Food waste is embarrassing! Motivations and actions to prevent it among students in Italy

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Abstract

Purpose – *According to recent studies, young people are most inclined to waste food, and an important category is represented by students. Unlike other young people, they possess several characteristics that influence their food waste behaviour. For these reasons, this study aims to identify the elements that influence students' behaviour towards food waste in Italy to provide insights on how to reduce food waste among young consumers.*

Design/methodology/approach – *In this exploratory research, a Web survey involving 1,066 Italian students was used, and, after a factor analysis, a hierarchical multiple linear regression model was applied.*

Findings – *The findings showed that, at a young age, the food thrown away and the reasons are positively associated with food waste, while the family size and the actions that students adopt to prevent food waste are negatively associated with it.*

Practical implications – *Recognizing that students are the people who will shape the food waste scenario of the future, it is important to implement educational paths about it and to raise consumer awareness. The findings might provide interesting insights on how to develop educational campaigns for specific target groups, such as students. In fact, the results underline that local institutions and retailers should be involved in educational campaigns aimed at both addressing the motivations behind food waste and improving the actions people take to prevent it.*

Originality/value – *The paper revisits the issue using a relatively large sample of Italian students (youths aged 16–18 years). The results provide valuable insights on how to approach hypothetical Italian students in view of the potential development of new strategies for reducing food waste.*

Keywords *Food waste behaviour, Mediterranean diet, Hierarchical multiple linear regression model, Perishable food, Students, Italy*

Paper type *Research paper*

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1. Introduction

In the European Union, over 59 million tonnes of food waste (132 kg/inhabitant) are generated annually (Eurostat, 2024), with an associated market value estimated at €132bn (SWD (2023) 421). Households generate more than half of the total food waste (54%), accounting for 72 kg per inhabitant (Amicarelli *et al.*, 2021; Eurostat, 2024), while over 42 million people cannot afford a quality meal every second day (Eurostat, 2023). However, food waste is not only an ethical and economic issue, but it also harms the environment (Aschemann-Witzel *et al.*, 2016; Bravi *et al.*, 2019a, 2019b; Combest and Warren, 2019; Palmieri and Palmieri, 2023). For these reasons, the European Union is committed to meeting the Sustainable Development Goal Target 12.3, which aims to halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains by 2030 (Agenda, 2030). According to some authors (Bravi *et al.*, 2019a, 2019b), one of the largest driving forces behind food waste is the consumer.

In fact, on average, each European citizen wastes between 180 kg/year (Monier *et al.*, 2010) and over 290 kg/year (Kemna *et al.*, 2017) with several differences among European countries. However, according to Gayana Karunasena *et al.* (2021), there are generational differences in behaviours with respect to food consumption and waste in households. In fact, it has been observed that there is a significant negative relationship between age and food waste (Gayana Karunasena *et al.*, 2021). In other words, younger generations tend to waste more food (Gayana Karunasena *et al.*, 2021). Madkulturen (2012) found that more than 38% of food waste comes from the plate, and that Danish young people's cooking abilities in this phase of life are among the several reasons for food waste. According to Gayana Karunasena *et al.* (2021), young consumers food waste is caused by a lack of food management skills in the areas of shopping, storing, and cooking with leftovers. Similarly, Kymäläinen *et al.* (2021) found that young consumers' food waste stem from large food packaging sizes, poorly planned or unplanned sizes of meal portions, and/or lack of knowledge about preparing food. According to Bravi *et al.* (2020), instead, young people in high-income countries generate several amounts of food waste, while young consumers with low income are very aware that it is unwise to lose money by throwing away edible food (Porpino *et al.*, 2015). However, Roodhuyzen *et al.* (2017) suggested that research on food waste often has conflicting findings, and it might be a mistake to target all young people in the same way just because they are young. In other words, there is a risk of overlooking factors that may have different impacts within the same target group. In this framework, it has been observed that in the 28 member countries of the European Union (including Italy), youths aged 15–24 had a higher propensity to food waste (Burlea-Schiopoiu *et al.*, 2021; Principato *et al.*, 2021, 2015; Secondi *et al.*, 2015; Waste and Resources Action Programme, WRAP, 2019), and therefore, they need to be analysed more carefully, because they are likely to waste more than 6% of the food they purchase per week (Mondejar-Jimenez *et al.*, 2016).

