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Food waste behaviors of the families of the Cilento Bio-District in comparison with the national data: elements for policy actions

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Introduction: Consumer food waste at the household level results from a complex set of behaviors depending on the local food environment, among other factors. This study mainly aimed at comparing food waste behaviors in the Cilento Bio-District with those recorded at the national level to explore if the organic district model had an impact on food waste attitude as a sustainability element.

Methods: Household food waste behavior indicators performed better at the national level than in the Cilento Bio-District, with some relevant exceptions, such as the avoidance of having too much food at home and impulse buying.

Results: The study results suggest that some food waste attitudes in the rural community of the Bio-District might be so embedded in everyday practices that they are no longer perceived as relevant descriptors, considering the lower food waste (FW) levels in Cilento compared to national data. The key findings of the study were interpreted for policy action development.

Discussion: The overall priority of actions would be the enhancement of consumers' abilities to impact practices for food waste prevention. Community engagement aspects and the local products' promotion should be particularly pursued in the Cilento Bio-District, while broader policy actions were proposed at the national level with the involvement of the different sectors of the food chain and the proposition of regulatory aspects (e.g., labels). Future research on Cilento Bio-District characteristics and the comparison with national data would need a more comprehensive examination of additional factors affecting the food system, such as dietary patterns or organic product consumption, to understand their potential influence on food waste and, in general, the sustainability of food choices.

KEYWORDS

food waste, household, Cilento Bio-District, Italy, SysOrg project

1 Introduction

Agri-food systems play a key role in influencing environmental sustainability. It is estimated that population growth will require the primary production to generate more food to address the needs of all, causing the system to strain to keep up with demand (Food and Agriculture Organization of the United Nations, 2017). Addressing the environmental and social challenges of food systems is essential for promoting responsible resource management and ensuring the health of both the planet and the communities. In the context of the sustainability of food systems, the model of the Bio-Districts should be considered given their role in territorial protection (Stefanovic and Agbolosoo-Mensah, 2023). The design of the Bio-District was derived from Becattini's concept (Becattini, 2017) of the industrial district and was defined as a community of people and businesses "in one naturally and historically bounded area." Hence, the districts are characterized by being a homogeneous system of values and opinions. Specifically, a Bio-District is "a geographical area where farmers, citizens, tourist operators, associations and public authorities agree with the sustainable management of local resources, based on organic production and consumption" (Basile and Cuoco, 2012). The concept of Bio-Districts is also enshrined in Law No. 205 of 27 December 2017 (Rete Rurale Nazionale et al., 2018). The first Bio-District in Europe was set up in 2009 in Southern Italy, specifically in the Cilento area of the Campania region (Figure 1). This example has inspired the creation of many other Bio-Districts over the years not only in Italy but also in other countries. The International Network of Organic Regions (IN.N.E.R., 2022) has expanded the management of Bio-Districts to several other countries in Europe. To date, it registered 74 Bio-Districts throughout Europe, with 63 already established and 11 under development. In 2020, in Rome, the IN.N.E.R. signed an important Memorandum of Understanding (MoU) with the world's leading organic organizations: Asian Local Governments for Organic Agriculture (ALGOA), International Federation of Organic Agriculture Movements (IFOAM), IFOAM Asia, IFOAM EU, and Baltic Foundation. Later in the same year, the members of the mentioned MoU founded the Global Alliance for Organic Districts (GAOD). The purpose of the GAOD is to support the various governance of Bio-Districts around the world in their development; a network of experts, and local or national institutions from several territories, was created to support the development and growth of the Bio-Districts. The IN.N.E.R. and GAOD organize living labs, education programs, and working groups to engage the Bio-District stakeholders toward the common goal of protecting the biodiversity of the land by making sustainable choices (Global Alliance for Organic Districts, 2023). At the national level, the Italian Association for Organic Agriculture has promoted several territorial initiatives under common traits that allowed for the development of guidelines for the use of the registered trademark "Bio-District" (Basile and Cuoco, 2012). In addition, this association supports various research projects at national, European, and international levels, promoting participatory

research, field trials, and dissemination of results among the scientific community, agricultural professionals, farmers, and consumers (Associazione Italiana Agricoltura Biologica, 2024).

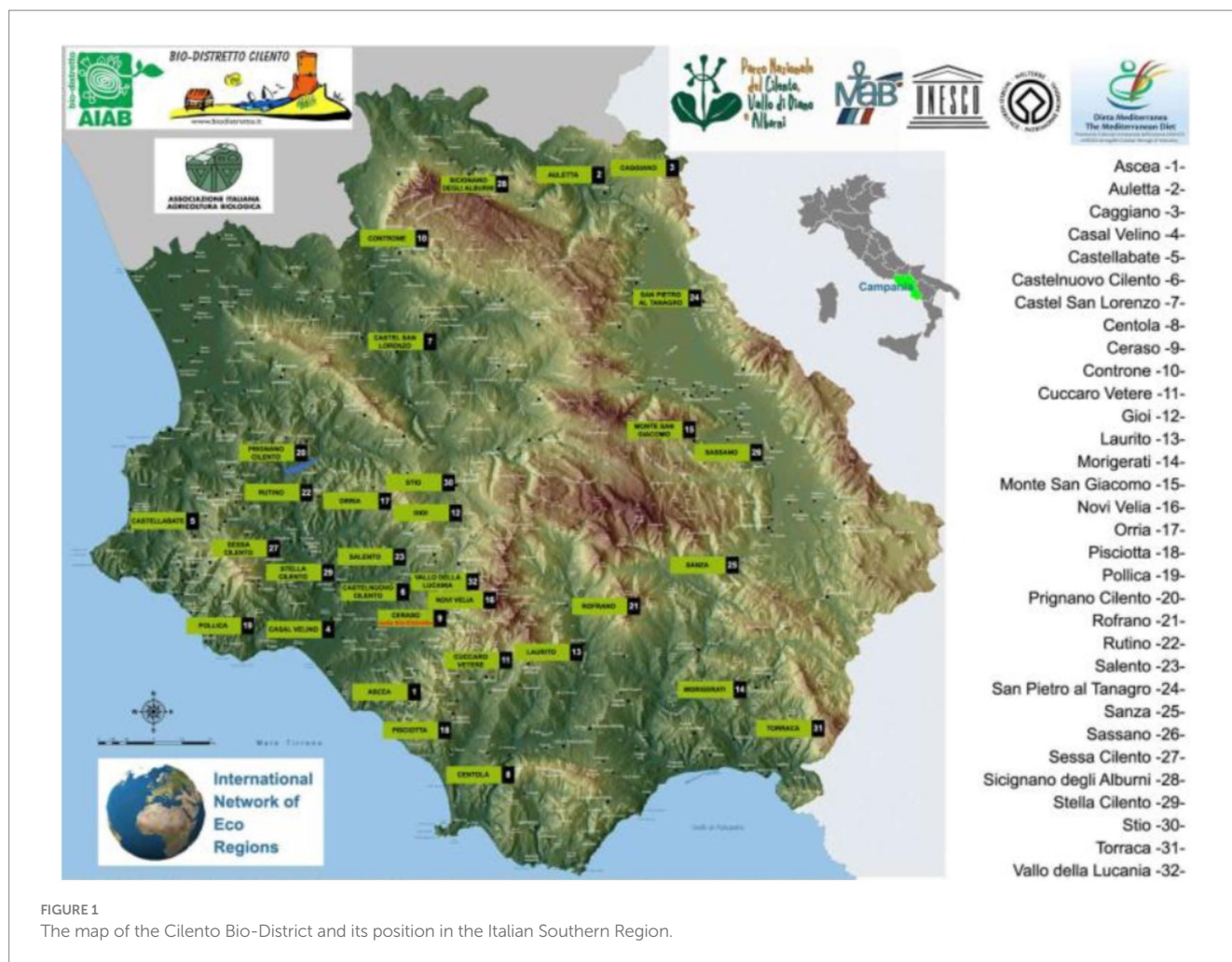
In general terms, the intended purpose of Bio-Districts is to safeguard the territory through the promotion of organic regenerative agriculture practices, encouraging smallholder farmers, supporting the consumption of local products, and thereby enhancing the short supply chain. This type of action would impact the agribusiness system, increasing the sustainability of the whole territory, hosting the Bio-District, and also influencing the food choices of people living in the Bio-District area (Pugliese and Antonelli, 2015; Stotten et al., 2018; Mazzocchi et al., 2022). The global-level impact of Bio-Districts is related to the fact that they are a new and fast-growing example of sustainable food systems that use agroecological principles as tools for rural development (Packer and Zanasi, 2023). The qualitative development of the Bio-Districts or Eco-regions was the corrective measure put in place to revitalize territories that experienced desertification, loss of employment, and the abandonment of rural and agricultural activities from social, economic, and environmental perspectives (Dias et al., 2021). The increasing interest in Bio-Districts is part of the debate on the capacity to integrate agri-food systems with the territory to improve the quality of life in rural communities (Guareschi et al., 2020). The concept of a Bio-District was particularly in line with the European Green Deal (European Commission, 2019), which claimed a transition of the agri-food sector into a sustainable production and consumption model, as well as the European "Farm to Fork" strategy (European Commission Farm to Fork Strategy, 2020) that aimed to make the food system fair, healthy, and environmentally friendly (Poponi et al., 2021).

