

Article

Comprehensive Measurement of Italian Domestic Food Waste in a European Framework

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Abstract: Food management is an inefficient activity, and households are the major contributors responsible for food waste across the food supply chain. Ten years remain to halve household food waste, as recommended by the 2030 Agenda for Sustainable Development. Up to now, Italian investigations into household food waste have been research activities with limitations in measurement and sampling. The need to establish a monitoring system led the Italian Observatory on Food Surplus, Recovery and Waste to apply a methodology that permits comparison with other European countries. In 2018, a survey involving a representative sample of 1142 Italian households was carried out. The majority of respondents (77%) reported that they had wasted 370 g of food during the last week, evidence in line with data from the Netherlands and progressively different from what was found in Germany, Hungary, and Spain. Perishable products, such as fresh fruit and vegetables, bread, and nonalcoholic drinks, were mainly wasted. The most frequently disposed foods were unused (43.2%) or partly used (30.3%). As for possible causes, household food waste was significantly associated with preventive practices and ability. This study endeavored to segment household food waste based on possible drivers and barriers to preventive action, setting the stage for future monitoring, supporting policy action, and educational intervention.

Keywords: household food waste; food waste monitoring; consumer behavior; international data; harmonization



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1. Introduction

Supporting the needs of the present and future generations urgently requires protecting the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources, and taking action on climate change (<https://www.un.org/sustainabledevelopment/development-agenda/>). Ensuring sustainable consumption and production patterns contributes to reducing environmental, economic, and social costs, strengthening economic competitiveness, and reducing poverty. Different aspects contribute to making production and consumption unsustainable; among them, food loss and waste play a major role with a significant magnitude and negative impacts on the environment (i.e., unnecessary Greenhouse Gas emissions, occupied land, water usage, and loss of biodiversity), economic growth (inefficient process and low productivity), and food security and nutrition [1,2]. Different approaches have been adopted to assess the impact of proposed policies, strategies, and action plans from the sustainable development point of view. Sustainability impact assessment (SIA) has been applied to provide a fully integrated outline of economic, environmental, and social impacts. Carrying out an SIA requires a large amount of complex information: Defining the nature and dimension of the phenomena, the cause–effect relationships, the views of the stakeholders involved, policy objectives, critical issues to be solved, likely impacts (social, economic, environmental, and institutional), and possible side-effects [3]. In this sense, the Eat Lancet Commission defined an operating space for food systems that allows one to assess which diet and food production practices could ensure that the UN Sustainable Development

Goals (SDGs) and Paris Agreement Recommendations are achieved. Substantial reduction in food loss and waste across the food supply chain, from production to consumption, is one of the identified essential strategies for improving the sustainability of the global food system [4].

In this context, reduction in food waste and losses has become central to the international agendas that recommend action throughout the whole food supply chain, including waste generated at the household level (<https://sustainabledevelopment.un.org/>). In high-income regions, household food waste has been shown to be the main source, accounting for 42% of the total amount generated along the food supply chain in Europe [5]. Recently, the Food and Agriculture Organization of the United Nations (FAO) [2] called for a more comprehensive analysis of food loss and waste in food supply chains, moving beyond the global estimate and focusing on the most wasted foods and prioritizing effective strategies at critical stages along the food supply chain. The European Union (EU) Platform on Food Losses and Food Waste encouraged the understanding of target audience segments to be improved and to gain insights into barriers to behavior change to identify consumer food waste attitudes, shape more effective interventions, and facilitate their transferability at local, national, and EU levels [6].

In the last decade, in Europe, some studies have outlined the main features of household food waste (HFW) at the country level [7], mostly in northern and eastern EU countries [8–15], but also in southern EU areas [16,17]. However, few assessments gained insight into comparable data on HFW in the European context, focusing on specific issues, such as the magnitude [18], attitudes and behaviors [19], or characterization of food wastage based on food groups across EU-28 [20].

The focus on in-home settings, including food purchase, is considered important because the ability of consumers to influence reduction in food waste is larger at the level of the household than in out-of-home food consumption [21].

Knowledge and understanding of the current barriers to adopting food waste prevention practices are a priority, not only for policy makers, but also for agri-food chain operators and researchers. A comprehensive analysis of food waste could bring a better understanding of the phenomena and raise awareness of the potential gains that food chain actors could pursue by adopting corporate social responsibility, including actions that prevent food loss and waste at the domestic level. For example, diversifying the business by selling food in smaller packaging to meet the needs of a one-person household, or developing goods with an improved shelf life could help to prevent food waste and increase the business performance. Efficient and socially responsible economic growth and development, as well as social and environmental performance, should be part of the business model, along with gaining an immediate positive economic outcome or a remarkable competitive advantage [22]. In this view, sustainability assessment faces an increasingly methodological framework and has become a valuable practice to strengthen the market position [23].

Domestic food waste plays a central role in the multidisciplinary scientific debate, with increasing numbers of projects and studies occurring in this field [24]. Many recent studies aimed at measuring the quantitative dimension of this phenomenon have taken an exploratory and cognitive approach that considers not only the quantitative dimension of food waste, but also its potential and hypothetical causes [25–27]. Romani and co-authors [28] found evidence that the generation of food waste could be largely preventable through targeted educational strategies.

In the last decade, a number of studies have focused on the measurement of food waste across Italian households and have investigated the main drivers of its generation. However, the different methodological approaches and the different objectives of the studies have limited the possibility of data and results comparisons [29]. So far, HFW estimations at the national level, as well as assessing related behavior in Italy, have been conducted on a small sample size [30] or based on self-selected samples with respondents participating on a voluntary basis [29], not allowing statistical generalization to the entire Italian population.