To the best of our knowledge, there are few studies on how teenagers perceive food waste in the current literature (Burlea-Schiopoiu *et al.*, 2021; Palmieri and Palmieri, 2023); therefore, this target group needs to be studied more deeply (Mondejar-Jimenez *et al.*, 2016). For these reasons, the study tried to investigate students' behaviour towards food waste in Italy, a country of strong culinary traditions and where the Mediterranean Diet is strongly rooted (Palmieri and Palmieri, 2023). Precisely speaking, the study focuses on a sample of youths residing in Italy, where there is a high adherence to the Mediterranean diet, a dietary pattern recognized as an environmentally sustainable diet and characterized by a high consumption of perishable food such as fish, fruits and vegetables. Thus, it becomes crucial that these purchases are properly planned and then stored or immediately consumed to avoid generating food waste (Mondejar-Jimenez *et al.*, 2016). In this framework, the research questions (*RQ*), which this paper tried to answer, are the following:

RQ1. Which are Italian students' behaviour towards food waste, and which food categories do they waste most?

RQ2. What are the motivations for food waste and the actions students take to avoid it?

RQ3. Which elements affect Italian students' behaviour towards food waste?

The paper is written as follows. Section 2 defines the research design, Section 3 describes the main results obtained, while Section 4 discusses the contribution of the paper, drawing the conclusions in Section 5.

2. Methodology

2.1 Data

An online survey was designed in Italian using Google Forms (Palmieri *et al.*, 2019, 2021) and administered for 9 months (from January to September, 2020) through social media

(LinkedIn, WhatsApp and Facebook) and via e-mail. Precisely speaking, the Web-based survey was used because it is well established in the current literature (see, e.g. Bravi *et al.*, 2019a, 2019b) and it was spread through websites, social media and emails to reach the widest audience while reducing costs and time requirements (Palmieri *et al.*, 2019, 2021, 2024). Moreover, following some research about consumers' behaviour (see e.g. Palmieri *et al.*, 2024), a snowball sampling recruitment technique was also adopted, using the emails of our interpersonal relations to reach many respondents. Given the recruitment method applied, we believe that the sample used in the present study suffers from a smaller degree of sample self-selection. In addition, a pre-test on 150 students was conducted to identify any possible misinterpretations and errors, and minor adjustments were then made to the questionnaire. To be involved in the survey, the respondents had to fulfill the following requirements: being an Italian student, living at home with their own family and being 16–18 years old. The final sample consisted of 1,066 observations.

2.2 The questionnaire

Following the current literature (Bravi *et al.*, 2019a, 2019b; Mondejar-Jimenez *et al.*, 2016; Palmieri and Palmieri, 2023; Vittuari *et al.*, 2020), a survey was developed. Precisely speaking, the participants were asked to complete an anonymous questionnaire focused on the students' behaviour towards food waste. The online questionnaire was composed of four sections, and most of the items were scored on a 1–10 scale (i.e. from 1. strongly disagree to 10. strongly agree). In addition, all students provided their informed consent before responding to the questionnaire.

The first part of it investigated students' purchasing habits and their food waste behaviour. Following some studies on Italian consumers (Bravi *et al.*, 2019b; Grant *et al.*, 2023; Mondejar-Jimenez *et al.*, 2016; Vittuari *et al.*, 2020), questions were focused on behaviours and on the categories of food mostly wasted by the respondents. In particular, the participants were asked to indicate where they mainly buy groceries, their purchase frequency of groceries, their habits of throwing food away, the categories and quantity of food they generally waste and to self-estimate the economic value of the food they wasted (Bravi *et al.*, 2019b; Palmieri and Palmieri, 2023; Vittuari *et al.*, 2020).