Sustainability and food security are influenced by food loss in the early stages of the supply chain and food waste (FW) in the final stages (United Nations, 2015; Beretta et al., 2017). Wasted food causes economic and environmental damage, with the loss of raw materials, energy, and labor.

In addition to that, food waste (FW) represents a relevant social issue considering that waste prevention would contribute to a more equitable food resource distribution (Roe et al., 2020). In the European context, the highest level of FW occurred at the household level in which 54% of still edible food was thrown away (Eurostat, 2022). For this reason, many studies in recent years have focused on measuring FW generated by consumers (Herzberg et al., 2020; Ilakovac et al., 2020; Grant et al., 2023). In addition to the quantification, it is important to evaluate the reasons for food waste which are varied and depend on several factors and behaviors (European Commission, Joint Research Centre, 2023). Van Geffen et al. (2016) designed a conceptual model for consumer food waste, investigating the attitudes about FW in the household. The analysis of the drivers and motivations behind FW generation is of relevance for the development of actionable recommendations and policy actions to prevent and reduce the quantity of food thrown away in families.

The present study originated from an international project and a national action that are interrelated in terms of objectives having FW as a common topic with the possibility that the outcomes of the one could feed up the findings and conclusions of the other. The European project SysOrg (Organic agro-food systems as models for sustainable food systems in Europe and Northern Africa) studied the Cilento Bio-District as a typical territory experiencing a positive

Abbreviations: CBD, Cilento Bio-District; FLW, Food Loss and Waste; FW, Food Waste; HFWB, Household Food Waste Behavior.



ecological transition (SysOrg project, 2021). This project started in 2021 (period of activity 2021–2024) to investigate the barriers and drivers for transforming the food system and increasing its sustainability. In addition to the Cilento-Bio-District, the other territories studied in the SysOrg project are Copenhagen Municipality, Warsaw Municipality, North Hesse Federal State, and Kenitra Province. Four perspectives will be examined for each territory, namely, diet, organic food and farming, FW, and food system transition aspects. A previous study (Peronti et al., 2024) on the waste perspective of the SysOrg project reported that in Cilento Bio-District, FW accounted for 136 g (SE 3.5) per person per week, and that food was thrown away as partly used (38%), meal leftovers (31%), completely unused (20%), and stored leftovers (11%). Furthermore, the comparative analysis confirmed that rural areas, e.g., Cilento Bio-District in Italy and North Hesse Federal State in Germany were better at preventing FW than metropolitan areas (Warsaw and Copenhagen). At the national level, the waste perspective of the SysOrg project activities carried out in the Cilento Bio-District was studied under the umbrella of the Italian Observatory on food surplus, recovery, and waste, a technical entity with a pivotal role in the production of research, methodologies, and data. The Observatory developed methodologies for a comprehensive assessment of FW that include the quantification and the element of consumers' behavior which could influence the

generation of waste. The evaluation of household FW at the national and regional levels has monitoring purposes to support the development of actions aimed at preventing and reducing FW (Grant and Rossi, 2022).

This study mainly aimed at comparing the FW behaviors of people living in the Cilento Bio-District with the FW attitudes recorded at the national level. Specifically, FW behavioral indicators, such as preventive practices, personal abilities, competing goals, meaning the prioritization of goals in conflict with food waste generation, food involvement attitude, and parents' attention to food waste, have been analyzed in the context of the Cilento Bio-District to explore if this model had an impact on the FW behavior as a sustainability element. The third objective of the study was the provision of inputs for preventive actions analyzing the differences and commonalities of a local area with specificities, such as Cilento Bio-District, with respect to the actions that could be promoted at the national level.

As mentioned, Cilento Bio-District represents a peculiar reality in Italy being the first organic district that inspired the creation of other similar territories in Italy. Hence, the theoretical hypothesis underlying this study was that in the Cilento Bio-District, the metrics of FW attitudes and behavior indicators would better correspond to FW prevention and reduction considering the inherent organic districts' concept of sustainability and protection

of natural resources. The comparison between Cilento Bio-District data and national data was made possible due to the provision of methodologies, developed by the Italian Observatory, which permitted the comparative assessment. The research questions that this study intended to address are as follows: (i) What are the metrics of FW behaviors in Cilento Bio-District and Italy? (ii) What are the reasons, motivations, or barriers for waste reduction and prevention? (iii) What are the distinctive elements, if any, of the FW behaviors that could address the development of preventive actions at local and national levels?

2 Materials and methods

The data presented in this study were derived from two sets of data collections in which the same questionnaire was used: (i) The Cilento Bio-District study, a cross-sectional assessment, carried out in 2023 and (ii) The Italian national survey carried out in 2021. The datasets of the two assessments were duly elaborated for the comparative purpose of the present study. The comparison of FW behaviors at both the local (Cilento Bio-District) and national levels allowed for a comprehensive understanding of FW dynamics, including variations across different geographical scales. Local specificities and factors that may contribute to FW behaviors within the Cilento Bio-District were identified and discussed.

2.1 Methodology of the surveys

The Cilento study was a cross-sectional assessment conducted by administering a questionnaire to adult (>18 years) residents in the 95 municipalities of the Cilento Bio-District territory. The data collection was carried out from 13 April to 9 May 2023. A sample of 541 subject representatives of the population residents in the target territory completed the survey. The sample was stratified by sex and age groups. The random selection of respondents was carried out using the municipalities' personal data lists of the Cilento Bio-District residents.

The 2021 Italian survey was a nationally representative cross-sectional assessment for which the detailed sampling procedure was reported in the study by Grant et al. (2023). In summary, the fieldwork was carried out between 5 July and 21 July 2021 and included 1,104 respondents with a quota of 110 subjects that did not use telematic tools. A stratification plan for Italian macro-regions (North-East, North-West, Centre, South, and Islands), differentiating for the town size (small: <10,000 inhabitants; medium: 10,000–100,000 inhabitants; large: >100,000 inhabitants) and using minimum quotas for family size and age for each macro-region, was carried out.

The sampling unit of the two studies was the family, although the surveys' respondents were responsible for food purchasing and preparation.

The fieldwork was performed with the collaboration of two specialized consumer agencies, Format Research S.r.l. for the Cilento Bio-District survey and SWG S.p.A. for national data collection. The consumer agencies permitted the recruitment of the respondents in accordance with the study protocol.

2.2 The questionnaire

The questionnaire used in the present study was shaped according to the objective of the study. In the Cilento Bio-District survey and the Italian national survey, the same questionnaire assessing the Household Food Waste Behaviors (HFWB) by measuring the determinants and behaviors of consumers toward FW was used (Supplementary Table S1). The questionnaire included an initial part covering sociodemographic information (sex, age, level of education, typology of job, region of living, and size of the family). The HFWB section comprised a validated questionnaire developed by Van Herpen et al. (2019) and further adapted to the Italian context. The Italian version of the HFWB questionnaire is a tool of the Italian Observatory tested and used in different surveys (Scalvedi and Rossi, 2021; Grant and Rossi, 2022) for monitoring purposes. In congruence with the design outlined in the introduction, the HFWB section of the questionnaire consisted of 11 questions that comprised 52 items assessing the following sections: (i) *Prevention practices* (e.g., planning of shopping, impulse buying, and using leftovers); (ii) *Personal Abilities* to prevent food waste generation (e.g., difficulties in assessing food safety, creative cooking, and accurate planning); (iii) *Competing goals* meaning the prioritization of food choice behaviors in potential conflict with food waste reduction (e.g., safety, taste, convenience of use, costs, and attention to quantity); (iv) *Food involvement attitude* (e.g., enjoyment of cooking, talking about food, and enjoyment of mixing or chopping food); (v) *Parents' attention to food waste* (e.g., parents' awareness of food waste, parents' teaching on the value of food, and maintenance of the attention toward food waste when growing up). A seven-point scale was used with answers ranging from "strongly disagree" to "strongly agree" or from "never" to "always."

