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REGIONAL CASE STUDY

Did COVID-19 influence food waste habits? A comparison of Polish and British households

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Abstract

Culture and customer behaviour play an important role in managing food waste. The responsible involvement of householders in purchasing, storing, and consuming food are indeed required not only to produce less waste but also to manage it rationally. In this paper, a research study across two countries was conducted to verify the influence of the COVID-19 pandemic, and of associated public health measures, on household food waste habits. Food consumption behaviours (like planning meals and food purchases) during COVID-19 in UK and Poland were assessed, to identify environmentally friendly practices that could be adopted on a stable basis. The results indicate that lockdowns did not influence food-management habits significantly in both countries. However, during lockdown periods, respondents showed a change in their purchasing methods in the UK, where survey respondents bought more online (51.20%). The opposite was observed in Poland, where there was no noticeable increase in online shopping (84.07%). The promotion of positive habits in food purchases and environmentally friendly practices such as food sharing and using advanced technology to optimise food management could be beneficial. Our study also paves avenues for future research on the environmental impact of consumers' food habits after COVID-19.

Keywords Food waste · Consumption habits during COVID-19 · Young consumers · Food waste reduction possibilities

Introduction

According to FAO [1], through the food supply chain (FSC), a significant quantity of food can be lost and wasted. Food losses occur at production, postharvest and the processing phases. In contrast, food waste is related with the behaviour of retailers and consumers. Both only take into account products for human consumption.

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Different factors generate deficiencies along the FSC. The main elements are a lack of technical skills, problems with the cold chain management, regulations, and inefficient storage and distribution [1]. Therefore, the losses are reflected in failures in the cold chain, expired food, water contamination, labelling and packaging [2].

The COVID-19 pandemic affected all the areas (suppliers, manufacturing, packaging, distributors, retailers and consumer) of the supply chain, being the most significant disruptor in recent history [3]. At a consumer level, the pandemic impacted mainly on consumption behaviour and purchasing [4]. People began to buy long-lasting products, to plan before buying food and meals [4, 5]. Having more time at home, the preparation of home-grown food, and the reuse of leftovers appeared as a trend [6–9]. Thus, there was a change in the behaviour of the people at a consumer level towards the reduction of food waste [10, 11].

The pandemic changed the world significantly and permanently in many vital areas [12]. Fear, uncertainty and often the need for isolation [13] influenced individual attitudes and mutual relations for B2B and B2C market participants. One of the areas significantly affected by the scale of the problem was the food sector, which is crucial for human life

and health [14]. Interruptions in the continuity of supplies, problems in the field of production and distribution, and rising prices [15] with the simultaneous atypical, often irrational, behaviour of individual buyers, are the variables that have contributed to the undoubtedly visible and wide-ranging transformation of this industry [16], often considered through the prism of four dimensions: availability, stability, access and utilisation, agency and sustainability [17]. In particular, the last area is closely related to the guidelines of the widely promoted concept of sustainable food management. This area is associated with a high demand for science and business practices for multi-faceted analyses of the extensive consumption phase, which, depending on many factors, can be an essential source of the undesirable phenomenon of food loss and waste [18].

The European Commission takes the issue of food waste very seriously. In fact, it sees many tangible benefits from the implementation of food efficiency guidelines, particularly in terms of achieving Sustainable Development Goal 12.3. In view of this, it is undertaking numerous initiatives to support their implementation, starting with the Waste Framework Directive [19], the Circular Economy Plan [20], the Farm-to-fork Strategy [21] or the creation of an EU Platform on Food Loss and Waste [22]. In 2020, an analysis was made of member countries' actions on the 2016 Council's findings. The conclusions indicated that almost all member states have adopted national strategies and legislations, along with other non-legislative instruments, to reduce food loss and waste, and those that have not, plan to do it soon [23]. In July 2023, The European Commission presented a proposal to revise the EU Waste Framework Directive. The revision includes new EU targets for food waste reduction by 2030. The proposal is under discussion in the Council [24]. The Commission will conduct another formal review of the progress made by member states by 2027.

For this study, Poland and the United Kingdom were selected. The choice of these two countries is significant for a number of reasons. Polish and British households waste a lot of food [25], even though they are nations with different economic, social and cultural roots. Polish and British citizens have different income levels.

The average British family has a higher income than the average Polish family and spends more than Poles. Both countries have similar household sizes (on average 2.48 people per household) [26, 27], although the family structure is different. Multi-generational families are still more common in Poland [28]. However, almost as many people live in single-person households (27 per cent in Poland, 30 per cent in the UK) [27–29]. Both countries have a system of social support that helps them to develop. The UK is a larger country with more than 68 million inhabitants compared to Poland's population of almost 37 million. Poland is characterised by family cohesion, whilst the UK is characterised by higher individualism. Comparing these aspects helps to understand the different challenges and strengths of households in Poland and the UK, providing a comprehensive view of their living conditions and social dynamics.

Furthermore, comparing both countries with different geographical location, history, culture and food habits seems to be beneficial and may bring new perspective to the already conducted discussion. The range of different approaches can be analysed from a single perspective, such as personality traits [30]. The differences also emerge when discussing specific food-related issues such as organic food [31]. Thus, the idea behind the study was to explore the issue of food waste and food behaviour in these two countries. What is more interesting is that differences in food waste are observed between Poles living in Poland and the UK [32]. In addition, growing economic tensions are leading to changes in consumer behaviour amongst Poles, as shown by the The Future Consumer Index survey [33]. The initial findings were a focal point for conducting research on food waste in Poland and the UK.

Moreover, Poland, as a full-fledged member state, has also taken action in the field in question. First of all, the Act of July 19, 2019 on food waste prevention, which lays down the rules for handling food and the obligation for food business operators to prevent food waste, was enacted. In addition, several other initiatives should be mentioned, such as operational programmes on food waste prevention or the strategy for rationalising losses and reducing food waste [34]. In addition, in 2019, the Polish legislature published the roadmap towards the transition to circular economy, where the measures on food waste were presented.

In addition, in 2018, the UK published the 25 Year Environmental Plan which contains policies to protect the environment [35]. Three years later, the Environment Act 2021 became law and designated the 25 Year plan as the leading environmental plan which tries to minimise waste amongst others environmental targets [36].

