by the church or so and you go and ask for something, 'oh you have a business, you ain't want food, you ain't going to want this,' that's what they doing now here.” 216–221 CS9I1.

More than a third ( $n = 59$ , 34%) of participants reported that they had to change their food sources since the beginning of the COVID-19 pandemic. Of those changing food sources, 81% reported that they

had either a decrease in food source options or used different food sources. There were small, non-significant ( $p > 0.05$ ), changes in the proportions of participants reporting own food production (35% vs. 34%) and purchasing from stores and markets (58% vs. 61%). Reported engagement in farming and backyard gardening decreased to 87% from 93% ( $p = 0.0205$ ).

### 3.1.3 Additional burden of a natural disaster

Further, 81% of participants ( $n = 143$ ) stated that the volcanic eruption impacted food production, with 68% ( $n = 97$ ) stating that food production decreased as a direct result. Similar to the impact of COVID-19, most stated that the volcanic eruption affected the way in which they sourced food ( $n = 124$ , 70%), either decreasing options or creating a need for alternative options (87%). Additionally, participants reported that the volcanic eruption also affected shopping behavior among more than half of the participants which led to purchasing smaller quantities (67%), buying cheaper food (20%) or buying less preferred foods (5%) (Table 5).

The qualitative data highlighted that while own food production was perceived as a means for household food security, the volcanic eruption also made home growing difficult.

“This is what I’m telling you it is real challenging for me now. Because I have to get plants. It is going to be real challenging for me to get back plants, to get back seeds and the government not giving you anything back now.” 235–237 CS4I1.

“I was now going to tell you that I now have to get back the seeds, have to get back dasheen, tania and pay someone to help me clean up the land and dig it so you know it’s not easy. The volcano did a lot of damage.” 275–277 CS4I1.

These challenges overlapped with restriction and barriers due to COVID-19, from lower importation to the consequent increased cost of food supplies. Social distancing and other COVID-19 related restrictions hampered social networking, and shared labor activities which was compounded by the destruction caused by ashes from the eruption.

“The negative is that people will not want to go out or to leave their home to buy seeds or buy meat and herbs that they did not have. It’s kind of scary to go outside to mingle in Kingstown especially on a Friday and on the positive side because people are mostly at home they will take their time to walk in their garden, easy access to their house, to their yard, to their back yard, getting themselves involved planting their own food, because they cannot go to town, so that will be on the positive side.” 200–202 CS1I2.

### 3.1.4 Impact of concurrent crises on food security

The mean FIES score was 5.31 (95% C.I. 4.98,5.63; Table 6). Almost two thirds of the participants (64% 95% C.I. 50.0, 74.2) were classified as moderately or severely food insecure and almost half were severely food insecure (48% 95% C.I. 31.2, 57.8) during the pandemic. For each scale item more than half of the participants

TABLE 5 Impact of COVID-19 and volcanic eruption on food sources and food production.

Variable	n (%)
Impact of COVID on food sources	
No	117 (66)
Yes	59 (34)
How food source changed	
Increase in food source options	11 (19)
Decrease in food source options	24 (41)
Different food source options	24 (41)
Main food source before COVID-19	
Own production	62 (35)
Purchasing from stores/markets	102 (58)
Borrow/barter or exchanging	5 (3)
Food aid	3 (2)
Other	4 (2)
Main food source during COVID-19	
Own production	59 (34)
Purchasing from stores/markets	107 (61)
Borrow/barter or exchanging	2 (1)
Food aid	5 (3)
Other	3 (2)
Impact of volcanic eruption on food production	
Yes	143 (81)
No	30 (19)
Prefer not to say	2 (1)
Not applicable	1 (1)
How has it affected food production	
Increased	10 (7)
Decreased	97 (68)
Some increased some decreased	33 (23)
Prefer not to say	3 (2)
Affect way food is sourced	
Yes	124 (70)
No	49 (28)
Prefer not to say	3 (2)
How has it affected way food is sourced	
Increase in food source options	16 (13)
Decrease in food source options	86 (69)
Different food source options	22 (18)
Affected shopping behavior	
Yes	100 (57)
No	74 (42)
Prefer not to say	2 (1)
How affected shopping behavior	
Bought larger quantities	8 (8)
Bought smaller quantities	67 (67)
Bought cheaper foods	20 (20)
Bought less preferred foods	5 (5)

attributed these challenges to implications occurring during the pandemic.