Participation in the survey was voluntary and anonymous, and the participants were informed about the objectives of the study and the intention to publish the results. Data were collected following the European Commission General Data Protection Regulation (679/2016), and the study was conducted according to the guidelines of the Declaration of Helsinki (World Medical Association, 2018). The questionnaire was administered using the Computer-Assisted Web Interview (CAWI) system or Computer-Assisted Telephone Interview (CATI) system for non-internet user respondents. All procedures involving research study participants were approved and are in line with the Code of Conduct of the agencies that performed the data collection (Format research; SWG, 2021). The assessments neither involved any invasive procedures nor induced any changes in dietary patterns. Therefore, the study did not require approval from the ethics committee.

2.3 Data analysis

The seven-point scale of the answers to the questionnaires was used to calculate scores ranging from 1 (minimum) to 7 (maximum). A descriptive analysis of the scores was performed using means, standard deviation, and frequencies. The presence of frequencies' significant association between the area of residence and HFWB variables was assessed by the chi-squared test of independence which checks for a relation between two variables. This test aimed to compare the observed and expected frequencies

under the assumption of independence, given the rows and columns of the contingency table. The values ≤ 0.05 were considered significant, which is sufficient to reject the hypothesis of independence. Furthermore, the effect size was measured by complementing the chi-squared test with Cramer's V calculation carried out using the following formula:

$$V = \sqrt{\frac{\chi^2}{\min(r-1; c-1)n}}$$

where χ^2 = chi-squared statistic; r = number of rows; c = number of columns; and n = number of observations.

V interpretation was carried out considering the values of 0.1 corresponding to small effect size magnitude, 0.3 corresponding to medium effect size magnitude, and 0.5 corresponding to large effect size magnitude (Cohen, 1988; University of Cambridge, 2021).

The presence of significant differences between the mean scores of the two territories was evaluated using the t -test for two independent samples. The values ≤ 0.05 were considered significant, which is sufficient to reject the hypothesis that the means of the two territories were equal with an association of the means. In this case, the magnitude of the effect size was measured by complementing the t -test with Cohen's D calculation carried out using the following formula:

$$D = \frac{\bar{x}_a - \bar{x}_b}{\sqrt{\frac{\sum_{i \in a} (x_i - \bar{x}_a)^2 + \sum_{j \in b} (x_j - \bar{x}_b)^2}{n_a + n_b - 2}}}$$

where a and b = the two samples; $n_{a/b}$ = sample size a/b ; $\bar{x}_{a/b}$ = average of the sample a/b .

D interpretation was carried out considering the values of 0.2 corresponding to small effect size magnitude, 0.5 corresponding to medium effect size magnitude, and 0.8 corresponding to large effect size magnitude (Cohen, 1988; University of Cambridge, 2021).

V and D value distributions were plotted for each section, and values greater than the 75° percentile were fixed as the highest cutoff points of the data distributions. Furthermore, the V and D distributions of all sections were put together and plotted. The values greater than the 75° percentile both for V and D (meaning $V > 0.19$ and $D > 0.28$) were used to define the largest magnitude of the effect size of the analyzed data.

Synthetic indicators were calculated for each HFWB section and subsection, applying appropriate polarity changes when necessary. The arithmetic mean was used assuming compensation between the items constituting the synthetic indicator. Association analysis as described above was applied also to the HFWB synthetic indicators with respect to the residence area. Considering prevention practices as the results of the combined effects of abilities, competing goals, food involvement, parents' education, and territory, linear models were applied to estimate the influence of the mentioned variables on the prevention of FW; models with single explanatory variables and a complete model incorporating all variables were used.

The statistical analysis was performed using R Software version 4.3.2 (updated on 2023-10-31).

3 Results

The sociodemographic characteristics of the samples analyzed in the present study are shown in Table 1. The Cilento Bio-District showed a high proportion (30%) of young people (18–34 years) and a small percentage (9%) of families with one member in comparison to Italy (14 and 20% respectively). On the other hand, the high education level (high school) proportion was greater in the national sample (52%) than in the Cilento Bio-District (43%).

The results of the HFWB sections of the survey are reported in the following paragraphs. The detailed responses to all the questions are shown in Supplementary Tables S2–S6.

3.1 Food waste prevention practices

In the section, assessing the behaviors on FW prevention practices, the inhabitants of Cilento Bio-District recorded slightly worse average scores than respondents at the national level, with the only exception of the items related to impulse buying. The group of items related to leftover utilization received the highest average scores at the Cilento Bio-District and the national level with differences in the selected options, i.e., the habit of finishing all what is on the plate (no leftovers generation) for the Cilento Bio-District (5.55; SD 1.37) and the attitude of saving the leftovers if cooked too much for Italy (5.99; SD 1.22). Activities related to food planning and management registered the worst mean scores with the construct on the planning for cooking every day having the lowest values both in Cilento Bio-District (4.14; SD 1.84) and Italy (4.10; SD 1.65) (Table 2 and Supplementary Table S2).

Scores of food waste prevention practices and metrics of the association with territorial variables are shown in Table 2. The food waste prevention practices in Italy and the Cilento Bio-District moderately diverged, even though for more than half of the practices, significant differences were found. The strongest differences between the Cilento Bio-District and Italy were found in the items related to storing and using leftovers. The territory of residence was significantly associated (small-medium magnitude of the effect size) ($V = 0.21$; $D = -0.39$ both with a p -value of < 0.05) with the practice of finishing all the food on the plate, which showed a higher average score in Italy (5.98; SD 0.99) compared to the Cilento Bio-District (5.55; SD 1.37). In addition, the habits of saving leftovers if cooked too much ($V = 0.19$; $D = -0.34$ both with a p -value of < 0.05) and eating all the stored leftovers ($V = 0.18$; $D = -0.30$ both with a p -value of < 0.05) were more common in Italy than in the Cilento Bio-District with small-medium magnitude of the effect size. To a similar extent, in the section related to food purchase planning, the habit of making a shopping list (small-medium effect size magnitude $V = 0.19$; $D = -0.36$ both with p -value < 0.05) was more commonly reported in Italy (5.09; SD 1.70) than in the Cilento Bio-District (4.45; SD 2.00) (Table 2).

3.2 Abilities to prevent food waste generation

As shown in Table 3 and Supplementary Table S3, the scores for items corresponding to the abilities to prevent food waste generation received worse scores in the Cilento Bio-District compared with the

TABLE 1 Sociodemographic characteristics of the studied samples.

Variable	Category	Cilento Bio-District 2023		Italy 2021		Both samples	
		<i>n</i> = 541		<i>n</i> = 1,104		<i>n</i> = 1,645	
		(<i>n</i>)	(%)	(<i>n</i>)	(%)	(<i>n</i>)	(%)
Sex	Male	247	46%	448	41%	695	42%
	Female	294	54%	656	59%	950	58%
Age	18–34	164	30%	157	14%	321	20%
	35–44	85	16%	178	16%	263	16%
	45–54	86	16%	233	21%	319	19%
	55–64	81	15%	211	19%	292	18%
	≥65	125	23%	325	29%	450	27%
Education	Primary school or lower	35	6%	29	3%	64	4%
	Secondary school	86	16%	122	11%	208	13%
	High school	233	43%	572	52%	805	49%
	University or higher	187	35%	381	35%	568	35%
Job	Unemployed	64	12%	119	11%	183	11%
	Retired	91	17%	278	25%	369	22%
	Housewife	85	16%	127	12%	212	13%
	Worker	301	56%	580	53%	881	54%
Family size	1 member	48	9%	220	20%	268	16%
	2 members	136	25%	339	31%	475	29%
	3 members	129	24%	263	24%	392	24%
	4 members	149	28%	224	20%	373	23%
	≥5 members	79	15%	58	5%	137	8%
Children	Without	357	66%	813	74%	1,170	71%
	With	184	34%	291	26%	475	29%

national level. The obstacles showing the highest scores were those related to creative cooking, with difficulties in using leftovers for new meals (3.34; SD 1.75) and deviating from known recipes (3.37; SD 1.73), which reached higher scores in the Cilento Bio-District than in Italy (2.82; SD 1.58 and 2.88; SD 1.65, respectively). The items with lower scores were the difficulties in the preparation of meals from foods already present at home (at the national level, 2.31; SD 1.39) and the habit of leaving food in the fridge for a long time because of not knowing how to cook (uncommon in both samples: Cilento Bio-District 2.88; SD 1.54 and Italy 2.46; SD 1.45). The item with the highest score in the Cilento Bio-District was the ability to know product preservation (5.14; SD 1.37), while in Italy, it was a good ability to estimate the needs of food to buy (2.48; SD 1.34) and cook (2.38; SD 1.32).