The UK and Poland share several commonalities in the approach that both countries follow regarding food waste, largely because both countries align with European Union directives such as the EU Waste Framework Directive (2008/98/EC), which sets the foundation for waste management across members states and, prior to Brexit, applied to the UK as well [37].

Furthermore, to reduce food waste at a consumer level, and as an approach to manage food waste, the United Kingdom launched, in 2018, the 'Our Waste, Our Resources: A Strategy for England' programme, which seeks to shift to a more Circular Economy to keep resources in use for more time [38]. The Waste & Resource Action Programme (WRAP) was one of the organisations delegated to investigate and develop initiatives to help the UK Government to create policies on the matter. WRAP is working with the

circular economy unit of the Government and operating in all nations part of the UK [38, 39]. 'Love Food Hate Waste' and 'The Courtauld Commitment 2030' are two initiatives developed by WRAP. The first initiative is a campaign that provides consumer education regarding packaging, food and marketing [40]. The Courtauld Commitment 2030 is an initiative to decrease through the entire food supply chain: food waste, water stress and Greenhouse Gas Emissions [41].

To understand the context of the issues addressed in this article, a literature review was conducted from the SCOPUS database. The analysis covered the years 2020–2024, whilst the following keywords were employed: consumer; attitude; food waste; COVID. The search resulted in 44 articles, approaching the subject from different perspectives, both from the side of differences in individual countries (both Europe and non-European countries), as well as specific issues, shaping the broader subject of food waste, with 15 articles presented in the Table 1.

Nonetheless, the restrictions in many countries have been lifted, thus there is a lack of studies about whether the behaviour of Polish and British consumers acquired during the pandemic have been kept or was only momentary. Therefore, in this research, it was decided to use the gap existing in the literature to determine if the behaviour of analysed consumers about measures taken to reduce food waste at home has been changed and what kind of solutions can be proposed to enhance and maintain positive patterns of food management after the lifting of lockdown restrictions.

Although, in practice, all participants in the agri-food chain are responsible for losses and food waste, it is particularly important to focus on the main source of the problem, namely households, which, according to data, generate more than half of the total volume of waste. This is an indicator visible in both global [57] and Polish data [58]. Therefore, there are multidimensional awareness raising campaigns in Poland and in the UK. For example, in 2021 a campaign called 'Eat without throwing away' was conducted in the UK. Its main goal was awareness raising to prevent food waste, especially in households. The campaign was linked to the PROM project, which aimed to strengthen public institutions to manage (mainly monitoring and measuring) public policies to reduce food loss and waste, as well as to develop a plan to prevent food loss and waste [59].

Table 1 Broader dimensions

Dimension	Country	Year
[42] Define the determinants of consumers' intention to reuse food delivery containers using the extended theory of planned behaviour	Malaysia	2024
[43] Prepare quantitative research, the impact of the COVID-19 pandemic on online food delivery in Italy and Poland	Italy and Poland	2024
[44] Analyse recent effects, difficulties, policies and legislations, technology, and innovations in waste management as a response to COVID-19	Bangladesh	2024
[45] Analyze Food Safety Awareness—Consumer behaviour and attitudes in Türkiye	Turkey	2023
[46] Identify key factors influencing food waste by conducting a survey with 1,551 respondents on stated preferences	Czech Republic	2023
[47] Analyse the quality and safety of raw foods, suitability and availability of manufacturing places, physical facilities, drinking water and waste management system, and processing conditions to assess the knowledge, attitudes, practices regarding food safety and hygienic practices amongst food handlers at fast foods restaurants in the different universities in Jordan during COVID-19	Jordan	2023
[48] Define the factors that lead to food-waste behaviour at the household level in the Klang Valley area	Malaysia	2023
[49] Investigate whether purchasing decisions about bakery products (bread, snacks and biscuits) are influenced by concerns about health, climate change, biodiversity loss and food waste	Italy	2023
[50] Determine food consumer behaviour and attitudes towards food consumption and household food waste in Montenegro	Montenegro	2023
[51] Examine why consumers in Saudi Arabia engage in excessive food-buying behaviour amid COVID-19	Saudi Arabia	2023
[52] Investigate the immediate effects of the COVID-19 pandemic on consumer knowledge and reported behaviours linked to food waste in Bosnia and Herzegovina	Bosnia and Herzegovina	2023
[53] Examine the antecedent roles of restaurant customers' nature connection and biospheric values in fostering their food leftover reduction intention through environmental self-identity and sense of obligation to reduce food leftover	South Korea, China	2023
[54] Identify food waste behaviour antecedents for households during the COVID-19 pandemic in Iran	Iran	2023
[55] Evince a new understanding of the tourist city during the COVID-19 pandemic by exploring the effects of the new health protocol on FW management at the consumption stage in the hospitality sector in Dubai	Dubai	2023
[56] Focus on the consumer's fear of food security for the time of the first wave of COVID-19 and the associated concern for food security in the future and the changes in consumer behaviour	Slovenia	2023

Theoretical Background

A Pneumonia with an unknown origin was detected in China (Wuhan) in December 2019 [60], being identified in January 2020 by the Chinese Center for Disease Control and Prevention with the name of '2019-nCoV' (Coronavirus or COVID-19) [61]. The virus rapidly entered most of the world's countries [60], being declared a pandemic on 11 March 2020 by the World Health Organization [62]. Different governments implemented many restrictions to reduce the infection rate [63], including restrictions on mobility, social distance, lockdowns and transitory closes of companies [64].

The COVID-19 altered industries in an astonishing way [65]. The pandemic produced a deceleration in the economic activity due to the restrictions implemented [66], impacting the supply and demand mainly because many companies had to stop production [67], with customers rejecting buying non-essential products and services [68]. In addition, COVID-19 was the most severe disruptor in the supply chain in recent history [3].

In general, and especially in FSC management, the customer is the most critical part of the supply chain because food consumption is the reason for which the food supply chain works [69]. Furthermore, consumers are commonly culpable of producing household food waste [7]. Around 17% of worldwide food production is wasted, from which 13% comes from retail, 26% from food services, and 61% come from households [70]. In the UK, almost 20% of food is wasted, from which 73% comes from households [71]. In addition, according to Przezbórska-Skobiej et al. [72], in Poland, approximately 30% of food is wasted or lost, with 60% of this coming from households. A comparison developed by Bräutigam et al. [73] showed that in terms of food waste, the UK ranks fourth and Poland fifth, just behind Germany, France and the Netherlands. Furthermore, Przezbórska-Skobiej et al. [72] indicated that in Poland, unlike western countries, the production stage is where more food is wasted.

