

## Article

# Domestic Food Waste and Covid-19 Concern: An Application of the Theory of Planned Behaviour

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**Abstract:** The ongoing Covid-19 pandemic rapidly and dramatically disrupted household behaviours in almost all areas and, among these, eating behaviours and daily food patterns have also been radically altered. All reported changes have potential effects in terms of food waste, which is a global problem that mainly occurs at household level. Many scholars attempted to understand the antecedents of food waste in the framework of Theory of Planned Behaviour (TPB). In this paper we follow this strain of research by focussing on two different behaviours, suggested by the Waste Framework Directive of the EU, namely (a) reducing servings and (b) using leftovers, which may be predicted by the intention to reduce food waste. An online questionnaire containing the key constructs of the TPB and the concern towards the pandemic was administered to a sample of 201 Italian consumers. Results show that the TPB model was confirmed for both behaviours while the Covid-19 concern had no direct effect. However, in the case of portion reduction, there is a significant interaction between concern and intention not to waste food. That is, the effect of intention on reducing servings is increasing as the level of concern increases. Therefore, some indications on how to address food waste policies are drawn.

**Keywords:** food waste; TPB; moderation; leftovers; reduce servings



**Citation:** Amato, M.; Verneau, F.; Coppola, A.; La Barbera, F. Domestic Food Waste and Covid-19 Concern: An Application of the Theory of Planned Behaviour. *Sustainability* **2021**, *13*, 8366. <https://doi.org/10.3390/su13158366>

Academic Editors: Gaetano Chinnici and Giuseppe Antonio Di Vita

Received: 29 June 2021  
Accepted: 24 July 2021  
Published: 27 July 2021

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## 1. Introduction

According to the recent Food Waste Index Report [1], 930 million tonnes of food are globally wasted, equivalent to 23 million fully loaded 40-tonne trucks, one-third of the food produced for human consumption. From a sustainability perspective, the problem of food waste adds to the economic, energy and resource losses already widely involved in global food production and consumption, which alone are responsible for 30–35% of global climate impact and 70% of freshwater use [2]. According to UN's SDGs (Sustainable Development Goals), per-capita food waste should be halved by 2030, therefore meeting this target will result in a reduction of 11% of total CO<sub>2</sub> emissions per capita [3].

Despite the fact that this is a global problem, which concerns the whole supply chain, it has been suggested that in developed countries most of the thrown away food occurs at household level [4], where consumers waste more than the food service industry or stakeholders situated way earlier in the chain [5].

The food waste issue has gained greater attention over the last decade and scholars also multiplied their efforts to understand the psychological factors which foster and hinder the reduction of food waste by individuals, highlighting the need to better understand why households waste food. Many scholars investigated and highlighted that food waste is a consequence of a series of consumption habits and behaviours that start while shopping for food, such as the lack of planning, which diminish purchasing accuracy [6] or indulge in impulse buying [7], and conclude within the household where food is often improperly

stored [8], not properly measured before cooking [9] or thrown away instead of using the leftovers [10].

The Covid-19 pandemic has rapidly and dramatically disrupted household behaviours in almost all areas and, among these, eating behaviours and daily food patterns are also radically altered. Indeed, all research so far carried out suggests clear changes in the way consumers are planning their food purchases, eating and more generally interacting with the household technology of food storage, preparation and consumption, as a consequence of the progressive spread of the epidemic [11]. Specifically, both food acquisition patterns and at-home meal preparation have undergone significant changes compared to pre-covid levels [12,13]. Due to restrictions on the movement of people and the widespread lockdowns imposed in the early stages of the pandemic, with regard to purchasing patterns three main trends emerge from the research undertaken to this point: (1) changing purchasing preferences in favour of non-perishable food with a long shelf-life (frozen, canned, dehydrated foods); (2) panic buying and subsequent stockpiling tendencies, (3) sharp increase in online purchases, takeout and home delivering [14–16]. The main change that has been observed regarding food-related household behaviours was a general increase in involvement in cooking with more meals prepared and eaten at home.