The second part explored students' motivations for food waste. According to Bravi *et al.* (2019b) food waste comes from some aspects such as excessive purchases, over preparation and inappropriate conservation methods. Moreover, marketing tools have a significantly negative effect on consumer behaviour (Mondejar-Jimenez *et al.*, 2016; Principato *et al.*, 2021, 2015), pushing them to purchase in excess (Bravi *et al.*, 2019b). Hence the need for more information on fresh food and on how to store food correctly, as well as the availability of smaller packages of food in stores (Mondejar-Jimenez *et al.*, 2016). For these reasons, the participants were asked to indicate the reasons (i.e. excessive purchase, excess cooked food, inapt conservation method, inadequate packaging, low frequency of groceries, inadequate portion, too many offers at the supermarket) that affect their food waste (Bravi *et al.*, 2019b; Mondejar-Jimenez *et al.*, 2016; Principato *et al.*, 2021, 2015).

In Section 3, instead, questions about actions to prevent food waste that students adopt were investigated (Bravi *et al.*, 2019a, 2019b). Some aspects, such as purchasing only what is necessary, paying attention to offers, expiration dates, and formats, using leftovers and supporting food donation (Bravi *et al.*, 2019b; Palmieri and Palmieri, 2023), have been explored. In addition, people's ability to eliminate the amount of food waste, as well as respondents' opinion about food waste as a problem, were examined (Bravi *et al.*, 2019a, 2019b; Principato *et al.*, 2021, 2015).

Finally, Section 4 of the questionnaire contained questions on the sociodemographic characteristics of the respondents, such as gender, age, number of family members and the monthly income situation of households (Gaiani *et al.*, 2018; Grant *et al.*, 2023).

2.3 Data analysis

This research aims to assess which elements influence students' behaviour towards food waste. Firstly, a descriptive analysis was conducted to identify the sample characteristics.

Secondly, a factor analysis (FA), followed by Oblimin rotation (Jennrich and Sampson, 1966), was applied to reduce the data into a few factors related to the categories of food mostly wasted, the principal motivations for food waste, and the main actions to prevent it (Bravi *et al.*, 2019b). Because a little correlation among the item groups has been found, an Oblimin rotation was applied because according to Jackson (2005), Oblimin rotation allows the identified factors to be correlated. Moreover, the Kaiser–Meyer–Olkin (KMO) and Barlett's tests have been calculated to verify both the sampling and correlation adequacy, respectively. Later, Kaiser's method was used to find the appropriate number of factors to consider in the analysis. Furthermore, the comparative fit index (CFI), Tucker–Lewis Index (TLI) and the root mean squared error of approximation (RMSEA) have been calculated to measure the goodness-of-fit of the analysis with the number of identified factors (Hu and Bentler, 2009; Medsker *et al.*, 1994). Subsequently, the reliability of the 1–10 scale was assessed by calculating internal consistency (Cronbach's α), considering only α values that are greater than 0.60, as proposed by Eisinga *et al.* (2013) and Nunnally and Bernstein (2004).

Thirdly, a hierarchical multiple linear regression model (HMLR) was applied to both the socioeconomic information of the sample and the identified factors to determine the predictors that have the greatest influence on young consumers' behaviour towards food waste. Specifically, in the HMLR model, gender and age were used as a set of independent variables in Step 1; in Step 2, the number of family members and monthly family income were considered; and in Step 3, the categories of food mostly wasted, the principal motivations for food waste and the main actions to prevent it were included in the regression model.

The econometric model was estimated as follows:

$$Y_i = \beta_0 + \beta_1 Gender + \beta_2 Age + \beta_3 Family + \beta_4 Income + \beta_5 Food\ Leftovers + \beta_6 Motivation + \beta_7 Action + \varepsilon \quad (1)$$

where Y_i is the dependent variable and measures students' behaviour towards food waste. This variable refers to the responses to the question "In your family, how often do you throw away food?" to which each student answered with a value from 1 to 10 (i.e. from 1 = never to 10 = very often). Moreover, *Age* is a categorical variable, while *Family* and *Income* refer to the number of family members and monthly family income, respectively. In addition, the *Food Leftovers* factor indicates the categories of food mostly wasted, while the *Motivation* factor expresses the motivations for food waste and the *Action* factor refers to the actions adopted by students to prevent it. All statistical elaborations were carried out using the RStudio 2023.12.0 statistical software package.