Living in the Cilento Bio-District or Italy showed a significant association with the abilities to prevent food waste generation; in terms of the magnitude of the effect size, *V* and *D* values corresponded to a medium-low level. The strongest differences between the Cilento Bio-District and the whole country were found in the ability to cook creatively and accurately plan food purchases, according to the needs of the family, with a medium or medium-low association with the territory measured by the effect size magnitude. Difficulties to prepare a meal with foods already available at home ($V=0.24$, $D=0.44$; both with a p -value of <0.05), difficulties in the estimation of the quantity

of food to be purchased ($V=0.23$, $D=0.40$; both with a p -value of <0.05), difficulties in the estimation of weekly food needs of the family ($V=0.20$, $D=0.36$; both with a p -value of <0.05), and difficulties of the estimation of the quantity of food to cook ($V=0.20$, $D=0.33$; both with a p -value of <0.05) were reported with higher scores in the Cilento Bio-District compared with Italy. The questions on skills related to food safety assessment resulted in the lowest associations with the area of living (all with $V=0.17$ or 0.14 ; D = between -0.16 and -0.22 with $p < 0.05$).

3.3 Goals in competition with food waste

In this section, food-related goals that consumers have and that compete to prevent food waste were analyzed. The healthiness (Cilento Bio-District 5.81; SD 1.32 and Italy 6.12; SD 0.99) and the taste (Cilento Bio-District 5.72; SD 1.30 and Italy 6.00; SD 0.97) were the competing goals prioritized higher than FW prevention and reduction; lower scores were recorded for the cheapness of food (Cilento Bio-District 4.37; SD 1.51 and Italy 4.16; SD 1.43) (Table 4 and Supplementary Table S4).

The set of questions related to goals in competition with FW showed better scores in the Cilento Bio-District than in Italy (Table 4). Territorial differences were found for the prioritization of healthy

TABLE 2 Scores of food waste prevention practices set of questions (mean; standard deviation) and measure of association with territorial variable (Cilento Bio-District and Italy), significant p -value < 0.05.

Items	Cilento Bio-District		Italy		χ^2 p -value	Cramer's V	t -test p -value	Cohen's D
	Mean	SD	Mean	SD				
Planning (highest score, best FW behavior)								
Shopping list	4.45	2.00	5.09	1.70	0.000	0.19	0.000	-0.36
Planning cooking every day	4.14	1.84	4.10	1.65	0.003	0.11	0.712	0.02
Eating first food almost spoiled	5.48	1.60	5.83	1.12	0.000	0.21	0.000	-0.26
Planning handling food	4.60	1.77	4.98	1.46	0.000	0.16	0.000	-0.24
Planning buying and cooking food	4.65	1.76	4.86	1.39	0.000	0.19	0.016	-0.14
Impulse buying (lowest score, best FW behavior)								
Buying not needed products	2.90	1.65	3.06	1.33	0.000	0.21	0.046	-0.11
Buying not planned food	3.06	1.61	3.32	1.32	0.000	0.19	0.001	-0.19
Consider myself impulsive buyer	2.89	1.68	3.07	1.35	0.000	0.22	0.030	-0.12
Overview of the food in stock (highest score, best FW behavior)								
Knowledge of food stock	5.23	1.57	5.43	1.22	0.000	0.18	0.011	-0.15
Quick evaluation of food stock	5.14	1.59	5.30	1.25	0.000	0.17	0.045	-0.11
Putting in sight food to be eaten first	5.35	1.57	5.47	1.29	0.000	0.15	0.130	-0.09
Organization of shelves and fridge	5.17	1.51	5.29	1.25	0.000	0.13	0.138	-0.08
Cooking precisely (highest score, best FW behavior)								
No getting unnecessary leftovers	5.34	1.62	5.57	1.14	0.000	0.22	0.003	-0.17
Measuring ingredients	4.71	1.86	5.00	1.53	0.000	0.17	0.002	-0.17
Right quantities use	5.05	1.61	5.27	1.22	0.000	0.19	0.005	-0.16
Valuation of needed quantities	5.18	1.60	5.40	1.24	0.000	0.19	0.007	-0.16
Storing & using leftovers (highest score, best FW behavior)								
Plate finished	5.55	1.37	5.98	0.99	0.000	0.21	0.000	-0.39
Saving leftovers in the dish	5.03	1.84	5.42	1.63	0.000	0.13	0.000	-0.23
Saving leftovers cooked	5.53	1.57	5.99	1.22	0.000	0.19	0.000	-0.34
Eating stored leftovers	5.38	1.55	5.78	1.22	0.000	0.18	0.000	-0.30
Eating all prepared food	5.43	1.50	5.76	1.21	0.000	0.14	0.000	-0.25
Saving plate or pan leftovers	5.20	1.74	5.13	1.77	0.528	0.06	0.452	0.04

Items in bold have the highest association with territorial variable ($V > 0.19$ and $D > 0.28$); numbers in bold have Cramer's V or Cohen's D highest than the 75^o percentile of V or D distribution.

($V = 0.19$; $D = -0.28$) and tasty food ($V = 0.21$; $D = -0.26$) with higher scores reported at the national level compared with the Bio-District. On the other hand, the construct on the importance of not having too much food at home, which is a goal positively associated with FW reduction, showed a particularly high score in the Cilento Bio-District compared with the national level, even though this association had a small magnitude of the effect size ($V = 0.14$ and $D = 0.22$ both with a p -value of 0.00).

3.4 Involvements in cooking and handling food

In this section, the involvement in meal preparation and pleasure in food handling were analyzed. Mealtime was largely reported as an important moment of the day, and cooking was considered an enjoyable activity both in the Cilento Bio-District (5.03; SD 1.48 and 4.90; SD 1.50, respectively) and Italy (5.37; SD 1.25 and 5.25; SD 1.49,

respectively). Other food handling procedures such as mixing or cutting gained lower scores (Cilento Bio-District 4.13; SD 1.67 and Italy 4.22; SD 1.53) (Table 5 and Supplementary Table S5).

Food involvement aspects showed generally significantly higher scores in Italy compared with the Cilento Bio-District. Nevertheless, the effect size magnitude resulted at a small level (Table 5). The enjoyment of cooking for oneself and others and the importance of mealtime showed the highest associations with the territory, with a small level of effect size magnitude ($V = 0.16$, $D = -0.23$; $V = 0.16$, $D = -0.25$, respectively).

3.5 Parents' attention to food waste

This set of questions aimed to investigate the effect of parents' education on attention to food waste. Very high scores were recorded for all items. The parents' teaching to treat food with care (food value) reached the highest scores in the Cilento Bio-District (5.82; SD 1.29)

TABLE 3 Scores of abilities to prevent food waste generation section questions (mean; standard deviation) and measure of association with the territorial variable (Cilento Bio-District and Italy), significant p -value < 0.05.

Items	Cilento Bio-District		Italy		χ^2 p -value	Cramer's V	t -test p -value	Cohen's D
	Mean	SD	Mean	SD				
Assessing food safety (lowest score, best FW behavior)								
Food safety estimation using sense	2.99	1.65	2.68	1.56	0.000	0.13	0.000	0.19
Estimation food still safe to eat	2.97	1.66	2.74	1.51	0.000	0.14	0.007	0.15
Not knowledge food still safe to eat	3.15	1.65	2.98	1.61	0.013	0.10	0.054	0.10
Creative cooking (lowest score, best FW behavior)								
Prepare meal with available products	2.97	1.63	2.31	1.39	0.000	0.24	0.000	0.44
Use leftovers for new meals	3.34	1.75	2.82	1.58	0.000	0.18	0.000	0.32
Deviate from known recipes	3.37	1.73	2.88	1.65	0.000	0.19	0.000	0.29
Leave food in the fridge not knowing how to cook	2.88	1.54	2.46	1.45	0.000	0.19	0.000	0.28
Accurate planning (lowest score, best FW behavior)								
Estimation of food to buy	3.06	1.68	2.48	1.34	0.000	0.23	0.000	0.40
Estimate food eaten	3.21	1.72	2.66	1.43	0.000	0.20	0.000	0.36
Estimation of food to cook	2.85	1.56	2.38	1.32	0.000	0.20	0.000	0.33
Knowledge on prolonging shelf-life (highest score, best FW behavior)								
Knowledge of fruit and vegetables preservation	5.11	1.40	5.35	1.27	0.000	0.17	0.001	-0.18
Knowledge of meat and fish preservation	5.04	1.43	5.34	1.28	0.000	0.17	0.000	-0.22
Knowledge of best fridge temperature	4.99	1.42	5.27	1.31	0.000	0.14	0.000	-0.21
Knowledge of products preservation	5.14	1.37	5.35	1.25	0.000	0.14	0.003	-0.16

Items in bold have the highest association with the territorial variable ($V > 0.19$ and $D > 0.28$); numbers in bold have Cramer's V or Cohen's D highest than the 75° percentile of V or D distribution.

at the national level (6.16; SD 1.18) (Table 6 and Supplementary Table S6).