In 2017, the Italian Ministry of Agriculture appointed CREA Research Centre for Food and Nutrition to establish an observatory on food surplus, recovery, and waste with the aim of providing information and data throughout the food chain. One of the priorities recognized by the observatory was to assess and monitor household food waste at the national level to support the development of actions aimed at reducing the amount of HFW. In light of this commitment, several methods to measure household food waste were taken into consideration, such as diaries, waste composition analyses, and surveys with the use of questionnaires. However, as stated by van Herpen and collaborators [31], all these methods have advantages and disadvantages related to time, cost, accuracy, and reliability, with none clearly superior to the others. For example, although diary and waste composition analyses have been recognized as the most reliable quantitative methods, they are not exempt from biases, with diaries substantially underestimating HFW, if compared to waste composition analysis [32]. However, diary and waste composition analyses are complex survey methodologies requiring time-consuming involvement of participants that could be adopted in research settings based on small samples, but are less applicable at a large scale, as is the case for surveillance and monitoring activities. Thus, with these methodologies the respondent effort required led to high drop-out rates and self-selected samples that would limit the reliability of waste behavior measurements [31–34]. Giordano and co-workers [30] found that data collected through questionnaires substantially underestimated the amount of food waste at home, when compared to information collected through diaries. However, a recent study investigating the validity of different methods (diaries, photo coding, kitchen caddies, and preannounced survey questions regarding a specific period) proved that the weekly HFW amount obtained through questionnaires and diaries were highly correlated (0.71) [31]. A questionnaire aiming at estimating food waste in the previous week appears to be a useful method for large-scale measurements to differentiate households according to the amount of food waste generated, even if it underestimates the amount of food waste [31]. Moreover, a methodology has been proposed by Van Herpen and co-authors [35] as a practical solution for having a valid and cost-effective survey measurement that requires relatively low effort from participants. According to these premises, the development of the Household Food Waste Questionnaire (HFWQ) [35] corrected a series of limitations resulting from previous surveys. Specifically, the measurement period, food categories, and measurement units were clearly defined and communicated to respondents to limit bias. Furthermore, to limit underestimation, the survey was anticipated by a preannouncement to make respondents more aware of generating food waste in the following phase. The real added value of this assessment is due to the potential of the international monitoring activity. In fact, this tool has been applied to a comparative cross-country survey conducted in four European countries (the Netherlands, Spain, Germany, and Hungary), providing the first harmonized and comparable data at European level [21]. However, the HFWQ is not limited to the quantification of food waste, but it includes questions measuring factors that influence HFW, according to the MOA (Motivation, Opportunity, and Ability) theoretical framework [36–40]. Specifically, these factors refer to the following pillars: (i) Motivation includes drivers of intention-setting, such as values, attitudes, and subjective norms, namely, the awareness of the consequences of food waste, attitudes and feelings towards food waste, perceived disapproval by relevant others when wasting food, and observed disapproval when others waste food; (ii) opportunity encompasses aspects related to the conditioning of the living context, such as availability of products in stores, accessibility of stores, availability of equipment for food storage, and ability to manage unexpected food-related events; (iii) ability concerns skills and knowledge required to prevent food waste generation, related to difficulties in assessing food safety, with creative cooking, accurate planning, and with shelf life knowledge. In addition, the theoretical framework includes the assessment of food management practices (consumption planning, impulsive food purchase, food storage inventory, accuracy in planning quantities, and capacity of leftover management) as well as prioritization of several determinants of food choice in potential conflict with food waste

reduction (i.e., safety, taste, convenience of use, costs, attention to quantity). Household food waste is not the consequence of a single behavior, and the proposed model has an integrated perspective on the reasons why consumers waste food. For example, a motivated consumer who has neither the skills nor the knowledge of how to handle food would be less able to prevent food waste. If food choice follows priorities such as health, taste, and price, this can conflict with the food waste reduction goal; otherwise, avoidance of food surplus is a driver of food waste prevention. [8]. This behavioral assessment provides inputs for understanding the causes of household food waste as well as information to develop potential targets and intervention strategies for reducing food waste [41,42].

Although the estimation of HFW measured by using HFWQs is likely to underestimate the actual amount, this method provides many advantages. It appeared particularly suitable for large representative samples and for examining differences between households and/or for surveillance purposes to monitor changes over time. Moreover, it is relatively cost-effective, providing insights into food groups, the preparation stage, and causes of waste.

Considering the difficulties in understanding the HFW phenomenon in Europe due to effect of heterogeneity of definitions, measurements, and inappropriate survey samples, the objective of the present study was to provide an improved national quantification and characterization of the nature of HFW in Italy in the framework of a harmonized European approach. The present work studies the application of HFWQs—a pragmatic and solid toolbox—to Italy, a country different from those that developed the method. Thus, this study provides advances in terms of applicability issues and comparability of findings. Interestingly, the method applied to the Italian context has been capable of finding associations between different levels of food waste with behavioral indicators, such as preventive practices, personal ability, and conflicting goals, showing the potentiality to be used for monitoring purposes.

2. Materials and Methods

2.1. Design of the Study

The survey covered the period May–September 2018. The fieldwork was carried out in July 2018 by a specialized market research agency, GFK (Growth for Knowledge) Italia, the Italian branch of the international group GFK which performed the survey in other EU countries, to minimize variability factors. A representative sample of Italian families was extracted from a consumer panel. Household sampling was carried out, setting quotas at the household level on geographical area, household size, socio-economic index, city size, age, and education of the person who was responsible for food purchasing, by matching the census data of the National Institute of Statistics. The respondents were adults (over 18 years old) mainly responsible for food purchase and in charge of preparing meals in the household. To participate in the GFK panel consumer surveys, respondents were required to sign a policy privacy and consent form for collecting and processing personal data in advance according to the EU General Data Protection Regulation. The survey was carried out over two periods (first phase: 5–9 July and second phase: 16–23 July) using a CAWI (Computer-Assisted Web Interviewing) technique based on a self-reported questionnaire. A large sample of households ($n = 4000$) was contacted to start the fieldwork; 2936 of them proved eligible. The first phase had a drop-out rate of 39% (1792 households filled in the questionnaire). This phase ended with a preannouncement in which respondents were asked to pay attention to the level of waste in the following week as a containment strategy to reduce the underestimation due to the unawareness of the amount of wasted food. In the preannouncement, the importance of not changing behavior during the study was stressed. A total number of 1470 households agreed to proceed to the second phase of the study. At the end of the study, 1142 households had completed both questionnaires of the study, constituting a drop-out rate of 22%.

2.2. The HFWQ Adapted to the Italian Context

The English and Spanish versions of the HFWQ were translated into Italian, ensuring accurate correspondence of semantic contents. All scales, questions, and constructs adopted in this study were the same as in the abovementioned questionnaire. At this stage, it was decided to avoid as many changes to the structure and contents of the questionnaire as possible, for better comparison of Italian data with that of other European countries. The Italian HFWQ is available as Supplementary Material. In the first questionnaire (first phase), questions aimed at selecting respondents according to eligibility criteria, measuring purchasing frequency and priority in food choice, were asked. In the second questionnaire (second phase), respondents were asked to report the amount of food wasted in the previous week, providing a definition of food waste as “the edible fraction of food intended to be eaten by humans excluding inedible fractions, such as bones, peels, seeds, stumps, etc.” Specifically, closed-ended questions referring to 24 food products (two of them being drinking items) to be quantified with practical measurement units (i.e., vegetables in tablespoons, units of fruit, slices of bread, etc.) were reported. For each wasted foodstuff, the respondent was asked to indicate the wastage state, namely (i) completely unused food, (ii) partially used food, (iii) meal leftovers, (iv) leftovers after storing. Factors assumed to influence HFW, according to the MOA theoretical model, were assessed using a 7-point agreement/disagreement scale or a 7-point frequency scale or scales anchored to specific opposite issues (for example, responsible vs. irresponsible). As for the attitude scale, the positive attitude in preventing HFW was anchored at 1, and the negative attitude at point 7. To measure descriptive social norms, a trustful attitude towards others not wasting food was anchored at 1, and the opposite at point 7.

