

REVIEW

Open Access



A review of global research trends on the impact of the COVID-19 pandemic on food security

Khaeriyah Darwis^{1,2}, Muslim Salam^{3*} , Musran Munizu⁴ and Pipi Diansari³

Abstract

Since the outbreak of the COVID-19 pandemic in 2020, tens of thousands of scientific articles have been published. Researchers are enthusiastic to uncover the effects of COVID-19. This study aims to critically assess the methods researchers used to analyze the impact of COVID-19 on food security. The PRISMA and Bibliometric Methods were utilized in this study. The results of the PRISMA indicate that most researchers utilize quantitative methods, 61%, compared to 32% for qualitative and 7% for mixed methods. These findings provide important data. Firstly, researchers continue relying on quantitative methods (multiple linear regression and Chi-square). Secondly, 32% of the articles utilized qualitative and only two qualitative methods, phenomenological and case studies, have been identified. No researchers use grounded theory research (GTR) and ethnographic studies (SE). Thirdly, using mixed method among COVID-19 researchers is uncommon; only 3% of researchers employed it. Next, the results of the bibliometric reveal that the USA and China contribute the most to the publication on the impact of COVID-19 on food security. A review of research publications on the impact of COVID-19 on food security shows an alarming increase in food loss and waste due to excessive household food purchases. This trend has the potential to endanger food availability in the future. Recommendations to the government include offering incentives to reduce food loss and waste, improving supply chain coordination, training, and technical breakthroughs and innovations, especially for small-scale farmers. The government should support food banks and farmers' markets to shorten the value chain and connect farmers with consumers.

Keywords Bibliometric, PRISMA, Food security, COVID-19, Research method

Introduction

Since the initial report of the transmission of COVID-19 in China in December 2019, this viral infection has swiftly disseminated across the globe, prompting the World Health Organization (WHO) to designate it as a worldwide pandemic in March 2020. Based on the data provided by the John Hopkins Corona Virus Resource Centre, there was a notable increase in the number of confirmed positive cases of COVID-19 in both 2020 and 2021. Specifically, 2020 witnessed an additional 83.6 million positive cases, while the figure rose to 256 million cases in 2021, encompassing both confirmed positive cases and fatalities. The escalating tally of documented

*Correspondence:

Muslim Salam
muslimsal@yahoo.com

¹ Doctoral Program of Agricultural Sciences, Graduate School of Hasanuddin University, Makassar 90245, Indonesia

² Faculty of Agriculture, Muhammadiyah Makassar University, Makassar, Indonesia

³ Laboratory of Farm Management & Agricultural Marketing, Department of Socio-economics of Agriculture, Faculty of Agriculture, Hasanuddin University, Makassar 90245, Indonesia

⁴ Faculty of Economics and Business, Hasanuddin University, Makassar 90245, Indonesia



© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

coronavirus disease 2019 (COVID-19) from late 2019 to 2021 globally proves that the current circumstances can be characterized as an ongoing, unresolved pandemic. Numerous endeavors have been undertaken, albeit with restricted efficacy, to mitigate the transmission of this global health crisis. The dissemination of inaccurate information, such as false news or deceptive content, alongside the lack of coherence in governmental strategies to address the COVID-19 pandemic, has engendered a state of public perplexity in effectively navigating this worldwide public health emergency. Consequently, the variability in individuals' perception of the risks of the transmission of COVID-19 engenders a misguided perception of safety, thereby fostering a rise in hazardous conduct and incongruities in individuals' adherence to health protocols. These observations underscore the deficiencies in risk communication strategies employed throughout the COVID-19 pandemic. Governments in different nations are endeavoring to enhance and fortify their communication strategies in response to the risk of COVID-19 transmission. These efforts primarily focus on prioritizing the principle of information disclosure, supporting behavioral changes within the community to implement health protocols, strengthening community engagement consistently and continuously in communicating the risk of COVID-19 transmission, and ensuring the community's adaptive behavior is in order [1–3].

Since the emergence of the COVID-19 pandemic in 2020, many researchers have dedicated their efforts to investigating this phenomenon. Academics are highly motivated to investigate the impact of COVID-19, as it significantly influences various domains, including agriculture, the economy, society, education, and food accessibility. According to economic analysts, it is anticipated that the COVID-19 pandemic will have significant repercussions on the global economy, leading to a worldwide recession. A significant number of individuals will be pushed below the poverty line. Researchers have estimated the potential influence of the COVID-19 pandemic on global poverty levels, projecting that approximately 1.2 million individuals within each country may become infected. This phenomenon may be attributed to the adverse effects of the COVID-19 pandemic, which resulted in widespread job losses, bankruptcies among entrepreneurs, diminished purchasing power among individuals, and, consequently, a weakened state of the global economy [1, 4].

Furthermore, the advent of COVID-19 has profoundly affected the implementation of distance learning or remote education within the realm of education. The current circumstances challenge certain students in their adjustment to the educational environment, leading to many of them discontinuing their studies. This can

be attributed to the deteriorating economic conditions experienced by their families, resulting in their inability to procure electronic devices or purchase internet data plans. Furthermore, some students struggle to acquire knowledge through remote learning methods effectively. The agricultural sector has experienced a decline in productivity due to government policies restricting social movements and mobility. This has led to a slowdown in supply chains and subsequent shortages of agricultural products. Consequently, food supply and demand stability has been disrupted, increasing prices for essential items and limiting access to food for a significant portion of the population [4].

In response to the diverse ramifications of the COVID-19 pandemic, scholars hailing from multiple nations have undertaken investigations to examine the effects of COVID-19 on food security, food crises, household dietary patterns, and the financial well-being of farmers. Approximately 20,000 scholarly and scientific publications have been identified about the influence of the COVID-19 pandemic on food security. The extensive body of research conducted on the effects of COVID-19 serves as compelling evidence of the significant influence of this pandemic on global food security. Furthermore, the extensive body of research and scientific literature on this subject indicates considerable interest among scholars from diverse fields in investigating the manifold repercussions of this global health crisis on the global food crisis and security. This fact additionally presents a robust indication of alterations in the global food supply consequent to the COVID-19 pandemic. Researchers employ diverse research approaches, encompassing qualitative and quantitative methodologies and mixed-methods approaches, to conduct their scientific investigations. The research [5–7] have employed a qualitative methodology to examine the ramifications of the COVID-19 pandemic on food security.

In contrast to the studies conducted by [8–10], the present research employs a quantitative methodology to ascertain the diverse determinants influencing global food demand. Meanwhile, Henrici and Thilmany employed a mixed methodological approach to examine the adverse effects of the COVID-19 pandemic. The methodology of studies on the impact of COVID-19 on food security is presented in Table 2. Another aspect that can be discerned from diverse scholarly articles published amidst the COVID-19 pandemic is the geographical provenance of the researchers who have dedicated their efforts to examining the diverse ramifications of COVID-19 on global food security. The investigation and mapping of disparities in scientific methodologies and the nationalities of researchers present intriguing avenues for further exploration. Such endeavors aim to provide

a comprehensive overview and description of prevailing patterns, research interests, and the geographic origins of scholars in this domain.

Based on the empirical evidence and descriptions, this study's primary aim is to assess the influence of COVID-19 on food security critically. Additionally, it seeks to critically evaluate the methodologies employed in analyzing this impact as documented in scientific literature. The primary objective of this study is to analyze and assess different research methodologies (quantitative, qualitative, and mixed methods) and identify the indicators employed in analyzing food security amidst the COVID-19 pandemic. The research aims to achieve specific objectives: (1) this paper aims to critically examine and assess different research methodologies, focusing on quantitative and qualitative approaches. The objective is to identify the indicators employed in analyzing food security amidst the COVID-19 pandemic; (2) to thoroughly examine scholarly publications within the past 3 years, particular attention will be given to investigating and consolidating the effects of COVID-19 on food security. The forthcoming analysis will identify publication trends across various countries, employing pertinent keywords and recurring research theme titles.

The present study aims to make a significant scholarly contribution by advancing the understanding of research methodology and its practical implementation in food security. In the past, there was limited discussion and assessment regarding the research methodology employed in investigating the worldwide consequences of the COVID-19 pandemic on households' food security. The advancement of research methodology across various scientific disciplines holds significant importance in expediting the progress of science and technology, including food security. Furthermore, this study will advance scientific knowledge, particularly in data and information about the distribution and intensity of research endeavors across different nations. Given the available data and information, it is feasible to discern the countries that hold a prominent role in addressing the repercussions of the COVID-19 pandemic on global food security.

Literature review

Three COVID-19 food security study methods

The utilization of quantitative methodologies in numerous studies about the ramifications of the COVID-19 pandemic on food security has yielded diverse outcomes because of employing heterogeneous research approaches, such as linear regression [11–14]; logistic regression [14–18] Chi-square test [18–23]. During the COVID-19 pandemic, individuals who employed a quantitative methodology typically relied on online

surveys and phone surveys as means of data collection, because of the imposed limitations on physical movement and restrictions on individuals' mobility during that period. For researchers employing a positivistic paradigm and utilizing a quantitative approach, an outbreak such as COVID-19 does not pose any concerns regarding exposure. One potential issue that may arise is the limited accessibility of residents as research subjects or respondents who lack access to electronic devices or face challenges with internet connectivity. This presents a potential opportunity, given that numerous community members are engaging in remote work arrangements in response to the government's directive to work from home (WFH). Using online survey methods or network analysis with social media big data presents a valuable opportunity in quantitative research. Nevertheless, a notable distinction exists between research endeavors employing interpretive/critical paradigms and qualitative methodologies [24, 25].

Qualitative methodologies commonly used in social sciences include phenomenology, case studies, ethnography, symbolic interaction, ethnomethodology, reception analysis, and grounded theory [8, 9, 26–37]. This interpretive paradigm aims to ascertain and integrate the intricacy of the subjects' experiences and feedback within the research process. Researchers employ a diverse range of methodologies to assert their interpretive authority. In the context of the COVID-19 pandemic and its impact on research activities in the qualitative field, it is imperative for researchers to carefully consider their operational strategies considering the prevailing circumstances. The individual is adhering to social distancing measures and remaining in their residence. Anticipating, identifying, and fully articulating the experience of research subjects/participants and the mediating context in the qualitative approach is challenging before the implementation of the research. Academic researchers are required to address ongoing research activities in real-time promptly [25, 38].

The issue pertains to the validity and reliability of research. Thus far, the field of social communication has predominantly employed a quantitative measurement approach. In the context of qualitative research, it is imperative to acknowledge that using terminology and assessing validity and reliability necessitates adjustment to accommodate the dynamic and distinctive social environments inherent to qualitative inquiry. In qualitative research, validity is commonly understood as the degree to which the findings can be considered trustworthy or truthful. This is often achieved through establishing authenticity, which encompasses qualities such as honesty, fairness, and the inclusion of diverse perspectives. The issue of reliability is defined as the consistency

in the utilization of different interview techniques, participation, drawings, and documentation review. Some qualitative researchers argue that the primary measure of validity in qualitative research lies in the researcher's loyalty to the research subjects and their experiences rather than rigidly adhering to research methods and design.

The challenges and barriers that pose a potential concern for qualitative research revolve around identifying the research subjects, particularly since individuals no longer gather in physical, naturally occurring groups and organizations. Inquiring about the feasibility of scheduling interviews and obtaining access to focus group discussions (FGDs) while considering the substantial concern surrounding potential exposure to the COVID-19 pandemic in group settings. However, it is important to consider that in a work-from-home (WFH) scenario, individuals may encounter concerns regarding privacy and confidentiality, which can arise from both the employee's and employer's perspectives, particularly about using electronic devices and screens. The disclosure of in-depth and unrestricted information regarding family dynamics in online interviews conducted within the participants' homes raises concerns about potential disturbances and breaches of confidentiality [39, 40].

Mixed methods research integrates the strengths of quantitative and qualitative methodologies to offer a comprehensive understanding of the phenomenon under investigation. Using quantitative methods enables researchers to empirically examine hypotheses and derive logical conclusions, whereas qualitative methods facilitate a comprehensive comprehension of the underlying reasons and mechanisms behind a phenomenon. An event occurs [41, 42], therefore it can be argued that employing a mixed-method research approach has the potential to yield research findings that are more precise and dependable. Given the multifaceted nature of the COVID-19 pandemic's impact, it is evident that employing a mixed-method approach is indeed suitable. However, it is imperative to acknowledge the inherent limitations associated with this approach, including intricacy, financial implications, time constraints, and the challenge of synthesizing findings due to the need to incorporate both quantitative and qualitative methodologies [43, 44].

Food security pre- and post-COVID-19

Food security and food supply have been discussed even before the onset of the COVID-19 pandemic. This is because the global human population has steadily increased each year, which has not been met with a proportional increase in food supplies. Before the onset of the COVID-19 pandemic, numerous research findings were dedicated to exploring strategies to mitigate food

waste. Both in terms of food waste processing and human behaviors towards food. One relevant study [58, 59] examines the potential of food sharing to mitigate food waste and optimize food waste management to minimize the likelihood of food loss [45]. The research component plays a significant role in shaping future food security and security, particularly the potential risks posed by food security in the aftermath of the COVID-19 pandemic. Research on food valorization is an essential endeavor that plays a significant role in reducing food waste [46–48]. The conversion of food waste into value-added products holds significant potential for implementation both presently and in the future, particularly considering the COVID-19 pandemic's impact on food security.

