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Appetite 180 (2023) 106313

Contents lists available at ScienceDirect

Appetite

journal homepage: www.elsevier.com/locate/appet

Food waste in time of COVID-19: The heterogeneous effects on consumer groups in Italy and the Netherlands

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ARTICLE INFO

Keywords:
COVID-19
Food waste
Cluster analysis
Behavioral change
Motivation-opportunity-ability
Food habits

ABSTRACT

Since COVID-19 outbreak, States adopted different combinations of measures to restrain its spread that affected individual behaviors and the already fragile local and global food systems. The aim of this research is to contribute to the scientific debate around food systems sustainability through the analysis of behavioral shifts in household food waste drivers, specifically occurring during the recent global pandemic. A survey was developed based on an extended version of the Motivation-Opportunity-Ability (MOA) approach. A representative sample of 3000 respondents in Italy and in the Netherlands (1500 per country) completed this survey in May 2020, while lockdown to mitigate the first wave of COVID-19 outbreak was active in both countries. A cluster analysis based on individual food-waste- related behaviors identified four homogenous groups of consumers in the Italian sample and five in the Dutch sample. The comparative analysis of these groups led to the identification of several communalities in behavioral patterns, both within and between the two countries. Results suggest that in both countries, self-reported quantities of household food waste actually decreased, with a stronger reduction reported by Italian consumers. The MOA approach allowed to explain this perceived reduction as largely depending on the increase of opportunity to dedicate more time - to food-related activities as compared to the pre-COVID-19 period, with positive consequences on food management ability. These findings assist in drafting recommendations for tailored interventions to reduce the amount of domestic food waste and preserve positive behaviors emerged during lockdown, that could be continued in the absence of crisis.

1. Introduction

Household food waste is a complex problem with a negative economic, societal and environmental impact. The Food and Agriculture Organization (FAO) estimates indicate that approximately one third of all food produced globally is not consumed by humans (FAO, 2019) and, within the EU, approximately 88 Mton of food is discarded as waste annually (Stenmarck et al., 2016). These numbers indicate an urgent need to tackle the issue of wasted resources in the food system, by improving the organization of our food systems and the behavior of consumers.

In this context, the COVID-19 crisis emerged in Europe during the first months of 2020, forcing national governments to implement restrictions on freedom of movement and non-essential economic activities to prevent the spread of the disease. This had strong and diverse impacts on both the food supply chain management and the decisions of consumers (Ibn-Mohammed et al., 2021; Vidal-Mones et al., 2021), including household practices related to food waste generation. (Aldaco et al., 2020; Ibn-Mohammed et al., 2021; Vanapalli et al., 2021). On the supply side, lockdown measures generated serious inefficiencies and distortions, potentially leading to generation of food losses (food waste generated in the supply chain) due to labor shortage, limited production capacity and more complex distributing logistic. On the demand side, the interruption of eating-out facilities generated a peak in the consumption of food at home, influencing consumers' preferences and purchase decisions (Roberts & Downing, 2020). Food access, food security and food safety emerged as major concerns due to suspected transmission of COVID-19 by food and food packaging along the supply chain (Galanakis, 2020; Rizou et al., 2020). Lifestyle modifications, reduced income, and job insecurity together with changes in time

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https://doi.org/10.1016/j.appet.2022.106313
Received 5 April 2022; Received in revised form 12 September 2022; Accepted 12 September 2022
Available online 17 September 2022
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availability, induced individuals to cope through changes in behaviors, eating habits (Ben Hassen et al., 2021; Ibn-Mohammed et al., 2021; OECD, 2020) and consequently affect the amount of food wasted.

The response to COVID-19 has not been the same across Europe. National advisory and regulatory measures differed between Member States in timing, aim and intensity, depending on emergency severity and national strategies. In general, two different approaches could be identified. Some EU Member States, like Italy, where the pandemic hit hardest in its initial stages, adopted a very restrictive approach. These countries imposed limiting or even prohibiting personal mobility and economic activities, except for those strictly related to essential needs such as supermarkets or other food stores (retail). Restaurants, catering and food services were forced to close. In other countries, like the Netherlands, the restrictions on freedom of movement and non-essential economic activities were less severe. Consequently, the associated impacts on food-related habits of citizens are assumed to be different as well. Therefore, this study investigates two cases, Italy and the Netherlands, which represent different contexts with regards to measures to mitigate the effects of the pandemic. Moreover, both countries share a long tradition of food waste mitigation policies like the Gadda Law promoted in Italy and the Realisation Plan Circular Agriculture, to achieve the SDG 12.3 target (halve global per capita food waste by 2030) by focusing on awareness, activation and adaptation for the Netherlands. Main action lines include monitoring, business collaboration, consumer awareness and addressing inhibiting regulations at national and EU level. The COVID-19 outbreak and its consequences provide a unique opportunity to analyze the impact of crisis-induced changes on household food management and food waste related behaviors and this work aims to expand this field of research. Although some studies underlined that some type of solid waste have increased during the pandemic (like medical waste or plastic packages), the consequences of lockdown measures on consumers' food waste and food-related behaviors at home are still a caveat on scientific literature. Some works have tried to explore this link, but they were not based on a theoretical framework to systematically explore consumer food waste drivers and were based on convenience samples that precluded generalizations of results (Leal Filho et al., 2021; Liang et al., 2021; Valizadeh et al., 2021). Therefore, the aim of this research is to explore how different COVID-19 related restrictive measures imposed between February and June 2020 affected changes in food (waste) related behaviors of Italian and Dutch consumers during the first wave of the COVID-19 pandemic using the Motivation-Opportunity-Ability framework to analyze consumer food waste drivers of two nationally representative samples.

The paper is organized as follows: section 2 describes the differences in the national responses in the two countries to address the health crisis; section 3 describes the theoretical framework at the base of this work; section 4 the methodology implemented for the survey development and the analysis; section 5 describes the results; section 6 contains the discussion of results including policy implications and strengths and limitations of the work; section 7 describes the conclusion that can be drawn.

2. COVID-19 outbreak and responses in Italy and the Netherlands

Italy has been the first European country severely hit by the COVID-19 outbreak in late January 2020. From February 23rd onwards, the Italian Government implemented several social restriction measures to control the spread of COVID-19 infections leading up to a national lockdown two weeks later. At first, the restrictions were limited to specific territories, with the establishment of the first "Red Zones" in Lombardia and Veneto Regions, in which only retailers selling essential goods, including food, could operate. Two days later, these restrictions were extended to other Northern territories and new ones were introduced by March 1st. Schools of any grade, including universities, closed across the whole country on March 4th. By March 11th, the lockdown was extended to the entire national territory, and a 24/7 curfew affecting the freedom of movement was installed for all Italian citizens, except for the workers providing essential services, like healthcare professionals or food retail staff. In this context, leaving one's home was perceived as a danger for the risk of contracting COVID-19 and for the possibility to incur a fine due to the strict controls performed by police officers. Nearly two months later, from May 18th onwards, citizens were allowed to leave their homes again for other purposes than acquiring food or travelling related to essential jobs, while social distancing measures (e.g. keeping a distance of at least 1.5 m from each other) and other measures, like wearing mouth masks and avoiding crowded places, were still enforced and encouraged.