Among the three assessed constructs, both the attitude of parents toward not throwing food away ($V = 0.18$; $D = -0.32$) and parents' teaching of the value of food ($V = 0.19$; $D = -0.28$) showed a significant association (small-medium magnitude of the effect size) with the territory (Table 6).

3.6 Overall assessment of household food waste behavior

The summary results of the HFWB constructs showed that the highest scores were found for the sections related to the education received from parents (Cilento Bio-District 5.64; SD 1.29 and Italy 5.95; SD 1.18) and for prevention practices, in particular for the items related to the storage and use of leftovers (Cilento Bio-District 5.35; SD 1.26 and Italy 5.68; SD 1.05). In contrast, the lowest values of the scores were found for the section of the goals in competition with FW (Cilento Bio-District 3.66; SD 0.73 and Italy 3.45; SD 0.76), especially for the attitude of avoiding having too much food at home (Cilento Bio-District 4.47; SD 1.47 and Italy 4.15; SD 1.47). Detailed scores are shown in Supplementary Table S7.

Figure 2 and Table 7 report the results of the overall HFWB assessment. Italy had better HFWB indicators than the Cilento

Bio-District, except for the competitive goal section and the impulse buying items showing better scores in the Cilento Bio-District. The highest levels of divergences between the territories were found for the set of questions related to the abilities to prevent and generate FW ($D = 0.38$; $p < 0.05$), especially for the capacity of having a creative approach to cooking (e.g., use of leftovers for new recipes or experiment new dishes preparation) ($D = -0.40$; $p < 0.05$) and for having the ability of accurate planning with the capacity to estimate quantities of food for the family ($D = -0.40$; $p < 0.05$), which were significantly better at the national level. The Cilento Bio-District showed the best scores in the section related to the goals in competition with FW with a medium-small effect size magnitude ($D = 0.29$; $p < 0.05$) of the association with the territory. In this section, the construct on the avoidance of having too much food at home better characterized the Cilento Bio-District. The section on the involvement in meal preparation and pleasure in food handling showed the lowest territorial differences ($D = -0.19$; $p < 0.05$).

Table 8 reports the results of the linear models using the indicators that showed the major differences between the two territories, namely creative cooking, accurate planning, and abilities, as response variables. The variables with the most significant influence were reported, while the complete analysis is shown in the Supplementary Table S8. Among the sociodemographic variables, sex and age were the most related to the selected FW behaviors. The scores were higher in women than men ($\beta_{\text{female}} = +0.19$) and increased with age reaching the maximum in the

TABLE 4 Scores of goals in competition with food waste set of questions (mean; standard deviation) and measure of association with the territorial variable (Cilento Bio-District and Italy), significant p -value < 0.05.

Items	Cilento Bio-District		Italy		χ^2 p -value	Cramer's V	t-test p -value	Cohen's D
	Mean	SD	Mean	SD				
Competing goals (lowest score, best FW behavior)								
Healthiness	5.81	1.32	6.12	0.99	0.000	0.19	0.000	-0.28
Taste	5.72	1.30	6.00	0.97	0.000	0.21	0.000	-0.26
Convenience	4.92	1.38	4.91	1.34	0.001	0.11	0.876	0.01
Enough food	4.87	1.35	5.07	1.25	0.000	0.13	0.004	-0.16
Cheapness	4.37	1.51	4.16	1.43	0.000	0.15	0.006	0.15
Competing goal (highest score, best FW behavior)								
Not too much food	4.47	1.47	4.15	1.47	0.000	0.14	0.000	0.22

Items in bold have the highest association with the territorial variable ($V > 0.19$ and $D > 0.28$); numbers in bold have Cramer's V or Cohen's D highest than the 75° percentile of V or D distribution.

TABLE 5 Scores of involvements in cooking and handling food set of questions (mean; standard deviation) and measure of association with the territorial variable (Cilento Bio-District and Italy), significant p -value < 0.05.

Items	Cilento Bio-District		Italy		χ^2 p -value	Cramer's V	t-test p -value	Cohen's D
	Mean	SD	Mean	SD				
Food involvement (highest score, best FW behavior)								
Pleasure to cook	4.68	1.55	5.00	1.58	0.000	0.15	0.000	-0.20
Liking to talk about food	4.74	1.49	4.71	1.54	0.182	0.07	0.738	0.02
Prioritization of food choices	4.87	1.44	5.02	1.31	0.000	0.13	0.047	-0.11
Liking to cook for me/others	4.90	1.50	5.25	1.49	0.000	0.16	0.000	-0.23
Liking to mix/chop food	4.82	1.46	5.04	1.38	0.038	0.09	0.004	-0.15
Thinking a lot of food	4.13	1.67	4.22	1.53	0.000	0.15	0.268	-0.06
Mealtime very important	5.03	1.48	5.37	1.25	0.000	0.16	0.000	-0.25

Items in bold have the highest association with the territorial variable ($V > 0.19$ and $D > 0.28$); numbers in bold have Cramer's V or Cohen's D highest than the 75° percentile of V or D distribution.

TABLE 6 Scores of parents' attention to prevent food waste set of questions (mean; standard deviation) and measure of association with the territorial variable (Cilento Bio-District and Italy), significant p -value < 0.05.

Items	Cilento Bio-District		Italy		χ^2 p -value	Cramer's V	t-test p -value	Cohen's D
	Mean	SD	Mean	SD				
Parents' attention to preventing food waste (highest score, best FW behavior)								
Parents' attention prevents FW	5.59	1.53	6.03	1.27	0.000	0.18	0.000	-0.32
Parents teaching food value	5.82	1.29	6.16	1.18	0.000	0.19	0.000	-0.28
Not allowed FW when grown up	5.52	1.50	5.67	1.41	0.000	0.17	0.059	-0.10

Items in bold have the highest association with the territorial variable ($V > 0.19$ and $D > 0.28$); numbers in bold have Cramer's V or Cohen's D highest than the 75° percentile of V or D distribution.

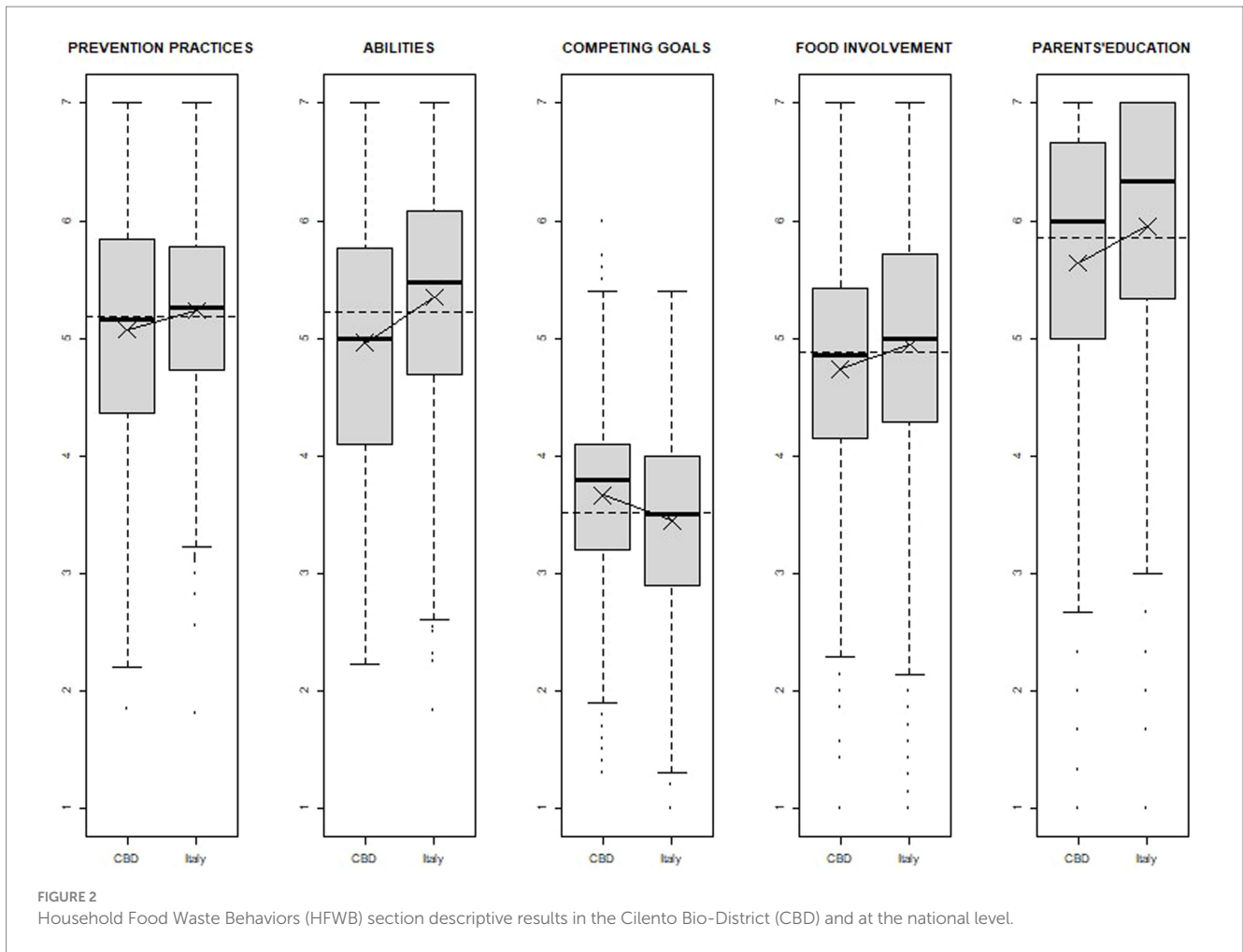


FIGURE 2 Household Food Waste Behaviors (HFWB) section descriptive results in the Cilento Bio-District (CBD) and at the national level.