All reported changes have potential effects in terms of food waste and, very often, they produce mixed effects. Food stockpiling was identified as a significant predictor of increased food waste [15]. The accumulation of long shelf-life food products does not appear to produce more food waste in the short run, but in the long run it could result in a rapid increase in the amount of food thrown away. Also, the higher involvement in at home meal preparation can produce opposite results in terms of food waste. A recent survey conducted in USA and Italy found that higher engagement in cooking is associated with perceptions of lowered food waste [17]. On the contrary, Qian, Javadi & Hiramatsu [18] have argued that this behaviour may also induce greater food purchases, even though an increased involvement in cooking stimulates higher consciousness and concerns about food waste. In addition, the reliance on home prepared meals very likely can reduce plate waste, but since food waste is largely generated during food preparation and food cleanout settings, home prepared meals do not necessarily have an unambiguous and predetermined consequence on waste [14]. In line with these findings, Amicarelli & Bux [19] using a food diary methodology, observed that the largest part of food waste is represented by unavoidable waste, occurring during food preparations, such as skins and scraps of fruit and vegetables.

Although Covid 19-induced changes in household food habits produce mixed effects on food waste [20], the majority of research has found that consumers have a general perception of reduced food waste during the first year of the covid epidemic. Indeed, the reduction of household food waste has been observed in several developed countries such as the United States, Italy and Japan [17,18,21]. Similar results have also been observed in Tunisia, and Qatar [22,23].

The reduction in household food waste could persist beyond the Covid-19 emergency, because several surveys have found changes in household behaviours that could have long-term effects, such as improved cooking and food management skills [14,24]

## 2. Food Waste and the Theory of Planned Behaviour

In recent years, many studies [25–36] attempted to understand the antecedents of food waste in the framework of theory of planned behaviour (TPB—[37]). Overall, this research has shown the relevance of the TPB main constructs—attitude (ATT), subjective norms (SN), and perceived behavioural control (PBC)—as regards individuals' intention to reduce food waste. In addition, scholars made efforts to add explaining variables to the original TPB, with diverse and mixed results. For example, Stefan and colleagues highlighted that consumers' planning and shopping routines, determined by moral attitudes towards food waste and perceived behavioural control, are important predictors of food waste [31]. In a similar fashion, also Aktas and colleagues found that planning routines, jointly with social

relationships, are important predictors of food waste behaviours [35]. Finally, Graham-Rowe and colleagues observed the contribution of additional predictive variables, namely self-identity and anticipated regret, in increasing the amount of variance explained by the TPB model [26].

TPB maintains that behavioural intention—i.e., the readiness to perform a behaviour—is the direct antecedent of human behaviour [38]. Intention is determined by attitude (ATT), subjective norms (SN), and perceived behavioural control (PBC); more precisely, intention is determined by attitude and subjective norm, whose relative importance is moderated by perceived behavioural control [39,40].

The theory is illustrated in Figure 1.