The Netherlands was hit by the COVID-19 outbreak a few weeks after Italy. On March 15th, the Dutch government announced several measures to slow down the spread of the virus and to prevent hospital intensive care units from running out of capacity. During the so-called 'intelligent lockdown', a set of rules and measures were implemented on national level, including social distancing and the closing of all eating and drinking establishments (except for hotels), which were only allowed to offer take-away concepts. The number of visitors in households was restricted to three 13+year old guests, and it was strongly advised, to work from home whenever possible. Furthermore, schools and daycare organizations at all levels were closed and a protocol for responsible shopping was introduced, taking hygiene and social distancing measures into account. From May 11th, the first measures were lifted. Primary schools partially reopened, and children went back to school at half-time. From June 1st, more measures were lifted. Bars and restaurants reopened, and schools reopened completely. Social distancing and all other basic rules, like washing and disinfecting hands, staying at home in case of symptoms were still in place. Table 1 summarizes the different measures in Italy and the Netherlands related to shopping, eating-out/take-away and freedom of movement during the first wave of lockdowns. The COVID-19 pandemic has not kindled out since this first wave during the first half of 2020, seeing surges of new COVID-19 variants happening across the world and Europe throughout 2021 and into 2022.

When comparing both countries, the measures during February–June 2020 were stricter in Italy than in the Netherlands, regarding shopping measures and limitations of movement. Most noticeable is the installment of a fulltime curfew in Italy, which did not happen in the Netherlands in the first wave of the pandemic. These differences allow to explore differences in food (waste) related behaviors due to different patterns of COVID-19 related restrictive measures.

3. Theoretical framework

To understand the complexity of the multiple and interconnected behaviors leading to the generation of food waste, a number of conceptual frameworks have been developed in recent years. This research relies on the well-established Motivation-Opportunities-Abilities (MOA) theoretical framework as starting point to investigate food waste behavior under the restrictive COVID-19 measures in Italy and the Netherlands. The MOA framework (Fig. 1) considers food waste as an unintended consequence of iterative decisions and behaviors related to household food management practices, that are driven by both internal (Motivation and Abilities) and external (Opportunities) factors (Van Geffen et al., 2017). The MOA framework has been tested recently within the household food waste issue on its capacity to consider both internal and external factors, its adaptability and its validation, using large-scale surveys in several EU countries, including Germany, Hungary, Italy, Spain, and the Netherlands (Van Geffen et al., 2017). The framework was developed within the European H2020 REFRESH project (van Geffen et al., 2016), building on the earlier work of, amongst others, Rothschild (1999). REFRESH was a Horizon 2020 project focused on the reduction of avoidable waste and improved

Table 1
Measures in place relating to grocery shopping, eating out and take-away of food and freedom of movement during the first lockdown between February and June 2020 in Italy and the Netherlands.

Country	Grocery shopping	Eating out and take-away	Freedom of movement
Italy	Only stores within the municipality of residence reachable Only 1 person per household allowed in food store at once Shopping baskets/carts cleaned with disinfectant solutions Social distancing (1.5 m) in the shop All shops handled a maximum number of customers at once Face masks and gloves mandatory Farmers' markets closed	All eating and drinking establishments closed Only delivery allowed	Remote working was mandatory except for the workers providing essential services, like healthcare professionals or supermarket staff Going out allowed to obtain food for the household Going for a walk outside allowed within 200 m around the house and only alone Only necessary travel allowed (examples are a crucial job or health reasons)
Netherlands	All stores reachable for every citizen. Only 1 person per household allowed in food store at once Shopping baskets/carts cleaned with disinfectant solutions Social distancing (1.5 m) in the shop All shops handled a maximum number of customers at once, based on available m2 of shopping area Face masks and gloves not mandatory In some cities, food markets closed, in some they remained open (municipality could decide)	All eating and drinking establishments closed Delivery, take-away and to-go concepts allowed	Advice to stay home as much as possible Working from home is the standard, unless this is really not possible (e.g., job that is essential and has to be carried out on location) Advice to avoid crowded places Going for a walk outside allowed, with a maximum of 2 persons, unless from same household. No restrictions on distance from house Only necessary travel allowed (examples are a crucial job or taking care of an ill relative)

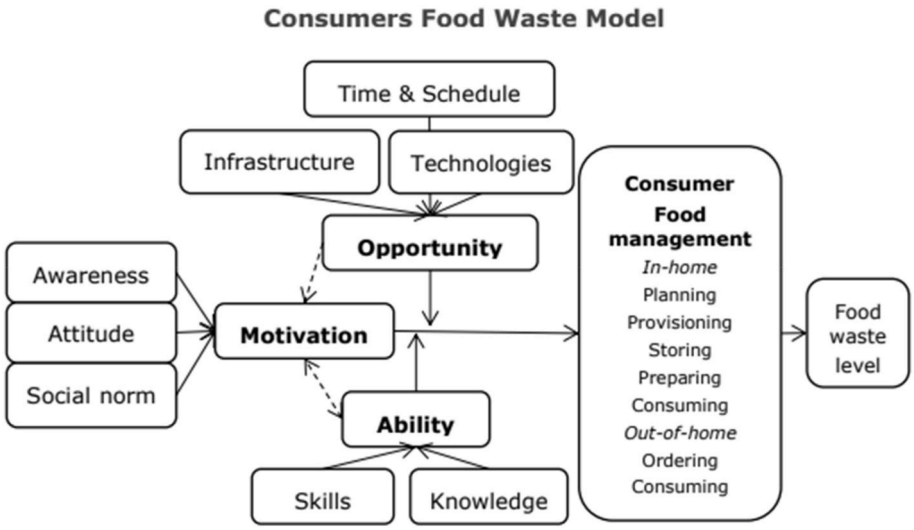

Fig. 1. MOA framework - source (van Geffen et al., 2016).

valorization of food resources. Backed by research to better understand the drivers of food waste, the project supported better decision-making by industry and individual consumers.[1] Within REFRESH, monetary and non-monetary drivers of household food waste were investigated on the base of a version of the Motivation-Opportunity-Ability framework adapted to describe individual behaviors related to the food management domain. The individual decisions and behaviors described in the framework are largely part of habits, routines and semi-conscious intentions executed to manage the food supply in the household, structured as provisioning, storing, preparing and consuming. Each stage in household food management practice covers different but interconnected sets of behaviors that, at any point, can lead to intended or unintended food discards (van Geffen et al., 2020). For example, preparing too much food can displace existing meal plans, meaning that originally planned food items may get wasted (Quested et al., 2013; Schmidt, 2016).

