Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Impacts of the COVID-19 pandemic on household food waste behaviour: A systematic review

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ABSTRACT

Food waste has adverse economic, social, and environmental impacts and increases the prevalence of food insecurity. Panic buying at the beginning of the COVID-19 outbreak raised serious concerns about a potential rise in food waste levels and higher pressure on waste management systems. This article aims to investigate the impact of COVID-19 on food waste behaviour and the extent to which it occurs using the systematic review method. A total of 38 articles were identified and reviewed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The findings showed that the COVID-19 pandemic led to reductions in household food waste in most countries. Several changes in shopping and cooking behaviours, food consumption, and managing inventory and leftovers have occurred due to COVID-19. Based on these insights, we predicted that some desirable food-management habits would be retained, and others would roll back in the post-COVID-19 world. The review contributes to the food waste literature by offering a comprehensive overview of behavioural changes during the COVID-19 pandemic and future research directions.

1. Introduction

Food waste is a fast-growing global issue with adverse environmental, social, and economic impacts (Amicarelli & Bux, 2021). Around one-third of produced food never reaches a human stomach and is wasted (FAO, 2019). Nearly 1.3 billion tons of food are wasted every year, costing the global economy around the US $2.6 trillion and accounting for 8% of global greenhouse gas emissions (Massari et al., 2021). The 821 million people affected by famine could be fed four times over with the avoidable food wastage worldwide (FAO, 2019). Providing a sustainable food system and ending food insecurity are among the main challenges of global sustainable development, which are related to Goal 2, "Zero Hunger", and Goal 12, "Responsible Consumption and Production" from the United Nations (UN) Sustainable Development Goals (SDGs) (United Nations, 2015). It is crucial to decrease food waste in order to reduce its adverse environmental, economic, and social consequences.

As household food waste forms a substantial proportion of food waste (Haque et al., 2021; Setti et al., 2018), reducing waste at the household level is crucial and has received attention from scholars and practitioners over the past few years. Food waste is a consequence of poor food-management behaviours and habits, such as planning, purchasing, cooking, eating, storing, and managing leftovers (Berjan et al., 2021). Recent studies have reported that the COVID-19 pandemic has changed daily routines, eating habits, and household food management behaviours (Özbük et al., 2021; Scacchi et al., 2021). COVID-19 could either increase household food waste due to panic buying and online food shopping (Li et al., 2022; Roe et al., 2021) or reduce food waste as a

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consequence of better food planning and management or the development of cooking skills (Özbük et al., 2021; Vittuari et al., 2021). Studies on the impact of COVID-19 on household food waste have also reported contradictory results. Although Amicarelli and Bux (2021) and Burlea-Schiopoiu et al. (2021) reported reductions in household food waste during COVID-19 in Italy and Romania, Berjan et al. (2021) and Liu et al. (2021) reported higher amounts of food waste in Serbia and Thailand. The impacts of COVID-19 on the amount of food wasted depends on various socio-demographic (e.g., household size and the number of children), socio-economic (e.g., income loss, governmental restrictions), behavioural (e.g., developing cooking skills, better meal planning, more efficient stocking), psychological (e.g., depression, fear, stress), situational (e.g., individuals' available time), and cultural (e.g., eating at a restaurant) factors (Everitt et al., 2021; Özbük et al., 2021; Qian et al., 2020). Accordingly, the impact of COVID-19 on food waste behaviour probably differs from one country to another. This review aims to offer a comprehensive overview of the linkage between COVID-19, changes in food-related behaviours, and ultimate food waste generation. The study synthesises research findings to answer the following research questions:

- What are the impacts of COVID-19 on household food waste behaviours?
- How has COVID-19 changed household food waste behaviours?

This review contributes to the literature by exploring and describing how COVID-19 has changed food waste behaviours. Such contribution enables us to discuss what changes in household behaviours may persist after the COVID-19 pandemic. Furthermore, future research trends are proposed based on recent findings in the literature. A better understanding of the association between COVID-19 and households' food management behaviours will enable policymakers to act more appropriately and design effective and efficient policy interventions to maintain the favourable influences of COVID-19 on food waste behaviours and mitigate their undesirable impacts.

2. Systematic review protocol

The present research applies the systematic review approach to synthesise the literature on the impact of COVID-19 on household food waste behaviours and provides directions for policymakers and future scholars. Systematic reviews are conducted based on pre-defined search and eligibility criteria that minimize bias in article identification and selection, synthesising the literature, and reporting the outcomes (Moher et al., 2015). The systematic review enables us to reach a clear conclusion on the association between the COVID-19 pandemic and food waste behaviours (Bond, 2020). This systematic review was conducted and reported following the standard requirements outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009, 2015). The PRISMA protocol is the most commonly used guidance and explicit plan for systematic reviews: it aims to minimize biases in source article selection and content analysis (Rethlefsen et al., 2021; Xiao & Watson, 2019). The process of the systematic review is elaborated in the following sections.

2.1. Database and search terms

The articles published on the impacts of the COVID-19 pandemic on household food waste behaviours were extracted from the SCOPUS database, which is regarded as one of the largest and most extensive sources, covering more articles than other databases, such as Web of Science (Pham et al., 2021; Wolfenden et al., 2016). Sahu et al. (2020) argued that SCOPUS covers 95% of peer-reviewed multidisciplinary research articles. The search terms were selected by reviewing articles on the effect of COVID-19 on food waste generation and household food behaviours (e.g., Lahath et al., 2021; Laila et al., 2021). Furthermore, the authors reviewed the search terms that have been used in extant review articles on household food waste to ensure that appropriate search terms were selected for this study (e.g., Schanes et al., 2018). Accordingly, keywords related to food (Food OR Agri*) AND COVID-19 (COVID OR SARS-COV2 OR SARS-COV-2 OR 2019-nCOV OR CORONAVIRUS) AND waste (Wast* OR Sustainable OR Green) AND household (People OR Customer* OR Consumer* OR Young OR Famil* OR Household*) were used to search the titles, abstracts, and keywords of articles in the Scopus database in November 2021.

2.2. Article inclusion and exclusion criteria

The following inclusion and exclusion criteria were applied to select relevant articles: 1) journal and article, 2) written in English, 3) articles on the impacts of COVID-19 on the amount of food waste, 4) articles that elaborated on the changes in household food waste behaviours, and 5) articles that investigated the factors that cause changes in food waste behaviours. By limiting our search to journals, we excluded book series and conference proceedings. Furthermore, we excluded conference papers, book chapters, data papers, notes, short surveys, and editorials by limiting the search to articles. The search was limited to articles because they have been peer-reviewed. Inclusion criteria 3, 4, and 5 enabled us to find articles that were relevant to the objectives of this review. Fig. 1 demonstrates the steps involved in article selection, which were developed based on the PRISMA standard guidelines (PRISMA, 2022).

2.3. Search results

By searching the SCOPUS database using the selected search terms, we found 342 articles. After limiting the search to articles, journals, and the English language, we reached 243 articles. Two authors screened the articles using inclusion and exclusion criteria and removed 182 articles based on their titles and abstracts and 23 articles after reading the full text. Finally, 38 eligible articles remained and were reviewed in this study. Any disagreements between the authors who screened the articles were resolved by consensus after discussion among all the authors.