3. Findings

3.1 Participants' profiles

Table 1 shows the socio-economic information of the sample. The sample consists of 1,066 individuals (51% are females and 49% are males) who are 18 years old (about 43%) and have a monthly income of their households ranging from €0 to €2,500 per month (66.80%).

When analysing how often respondents buy groceries and where they mainly buy them, the findings showed that about 52% of young people buy groceries two or three times a week, followed by 38% of the sample who buy food once a week (Table 2). The supermarket is

Table 1 Socio-economic information of the sample

Variable name	N	%
Gender		
Female	536	50.28
Male	530	49.72
Total	1,066	100.00
Age		
Age 16 years	231	21.67
Age 17 years	378	35.46
Age 18 years	457	42.87
Total	1,066	100.00
Monthly income situation of household		
Less than €1,800	343	32.18
Between €1,801 and €2,500	369	34.62
Between €2,501 and €3,200	135	12.66
Between €3,201 and €3,900	91	8.54
Between €3,901 and €4,600	94	8.82
More than €4,601	34	3.18
Total	1,066	100.00

Source: Authors' own work

Table 2 How often respondents buy groceries

Variable name	N	%
2 or 3 times a week	554	51.97
Once a week	400	37.52
Less than once a week	71	6.66
Once a month	41	3.85
Total	1,066	100.00

Source: Authors' own work

among the places that are most used by young people, followed by online purchases and small specialized shops (data not shown).

About 77% of the sample claims not to often throw away edible food (data not shown). It goes without saying, when asked about students' food quantity wasted and categories of food thrown away, most consumers stated rather low values (Tables 3 and 4), and this could be because of answers based on self-reported questionnaires. In fact, about 50% of the sample stated they throw edible food away, around 200 g per day; in particular, fruits and vegetables are more wasted than other foods, followed by bread and dairy products (Table 4).

Table 3 Quantity of food thrown away per day

	N	%
From 0 to 200 g	531	49.81
From 201 to 500 g	338	31.71
From 501 to 800 g	116	10.88
From 801 to 1,000 g	54	5.07
More than 1,000 g	27	2.53
Total	1,066	100.00

Source: Authors' own work

Table 4 Categories of food mostly wasted per day

Food categories	*Mean*	*SD*
For each food, how often do you throw food away per day? (0 = never; 10 = very often)		
Fruit	2.17	1.62
Vegetables	2.17	1.60
Legumes	1.62	1.27
Pasta	1.86	1.49
Bread	2.02	1.56
Meat	1.71	1.35
Fish	1.71	1.37
Dairy products	1.93	1.43
Eggs	1.76	1.44
Long-lasting food	1.68	1.36

Source: Authors' own work

Moreover, about 56% of the sample believes that food waste does not cause a waste of money. In fact, according to them, the economic amount of food thrown away could be from €0 to €30 per month (Table 5). Also, environmental and social impacts of food waste are underestimated. As a matter of fact, about 50% of students remain unaware of the environmental and social impacts that food waste causes (data not shown).

When considering the main motivations for food waste (Table 6), instead, these attained low scores on the 1–10 scale. Among the main ones, there is the presence of supermarkets selling too many offers (mean = 6.07; std. deviation = 2.30), the inadequacy about packaging of food offers (mean = 4.40; std. deviation = 3.04), and the lack of knowledge about conservation methods (mean = 4.08; std. deviation = 3.01).