In the MOA framework, *Motivation* (M) equates to a person's willingness to perform actions that avoid food waste generation (Principato et al., 2015; Setti et al., 2018; Vittuari et al., 2020) and includes awareness, concerns about monetary and environmental impact, and food safety. In addition, Stancu et al. (2016) indicate attitudes, injunctive norms and moral norms as well as perceived behavioral control, intention, awareness of environmental, social and economic impacts as important elements. Visschers et al. (2016) also include perceived health risks, subjective norms and good provider identity as Motivation elements (Aktas et al., 2018; Schanes et al., 2018; Stangherlin & de Barcellos, 2018).

Opportunity (O) refers to the availability and accessibility of materials and resources needed to change behavior (Shwom & Lorenzen, 2012). Time and schedule, materials, technologies and infrastructure further shape this driver of food waste, e.g., portion or package size, discount promotions in shops, etc. (Stancu et al., 2016; van Geffen et al., 2020).

Finally, *Ability* (A) is a driver for food waste generation. Prior findings suggest items related to knowledge and skills on the use of date labelling and estimating food edibility to contribute to household food waste (Smith & Landry, 2020; van Geffen et al., 2020). Ability also refers to a person's proficiency to solve the problems that he or she encounters

[1] https://www.eu-refresh.org/about-refresh.html.

when changing behavior, including breaking well-formed habits and routines or countering the arguments of peers (Rothschild, 1999).

Next to behavioral drivers, various socio-demographic factors play a role in the generation of household food waste. In van Herpen et al. (2019), socio-demographic characteristics correlated to food waste level, household management practices, motivation, abilities and opportunities. Therefore, age, household size, gender and country need to be considered when applying the MOA framework. Furthermore, employment status, income and education level have shown to influence food waste generation at the household level (van Geffen et al., 2020).

The analytical framework used in this study was extended with novel elements of *Uncertainty* (U) that consumers experienced due to the COVID-19 restrictions. Uncertainty is defined as incomplete information or knowledge about a situation – meaning, the possible alternatives or the probability of their occurrence or their outcomes are not known. (Scholz, 1983, pp. 3–18). This was the case for the restrictions adopted to contain the COVID-19 outbreak, due to the unknown potential sanitary and economic consequences of the pandemic. Behavioral economics proved that the presence of events that cannot be estimated precisely undermines the rationality of decisions, including those related to purchasing habits. This can lead to potential irrational behaviors (Setti et al., 2018; Tversky & Fox, 1995; Tversky & Kahneman, 1992) that should be considered in analyzing food waste drivers. In this work, Uncertainty is investigated in relation to the domain of household food waste generation. To do so, Uncertainty items like fear of being exposed to the COVID-19 virus during grocery shopping, social pressure inside the shops (e.g. the repeated requests of spending a low amount of time inside supermarkets and the fear of being in contact with other people inside shops), the change in number of meals consumed at home, and the occurrence (or absence) of unforeseen events influencing the management of meals) were added to the questionnaire. In the current study, an extended "MOA + U" framework is applied (Vittuari et al., 2021).

4. Method and materials

The study used a cross-sectional design in which a questionnaire was submitted to two representative samples of Italian and Dutch consumers (1500 respondents each) in May 2020, when lockdown measures were active in both countries as described in Section 1. In Italy data were collected from the 24th to the 30th of May, just after the end of the most restrictive measures. In the Netherlands data collection took place between the 8th and the 17th of May, which was still in the lockdown period. Halfway this period (11th of May), the advice to 'stay home as much as possible' was changed to 'avoid crowded places'. Since questions were clearly referred to the lockdown period that ended just a few days before in Italy and was still partly in place for the Netherlands, the reliability of answers was considered high, and behaviors were most probably still influenced by the restrictions.

The questionnaire was based on items tested and validated across several EU countries as a consistent tool to investigate food waste drivers at consumer level (van Herpen et al., 2019). The Likert scale was adopted for the answers after a careful review of existing literature on the method for measuring food-related behaviors (Grainger et al., 2018).

Respondents were 18 years and older, and responsible for at least half of the food shopping and cooking in the household and were not sick for more than two weeks during the lockdown. The selected samples were nationally representative in terms of key demographics: household size, gender, age, income, education, region and urban-rural living area. Respondents were randomly drawn from the online panel based on the available profile data (age, gender and region) and pre-defined subsample sizes (quota) based on official population statistics in terms of key demographics. Quotas allow for generalization to national household level and cross-country comparison during data collection. A professional market research organization, MSI-ACI EUROPE BV, was contracted for the recruitment and data collection of the survey for both countries. The sampling methodology adopted by MSI-ACI EUROPE BV is based on the blending of different panel and sample sources for each study through one controlled platform to ensure quality sampling. Non-probability/volunteer online access panels were used as a sampling frame. Recruitment of respondents continued until the agreed simple size was achieved while always considering sampling quotas. The survey was conducted online through computer-assisted web interviewing (CAWI) and was compliant with the General Data Protection Regulation (GDPR). All respondents gave informed consent before filling out the survey. It was explained to respondents that the aim of the survey was to investigate how the COVID-19 restrictions taken by the government affect shopping routines, purchasing behavior and the way food is handled in households. As an incentive, respondents earned points for a personal saving system. These points could then be used for specific discounts or products. Answers were checked for consistency by verifying answering speed (per question, per screen, and overall completion time per questionnaire) and machine-generated or speed clicked answers. These outliers were removed from the dataset.

4.1. Questionnaire development

The questionnaire was designed following the conceptual MOA framework, integrated with elements related to Uncertainty and included 42 questions. The questionnaires for the Dutch and Italian sample shared a common basis as well as specific questions targeting the characteristics of the COVID-19 measures and the food culture context in each country. Questionnaires were developed in English, on the base of the REFRESH framework, and then translated in Dutch and Italian. Before the submission, the questionnaires were tested for clarity and readability by submitting them to colleagues of both research teams not involved in this research and in the REFRESH project. Then it was technically revised and piloted by the market research company. In line with the research aim, the questionnaire focused on discerning differences in food (waste) related behaviors of Italian and Dutch consumers during the period of implementation of restrictive measures, compared to the pre-COVID-19 situation. Respondents were asked to self-compare their food (waste) behaviors on changes in prevalence before and during the COVID-19 restrictions on a 7-point Likert scale (from 1 = much less to 7 = much more). Items of each question were presented in randomized order to avoid item ordering effects.

The 42 questions were structured in 7 sections. Section 1 (S0–S4) was dedicated to the screening of respondents, section 2 (Q1-Q11a) concerned grocery shopping habits and planning, section 3 (Q12 to Q16) referred to meal preparation, section 4 (Q17, Q18) investigated behaviors and habits related to stock management, and section 5 (Q19-Q25) was related to self-reported food waste amounts and handling of meal leftovers. Finally, section 6 (Q26-Q29) referred to a set of behaviors and habits adopted by the household during the lockdown, and section 7 (Q32-Q38) concerned the socio-demographic characteristics of the respondent's household.

In each section, the theoretical constructs of the MOA + U framework were explored using dedicated different questions to capture all different aspects and nuances of these theoretical constructs. For the complete list of questions and their differences across countries, see Appendix A. Completing the questionnaire took 15–20 min.