The emergence of the COVID-19 pandemic over the past 2 years has indeed contributed to the narrative surrounding the issue of food waste. Undoubtedly, this phenomenon is intricately linked to the policies formulated in response to the pandemic, including measures aimed at curbing the proliferation of this dangerous virus. For instance, there exist policies at both local and national levels that impose restrictions. These policies have diverse consequences, including the disruption of the food supply cycle, the closure of public spaces, and the shift of offline activities to online platforms [49, 50]

Experts have divergent viewpoints concerning food waste generation in the context of the COVID-19 pandemic. The first perspective posits that during times of crisis, individuals tend to adopt a conservationist approach toward food, thereby diminishing the occurrence of food waste. Conversely, the second viewpoint contends that pandemic-related factors such as lockdown measures, restrictions on storage capacity, hoarding behaviors, limited culinary skills, and panic-driven purchases can contribute to an escalation in the volume of food waste generated throughout the pandemic [51, 52]. While certain articles suggest a positive correlation between increased purchases and heightened food waste, alternative studies indicate a reduction during the COVID-19 pandemic.

The three primary components of sustainability, namely the economic, community, and environmental aspects, are closely linked to the reduction and elimination of food waste. This behavior has experienced a significant increase in recent years and is considered undesirable as it poses a threat to food safety and disrupts economic, societal, and environmental sustainability. The problem of food waste is aligned with other important concerns, including health and sustainable development. The sustainability of food waste has a direct impact on overall food availability. Therefore, preventing food waste requires significant adjustments in attitudes, behaviors, and work structures. Implementing standards in food

waste prevention and related policies is a prioritized effort, focusing on their effectiveness and potential constraints [53–55].

The decline in food availability amid the pandemic can be attributed to several factors. Firstly, individuals have exhibited an inclination toward meticulous planning of their shopping lists, which has led to a decrease in overall food consumption [49, 50, 56]. Secondly, there has been a notable shift towards purchasing food items specifically believed to enhance immune system functionality. Thirdly, implementing lockdown policies has prompted individuals to explore innovative approaches to optimize food utilization. Lastly, the reduced frequency of leaving one's residence and a corresponding decrease in impulsive purchases have contributed to the overall decrease in food consumption. The pandemic has yielded evidence of a decline in food waste in both Italy and the United Kingdom [57, 58].

Impact of the COVID-19 pandemic on 4 food security pillars

According to a study conducted during the COVID-19 pandemic, a significant majority of participants residing in rural and suburban regions, who were interviewed online, expressed apprehension regarding the food security of their households whenever governmental authorities announced restrictions on social mobility. This research, encompassing respondents from rural and suburban areas, revealed that approximately 90% of individuals voiced concerns about their ability to access sufficient food resources considering these restrictions. Indeed, a substantial majority of respondents, specifically 70%, voiced notable apprehensions about the sufficiency and convenience of obtaining food provisions for their households. Similarly, upon reviewing the outcomes of their completed questionnaire through the Google form, urban dwellers voiced apprehension regarding the accessibility of food in the market during the implementation of a government-enforced lockdown, particularly in food items that are frequently ingested, such as fresh meat, fresh fish, and vegetables [48, 53, 59].

On the eve of the official declaration of the lockdown, a significant proportion of urban residents, approximately 60%, engaged in panic buying as a precautionary measure to accumulate food reserves within their households. This behavior was driven by the desire to ensure a continuous food supply and mitigate the risk of experiencing hunger during the lockdown period. The remaining 40% of respondents believed in the adequacy of government assurances regarding food availability during the lockdown, perceiving it as a normal situation that did not warrant panic buying. However, the consistency of food prices during the COVID-19 pandemic has been variable.

Indeed, it is evident that there is a consistent upward trend in daily market prices. This pertains to the notion of food accessibility, encompassing both financial access and physical access to food, as well as food availability, which includes factors such as variety, quantity, and options [59–61].

A limited proportion of individuals residing in urban regions assert that they find it convenient to procure food online, despite the increased prices. However, it is important to note that this assertion applies solely to individuals who possess a consistent source of revenue despite their sole residence being their place of dwelling. An illustration of individuals transitioning to remote work during the COVID-19 pandemic includes civil servants and private sector employees. However, individuals residing in the periphery of the urban area, despite possessing a consistent source of income, encounter difficulties in procuring food through online platforms due to the scarcity of online vendors operating in their locality [62, 63].

Overall, the participants expressed a positive outlook when questioned about the potential future obstacles they may encounter in ensuring the security of their household's food supply. Two-thirds of the participants indicated that they and their families would need to adjust to the "new norms", particularly their daily routines following the COVID-19 pandemic. A significant majority of the participants, specifically 82%, expressed their intention to reassess their methods of acquiring food for their households following the implementation of the Movement Control Order (MCO). A significant percentage of respondents indicated their intention to minimize food waste by purchasing only the necessary food for their respective households. Furthermore, approximately 50% of the participants expressed their intention to initiate personal vegetable gardens within the confines of their residential properties. According to their assertion, this proposed measure would facilitate the acquisition of a consistent provision of vegetables, ensuring the availability of safe and fresh sustenance. The incorporation of the garden-to-table concept, along with the reduction of food waste, aligns closely with the objectives of the Sustainable Development Goals (SDGs) [64–66].

In addition, some respondents believed purchasing food online would become more appealing after the COVID-19 pandemic. The authors posited that the availability of both online purchasing and purchasing at physical marketplaces would afford individuals the autonomy to make choices. This pertains to the fundamental notions of food availability and accessibility. As articulated by a respondent, it is worth considering whether reverting to traditional shopping practices is necessary, given the recognition that online shopping offers

comparable convenience, accessibility, and practicality [67, 68] This situation is of particular concern, especially if the pandemic persists and further affects the economy, potentially leading to increased households experiencing food insecurity. The primary obstacle in attaining and sustaining household food security pertains to the strategies employed by households in response to the various alterations induced, both directly and indirectly, by the pandemic. As previously mentioned, various factors, including availability, accessibility, affordability, and choices, play a significant role in determining a household's food security level. To address the issue of household food security, it is imperative to consider the actions that both individuals and communities can undertake. The option of embracing new norms, such as engaging in food production, establishing home gardens in residential spaces, or relying on online food shopping, can expand food accessibility and availability. Nevertheless, it is plausible that alternative options are presently unexplored [69, 70].

Methods

To accomplish the goals of this research, we employed two methodologies: (a) the PRISMA Method (Preferred Reporting Items for Systematic Reviews and

Meta-Analyses Statement) and (b) bibliometric analysis. The PRISMA approach is widely recognized as a valuable tool and guide for evaluating systematic reviews. It is a valuable resource for authors and researchers in effectively conducting high-quality systematic reviews and meta-analyses [44–47]. Bibliometric analysis is a quantitative approach employed by authors and academics to delineate the attributes of a collection of published literature [48–52].

(a) PRISMA method

The PRISMA method was employed in this study for literature screening. The utilization of this method is carried out by strictly following six systematic steps that serve as practical guidelines (PRISMA) [45], namely: (1) formulation of a research question; (2) creation of search terms and phrases; (3) application of inclusion and exclusion criteria; (4) evaluation of selected study quality; (5) collection of data from studies that meet quality standards; and (6) analysis of the collected data. The six processes are visually depicted in Fig. 1, with each step being subsequently elucidated.

(1) Formulation of research questions

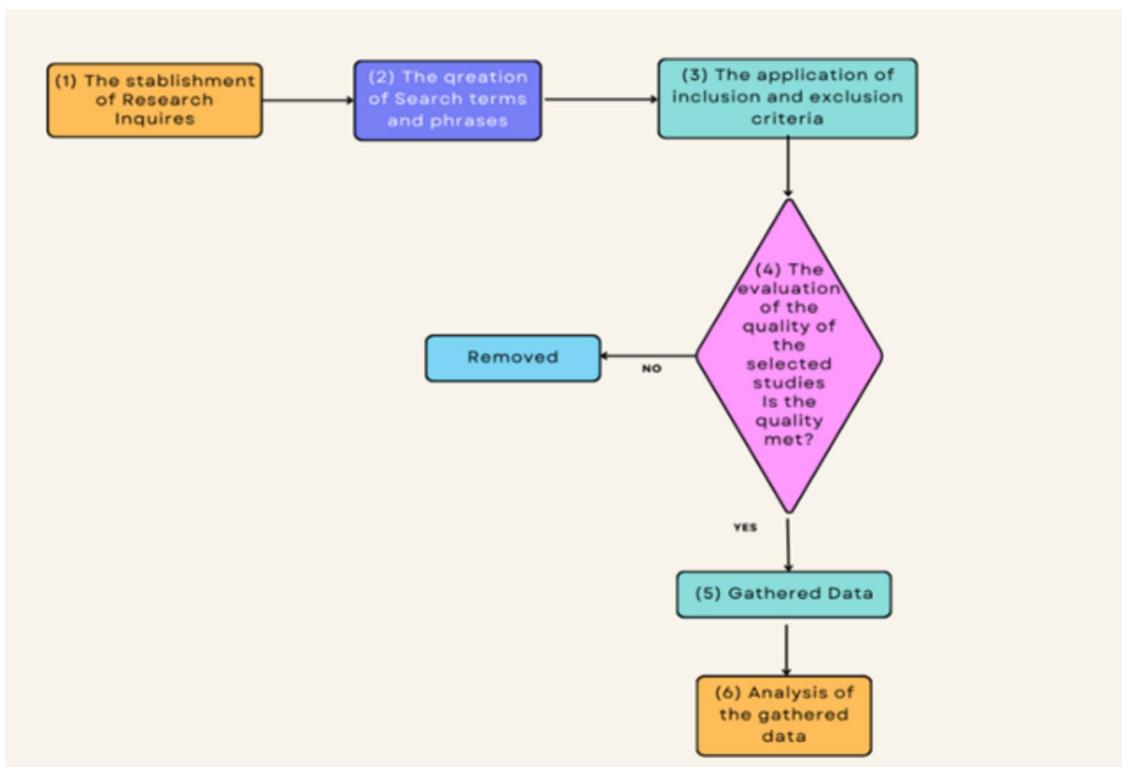


Fig. 1 Flowchart of systematic review on the impact of COVID-19 pandemic on food security

The first and foundational step of the Systematic Literature Review (SLR) involves the formulation of research inquiries. These inquiries are a guiding framework for the literature search and extraction procedure. The analysis and synthesis of data derived from the systematic literature review (SLR) serves as the solution to the research inquiries established at the outset. An effective research question possesses utility, quantifiability, and a focus on comprehending the current knowledge about a specific research area. This study examines the research inquiries about the effects of the COVID-19 pandemic on food security. Specifically, it explores employing quantitative, qualitative, and mixed-method methodologies in investigating this topic. Additionally, it investigates the interplay between author citations, keywords utilized in scholarly articles, and publications across different countries concerning the impact of the COVID-19 pandemic on food security.

(2) Creation of search terms and phrases

To conduct a comprehensive literature search in the database, a set of carefully selected keywords will be used to effectively capture the implications of the COVID-19 pandemic on household food security conditions. The search query for all databases will consist of the following terms: (Impact) OR (Burden) OR (Effect) AND (“COVID-19”) OR (“COVID 19”) OR (“SARS-COV-2”) OR (“SARS COV 2”) OR (“Coronavirus Disease 2019”) OR (“Coronavirus Disease- 19”) (“Food Security”). 19 (“Food Security”) OR (“Food Insecurity”) OR (“Food Shortage”) OR (“Dimensions of Food Security”) OR (“COVID-19 Food Security”) AND (“Household Food Security”). The time frame under consideration is from March 31, 2020, to May 12, 2023.

(3) Application of inclusion and exclusion criteria

Table 1 presents the use of six distinct criteria by the writers. These criteria consist of three fundamental aspects: research articles written in English and a complete technique derived from multiple review papers employed by researchers [71–73]. Researchers objectively determined three criteria: the publication time of the paper, which spans from 2020 to 2023; the scope of the influence of COVID-19 on food security; and the evaluation of food security during the COVID-19 pandemic.

(4) Quality evaluation of selected studies

The initial step in gathering research articles from several journal publishers, including Elsevier, Springer, Wiley, Emerald, and Taylor & Francis, was acquiring data using the phrase “COVID-19 Food Security”. Elsevier, a renowned academic publisher, boasts a substantial collection of 12,363 articles. Similarly, Taylor and Francis, another prominent publisher in the scholarly community, offers a noteworthy compilation of 7287 pieces. Wiley, a reputable publishing house, contributes to academic discourse with a commendable assortment of 5608 articles. Lastly, Springer, a well-established publisher, enriches the scholarly landscape with a collection of 6155 articles. A total of 31,413 articles were gathered examining the effects of the COVID-19 pandemic on food security. The screening step employs the inclusion criteria outlined in Table 1. Specifically, it encompasses publications published between 2020 and 2023 and is restricted to research articles exclusively. Consequently, article genres such as review articles, short communications, reports, and others are excluded from consideration.