TABLE 7 HFWB overall assessment (mean; standard deviation) and measure of associations with the territorial variable (Cilento Bio-District and Italy), significant p -value < 0.05.

HFWB	Cilento Bio-District		Italy		t -test p -value	Cohen's D
	Mean	SD	Mean	SD		
Planning	4.66	1.36	4.97	1.09	0.000	-0.26
Impulse buying	5.05	1.47	4.85	1.18	0.005	0.16
Overview of the food in stock	5.22	1.32	5.37	1.07	0.026	-0.13
Cooking precisely	5.07	1.39	5.31	1.10	0.001	-0.20
Storing and using leftovers	5.35	1.26	5.68	1.05	0.000	-0.29
PREVENTION PRACTICES	5.07	0.96	5.24	0.76	0.001	-0.20
Assessing food safety	4.96	1.45	5.20	1.45	0.002	-0.16
Creative cooking	4.86	1.36	5.38	1.29	0.000	-0.40
Accurate planning	4.96	1.42	5.49	1.28	0.000	-0.40
Shelf-life knowledge	5.07	1.19	5.33	1.20	0.000	-0.21
ABILITIES	4.96	1.01	5.35	1.01	0.000	-0.38
Competing goals(-)	5.14	0.91	5.25	0.74	0.012	-0.14
Not having too much food	4.47	1.47	4.15	1.47	0.000	0.22
COMPETING GOALS	3.66	0.73	3.45	0.76	0.000	0.29
FOOD INVOLVEMENT	4.74	1.06	4.94	1.10	0.000	-0.19
PARENTS' EDUCATION	5.64	1.29	5.95	1.18	0.000	-0.25

Items in bold have the highest association with the territorial variable ($D > 0.28$); numbers in bold have Cohen's D highest than the 75° percentile of V or D distribution.

TABLE 8 Results of the linear models with the indicators that showed the greatest differences between the two territories (creative cooking, accurate planning, and ABILITIES) as response variables and the sociodemographic variables (sex, age class, education, job, income, family size, and presence of children in the family) as explanatory variables.

Response variable	Explanatory variable	Category	lm estimation	t-test p-value	R ²	F-test p-value
Creative cooking		Intercept	4.19	0.000	0.05	0.035
	Sex	Female	0.19	0.006		
	Age class	35–44	0.29	0.010		
		45–54	0.48	0.000		
		55–64	0.71	0.000		
		≥65	0.46	0.001		
Accurate planning		Intercept	4.31	0.000	0.07	0.021
	Sex	Female	0.20	0.004		
	Age class	35–44	0.20	0.070		
		45–54	0.54	0.000		
		55–64	0.79	0.000		
		≥65	0.65	0.000		
	Education	Secondary school	0.39	0.041		
		High school	0.43	0.017		
		University or higher	0.29	0.129		
	Income	Medium	0.21	0.041		
		High	0.22	0.033		
I prefer not to answer		−0.06	0.679			
ABILITIES		intercept	4.30	0.000	0.09	0.004
	Sex	Female	0.18	0.001		
	Age class	35–44	0.33	0.000		
		45–54	0.56	0.000		
		55–64	0.77	0.000		
		≥65	0.54	0.000		

Significant *p*-value < 0.05.

respondents aged 55–64 years ($+0.7 < \beta_{55-64 \text{ years}} < +0.8$). The capacity in food planning was higher in people with high or medium income (both approximately $\beta = +0.21$) and increased with the educational level ($\beta_{\text{high school}} = +0.43$) while decreasing in people with a university degree ($\beta_{\text{university or higher}} = +0.29$). Sociodemographic parameters explained the highest percentage of the variability of the response variable in the model that analyzed abilities ($R = 0.09$). Table 9 shows the results of the linear models estimating the influence of FW behavior variables (abilities, competing goals, food involvement, and parents' education), sociodemographic variables, and the territory on FW prevention practices. All FW behavior variables, when individually analyzed, influenced the prevention practices (*F* test *p*-values < 0.05) with abilities ($R = 0.32$ and $\beta = +0.46$, both $p = 0.00$) and parents' education ($R = 0.24$ and $\beta = +0.33$, both $p = 0.00$) being strongly correlated with prevention practices. On the other hand, belonging to Cilento or Italy had a lower influence on practices aimed at preventing FW ($R = 0.01$ and $\beta_{\text{Italy}} = +0.16$, both $p = 0.00$). Among the sociodemographic parameters, sex ($R = 0.015$) and age ($R = 0.042$) were identified as the most significant variables that explained FW prevention practices. Specifically, female individuals ($\beta_{\text{female}} = +0.23$) and the age class of 55–64 years ($\beta_{55-64 \text{ years}} = +0.41$) confirmed to have the highest HFWB scoring. Considering

the linear model including the whole set of FW variables, the central role of the abilities as predictor of prevention practices was further confirmed ($R = 0.31$ and $\beta = 0.34$, both $p = 0.00$) either in the model controlled for sociodemographic variables or in the model without this control.

4 Discussion

This study aimed to compare the FW behaviors of people living in the Cilento Bio-District with the FW attitude recorded in Italy. HFWB indicators better performed at the national level than in the Cilento Bio-District with some relevant exceptions, such as the prioritization of goals related to food at home in competition with FW generation resulting in more in line with an attitude of avoiding FW. These results are unexpected, considering the study hypothesis.

The authors' interpretation of these findings is that probably in the Cilento Bio-District, certain FW attitudes are seamlessly integrated into daily life becoming implicit behaviors. The natural environment of the Cilento Bio-District, which was characterized by its biodiversity, traditional food culture, and commitment to sustainability, would

TABLE 9 Results of linear models with FW prevention practices as the response variable: models with single explanatory variable, complete model incorporating all variables as explanatory variables, model with all sociodemographic variables as explanatory variables and complete model incorporating all indicators as explanatory variables controlling for sociodemographic variables.

Model	Explanatory variable	Category	lm estimation	t-test p-value	R ²	F-test p-value
Single Predictor Model	ABILITIES	Intercept	2.80	0.000	0.32	0.000
		β	0.46	0.000		
	COMPETING GOALS	Intercept	5.38	0.000	0.00	0.038
		β	-0.06	0.038		
	FOOD INVOLVEMENT	Intercept	3.83	0.000	0.13	0.000
		β	0.28	0.000		
	PARENTS' EDUCATION	Intercept	3.24	0.000	0.24	0.000
		β	0.33	0.000		
	Territory	Intercept	5.07	0.000	0.01	0.000
		β (Italy)	0.16	0.000		
Sociodemographic Model		Intercept	4.78	0.000		
	Sex	Female	0.23	0.000	0.01	0.000
	Age class	35-44	0.19	0.007	0.04	0.000
		45-54	0.25	0.000		
		55-64	0.41	0.000		
		≥ 65	0.29	0.001		
	Education	Secondary school	0.01	0.952	0.00	0.436
		High school	-0.06	0.598		
		University or higher	-0.09	0.415		
	Job	Retired	0.17	0.079	0.01	0.009
		Housewife	-0.03	0.714		
		Worker	-0.08	0.234		
	Income	Medium	0.05	0.409	0.01	0.016
		High	0.16	0.013		
		I prefer not to answer	0.15	0.080		
	Family size	2	0.07	0.257	0.00	0.408
		3	0.06	0.378		
4		0.04	0.607			
≥ 5		0.17	0.061			
Children	With	-0.08	0.081	0.00	0.081	
Complete Model		intercept	1.65	0.000		
	Territory	β (Italy)	-0.05	0.175	0.01	0.000
	ABILITIES	β	0.34	0.000	0.31	0.000
	COMPETING GOALS	β	0.03	0.232	0.00	0.898
	FOOD INVOLVEMENT	β	0.13	0.000	0.05	0.000
	PARENTS' EDUCATION	β	0.19	0.000	0.06	0.000
Complete Model checking by sociodemographic variables (sex, age class, education, job, income, family size, and children)		Intercept	1.77	0.000		
	Territory	β (Italy)	0.01	0.782	0.01	0.000
	ABILITIES	β	0.33	0.000	0.31	0.000
	COMPETING GOALS	β	0.02	0.262	0.00	0.896
	PARENTS' EDUCATION	β	0.17	0.000	0.06	0.000