4.2. Data management and cluster analysis

Since the aim of the work is to explore different groups of consumers adapted to different types of COVID-19 related restrictions, descriptive statistics and clustering analysis were performed for each country. The comparability of the survey design both in terms of questionnaire and sampling strategy with national representative quotas allows the comparison of results in both countries. Cluster analysis identified homogeneous groups of consumers in each of the two countries based on food management habits and adaptation strategies implemented to cope with the COVID-19 measures. Variables have been recoded from the 7-point

Table 2
Pseudo-F for Italy and the Netherlands.

Number of Clusters	Pseudo-F Italy	Pseudo-F the Netherlands
2	143.02	95.45
3	109.98	72.04
4	83.33	60.85
5	70.61	52.67
6	61.94	47.63
7	55.65	44.34
8	50.92	41.57
9	47.4	39.50
10	44.08	37.34
11	41.15	35.43
12	38.43	33.71
13	36.15	32.09
14	34.19	30.65
15	32.46	29.42

Likert scale to a −3 (highest decrease or strongest disagreement) to +3 (highest increase or strongest agreement) scale and were then standardized. Then, several hierarchical (single, average, complete, weighted-average, median, centroid, and Ward's linkage) and partition (k-means and k-medians) clustering algorithms were implemented. Output for the Ward's minimum variance clustering was retained, since it returned the most balanced number of clusters in terms of size. In addition, Ward's minimum variance method, minimizing the intra-cluster variance and maximizing the variance among the clusters, allows identifying the most coherent groups of subjects, and avoids overlap among clusters. The cluster analysis resulted in the identification of four Italian and five Dutch homogeneous groups of consumers that presented internally homogeneous and externally heterogeneous food-related behaviors during the sampling. The number of clusters of consumers considered for each of the two countries is defined by the values of the pseudo-F index calculated for the two samples, presented in Table 2.

The differences across clusters were statistically tested within each country then a descriptive cross-country comparison was conducted among the different theoretical constructs of the MOA framework explored with the survey items. ANOVA models and Bonferroni multiple-comparison tests were used to assess whether the clusters differed significantly in terms of socio-demographic characteristics, and for the items related to food management and COVID-19 measures' responses. The use of parametric tests as ANOVA and Bonferroni to test differences for Likert scales is widely used in literature and is proven to be robust, also given the size of the two samples analyzed in this work. (Carifio & Perla, 2007, 2008; Norman, 2010).

5. Results

5.1. Description of the clusters

The Clusters identified in Italy and the Netherlands were named with acronyms related to the country (I for Italy, NE for the Netherlands) the level of adaptation of their members to the new context generated by the COVID-19 related restrictions and to the declared level of concern about the consequences of the pandemic. Concerning the level of adaptation, *W* indicates *weakly adapting* consumers, *M* stands for *moderately adapting* members, and *S* represents *strongly adapting* consumers. The level of concern of consumers for the consequences of COVID-19 is described by the letter *U* for *unconcerned* or by the letter *C* for *concerned*.

The four Italian clusters were called *Weakly Adapting & Unconcerned (I-WU), Moderately Adapting & Unconcerned (I-MU), Moderately Adapting & Concerned (I-MC),* and *Strongly Adapting & Concerned (I-SC)*. The five Dutch clusters were defined as *Moderately Adapting &Unconcerned (NE-MU), Non-adapting & unconcerned (NE-NU), Weakly adapting & unconcerned (NE-WU), Weakly adapting & unconcerned old women (NE-WUO),* and *Strongly adapting & concerned (SC)* (Table 3). The NE-WUO group has not been further considered in the analysis for purposes of clarity, in particular because of its very small size (2% of the total sample for the Netherlands) and its similarity with the NE-WU cluster.

Table 4 shows the main demographics, the average shifts in self-reported quantity of household food waste compared to the pre-COVID-19 period, and the average intensity (in absolute values) of shifts in the theoretical constructs of the MOA + U framework for the whole sample and the different clusters of each country and the proportion of responses in the different parts of the aggregated scale. Larger positive shifts stand for an increase/agreement for the mentioned item, while larger negative shifts mean a decrease/disagreement. Values close to zero represents no changes in behavior as compared to pre-COVID-19.

Comparing both countries on a descriptive level, it is noticeable that shifts in (self-reported) food waste generation and average shifts regarding behaviors connected to food waste differ. This suggests a different impact of COVID-19 restrictions and the development of different adaptation strategies in the two countries. Both Italian and Dutch consumers self-reported to have produced less food waste within their household, and increased Motivations, Abilities and Opportunities, but these shifts were larger in Italy than in the Netherlands.

I-WU and I-MC are the two largest clusters identified for the Italian sample, followed by I-SC and I-MU groups. Average age of I-WU cluster is 46 years old and the 69% of its members does not have children living with them. I-MU cluster has the highest average age among the Italian groups of consumers, 52 years old, 15% of its members is single and the 79% does not live with children. I-MC cluster registers an average age of 45 years old, includes the lowest share of single members (4.5%) and the 46% of its members live in families with 1 or more children. Finally, I-SC cluster has the lowest average age and includes the highest shares of women (67%) and of highly educated members (43%). Half of its members live in families with 1 or more children under 12 years old.

For the Netherlands, NE-MU is the largest cluster identified, including the 36% of respondents, followed by NE-WU, NE-NU and NE-SC groups. NE-MU cluster include respondents with an average age of 47 years old. This group is the one with the highest share of singles among the Dutch clusters. NE-WU cluster includes members with an average age of 45 years, who are living in small families with a number of children in line with the Dutch National value (around 1 per family). The NE-WU cluster incudes one fifth of Dutch respondents, with an average age of 56 years old, being the eldest group identified in the country. Families included in this cluster register the highest share of families without children. Finally, the NE-SC cluster is the smallest of the Dutch sample (includes the 13% of respondents), while being the youngest, with an average age of 44 years, and the one including the highest share of highly educated people (see Table 1).

Table 3
Homogeneous clusters for the Italian and the Dutch samples.

Italian sample		Dutch sample	
Label	***Cluster name***	***Label***	***Cluster Name***
I-WU	*Weakly adapting & unconcerned*	**NE-MU**	*Moderately Adapting & Unconcerned*
I-MU	*Moderately Adapting & Unconcerned*	**NE-NU**	*Non-adapting & unconcerned*
I-MC	*Moderately Adapting & Concerned*	**NE-WU**	*Weakly adapting & unconcerned*
I-SC	*Strongly Adapting & Concerned*	**NE-WUO**	*Weakly adapting & unconcerned old women*
		NE-SC	*Strongly adapting & concerned*

Table 4
Main characteristics of the clusters in Italy and in the Netherlands.