In Fig. 2, the utilized journal titles encompassed *Agriculture and Food Security*, *Agricultural Systems*, *Global Food Security*, *Food Policy*, *Socioeconomic Planning Sciences*, *Sustainable Production and Consumption*, *Heliyon*, *World Development Journal*, and additional publications on agriculture and food security. In the context of journal

Table 1 Inclusion and exclusion criteria of studies

| Inclusion criteria | Exclusion criteria |
|--|--|
| 1. Original research article | 1. Review, report, opinion, conference article |
| 2. Written in the English language | 2. Written in languages other than English |
| 3. Comprehensive methodology | 3. No diagrams or visuals to help illustrate ambiguity and unexplained methodology |
| 4. Published from March 31, 2020, to May 12 2023 | 4. Research published before or after March 31, 2020, to May 12 2023 |
| 5. Studies that included only the COVID-19 problem affecting food security, coverage of all aspects of food security | 5. Studies that lack the concept of at least one or more food security dimensions |
| 6. Research that encompasses both pre- and post-COVID-19 pandemic evaluations of food security | 6. Studies that report food security conditions only before or after the COVID-19 pandemic |

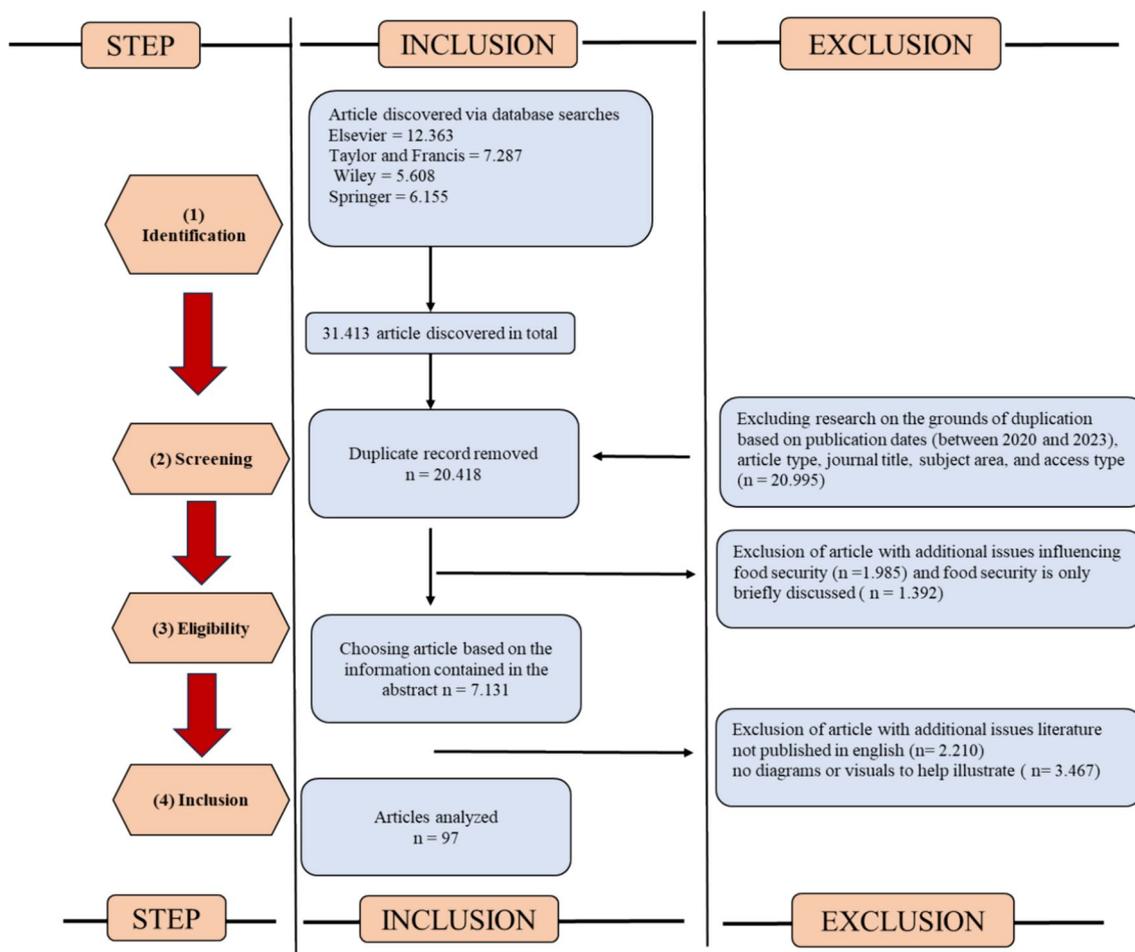


Fig. 2 PRISMA diagram illustrating the full-text article selection procedure

access, open access was employed, resulting in a total of 20,995 articles being published. Among these, 10,418 articles underwent a filtration process. Moreover, during the eligibility stage, articles were screened in the second stage based on more detailed exclusion criteria, including the assessment of methodology and a comprehensive examination of food security. As a result, a total of 10,321 articles were filtered. During the inclusion stage, 97 papers were analyzed in this study.

(5) Data collection from studies that meet quality standards

Table 2 provides a comprehensive breakdown of the classification of research articles, serving as a valuable tool for optimizing search outcomes within the database. The articles that underwent screening at Stage 4 of the eligibility section were further classified using manual categorization, which involved identifying the research method employed. The articles were

categorized according to quantitative, qualitative, and mixed-method approaches.

(6) Examination of gathered data

The present study employs statistical analytic techniques to analyze the data collected under the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A total of 97 scholarly publications, spanning the period from 2020 to 2023, were dedicated to examining and evaluating various analysis methodologies, encompassing quantitative, qualitative, and mixed techniques. Subsequently, the statistical analysis was conducted after applying classification based on the study kind to the papers mentioned above. This study included descriptive statistics, including measures such as means, frequencies, and proportions.

Table 2 Methodology for assessing the impact of COVID-19 on food security

| Measurement methodology | | Sample size | Time of data collection | References | Number of articles | (%) |
|--------------------------|--|-------------|------------------------------|--|--------------------|------------|
| Quantitative | Linear regression | 250–360 | August–October 2020 | [5–7, 9, 17, 21, 36, 37, 74–84] | 20 | 61 |
| | Chi-square | 200–310 | September 2020–December 2021 | [15, 16, 18–21, 34, 85–93] | 17 | |
| | Logistic regression | > 200 | January 2021–February 2023 | [11, 17, 36, 37, 62, 76, 94–101] | 13 | |
| | Probit regression | > 200 | September 2020–April 2021 | [18, 35, 75, 102–108] | 10 | |
| | SEM | > 200 | October 2020–December 2021 | [84, 109, 110] | 3 | |
| Total | | | | | 63 | |
| Qualitative | Phenomenology | ≤ 25 | April 2020–December 2022 | [7–9, 29, 32–35, 37, 75, 88, 99, 101, 111–123] | 25 | 32 |
| | Case study | ≤ 30 | May 2020–January 2023 | [26, 28, 30, 122, 124] | 5 | |
| Total | | | | | 30 | |
| Mixed-method | Case study–logistic regression | 75 | June 2021 | [101] | 1 | 7 |
| | Phenomenology–quantitative descriptive | < 100 | July 2021 | [88] | 1 | |
| | Case study–qualtrics XM | 50 | March 2021 | [122] | 1 | |
| | Case study–quantitative descriptive | 65 | November 2022 | [28] | 1 | |
| Total | | | | | 4 | 100 |
| Articles in total | | | | | 97 | |

The United State show the highest number of document and citation followed by China, Italy, Canada, and United Kingdom, as clearly can be seen in Table 4.

PRISMA analysis instruments

Table 3 presents the research findings [125], consisting of 122 data points utilized to evaluate the publications

included in the study. This study encompasses up to six essential components for doing content analysis. The elements under consideration encompass various

Table 3 Content analysis of review aspects and categories aspect category

| Aspects | Categories |
|---|---|
| A. Types of research | A1. Quantitative research A.3. mixed-method research A2. Qualitative research |
| B. Types of quantitative research | B1. Survey (online, phone, direct) B5. Comparative B2. Correlation B6. Experiment B3. Descriptive B7. Inferential B4. Comparative causal |
| C. Types of qualitative research | C1. Narrative research study C2. Case study C3. Phenomenological study C4. Ethnography C5. Grounded theory study |
| D. Data analysis technique of quantitative research | D1. SPSS Version 22/25/26 D2. Computable general equilibrium D3. Excel D4. Structural equation modeling (SEM) D5. Others |
| E. Data analysis technique of qualitative research | E1. Descriptive qualitative E2. Longitudinal qualitative analysis framework E3. NVivo E4. ATLAS.ti E5. Hyper RESEARCH E6. MAXQDA E7. R version 3.6.2 E8. SWOT analysis |

aspects of research, including the type of research being conducted, such as quantitative research, qualitative research, or mixed-method research. Additionally, the analysis techniques employed for quantitative, qualitative, and mixed-method research data are all important considerations to consider.

Despite its thoroughness, comprehensive categorization, and relatively straightforward research process using keyword filtering, the PRISMA method had limitations. Specifically, our analysis may have excluded certain potentially significant articles that did not align with the pre-defined keywords or criteria (Table 4).

Table 4 Top ten active countries in publishing scientific articles

| Rank | Countries | GDP (trillion USD) | Documents | Citations | Total link strength |
|------|----------------|--------------------|-----------|-----------|---------------------|
| 1 | United States | 27.36 | 455 | 6570 | 1681 |
| 2 | China | 17.52 | 360 | 3955 | 1112 |
| 3 | Italy | 2.63 | 150 | 1952 | 808 |
| 4 | Canada | 2.12 | 120 | 2702 | 763 |
| 5 | United Kingdom | 3.09 | 264 | 3406 | 735 |
| 6 | Australia | 1.74 | 135 | 1899 | 717 |
| 7 | India | 3.42 | 188 | 2370 | 685 |
| 8 | Germany | 4.06 | 112 | 1524 | 504 |
| 9 | Netherlands | 1.05 | 77 | 1812 | 496 |
| 10 | Spain | 1.58 | 112 | 1491 | 483 |

b. Bibliometric analysis

The utilization of VOSviewer for generating visual representations of research maps can be delineated into four distinct stages, encompassing the preparation of datasets, the importation of datasets, and the subsequent visualization procedures. The subsequent elucidation pertains to the three sequential stages depicted in Fig. 3.

(1) Dataset preparation

The articles or literacy sources gathered will be the primary dataset before being imported into the Vosviewer program. The bibliographic data were obtained from the Dimensions database from January 2020 to March 2023 and recorded in a comma-separated value (CSV) format suitable for Microsoft Excel. As of March 20, 2023, 1,351 research publications about the correlation between COVID-19 and food security were identified in the Dimension database. These papers underwent a process of reevaluation, during which certain studies were deemed unsuitable for inclusion in the dataset and therefore eliminated. In the data extraction process, meticulously crafted search queries have been employed to obtain all pertinent records within the Dimension database systematically. The search query was meticulously constructed to encompass all possible variants of COVID-19 keywords, in conjunction with the concept of food security, to retrieve a comprehensive collection

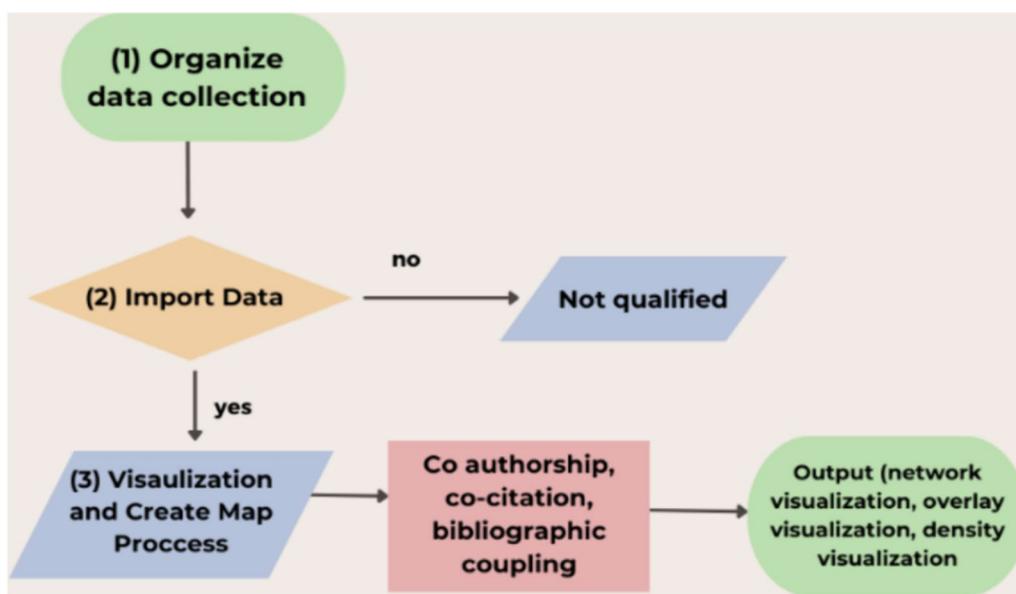


Fig. 3 Flowchart steps of bibliometric analysis on the impact of COVID-19 pandemic on food security

of publications about the topic. The Dimension data source was utilized in this study to address the difficulties that may arise when integrating multiple datasets.