2.3. Data Analysis

Assessment of the HFW amount for each food category was performed by converting units (categorical answers) to weight (grams), according to a defined conversion table [21]. The total HFW resulted as the sum of the estimated HFW of each category. On the other hand, HFW amount per state was estimated by dividing the total HFW by the number of food waste states indicated by the respondent. The construct measurements were built based on the mean value of the items associated to the construct. ANOVA was performed to analyze the differences in the average amounts of HFW among sociodemographic groups. A categorical variable of HFW amount was built based on quartiles. A chi-square test was used to investigate the association between HFW segments and the possible determinants. Statistical analysis was carried out using IBM SPSS Statistics, version 25.

3. Results

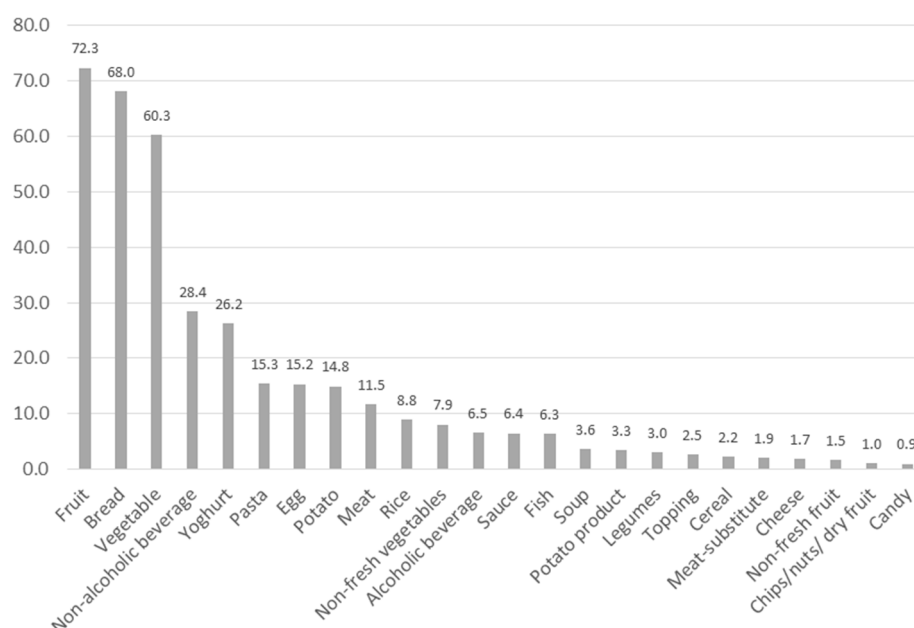
The household characteristics observed were in line with national data, mostly in terms of distribution per region and household size (Table 1). Small differences were observed for urban size (households living in small cities, 26% in our sample vs. 32% at national level). Most respondents were female (61%), mostly 35–49 years old (42%), and with medium education level (54%).

3.1. Food Waste: Quantification and Categorization

A large number of families (77%) wasted foods in the week before the interview. The overall average amount of Italian household waste was 370 g per week. In Figure 1, the average amount of food wasted per category is reported, showing that fresh produce was the most wasted compared to other products. Fresh fruit, bread, fresh vegetables, and non-alcoholic drinks (including milk) were the categories with the greatest amount of waste.

Table 1. Comparison of sample characteristics (n = 1142) with population statistics according to the Italian national demographic balance, ISTAT.

<i>Sociodemographics</i>	<i>% Sample</i>	<i>% Population</i>
Regions		
North-west	27.4%	28.0%
North-east	21.5%	20.0%
Center	21.4%	20.0%
South and islands	29.8%	32.0%
Household Size—n.of components		
1	29.8%	31.0%
2	27.9%	28.0%
3	20.2%	20.0%
4	15.3%	16.0%
5+	6.7%	5.0%
Presence of children		
Young children (age 0–10)	21.0%	16.0%
Without young children	79.0%	84.0%
Children age 11–18	15.0%	10.0%
Without children age 11–18	85.0%	90.0%
City size		
Small	25.8%	32.0%
Middle	45.3%	42.0%
Large	28.9%	25.0%

**Figure 1.** Average amount of food thrown away by category (grams/family/week).

In terms of the state of food waste, the largest proportion of all disposed food was food not used at all (43.2%), such as, for example, unopened packages, followed by food that was disposed of after it had been partly used (30.3%), such as, for example, a piece of bread, part of an apple, or an open package of milk. Meal leftovers, which include food left uneaten or still in the cooking pot, accounted for 14.6%, and stored leftovers 11.9%. Breakdown of overall HFW by state showed that perishable products such as fruit, yogurt, eggs, and potatoes were disposed of as unused. Many products such as sauces, sweets, chips, and beverages (alcoholic and non-alcoholic, including milk), but also breakfast cereals, cheese, sandwich fillings (e.g., sliced preserved meats), and bread were wasted

after partial use. Pasta, rice, legumes, fish, and meat were mainly left uneaten or in the pot, while potato products, legumes, and packaged fruit were wasted after storage (Table 2).

Table 2. Food category by food waste state—percentage values.