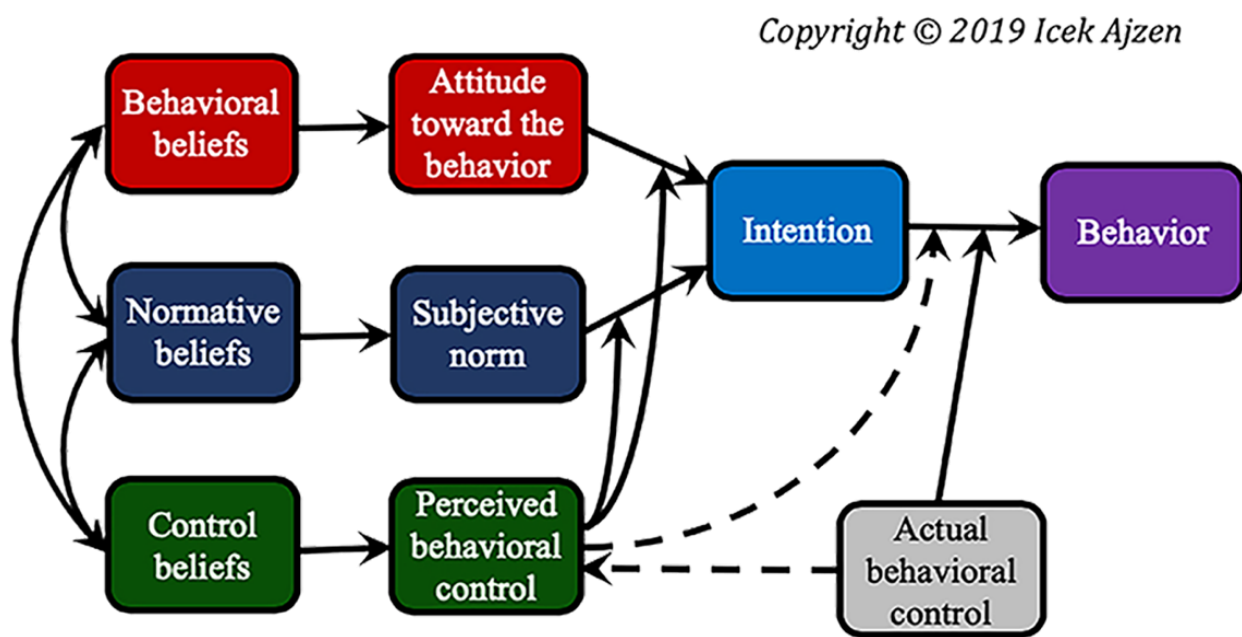


Figure 1. Theory of Planned Behaviour Diagram.

The attitude is defined as the result of individual's beliefs about the possible outcomes of a certain behaviour; in a similar fashion, subjective norms regarding a specific behaviour are determined by the beliefs that an individual holds about the opinion of people s/he care in relation to that specific behaviour. Finally, perceived behavioural control is determined by beliefs about factors which may hinder or facilitate the implementation of behaviour [41]. Overall, in the TPB framework, human behaviour is guided by the individual beliefs about (1) the likely consequences of the behaviour (behavioural beliefs); (2) the expectations of others (normative beliefs); (3) the presence of factors facilitating/hindering the behaviour (control beliefs) [42].

A key point of TPB is the sufficiency principle, according to which the three major constructs of the theory (i.e., ATT, SN, PBC) are sufficient to predict intention. Other possible influential factors, such as age and personality characteristics—which are called background factors in the TPB framework—are said to influence intention only indirectly, via the mediation of the TPB major constructs. Therefore, measuring the three major TPB factors should be sufficient to have a reliable prediction of behavioural intention, which in turn is the main predictor of behaviour [42].

Notwithstanding the remarkable effort of scholars to improve the scientific knowledge of the psychological and social factors explaining food waste in the framework of TPB, several key points remain unclear. First and foremost, in the realm of food waste, research has not consistently shown the characteristics of the relation between intention and behaviour, nor the strength of their association. This is firstly due to the fact that several studies measured intention, but not behaviour. In addition, even when scholars measured both,

there may be issues about the operationalization of variables and compatibility of measures. Scholars have measured intention to reduce food waste or avoid throwing food away; after this, they asked participants how much food they had thrown away or generally throw away. Nevertheless, the act of throwing food away cannot be intended as a behavioural implementation of the intention not to waste food. How can individuals positively act upon their intention to reduce their food waste? How can individuals translate in positive and concrete behaviours their intention of not throwing food away? Effort should be made to investigate the relation between individuals' intention to reduce food waste and concrete behaviour they could perform. This is the main aim of the current paper.

The Waste Framework Directive adopted in the European Union [43] indicates prevention as the preferred and most efficient option, whereas re-use is intended as a second-best. Drawing on these guidelines, we decided to focus on two behaviours which implement these solutions in behavioural terms and may be predicted by intention to reduce food waste: (1) reducing servings and (2) using leftovers. We sought to assess whether a TPB-based model could predict not only individuals' intention to reduce food waste, but also those two specific behaviours.

In addition, as outlined above, the Covid-19 outbreak has profoundly affected habits and behaviours relevant to purchasing and consuming food. Therefore, the concern related to Covid-19 may influence individuals' intentions and behaviours, and their antecedents as well (in the TPB, participants' attitudes, norms, and perceived behavioural control). However, in line with the TPB and its sufficiency principle, Covid-concern should not influence intention and behaviour directly, because its effect should be fully mediated by TPB constructs. In addition, Covid-related concern could influence the relations between the TPB constructs, thus acting as a moderator. Recent TPB research has shown an increasing interest for interactions between TPB factors [39,40] and the impact of additional moderating variables [44,45]. In the current study, we have tested the moderation of Covid-related concern as regards the relation between intention and behaviour. The basic idea emerging from the literature review is that, in the food domain, the concern for the outbreak could create a sense of urgency which, in turn, may encourage individuals to act upon their intention. Therefore, we expect that intentions and behaviours related to food waste will be more strictly associated when individuals are more concerned about Covid-19.