3. Descriptive analysis

A descriptive analysis of the geographical distribution of eligible articles illustrates that most of the studies were conducted in Europe, North America, and Asia (Table 1). The influence of COVID-19 on food waste behaviour has received the most significant attention in Italy. Surprisingly, no study has been conducted in Oceania.

Most of the studies were quantitative (Table 2). Limited studies have used mixed-method (13.2%) or qualitative approaches (2.6%). Interviewing customers and experts may provide first-hand insights into the factors that cause changes in food waste behaviour and the likelihood of changes in the future.

The studies used various methods to measure household food waste. Table 3 provides an overview of measurement methodologies, sample sizes, and data collection dates. Most studies used surveys to collect data, particularly on food waste recall. However, many scholars have argued that the use of surveys to measure food waste is subject to social desirability and recall biases (Elimelech et al., 2019; Everitt et al., 2021). In the self-reported survey approach, the participants completed the survey by recalling their food waste behaviours and amounts of food wasted. Although self-reported surveys represent a cost-effective approach, as the participants estimate their own food waste amounts, this approach is not accurate and is subject to recall bias. Furthermore, the respondents may report less food waste to present a positive image, which is called social desirability bias (Delley & Brunner, 2018). van Herpen et al. (2019) compared five methods of measuring food waste (surveys, pre-announced surveys about a specific time period, kitchen caddies, photo coding, and diaries). They found that surveys had the lowest validity and underestimated the amount of food wasted. As such,

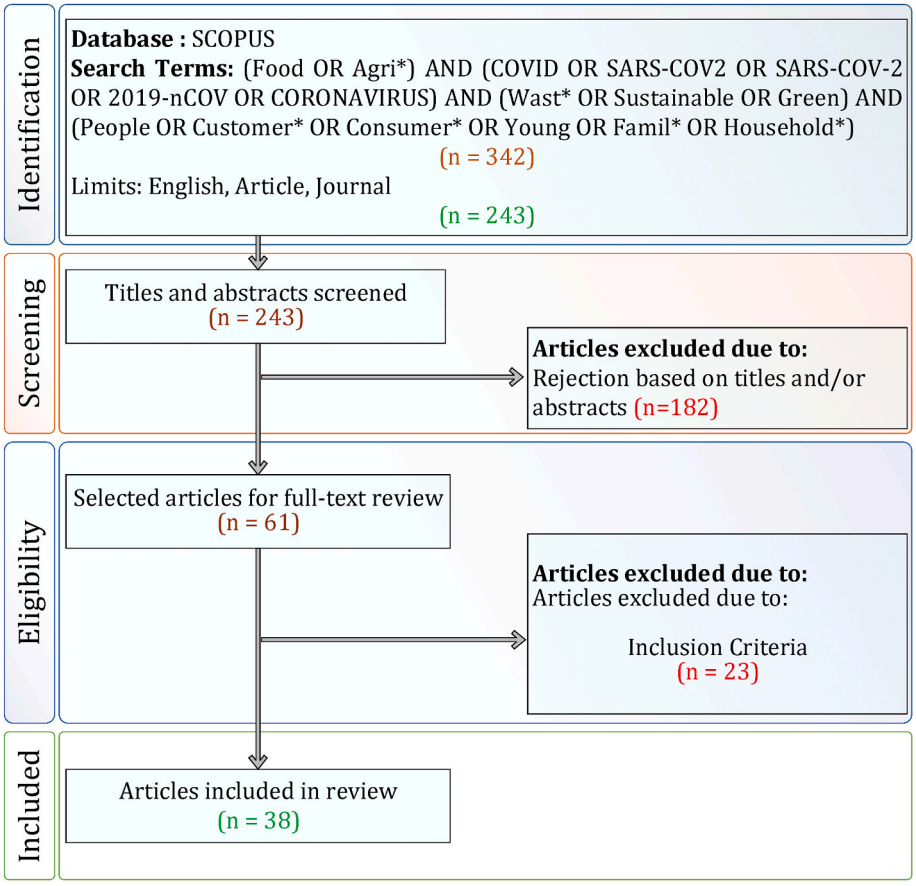

Fig. 1. Flow diagram of the article search and selection process.

Table 1
Geographical location of data collection.

Continent	No. of Articles	Countries	No. of Articles
Europe	20	Italy	7
		UK	3
		Spain	2
		Germany	1
		Portugal	1
		Romania	1
		Russia	1
		Turkey	1
		Serbia	1
		Czech Republic	1
		Bosnia	1
North America	8	US	5
		Canada	2
		Mexico	1
Asia	6	Malaysia	1
		Thailand	1
		Japan	1
		China	1
		Lebanon	1
		Qatar	1
South America	3	Brazil	2
		Peru	1
Africa	1	Tunisia	1
More than one Continents	2	More than 10 Countries	2

Note. Three studies were conducted across two countries (Cequea et al., 2021; Everitt et al., 2021; Rodgers et al., 2021).

Table 2
Research design.

Research Design	No. of Articles (%)	Percentage (%)
Qualitative	1	2.6
Quantitative	33	86.8
Mixed-Method	4	10.5

the findings of survey-based studies should be interpreted with caution. Four studies used secondary sources of data to measure food waste. These studies assessed food waste at a national level instead of a household level and relied on assumptions that lack accuracy (van Herpen et al., 2019). Household food waste is calculated as a proportion of the national food waste based on government estimates and historical data. Estimating household food waste using proportional assumptions is not accurate, as there is no observation of food waste amounts at the household level (Withanage et al., 2021). Furthermore, the secondary data may be outdated. Only four studies used food dairy approaches to estimate household food waste. Amicarelli and Bux (2021) and Laila et al. (2021) asked their respondents to audit and report their own food waste. According to Everitt et al. (2021), self-reporting diaries are also subject to social desirability bias. Kubíčková et al. (2021) and Everitt et al. (2021) were the only studies that collected and measured food waste. Although measuring food waste through direct collection is costly and time-consuming, the approach has high accuracy, as it does not rely on self-reported amounts (Withanage et al., 2021).

4. Thematic analysis

The lockdowns imposed by governments to control the spread of COVID-19 raised concern about their impacts on household food waste

Table 3
Methodology of studies on household food waste.