(2) Data importation

Once the article data have been collected from multiple sources, the subsequent step involves importing the dataset into Vosviewer. There are numerous possibilities for displaying visualizations. Thus, it is necessary to determine the specific visualizations required. Depending on the desired perspective for visualizing our study, these may include visualizations pertaining to the title, co-authorship, keyword co-occurrence, or content analysis. The process of importing the dataset is straightforward, involving the selection of the “open” or “create” option and selecting the previously stored CSV file.

(3) Visualization and creation map process

The data will be processed by selecting various analysis types, including co-authorship, co-citation, and bibliographic coupling. The mapping results will be shown in three distinct parts: network visualization, overlay visualization, and density visualization. Once the dataset import has been completed in the preceding stage, it is imperative to visualize the data by the specific requirements of the researcher. As part of our study, we want to ascertain the approximate number of authors engaged in similar research endeavors using the specified keywords. Alternatively, in the case where the number has already been established, we can examine the presence of correlations in the findings between studies or among different authors.

Results and discussion of PRISMA analysis

Research types impact COVID-19 on food security

The types and designs of the research employed determine the topic of the study. According to Fig. 4, quantitative research was the most prevalent method used by researchers to explore the impact of COVID-19 on food security. The more considerable proportion of quantitative research relative to other types of research is consistent with findings from earlier research indicating that quantitative research designs were chosen over qualitative ones for conducting agriculture-related research [18, 126]. The precision and conformity of the analysis’s findings are high. It is common in quantitative research for an interaction between two or more variables. Utilizing quantitative approaches, researchers can determine the magnitude of a phenomenon for later comparison. Using inferential statistics, researchers can determine the pattern of observable links, interactions, and causes. However, qualitative design has been rising [43] and has addressed social research, including several social economy agriculture topics. Such a condition was intricately intertwined to the benefit of the qualitative approach to characterizing a phenomenon thoroughly and in-depth.

Both qualitative and quantitative research has benefits and drawbacks. Figure 4 shows that researchers still commonly utilize quantitative analysis to answer problem formulation questions. This method is widely chosen because researchers want accurate data based on empirical and measurable phenomena. The disadvantages of data collection often stem from the highest value; orientation is restricted to weight and quantity, and the ability to study respondents and the quality of the original data collecting tool is limiting factors. Unlike qualitative research, the advantages are that the description and interpretation of the informants may be explored in depth, the theoretical underpinning is consistent with

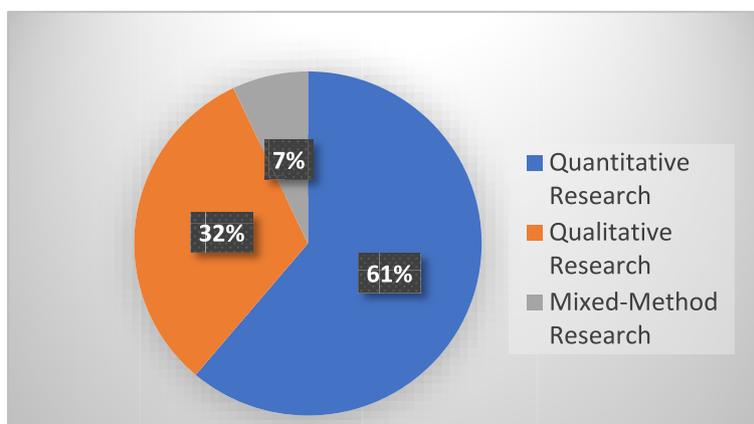


Fig. 4 The distribution of research with the impact of COVID-19 on food security based on types of research

the facts, and face-to-face interviews are phenomenally successful in eliciting replies and opinions. The downsides include that the research sample size is smaller, the boundary between truth and policy is less evident, and it is ineffective for large-scale or comprehensive research [43, 127].

Why is it essential to use mixed methods as a methodology? Our problems are so complex today that we need multiple methods to study them, such as the case of the COVID-19 pandemic, whose impact comprehensively affects our lives. The research by Béné et al. [34] indicates that 22 factors directly result from the post-COVID-19 food system. Economically and socially, this issue unquestionably necessitates in-depth research. This involves both quantitative and qualitative data analysis. COVID-19 is an extensive issue. Mixed-method research involves carefully gathering and analyzing quantitative and qualitative data in response to research questions better to understand behavior, social, and health-related issues. The two types of data are then combined or mixed research designs to produce fresh and more comprehensive insights that could be obtained from either quantitative or qualitative data alone [36, 76, 128–130].

The most quantitative research who conducted through survey methods. The survey approach has various advantages, including a low budget, time efficiency, and a quantity of information regarding the observed population's attitudes, beliefs, thoughts, and abilities. In addition, due to the COVID-19 pandemic crisis course, researchers opted for the survey approach to finish their journals fast and precisely. Most researchers also employ various survey techniques, from phone to internet surveys with online questionnaires to direct surveys. In around 25 articles, phone surveys are the most prevalent research too [22, 94, 126, 131, 132], followed by online survey methods in 12 articles [21, 83, 88] and direct surveys in 23 articles [15, 17, 23, 93, 97, 133–136]. The descriptive approach is one of the quantitative research methods with a problem formulation that integrates research to explore or picture social events that will be studied comprehensively, broadly, and in-depth. Various quantitative research methodologies, such as descriptive, seek to characterize the facts or characteristics of specific populations or fields precisely and methodically. This methodology is also suitable for investigating the effects of COVID-19 on food security.

The phenomenological method of qualitative research is the most prevalent in 28 qualitative analysis publications. The COVID-19 pandemic has produced a phenomenon that has significantly affected human life today. In most of the journals we examined, the COVID-19 phenomena were explained or described in an organized manner, including how farming households, city,

and village people recounted how the phenomenon was experienced and passed. According to journals, as many as seven journals that use case studies as their research methodology provide a complete summary before discussing the case's central theme or topic [55, 105, 106, 137, 138]. Qualitative research methodologies are commonly used to analyze contemporary and complicated issues [139]. The COVID-19 pandemic has not been a brief exogenous shock to Global Value Chains (GVC) but a global disruption with many waves spanning multiple areas and periods. Given the absence of prior empirical research addressing the impact of these dynamics on GVC decision-making, researchers opted for an in-depth, longitudinal single-case study to examine the resulting complexity and ambiguity over time. This allowed them to determine in detail the “how” and “why” executive data techniques and decision-making processes evolved. Synthesizing these findings by drawing on existing literature and employing several theoretical lenses enabled theory triangulation and increased the study's internal validity.

The study uses qualitative research methods, including focus group discussions, interviews with essential informants, and casual empiricism [123]. They have claimed that qualitative research permits inquiry into the “why”, “how”, and “processes” behind a phenomenon. Understanding COVID-19's impact involves examining how individuals adapted, the processes leading to adaptations, consumer purchasing behavior, food distribution systems, food production, price increases, the causes for price increases, and the resilience agricultural sector. The purpose was to comprehend, from the perspective of the major players, what was occurring on the ground concerning resilience to COVID-19 and beyond.

Additionally, grounded theory can be utilized in this research on COVID-19. The grounded theory research design is a series of processes used to construct a theory that describes a substantive topic's process. Grounded theory research is appropriate for explaining phenomena and methods or developing a broad idea about a phenomenon that current theories cannot explain. As a method, the grounded theory addresses the differences in constructing hypotheses based on existing evidence by explicating this link derived from case studies [127, 140]. The most appropriate description of grounded theory is a research process in which theory is developed from evidence, not the opposite, where data are generated from existing approaches and new ideas are formed. Consequently, this approach is appropriate for mitigating the effects of the COVID-19 pandemic. This condition has never occurred before; hence the current theory cannot explain or propose a solution for the COVID-19 problem. Using the grounded theory method, the seven prior case

study-based journals might be continued and developed into a new theory.

Impact of COVID-19 analysis using quantitative research

Validity will be determined by the precision with which data analysis methods are selected. According to the graph depicted in Fig. 5, 20 research utilizes linear regression. This indicates that linear regression is often utilized. Validity will be determined by the appropriateness of the data analysis method chosen. According to the graph depicted in Fig. 5, 20 studies used linear regression. This indicates that linear regression is used more often than logistic regression and structural equation modeling (SEM), because in general the research data in the reviewed articles used more numerical dependent variable data and only measured one dependent variable at a time.

This finding demonstrates that researchers frequently utilize it to identify and assess the factors determining the prevalence of food consumption alterations during the COVID-19 pandemic. Research using logistic regression found that poor household income before COVID-19 and after the epidemic and lockdown declined even further until there was no household income. As a result of job loss, former stay-at-home mothers are forced to return to their previous roles. Significant relationships exist between numerous family members and moderate-to-severe food insecurity [17, 77, 141–143]. Food insecurity and limited access to food induce dietary changes, decreased food intake, and increased reliance on less nutrient-dense foods. This is common in rural, urban, and farmer households [13–15, 83, 144–148]. This analysis is recommended for survey research on food security before, during, and after the COVID-19 pandemic.

Consumer/household behavior in satisfying food demands is included in household food security. Since the COVID-19 pandemic, numerous changes have occurred, including households altering their diet and decreasing food nutritional standards because their household income is no longer sufficient. This study [16, 149] investigates the impact of the initial COVID-19 lockdown on job loss, reduced income, food expenditure, and food availability, accessibility, and affordability in rural and urban households in Bangladesh, India, Indonesia, Myanmar, the Philippines, and Vietnam during the pandemic’s early stages. A quantitative analytical method and logistic regression analysis tools were used to investigate these indicators or variables. However, this study did not address some variables, most notably food spending, availability, and access to food. These can be qualitatively analyzed and are significant when analyzing how households can withstand COVID-19 quarantine. In contrast to the article [101], which uses a mixed-method research strategy to investigate the same variable, namely food accessibility during the COVID-19 lockdown, this study uses a single-method approach.

Managing food waste within households predates the onset of the COVID-19 pandemic, albeit with limited effectiveness. The study’s findings [59, 150] indicate that three groups demonstrate proactive behavior in terms of environmental care among the five household groups examined. This includes recycling household waste, purchasing environmentally friendly food products, participating in food-sharing initiatives, and practicing energy, water, and waste reduction. The advent of the COVID-19 pandemic brought about significant changes in human behavior, particularly in households’ approach to fulfilling their dietary requirements. Additionally, it has been elucidated that households managed to decrease food waste by an average of 9% in the year 2020, specifically

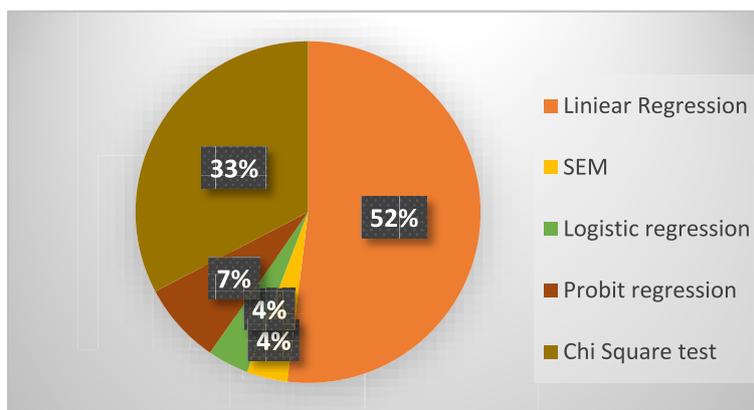


Fig. 5 The distribution of data analysis of quantitative research on the impact of COVID-19 on food security

during the COVID-19 pandemic, compared to the levels observed before the outbreak in 2019. The utilization of grocery lists, the application of purchase discounts, and the occurrence of precautionary purchases, coupled with reduced dining at restaurants, heightened engagement in home cooking, and increased food sharing, have exhibited a notable surge in prevalence during the pandemic compared to the preceding period. The paper by [3, 58, 151–153] uses propensity score match to analyze household behavior after the COVID-19 pandemic, indicating that it has exhibited a moderate level. The practice of saving money, which emerged during the COVID-19 pandemic because of constrained resources and economic conditions, has persisted and become a prevalent behavior in contemporary times. The pandemic has brought about notable shifts in food governance and food-wasting practices. These changes provide valuable lessons for behavior change initiatives to mitigate household food waste. Consequently, the impact of such campaigns on household food security in the post-COVID-19 era becomes significant.