Investigating the main actions students take to prevent food waste (Table 7), instead, the framework is positive. In fact, they say to pay attention to offers, expiration dates, and formats (mean = 8.39; std. deviation = 1.60 and mean = 8.09; std. deviation = 1.30), to use leftovers

Table 5 Economic value of food wasted per month

Euro	N	*%*
€0–10€	290	27.20
€11–30€	305	28.61
€31–50€	250	23.45
€51–100€	144	13.51
>100€	77	7.22
Total	1,066	100.00

Source: Authors' own work

Table 6 Motivation for food waste

Variable name	*Mean*	*SD*
I buy more than I need	2.42	2.14
I do not know conservation methods	4.08	3.01
I cook too much	2.81	2.35
Supermarkets sell too many offers	6.07	2.30
Packaging is inadequate	4.40	3.04
I spend too much time from one purchase to the other and the food deteriorates	3.45	2.79
The portions are inadequate	2.63	2.30

Source: Authors' own work

Table 7 Action to prevent food waste

Variable name	*Mean*	*SD*
Purchase only what is necessary	5.65	3.41
Pay attention to offers and expiration dates	8.39	1.60
Pay attention to formats	8.09	1.30
Use leftovers	8.02	1.30
Encourage the donation of food	5.98	3.51

Source: Authors' own work

(mean = 8.02; std. deviation = 1.30), to encourage the donation of food (mean = 5.98; std. deviation = 3.51) and to purchase only what is necessary (mean = 5.65; std. deviation = 3.41).

3.2 The analysis

Before carrying out the FA, the KMO and Barlett's tests were calculated. In fact, KMO was equal to 0.90, and Barlett's test (χ^2 = 19,733; df = 666; p-value < 0.000) was significant (Arsham and Lovric, 2011), indicating that the sample and correlation matrix were suitable for the FA. Later, applying Kaiser's method, three factors were found as the optimum number of factors to consider in the analysis, and together, they explained 82% of the original variance. It is important to underline that, following the current literature (Hu and Bentler, 2009; Medsker *et al.*, 1994), the analysis with three factors showed a good fit (CFI = 0.91; TLI = 0.90; RMSEA = 0.07).

Table 8 shows the three factors included in the analysis with their Cronbach's α values. Precisely speaking, the first element that comes from the FA on categories of food mostly wasted by the respondents is called the *Food Leftovers* factor and shows a Cronbach's α equal to 0.91.

The second factor, on the other hand, is named *Motivation* and is related to excessive purchase of food, excessive cooking of food, lack of knowledge about conservation methods, excessive selling offers by supermarkets, inadequate packaging, excessive time between one purchase and the other and, finally, inadequate food portions.

The third factor, instead, regards the actions that students adopt to avoid food waste. This factor is called *Action* and concerns the attention paid to purchasing what is necessary, to offers, expiration dates, and formats as well as reusing leftovers to create new dishes. Moreover, the Action factor includes all actions that students take to encourage the donation of food to the needy.

3.3 The model

To assess the factors that affect students' behaviour towards food waste, an HMLR model was applied.

The findings in Table 9 show the effect of variables such as socio-demographic characteristics, *Food Leftovers*, *Motivation* and *Action* on young consumers' behaviour towards food waste. In particular, the inclusion of gender and age in the first step of the analysis was significant (R^2 = 0.017, p < 0.001), and the gender variable shows a positive value associated with the students' behaviour, as for food waste, while the age variable shows a negative value. This means that young males are most inclined to waste food. Subsequently, the addition of variables about family and income in the second step of the HMLR model led to a large significant increase in R^2 (ΔR^2 = 0.10, R^2 = 0.20, p < 0.001). This means that the young males with high incomes are most inclined to waste food. The final step resulted in a significant further increase in R^2 (ΔR^2 = 0.15) and the overall model was significant (R^2 = 0.37, p < 0.001), showing that young age, the categories of food and

Table 8 Factor analysis

	Factor food leftovers	*Factor* motivation	*Factor* action
Cronbach's α: 0.91			
Fruit	0.66		
Vegetables	0.70		
Legumes	0.73		
Pasta	0.74		
Bread	0.67		
Meat	0.81		
Fish	0.71		
Dairy products	0.74		
Eggs	0.73		
Long-lasting food	0.70		
Cronbach's α: 0.71			
I buy more than I need		0.85	
I do not know conservation methods		0.83	
I cook too much		0.80	
Supermarkets sell too many offers		0.75	
Packaging is inadequate		0.70	
I spend too much time from one purchase to the other and the food deteriorates		0.73	
The portions are inadequate		0.72	
Cronbach's α: 0.79			
Purchase only what is necessary			0.89
Pay attention to offers and expiration dates			0.78
Pay attention to formats			0.74
Use leftovers			0.76
Encourage the donation of food			0.92