Study	Region	Measurement Methodology	Sample Size	Time of Data Collection
Li et al. (2022)	China	Survey	1006 consumers	June 2020
Vittuari et al. (2021)	Italy	Survey	1500 Consumers	May 2020
Kubíčková et al. (2021)	Czech	Food Diaries, Survey and Interviews	900 households	Summer 2019 – Spring 2020
Lahath et al. (2021)	Malaysia	Survey	274 consumers	April–May 2020
Hassen et al. (2021a)	Russia	Survey	1297 consumers	October–November 2020
Babbitt et al. (2021)	USA	Survey	300 consumers	March–July 2020
Armstrong et al. (2021)	UK	Survey	473 consumers	March 2020
Brzustewicz and Singh (2021)	No Specific Country	Secondary Data	13,635 Tweets	July 2021
Liu et al. (2021)	Thailand	Survey	222 Consumers	June 2020
Hassen et al. (2021)	Bosnia	Survey	3133 Consumers	October–November 2020
Filho et al. (2021)	23 Countries	Survey	204 consumers	August–November 2020
Cequea et al. (2021)	Peru and Brazil	Survey	418 consumers	May 2020
Scharadin et al. (2021)	USA	Secondary Data	Not Applicable	Not Mentioned
Rodgers et al. (2021)	USA and Italy	Survey	478 consumers (USA) 476 consumers (Italy)	April 2020
Burlea-Schiopoiu et al. (2021)	Romania	Survey	375 Students	Not mentioned
Schmitt et al. (2021)	Brazil	Survey	458 consumers	May 2020
Vidal-mones et al. (2021)	Spain	Survey	6293 consumers	May–June 2020
Roe and Bender (2021)	Not Applicable	Review	Not Applicable	Not Applicable
Scacchi et al. (2021)	Italy	Survey	1865 consumers	May 2020
Cosgrove et al. (2021)	USA	Survey	946 consumers	October 2020
Amicarelli and Bux (2021)	Italy	Food Diaries	15 households	March–May 2020
Laila et al. (2021)	Canada	Survey, Food Diaries, and Interviews	19 households	February–March 2020 and July–August 2020
Berjan et al. (2021)	Serbia	Survey	1212 consumers	May–June 2020
Massari et al. (2021)	No Specific Country	Secondary Data	Not Applicable	Not mentioned
Profeta et al. (2021)	Germany	Survey	973 consumers	April 2020
Bender et al. (2021)	USA	Survey	396 consumers	July 2020
Filimonau et al. (2021)	UK	Survey and Interviews	205 consumers	June–July 2020
Amicarelli et al. (2021)	Italy	Survey	831 consumers	November 2020
Everitt et al. (2021)	UK and Canada	Food Diaries	100 households	June 2020
Yetkin Özbük et al. (2021)	Turkey	Survey	511 consumers	January 2021
Hassen et al. (2021b)	Lebanon	Survey	201 consumers	July–August 2020
Vargas-Lopez et al. (2021)	Mexico	Survey	538 households	December 2020–January 2021
Pappalardo et al. (2020)	Italy	Survey	1188 consumers	April 2020
Qian et al. (2020)	Japan	Survey	1959 consumers	July 2020
Aldaco et al. (2020)	Spain	Secondary Data	Not Applicable	March–April 2019
Hassen et al. (2020)	Qatar	Survey	579 consumers	May–June 2020
Jribi et al. (2020)	Tunisia	Survey	284 Consumers	March–April 2020
Pires et al. (2020)	Portugal	Survey	841 consumers	May–June 2020
Principato et al. (2020)	Italy	Survey	1078 Consumers	March–April 2020

and the potential of adding pressure to food waste management systems. Surprisingly, among 27 studies that reported household food waste during the pandemic, only four found higher household food waste production than before COVID-19. Studies conducted in Italy, Russia, the US, Bosnia, Romania, Spain, Canada, Germany, Turkey, Lebanon, Mexico, Japan, Qatar, Tunisia, and Portugal all reported less food waste (e.g., Babbitt et al., 2021; Profeta et al., 2021; Vittuari et al., 2021). However, studies conducted in Thailand (Liu et al., 2021), Serbia (Berjan et al., 2021), and the UK (Filimonau et al., 2021), and one international study in 23 countries (Filho et al., 2021) found an increase in food waste. Most of these studies relied on self-reported food waste (Table 3), which is subject to bias, so their results should be interpreted with caution. The influence of the COVID-19 lockdowns on food waste in different households was varied. For instance, in Hassen et al. (2020) study on Qataris, 44.81% of the respondents indicated reductions in food waste during the pandemic, while 41.6% indicated no change in the amount of food waste. How COVID-19 lockdowns influenced food waste, and why they caused reductions in food waste in some countries and households, but increased food waste in others, are complex questions, as many factors play a role. The following sections summarize influential factors and their impact on household food waste.

4.1. Personal development and behavioural change factors

The COVID-19 pandemic has changed customers' purchasing, consumption, and food management behaviours. These behavioural shifts have had both positive and negative influences on household food waste generation. Table 4 provides a list of behavioural and personal changes caused by the pandemic. These changes are interrelated. For instance, a reduction in shopping frequency has caused an increase in online shopping, using leftovers, meal planning, purchasing in bulk, and stockpiling. The changes that have been discussed in the literature are elaborated on below.

4.1.1. Panic buying

Panic buying is a typical human response to crisis and uncertainty (Hassen et al., 2021b). Customers react to fear of running out of food by panic buying, which gives them a sense of control through food acquisition (Qian et al., 2021). Panic buying can cause supply shortage, price inflation, and significant food waste due to overbuying and improper food storage. Although most of the studies conducted around the world have reported panic buying, Hassen et al. (2020) reported the absence of panic buying in Qatar. Trust in strategies and policies implemented by the Qatari government in mitigating the impact of the COVID-19 pandemic on food supply could be one of the reasons for low panic buying among Qataris (Hassen et al., 2020). Pappalardo et al. (2020) found less panic buying during the second wave of the COVID-19 pandemic. Higher cooking skills and the ability to cook new and novel recipes with available food supplies and leftovers are potential reasons for this reduction in panic buying (Vidal-Mones et al., 2021). Trust in food supply chain resilience is another possible reason (Pappalardo et al., 2020). As such, assurance provided by governments on food supply chain resilience can reduce panic buying.

Although Berjan et al. (2021) found panic buying to be the primary driver of increased household food waste in Serbia, many studies have reported a non-significant relationship between panic buying and

Table 4
Influence of COVID-19 on personal development and behavioural change.