In addition, those without access to food aid, during the pandemic, had a higher likelihood of being moderate to severely food insecure (adjusted odds ratio OR): 3.7 (95% confidence interval 1.51, 9.07;  $p=0.004$ ), there was also some indication ( $p>0.05$ ) of a higher likelihood of being moderate to severely food insecure among persons who had no change in food source (OR 1.74 0.82, 3.65) and those with no change in volume of food production (OR 2.66 0.99, 7.19). In addition, those whose food production activities were not affected by the volcanic eruption had a higher likelihood of being moderately to severely food insecure (OR 6.65 1.22, 36.19 L;  $p=0.028$ ), there was also a higher likelihood of being moderate to severely food insecure among those who stated that the volcanic activity did not affect the way that they sourced food (OR 3.88 1.33, 11.36) and those who stated that their shopping behavior did not

change during the pandemic due to the volcanic eruption (OR 2.26 0.99, 5.16; Table 7).

## 4 Discussion

The primary aim of this study was to assess the impact of the concurrent COVID-19 pandemic and associated restrictions and La Soufrière’s volcanic eruption on local food production and food security in SVG. All aspects affecting food security including SES in relation to income or employment, food sources including own food production, and access to food aid were explored.

### 4.1 Findings in context

Overall, our results indicate that food security in SVG was negatively impacted by the COVID-19 pandemic and the impact was further exacerbated by the volcanic-eruptions. The pathways in which these two crises converged were multi-facilitated. Regarding the pathways in which COVID-19 impacted food security, our results indicate that household income and employment was negatively impacted by COVID-19 related restrictions. Many persons who earned above minimum wage before the pandemic earned less than minimum wage during the pandemic. This was consistent across groups in relation to age, gender, education, and household size and was linked to challenges such as decrease in job hours and loss of job. Income related challenges and shocks associated with COVID-19 are widely reported globally, with several studies highlighting the impacts across sectors (Béné, 2020; Iese et al., 2021; Daley et al., 2022). However, data from the interviews indicated that apart from lessened job hours and loss of jobs due to market decrease or closure, some chose to forego employment due to vaccine hesitancy. A study conducted by Lazarus et al. (2022), showed that almost a quarter of a sample population

TABLE 6 Participants experiencing food insecurity in past 12 months.

FIES responses	n (%)
Worried (not enough to eat)	77 (44)
Healthy (unable to eat nutritious food)	102 (58)
Few Foods (ate only few kinds of food)	104 (59)
Skipped (skipped meals)	132 (75)
Ate less (ate less than needed)	114 (64)
Runout (Ran out of food)	117 (66)
Hungry (hungry but did not eat)	141 (80)
Whole day (did not eat for a whole day)	150 (85)
Moderate to severe food insecurity	113 (64)
Severe food insecurity	85 (48)

\*FIES Mean Score 5.31 (95% C.I. 4.98, 5.63), Moderate to Severe Food Insecurity 64% (95% C.I. 50.0, 74.2) Severe Food Insecurity 48% (95% C.I. 31.2,57.8).

TABLE 7 Multivariable logistic regression of food insecurity, COVID-19 and Volcanic activity.

Characteristic	Moderate to severe food insecurity			Severe food insecurity		
	OR	95% OR	Value of p	OR	95% OR	Value of p
<b>COVID-19</b>						
Did not access food aid	3.7	1.51, 9.07	0.004***	1.18	0.51, 2.7	0.703
No change in food source	1.74	0.82, 3.65	0.147	1.59	0.83, 3.05	0.165
No change in food production	2.66	0.99, 7.19	0.053**	3.56	1.53, 8.27	0.003***
<b>Volcano</b>						
No effect on food production (volcanic eruption)	6.65	1.22, 36.19	0.028**	5.47	1.9, 15.71	0.002***
No effect on way food is sourced (volcanic eruption)	3.88	1.33, 11.36	0.013***	6.27	2.78, 14.18	<0.001***
No change in way food is sourced	2.26	0.99, 5.16	0.054**	3.76	1.92, 7.37	<0.001***

Models adjusted for gender, age, education, and household size, Level of significance—1,5, and 10% denoted by \*, \*\*, and \*\*\*.

**COVID-19**

Did not access food aid. Moderate to severe food insecurity (Psuedo R2=0.1180) Severe food insecurity (Psuedo R2=0.0274).