Food Category	Unused	Partly Used	Leftover	Stored Leftover	Total
Fresh vegetable	37.0%	30.9%	18.2%	14.0%	100.0%
Packed vegetables	38.7%	31.7%	18.0%	11.5%	100.0%
Fresh fruit	70.2%	15.3%	6.2%	8.3%	100.0%
Non-fresh fruit	22.0%	26.2%	23.8%	28.0%	100.0%
Potato	54.5%	25.7%	9.9%	9.8%	100.0%
Potato-based product	18.2%	23.1%	22.5%	36.2%	100.0%
Pasta	10.3%	14.9%	67.3%	7.5%	100.0%
Rice	12.0%	28.8%	41.4%	17.8%	100.0%
Legumes	13.1%	27.4%	27.8%	31.8%	100.0%
Meat	38.4%	25.6%	20.7%	15.3%	100.0%
Meat-substitute	40.1%	47.4%	7.8%	4.7%	100.0%
Fish	25.3%	38.3%	24.7%	11.7%	100.0%
Topping	28.1%	47.0%	9.3%	15.6%	100.0%
Bread	28.6%	45.3%	14.9%	11.3%	100.0%
Cereal	32.8%	52.4%	12.7%	2.1%	100.0%
Yoghurt	73.1%	15.4%	3.2%	8.3%	100.0%
Cheese	34.0%	48.4%	8.1%	9.4%	100.0%
Egg	71.3%	10.9%	8.5%	9.2%	100.0%
Soup	62.9%	10.6%	8.8%	17.8%	100.0%
Sauce	19.9%	52.2%	6.8%	21.0%	100.0%
Candy	23.7%	56.1%	13.1%	7.1%	100.0%
Chips/nuts/dry fruit	31.6%	51.8%	9.2%	7.5%	100.0%
Non-alcoholic beverage	23.3%	55.7%	4.0%	17.0%	100.0%
Alcoholic beverage	37.8%	45.5%	7.7%	9.1%	100.0%
Total	43.2%	30.3%	14.6%	11.9%	100.0%

Sociodemographic characteristics and their association with total food waste are reported in Figure 2. Household size was strongly associated with food waste: The larger the size of the family, the greater the food waste. However, considering the per capita average amount, the greatest amount of waste was found in one-person households (303 g/week) compared to families having five or more members (105 g/week). Larger waste was reported from families with children under 10 years old (524 g/week) as against families without children under 10 years old (329 g/week).

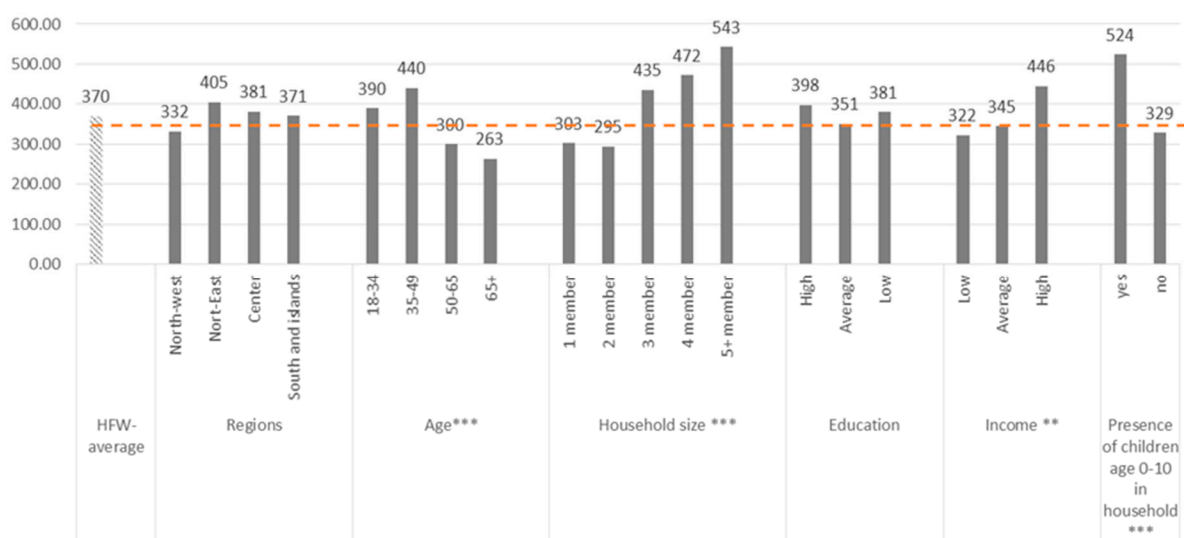


Figure 2. Average amount of food waste (g/week) by sociodemographic characteristics. *** $p < 0.001$; ** $p < 0.005$.

Older respondents reported less household food waste than younger respondents. High income was significantly associated with high food waste as well. Education, geographic area, and city size did not have a significant influence on the amount or category of food waste reported.

3.2. Factors Assumed to Influence Food Waste

3.2.1. Preventive Practices

About two thirds of the respondents stated that they plan purchases (often, almost always, always) without impulse purchasing (never, almost never, rarely). Most of them declared to be aware of and to be organized with respect to food storage management (often, almost always, always). Planning weekly menus in adequate quantities was not considered a high priority. Most respondents claimed to finish what they had on their plates; the declared capacity to manage leftovers was less frequent (data not shown).

As shown in Figure 3, preventive practices were mostly applied by respondents aged 50–64 and older than 65. Attention to food storage inventory and use of leftovers were significantly more common in households living in the north-west (5.6 and 5.7, respectively) compared to households from central Italy (5.2 and 5.3, respectively, $p < 0.01$). Families with two members were more active in prevention than larger families with four members, mostly in shopping planning and use (5.1 vs. 4.7, $p < 0.001$), overview of food stock (5.6 vs. 5.2, $p < 0.01$), and cooking precisely (5.5 vs. 4.9, $p < 0.01$). As for cooking precisely and using leftovers, there was also a significant difference between households with two members and households with five or more members (5.5 vs. 4.9, respectively, $p < 0.001$; 5.6 vs. 5.1, $p < 0.05$). Impulse purchasing was higher ($p < 0.001$) for respondents with high-level education (3.2) than for respondents with low-level education (2.7).

3.2.2. Motivation

Food waste was associated with a widespread negative emotional experience, since almost half of the sample answered all the attitude questions by strongly deprecating food wastage and its consequences. Most respondents showed respect for food and attention to waste as cultural factors as well as not wasting behavior as a family tradition. Respondents considered the economic impact of food waste to be more relevant than its environmental consequences (data not shown). The motivation differed across age groups, with older people most convinced and motivated in preventing food waste (Figure 4). Larger households appeared less attentive and sensitive, since four-member households displayed poorer awareness scores than two-member families (4.9 vs. 5.2, $p < 0.01$), with attitude displaying a similar significant distance too.

3.2.3. Opportunity

Availability of food products and accessibility of food shops were not reported as critical aspects for almost all respondents; a large majority of households reported that they were properly equipped for food storage. However, about half of the respondents reported that they encountered unexpected events and/or had limited time to deal with food preparation (data not shown). The opportunities that favor food waste prevention were mostly mentioned by older people (Figure 5). As for available equipment (perceived availability of equipment and space in the household to store foods), respondents living in the north-west of Italy displayed higher scores than respondents living in central and southern Italy (north-west 5.7 vs. center 5.4, $p < 0.05$; south 5.3, $p < 0.001$). Accessibility to the store resulted easier for respondents living in the north-west compared to respondents living in the south (5.9 vs. 5.6, $p < 0.01$). Unforeseen events were mentioned as a source of food waste by larger families and by respondents with a high education level.