Factors	Causes and Effects	Sources
Panic Buying	• Due to fear and anxiety • Fear of food supply chain disruption • Stockpiling gives a sense of control • Overbuying and inappropriate food storage may increase food waste • Panic buying of perishable foods can cause food waste • Trust in government policy reduces panic buying • Trust in supply chain resilience reduces panic buying • Using leftovers, better inventory management, preparing a shopping list, and purchasing non-perishable products offset the influence of panic buying of food waste.	Hassen et al. (2020); Berjan et al. (2021); Pappalardo et al. (2020); Roe et al. (2021); Vidal-Mones et al. (2021); Vittuari et al. (2021)
Home Cooking	• Have a better overview of the food that they had at home. • Better awareness of expiration dates of their food stock. • More eating at home • Less out of home meals • People who cook have more concerns about food waste. • Overcooking culture has an adverse effect on food waste. • Better estimation of how much to cook.	Babbitt et al. (2021); Bender et al. (2021); Jribi et al. (2020); Kubíčková et al. (2021); Laila et al. (2021); Pires et al. (2021); Qian et al. (2020); Rodgers et al. (2021); Scacchi et al. (2021); Scharadin et al. (2021); Vidal-Mones et al. (2021); Vittuari et al. (2021)
Cooking Skills Development	• More time to develop cooking skills • Better cooking skill • Confidence in cooking • Cooking more efficiently	Amicarelli et al. (2021); Hassen et al. (2020), Hassen et al. (2021b); Bender et al. (2021); Berjan et al. (2021); Pires et al. (2021); Roe et al. (2021)
Using leftovers	• Higher usage of leftovers • Cooking new recipes with leftovers • Serving leftovers at the family meal • Feeding dogs with leftovers in cities • Feeding chickens in the countryside	Amicarelli and Bux (2021); Babbitt et al. (2021); Hassen et al. (2021a); Bender et al. (2021); Filimonau et al. (2021); Hassen et al. (2021b); Jribi et al. (2020); Pappalardo et al. (2020); Pires et al. (2021); Principato et al. (2020); Scacchi et al. (2021)
Online Shopping	• Reduce bulk shopping • Limiting panic shopping • Less stockpiling	Amicarelli et al. (2021); Babbitt et al. (2021); Hassen et al. (2020); Laila et al. (2021); Liu et al. (2021); Vidal-Mones et al. (2021)
Food Delivery Services	• Ordering unfavourable foods • Pre-planned food ordering can reduce food waste by reducing excess food purchases. • More ready-made meals	Amicarelli et al. (2021); Amicarelli and Bux (2021); Bender et al. (2021); Lahath et al. (2021); Liu et al. (2021); Scharadin et al. (2021)
Shopping Frequency	• Less shopping frequency may either increase or reduce food waste. • Less shopping frequency increases the wastage of fresh foods. • Lower frequency of shopping forces households to think more about their needs and have a better plan for food shopping. • More responsible purchasing by checking the refrigerator • Writing shopping lists • Eating whatever is available • More online shopping and food delivery services.	Bender et al. (2021); Berjan et al. (2021); Kubíčková et al. (2021); Laila et al. (2021); Liu et al. (2021); Scacchi et al. (2021); Scharadin et al. (2021); Vidal-Mones et al. (2021); Vittuari et al. (2021)
Meal Planning	• Meal planning reduces food waste	Babbitt et al. (2021); Laila et al. (2021); Principato et al. (2020)
Food Shopping Planning	• Less shipping frequency triggers shopping planning • Better food shopping plan • Preparing shopping list	Amicarelli and Bux (2021); Hassen et al. (2021b); Jribi et al. (2020); Laila et al. (2021); Liu et al. (2021); Pires et al. (2021); Principato et al. (2020); Vittuari et al. (2021)
Stockpiling	• Better in house food storage • Storing more food may lead to higher waste • Buying not-intended food can increase food waste. • More stockpiling gives a sense of stability and predictability during uncertain times • Purchasing more non-perishable food	Babbitt et al. (2021); Hassen et al. (2021); Bender et al. (2021); Berjan et al. (2021); Cosgrove et al. (2021); Laila et al. (2021); Liu et al. (2021b); Pappalardo et al. (2020); Roe et al. (2021); Scacchi et al. (2021); Schmitt et al. (2021); Vidal-Mones et al. (2021)
Inventory Management	• Use of inventories that would be subsequently be discarded • Organized food based on the expiration date • Check the refrigerator regularly to monitor the state of store food. • Expand cold storage capacity	Bender et al. (2021); Hassen et al. (2021b); Jribi et al. (2020); Laila et al. (2021); Pires et al. (2021); Vittuari et al. (2021)
Impulse Buying	• Buying unfavourable foods leads to more food waste. • Online shopping and social media platforms trigger impulse buying.	Lahath et al. (2021); Laila et al. (2021); Filho et al. (2021); Roe et al. (2021); Scacchi et al. (2021); Vidal-Mones et al. (2021)
Social Media Usage	• Purchase exotic food influenced by social media • Exposure to food-related content motivates to purchase and consume more food • Food-related pages on social media can develop cooking skills.	Lahath et al. (2021); Liu et al. (2021)
Sustainability Awareness	• Higher awareness of the environmental consequences of food waste • Higher awareness of the ethics of food waste. • High sustainability awareness Leads to responsible behaviour • Less food wastage	Burlea-Schiopoiu et al. (2021), Pappalardo et al. (2020), Pires et al. (2021), Vittuari et al. (2021), Brzustewicz and Singh (2021)
More Dieting	• More time to take diet. • Diet leads to a planned meals routine. • Well-organized shopping list. • Consuming more fruit and vegetables during a diet can increase food waste.	Scacchi et al. (2021), Scharadin et al. (2021)

(*continued on next page*)

Table 4 (*continued*)

Factors	Causes and Effects	Sources
Awareness of Children's Favourites	• Better awareness of favourite food of children • Fewer leftovers	Laila et al. (2021)

household food waste (Bender et al., 2021). Using leftovers, better inventory management, having a shopping plan, higher food consumption due to staying at home more, and purchasing non-perishable products are some of the factors that may offset the influence of panic buying on food waste (Bender et al., 2021; Principato et al., 2020). Although panic buying of vegetables and fruit may cause food waste, people mostly stockpile non-perishable foods such as canned foods, pasta, flour, rice, and frozen foods (Hassen et al., 2021b; Scacchi et al., 2021).

4.1.2. Home cooking and cooking skills development

Cooking at home was one of the main reasons for the reduction in household food waste (Rodgers et al., 2021). The number of people cooking increased during the COVID-19 pandemic due to gaining additional time to prepare meals, restrictions on going to restaurants, and income disruption (Bender et al., 2021; Kubíčková et al., 2021; Filho et al., 2021). Many people developed their cooking skills during the COVID-19 pandemic (Berjan et al., 2021). Previous studies have found a negative association between dedicating more time to home cooking and the amount of household food waste (Laila et al., 2021; Roe et al., 2021). Although preparation waste in home cooking is higher than in restaurants, plate waste is lower (Babbitt et al., 2021). Developing cooking skills, cooking more efficiently, making better use of leftovers, better estimation of how much food to cook, and better awareness of expiration dates of food stocks are some potential reasons why cooking at home leads to lower food waste (Kubíčková et al., 2021; Pires et al., 2021). Laila et al. (2021) found that confidence in cooking and time spent preparing meals would negatively influence food waste. Qian et al. (2020) asserted that people who cook have deeper concerns and consciousness about food waste.

4.1.3. Using leftovers

Using leftovers was another critical driver of food waste reduction during the COVID-19 pandemic (Principato et al., 2020; Scacchi et al., 2021). Pires et al. (2021) found that making better use of leftovers was the most important cause of food waste reduction. People increased their usage of leftovers to cook new recipes and feed their poultry in the countryside and pets in cities (Vidal-Mones et al., 2021). Pires et al. (2021) reported that 25% of their Portuguese respondents used leftovers during the pandemic by developing creative recipes. Better awareness of leftovers and having time to reuse them may cause higher usage of leftovers (Filimonau et al., 2021; Laila et al., 2021).

4.1.4. Online shopping and food delivery services

Online shopping and using food delivery services were other changes in customers' shopping habits and behaviours triggered by the COVID-19 pandemic (Kubíčková et al., 2021). McKinsey and Company (2020) reported that food delivery grew by 15–19% during the pandemic in the US, Japan, and Italy. Around 58% of Vietnamese respondents reported that they did more online shopping during the COVID-19 pandemic (Statista, 2020). In Filimonau et al.'s (2021) study of English households, 45–48% of the respondents observed an increase in the use of food delivery services.