Source: Authors' own work

Table 9 Hierarchical multiple regression model

Variable	B	*Std. error β*	t-*value*
Step 1			
(Intercept)	6.80***	0.25	27.15
Gender	0.53*	0.24	2.25
Age	−0.18***	0.05	−3.30
Step 2			
(Intercept)	5.93***	0.52	11.36
Gender	0.49*	0.24	2.08
Age	−0.14**	0.06	−2.55
Family	0.20†	0.11	1.78
Income	0.04*	0.07	0.60
Step 3			
(Intercept)	4.31***	0.55	7.80
Gender	0.28†	0.22	1.26
Age	−0.10*	0.054	−1.86
Family	−0.15*	0.10	1.49
Income	0.01	0.06	0.15
Food leftovers	1.19***	0.10	11.27
Motivation	0.40***	0.09	4.09
Action	−0.45***	0.07	−6.57

Notes: $R^2 = 0.017$ for Step 1 ($p < 0.001$); $\Delta R^2 = 0.10$ for Step 2; $R^2 = 0.20$ for Step 2 ($p < 0.001$); $\Delta R^2 = 0.15$ for Step 3; $R^2 = 0.37$ for Step 3 ($p < 0.001$); significance levels: $^{***}p < 0$; $^{**}p < 0.001$; $^{*}p < 0.01$; $^{\dagger}p < 0.05$

Source: Authors' own work

motivations are positively associated with food waste, while the rise in the number of family members and the actions addressed to prevent it are negatively associated with food waste.

4. Discussion

Youths aged 15–24 show a higher inclination to food waste (Burlea-Schiopoiu *et al.*, 2021; Principato *et al.*, 2021, 2015; Secondi *et al.*, 2015; Waste and Resources Action Programme, WRAP, 2019), and, in particular, an important category is represented by students, who, unlike other young people, possess several characteristics that influence their food waste behaviour, such as lifestyle, buying habits, eating and storing food (Burlea-Schiopoiu *et al.*, 2021). Thus, it is important to understand youths' behaviour towards food waste (Burlea-Schiopoiu *et al.*, 2021; Palmieri and Palmieri, 2023). In fact, according to Quested and Luzecka (2014), understanding people's behaviour regarding food waste would lead to the development of interventions that face the specific needs of different groups, considering that they require different approaches.

However, as mentioned above, it might be a mistake to target all young people in the same way just because they are young. In other words, there is a risk of overlooking factors that may have different impacts within the same target group (Roodhuyzen *et al.*, 2017). In this framework, the present study is aimed at identifying the elements that influence Italian students' behaviour towards food waste to offer insights on how to reduce it among young consumers. Specifically, the study is carried out on Italian students aged between 16 and 18 years.

The findings suggest that young age, the food categories most wasted and motivations are positively associated with food waste, while the family size and the actions addressed to prevent food waste are negatively associated with it. These results were confirmed by the current literature about people's behaviour towards food waste (Bravi *et al.*, 2019a, 2019b; Grant *et al.*, 2023; Mondejar-Jimenez *et al.*, 2016; Palmieri and Palmieri, 2023). Precisely speaking, the age of respondents is negatively associated with the students' behaviour, indicating that the youngest are most inclined to waste food (Lyndhurst *et al.*, 2007; Thyberg and Tonjes, 2016). Also, family size is a determinant of food waste, with higher per capita values in families with one member that gradually decreased in larger families (Grant *et al.*, 2023). Similarly, in our case, family size is an important variable of the econometric model. In fact, negative students' behaviour towards food waste increased as family size decreased, indicating that negative students' behaviour towards food waste was more pronounced in smaller families.