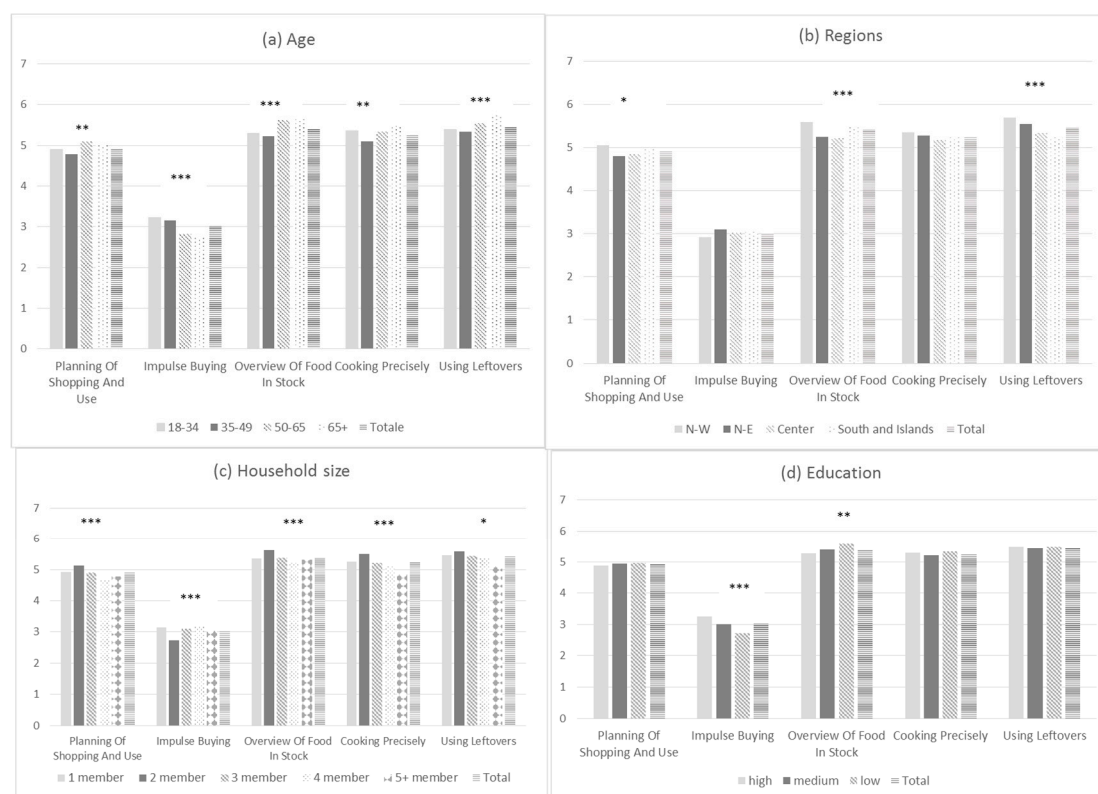


Figure 3. Food waste prevention household practices by sociodemographic characteristics. * = significant construct; scale 1–7; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

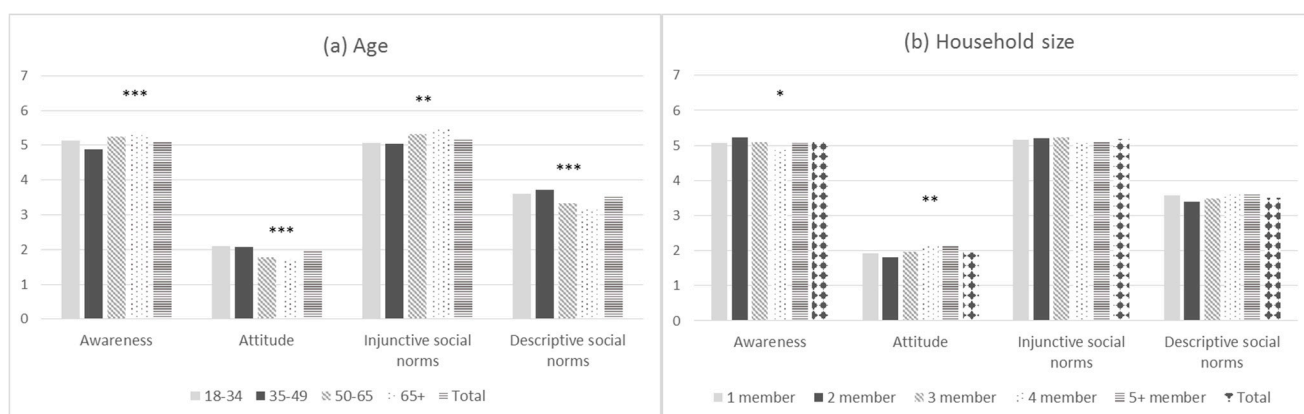


Figure 4. Motivation by sociodemographic characteristics. * = significant construct; scale 1–7; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

3.2.4. Ability

Most respondents reported that they had skills and knowledge that enable them to prevent food waste. About 15–20% of the sample reported they were able to cook something different from the usual recipes, had few difficulties in dealing with new recipes involving the use of leftovers, in evaluating the safety of foods after a period of storage, and in planning appropriate quantities (data not shown).

As shown in Figure 6, younger respondents reported that they had less skill and knowledge than the elderly, who were more able to put in place procedures aimed at preserving food. Two-member households reported fewer perceived difficulties than one-member and four-member families, mostly with assessing food safety (2.4 vs. 2.7 and 2.8,

both $p < 0.05$), and with cooking creatively (2.4 vs. 2.8 for one-member families and 2.9 for four-member families, both $p < 0.01$).