Online shopping and food delivery services could be a double-edged sword, having a mixed effect on household food waste. Online shopping may reduce food waste due to limiting panic shopping and mitigating the need for food stockpiling (Hassen et al., 2021b; Roe et al., 2021). Furthermore, there is less intention to purchase perishable products through online shopping due to quality concerns, leading to lower food waste (Roe et al., 2021). However, online shopping may enhance food waste due to ordering food that seems desirable on online platforms but is not liked on delivery and is consequently wasted. Using food delivery services instead of developing cooking skills and cooking more at home caused the increase in household food waste in Thailand (Liu et al., 2021). The respondents in Thailand indicated that purchasing ready-made meals online and using food delivery services were the main reasons for their increase in food wastage.

4.1.5. Shopping frequency

The most remarkable change in customers' shopping patterns during the COVID-19 pandemic involved the frequency of shopping (Kubíčková et al., 2021). Customers reduced the frequency of shopping trips to reduce the risk of exposure to COVID-19 and potential infection (Hassen et al., 2021b). Kubíčková et al. (2021) reported that customers in the Czech Republic who had previously shopped every day or every other day had reduced their shopping frequency to once or twice a week. Reduction in shopping frequency may either increase food waste due to buying more per shopping trip and relying on food delivery services or reduce it due to better meal planning and storage management (Laila et al., 2021; Roe et al., 2021). Scacchi et al. (2021) found a non-significant relationship between the frequency of shopping and the amount of food waste. This indicates that proper food management practices offset the adverse impact of reducing grocery shopping trips on food waste. Shopping less frequently may encourage customers to check refrigerators before shopping, think more about their needs, prepare shopping lists, purchase non-perishable foods, and demonstrate more responsible shopping and good food management habits (Vidal-Mones et al., 2021; Vittuari et al., 2021).

4.1.6. Meal and shopping planning

Customers tended to prepare meal plans and shopping lists before grocery shopping in response to the reduction in shopping trips (Principato et al., 2020). Babbitt et al. (2021) found that over 60% of the American respondents in their study had started meal planning before grocery shopping. The customers thought more about what they needed to buy and prepared shopping lists by planning their daily meals and estimating the amount of food required (Kubíčková et al., 2021). Laila et al. (2021) found a significant relationship between lack of meal and shopping planning and household food waste.

4.1.7. Stockpiling and inventory management

Customers bought more per shopping trip and stockpiled products to reduce the frequency of shopping trips and infection risk (Hassen et al., 2020; Li et al., 2022). Although Babbitt et al. (2021) and Cosgrove et al. (2021) found that buying food in bulk quantities significantly increased food waste, many other studies reported a non-significant relationship between stockpiling and food waste as a consequence of proper inventory management and stockpiling of non-perishable foods (Hassen et al., 2021b; Scacchi et al., 2021). Around 26.0% of American respondents in Bender et al.'s (2021) study indicated that they had expanded their cold storage capacity during the COVID-19 pandemic, which might stimulate food stockpiling and consequently put pressure on the food supply chain and increase food waste.

4.1.8. Impulse buying

Impulse buying refers to irrational and impulsive purchases (Filho et al., 2021). Although some studies have used the terms 'impulse buying' and 'unplanned shopping' interchangeably, these two terms are not the same, and an unplanned purchase may not be irrational (Lahath et al., 2021). A person may forget to buy a product and make an unplanned purchase. However, impulse buying is a distinctive type of unplanned purchase that customers make due to exposure to impulse stimuli such as sound and colour. Impulse buying and purchasing foods that are not needed may lead to food waste (Scacchi et al., 2021). During the COVID-19 pandemic, online shopping using social media platforms might have motivated people to buy undesirable foods and caused

impulse buying (Lahath et al., 2021; Roe et al., 2021).

4.1.9. Social media usage

Higher usage of social media platforms during lockdowns exposed household members to visually attractive food content whose taste they are not familiar with. These visually exciting foods motivated customers to purchase exotic items, leading to food waste (Lahath et al., 2021). On the other side, food-related pages on social media can enhance cooking skills through cooking videos or recipes and provide ideas about what to cook, leading to less food waste (Liu et al., 2021).

4.1.10. Sustainability awareness

Sustainability awareness and knowledge of the environmental, social, and economic consequences of food waste trigger more responsible behaviours (Pires et al., 2021). Understanding the causes of food waste and its adverse impacts is crucial, as lack of awareness is why people do not consider it a critical problem and do not perceive it as something that can be avoided (Cequea et al., 2021). The COVID-19 pandemic increased awareness of the consequences of food waste (Castellini et al., 2021; Pappalardo et al., 2020). Castellini et al. (2021) argued that the stress of running out of food during the COVID-19 lockdowns had raised people's attention to food waste consequences. Burlea-Schiopoiu et al. (2021) found that the COVID-19 pandemic had increased awareness of the ethics of food waste and the environmental consequences of food waste among young people. Pappalardo et al. (2020) reported higher awareness among Italian customers regarding the impact of food waste reduction on the environment in terms of groundwater pollution and greenhouse gas emissions. Having more time to think about the consequences of food waste may lead to higher awareness and more responsible behaviour (Pires et al., 2021).

4.1.11. More dieting

Diet is also considered a healthy behaviour that may reduce food waste. The pandemic and lockdown provided opportunities and time for customers to adopt diets (Amicarelli et al., 2021). Scacchi et al. (2021) found a negative association between being on a diet and food waste. Dieting reduces unplanned food shopping, as people follow a planned meal routine, which may lead to less food waste (Scacchi et al., 2021). However, Scharadin et al. (2021) argued that consuming more fruit and vegetables during a diet may lead to higher food waste.

4.1.12. Awareness of Children's favourites

Parents mentioned that their children often brought back some of the food that they took to school for lunch. When children were at home during lockdowns, awareness of their food preferences was enhanced, leading to a reduction in avoidable food waste (Laila et al., 2021).

4.2. Demographic and situational factors

The influence of the COVID-19 pandemic on food waste production depends on demographic and situational factors (Qian et al., 2020). Several studies on food waste have discussed the importance of household size, gender, age, education, employment status, income, place of residence, and time availability during the COVID-19 pandemic (Table 5). The roles of demographic and situational factors are discussed in the following sections.

4.2.1. Household size

Studies of food waste before the COVID-19 pandemic and most of the studies investigating the influence of household size during COVID-19 have reported a positive association between household size and food waste (Everitt et al., 2021; Schanes et al., 2018). This means that larger households and those with more children produce more food waste. Interestingly, larger households showed greater reductions in food waste during lockdowns (Pappalardo et al., 2020). One potential reason is that additional household members are associated with higher consumption

Table 5
The impacts of demographic and situational factors on the association between COVID-19 and food waste.