In total, according to the World Economic Forum [74] the food loss and waste over the supply chain in the global economy have an approximate cost of US$ 936 billion per year. Besides, between health, economic, and environmental cost, the prevailing food system has a cost for society near US$ 12 trillion, 20% more expensive than the ongoing food system [74]. However, food waste also has also other implications, such as greenhouse emissions, the loss of resources like water, fertiliser, and the nutritional aspect of food that is never eaten. All the aspects mentioned before affect the planet and lead to climate impact [8].

Many factors have been described in the literature regarding household food waste generation. The examples include buying more than in fact was needed, lack of planning, and poor storage of food [7, 8, 10]. Besides consumption and preparation [75], ignorance of the quantity of food waste that is generated, the environmental impact produced, and unawareness on how to manage food waste aggravate the problem [8]. Also, other drivers can be included regarding the quantity of food waste produced in a household, for instance, the number of people living in a house (The more people live in a house, there is a major possibility of eating all the cooked food resulting in less production of food waste), unemployment [69], sociodemographic, and personal beliefs [9].

To reduce food waste, scholars have suggested that consumers should plan meals and food purchases, use a shopping list, and be ready in case of any logistic problem related to cold chains and storage. Moreover, people should know about the label of products and to have a routine to learn how to manage leftovers. Additionally, customers should have essential culinary expertise [9, 76].

The pandemic transformed lives worldwide [75]. Restrictions changed how households managed food [9]. Güney and Sangün [4] indicated that customers were affected mainly by food purchasing and consumption behaviour. Online purchases grew, food preparation and consumption at home increased, and consumers bought more long-lasting products [4, 5]. Besides spending more time at home , customers became used to prepare shopping lists, plan meals, and cook and reuse leftovers [9]. Additionally, some researchers have noted that there was an increment in the quantity of food that consumers bought, leading to eating more during the pandemic [77]. For example, Năstăsescu et al. [78] suggested in a study that there was an increment of 20% in mental health problems like nervousness, depression and anxiety. Therefore, according to Farello et al. [79] the amount of food that people ate at home increased during lockdown by 50%.

Further research undertaken in the US, Italy, Tunisia, and Malaysia reported reduced household food waste during the restriction [75]. In contrast, Vidal-mones et al. [7] mentioned that in Spain, the habits did not change considerably; only specific changes were noted, such as the frequency in which people bought (being less than before), planning and optimising their purchases, storage and conservation. Furthermore, people bought more locally than before the pandemic. In the same direction, a study developed in the UK showed that people were showing some changes that were likely to continue after the pandemic, such as planning before buying, reusing leftovers, and freezing some items [80]. Therefore, during COVID-19, people changed their behaviour in a positive direction to reduce food waste [10, 11]. In addition, some scholars have reported that the food waste production in households after the lockdown era is lower than during the pandemic but higher than before COVID-19 [81, 82]. However, the same authors indicated

that at the end of 2020, food waste levels increased when people returned to work normally. However, the wastage was still 22% less than before the pandemic.

It is still uncertain what the long-term effects of COVID-19 will be [83], but some lessons learned during the pandemic may help reduce food waste. For example, the continuation of work-from-home arrangements [84] and habits developed during lockdowns—such as checking the fridge before shopping, making grocery lists, and using leftovers—are expected to contribute positively in this regard [81, 83].

Materials and methods

The paper presents the results of quantitative research conducted in the UK and Poland between 2021 and 2022, replicating the study undertaken by Vidal-Mones et al. in Spain during 2020 [7].

The UK and Poland were chosen because of their difference in location, history, culture, and food habits. Moreover, in research developed in 2018 about Polish living in the UK compared against those living in Poland, shows that those who live in the UK waste more food than those living in Poland, for households composed of one and two people [32]. Therefore, understanding the behaviour of both countries might bring a new perspective.

The research undertaken in the UK and Poland aimed to investigate the impact that the COVID-19 pandemic has had on the food waste habits in British and Polish households. Moreover, the aim was also to determine if the behaviour of consumers regarding measures taken to reduce food waste at home has been kept after finished lockdown restrictions or if the attitude existed only was during the restriction mentioned before. In this study, food waste (FW) is understood as the perceived amount of edible parts of foods thrown away by the participants in their households. Consequently, two research questions were posed:

(RQ1) Did food consumption and waste habits change due to the pandemic?

(RQ2) What are the possibilities to maintain the positive food consumption practices in the long run?

Questions of this survey were adapted from the study undertaken by Vidal-Mones et al. [7] in Spain. Consequently, the responders were asked to complete an online questionnaire about their own experiences related to food practices that could have influenced food waste generation at home. The questionnaire was sent via mass email and social media such as WhatsApp phone application, using institutional contact networks. The participants must have been living in the UK/Poland, aged 18 and above, and be the principal household food purchaser. After reviewing the received responses and checking whether they were duplicates or anomalous data, the sample consisted of 129 in the UK and 182 results in Poland (Table 2 and Fig. 1).

The questionnaire consisted of 37 close-ended questions, divided into four sections. The first section collected socio-demographic information. The second focused on participants' behaviours during lockdown periods, including food purchasing, storage, and consumption at home. The third section addressed changes in household behaviour after lockdowns, particularly in relation to food waste generation and management. Finally, participants were asked whether they believed they discarded more, the same, or less food compared to during lockdowns. Completing the questionnaire took only a few minutes. Participation was voluntary and fully confidential, with this information clearly communicated to respondents prior to the start of the survey. The research was conducted over two weeks in August 2021 in the UK, and again in January–February 2022 in Poland. The data were analysed using descriptive statistics.

Results

The results of quantitative research obtained are shown in the following order. First, the information received from the survey undertaken in Poland is provided. Second, the data collected in the UK is described. Finally, a comparison between both countries is developed.

Poland

Table 2 and Fig. 1 present the socio-demographic characteristics of the sample. The socio-demographic variables considered included gender, age, household size, the presence of individuals under 18 years old, employment status changes due to COVID-19, and any personal contact with COVID-19 (e.g., having been ill or required to self-isolate). The sample was predominantly composed of young women. On average, households consisted of three members. Most respondents either contracted COVID-19 themselves or had to isolate due to its presence in their household. Employment was affected for 28.02% of participants, indicating a notable economic impact. Overall, the employment status of respondents during the pandemic was diverse.