Italy						The Netherlands				
	Weakly adapting & unconcerned (I-WU)	Moderately Adapting & Unconcerned (I-MU)	Moderately Adapting & Concerned (I-MC)	Strongly Adapting & Concerned (I-SC)	Total sample	Moderately Adapting & Unconcerned (NE-MU)	Non-adapting & unconcerned (NE-NU)	Weakly adapting & unconcerned (NE-WU)	Strongly adapting & concerned (NE-SC)	Total sample
% of total sample	38%	8%	38%	16%	100%	36%	20%	29%	13%	98%[a]
Mean age (years) ± SD	46.3 ± 14.6	51.9 ± 13.7	45.4 ± 13.2	40.4 ± 12.6	45.4 ± 14	46.9 ± 14.6	56.2 ± 15.1	45.3 ± 16	43.9 ± 15.2	48 ± 15.8
Household size	2.8 ± 1.2	2.7 ± 1.4	3.2 ± 1.1	3.3 ± 1.2	3.0 ± 1.2	2.3 ± 1.2	2.0 ± 1.0	2.4 ± 1.2	2.6 ± 1.4	2.3 ± 1.2
% Women	48%	64%	66%	67%	61%	59%	63%	55%	58%	58%
% Working from home	36%	30%	43%	48%	40%	27%	17%	31%	41%	28%
Average declared shift in food waste	−1	−1	−1	−2	−1	0	0	0	−1	0
% < 0	36.2%	43.0%	58.9%	74.4%	51.6%	13.7%	16.4%	29.9%	70.1%	26.4%
% = 0	56.2%	57.0%	32.5%	12.2%	40.1%	82.6%	82.6%	63.7%	20.1%	68.9%
% > 0	7.6%	0%	9.6%	13.4%	8.3%	3.7%	1.0%	6.4%	9.8%	4.7%
Motivation*	0	1	0	1	0	0	0	0	1	0
% < 0	7.4%	14.3%	27.1%	6.2%	13.4%	4.1%	0.3%	2.7%	5.4%	2.5%
% = 0	13.0%	28.6%	29.5%	13.9%	18.6%	90.3%	97.7%	89.3%	89.2%	84.3%
% > 0	79.6%	57.1%	43.4%	79.9%	68.0%	5.6%	2%	8%	5.4%	13.2%
Opportunity*	0	1	1	1	0	0	0	0	1	0
% < 0	30.4%	5.0%	21.3%	13.8%	22.2%	19.2%	37.1%	13.1%	15.5%	17.5%
% = 0	3.9%	0.8%	2.8%	3.7%	3.2%	78.3%	60.0%	74.4%	46.5%	69.0%
% > 0	65.7%	94.2%	75.8%	82.5%	74.6%	2.5%	2.9%	12.5%	38.0%	13.5%
Ability*	0	1	1	2	1	0	0	0	1	0
% < 0	11.0%	6.2%	0.8%	0.0%	4.8%	3.3%	1.5%	1.2%	–	1.8%
% = 0	82.1%	78.4%	45.9%	11.9%	56.0%	92.6%	92.3%	80.6%	26.9%	78.5%
% > 0	7.0%	15.5%	53.4%	88.11%	39.2%	4.1%	6.2%	18.2%	70.1%	19.8%
Uncertainty*	0	1	1	1	1	0	0	0	1	0
% < 0	14.4%	38.1%	4.11%	0.5%	8.4%	52.8%	70.6%	13.0%	22.0%	35.4%
% = 0	65.5%	57.1%	38.6%	13.9%	46.1%	42.3%	26.5%	59.0%	37.0%	46.5%
% > 0	20.1%	4.8%	57.3%	85.7%	45.4%	4.9%	2.9%	28.0%	41.0%	18.1%
MOA + U*	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**1**	**0**
% < 0	**13.9%**	**0.0%**	**1.5%**	**0.0%**	**3.81%**	**17.1%**	**0.0%**	**0.8%**	**0.0%**	**5.1%**
% = 0	**80.6%**	**75.0%**	**66.2%**	**15.6%**	**52.1%**	**81.6%**	**100%**	**87.3%**	**42.9%**	**77.1%**
% > 0	**5.6%**	**25.0%**	**32.3%**	**84.4%**	**44.1%**	**1.3%**	**0.0%**	**11.9%**	**57.1%**	**17.8%**

Notes: *The average size in absolute values of the shift in self-reported food waste and of the theoretical constructs of MOA + U framework are indicated; values range from −3 = strongly decreased to 3 = strongly increased, with 0 = remained the same.

[a] For the sake of clarity, the NE-WUO group has not been considered further in the analysis, because of its very small size (2% only) and its similarity with the NE-WU cluster.

5.2. Food waste related behavioral changes

The behavioral changes registered for the Italian and Dutch samples can be divided in a) common shifts, which do not present statistically significant differences between clusters but are significant for the overall national samples, and in b) cluster-related shifts, which are related to the items of the questionnaire that presented statistically significant differences among the clusters identified within the two national samples. Both types of shifts in behavioral change are described in the next two sections. Figs. 2 and 4 represent the common shifts for Italy and the Netherlands and Figs. 3 and 5 represent the cluster-related shifts for the two countries, along with the items of the questionnaire included in the cluster characterization and the theoretical construct to which they belong. In Figs. 3 and 5, clusters are superimposed, to provide a direct comparison of the different adaptation strategies related to COVID-19 adopted by the groups of consumers.

5.2.1. The Italian case

Significant shifts in Motivation shared by the entire Italian sample across all four clusters (Fig. 2) consisted of an increase in awareness of food waste consequences and of sense of responsibility connected to the wastage of food.

Common changes in behaviors related to Opportunity were a decrease in shopping frequency in markets, local shops, and takeaways and, as expected, by an increase in online shopping. In addition, Italian consumers reported a general increase in the overall amount of purchased food.

Common behavioral changes related to Ability are mainly connected with the increased knowledge and organization of in-home food stock and in the increased propensity to try new recipes.

Common changes related to Uncertainty concerned a general increase of the amount of food purchased per shopping trip, the fear of going to the shops too often, and of fear of contacts with others inside supermarkets. At the same time, the Italian respondents reported a decrease in forgetting to buy previously planned food items.

Considering differences between the four Italian clusters, results displayed in Fig. 3 show that *I-SC* cluster consumers present the highest level of adaptation (see also Table 4 above).

Members of this cluster showed the highest average intensity value of the combined MOA + U behavioral shifts (with 84.4% of the sample declaring positive shifts), followed by the members of *I-MC* group (with 32.3% of respondents reporting positive shifts). *I-WU* however, appeared to be the least adaptive cluster, with only 5.6% of the sample declaring positive shifts (Table 4). These shifts in adaptation strategies correspond with shifts in household food waste self-reported levels, i.e. *I-SC* showed the highest perceived decrease in food waste generated (−2

Fig. 2. Common shifts for Italy
FW = food waste; freq. = frequency. Values range from −3 = strongly decreased to 3 = strongly increased, with 0 (= no shifts) as reference point.