No change in food source. Moderate to severe food insecurity (Psuedo R2=0.0892) Severe food insecurity (Psuedo R2=0.0346).

No change in food production. Moderate to severe food insecurity (Psuedo R2=0.0998) Severe food insecurity (Psuedo R2=0.0692).

**Volcanic Eruption**

No effect on food production. Moderate to severe food insecurity (Psuedo R2=0.1215) Severe food insecurity (Psuedo R2=0.0829).

No effect on way food is sourced. Moderate to severe food insecurity (Psuedo R2=0.1180) Severe food insecurity (Psuedo R2=0.1280).

No change in way food is sourced. Moderate to severe food insecurity (Psuedo R2=0.0968) Severe food insecurity (Psuedo R2=0.0938).

23,000 respondents across 23 lower middle-income counties, including one SIDS setting (Singapore) were hesitant to take the COVID-19 vaccines. This was related to a lack of trust of the vaccines, and skepticism about their efficacy. The authors also emphasized that vaccine hesitant respondents were highly resistant to the requirement of vaccination proof to access travel, employment, and education (Lazarus et al., 2022).

The qualitative interviews also showed that employed women were particularly affected by COVID-19 restrictions and stay at home orders due to the necessity of facilitating online schooling. Mothers stated that the situation was difficult as there were many children dependent on school meals. Studies conducted in other settings highlighted that women in particular were affected by the COVID-19 pandemic due to disproportionate numbers among men and women working as essential workers such as medical doctors and teachers, disparities related to job loss in service-oriented professions and non-formal sectors frequented by women (Foley and Cooper, 2021; Israni and Kumar, 2021; Yavorsky et al., 2021; Thompson, 2022). Authors highlighted that women worried about the lack of adequate consideration for childcare in order to balance work and family life where they were expected to facilitate online schooling (Foley and Cooper, 2021; Israni and Kumar, 2021; Yavorsky et al., 2021; Thompson, 2022). In addition, the most severely disadvantaged by the lockdown were thought of as mothers that were less educated or unmarried, who now had to provide more meals for children at home (Foley and Cooper, 2021; Israni and Kumar, 2021; Yavorsky et al., 2021; Thompson, 2022).

We also found that shocks to income and employment impacted respondents' ability to secure necessities, with the largest impact on women who earned less than minimum wage, only completed primary level education and resided in large households (>4 persons). Ability to secure necessities during the COVID-19 pandemic was also affected by reduced markets and concern for leaving home. This is consistent with other studies which highlighted that COVID-19 prevention measures including lockdown, stay-at-home orders, mass quarantines, as well as transport halt were highly challenging in developing countries, causing mass concern to populations (Workie et al., 2020; Gatto and Islam, 2021; Kansime et al., 2021; Wegerif, 2022). Due to the fact that many developing countries imposed short state of emergency border lockdowns, movement of imports and exports became slower or stopped, reducing markets (Workie et al., 2020; Gatto and Islam, 2021; Kansime et al., 2021; Wegerif, 2022).

Our results also highlighted that the COVID-19 pandemic impacted the way in which persons sourced food due to challenges including unavailability and inability to afford food normally purchased. Results from other studies are concurrent. Studies highlighted that the COVID-19 pandemic impacted the whole food system from the process of agricultural production to consumption, due to national and international level restrictions such as restricted food trade policies, and closure of food production facilities (Aday and Aday, 2020; Mardones et al., 2020; Boyacı-Gündüz et al., 2021). These issues made it impossible for a limited supply of raw agricultural products to meet a now increased demand since restaurants and other prepared food places were also closed (Aday and Aday, 2020). These restrictions thereby caused food price spikes due to instability of

agricultural production and limitations to food import (Boyacı-Gündüz et al., 2021).

In our study, although we found only small, reported changes (decrease) in sourcing food from own production, and from participation in farming and backyard gardening, these are consistent in direction with what has been found elsewhere. Studies conducted in India highlighted that small-scale farmers were more vulnerable to COVID-19 shocks. This was due to lockdowns and restrictions that limited movement to their farms or purchasing of agricultural items needed to maintain agricultural production, which decreased their overall output and sales (Acharya, 2020; Harris et al., 2020; Jaacks et al., 2021). Issues with food sourcing based on our results was further amplified due to the fact that most did not have access to food aid during this period. Those who did have access to food aid were unhappy about its contents which was primarily processed food. This point was also raised by Boyacı-Gündüz et al. (2021), and others who highlighted that the COVID-19 pandemic caused extreme dependence on emergency food packages, which were not enough in vulnerable populations (Workie et al., 2020; Boyacı-Gündüz et al., 2021; Gatto and Islam, 2021; Kansime et al., 2021; Wegerif, 2022).