Generally, the food habits did not change during the first wave of COVID-19 lockdown (Table 3, Fig. 2). The study reveals that, during the lockdown periods, some respondents changed their diet (34.07%). Most consumers did not significantly change their food purchasing behaviour during the pandemic. The increased volume of food purchases appeared to be driven more by fear and anxiety than by an actual intention to consume more. Interestingly, there was no notable rise in online food shopping, which may be considered

Table 2 Socio-demographic characteristics

Description	Poland		UK	
	Frequency	%	Frequency	%
Gender				
Female	108	59.34	83	64.34
Male	73	40.11	44	34.11
Not declared	1	0.55	2	1.55
Age (years)				
18–25	134	73.63	27	20.93
26–35	15	8.24	42	32.56
36–50	28	15.38	39	30.23
51–65	4	2.20	15	11.63
Above 65	1	0.55	6	4.65
Number of people per household (HH)				
1	12	6.59	31	24.03
2	39	21.43	41	31.78
3	62	34.07	15	11.63
4	40	21.98	28	21.71
5 and more	29	15.93	14	10.85
No. HHs with people aged under 17 years:	60	32.97	29	22.48
Since the beginning of the pandemic, have you or somebody in your household lost their job or earned less salary?				
Yes	51	28.02	40	31.01
No	131	71.98	89	68.99
Since the beginning of the pandemic, have you or somebody in your household been sick or had to isolate due to COVID-19?				
Yes	115	63.19	49	37.98
No	67	36.81	80	62.02
Employment status due to COVID-19				
Employed teleworking	50	27.47	39	30.23
Employed on-site physical work	46	25.27	27	20.93
Unemployed and incomeless	28	15.38	12	9.30
Employed: furlough scheme—COVID-19	6	3.30	5	3.88
Retirement pension	2	1.10	10	7.75
Other	49	26.92	36	27.91

unexpected given the broader shift to digital platforms in other sectors.

After the lockdown periods, some encouraging signs of more environmentally conscious behaviour emerged. Respondents reported increased efforts compared to pre-COVID-19 times, such as cooking food that was close to expiring, using freezers to preserve both purchased items and leftovers, and preparing creative meals using leftovers and all edible parts of food. These behaviours were adopted by more than 20% of participants. However, they did not represent the majority, as over 65% of respondents indicated that their behaviour remained the same as before the pandemic (Table 4, Fig. 4).

From the total, 55.5% of people who participated in the research could estimate the amount of food thrown away for different reasons in a household every week. Moreover, respondents are convinced that they waste less food than the average family in Poland (42%), much less (20%) or the same as the other families (29%). Only 15 people admitted they throw out more food than the others. In Poland there was no noticeable increase in online shopping (84.07% said no).

Due to restricted mobility to go shopping, only 24% of respondents made more effort in not wasting food, and 38% reflected on food management more than before the pandemic.

The United Kingdom

A survey was carried out in August of 2021 in order to know about the impact of COVID-19 on food waste production habits in UK households. The sample consists of