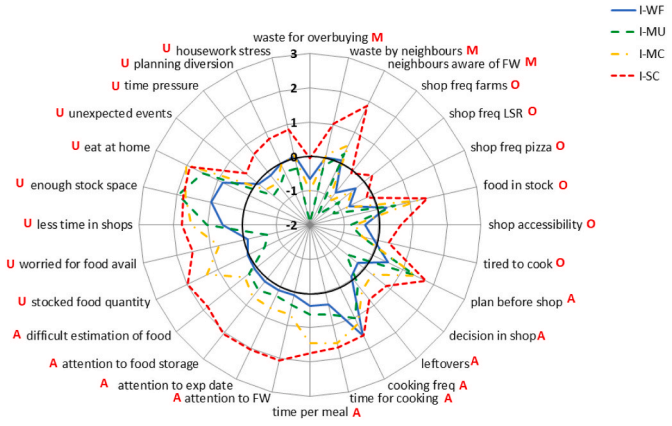

Fig. 3. Differences in behavioral shifts for the four Italian clusters
FW = food waste; freq = frequency. *values range from −3 = strongly decreased to 3 = strongly increased, with 0 (= no shifts) as reference point.

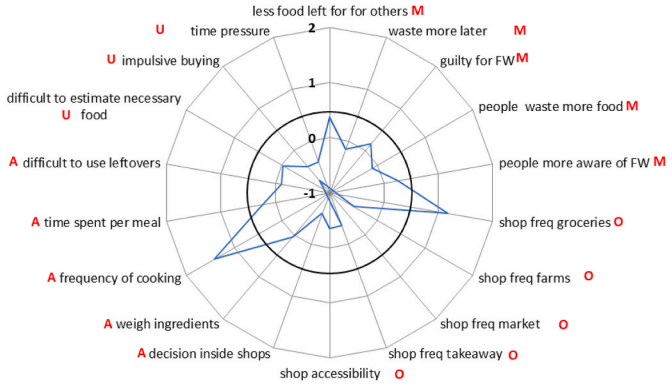

Fig. 4. Common shifts for the Netherlands
FW = food waste; freq = frequency. *values range from −3 = strongly decreased to 3 = strongly increased, with 0 (= no shift) as reference point.

with 74.4% of the sample declaring a perceived decrease), while this was lowest for *I-WU* (−1 with 36.2% perceiving less food waste).

Concerning the shifts for items related Motivation, *I-MC* showed the highest increase in the perceived subjective and injunctive social norms on their food waste related behaviors; the other three groups all showed a decrease in the concern for food waste due to overbuying where this was unchanged for I-SC (Fig. 3). For Opportunity, *I-WU*, *I-MU*, and *I-MC*

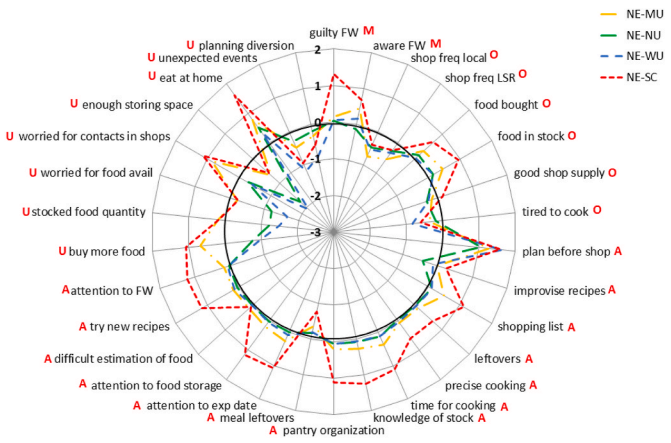

Fig. 5. Differences in behavioral shifts for the four Dutch clusters
FW = food waste; freq = frequency. *values range from −3 = strongly decreased to 3 = strongly increased, with 0 (= no shift) as reference point.

displayed several commonalities. Members of these clusters reported a significant decrease in shopping frequency in all three types of shops and a decrease in both perceived accessibility of shops as well as a feeling of tiredness for cooking. Moreover Fig. 3 and Table 4, show that *I-MU* cluster showed the largest negative average shift for the Opportunity items, while members of *I-WU* cluster registered the weakest adaptations. Finally, *I-SC* cluster presented the largest positive shift and the largest average shift for the Opportunity items.

For Ability items, behavioral shifts in the four Italian clusters are similar in direction (increase), but different in intensity, except for impulsive buying (unplanned shopping decisions taken inside shops). This is also reflected in the highest average shift value (Table 4), the *I-SC* cluster showed the highest increase for the Ability items, in particular for the attention paid to a) the perceived level of food waste produced, b) expiration dates of foods, and c) the correct storing techniques. *I-MU* members were most extreme in adapting their impulsive buying habit, by indicating to do this less frequently than the other clusters.

Finally, the shifts related the Uncertainty construct depict different patterns for the four Italian clusters. Also, in this case, the *IT-SC* group showed only increases (see also highest average shift for U in Table 4), with the highest values for the frequency of stocking up food and for the reduction of time spent inside shops. *I-WU, I-MU*, and *I-MC* clusters showed similar patterns, but the magnitude/size of their behavioral changes differed. These three groups reported decreases in the occurrence of unexpected circumstances potentially generating food waste, for the perceived time pressure, and for the divergence of food planning. Shifts for the other Uncertainty items to were into the positive direction (indicating that these items happened more often).

5.2.2. *The Dutch case*

Starting with common Motivation shifts in the Dutch sample (see Fig. 4), an increase in awareness about food security can be noticed, because of less food available for other consumers, together with small changes in the importance of descriptive and injunctive social norms.

Common changes related to Opportunity consist by an increase in shopping frequencies of groceries and a decrease in shopping frequency in farms, local markets and take-away and by a decrease in perceived accessibility of shops. Concerning Ability, common shifts are related to a strong increase in the frequency of cooking, as well as small changes in frequency of weighing ingredients (slightly increased), in the difficulty in reusing leftovers (decreased), and in the total amount of time dedicated to preparation of single meals (increased). Finally, common Uncertainty trends can be seen in the decreased frequency of impulsive buying and in feeling time pressure less often.

Regarding the differences between the clusters, cluster *NE-SC*

members showed the strongest adapting attitude, characterized by both the highest average intensity of behavioral shifts in food waste-related behaviors (with 57.1% of positive answers) and the largest reduction in self-reported food waste during the pandemic (−1 with 70.1% of respondents perceiving lower levels of food waste), see Table 4 and Fig. 5 below.

At the other end, cluster *NE-MU* represents those a segment of consumers who changed very little in their food-related behaviors as reaction to the restrictions (81.6% declared no change, Table 4) and is characterized by the smallest decrease in self-reported food waste generated during the lockdown (only 13.7% declared a perceived decrease in food waste generation, Table 4). In between of these two extremes are the *N-MU* and *NE-WU* clusters. Consumers/members of these clusters are quite different in terms of demographic characteristics but registering an intermediate level of change of their food waste related habits. Also, these clusters respectively self-reported the second and third biggest reduction in food waste generation during the lockdown (Table 4).

Exploring the results of the Motivation items more in detail, *NE-SC* is the only group that shows an increase of both awareness and guilt around food waste during the lockdown, while consumers in *NE-WU* declared a marginal but significant increase only in their general awareness about food waste.