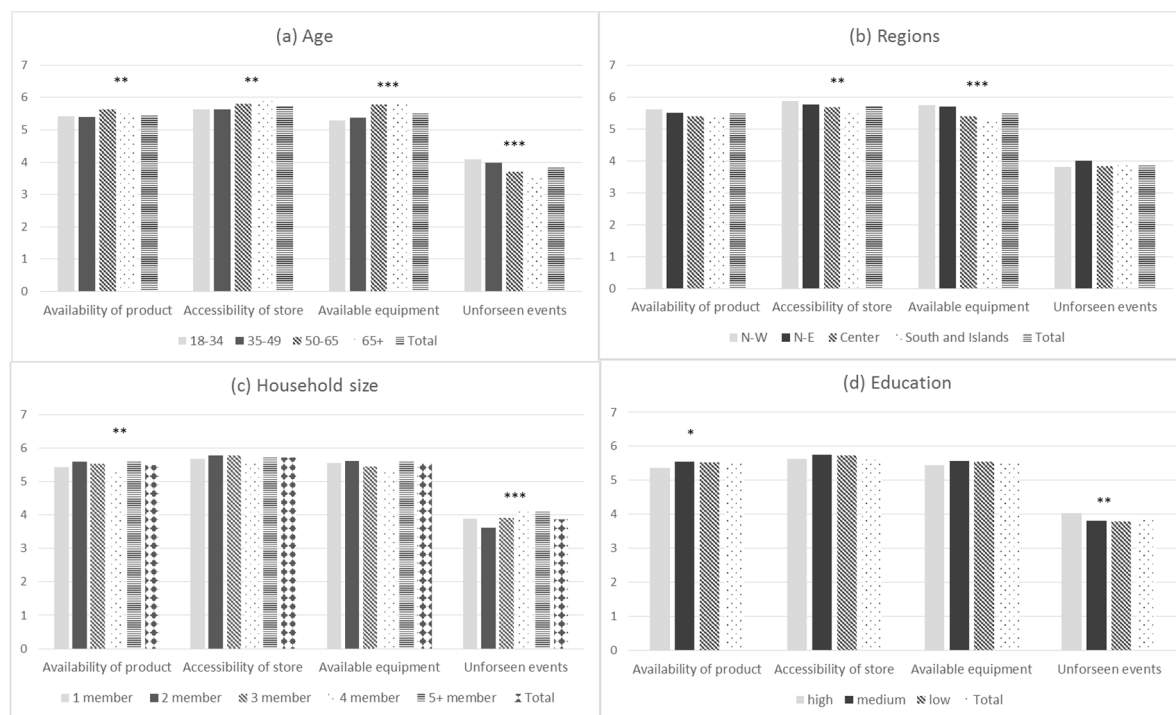


Figure 5. Opportunity by sociodemographic characteristics. * = significant construct; scale 1–7; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

3.2.5. Food Choices and Food Waste Reduction

Food choice determinants could result in competing goals potentially in conflict with food waste prevention. Almost all respondents chose health and taste as the most important drivers in food choice. On the one hand, paying attention not to having too much food at home was considered as a lower priority in food choice (data not shown). Less attention to avoid food stock abundance was paid by families living in central Italy. On the other hand, larger households and respondents with low education prioritized having sufficient food at home (data not shown).

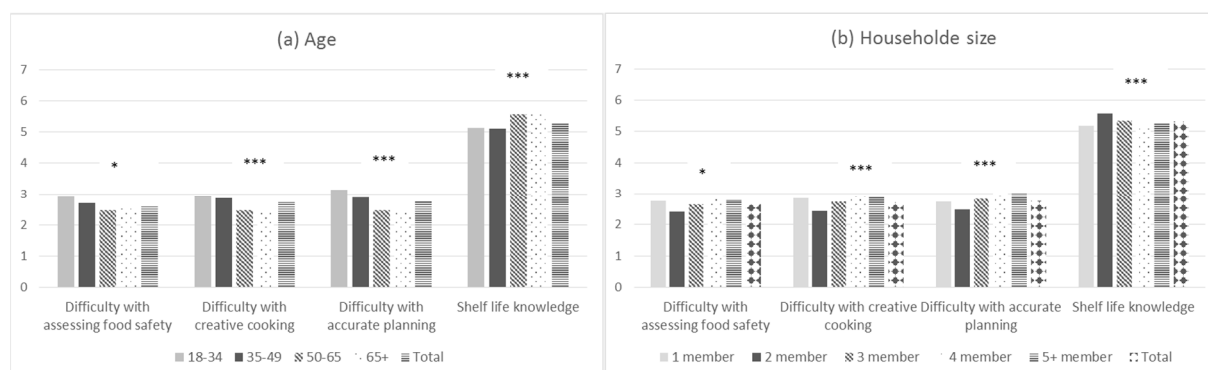


Figure 6. Ability by sociodemographic characteristics. * = significant construct; scale 1–7; * $p < 0.05$; *** $p < 0.001$.

3.3. Food Wastage and Possible Determinants

Relationships between possible determinants and HFW levels were investigated (Table 3). Based on quartiles, the weekly HFW assessment was categorized into four levels: (i) No food waste, (ii) low (≤ 200 g), (iii) medium (201–510 g), and (iv) high (> 510 g). HFW levels were significantly associated with all indicators measuring both application of preventive practices and ability. Conflicting goals were associated with food waste levels for the item “having enough food at home”, which was significantly higher in households with the highest level of food waste, while “not keeping too much food” at home scored significantly higher in the low level group.

Table 3. Household food waste and assumed causes—average values per food waste level.

Determinant	Construct	Food Waste Level					Test F	Significance
		No Waste	Low	Medium	High	Total		
Percentage of Households		22.9%	27.3%	25.0%	24.8%	100%		
Food waste prevention household practices	Planning Of Shopping And Use	5.28	5.06	4.82	4.54	4.92	20.57	***
	Impulse Buying	2.62	2.93	3.07	3.43	3.02	21.67	***
	Overview Of Food In Stock	5.85	5.52	5.18	5.07	5.40	28.7	***
	Cooking Precisely	5.57	5.42	5.16	4.89	5.26	18.52	***
	Using Leftovers	5.93	5.53	5.25	5.11	5.45	27	***
Motivation	Awareness	5.35	5.10	5.03	4.90	5.09	6.12	***
	Attitude	1.65	1.87	2.08	2.19	1.95	19.7	***
	Injunctive social norms	5.34	5.22	5.10	5.04	5.18	2.56	ns
	Descriptive social norms	3.32	3.42	3.54	3.76	3.51	5.5	***
Opportunity	Availability of product	5.63	5.55	5.40	5.40	5.49	4.15	**
	Accessibility of store	5.84	5.71	5.59	5.74	5.71	2.77	*
	Available equipment	5.78	5.64	5.38	5.32	5.53	9.6	***
	Unforseen events	3.39	3.82	3.93	4.29	3.87	29.67	***
Ability	Difficulty with assessing food safety	2.24	2.55	2.84	2.91	2.64	11.49	***
	Difficulty with creative cooking	2.25	2.57	2.99	3.03	2.72	19.67	***
	Difficulty with accurate planning	2.34	2.53	2.90	3.22	2.75	21.26	***
	Shelf life knowledge	5.55	5.48	5.16	5.04	5.31	12.28	***
Competing goals	Health	6.30	6.23	6.13	6.20	6.22	1.29	ns
	Taste	6.12	6.18	6.16	6.25	6.18	0.89	ns
	Convenience	4.80	4.69	4.96	4.77	4.80	1.99	ns
	Enough food at home	5.03	5.12	5.02	5.42	5.15	5.88	***
	Price	4.39	4.34	4.38	4.34	4.36	0.08	ns
	Not too much food at home	3.97	4.15	4.10	3.81	4.01	2.76	*
Psicographics	Attention of parents on food waste during upbringing	6.16	5.88	5.71	5.68	5.85	9.43	***

Family weekly food waste level: No waste, low = up to 200 g, medium = 201–510 g, high ≥ 510 g. One-way ANOVA test: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; ns = not significant.