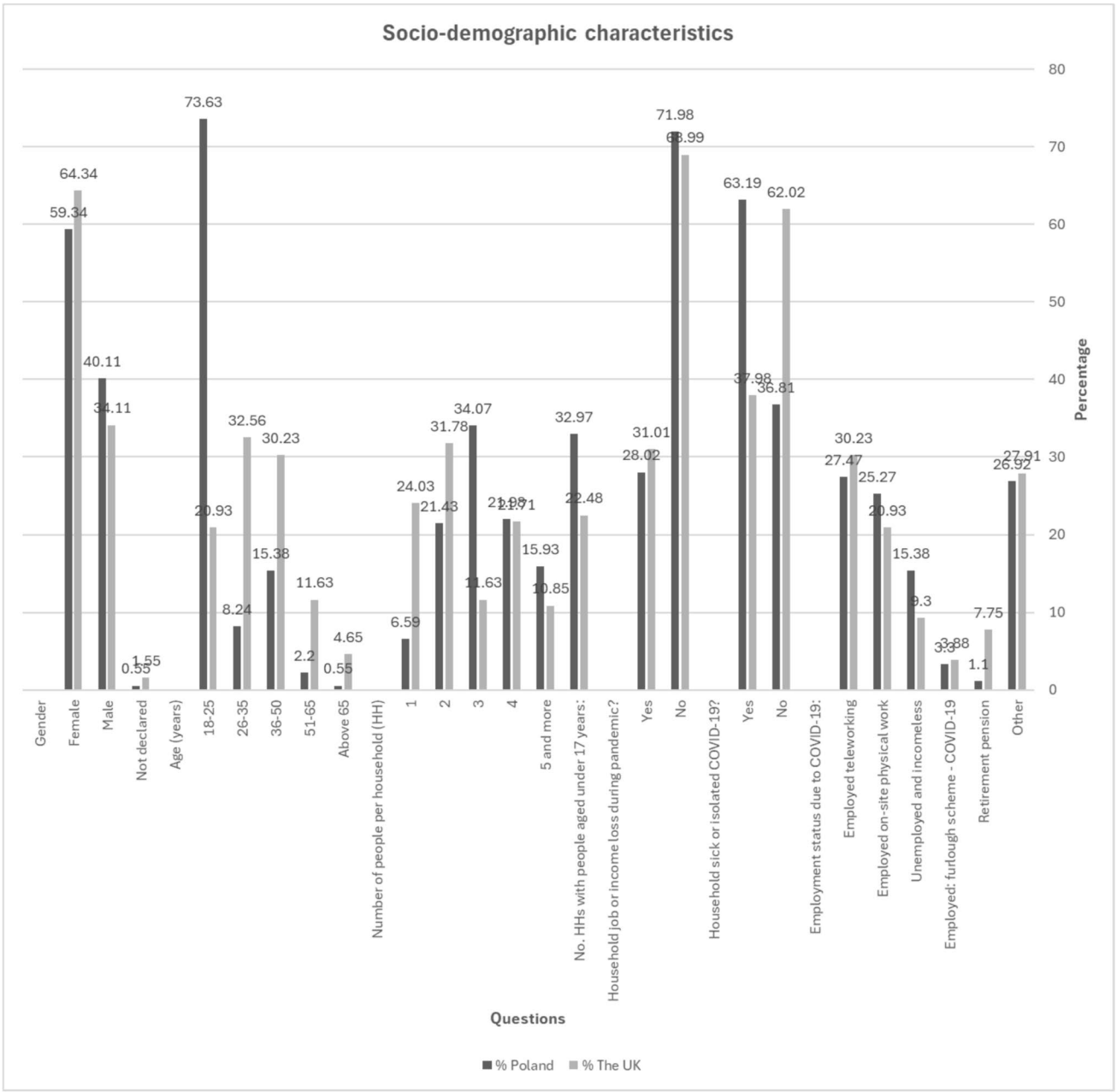

Fig. 1 Socio-demographic characteristics

129 respondents. Table 2 presents the socio-demographic characteristics of the people that answered the survey. The socio-demographic category considered were the same as per Poland. The female gender dominates the answers with 64.34%. Two-people households were the most represented in the survey (31.78%). Only 37.98% of the participants experienced cases of COVID-19 or isolation due to the pandemic. Regarding the employment status due to COVID-19, the group "Employed on-site physical work" reached 20.9% and "Employmed through teleworking" achieved 30.2%. The above could indicate that more than half of the sample had a job.

Table 3 and Fig. 3 show the behaviour during lockdown periods. The respondents indicated a change in the purchasing method during the periods of confinement. People were going out shopping less (66.7%), buying more online or in neighbourhood businesses (56.6%). Furthermore, participants indicated storing more food than usual (51.9%). In contrast, the respondents declared not to buy more food than expected due to anxiety or fear of COVID-19, not eating

Table 3 Behaviour patterns

Question	Poland		The UK	
	No (%)	Yes (%)	No (%)	Yes (%)
Did you buy more food than usual out of fear or anxiety during lockdown periods?	59.89	40.11	56.25	43.75
Did you eat more food than usual?	75.27	24.73	56.60	43.40
Have you stored more food than usual?	53.85	46.15	47.66	52.34
Did you waste more food than usual?	86.19	13.81	81.40	18.60
Have you changed your diet?	65.93	34.07	51.90	48.10
Did you buy more food products online?	84.07	15.93	48.80	51.20
Did you go shopping less often?	60.99	39.01	33.30	66.70
Did you buy more often in neighborhood stores?	49.45	50.55	43.40	56.60

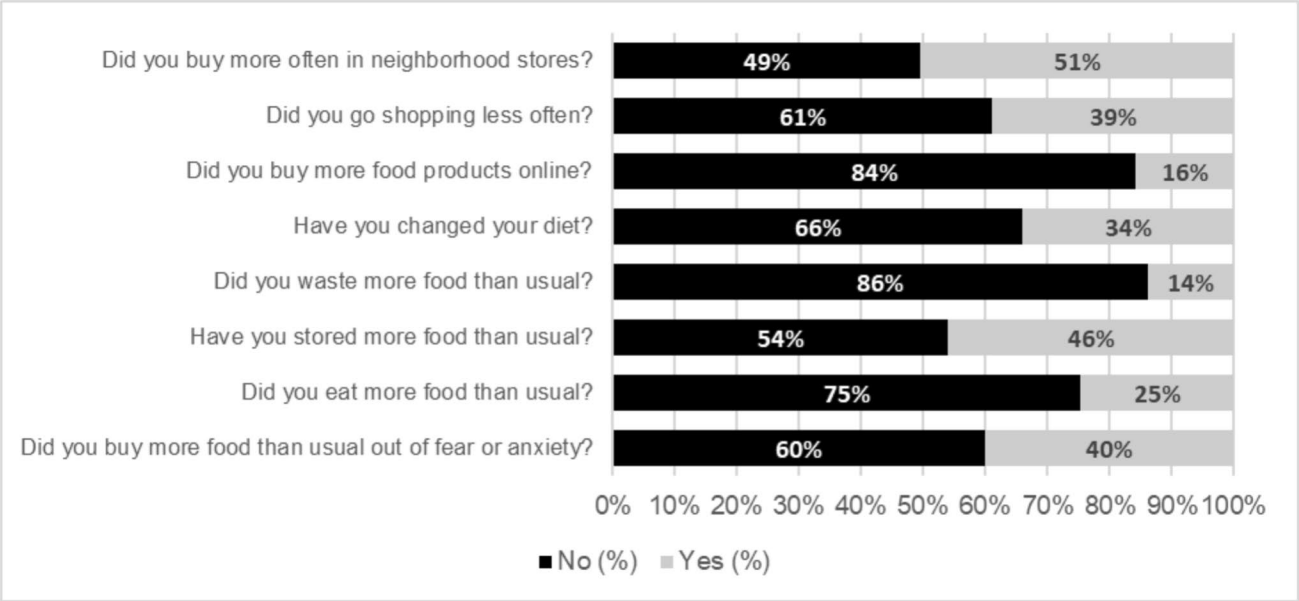

Fig. 2 Behaviour patterns during Lockdown periods in Poland

more than usual (56.6%), and not wasting more food than usual (81.4%).

Changes in food management were not observed after lockdown periods, as seen in Table 4 and Fig. 4. Nonetheless, some good behaviour can be identified. For instance, participants mentioned attempts "to go grocery shopping with a list of what they need", "to cook the products that are going to expire or spoil first", "to use the freezer to preserve what they buy and what is left over from what they cook", and "to make different creative recipes using leftovers and all edible parts of food". Although the answers indicated were for more than 20% of the respondents, these are not dominant.

From the survey, 53.49% of the participants could specify the quantity of household food waste generated per week. In addition, 50.4% of the respondents believe that they waste less food than the average family in the UK, much less (25.6%) or the same as the other families in the UK (18.6%). Only 5.4% recognised waste as more than the average.

In addition, respondents showed a change in their purchasing methods in the UK. 51.2% of the survey respondents answered buying more online.

During the confinement, 28.7% indicated making more effort in not wasting food due to the restrictions in mobility to go shopping, and 38% reflected more on food management than before the pandemic.

Comparison

Based on the results of both countries, it can be seen that female respondents prevail in both the surveys in Poland (59.34%) and in the UK (64.34%). The results align with the study developed in Spain by Vidal-Mones et al. [7], in which women represent 74.6% of the sample.