There are additional research endeavors that employ quantitative methodologies. The conversion of food waste into consumable products presents an alternative approach to address the forthcoming challenges and risks associated with food security. This action was undertaken before the COVID-19 pandemic [47, 48]. The findings of this study, in comparison to previous research conducted during and after the COVID-19 pandemic [154] indicate that the utilization of date seed waste as a fiber-rich flour holds potential as a future alternative food source. However, additional investigation is required to explore this possibility further. Additionally, [155], the extraction of

mango peels, banana peels, and pineapple peels as supplementary raw materials in the food industry is an area that warrants further research.

Impact of COVID-19 analysis using qualitative research

According to the graph depicted in Fig. 6, 25 phenomenology studies are still extensively employed by researchers compared to other analytical methods. Many researchers utilize it to explain the circumstances seen in the field with greater precision, clarity, and depth. This study aims to explain the situation/event so that descriptive data can be gathered to understand the internal and external factors contributing to the high food insecurity level during the COVID-19 epidemic. Researchers do not appear to be familiar with or knowledgeable about other qualitative data, such as Grounded Theory Research (GTR) and Ethnography. Given that the COVID-19 pandemic is a novel phenomenon that has swept the globe, most researchers employ the phenomenon as a research strategy.

Results of qualitative descriptive research [34, 37, 75, 114, 116, 156, 157] to assure adequate food and nutrition, save lives, and protect people's way of life. COVID-19 is an extraordinary challenge that requires an immediate and prompt reaction. Regional and international cooperation is also necessary to address the consequences of COVID-19 and climate change. All nations must cooperate to exchange ideas and repair the agricultural supply chain. Both the coronavirus and climate problems demand the implementation of strategies and methods. The current COVID-19 epidemic and its associated recovery initiatives present

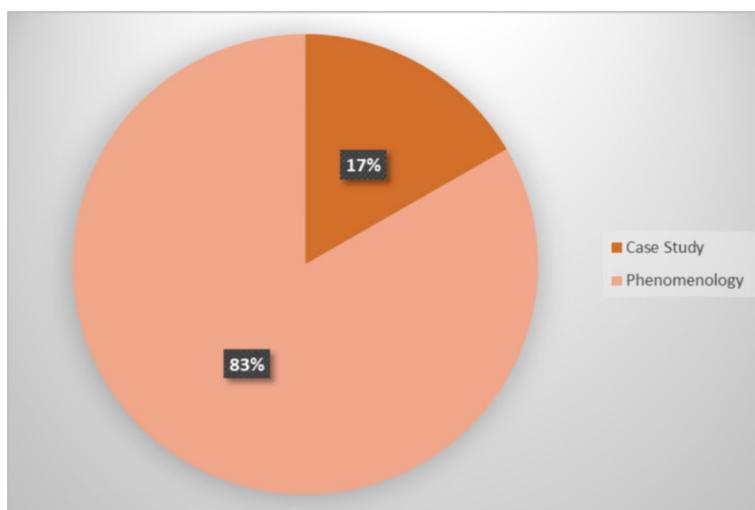


Fig. 6 The distribution of data analysis of qualitative research with the impact of COVID-19 on food security

a distinctive opportunity to expedite the shift toward a food system that is both sustainable and resilient. The outcomes of this study demand additional examination, such as developing a problem-solving theory based on data compilation. Researchers can use GTR. Given that the covid-19 pandemic is a new problem, it stands to reason that no explanations for its occurrence have been identified [43, 127]. Another research [112] employs longitudinal qualitative analysis.

In contrast, this journal uses only one methodology. On page 15 (Fig. 4), many indicators of the influence of COVID-19 on dairy products are displayed. Some of these may be quantitatively examined using secondary data. For instance, due to government action, the price of dairy products is higher than before a result of government action; the cost of dairy products is higher than before the pandemic. Government intervention can use the variables of logistics certainty, production certainty, matching supply with demand, and market monitoring as described in the journal [158], where quantitative and qualitative methods are used to describe indicators of government intervention as a form of food system resilience. In addition, the study [112] revealed that milk prices were higher after the epidemic than before. This variable can be evaluated using quantitative techniques, such as the t-test, to compare spending on food and dairy products before and after the epidemic [16]. As a result, it is strongly advised to use the mixed-method as a research approach so that the formulation of the problem, research objectives, and comprehensively the issues of the impact of COVID-19 on human life can be answered and make it easier to determine strategies for dealing with both short-term and long-term effects of COVID-19 on human life can be answered.

Impact of COVID-19 analysis using mixed-method research

In Fig. 7, the mixed methods tab in the menu contains most functionality related to mixed methods. On the one hand, some functions relate documents and document variables, such as subjects from qualitative interviews and variables from standardized interviews. With these functions, it is possible to develop so-called joint displays [42, 159]. This study employs a mixed-methods approach, wherein qualitative and quantitative data are analyzed and interpreted to draw broad conclusions [28, 101, 122, 160].

The mixed-method approach integrates two distinct philosophical paradigms that may be considered divergent or contrasting. One possible approach to synthesizing divergent perspectives. Different philosophical perspectives underpin quantitative and qualitative research methodologies, and integrating these two approaches is being pursued. Mixed-method research seeks to adopt a paradigm that accommodates divergent views, despite their opposing nature. This study explores four distinct paradigms or worldviews and reports the utilization of both dialectic and pluralistic worldviews. The dialectic pluralism approach facilitates the synthesis of these worldviews. It has been suggested that there may be certain benefits to possessing divergent worldviews, particularly in an explanatory sequential design context.

We are commencing with a quantitative approach, prioritizing the reporting of numerical data while potentially disregarding qualitative aspects. We would submit a worldview that we may subsequently endorse. The culmination of the discourse leads to the emergence of participatory worldviews, which may manifest in three distinct forms. It is possible to integrate multiple worldviews in a mixed-method study, including the pragmatic approach,

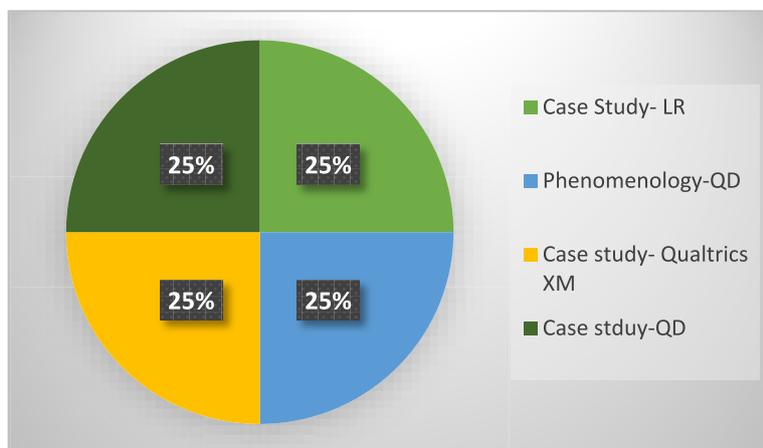


Fig. 7 The distribution of data analysis of mixed-method research with the impact of COVID-19 on food security

which facilitates the incorporation of diverse philosophical perspectives. Mixed-method because, according to the papers reviewed, this methodology is still hardly utilized, and no one has used it. Although it is hoped that using this mixed method will produce a breakthrough finding on taking the appropriate steps to overcome the food crisis occurring because of the COVID-19 pandemic, the impact will continue, as will the uncertainty regarding the future condition of our food supply.

Results and discussion of bibliometric analysis

Prominent author keyword

The network visualization map of the top 50 author keywords is depicted in Fig. 5. The term “COVID-19” exhibits the largest node size on the map, with a total of 1040 occurrences. The node with the second largest size is “food security” (*n*=550), which is succeeded by “resilience” (*n*=303), “agriculture” (*n*=265), “food insecurity” (*n*=231), and “poverty” (*n*=173). The map incorporates several pertinent keywords: sustainability, food supply chain, agricultural production, households, small farmers, and food production. However, the cumulative link strength falls below the threshold of 100.

Figure 8 indicates a dearth of research on the effects of COVID-19 on the food security of households and small-scale farmers, even though the COVID-19 pandemic had a significant impact on households in urban and rural

areas. Furthermore, the absence of the keyword “food policy” in the density visualization suggests that this term is infrequently or negligibly employed in scholarly investigations. The interplay between rural and urban households, small-scale farmers, and food policy influences the outcome. Impacts on the fundamental underpinnings of a nation’s economy. Moreover, the findings of studies about household food security in the aftermath of the COVID-19 pandemic are expected to significantly aid governmental decision-making and the formulation of food-related policies at the national level.

Change in the publication by countries

The United States continues to publish more scientific publications than any other nation (Fig. 9). Additionally, this nation has listed itself as one that actively collaborates on publications with 55 other nations and China 48 nations. The current trend in collaborative knowledge production regarding a significant issue highlights the absence of limitations in research and the proactive engagement of researchers in providing timely scientific contributions. Ten countries actively publish articles on the impact of the COVID-19 pandemic on food security.

Research topic

Figure 10 depicts a network visualization map that illustrates the terms found in the titles and abstracts of the

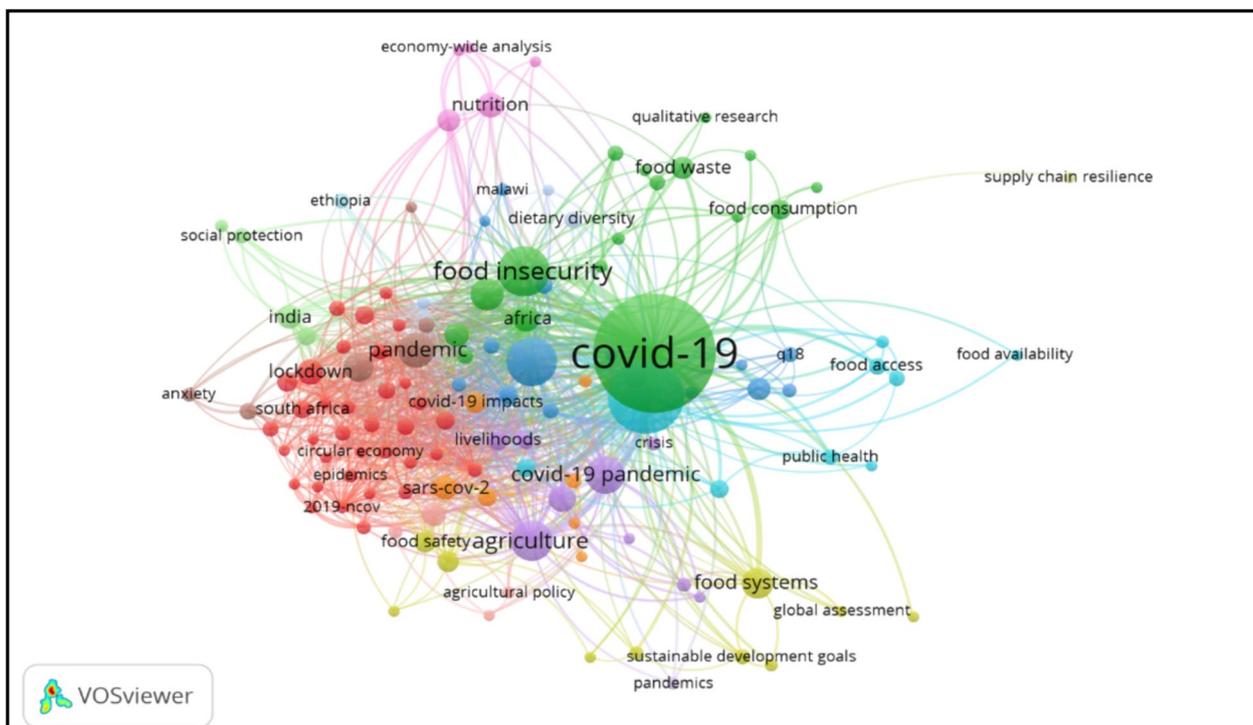


Fig. 8 Network visualization map of top 50 author keywords. The node size is proportional to the number of occurrences