4. Discussion

This study investigated food disposed of at home in Italy: Food categories and typology of waste, as well as causes and determinants of waste, were measured using a methodology and a theoretical model developed in the EU Refresh Project [21,35]. To date, this is the first survey carried out in Italy measuring food waste at household level on a representative national sample. These characteristics, combined with the quantitative and behavioral nature of the data collected, make this approach a comprehensive tool for policy actions and a baseline for further monitoring of HFW at country level in a European framework.

Italian HFW showed interesting commonalities and differences with what was found in other EU countries [21]. The percentage of Italian households reporting to have wasted food during the week before the survey was 77%, similar to what was found in Spain (82%), Germany (73%), Hungary (76%), and the Netherlands (78%). Italian families wasted 370 g of food per week, a quantity in line with Netherlands (365 g/week), and

progressively different from Germany (425 g/week), Hungary (464 g/week), and Spain (534 g/week). Comparing food waste patterns, it is worth noting that the perishable nature of products increases the risk of waste, since the most perishable foods are at the top of the food group waste ranking in all EU countries. Fresh vegetables, fruits, bread, non-alcoholic drinks (including milk), and yogurt were the most frequently disposed foods. However, some peculiarities emerged in the Italian case, where those commodities accounted for 69% of the total waste, a higher value than in the other EU countries (62%). In those countries, wasted meat seems to play a more relevant role (Spain 6.5%, Netherlands 5.7%, Germany 4.7%, and Hungary 4.4%), compared to the Italian result (3.1%), probably due to its negative consumption trend [43] and the economic value (e.g., price) of these goods. In addition, the Italian sample showed a larger propensity to waste fresh fruit (72 g vs. 66 g per week), and vegetables (60 g vs. 51 g per week), and a lower propensity to waste soups (4 g vs. 22 g per week), soft drinks (28 g vs. 36 g per week), potatoes (15 g vs. 24 g per week), and yogurt (26 g vs. 31 g per week). Focusing on fruit and vegetables, Italy shows higher waste percentages for these products than other countries, with similar figures for Spain and Netherlands (fresh fruit: 19.6%, 16.1%, and 17.4%; vegetables: 16.3%, 12.2%, and 15.1%, respectively). The issue of fruit and vegetable waste in Italy and Spain is consistent with what was found by Priefer and co-authors [20]. According to studies performed by Abeliotis and co-workers [44,45], in Greece, too, food waste mainly consists of vegetables and fruits. These distinctive traits suggested that food waste seems to reflect food habits and local culinary culture. However, with globalization, urbanization, and income growth, people are having new experiences with food, expanding their food choices, and diversifying their dietary patterns in both positive and negative directions. Analyzing the worldwide trends of adherence to the Mediterranean Diet in 1961–1965 and 2000–2003, Da Silva and co-workers [46] observed that many countries in the Mediterranean basin, in particular Italy, Spain, and Greece are drifting away from the Mediterranean dietary pattern. Northern and southern EU countries presently have reverse dietary patterns than those found by Ancel Keys and co-workers in their famous Seven Countries Study [47], with some northern EU countries (e.g., Denmark, Netherlands, Norway) with better nutritional indicators than Mediterranean countries [48]. The increased attention to dietary patterns could have positive implications also in preventing food waste. This appears a central aspect that is already part of dedicated actions in several northern EU countries. In this complex scenario, without a duly designed assessment it is difficult to identify food consumption patterns that could be put in relation with food waste quantification, attitudes, and categories. Further cross-country analysis would permit better characterization of food waste patterns related to food habits. It would be interesting, for example, to confirm the existence in the Mediterranean area of a food waste pattern other than the one existing in the north-eastern countries such as the Netherlands, German, and Hungary.

In Italy, the majority of products that were disposed of were totally unused or partly used, meaning that it is more frequent to find unopened or open food packages in the fridge or in the pantry rather than to leave food uneaten or to dispose of food stored in the freezer. These findings revealed differences from the overall values of the other EU countries investigated. Throwing away unused food was most common in Italy (43.2% vs. 31%), while leftover and partly used food were less disposed of in Italy (respectively, 14.6% vs. 20.0% and 30.3% vs. 36%). These aspects concerning the state of wasted food are of particular importance to design prevention strategies, to encourage diversification of education interventions, to raise awareness about buying less to avoid excess food in the kitchen, or to provide information on food storage and the use of leftovers.

One of the novelties of this study was to provide national data on Italy's positioning as regards food waste compared to other EU countries. Data collected in the present work have added value to permit comparisons at a national level with other surveys carried out in Italy, even if with different methodologies. Notably, the data provided by Giordano and co-workers [30] estimated 1224 g of household food waste per week on average, an

amount three times higher than the present study. This discrepancy could be related to the different methods. In fact, food waste measurement carried out by means of questionnaires is claimed to underestimate the amount compared with the evaluation carried out with diaries with a magnitude of difference of 1.75 times [31]. The differences between the two Italian studies could be exacerbated by the sampling method, which for the study with diaries was based on a sample of 388 households, mainly from the northern regions, and consequently underrepresenting central and southern areas. In contrast, the present survey was based on 1142 households selected in accordance with the National Census data. As a consequence, the figures reported by Giordano and collaborators [30] could lead to an assessment with a larger margin of error (confidence interval). Other data collection aspects could explain the difference between the two Italian studies. Among others, the definition of food waste should be emphasized: This is an open issue that still needs harmonization at international level. In the present study, edible food was defined on the basis of a clear explicit statement provided at the beginning of the questionnaire with the purpose of avoiding any personal interpretation. However, in the study of Giordano and coworkers [30], the FW definition was based on the personal beliefs of the respondents (checkbox survey: Edible vs. non edible food waste). Even with the differences mentioned, it is important to point out that both Italian studies showed the same patterns of wasted foods, since the highest level of waste was found for perishable products, confirming what was found also by Van Herpen and co-authors [31].