Table 4 Food habit

Food Habits	Much more than before	More than before	Same	Less than before	Much less than before	Country
I go grocery shopping with a list of what I need	6.04	10.44	78.02	3.85	1.65	Poland
	6.2	25.58	62.79	3.88	1.55	UK
When I go shopping, I end up improvising and taking products that I had not planned	2.20	9.34	67.03	15.93	5.49	Poland
	0.78	24.81	62.02	8.53	3.88	UK
I prefer to buy more food products online than go shopping	3.87	18.23	60.77	1.66	15.47	Poland
	10.85	20.93	47.29	13.95	6.98	UK
I try to cook the products that are going to expire or spoil first	12.15	19.34	65.19	3.31	0.00	Poland
	13.95	24.81	60.47	0.78	0.00	UK
I try to cook just like during lockdown periods	3.87	10.50	80.11	5.52	0.00	Poland
	6.98	15.5	61.24	13.95	2.33	UK
I use the freezer to preserve what I buy and what is left over from what I cook	5.56	17.78	75.00	1.11	0.56	Poland
	9.3	24.81	59.69	5.43	0.78	UK
When storing food, I take into account its consumption date and the storage instructions given by the manufacturer	6.63	11.60	80.11	1.66	0.00	Poland
	7.03	12.5	78.13	1.56	0.78	UK
I check the fridge to know the state of food I keep in it	7.18	17.68	74.03	1.10	0.00	Poland
	6.98	18.6	71.32	3.1	0.00	UK
I organise the food based on the label of products (e.g. expiration date) to know what we should eat first	3.87	4.42	87.29	1.66	2.76	Poland
	6.2	13.18	75.97	3.88	0.78	UK
I make different creative recipes using leftovers and all edible parts of food	3.31	22.10	69.06	2.21	3.31	Poland
	7.75	23.26	57.36	8.53	3.1	UK
I adjust cooking portions to avoid leftovers	3.87	17.13	75.69	2.76	0.55	Poland
	6.98	18.6	68.22	3.88	2.33	UK
If the occasion arises, I consume food that has passed its best before date	3.89	15.00	77.22	2.78	1.11	Poland
	3.15	15.75	70.87	3.94	6.3	UK
If the occasion arises, I consume food that has passed its use-by date	1.10	6.08	79.56	4.42	8.84	Poland
	2.33	14.73	68.22	9.3	5.43	UK
We recycle and sort food waste carefully	5.52	17.68	71.82	2.21	2.76	Poland
	4.69	24.22	67.97	2.34	0.78	UK

In Poland, most of the surveyed participants experienced cases of COVID-19 or isolation due to the pandemic. In contrast, in the UK, only 37.98% of the respondents indicated having issues with COVID-19. Comparing both results with the study developed in Spain, only 7.8% had issues with the disease. In addition, in the first country, 28.02% of the respondents indicated that their employment situation was affected, compared with only 13.18% in the UK. In Spain, 8.9% of the people declared being "unemployed and incomeless" and "employed using the furlough scheme due to COVID-19".

Regarding food habits during lockdown periods, respondents showed a change in their purchasing methods in the UK. Survey respondents answered buying more online (51.2%). The opposite was observed in Poland, where there was no noticeable increase in online shopping (84.07%). The above is in line with the results obtained in Spain, where people (85.2%) recognised not buying more products online. After the lockdown, there were no changes observed in food management habits in both countries. In Poland, only 8.24% of the respondents admitted that they could throw out more food than the others. Based on the above, just 5.4% of the surveyed participants in the UK recognised waste more food than the average.

Due to restricted mobility to go shopping, only 24% of the Polish participants and 28.7% in the UK of the respondents made more effort in not wasting food, and 38% (in both countries) reflected more on food management ompared to before the pandemic.

Discussion

Food waste has been a problem on a global scale for several years and affects all parts of each supply chain. However, more than half of the food losses are generated in households

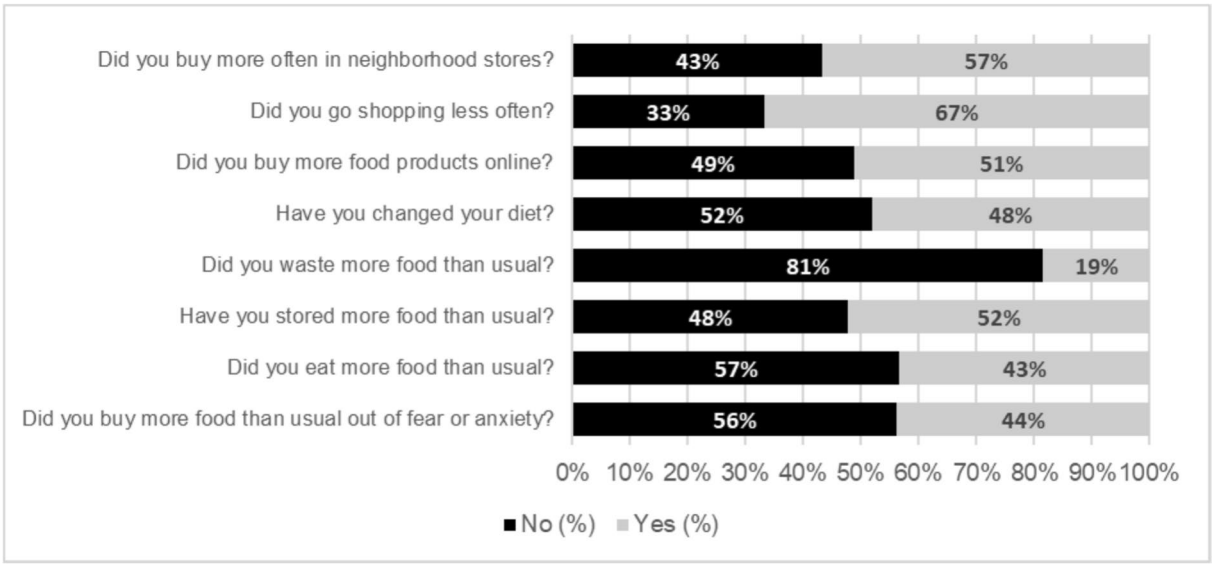

Fig. 3 Behaviour patterns during Lockdown periods in the UK

[70]. The pandemic of COVID-19 was a time of many concerns about the sustainability of supply chains and the source of many changes in consumer habits so far.

Food consumption is one of the basic needs of every human being. However, we have been observing disturbing waste-related phenomena for several years. Hence, the idea for research in which answers were sought to questions about behaviour change in such an exceptional situation as a pandemic.