Significant p-value < 0.05.

contribute to lower levels of FW despite the absence of explicit FW prevention strategies. Furthermore, in the Bio-District, sustainable choices are promoted by living labs, education programs, and education initiatives that could contribute to building a more resilient and waste-conscious community (Global Alliance for Organic Districts, 2023). These aspects involved the whole productive system considering that the main actors of the Bio-District are not only farmers but also people working in the tourism, business, and educational sectors that cooperate to improve the quality of life in rural areas, safeguarding the land and biodiversity, and encouraging local small companies (Stefanovic and Agbolosoo-Mensah, 2023).

The quantitative evaluation of FW is in line with this interpretation. The measurement of FW levels in the Cilento Bio-District and at the national level was provided in other studies, showing quantities largely lower in the Cilento Bio-District (136 g per person per week Peronti et al., 2024) compared with the two national surveys carried out in Italy, reporting 187 g per person per week in 2018 and 204 g per person per week in 2021 (Grant et al., 2023). The comparability with 2021 poses problems in consideration of the fact that the pandemic situation probably impacted the FW quantification (Everitt et al., 2022). However, the comparison with 2018 national data showed that people living in the Cilento Bio-District wasted 27% less food compared with Italy. The comparability of these figures is ensured by the fact that the data collection was carried out with the same questionnaire and a robust sampling methodology. Previous research reported a significant negative correlation between the intention to reduce FW and the amount of FW produced (Visschers et al., 2016). However, the interpretation of these results cannot ignore the rural context of the Cilento Bio-District (Packer and Zanasi, 2023). According to Marwood et al. (2023), people who had even little experience in growing food had a lower significant propensity to waste food because food is seen as the result of physical efforts with an intrinsic economic and ethical value. In addition, the present assessment mainly analyzed cognitive drivers (e.g., shopping control or meal plan habits). However, the different behavioral drivers did not have the same influence on the FW level. As reported by Ammann et al. (2021), affective drivers meaning sensory level of food assessment (e.g., intolerance for imperfections and the perceived control of food waste), not considered in the present study, seemed to play a more important role than cognitive drivers in predicting the quantity of food thrown away. The present findings and interpretations confirmed once again the strong connection between FW and the food environment intended as the interface where people interact with the wider food system (Turner et al., 2018) and the need to investigate the consumer FW integrating different indicators of sustainability (Conrad et al., 2018).

In the HFWB model used in the present study, the prevention practices were considered as the effects of the combined influence of the abilities, the competing goals, the food involvement level, and the parents' education as reported by Van Geffen et al. (2017). In accordance with the study objectives, those aspects were complemented with the territorial context. The most relevant outcome of this analysis was the demonstration that the abilities largely influenced the FW behavior representing a determinant of FW prevention practices independently from the area of living. The relationship between FW and lack of ability in food preparation and portioning was largely reported (Abeliotis et al., 2014; Quedsted and Parry, 2017). According to the present study results, good skills in

estimating food needs and cooking creatively represented the major distinctive elements of differentiation between Italy and the Cilento Bio-District. This finding could be explained considering that, while attitudes and behaviors may not explicitly align with modern FW prevention and reduction strategies, such as meal planning or portion control, traditional practices of the Cilento Bio-District may inadvertently lead to less waste through methods such as using leftovers or preserving surplus produce (Stefanovic and Agbolosoo-Mensah, 2023). These results could be partially explained by the sociodemographic characteristics of the samples. Young respondents (18–34 years) were twice as many in the Cilento Bio-District (30%) compared with the national sample (14%), and the young consumers had low levels of cooking skills as a consequence of their limited experience (Bravi et al., 2020). The Cilento Bio-District showed better purchasing management by avoiding having too much food at home, and this aspect reflects the above-mentioned characteristics of the Bio-District where food purchased relies on the presence of small local producers and seasonal products with a direct relationship between local retailers and consumers (Clemente et al., 2013; Esposito et al., 2020). To enhance the comparative analysis using external benchmarks, Italy and the Cilento Bio-District scores were matched with the data from the four European countries assessed by Van Geffen et al. (2017). The highest scores in the FW prevention abilities found in Italy could be considered a national distinctive characteristic both in comparison to the Cilento Bio-District and other countries (5.35 versus 5.16 Hungary, 5.03 Germany, 5.01 The Netherlands, and 4.80 Spain). On the other hand, Cilento Bio-District was characterized by specific behaviors related to competing goals in line with FW prevention either with respect to Italy or other countries (3.66 versus 3.52 The Netherlands, 3.42 Germany, 3.29 Hungary, and 3.21 Spain).

The combination of community cohesion, traditional food culture, a closer connection to food sources, limited availability of retail chains, and environmental awareness may collectively contribute to the lower prevalence of certain behaviors, such as impulse buying in the Cilento Bio-District compared with more urbanized areas (Winkler et al., 2020). The Cilento region has a rich culinary tradition based on local, seasonal ingredients and traditional cooking methods (Motti et al., 2024). This food culture often emphasizes mindful consumption, appreciation for local flavors, and respect for natural resources, which may discourage impulse buying of non-essential foods (Aliberti et al., 2024). These aspects could also explain why the consumers in the Cilento Bio-District are less focused on planning to buy with respect to the national level. Other qualitative aspects such as cultural norms, social pressures, convenience factors, and perceived value of food could provide nuanced insights into the underlying reasons behind waste generation and explain the observed differences in waste-related decisions and behaviors.

The analysis of the indicators that showed the greatest differences between the two territories (creative cooking, accurate planning, and FW prevention abilities) resulted related to sociodemographic aspects, with female and old adults (55–64 years) overall showing the highest scores, and food planning resulting particularly reported by families with high socio-economic level (high educational level and high/medium income). These findings could be attributed to several factors. Traditionally, and in particular, in rural areas such as the Cilento Bio-District, women have often taken on the role of managing

household tasks, including meal planning and cooking, which may explain their higher scores in creative cooking and accurate planning (Flagg et al., 2014). Additionally, older adults might have accumulated more experience and knowledge in these areas over time, contributing to their higher scores (Bostic and McClain, 2017). The association between food planning and a high socioeconomic status suggests that access to resources, education, and possibly more time and flexibility might contribute to better food planning attempts. Higher education levels could provide individuals with better organizational skills and an understanding of the importance of meal planning for both health and economic reasons (Oliver et al., 2023).

The comparison of the Cilento Bio-District data with national data was possible due to the methodologies developed by the Italian Observatory on food surplus, recovery, and waste, which provided standardized and validated approaches for collecting, analyzing, and interpreting the data. This is an important strength of the study that enhanced the credibility and reliability of the assessment and facilitated the evidence-based decision-making allowing for a nuanced understanding of the Cilento Bio-District's position in the broader national context. In addition, the robust sampling methodology of the surveys, representative of the living population and stratified per age groups both in the Cilento Bio-District and at the national level, represented an added value of the study.