Investigating the food waste behavioral profile of Italian consumers provided inputs to address the causes and to design prevention strategies. Throwing away food is associated with a widespread negative emotional experience, with the majority of respondents declaring that reduction in food waste would contribute to a better world, considering it an unacceptable practice and feeling guilty for disposing of food. However, the fact that the environmental impact of food waste was considered less important shows that preventive actions should include, at least in the short term, the ethical aspects of food waste rather than ecological consequences. At the household level, time availability and unexpected events were reported as key aspects of difficult food management in the kitchen, even though respondents declared that they were skilled in terms of creative use of leftovers. This finding is in agreement with the results related to the state of waste, in which leftover and partially used foods contributed less to generate waste than unused food.

Food waste behavior indicators were strongly associated with respondents' age and family size. The motivation to prevent food waste was stronger in the elderly than in young people, confirming the traditional value of foods perceived by the former. Family size is another causal factor, with the largest families paying less attention to food waste. A possible explanation could be the intrinsic difficulty in evaluating portions, planning the quantity of food for a large family, or prioritizing the need to have enough food for the family. The present survey demonstrated a positive association between food waste generation and income. Moreover, the presence of children under 10 years of age in the family was a sociodemographic element that determined an increase in FW production. These features are in line with previous findings [49], but they were not shown in other EU countries analyzed in the Refresh project. Concerning the HFW regional pattern in Italy, even in the absence of an association between living area and the amount of HFW, the north-west regions showed the lowest quantities and highest attention to food storage inventory, using leftovers, and easy accessibility to a food store. These findings could be explained considering that in the Italian north-west regions, the issue of waste prevention is already part of regional actions and specific campaigns and that large retailers are notably present in these territories [50]. Consumption planning and avoidance of stockpiling were particularly prevalent in families with high educational level, which contributes to providing tools to better address kitchen management.

The findings related to the behavioral aspects of food waste of this study need to be placed in the framework of the considerations made by Romani and co-workers [28], which highlighted the positive role of household skills in planning meals to be considered

in conceptual frameworks aimed at explaining food waste. The authors suggested that a specific educational intervention, directed at increasing consumers' perceived skills related to food preparation planning behaviors, reduces domestic food waste. In a similar way, Porpino's research [7] points out the need to expand the approach to consumer food waste, considering indicators that would explain and predict consumer behavior, as well as conducting studies aimed at fostering nutritional education campaigns. Food-related practices (e.g., specific meal planning behavior, food storage conduct) could easily be considered when exploring food waste attitudes using a behavioral approach.

Food waste assessment is a complex and costly exercise that needs to combine performance efficiency, acceptance by respondents, and reliability of the data collected. Besides, self-reported food waste measurements, with whatever methodology, by means of questionnaires and diaries, could be affected by a social desirability bias, i.e., the tendency to give socially desirable responses showing virtuous attitudes. The most important limitation of this assessment is related to the fact that the method used implied an underestimation of the amount of domestic food waste. However, this study provided insights into different levels of food waste, since the behavioral indicators were able to well differentiate non-wasting households from wasting households, as well as the different levels of food waste segments, reflecting the effectiveness of the methodological approach in helping to understand food waste in the home and where to focus attention for policy interventions. Nevertheless, the analysis showed the association between variables rather than causal relationships. Behavioral indicators need to be better associated with the quantity and type of food wasted at the household level for a more in-depth investigation into the cause–effect relationship detected in this study, applying more sophisticated research methods.

5. Conclusions

The present study responds to the need to start monitoring domestic food waste in Italy, dictated above all by the urgency of the domestic waste reduction objective recommended by target 12.3 of the Sustainable Development Goals framework [51]. With this aim, multiple key research requirements coming from the literature for improving the underlying data sources have been considered, and harmonized methods and definitions were used for the collection and analysis of data on food waste generation [20]. Account has been taken of the diversity of factors potentially involved in an integrated view [49]. In this perspective, a cross-country comparison, as carried out in this study, advanced the knowledge and understanding of Italian situations versus other European contexts, leading to a number of relevant findings.

First, this Italian study made it possible to extend the harmonized HFW to about half of the EU27 population. Similarity of food waste patterns related to the percentage of households who wasted food, weekly average amount of HFW, and most often wasted perishable food groups were shown. On the other hand, Italian households present peculiar features associated with HFW, mostly for economic and cultural aspects (income and wasting fewer meat and leftovers).

Second, this study found evidence that is in line with the Recommendations for Action in Food Waste Prevention, developed by the EU Platform on Food Losses and Food Waste [6], which suggested promoting the value of food and working to shift social norms so that wasting food is no longer socially acceptable, especially targeting younger and larger households. In this sense, it would be important to use the experience gained in other sectors, such as public health, to design effective interventions to curb consumer food waste. Linking food waste to sustainable diet considerations could provide new reasons for citizens to engage in a positive response, at least in younger generations. Cooperation among institutions, producers, and retailers could further support preventive actions to raise awareness of the food management issues considered in this study. To this aim, behavioral indicators could provide the basis for specific preventive actions that need to be included in general nutrition education campaigns. If replicated periodically, this

comprehensive measurement system will provide data, evidence, and trends, as well as comparisons across European countries.

Finally, this is the first attempt to describe the applicability and limitations of the methodology developed by Van Herpen and co-workers [35] in a country different from those participating in the EU project that originated the method [21], providing inputs for its performance at the national level for monitoring purposes. Future research could consider adapting food categories to a country's eating habits. The authors are strongly convinced that food waste needs to be considered in relation to the country's cultural context. In fact, food consumption patterns, food behavior, consumer knowledge, practices, and attitudes are all interrelated, could impact at different levels on food waste, and should be taken into account when establishing preventive actions. To complete the assessment of the geographical variability of HFW, as suggested by Roodhuyzen and co-authors [49], also other societal aspects, such as economic factors (e.g., food price and availability), regulatory, technological, retail, and climatological factors, should be considered.

Supplementary Materials: The following is available online at <https://www.mdpi.com/2071-1050/13/3/1492/s1>, The Italian Household questionnaire (Italian language).

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Institutional Review Board Statement: The investigations were carried out following the rules of the 1975 Declaration of Helsinki (<https://www.wma.net/what-we-do/medical-ethics/declaration-of-helsinki/>), revised in 2013. Ethical review and approval were waived for this study because it did not involve any invasive procedure (e.g., fecal samples, voided urine, etc.) or laboratory assessment or induced lifestyle changes or dietary intake modifications.

Informed Consent Statement: Informed consent was obtained from all respondents involved in the study.

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