Though the COVID-19 pandemic brought on several challenges related to income, securing necessities, and food sources, these issues were further exacerbated by the impact of the volcanic-eruptions. Most of our participants reported that the volcanic eruptions directly impacted food production, due to destruction of existing crops, and land related challenges due to large amounts of ashes that needed to be removed before back-yard gardening or small-scale farming commenced. Similar negative impacts of natural disasters on agricultural production have been highlighted in several studies focused on SIDS, emphasizing that SIDS' lack the adaptive capacity to rapidly recover post-disaster due to interaction of climate variability with rapid environmental change (Pelling and Uitto, 2001; Jenkins and Jupiter, 2015; Nunn and Kumar, 2018). Miller et al. (2022) specifically spoke about the challenges of volcanic hazards in SIDS as one resulting in heavy disruption of livelihoods, economic activities, and destruction of critical infrastructure (Miller et al., 2022). The authors referenced the La Soufrière eruption as a disaster that not only had negative impact on SVG, but its neighboring country of Barbados. They stated that generally a volcano is often viewed as a natural resource due to its association with rich agricultural soils, clean water sources, and abundant source of construction aggregate, hence it is often underestimated as a hazard (Pelling and Uitto, 2001). However, volcanic eruptions intensify various existing challenges that directly impact agricultural input, such as reductions in available land (Miller et al., 2022).

As shown in our study results the impact of the COVID-19 pandemic and the volcanic eruption severely impacted food security. This was highlighted as almost two thirds of the participants were moderately to severely food insecure, almost half severely food insecure, with more than half the participants attributing these to pandemic-related implications. In 2017, the CFaH study that piloted the FIES in this setting showed that 35.4% (27.9 to 43.5) of the sample were moderately to severely food insecure, highlighting that our results were almost double the amount (Bhagatani et al., 2022). Generally, participants without access to food aid, and no change in food source were more likely to be food insecure during the pandemic. Those whose food

source and food production efforts remained unchanged post volcanic eruption as a result of lack of access to food aid or support needed to rebuild (highlighted in the qualitative interviews) were also more likely to be food insecure. Miller et al. (2022) commented on the multiple crisis that is faced by several SIDS including volcanological risks, the prevailing COVID-19 pandemic, and for some hydrometeorological risks due to the existence of a hurricane season (Miller et al., 2022). Studies conducted in Iran and a Pacific SIDS, specifically looked at the impact of COVID-19 related restrictions amidst natural disasters (Steenbergen et al., 2020; Rad et al., 2021). The study conducted in Vanuatu, the Pacific SIDS reported that though in the earliest the Pacific was largely untouched by the COVID-19 pandemic, there was still a large-scale impact on trade and movement of people, due to restrictions implemented based on government-initiated state of emergencies (Steenbergen et al., 2020). These challenges had negative impacts on livelihoods and food security but was further exacerbated by the destruction caused by a category-5 Tropical Cyclone Harold (Steenbergen et al., 2020). Authors explained that the impact of this double crisis will be a lasting one, with a projected economic decline of 14%, and a job loss within the tourism sector of 70% (6 weeks post COVID-19 restrictions). The article further highlighted that many persons involved in food production had loss of harvests and damage to their gardens and farms, and many stated there was not sufficient food stock, while there were no immediate relief to address the shortages (Steenbergen et al., 2020). The study conducted in Iran was similar where the results showed that the COVID-19 pandemic had negative impacts on the economy, the agricultural sector, and food security of Iran through six major mechanisms including income, employment, the food supply chain, healthy diets, economic stability, and sustainable agricultural production (Rad et al., 2021). This corresponded to a 30% decrease in the purchasing power parity in 2020 which added to a significant increase in food prices as compared to those in 2019 (Rad et al., 2021). Simultaneously, the expansion of environmental issues and constraints related to natural disasters, in Iran greatly reduced the capacity of the agricultural sector to play a crucial role in the economy and ensure food security (Rad et al., 2021). Hence with the additional burden of the COVID-19 pandemic, the national programs and budget to combat rising ecological limitations was quickly depleted and over-burdened (Rad et al., 2021).