Factors	Causes and Effects	Sources
Household Size	• On average, the food wastage of large households is higher than small households. • During the COVID-19 lockdowns, the food wastage of large households was reduced drastically. • More members lead to less food waste due to higher consumption during the lockdown. • More children can lead to higher food waste as spending more time on childcare leads to less time for meal planning and cooking.	Berjan et al. (2021); Everitt et al. (2021); Li et al. (2022); Özbük et al. (2021); Pappalardo et al. (2020); Qian et al. (2020); Scharadin et al. (2021); Vidal-Mones et al. (2021); Vittuari et al. (2021)
Gender	• Women reduced food waste more than men during the pandemic • Women have more concerns about the adverse effects of food waste on the environment • Women have a better understanding of food waste • In most cultures, women are in charge of cooking and inventory management	Cosgrove et al. (2021); Hassen et al. (2021a); Qian et al. (2020); Scacchi et al. (2021); Vidal-Mones et al. (2021); Vittuari et al. (2021)
Age	• Older people reduce food waste more than young ones during the pandemic • Young people have less experience in food management, which causes higher wastage. • Older people may see food as more valuable if they have gone through economically challenging periods. • Older people spend more time at home and have more time to manage food. • Young people started food management practices during the pandemic	Cosgrove et al. (2021); Everitt et al. (2021); Hassen et al. (2021a); Liu et al. (2021); Muresan et al. (2021); Principato et al. (2020); Qian et al. (2020); Scacchi et al. (2021); Vittuari et al. (2021)
Education	• Higher academic levels lead to less food waste usually.	Hassen et al. (2020); Hassen et al. (2021a); Muresan et al. (2021)
Employment Status	• Employment status influences lifestyle (e.g., dietary habits and daily schedules) • Unemployment leads to food waste reduction	Amicarelli et al. (2021); Berjan et al. (2021); Qian et al. (2020); Scacchi et al. (2021); Scharadin et al. (2021); Vidal-Mones et al. (2021)
Income	• Loss of income leads to food waste reduction • Higher incomes lead to higher food waste.	Bender et al. (2021); Hassen et al. (2021a); Hassen et al. (2021b); Jribi et al. (2020); Özbük et al. (2021); Qian et al. (2020); Scharadin et al. (2021); Vittuari et al. (2021)
Time Availability	• Working from home • More time to develop cooking skills. • More time for cooking and food preparation. • More time for food planning. • Work-life balance • More time to invest in knowledge	Amicarelli et al. (2021); Amicarelli and Bux (2021); Babbitt et al. (2021); Bender et al. (2021); Laila et al. (2021); Pappalardo et al. (2020); Pires et al. (2021); Roe et al. (2021); Scacchi et al. (2021); Scharadin et al. (2021); Vittuari et al. (2021)
Residency Location	• Size of city • Rural against urban	Principato et al. (2020)

of food and leftovers. Before COVID-19, anticipating the number of family members who would be eating at home was difficult, as some might suddenly decide to eat out, which in turn would cause food wastage at home. During the lockdown, all members of the household were expected to stay at home, making the prediction of food consumption more accurate.

Furthermore, parents were able to monitor and control what their children ate and thus reduce avoidable food waste. Parents highlighted that before the COVID-19 pandemic, their children often returned some of the food they took to school (Laila et al., 2021). However, Scharadin et al. (2021) argued that childcare time had increased drastically due to children staying at home, leading to less time for cooking and, consequently, higher household food waste.

4.2.2. Gender

Gender is a significant determinant of food waste concern and attitude and behaviour towards food waste reduction (Everitt et al., 2021; Vidal-Mones et al., 2021). During the pandemic, women paid more attention to food waste and demonstrated more ability to reduce food waste than men (Qian et al., 2020). Women were more concerned about the adverse impacts of food waste and tended to reduce leftovers and food waste (Cosgrove et al., 2021; Qian et al., 2020). Women also played a more active role in food waste reduction because they tended to be in charge of cooking and food inventory management (Qian et al., 2020). People who cooked demonstrated a better understanding of household food waste and a more profound concern for food waste and its negative impacts (Cosgrove et al., 2021; Qian et al., 2020). Furthermore, people who cooked and managed food stocks had a more substantial influence on food waste than other household members (Qian et al., 2020).

4.2.3. Age

Previous studies have shown a significant relationship between age and food waste (Qian et al., 2020; Vidal-Mones et al., 2021). Generally, young people waste more food than older ones (Burlea-Schiopoiu et al., 2021; Everitt et al., 2021). Young people's low cooking and inventory management skills lead to higher food waste (Cosgrove et al., 2021). In general, older adults have more time to spend cooking and managing inventory, which leads to lower food waste (Principato et al., 2020). Furthermore, older adults may better understand food value due to past pandemics or experiences of economic challenges (Cosgrove et al., 2021). Interestingly, previous studies have reported that the COVID-19 pandemic has influenced young people's food waste awareness (Burlea-Schiopoiu et al., 2021), and that they have started preparing shopping lists and using leftovers, thus leading to a considerable reduction in their food waste production (Principato et al., 2020). This suggests that young people's food waste behaviour can be corrected by providing them with the time and resources to cook and develop their cooking and food-management skills (Principato et al., 2020).

4.2.4. Education

Education is another factor that may influence household food waste generation (Hassen et al., 2020). Although its relationship with food waste reduction during the COVID-19 pandemic has received less attention, three studies have reported its impact (Hassen et al., 2020, 2021a; Muresan et al., 2021). In a study in Romania, Muresan et al. (2021) found that people with higher education degrees were more engaged in sustainable behaviours and food waste reduction. Haseen et al. (2021) found that education had a significant effect on various food behaviours and consumption during the COVID-19 pandemic, such as cooking and preparing food, spending more time cooking, ordering groceries online, and eating with family members.

4.2.5. Employment status, income, and time availability

In this section, we will discuss the role of employment status, income, and time availability together, as these factors are highly interrelated. The impact of employment status on food waste can be explained in terms of income and time availability. In general, unemployed people have more time for cooking and food management and have less money to spend on food, and consequently, they waste less food than employed people (Qian et al., 2020; Roe et al., 2021). Vidal-Mones et al. (2021) compared the food waste production of individuals with different employment statuses in Spain. They found that employed individuals wasted more food than unemployed and retired people during the first COVID-19 lockdown.

Studies on the influence of lockdowns and stay-at-home policies on household food waste found that staying home and working from home provided time for people to develop their cooking and inventory management skills, engage in cooking and food management, and prepare shopping lists, which led to less food waste (Amicarelli et al., 2021; Vittuari et al., 2021). Furthermore, losing jobs and wages also caused a reduction in food waste (Hassen et al., 2021b). Qian et al. (2020) argued that the main difference between the food waste behaviour of employed, part-time employed, and unemployed people was related to the availability of time and not income. They found no significant relationship between yearly household income and the amount of food waste. Interestingly, the need for children to stay at home during the COVID-19 pandemic had significantly less effect on food waste in households where at least one of the parents was unemployed (Scharadin et al., 2021). Unemployed parents were able to allocate time for childcare and consequently absorb the influence of childcare during the lockdown on food waste.

4.2.6. Place of residence

Place of residence is another factor that may play a significant role in the association between COVID-19 lockdowns and household food waste reduction. Principato et al. (2020) found that people in urban areas wasted more food than those living in rural areas. This finding can be explained by the use of leftovers to feed poultry, having more time for cooking, and a lack of food delivery services in rural areas. Furthermore, they found that people who lived in larger cities tended to waste less food during lockdowns. Less food waste in larger cities may be related to stricter and longer lockdowns in these areas, which pushed people to stay at home for more time, make fewer grocery shopping trips, and consequently use and manage their food stocks more effectively.