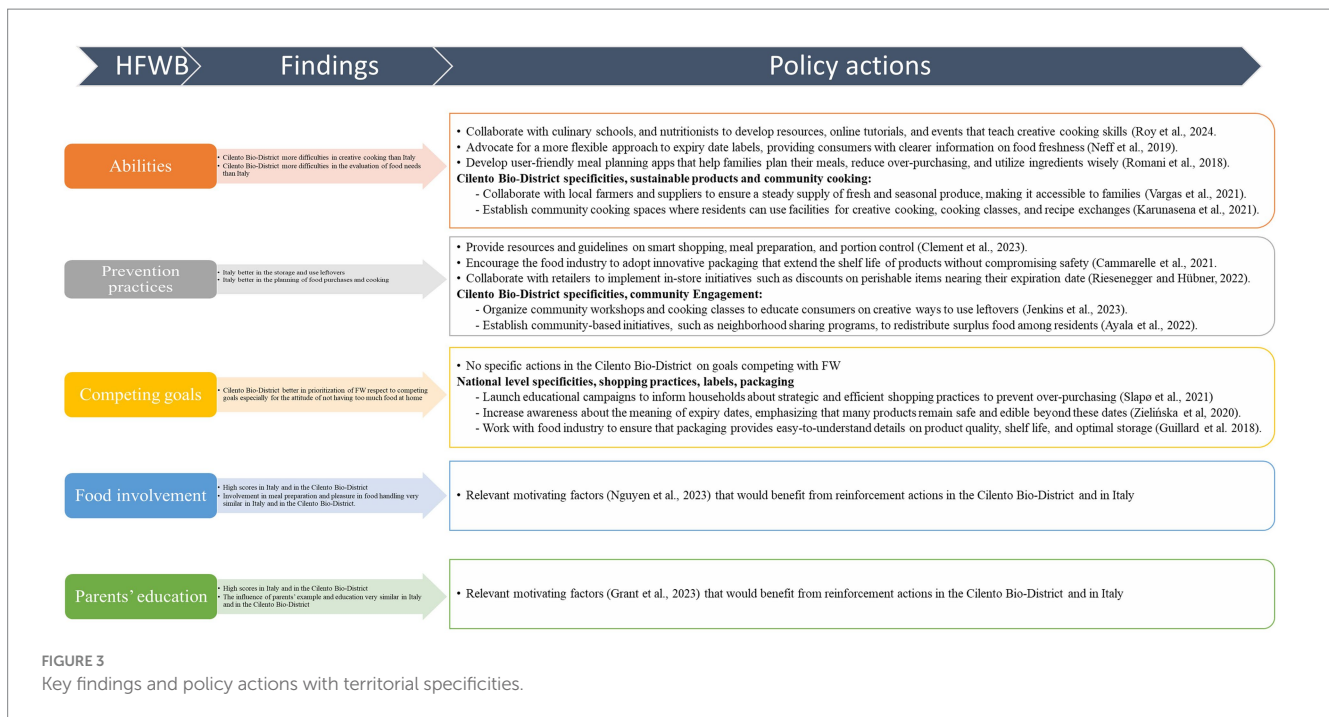
The main limitation of the present study was the inability to include the quantification of household FW to evaluate its relationship with the FW behaviors analyzed in this study. The reason for this issue was related to the fact that the quantification of household FW in the Cilento Bio-District was carried out in 2021 in a similar and comparable assessment that, however, evaluated different respondents (Peronti et al., 2024). Although a specific analysis of the relationship between behaviors and quantity of FW in the families could not be performed, these quantitative data were used in the discussion and were considered in the drafting of the policy actions and conclusions. Another limitation of the study was related to the use of questionnaires assessing behaviors that could imply a potential distortion in answers (response bias) due to the attitude of study subjects in providing responses aligned with social norms or expectations rather than reflecting their true behaviors, with the effect of an overestimation of socially desirable behaviors and an underreporting of undesirable attitudes (Latkin et al., 2017). Additionally, participants who are more aware of food waste issues or actively engaged in waste reduction efforts may be more likely to participate in the study, leading to biased estimates of FW behaviors (self-selection bias). In the present study, these aspects were mitigated using the strategies described in the literature, such as ensuring questionnaire anonymity or using indirect questioning techniques (Meisters et al., 2020). An aspect that could represent both a limitation and an added value of the research is related to the different data collection periods that could impact the outcome of the study and this is a potential limitation. However, the two data sets have provided different and integrating information also considering that the behavioral changes probably require more than 2 years to be revealed. National data collected in 2021 provided a comprehensive overview of food waste trends at the macro level while regional

data collected in 2023 from the Cilento Bio-District territory offered a more nuanced understanding of localized dynamics that influence waste behaviors within the community (Isaac et al., 2023). Integrating insights from both datasets could enrich the understanding of food waste dynamics and inform targeted interventions to address the problem, which is a strength of the study.

The study did not consider some external factors that could impact FW behaviors such as seasonal variations or cultural events, policy changes in FW-related initiatives, or economic fluctuation. This should be particularly considered in the future research on HFWB in the Cilento Bio-District. The comparisons with national data and the analysis of different assumptions and scenarios would need a more comprehensive examination of additional factors affecting the food system, such as dietary patterns, or organic food consumption and consumers' perceptions of organic production, to understand their potential influence on the HFWB and, more in general, on the sustainability of food choices. In addition to that, probably other relevant information that characterizes the Cilento Bio-District as well as economic indicators, environmental metrics, and agricultural practices would be suitable to differentiate the Cilento Bio-District from nationwide data with respect to HFWB. Depending on resource availability, further research should consider the possibility of performing longitudinal studies to monitor changes in FW behaviors over time, as well as experimental designs aimed at testing the effectiveness of interventions proposed by the findings of this study.

5 Conclusion and policy implications

The Cilento Bio-District showed lower FW quantities compared to Italy, yet the attitudes and behaviors toward FW prevention and reduction were less aligned. This is probably related to the fact that certain waste reduction practices are so inherent in the Cilento Bio-District community's lifestyle that they may not be consciously articulated or explicitly addressed. The key findings and results of the study were interpreted for policy action development in the Cilento Bio-District and Italy. The concept underlying the framework presented in Figure 3 was that the prioritization of the needs to be addressed with educative intervention and community-based actions with a differentiation between the Cilento Bio-District and the national level. The reported actions were proposed identifying programs that resulted in better outcomes according to the existing literature. The study results suggested that the priority of actions would be the enhancement of consumers' abilities to impact practices for FW prevention. The present study outcomes and findings permitted the identification and proposition of programs taking into account the Cilento Bio-District specificities, highlighting the community engagement aspects with neighborhood sharing activities (Ayala et al., 2022), local products' redistribution among residents (Vargas et al., 2021), and community workshops (Jenkins et al., 2023) with community cooking spaces (Karunasena et al., 2021). These actions would address the difficulties in creative cooking and evaluating food needs, which are more reported in the Cilento Bio-District than in Italy. At the national level, broader policy actions were proposed with the involvement of the different sectors of the last part of food chain and, also, with the proposition of regulatory aspects (e.g., labels). Educational campaigns on shopping practices (Slapø



et al., 2021) with the use of meal-planning apps (Romani et al., 2018; Clement et al., 2023) and creative cooking online tutorials (Roy et al., 2024) were identified. Awareness about the meaning of expiry dates (Neff et al., 2019; Zielińska et al., 2020) should also be considered to improve the labeling system for FW prevention. Innovation in packaging (Guillard et al., 2018; Cammarelle et al., 2021) and collaboration with retailers to implement discounts on perishable items (Riesenegger and Hübner, 2022) were identified as actionable measures involving both the industry and distribution sectors. These actions would potentiate the better capacity in the storage and use of leftovers and the planning of food purchases and cooking, behaviors more reported in Italy than in the Cilento Bio-District. The HFWB constructs that received high scores (e.g., parents' education, involvement in cooking and handling food, and, only for the Cilento Bio-District, goals in competition with FW) could be reinforced in consideration of their role as motivating factors (Grant et al., 2023; Nguyen et al., 2023). In terms of policy actions, territorial specificities should be considered to maximize their impact on the Cilento Bio-District, which is particularly suitable for actions that permit collaboration with local farmers and community engagement policies. On the other hand, Cilento Bio-District resulted better in the prioritization of FW with respect to competing goals, especially for the attitude of not having too much food at home. The aim of having enough food at home was reported in competition with preventing FW when shopping, with the waste of unused products or partially used products, as well as when cooking, with the waste of leftovers (Van Geffen et al., 2017).

In conclusion, the reduction in FW within the Bio-District of Cilento can have significant environmental impacts that contribute to broader sustainability goals on both local and global scales reducing the pressure on the ecosystem and contributing to a more sustainable and resource-efficient food system. However, it is evident from the findings of the present study that the complexity underlying consumer FW is an important element that should be considered for

better-tailored and diversified actions that are capable of stimulating behavioral change. In addition, it should be pointed out that the drivers of food waste are diverse, which are largely interconnected with differences related to their nature and significance (European Commission, Joint Research Centre, 2023).

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participant was obtained for study participation.

Author contributions

JV: Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft. BP: Conceptualization, Investigation, Methodology, Writing – original draft. US: Data curation, Writing – review & editing. IB: Data curation, Writing – review & editing. FP: Funding acquisition, Writing – review & editing. LS: Project administration, Writing – review & editing. SB: Funding acquisition, Investigation, Writing – review & editing. YA: Funding acquisition, Investigation, Writing – review & editing. DŠ-T: Funding acquisition, Investigation, Writing – review & editing. LR: Conceptualization, Funding acquisition, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fsufs.2024.1385700/full#supplementary-material>

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