## 4.2 Implications for policy

The lasting economic impact of the COVID-19 pandemic and constant environmental challenges such as natural disasters faced by SIDS, exacerbate food security related challenges of already vulnerable and fragile food systems (Steenbergen et al., 2020; Boyacı-Gündüz et al., 2021; Rad et al., 2021). According to Boyacı-Gündüz, there is a need to develop resilient food systems, that can be rebuilt efficiently post crisis or disaster (Boyacı-Gündüz et al., 2021). Based on the global history of epidemics and pandemics, and uncertainty of the future the food-security related implications of the COVID-19 pandemic, particularly in developing countries underlines the importance of addressing issues related to food

shortage, food loss and food waste, due to the mass panic buying, restrictions affecting agricultural production, and food imports experienced (Boyacı-Gündüz et al., 2021). Strategies, interventions, and policies need to be geared toward improving food security and the integration of sustainable systems. Galhena et al. (2013) stated that multiple strategies are required to address the issue of food production and food security, specifically post crisis. The authors stated that the choice of feasible approaches depends on several factors including existing social, political, and economic conditions and resources available to design and implement much needed interventions (Galhena et al., 2013). Additionally, home gardens have been a time-tested local strategy that is broadly adopted and practiced in various circumstances among local communities in low resource settings with the help of institutional and other support (Galhena et al., 2013). Another article that reviewed the results of 12 studies that examined coping strategies and policy implications post disaster highlighted some strategies used as initiatives related to crop and plot diversification, income source diversification, investment in physical and human capital, and sharecropper tenancy (Skoufias, 2003). Our study highlighted that there was a need for more assistance or programs in place to help small scale farmers/persons involved in food production to rebuild post crisis. This includes the need for wider access to food aid post disaster, as many of the programs primarily focused on rebuilding gardens/farms have down time between planting and harvesting. It is important to prioritize the implementation of such strategies since the global population and urbanization will grow in the coming decades, and pandemics will likely occur more often, as climate change intensifies.

## 5 Strengths and limitations

This study was conducted using a mixed methods approach; although numbers interviewed were few, the interviews enabled us to gain contextual insight to findings from the surveys. One limitation is the gender imbalance with twice as many women as men in our sample. However, in most developing countries, or low-resource settings, women are normally responsible for food preparation at home or through small-scale food production. In addition, it is important to note that the changes reported by participants in relation to COVID-19 and the volcanic-eruptions are based on their memory/assessment and not on before and after data collection, hence the data is subject to recall bias.

## 6 Conclusion

At the height of the COVID-19 pandemic, an assumption was that local food systems would be strengthened, through self-sufficiency farming, particularly in the face of financial pressures due to furlough and decreased employment. However, here in our study, it appears that one impact of the pandemic was an increased burden to engage in local food production due to the restrictions related to movement such as physical distancing which hampered social networking, and border restrictions which impacted the importation and availability of items needed for food production,

and the prices of these items. Due to SVG's heavy reliance of food import (The Economist Group, 2022), the restrictions also directly impacted the availability of food which was exacerbated by the unexpected eruption of La Soufrière volcano, destroying several crops and livestock within the country. The double impact of the COVID-19 pandemic and the La Soufrière eruption also added to the increased burden of food insecurity due to lower household income, higher food prices, decreased food sources, limited access to food aid and several limitations to own food production. Our findings are primarily consistent with those found in other settings; however, it is important to look at SIDS' specific findings to inform future interventions and policies within this setting. This study highlights the need for strategies to be developed to increase resilience of vulnerable or weakened food systems within this setting post natural disaster and crises.

## Data availability statement

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

## Ethics statement

The studies involving humans were approved by Institutional Review Board, The University of the West Indies, Cave Hill Campus, Barbados. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

## Author contributions

EA: Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. MM: Conceptualization, Methodology, Supervision, Writing – review & editing. CG: Conceptualization, Methodology, Supervision, Writing – review & editing. KM: Conceptualization, Writing – review & editing. DR: Methodology, Supervision, Writing – review & editing. MW: Formal analysis, Methodology, Supervision, Writing – review & editing. SA: Formal analysis, Methodology, Supervision, Writing – review & editing. NU: Conceptualization, Funding acquisition, Methodology, Supervision, Writing – review & editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fsufs.2023.1268330/full#supplementary-material>

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