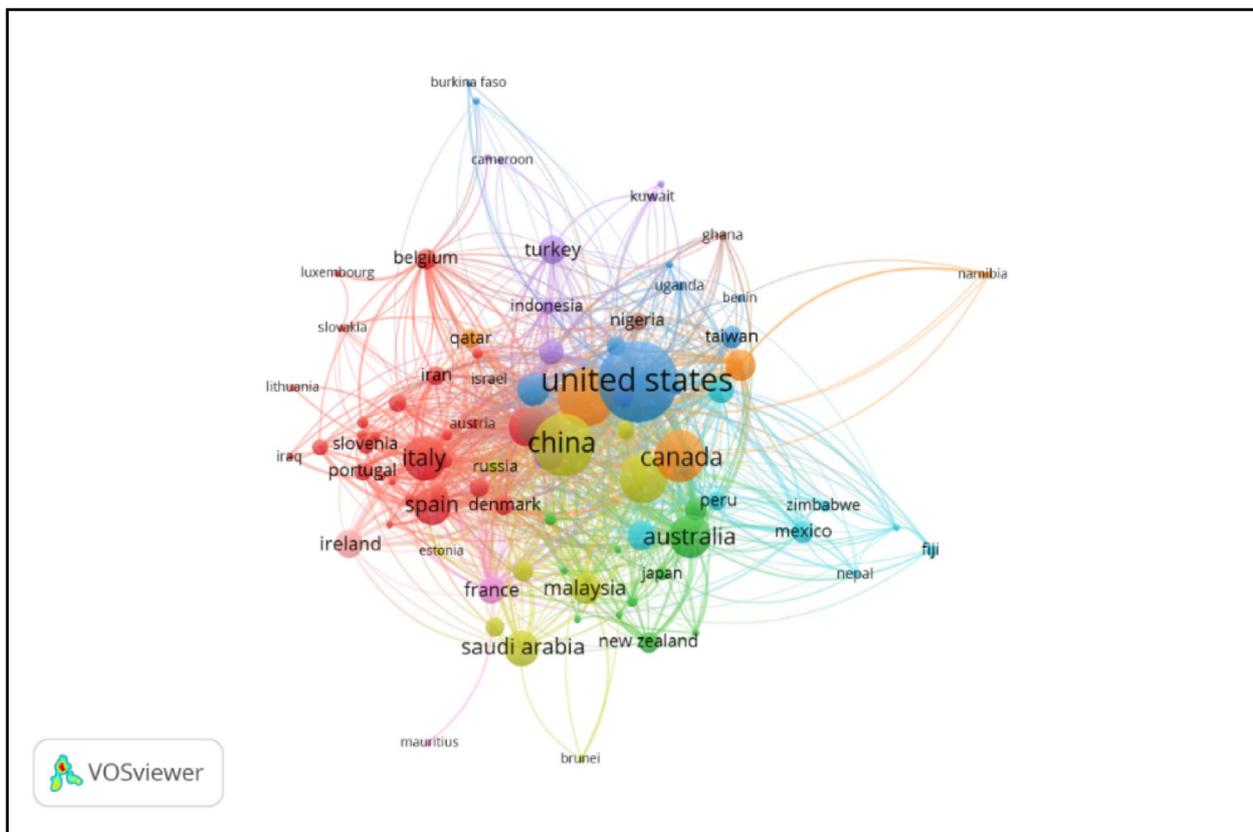


Fig. 9 Network visualization map of top 10 active countries

retrieved documents. The minimum occurrence of these terms is set at 50 times. The map encompasses 55 terms categorized into four distinct clusters, each represented by a unique color. Closely related terms are color-coded and denote different research topics or themes.

The cartographic representation displays four distinct groupings corresponding to four overarching research themes. The dominant theme, represented by the red cluster comprising 28 terms, pertains to the food supply chain, food system, resilience, and sustainability. The second research theme, denoted by the green cluster containing 14 terms, is consumption, household, income, and poverty. The third research theme, indicated by the blue cluster comprising eight terms, pertains to food insecurity, woman, and health. The fourth research theme, represented by the yellow cluster of 4 terms, is agricultural production.

Conclusion and recommendations

This study critiques scientific journals’ methodology for analyzing the COVID-19 pandemic’s influence on food security. PRISMA and bibliometric analysis were used to achieve this study’s goals. According to scientific categories, PRISMA filters scientific articles. We

then performed a systematic review and meta-analysis of 97 screened publications. The 762 selected scientific papers are described quantitatively using bibliometric analysis. The PRISMA method review found that 61% of researchers used quantitative methodologies. Qualitative approaches make up 32% and mixed methods 7%. These findings provide crucial and intriguing data for future researchers and policymakers.

Most of the quantitative research on COVID-19’s influence on food security uses standard approaches like multiple linear regression and Chi-square, which account for 20 and 17 papers, respectively. Few use complex methods like logistic regression and structural equation model. Second, 32% of articles used qualitative methods. This figure is positive for qualitative method proponents and consumers because quantitative researchers did not consider qualitative methods academic until the late 1990s. The only qualitative approaches discovered were phenomenological studies and case studies. No GTR/SE researchers have examined the COVID-19 pandemic’s impact on food security. Thirdly, COVID-19 researchers rarely use mixed methods. This is used by 3% of researchers. Mixed research approaches may give exhaustive results. It can be one way to solve pandemic concerns.

innovation, particularly for small-scale producers. Additionally, the government facilitates the establishment of food banks and enables farmers to directly access consumers by shortening the value chain through farmers' markets.

Limitations of the study

It is evident that a significant majority, approximately 80%, of the studies examining the effects of the COVID-19 pandemic on food security are freely accessible through open access platforms. The remaining 20% of articles require payment to access. We strongly encourage future authors to conduct more comprehensive article reviews by including sources from premium access, since this will enhance the overall quality of the review.

Acknowledgements

The authors thank BPPT and LPDP for their funding and Professor Dahlang Tahir, Chairman of Publication Management Center (PMC) Hasanuddin University, for his enthusiasm and encouragement.

Author contributions

KD, MS, MM, and PD contributed significantly to the review's conceptualization and writing. The final draft of the work was read and approved by all writers.

Funding

The present study received funding from the Center for Higher Education Financing (BPPT) through the Indonesia Endowment Funds for Education (LPDP) Nu. 1931/J5.2.3. /BPI.06/10/2021.

Availability of data and materials

All data presented in this manuscript are available on the Dimensions database using the search query in the "Methodology" section.

Declarations

Ethics approval and consent to participate

Not applicable. Hasanuddin University requires no approval for bibliometric and PRISMA studies.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Received: 16 May 2023 Accepted: 7 August 2024

Published online: 02 October 2024

References

1. Caferra R, Falcone PM, Morone A, et al. Is COVID-19 anticipating the future? Evidence from investors' sustainable orientation. *Eurasian Bus Rev.* 2022;12:177–96.
2. Kehinde A, Ojo T, Ogunleye A, et al. Impact of access to cash remittances on cocoa yield in Southwestern Nigeria. *Sustain Futures.* 2024;7:100168.
3. Iranmanesh M, Ghobakhloo M, Nilashi M, et al. Impacts of the COVID-19 pandemic on household food waste behaviour: a systematic review. *Appetite.* 2022;176:106127.
4. Darwis K, Salam M, Munizu M, et al. The influence of household characteristics, income, and technology access on household food security post-COVID-19 pandemic. *IOP Conf Ser Earth Environ Sci.* 2024;1364:012014.
5. Nordhagen S, Igbeka U, Rowlands H, et al. COVID-19 and small enterprises in the food supply chain: early impacts and implications for longer-term food system resilience in low- and middle-income countries. *World Dev.* 2021. <https://doi.org/10.1016/j.worlddev.2021.105405>.
6. Middendorf BJ, Faye A, Middendorf G, et al. Smallholder farmer perceptions about the impact of COVID-19 on agriculture and livelihoods in Senegal. *Agricultural.* 2021. <https://doi.org/10.1016/j.jagsy.2021.103108>.
7. O'Meara L, Turner C, Coitinho DC, et al. Consumer experiences of food environments during the Covid-19 pandemic: global insights from a rapid online survey of individuals from 119 countries. *Glob Food Sec.* 2022;32:100594.
8. Clapp J, Moseley WG. This food crisis is different: COVID-19 and the fragility of the neoliberal food security order. *J Peasant Stud.* 2020;47:1393–417.
9. Narasri P, Tantiprasoplap S, Mekwiwatanawong C, et al. Management of food insecurity in the COVID-19 pandemic: a model of sustainable community development. *Health Care Women Int.* 2020;41:1363–9.
10. Grewal D, Marmorstein H, Sharma A. Communicating price information through semantic cues: the moderating effects of situation and discount size. *J Consumer Res.* 1996;23:148–55.
11. Maredia MK, Adenikinju A, Belton B, et al. COVID-19's impacts on incomes and food consumption in urban and rural areas are surprisingly similar: evidence from five African countries. *Glob Food Secur.* 2022. <https://doi.org/10.1016/j.gfs.2022.100633>.
12. Tamru S, Hirvonen K, Minten B. Impacts of the COVID-19 crisis on vegetable value chains in Ethiopia. *IFPRI book chapters*, <https://ideas.repec.org/h/fpr/ifpric/133839.html> (2020).
13. Mueller V, Grépin KA, Rabbani A, et al. Food insecurity and COVID-19 risk in low- and middle-income countries. *Appl Econ Perspect Policy.* 2022;44:92–109.
14. Gundersen C, Hake M, Dewey A, et al. Food insecurity during COVID-19. *Appl Econ Perspect Policy.* 2021;43:153–61.
15. Fitzpatrick KM, Harris C, Drawve G, et al. Assessing food insecurity among US adults during the COVID-19 pandemic. *J Hunger Environ Nutr.* 2021;16:1–18.
16. Kang Y, Baidya A, Aaron A, et al. Differences in the early impact of COVID-19 on food security and livelihoods in rural and urban areas in the Asia Pacific Region. *Glob Food Sec.* 2021;31:100580.
17. Rezaul Karim KM, Tasnim T. Impact of lockdown due to COVID-19 on nutrition and food security of the selected low-income households in Bangladesh. *Heliyon.* 2022;8:e09368.
18. Elshahry N, Al-Sayyed H, Odeh M, et al. Effect of Covid-19 on food security: a cross-sectional survey. *Clin Nutr ESPEN.* 2020;40:171–8.
19. Nchanji EB, Lutomia CK. Regional impact of COVID-19 on the production and food security of common bean smallholder farmers in Sub-Saharan Africa: implication for SDGs. *Glob Food Sec.* 2021;29:100524.
20. Ceballos, F; Manuel, A; Cynthia P. Short-term impacts of COVID-19 on food security and nutrition in rural Guatemala.pdf.
21. Shupler M, Mwitari J, Gohole A, et al. COVID-19 impacts on household energy & food security in a Kenyan informal settlement: the need for integrated approaches to the SDGs. *Renew Sustain Energy Rev.* 2021;144:111018.
22. Bamiwuye O, Akintunde O, Jimoh L, et al. Perceived changes in food security, finances and revenue of rural and urban households during COVID-19 pandemic in Nigeria. *Agrekon.* 2022;61:282–91.
23. Vasko Z, Berjan S, El Bilali H, et al. Household food wastage in Montenegro: exploring consumer food behaviour and attitude under COVID-19 pandemic circumstances. *Br Food J.* 2022. <https://doi.org/10.1108/BFJ-01-2022-0019>.
24. Hoening JC, Huang Y, Keeble M, et al. Socioeconomic distribution of food outlet availability through online food delivery services in seven European countries: a cross-sectional study. *Health Place.* 2023;84:103135.
25. Shahzad MA, Razzaq A, Qing P, et al. Food availability and shopping channels during the disasters: has the COVID-19 pandemic changed peoples' online food purchasing behavior? *Int J Disaster Risk Reduct.* 2022;83:103443.