For Opportunity, *NE-SC* consumers experienced the strongest increase in the amount of food bought per trip and kept in stock. They reported the strongest increase in the quantity of purchased food and a small decrease in the use of local shops and supermarket stores. They perceived food supply in the stores as slightly better than before. *NE-WU* consumers reported the strongest decrease (compared to other clusters) in the use of local shops and Large-Scale Retail shops and perceived a small decline in the quality of food products available in shops. They also reported an increase in the amount of food bought and of food in stock. *NE-NU* and *NE-MU* reported almost no increase in food bought and kept in stock, and they showed a decrease in the use of local shops and Large-Scale Retailers (LSR)and in perceived food availability. *NE-NU* and to a somewhat lower extent *NE-SC* reported a rather large decrease in the frequency of feeling too tired to cook.

NE-SC showed the largest significant changes (increase) in almost all Ability items, that is also reflected by the largest average shift for Ability (1 and 70.1% of respondents reporting a positive shift, Table 4). For this cluster, especially the frequency of using shopping lists, the time spent for cooking and new recipes tried, the organization, the knowledge and the awareness of food stocks and of expiration dates increased. Also, precision cooking (e.g. the ability to cooking in relation to portion sizes and the amount needed in a specific moment) and attention to not produce unnecessary leftovers increased, along with a decrease in the perception of having produced leftovers during the lockdown. *NE-WU* members displayed some minor similarities in their changes in the Ability items compared to the *NE-SC* ones, especially small increases for the frequency of using a shopping list and time spent for cooking. *NE-MU* and *NE-NU* cluster members for most Ability items did not or hardly changed behaviors.

And lastly, regarding Uncertainty items, *NE-SC* and *NE-WU* consumers adaptation to Uncertainty items was rather similar. The largest increases for both clusters were an increase in the concern of contacts inside shops and a shift from eating outside to eat at home. This latter shift was larger for *NE-SC* than for the NE-WU members. In contrast, members of the *NE-MU* cluster worried the least about being in contact with others inside the shops and showed the smallest decrease in the occurrence of unexpected events generating food waste and for the diversion in meal planning, which is also reflected by the higher share of respondents reporting null or negative values of average shifts for Uncertainty as compared to *NE-SC* (Table 4). Consumers in the *NE-NU* cluster reported the largest decreases in the occurrence of unexpected circumstances potentially generating food waste and for deviating from the meal plan.

6. Discussion

The aim of this study was to explore differences in food (waste) related behaviors of Italian and Dutch consumers during the first wave of COVID-19 related restrictive measures (February–June 2020) that significantly differed for intensity and severity. From results, some points of attention can be highlighted specifically related to these two countries and also some general reflections can be drawn.

First, restrictive measures introduced by national governments to cope with the effects of COVID-19 pandemic, despite some initial concerns, did not lead to an increase in the perceived amounts of food waste generated by Italian and Dutch households. In particular, more than 90% of respondents in the two countries declared to have not increased the perceived amount of food waste generated. The 52% of Italian respondents and the 26% of Dutch respondents instead declared a decrease in the perceived food waste. These findings are coherent with results from similar studies conducted in other countries as Romania (Burlea-Schiopoiu et al., 2021), USA (Cosgrove et al., 2021; Rodgers et al., 2021), Canada (Laila et al., 2022), and Japan (Qian et al., 2020), as well as from meta reviews, as Iranmanesh et al., 2022. Moreover, while some attention has been put on the potential underestimation of food waste generated during the COVID-19 pandemic (Everitt et al., 2022), the decreasing of household food waste seems confirmed.

Second, results highlighted that households adopted different sets of behaviors connected to a perceived increase of opportunity to dedicate time to a more accurate management of food and this perception was higher for clusters declaring less food waste. Italian and Dutch consumers declared to have adopted more efficient planning strategies like precision cooking even though, especially in families with children, this can be difficult due to the unpredictability of children's intake., A more efficient management of food stocks and leftovers that could have generated lesser waste than before. These strategies were influenced by the lower occurrence of unforeseen circumstances potentially generating food waste (all the clusters except *I-SC* declared a decrease of occurrence of unexpected events), a direct consequence of the limitation of freedom of movement and of meeting with other individuals. Italian consumers declared an improvement of their knowledge of food stocked at home and planning before shop. Dutch consumers increased more the use of shopping list, and plan before shop. These planning strategies were related to the increased availability of time which was also consequence of the dramatic increase of working from home and to the loss of jobs. So, concerning the theoretical constructs of the MOA + U framework, results reveal shifts for all the Italian and Dutch clusters for items related to Opportunity and Uncertainty. These two theoretical constructs include items strongly connected with the restrictions adopted by national governments (Opportunity) and with the potential sanitary and economic consequences of the COVID-19 pandemic (Uncertainty).

Similar changes in food related behaviors were also found in studies conducted in countries as Canada (Laila et al., 2022), USA (Rodgers et al., 2021) Japan (Qian et al., 2020), and Romania (Burlea-Schiopoiu et al., 2021).

Results also highlight the presence of a positive spillover from Opportunity to Ability, as the increased availability of time dedicated to food management also may have stimulated investments in knowledge that increased consumers food-related skills and abilities. These trends are common for the majority of consumers groups, both in Italy and in the Netherlands, and consistent with studies conducted in other countries like US, Romania and Canada (Babbitt et al., 2021; Burlea-Schiopoiu et al., 2021; Richter et al., 2021).

Third, few clusters, in particular the *IT-SC* and *NE-SC*, presented a stronger adaptation and higher level of concern to the consequences of the COVID-19 pandemic and declared the highest decrease in household food waste perceived quantities (*I-SC* and *NE-SC*). Those consumers apparently were forced by the COVID-19 related restrictions to develop a stronger adaptation strategy that included the strongest shifts in items

related to Ability. They were the only groups that showed increase in levels of awareness and guilt around food waste during the lockdown, both for Italy and the Netherlands. This may be due to the higher propensity to change of those consumers, both in terms of financial capability and flexibility of behaviors, as they proved to be the most receptive to the consequences of the pandemic. This propensity to change is most likely also related to demographic characteristics of these two groups, as they mostly include young families with young children who were not going to school or daycare centers due to the lockdown. As these children needed to stay at home and to be taken care of, this required consumers from these groups to change their normal daily routines, including those related to food and household management. Moreover, these groups include the highest share of respondents who worked from home during the lockdown.

On the other hand, both countries presented evidence on clusters of consumers (*I-WU, NE-MU* and *NE-WU*) that showed smaller behavioral shifts for items related to the Uncertainty construct. This implies that these people were less bothered by the changes occurred during the lockdown. As these people were, on average, older than those of other groups and were more likely to have households without children, the consequences of the lock down on their daily routine presumably were less than those experienced by other consumer groups.

The different institutional responses resulted in different changes in behaviors during the lockdowns, as can be seen from the different adaptation strategies emerging across and within the two samples. Several items related to Opportunity and Uncertainty revealed significant changes for both countries, as these items were more closely connected to routines habits affected by the imposed restrictions. Due to the different restrictions, these shifts were, in general, less strong within the Dutch sample where restrictions were lighter. However, the number of common shifts for every construct of the MOA + U framework was higher for the Netherlands, with the Italian situation being more diversified in terms of behavioral changes caused by the restrictions due to the COVID-19 pandemic.