In addition, because the Mediterranean diet is characterized by a high consumption of perishable products such as fish, fruits, and vegetables (Mondejar-Jimenez *et al.*, 2016), it is important to identify the food categories most wasted to manage them correctly and avoid generating waste (Mondejar-Jimenez *et al.*, 2016). In fact, according to some studies at the European level (Grant *et al.*, 2023; Herzberg *et al.*, 2020; Kasza *et al.*, 2020), the categories of food mostly wasted in Italy are bread, fresh fruit, fresh vegetables, and dairy products. Similarly, in our case, although low food waste quantities have been declared by the respondents, the sample affirmed that fruits and vegetables are the categories of food mostly wasted, followed by bread and dairy products. As mentioned before, the sample shows low food waste quantities (under 200 g of food per day), which could indicate that respondents tended to underestimate food waste quantities as it is analysed in other studies (Giordano *et al.*, 2019a, 2019b, 2018). Moreover, according to some authors (Hebrok and Boks, 2017; Lyndhurst, 2007), this behaviour could be because of other factors: for example, most people are not consciously aware that they are wasting food or how much they are wasting. Consequently, people are not aware that they are wasting money (Palmieri and Palmieri, 2023). In fact, in our case, according to the sample, the economic amount of food thrown away could be from €0 to €30 per month.

Moreover, among the motivations for food waste, some factors such as marketing strategies could influence young people's behaviour towards food waste (Principato *et al.*, 2015). In fact, marketing strategies have a significantly negative effect on people's behaviour (Mondejar-Jimenez *et al.*, 2016; Principato *et al.*, 2015), pushing them to develop actions leading to excessive purchase (Bravi *et al.*, 2019b). In our case, the students declare that among the main motivations for food waste, there are supermarkets selling too many offers, the inadequacy about packaging of food offers, and the lack of knowledge about conservation methods. These findings highlight that food waste occurs at the consumer level and that supermarkets play a key role in avoiding food waste (Bravi *et al.*, 2019a, 2019b; Mondejar-Jimenez *et al.*, 2016). Moreover, according to the respondents, having more information on how to store food correctly could reduce food waste produced, confirming current literature (Palmieri and Palmieri, 2023).

About the main actions to prevent food waste, instead, the current literature (Abeliotis *et al.*, 2014; Bravi *et al.*, 2019b; Koivopuro *et al.*, 2012; Mondejar-Jimenez *et al.*, 2016; Silvennoinen *et al.*, 2014) shows that planning food purchases, understanding the data labels on food and consuming household leftovers are three key elements towards reducing food waste. In fact, it has been found that correct planning of food purchases could lead to positive behaviour in reducing food waste. (Bravi *et al.*, 2019b; Chandon and Wansink, 2006; Palmieri and Palmieri, 2023). Naturally, proper purchase planning must be accompanied by a correct understanding of the differences between "use by" and "best before" dates (Bravi *et al.*, 2019b). Also, leftovers are recognized as one of the main causes of food waste (Porpino *et al.*, 2015; Williams *et al.*, 2012). Palmieri and Palmieri (2023) found that students avoid making unnecessary purchases because they usually tend to reuse leftovers, make a list before shopping and know the differences between "use by" and "best before" dates. Similarly, in our study, the respondents stated to use leftovers, to purchase only what is necessary, to pay attention to expiration dates, formats and offers as well as to encourage the donation of food. It is important to underline that these findings could be because of the Italian origin of the sample, where reusing leftovers is an important aspect of the local traditional culture.

In conclusion, reducing food waste is widely recognized, at both the consumer and firm levels, as an important way to contribute towards environmental, economic, and social sustainability, improving food security (FAO, 2019). Among the solutions proposed to reduce food waste, some scholars (Lim *et al.*, 2017) have suggested the use of emerging technologies (i.e. apps). In fact, virtual applications (for example, through the use of the metaverse) should be developed to sensitize people about the concept of sustainability in the food sector in general, thus encouraging them to adopt sustainable behaviour patterns (Boccia and Covino, 2023; Boccia *et al.*, 2021; Boccia *et al.*, 2019). Thus, it is necessary to improve people's sensibility towards food waste (Lim *et al.*, 2017) through campaigns and/or educational programs (Mondejar-Jimenez *et al.*, 2016; Reynolds *et al.*, 2019). In fact, educational programs are central elements in promoting correct behaviour towards food waste to face present and future challenges according to a sustainable vision (Mondejar-Jimenez *et al.*, 2016; Reynolds *et al.*, 2019).