The study shows that consumers in Poland and the UK did not change their food management daily habits in the area buying, eating and saving since most of the answers were 'Same' as before. The respondents admitted that in some dimensions, their habits could even worsen, but the scale was not significant, luckily. The result is supported by other studies conducted amongst Polish consumers in which authors found out that people rather persisted with their habits no matter if they were positive or negative [85]. The worsening of some habits was also observed amongst Brazilian consumers [86]. This was underlined in the study conducted by Bennett et al. [87] as well. Moreover, changes were noted in the scope of reduced shopping frequency, changes in shopping locations and increased preference for long-shelf-life and non-perishable foods. Janssen et al. [88] found reduced shopping frequency across Denmark, Germany, and Slovenia. AlTarrah et al. [89] reported that 42.8% of participants in Kuwait opted for online food delivery services. Bölek [90] found that 40% of consumers in Turkey, particularly those under 65, adopted online food purchasing. Junxiong et al. [91] reported an increase in online shopping from 11 to 38% in China, making it the most popular channel during the outbreak. Referring to the changes in shopping locations a shift away from traditional markets like farmers' markets in China was noted, which saw a decline from 23 to 10% of consumers [91]. Small local independent shops experienced an increase in patronage, rising from 12 to 17%. The studies reported changes in product selection during the pandemic and increased preference for long-shelf-life and non-perishable foods. AlTarrah et al. [89] found that 76% of participants in Kuwait purchased more long-shelf-life foods such as canned food and dry staples. Janssen et al. [88] observed higher rates of change in consumption of frozen food and canned food across Denmark, Germany, and Slovenia. According to studies from other countries there has been an increased preference for fresh and healthier foods. Bölek [90] found that 58% of Turkish consumers were more willing to buy fresh products, and 65% tried to consume more food that boosts the immune system. In Turkey it was noted increased consumption of fresh vegetables and fruits, animal-based products, cereals, and pulses [92]. Consumers have shifted towards local products as reported Udimal et al. [93] an increase in preference for locally produced foods amongst 64.6% of participants in China. This trend was accompanied by a negative attitude towards imported frozen foods amongst 29.1% of participants.

Although not predominant, as it was just reported by an average of 22% of respondents, the willingness to modify diets, create new recipes, or use freezers to preserve food represents a valuable foundation for promoting long-term behavioural change. This openness indicates a certain level of readiness among consumers to reflect on and adjust their food-related habits. This is essential for fostering and reinforcing environmentally friendly practices and for highlighting the role of individual engagement in