5. Food waste in the post-COVID-19 lockdown era

Previous studies have reported food waste reduction during the COVID-19 pandemic. Although the COVID-19 lockdowns led to significant positive changes in food waste behaviours, it is unclear what will happen in the post-pandemic era. Fig. 2 illustrates a summary of the changes during the COVID-19 pandemic and the expected behaviours in the post-pandemic era. According to this figure, during the COVID-19 lockdowns, panic buying, home cooking, use of leftovers, online shopping, stockpiling, and food delivery services were higher than before the pandemic. Furthermore, people ate at restaurants less frequently.

Lockdowns forced people to stay at home and cook instead of going to restaurants. A fraction of the reduction in food waste caused by home cooking and staying at home may be reversed after the end of the lockdowns and social distancing, as people have less time to cook at home. Although spending less time at home is expected to increase food waste, it is expected that the amounts of household food waste will not return to pre-pandemic levels for several reasons. Firstly, as a consequence of work-from-home practices, which are predicted to continue in the post-pandemic era (Rafiq et al., 2022), people will stay at home more than they did before the pandemic. Secondly, the development of cooking skills during the COVID-19 lockdowns may also reduce household food waste in the post-pandemic era. Thirdly, COVID-19 has caused some positive habitual and behavioural changes, such as checking the fridge and available food stock before shopping, preparing a shopping list, using leftovers, and cooking at home, which are expected to remain, at least to a degree, after the pandemic (Massari et al., 2021). The studies

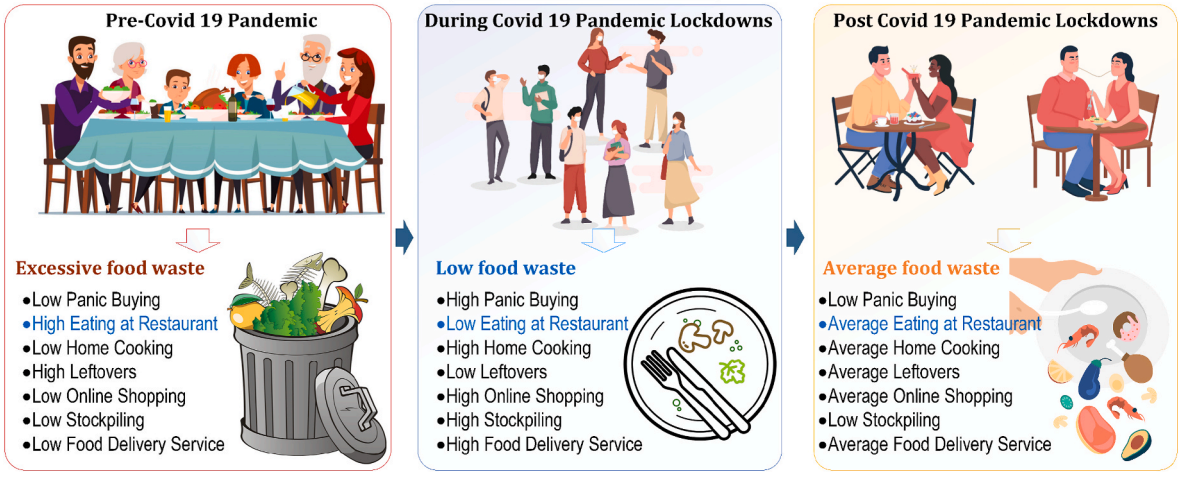

Fig. 2. Summary of changes during the COVID-19 pandemic and the expecting behaviours in the post-COVID 19 worlds.

on food waste in the post-COVID-19 lockdown era have confirmed our prediction that household food waste during the post-lockdown era might be lower than during the lockdown period and higher than before the pandemic (Laila et al., 2021; Massari et al., 2021). Massari et al. (2021) reported that the return to the workplace at the end of 2020 resulted in a return of food waste, but even so, there was 22% less wastage compared to the pre-pandemic level. Laila et al. (2021) found that customers had returned to physical shops to purchase grocery products when lockdowns were eased. However, the respondents indicated that they ate at restaurants less frequently than before the pandemic. According to Laila et al. (2021) and Massari et al. (2021), although behaviours related to additional time availability and stay-at-home orders, such as cooking at home and online shopping, might be reduced when people return to the workplace, these behaviours are unlikely to go back to their pre-COVID-19 levels, especially in the short term.

6. Theoretical and practical implications

This systematic review contributes to the literature on household food waste by synthesising the findings of studies on the impacts of COVID-19 on food waste behaviour. The study summarized what we know about the changes in food management behaviours during the COVID-19 pandemic and what factors caused such changes. According to the findings, changes in people's behaviours during the COVID-19 pandemic influenced the amount of food wasted. Although some unfavourable behaviours, such as panic buying, shopping less frequently, and impulse buying, had an adverse effect on the amount of food wasted, the studies found that their influences on the extent of food waste were not significant (Hassen et al., 2021b; Scacchi et al., 2021; Bender et al., 2021). The scholars highlighted favourable changes in human behaviours and habits, such as better inventory management, home cooking, using leftovers, meal and shopping planning, and stockpiling non-perishable foods as the potential reasons why panic buying, less frequent shopping, and greater stockpiling had no negative effect on household food waste. This suggests that these favourable behavioural changes offset the potential negative impacts of purchasing in bulk on food waste. Stockpiling non-perishable foods is another potential reason. Customers mostly purchased and stockpiled non-perishable foods such as pasta, rice, and canned foods, which had no impact on food waste. Expanding cold storage capacity, checking refrigerators regularly, and organizing foods based on their expiry dates led to better inventory management during the COVID-19 pandemic.

Reviewing the previous studies enabled us to explain why the influence of COVID-19 on food management behaviours has been varied, reducing household food waste in some countries and increasing it in others. For instance, although most of the studies reported panic buying during Covid-19 lockdowns, Hassen et al. (2020) reported the absence of panic buying in Qatar due to the trust of Qatari citizens in government. Furthermore, although Hassen et al. (2021b) reported online food shopping as a driver of reducing food waste in Lebanon, Liu et al. (2021) found that online food shopping led to higher household food waste in Thailand. Online food shopping and food delivery services may reduce food waste by mitigating the need for stockpiling but, conversely, may increase food waste through the ordering of foods that turn out to be undesirable. Besides that, the influence of online food shopping on food waste may depend on the types of food ordered. Using online shopping services to purchase grocery products for cooking at home may reduce food waste, whereas using such services to order ready-made meals may increase food waste. Furthermore, social media platforms and dieting can also play both positive and negative roles. Although using social media to enhance cooking skills may lead to less food waste, social media may increase food waste by motivating people to purchase exotic foods. Although more dieting can reduce food waste by reducing unplanned food shopping, consuming more vegetables and fruit may increase food waste.