5. Conclusion

The main aim of this study was to identify the elements that influence students' behaviour towards food waste to provide insights on how to reduce food waste among young consumers. The results showed that young age, the categories of food mostly wasted, and motivations are positively associated with food waste, while the family size and the actions that students adopt to prevent it are negatively associated with food waste.

The practical/managerial implications of our study are relevant. First, this study confirms that food waste comes from four main motivations: type of perishable food (i.e. fruits and

vegetables are more wasted than other food), excessive purchase (because of the presence of supermarkets selling too many offers and the inadequacy about packaging of food offers), over-preparation and inappropriate conservation. The type of food thrown away is characterized by a high level of perishable products, and it is therefore necessary for young people to learn to manage food correctly to avoid making waste. For these reasons, some tools, such as cooking classes, the use of emerging technologies and information campaigns, should be useful ways to reduce food waste among teenagers. In fact, information campaigns against food waste should improve teenagers' perception of food waste, as well as teach young consumers how to recognize both the level of freshness of food and the appropriate conservation methods. Secondly, excessive purchase would stem from incorrect shopping behaviours. In fact, purchasing too much food would lead to cooking too much food, resulting in leftovers, and contributing to food waste. Therefore, planning meals in advance or writing a shopping list for purchases can be identified as a correct way to lower food waste.

In this framework, the recognition of the elements that affect students' behaviour towards food waste should be an important starting point to implement different anti-waste strategies and plans at a national level. This consideration is even more true in a Mediterranean country such as Italy, where it is very important that food be correctly managed to avoid generating waste. In other words, recognizing that students are the people who will shape the food waste scenario of the future is an important aspect to implement educational paths about food waste and to raise consumer awareness. In fact, our findings might provide interesting insights on how to develop educational campaigns for specific target groups, such as students. However, food waste cannot be reduced by just one-way action from the young consumers; it goes both ways: consumers and retailers. In other words, the results underline that local institutions and retailers should be involved in educational campaigns addressed both to understand the motivations for food waste and to improve actions people take.

We are aware that the conclusions of this study cannot be overgeneralized, because the non-probabilistic survey design used in our research does not allow for a direct statistical generalization of the results to the specific population of Italian students. Moreover, a panel sample or other type of probabilistic research design would be more suitable for evaluating the students' behaviour towards food waste more precisely. In other words, future studies should investigate the issue on a representative sample of the Italian population. Moreover, it would be interesting to compare the food waste behaviour of young Italian consumers with those of the main Mediterranean countries, who have a lifestyle and food behaviour that is very similar to the Italian one, to see similarities and differences in both food behaviour and attitude towards food waste. In addition, it would be interesting to investigate the issue of the usage of emerging technologies to reduce food waste. However, we believe that the usefulness of pilot studies carried out on food policy issues such as food waste should not be dismissed so easily. In fact, we believe that our research should have important practical implications for local authorities, especially given that education is considered by UNESCO as a key instrument to achieve Sustainable Development Goals.

Compliance with Ethics Requirements

Before starting the data collection, participants were informed about the objective of the research and the consequent statistical analysis. Participation in the study was fully voluntary and anonymous and subjects could withdraw from the survey at any time and for any reason. Participants were required to sign a privacy policy and consent form for the collection and processing of personal data in advance, according to the Italian Data Protection Law (Legislative Decree 101/2018) and in line with the European Commission General Data Protection Regulation (679/2016). The investigation was carried out in

accordance with the rules of the 1975 Declaration of Helsinki (World Medical Association, 2018), revised in 2013. Ethical review and approval were waived for this study because it did not involve any invasive procedures (e.g. faecal samples, voided urine, etc.) or laboratory assessments or induced lifestyle changes.

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