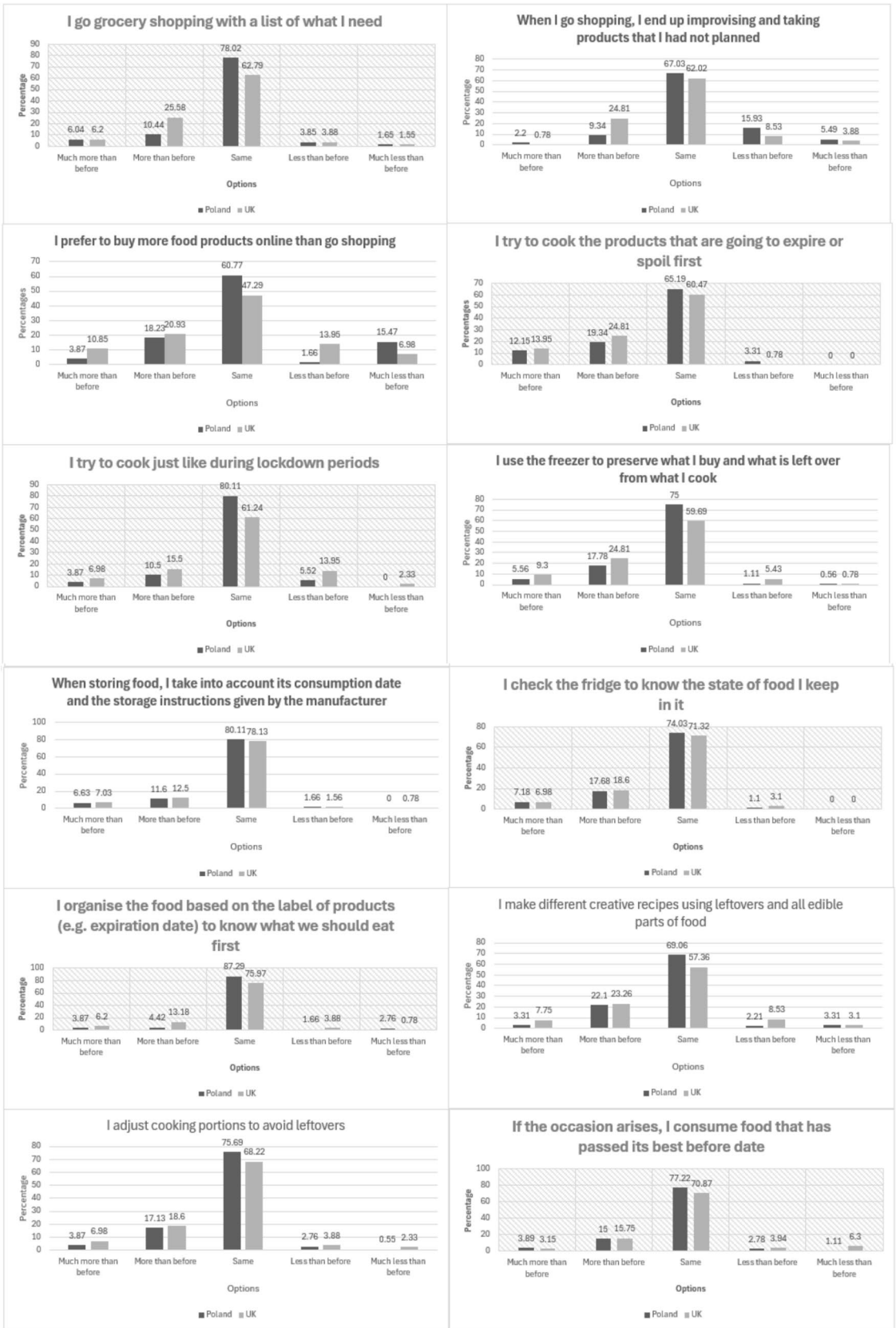

Fig. 4 Food habits

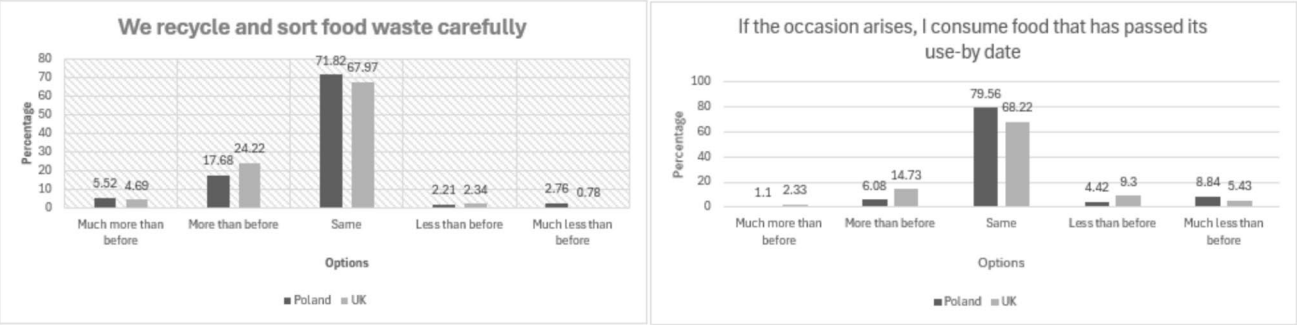

Fig. 4 (continued)

sustainable food waste management. The continued relevance of this issue has led to the development of various strategies and tools aimed at influencing consumer behaviour. These include persuasive approaches to encourage food waste reduction, such as tailored advertising that considers the relative effectiveness of different message framings and temporal focuses [94].

The study of Babbitt et al. show that reduced household food waste was significantly correlated with an increase in behaviours such as meal planning, preserving foods, and using leftovers and shelf-stable items [95]. However, numerous analyses in the literature clearly indicate that the condition for the effectiveness and efficiency of food waste management processes is a comprehensive approach that takes into account various dimensions that characterise consumers and the rules that prevail in their households [96].

It should be emphasised that it is very important to continuously improve public awareness of the issues discussed. There are different ways of spreading knowledge [6], increasing understanding and convincing consumers to develop and persist the positive habits also when an emergency situation like COVID-19 finishes.

There is a set of elementary steps that consumers can follow to improve their food habits like preparing shopping lists based on current needs, planning the meals in advance, implementing a system of food storage in the fridge to avoid food expiration dates or introducing a system of food containers and on leftovers. Those are the most common but not the only ways to cope with food waste in value chains, including households [6, 97].

Technology and the availability of the different applications and smart solutions integrated with household devices can make food waste elimination easier. The applications seem to be especially useful for younger generations but not limited to them. Users who prefer virtual shopping lists, cookbooks or checklists to monitor the amount of food available or needed to be bought can find propositions from different app providers [98].

Technological opportunities could play an essential role in food waste reduction, but time is still required to popularise them on a large scale. Liegeard and Manning [98] introduced other smart and intelligent solutions like interactive, intelligent, active packaging that extended product quality or monitored their freshness. This solution is part of the Internet of things. Another proposition of technology use is intelligent fridges with sensors and programmes aiming at efficient food management [98]. An interesting and increasingly popular solution are e-platforms, which allow users to purchase unsold food at a reduced price at the end of the day [99].

One of the solutions to prevent food waste is food sharing [100]. The idea of food sharing, even though it is beneficial, should not be indicated as the primary option for dealing with food waste. Food sharing can work when consumers do not know what to do with surplus food, especially food that cannot be frozen. However, considering that it seems more important to limit losses before shopping to avoid overconsumption, some ideas to prevent excessive food buying seem more crucial. The education of consumers should be treated as a priority. Consumers are expected to be more aware of the personal impact that they have on food waste and the consequences of irresponsible behaviours. In the era of social media and easy access to the different sources of information the social campaign, advertisements and governmental initiatives are very welcomed [100, 101].

Equally important is the education of young consumers, especially those still in education who run their households like students. Education makes people aware of the consequences related to food waste [102].

It is worth mentioning that consumers are not the only factor in food waste generation. There are possibilities to monitor and control the amount of required food to prevent a surplus in the whole supply chain, both online and offline selling [103]. Moreover, retailers and marketers can play an essential role in unnecessary food buying by designing the proper packaging size, avoiding promotional actions that enhance the willingness to buy more like free and extra

products or implementing the responsible pricing policies [104].

Going beyond the individual level in activities aimed at reducing food waste, it is also worth analysing activities in the local community which may support the desired everyday routines. Creating frameworks and policies for developing sustainable food management behaviours such as compost storage sites, educating, integrating and initiating actions that allow the local community to tackle the problems seem equally valuable [105].

The challenge of food waste can be solved by different methods, tools and approaches that should be introduced to consumers and to make them a part of their new food management habits.

Conclusion

Food habits during the COVID-19 period did not change substantially. However, in the UK respondents bought more online (51.2%) compared against Poland, where there was no noticeable increase in online shopping (84.07%). People behaved like they did before the pandemic with deeply ingrained habits. For example, in Poland, only 8.24% of the respondents admitted that they could throw out more food than the others and only 5.4% of the surveyed in the UK recognised waste more food than the average. It can be said that the challenges with food waste in households remained though some signals of more conscious behaviours amongst some respondents were observed.

Some limitations of the study may be highlighted. Due to the limited sample size, the results were not statistically significant but indicated some key areas for food waste generation in Poland and the UK. A few elements of the food management including sourcing and consumption practices are modified, but their scale is not significant for which the large-scale study from Spain had similar conclusions [7].

Future research may be needed to evaluate if the symptoms of changes would persist in everyday habits for a longer perspective. The analysis could benefit from a stronger quantitative focus. The aforementioned examples present valuable directions for future research aimed at identifying which strategies are most effective for improving household food management. Additionally, the role of environmental awareness warrants further exploration, as it appears that respondents did not explicitly consider environmental factors when reflecting on their food-related behaviours. Our findings point to the need for further investigation into the environmental impact of consumer food habits in the post-COVID-19 context. Future research could also be broadened to examine the pandemic's broader implications for waste management systems, drawing on illustrative examples from related fields [106, 107].

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