26. Music J, Charlebois S. Consumer perceptions about food retail and services during the first wave of COVID-19 in Canada: an exploratory study. *Cogent Soc Sci.* 2022. <https://doi.org/10.1080/23311886.2022.2072556>.
27. Ankrah DA, Agyei-Holmes A, Boakye AA. Ghana's rice value chain resilience in the context of COVID-19. *Soc Sci Human Open.* 2021;4:100210.
28. Adebayo TS, Oluwamayowa L. COVID-19 and food security as catalyst of conflict among rural households in Nigeria: a study of Ilaje community, Ondo state. *J Aggress Conf Peace Res.* 2021;13:169–85.
29. Sharma J, Tyagi M, Bhardwaj A. Exploration of COVID-19 impact on the dimensions of food safety and security: a perspective of societal issues with relief measures. *J Agribus Dev Emerg Econ.* 2021;11:452–71.
30. Alabi MO, Ngwenyama O. Food security and disruptions of the global food supply chains during COVID-19: building smarter food supply chains for post COVID-19 era. *Br Food J.* 2022. <https://doi.org/10.1108/BFJ-03-2021-0333>.
31. Adamchick J, Perez AM. Choosing awareness over fear: risk analysis and free trade support global food security. *Glob Food Sec.* 2020. <https://doi.org/10.1016/j.gfs.2020.100445>.
32. Davila F, Bourke RM, McWilliam A, et al. COVID-19 and food systems in Pacific Island Countries, Papua New Guinea, and Timor-Leste: opportunities for actions towards the sustainable development goals. *Agric Syst.* 2021. <https://doi.org/10.1016/j.agsy.2021.103137>.
33. Fan S, Teng P, Chew P, et al. Food system resilience and COVID-19—lessons from the Asian experience. *Glob Food Secur.* 2021. <https://doi.org/10.1016/j.gfs.2021.100501>.
34. Béné C, Bakker D, Chavarro MJ, et al. Global assessment of the impacts of COVID-19 on food security. *Glob Food Sec.* 2021;31:100575.
35. Nemes G, Chiffolleau Y, Zollet S, et al. The impact of COVID-19 on alternative and local food systems and the potential for the sustainability transition: insights from 13 countries. *Sustain Prod Consum.* 2021;28:591–9.
36. Priyadarshini P, Abhilash PC. Agri-food systems in India: concerns and policy recommendations for building resilience in post COVID-19 pandemic times. *Glob Food Sec.* 2021;29:100537.
37. Rahman MT, Akter S, Rana MR, et al. How COVID-19 pandemic is affecting achieved food security in Bangladesh: a perspective with required policy interventions. *J Agric Food Res.* 2022;7:100258.
38. Wang X, Zhao F, Tian X, et al. How online food delivery platforms contributed to the resilience of the urban food system in China during the COVID-19 pandemic. *Glob Food Sec.* 2022;35:100658.
39. Dowling M, Eicher M, Drury A. Experiences of cancer care in COVID-19: a longitudinal qualitative study. *Eur J Oncol Nurs.* 2022;61:102228.
40. Sharma GD, Talan G, Jain M. Policy response to the economic challenge from COVID-19 in India: a qualitative enquiry. *J Public Aff.* 2020. <https://doi.org/10.1002/pa.2206>.
41. Larson N, Alexander T, Slaughter-Acey JC, et al. Barriers to accessing healthy food and food assistance during the COVID-19 pandemic and racial justice uprisings: a mixed-methods investigation of emerging adults' experiences. *J Acad Nutr Diet.* 2021;121:1679–94.
42. Onwuegbuzie AJ, Burke JR. *The Routledge reviewer's guide to mixed methods analysis.* New York: Routledge; 2021.
43. Creswell JW, David CJ. *Research design: qualitative, quantitative, and mixed methods approaches.* USA: Sage publications; 2018.
44. Creswell JW, Clark VLP. *Designing and conducting mixed methods research—third edition.* California: Sage publications; 2018.
45. Garcia-Herrero I, Hoehn D, Margallo M, et al. On the estimation of potential food waste reduction to support sustainable production and consumption policies. *Food Policy.* 2018;80:24–38.
46. Otles S, Kartal C. Food waste valorization. In: Galanakis CM, editor. *Sustainable food systems from agriculture to industry: improving production and processing.* Amsterdam: Elsevier; 2018. p. 371–99.
47. Lin CSK, Koutinas AA, Stamatelatou K, et al. Current and future trends in food waste valorization for the production of chemicals, materials and fuels: a global perspective. *Biofuels, Bioprod Biorefin.* 2014;8:686–715.
48. Morone P, Falcone PM, Tartiu VE. Food waste valorisation: assessing the effectiveness of collaborative research networks through the lenses of a COST action. *J Clean Prod.* 2019;238:117868.
49. Lahath A, Omar NA, Ali MH, et al. Exploring food waste during the COVID-19 pandemic among Malaysian consumers: the effect of social media, neuroticism, and impulse buying on food waste. *Sustain Prod Consum.* 2021;28:519–31.
50. Bogevska Z, Berjan S, El Bilali H, et al. Exploring food shopping, consumption and waste habits in North Macedonia during the COVID-19 pandemic. *Socioecon Plann Sci.* 2022;82:101150.
51. Everitt H, van der Werf P, Seabrook JA, et al. The quantity and composition of household food waste during the COVID-19 pandemic: a direct measurement study in Canada. *Socioecon Plann Sci.* 2022;82:101110.
52. Vittuari M, Masotti M, Iori E, et al. Does the COVID-19 external shock matter on household food waste? The impact of social distancing measures during the lockdown. *Resour Conserv Recycl.* 2021;174:105815.
53. D'Adamo I, Falcone PM, Martin M, et al. A sustainable revolution: let's go sustainable to get our globe cleaner. *Sustainability.* 2020. <https://doi.org/10.3390/su12114387>.
54. Vågsholm I, Arzoomand NS, Boqvist S. Food security, safety, and sustainability—getting the trade-offs right. *Front Sustain Food Syst.* 2020. <https://doi.org/10.3389/fsufs.2020.00016>.
55. Vali-Siar MM, Roghanian E. Sustainable, resilient and responsive mixed supply chain network design under hybrid uncertainty with considering COVID-19 pandemic disruption. *Sustain Prod Consum.* 2022;30:278–300.
56. Burlea-Schiopoiu A, Ogarca RF, Barbu CM, et al. The impact of COVID-19 pandemic on food waste behaviour of young people. *J Clean Prod.* 2021;294:126333.
57. Principato L, Secondi L, Cicatiello C, et al. Caring more about food: the unexpected positive effect of the Covid-19 lockdown on household food management and waste. *Socioecon Plann Sci.* 2022;82:100953.
58. Ananda J, Karunasena GG, Pearson D. Has the COVID-19 pandemic changed household food management and food waste behavior? A natural experiment using propensity score matching. *J Environ Manage.* 2023;328:116887.
59. Morone P, Falcone PM, Imbert E, et al. Does food sharing lead to food waste reduction? An experimental analysis to assess challenges and opportunities of a new consumption model. *J Clean Prod.* 2018;185:749–60.
60. Herrera-Cuenca M, Landaeta-Jiménez M, Hernandez P, et al. Exploring food security/insecurity determinants within Venezuela's complex humanitarian emergency. *Dialogues in Health.* 2022;1:100084.
61. Cable J, Jaykus LA, Hoelzer K, et al. The impact of COVID-19 on food systems, safety, and security—a symposium report. *Ann New.* 2021. <https://doi.org/10.1111/nyas.14482>.
62. Huss M, Brander M, Kassie M, et al. Improved storage mitigates vulnerability to food-supply shocks in smallholder agriculture during the COVID-19 pandemic. *Glob Food Sec.* 2021. <https://doi.org/10.1016/j.gfs.2020.100468>.
63. Akalu LS, Wang H. Does the female-headed household suffer more than the male-headed from Covid-19 impact on food security? Evidence from Ethiopia. *J Agric Food Res.* 2023;12:100563.
64. Huss M, Brander M, Kassie M, et al. Improved storage mitigates vulnerability to food-supply shocks in smallholder agriculture during the COVID-19 pandemic. *Glob Food Sec.* 2021;28:100468.
65. Hobbs JE. Food supply chains during the COVID-19 pandemic. *Can J Agric Econ.* 2020;68:171–6.
66. Aday S, Aday MS. Impact of COVID-19 on the food supply chain. *Food Qual Safety.* 2020. <https://doi.org/10.1093/fqsafe/fyaa024>.
67. Zahir AA, Mahmud A, Islam MA, et al. COVID-19 and food supply in Bangladesh: a review. *Economics.* 2020. <https://doi.org/10.2139/ssrn.3595967>.
68. Luckstead J, Nayga RM, Heather A. Snell labor issues in the food supply chain amid the COVID-19 pandemic. *Appl Econ.* 2021. <https://doi.org/10.1002/aepp.13090>.
69. Garnett P, Doherty B, Heron T. Vulnerability of the United Kingdom's food supply chains exposed by COVID-19. *Nat Food.* 2020;1:315–8.
70. Mussell A, Bilyea T, Hedley D. Agri-food supply chains and Covid-19: balancing resilience and vulnerability. *Agri-Food Econ Syst.* 2020;519:1–6.
71. Gebeyehu DT, East L, Wark S, et al. Impact of COVID-19 on the food security and identifying the compromised food security dimension: a systematic review protocol. *PLoS ONE.* 2022. <https://doi.org/10.1371/journal.pone.0272859>.
72. Mody MA, Hanks L, Cheng M. Sharing economy research in hospitality and tourism: a critical review using bibliometric analysis, content

- analysis and a quantitative systematic literature review. *Int J Contemp Hosp Manag.* 2021;33:1711–45.
73. Štreimikienė D, Baležentis T, Volkov A, et al. Negative effects of covid-19 pandemic on agriculture: systematic literature review in the frameworks of vulnerability, resilience and risks involved. *Econ Res.* 2021. <https://doi.org/10.1080/1331677X.2021.1919542>.
 74. Prosper Bright M, Terrence Kudzai N, Ngavaite C. The impact of COVID-19 on agricultural extension and food supply in Zimbabwe. *Cogent Food Agric.* 2021. <https://doi.org/10.1080/23311932.2021.1918428>.
 75. Rasul G. Twin challenges of COVID-19 pandemic and climate change for agriculture and food security in South Asia. *Environmental Challenges.* 2021;2:100027.
 76. Workie E, Mackolil J, Nyika J, et al. Deciphering the impact of COVID-19 pandemic on food security, agriculture, and livelihoods: a review of the evidence from developing countries. *Curr Res Environ Sustain.* 2020;2:100014.
 77. Kaicker N, Gupta A, Gaiha R. Covid-19 pandemic and food security in India: can authorities alleviate the disproportionate burden on the disadvantaged? *J Policy Model.* 2022. <https://doi.org/10.1016/J.JPOLMOD.2022.08.001>.
 78. Mora AM, Lewnard JA, Rauch S, et al. Impact of COVID-19 pandemic on California farmworkers' mental health and food Security. *J Agromedicine.* 2022;27:303–14.
 79. Sharma R, Shishodia A, Kamble S, et al. Agriculture supply chain risks and COVID-19: mitigation strategies and implications for the practitioners. *Int J Logist Res Appl.* 2020. <https://doi.org/10.1080/13675567.2020.1830049>.
 80. Ben Hassen T, El Bilali H. Impacts of the COVID-19 pandemic on food security and food consumption: preliminary insights from the gulf cooperation council region. *Cogent Soc Sci.* 2022. <https://doi.org/10.1080/23311886.2022.2064608>.
 81. Rukasha T, Nyagadza B, Pashapa R, et al. Covid-19 impact on Zimbabwean agricultural supply chains and markets: a sustainable livelihoods perspective. *Cogent Soc Sci.* 2021. <https://doi.org/10.1080/23311886.2021.1928980>.
 82. Armstrong B, Reynolds C, Martins CA, et al. Food insecurity, food waste, food behaviours and cooking confidence of UK citizens at the start of the COVID-19 lockdown. *Br Food J.* 2021;123:2959–78.
 83. Güney OI, Sangün L. How COVID-19 affects individuals' food consumption behaviour: a consumer survey on attitudes and habits in Turkey. *Br Food J.* 2021;123:2307–20.
 84. Thanh PT, The Duy D, Bao DP. Disruptions to agricultural activities, income loss and food insecurity during the COVID-19 pandemic: evidence from farm households in a developing country. *J Agribus Dev Emerg Econ.* 2022;12:531–47.
 85. Kansiime MK, Tambo JA, Mugambi I, et al. COVID-19 implications on household income and food security in Kenya and Uganda: findings from a rapid assessment. *World Dev.* 2021;137:105199.
 86. Ceballos F, Kannan S, Kramer B. Crop prices, farm incomes, and food security during the COVID-19 pandemic in India: phone-based producer survey evidence from Haryana State. *Agric Econ.* 2021;52:525–42.
 87. Nicola M, Alsaifi Z, Sohrabi C, et al. The socio-economic implications of the coronavirus pandemic (COVID-19): a review. *Int J Surg.* 2020;78:185–93.
 88. Snow V, Rodriguez D, Dynes R, et al. Resilience achieved via multiple compensating subsystems: the immediate impacts of COVID-19 control measures on the agri-food systems of Australia and New Zealand. *Agric Syst.* 2021;187:103025.
 89. Ouoba Y, Sawadogo N. Food security, poverty and household resilience to COVID-19 in Burkina Faso: evidence from urban small traders' households. *World Dev Perspect.* 2022. <https://doi.org/10.1016/j.wdp.2021.100387>.
 90. Levy TM, Williams RD, Odum M, et al. Impact of COVID-19 stress on food insecurity and fruit and vegetable consumption among college students. *J Am College Health.* 2022. <https://doi.org/10.1080/07444841.2022.2098033>.
 91. Ko YH, Son JH, Kim GJ. An exploratory study of changes in consumer dining out behavior before and during COVID-19. *J Foodserv Bus Res.* 2022. <https://doi.org/10.1080/15378020.2022.2036569>.
 92. Gbashi S, Adebo O, Adebiji JA, et al. Food safety, food security and genetically modified organisms in Africa: a current perspective. *Biotechnol Genet Eng Rev.* 2021;37:30–63.
 93. Burrone S, Dingacci G, Dia M, et al. The role of staple crop production during the Covid-19 outbreak. Evidence for women small producers in Senegal. *Appl Econ.* 2022. <https://doi.org/10.1080/00036846.2022.2108749>.
 94. Tabe-Ojong MP, Gebrekidan BH, Nshakira-Rukundo E, et al. COVID-19 in rural Africa: food access disruptions, food insecurity and coping strategies in Kenya, Namibia, and Tanzania. *Agric Econ.* 2022. <https://doi.org/10.1111/agec.12709>.
 95. Guo S, Liu S, Xu J, et al. A quantitative evaluation model for biodegraded reservoirs based on multinomial logistic regression. *Geoenergy Sci Eng.* 2023;227:211923.
 96. Cardwell R, Ghazalian PL. COVID-19 and international food assistance: policy proposals to keep food flowing. *World Dev.* 2020;135:105059.
 97. Nchanji EB, Lutomia CK. Regional impact of COVID-19 on the production and food security of common bean smallholder farmers in Sub-Saharan Africa: implication for SDG's. *Glob Food Sec.* 2021. <https://doi.org/10.1016/j.gfs.2021.100524>.
 98. O'Meara L, Turner C, Coitinho DC, et al. Consumer experiences of food environments during the Covid-19 pandemic: global insights from a rapid online survey of individuals from 119 countries. *Glob Food Sec.* 2022. <https://doi.org/10.1016/j.gfs.2021.100594>.
 99. Ahmed JU, Akter S, Majumder KA. Impact of COVID-19 on agricultural production and distribution in South Asia. *World Food Policy.* 2021;7:168–82.
 100. Lenton TM, Boulton CA, Scheffer M. Resilience of countries to COVID-19 correlated with trust. *Sci Rep.* 2022. <https://doi.org/10.1038/s41598-021-03358-w>.
 101. Henrici J, Ju A. Wuhan household food provisioning under blockaded COVID-19 lockdown. *Cult Agric Food Environ.* 2021;43:96–106.
 102. Hirvonen K, de Brauw A, Abate GT. Food consumption and food security during the COVID-19 pandemic in Addis Ababa. *Am J Agric Econ.* 2021;103:772–89.
 103. Laborde D, Martin W, Vos R. Impacts of COVID-19 on global poverty, food security, and diets: Insights from global model scenario analysis. *Agric Econ.* 2021;52:375–90.
 104. Crush J, Si Z. COVID-19 containment and food security in the global South. *J Agric Food Syst Commun Dev.* 2020;9:1–3.
 105. Birner R, Blaschke N, Bosch C, et al. 'We would rather die from Covid-19 than from hunger'—exploring lockdown stringencies in five African countries. *Glob Food Sec.* 2021. <https://doi.org/10.1016/j.gfs.2021.100571>.
 106. Alvi M, Barooah P, Gupta S, et al. Women's access to agriculture extension amidst COVID-19: insights from Gujarat, India and Dang, Nepal. *Agric Syst.* 2021. <https://doi.org/10.1016/j.agsy.2020.103035>.
 107. Krauss JE, Artur L, Brockington D, et al. 'To prevent this disease, we have to stay at home, but if we stay at home, we die of hunger'—livelihoods, vulnerability and coping with Covid-19 in rural Mozambique. *World Dev.* 2022. <https://doi.org/10.1016/j.worlddev.2021.105757>.
 108. Yetkin Özbük RM, Coşkun A, Filimonau V. The impact of COVID-19 on food management in households of an emerging economy. *Socioecon Plann Sci.* 2021. <https://doi.org/10.1016/j.seps.2021.101094>.
 109. Nekomahmud M. Food consumption behavior, food supply chain disruption, and food security crisis during the COVID-19: the mediating effect of food price and food stress. *J Foodserv Bus Res.* 2022. <https://doi.org/10.1080/15378020.2022.2090802>.
 110. Amin F, Poespito Hadi W, Zauhar S, et al. Determinants of post COVID-19 food security policy success. *Int J Disaster Resil Built Environ.* 2022;13:440–50.
 111. Adamchick J, Perez AM. Choosing awareness over fear: risk analysis and free trade support global food security. *Glob Food Sec.* 2020;26:100445.
 112. Acosta A, McCorryon S, Nicolli F, et al. Immediate effects of COVID-19 on the global dairy sector. *Agric Syst.* 2021. <https://doi.org/10.1016/j.agsy.2021.103177>.
 113. Priyadarshini P, Abhilash PC. Agri-food systems in India: concerns and policy recommendations for building resilience in post COVID-19 pandemic times. *Glob Food Sec.* 2021. <https://doi.org/10.1016/j.gfs.2021.100537>.