Understanding the causes of changes enables us to predict and explain what changes will be retained in the post-lockdown era. We predict that household food waste will be lower in the post-lockdown era compared to pre-pandemic levels. Cooking at home, eating at restaurants less frequently, checking one's fridge more regularly, using leftovers, and preparing a shopping list are positive behavioural changes that may reduce food waste in the post-lockdown era. However, household food waste is expected to be higher in the post-lockdown era compared to during the COVID-19 lockdowns as a consequence of people returning to the workplace and having less time to cook. The study also elaborates on the gaps in the literature and proposes directions for future studies in the following section.

From a practical perspective, the findings of this study shed light on the positive and negative influences of COVID-19 on food waste, which enables policymakers and practitioners to develop informed policies. In general, the positive impacts of COVID-19 can be explained in terms of individuals having more free time. This is likely to be the main reason why household food waste has been reduced during the COVID-19 pandemic. People have used the extra time to develop their cooking and inventory management skills and cook meals from stocked food and leftovers. Furthermore, less eating at restaurants and the higher number of household members staying at home are other factors that have contributed to the reduction in food waste during the COVID-19 pandemic. However, panic buying, more online shopping, and food

delivery services are unfavourable behaviours that lead to more food waste. During the COVID-19 pandemic and other such crises, governments should ensure that the food supply chain is resilient to minimize panic buying. Governments should also establish educational campaigns on food inventory management and how to prepare food with minimal wastage. Furthermore, in the post-COVID-19 and lockdown era, governments should initiate awareness-raising campaigns to maintain the good food management practices (i.e., preparing shopping lists and using leftovers) that people have learned and implemented during the pandemic.

7. Research gaps and directions for future research

Reviewing the previous studies on the impacts of COVID-19 on food waste behaviours enables us to identify gaps in the literature and propose direction for future studies. Future studies are required to address the following gaps.

1. The studies have focused on the influence of COVID-19 on the amount of food waste and food waste behaviours. The results demonstrate that the pandemic reinforced positive food waste attitudes and behaviours and caused a reduction in the amount of household food waste. Maintaining positive changes over time is the main challenge. The potential implications of government interventions for preserving the correct food management practices and behaviours in the post-COVID-19 scenario have received less attention. Future studies are needed to study how governments can maintain favourable changes in food waste behaviours.
2. Principato et al. (2020) argued that the impacts of COVID-19 on food waste depend on the attributes of the living area (i.e., urban vs. rural area, small vs. large city). For instance, due to the lack of online grocery infrastructure, more panic buying to reduce the frequency of shopping trips is expected in rural areas. Local policymakers and planners need to consider the regional circumstances in developing food waste strategies. Accordingly, future studies are recommended to compare the impact of COVID-19 on food waste behaviours in areas with different attributes. Furthermore, cross-countries and cross-cultural studies are required to understand the responses of customers with different cultural backgrounds to COVID-19 in terms of food waste behaviour.
3. The personal characteristics of individuals, such as risk aversion and trust propensity, may moderate the association between COVID-19 and food waste behaviours. Individuals with high-risk aversion engaged more in stockpiling behaviour during the COVID-19 pandemic, which, in turn, might have led to higher levels of food waste (Brizi & Biraglia, 2021). Furthermore, people with a high trust propensity might have greater trust in the government's ability to supply food during the pandemic and consequently are less likely to panic buy or stockpile food (Hassen et al., 2020; Li et al., 2021). Accordingly, risk aversion and trust propensity may moderate the effect of COVID-19 on food waste behaviours. Empirical studies are required to test the moderating effect of personal characteristics. The findings will enable policymakers to develop various strategies by considering the individual characteristics of the target groups.
4. Most of the studies collected data from Europe, North America, and Asia. Only one study was conducted in Africa. As the infrastructures (i.e., online shopping, food service delivery) and people's lifestyles (i.e., consuming ready-made meals and using leftovers) may differ in Africa, more studies are required on the association between the COVID-19 pandemic and food waste behaviour in African countries.
5. Surprisingly, no study has been conducted on food waste behaviour during the COVID-19 pandemic in Oceania. As household food waste in Australia and New Zealand is very high, future studies are required to unpack the impact of the pandemic on food waste in these two countries. Australians are ranked as the fourth largest food wasters globally, and Reynolds et al. (2015) estimated that the amount of avoidable food wastage in Australia is equal to the annual food intake of 921,000 people.
6. Most of the studies were quantitative (84.2%). Conducting qualitative and mixed-method studies and interviewing experts and customers may provide first-hand insights on how the COVID-19 pandemic has changed food waste behaviour and what will happen in the post-pandemic world.
7. Most studies have relied on self-reporting, which is subject to bias and underestimation (Giordano et al., 2019; Visschers et al., 2016). Future studies are needed to estimate household food waste using more valid methods such as photo coding, kitchen caddies, and direct measurement of waste composition (Everitt et al., 2021; van Herpen et al., 2019).
8. Many countries have ended their lockdowns and opened their borders, schools, and businesses. Further studies need to be conducted on food waste behaviours in the post-lockdown period to better understand customers' intention to continue efficient food consumption and food management behaviours after the pandemic.
9. Massari et al. (2021) found that the return to the workplace resulted in higher household food waste. Future studies are recommended to investigate how the return to the workplace may influence food waste behaviours.

8. Limitations

The present study attempted to explain the impacts of the COVID-19 pandemic on household food waste behaviours and the causes of these changes. Although the objectives of the study were met, some limitations should be considered. Firstly, we only reviewed the articles published in journals indexed by Scopus, which is the largest database. Secondly, to ensure that only high-quality works were reviewed, we excluded book chapters and conference papers and limited the review to peer-reviewed articles. Thirdly, although two authors screened the extracted articles to select the relevant studies, the subjective judgment might have influenced the selection process. Finally, the articles were extracted in November 2021, and consequently, the data for most of the studies reviewed were collected during lockdowns. The lack of research on post-lockdown behaviour limits our ability to provide a precise picture of food waste behaviour in the post-COVID-19 lockdown era.

9. Concluding remarks

Food may be wasted at any point in the food supply chain, including harvesting, processing, transportation, storing, retailing, and final consumption. However, household food waste accounts for most of the total food waste. As food waste has serious economic, environmental, and social consequences, household food waste reduction has become a serious concern for governments and practitioners. In the early stages of the COVID-19 pandemic, practitioners raised concerns regarding the risk of COVID-19 causing more food waste and increasing pressure on waste management systems. Various studies have been conducted to explore the impact of COVID-19, and most of these studies have reported reductions in household food waste during the pandemic. The main behaviour changes caused by the COVID-19 pandemic are panic buying, reduced frequency of shopping trips, more online shopping, greater use of food delivery services, more home cooking, using leftovers, addiction to social media, more meal and shopping planning, and better inventory management. Based on the identified factors, we predict that households will waste more food in the post-COVID-19 era than during the pandemic, as they will have less time for cooking at home. However, we expect post-pandemic household food waste to be lower than food waste before the pandemic, as individuals' cooking and inventory management skills and awareness of the consequences of food waste have increased.

Ethical statement

We confirm that this manuscript is original and has not been published elsewhere, nor has it been submitted simultaneously for publication elsewhere. We have no conflicts of interest to disclose. The article is review and exempted from ethics.

Author declaration

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome. We confirm that the manuscript has been read and approved by all named authors.

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