6.1. Policy implications

Due to the relatively high proportion of food waste generated in households compared to the full supply chain, attention from national and European policy makers to tackle consumer food waste has grown over the past decade. To achieve the Sustainable Development Goal 12.3 of halving food losses and food waste by 2030, significant efforts need to be pursued. Although food and food waste behaviors are not easy to be modified in normal times, the outcomes of this study show that during the first wave of the COVID-19 lockdown period in Italy and the Netherlands, individuals were forced to change their food behaviors. While being forced, those changes were not homogeneous for individuals, and it was possible to identify different clusters of consumers. These clusters, both for Italy and the Netherlands, presented specific shifts in food waste related drivers along with different sized decreases in self-reported reported quantities of household food waste. These findings feed into several potential policy implications.

The heterogeneity of adaptation strategies embraced by consumers groups, suggests that there is no single solution to reduce domestic food waste that fits all consumers. Policy makers should provide a diversified mix of interventions and tools tailored to different types of consumers, according to their characteristics (e.g., demographic, lifestyle and motivations). This approach allows the design of more specific and potentially more effective interventions. The MOA approach emphasize how these interventions might be based on the relevant Motivation, Opportunity, and Ability domains (Michie et al., 2011).

The results of this study highlighted the importance of the affordability and accessibility of food for the reduction of domestic food waste. So, at the public level, policies should aim to increase the accessibility and affordability of food for the consumers, especially those living in urban and peri-urban areas. Innovative urban food policies should stimulate the diffusion of local and corner shops, which could both offer quality food at affordable prices, and decrease the amount of time and resources that must be dedicated to shopping, thereby improving time efficiency.

As emerging from the results of this study, the strongest decreases in the self-reported amounts of food waste were associated with the strongest improvements in food management and cooking activities in the household, paired with the strongest decrease in the frequency of unforeseen events. For this reason, interventions to prevent household food waste should focus especially on improving the amount of time dedicated to cooking, food management and the efficiency of food-related behaviors, thereby decreasing the impact of unforeseen events in the generation of food waste. So, it is likely that upon lifting of lockdown measures, the frequency (prevalence) of unforeseen events will return back to 'normal'. Measures targeting better planning and meal flexibility can support less wasteful household management practice.

6.2. Strengths and limitations

This study relies on consumer surveys in which they self-reported on their behavior, motivation and perceived amounts of food wasted. This methodology potentially suffers from cognitive biases, such as social comparison and social desirability bias as respondents tend to under-report food waste in self-report measures (van der Werf, 2020). While these weaknesses in surveys have been well recognized and discussed in literature, the survey through CAWI method remains a solid method to explore food waste and its related behaviors (van Geffen et al., 2016). Moreover, in this specific context, characterized by a widespread viral pandemic, this method represented the most efficient tool to cope with the obstacles posed by the COVID-19 situation. In addition, the use of Likert-scales covering both positive and negative values, mitigated the effects of potential social desirability biases, allowing responders to provide a large variety of answers (Giordano et al., 2019; Quested et al., 2020; Vittuari et al., 2020).

Furthermore, this data collection methodology allowed to obtain data with a high explanatory power and to draw representative and generalizable results. The results led also to the elaboration of solid conclusions about the impact of COVID-19 related restrictions on behavioral drivers of household food waste.

Finally, research on the impact of Uncertainty on food-related behaviors and household food waste generation are still limited. Future research should further investigate this connection, for example with longitudinal studies based on repeated measurements over time, with the aim to understand the evolution of behavioral drivers of household food waste and to have a better understanding of the discrepancies between what consumers perceived and what they reported. In addition, this longitudinal approach could lead to the identification of innovative policy initiatives aimed to reinforce and exploit the unexpected positive consequences of COVID-19 related restrictions, in particular the reduction of household food waste, by stimulating more sustainable food consumption and management behaviors.

7. Conclusions

The outbreak of COVID-19 and the institutional response that followed were different for Italy and the Netherlands. Italian government introduced restrictions to freedom of movement earlier and more severe than the Dutch government. This study explored how different COVID-19 related restrictions affected changes in food (waste) related behaviors with the support to the MOA + U theoretical framework to break down which food waste drivers were most affected. This study shows that during the first wave of COVID-19 related restrictive measures, on average Italian and over the Dutch consumers self-reported same or lower levels of food waste, compared to the pre-COVID-19 situation. Namely, more than 90% of respondents in the two countries declared

not to have increased the amount of food waste generated, and 52% of Italian respondents and 26% of Dutch respondents declared a decrease. A more efficient management of food via precision cooking, food stocks and leftovers, and an increased overall attention to food planning might have allowed consumers to adopt more sustainable behaviors. These findings highlight the presence of a positive spillover from Opportunity to Ability, as the increased availability of time dedicated to food management also may have stimulated investments in knowledge that increased consumers food-related skills and abilities. Besides these general trends, different consumer clusters were identified in each country. These clusters varied in the size and direction of their change in food-waste related behaviors due to the restrictions, which suggests that different interventions are needed to target the consumers in these different clusters.

Given the relations between consumption and disposal food-related habits that emerged from the cluster analysis, policies and interventions aiming at reducing household food waste should consider a comprehensive approach, with the aim to promote changes in a broad variety of behaviors. Examples of targets for policies are the constant increase of awareness of the impact of food waste, the increase of personal abilities related to management of food, including food literacy and cooking skills, and, with a prominent role, the increase of consumers' opportunity to adopt more sustainable behaviors and habits. From this point of view, the increase of availability of time to be dedicated to kitchen activities, together with the improvement of kitchen-related abilities should have a positive impact on the reduction of the amount of food waste generated in households. Moreover, future policies and interventions aimed to the reduction of food waste, should aim to strengthen sustainable behaviors that consumers were forced to develop during the lockdown periods. This can be achieved by providing citizens the adequate cultural and financial capabilities, with the aim to reduce the amount of food waste they produce, going beyond the simple increase of awareness of consequences and impacts of food waste.

Restrictive measures adopted to mitigate the effects of the COVID-19 pandemic led to a generalized reorganization of working activities, with a dramatic increase of the out-of-office work situations. This approach to work will most probably also be adopted in the post-pandemic era, and the daily habits of many workers will substantially change, including those related to food. Therefore, the elaboration of new organizational policies that allows citizens to dedicate more time to food-related activities could contribute to reduce the quantity of food waste generated by households.

Ethical statement

All of the authors declare that this study followed the ethical research procedure and reported relevant information in the manuscript. The survey was conducted in compliance with the General Data Protection Regulation (GDPR), as well as data storage and conservation. All respondents gave informed consent for participating in the survey.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgment

The questionnaire developed within this article was inspired by the work conducted within the H2020 project REFRESH and designed jointly with Wageningen Food & Biobased Research working on the project "Food waste in times of Corona", partly funded by Wageningen Food & Biobased Research and partly by The Netherlands Nutrition Centre.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2022.106313.

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