114. Orden D. Agrifood markets and support in the United States after 1 year of COVID-19 pandemic. *Can J Agric Econ.* 2021;69:243–9.
115. Swinnen J, Vos R. COVID-19 and impacts on global food systems and household welfare: Introduction to a special issue. *Agric Econ.* 2021;52:365–74.
116. Jablonski BBR, Casnovsky J, Clark JK, et al. Emergency food provision for children and families during the COVID-19 pandemic: examples from five U.S. Cities. *Appl Econ Perspect Policy.* 2021;43:169–84.
117. Deaton BJ, Deaton BJ. Food security and Canada's agricultural system challenged by COVID-19. *Cand J Agr Econ.* 2020;68:143–9.
118. Hobbs JE. Food supply chains during the COVID-19 pandemic. *Can J Agric Econ.* 2020. <https://doi.org/10.1111/cjag.12237>.
119. Deconinck K, Avery E, Jackson LA. Food supply chains and Covid-19: impacts and policy lessons. *EuroChoices.* 2020;19:34–9.
120. Cranfield JAL. Framing consumer food demand responses in a viral pandemic. *Can J Agric Econ.* 2020;68:151–6.
121. Panghal A, Mor RS, Kamble SS, et al. Global food security post COVID-19: dearth or dwell in the developing world? *Agron J.* 2022;114:878–84.
122. Thilmany D, Canales E, Low SA, et al. Local food supply chain dynamics and resilience during COVID-19. *Appl Econ Perspect Policy.* 2021;43:86–104.
123. Agyei-Holmes A, Ankrah DA, Boakye AA. COVID-19 and Ghana's agri-food system: an assessment of resilience. *Afr Geogr Rev.* 2021. <https://doi.org/10.1080/19376812.2021.1971096>.
124. Wegerif M. The impact of Covid-19 on black farmers in South Africa. *Agrekon.* 2022;61:52–66.
125. Susetyarini E, Fauzi A. Trend of critical thinking skill researches in biology education journals across Indonesia: from research design to data analysis. *Int J Instr.* 2020;13:535–50.
126. Amare M, Abay KA, Tiberti L, et al. COVID-19 and food security: panel data evidence from Nigeria. *Food Policy.* 2021. <https://doi.org/10.1016/j.foodpol.2021.102099>.
127. Cresswell JW, Poth CN. *Qualitative inquiry & research design.* USA: Sage publications; 2018.
128. Faghih N. *Socioeconomic dynamics of the COVID-19 crisis global, regional, and local perspectives.* Switzerland: Springer; 2022.
129. Cappelli A, Cini E. Will the COVID-19 pandemic make us reconsider the relevance of short food supply chains and local productions? *Trends Food Sci Technol.* 2020;99:566–7.
130. Borman GD, de Boef WS, Dirks F, et al. Putting food systems thinking into practice: integrating agricultural sectors into a multi-level analytical framework. *Glob Food Sec.* 2022. <https://doi.org/10.1016/j.gfs.2021.100591>.
131. Brück T, Regassa MD. Usefulness and misrepresentation of phone surveys on COVID-19 and food security in Africa. *Food Secur.* 2022. <https://doi.org/10.1007/s12571-022-01330-8>.
132. Jaacks LM, Veluguri D, Serupally R, et al. Impact of the COVID-19 pandemic on agricultural production, livelihoods, and food security in India: baseline results of a phone survey. *Food Secur.* 2021. <https://doi.org/10.1007/s12571-021-01164-w/Published>.
133. Karmaker CL, Ahmed T, Ahmed S, et al. Improving supply chain sustainability in the context of COVID-19 pandemic in an emerging economy: exploring drivers using an integrated model. *Sustain Prod Consum.* 2021;26:411–27.
134. Headey D, Goudet S, Lambrecht I, et al. Poverty and food insecurity during COVID-19: phone-survey evidence from rural and urban Myanmar in 2020. *Glob Food Sec.* 2022. <https://doi.org/10.1016/j.gfs.2022.100626>.
135. Kansiime MK, Tambo JA, Mugambi I, et al. COVID-19 implications on household income and food security in Kenya and Uganda: findings from a rapid assessment. *World Dev.* 2021. <https://doi.org/10.1016/j.worlddev.2020.105199>.
136. Ceballos F, Kannan S, Kramer B. Impacts of a national lockdown on smallholder farmers' income and food security: empirical evidence from two states in India. *World Dev.* 2020. <https://doi.org/10.1016/j.worlddev.2020.105069>.
137. Rengarajan S, Narayanamurthy G, Moser R, et al. Data strategies for global value chains: hybridization of small and big data in the aftermath of COVID-19. *J Bus Res.* 2022;144:776–87.
138. Aldaco R, Hoehn D, Laso J, et al. Food waste management during the COVID-19 outbreak: a holistic climate, economic and nutritional approach. *Sci Total Environ.* 2020;742:140524.
139. Dekkinga P, van der Horst H, Andriessen T. "Too big to fail": the resilience and entrenchment of food aid through food banks in the Netherlands during the COVID-19 pandemic. *Food Secur.* 2022;14:781–9.
140. Charmaz K. *Constructing grounded theory: a practical guide through qualitative analysis.* Thousand Oaks: Sage Publications; 2006.
141. Balana BB, Ogunniyi A, Oyeyemi M, et al. COVID-19, food insecurity and dietary diversity of households: survey evidence from Nigeria. *Food Secur.* 2023;15:219–41.
142. Fang D, Thomsen MR, Nayga RM, et al. Food insecurity during the COVID-19 pandemic: evidence from a survey of low-income Americans. *Food Secur.* 2021. <https://doi.org/10.1007/s12571-021-01189-1/Published>.
143. John-Henderson NA, Oosterhoff BJ, Johnson LR, et al. COVID-19 and food insecurity in the Blackfeet tribal community. *Food Secur.* 2022;14:1337–46.
144. Middendorf BJ, Traoré H, Middendorf G, et al. Impacts of the COVID-19 pandemic on vegetable production systems and livelihoods: smallholder farmer experiences in Burkina Faso. *Food Energy Secur.* 2022. <https://doi.org/10.1002/fes3.337>.
145. Mahajan K, Tomar S. COVID-19 and supply chain disruption: evidence from food markets in India†. *Am J Agric Econ.* 2021;103:35–52.
146. Ceballos F, Hernandez MA, Paz C. Short-term impacts of COVID-19 on food security and nutrition in rural Guatemala: phone-based farm household survey evidence. *Agric Econ.* 2021;52:477–94.
147. Akter S. The impact of COVID-19 related 'stay-at-home' restrictions on food prices in Europe: findings from a preliminary analysis. *Food Secur.* 2020;12:719–25.
148. Popescu GC, Popescu M. COVID-19 pandemic and agriculture in Romania: effects on agricultural systems, compliance with restrictions and relations with authorities. *Food Secur.* 2022;14:557–67.
149. Wang E, An N, Gao Z, et al. Consumer food stockpiling behavior and willingness to pay for food reserves in COVID-19. *Food Secur.* 2020. <https://doi.org/10.1007/s12571-020-01092-1/Published>.
150. Falcone PM, Imbert E. Bringing a sharing economy approach into the food sector: the potential of food sharing for reducing food waste. In: Morone P, Papendiek F, Tartiu VE, editors. *Food waste reduction and valorisation: sustainability assessment and policy analysis.* Cham: Springer International Publishing; 2017. p. 197–214.
151. Allahyari MS, Marzban S, El Bilali H, et al. Effects of COVID-19 pandemic on household food waste behaviour in Iran. *Heliyon.* 2022;8:e11337.
152. Theodoridis PK, Zacharatos TV. Food waste during Covid- 19 lockdown period and consumer behaviour—the case of Greece. *Socioecon Plann Sci.* 2022;83:101338.
153. Laila A, von Massow M, Bain M, et al. Impact of COVID-19 on food waste behaviour of families: results from household waste composition audits. *Socioecon Plann Sci.* 2022;82:101188.
154. Kamal H, Habib HM, Ali A, et al. Food waste valorization potential: fiber, sugar, and color profiles of 18 date seed varieties (*Phoenix dactylifera*, L.). *J Saudi Soc Agric Sci.* 2023;22:133–8.
155. Kumar S, Konwar J, Das PM, et al. Current progress in valorization of food processing waste and by-products for pectin extraction. *Int J Biol Macromol.* 2023;239:124332.
156. Fan S, Teng P, Chew P, et al. Food system resilience and COVID-19—lessons from the Asian experience. *Glob Food Sec.* 2021. <https://doi.org/10.1016/j.gfs.2021.100501>.
157. Rao M, Bast A, de Boer A. How COVID-19 impacted surplus food redistribution in the Netherlands: an explorative study. *Food Secur.* 2022;14:1377–85.
158. Zhan Y, Chen KZ. Building resilient food system amidst COVID-19: responses and lessons from China. *Agric Syst.* 2021. <https://doi.org/10.1016/j.jagsy.2021.103102>.
159. Kuckartz U, Rädiker S. *Analyzing qualitative data with MAXQDA.* Berlin: Springer International Publishing; 2019.
160. Stephens E, Timsina J, Martin G, et al. The immediate impact of the first waves of the global COVID-19 pandemic on agricultural systems worldwide: reflections on the COVID-19 special issue for agricultural systems. *Agric Syst.* 2022;201:103436.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.