We formulated the following hypothesis:

**Hypothesis 1 (H1).** *Intention should have a significant effect on both behaviours.*

**Hypothesis 2 (H2).** *Perceived behavioural control should have a significant effect on both behaviours.*

**Hypothesis 3 (H3).** *The effect of attitude and norms on intention should be significant, whereas it should not be significant on behaviour, because their effect should be fully mediated by intention.*

**Hypothesis 4 (H4).** *Covid-related concern should not have a direct influence on intention and behaviour, but it could moderate the effect of intention on both behaviours.*

### 3. Materials and Methods

Data were collected via an online survey developed with the Qualtrics survey software, between 8 September and 28 September 2020. Using a snowball sampling procedure, through online advertisements placed on Facebook and other social media, participants were invited to complete an anonymous 20 min online survey for a study focusing on food waste during the Covid-19 pandemic. A sample of  $n = 201$  (59.7% female) individuals from Italy, mean (SD) age = 33.09 (12.06), completed the questionnaire.

At the beginning of the survey, participants were asked to fill an informed consent form and were asked their age, since the only eligibility criterion was being 18 years old or over. These questions were followed by the measurement of participants' concern about the Covid-19 pandemic and several scales measuring all variables of the TPB, which will be

further detailed in the following section. At the end of the survey, participants were asked for relevant sociodemographic features, which are summarized in Table 1. Participants received no incentive for their participation and the study was approved by the Research and Ethics board of the “Laboratorio di Ricerca Psicologica e Sociale Roberto Gentile” of the University of Naples Federico II (Research Protocol number 0252019).

**Table 1.** Descriptive statistics of the sample.

Characteristics	Frequency	Sample (%)
<i>Gender</i>		
Male	81	40.3
Female	120	59.7
<i>Age</i>		
18–24	40	19.9
25–35	94	46.8
Over 35	67	33.3
<i>Education</i>		
Middle school	6	3.00
High school	63	31.3
Bachelor level	48	23.9
Graduate	72	35.8
PhD	12	6.0
<i>Household income (per month)</i>		
Less than 1000 euros	27	13.4
Between 1001 and 2000 euros	77	38.3
Between 2001 and 3000 euros	48	23.9
Between 3001 and 4000 euros	25	12.4
More than 4001 euros	24	11.9
<i>Household size (components' number)</i>		
1	4	2.0
2	36	17.9
3	44	21.9
4	84	41.8
More than 4	33	16.4
<i>Presence of children (less than 13 years)</i>		
No children	154	76.6
1	24	11.9
More than 1	23	11.5

The questionnaire consisted of three sections: at the beginning, individuals were asked how worried they were about the Covid-19 pandemic on a 7-point Likert scale ranging from 1 (not worried at all) to 7 (totally worried); after that, participants had to answer to the TPB items (attitude, injunctive subjective norms, descriptive subjective norms, perceived behavioural control, intentions, behaviours), collected on a 7-point Likert scale ranging from 1 (totally disagree) to 7 (totally agree), and demographic questions. Before finalizing the questionnaire, it was reviewed and commented on by senior academics and experts. According to their comments, minor adjustments to the wording, phrasing, formatting, and overall visual construct were made. Results and analysis have been carried out using SPSS 25 (IBM, 2020) and, specifically, the moderation analysis has been conducted using the macro PROCESS [46].

#### 4. Results

Table 2 illustrates constructs and corresponding items with model reliability. Participants' attitude towards food waste was measured by four items. As Norms are concerned,

previous scholars have argued that normative pressures derive from injunctive and descriptive norms [47–49]. The former specifies the behaviours others want one to perform, while the last specifies what most people do in a particular situation. In this work, both participants' injunctive and descriptive norms have been measured using three items each. Perceived behavioural control was measured using two items, and participants' intention to avoid throwing away food was measured using four items. Items measuring attitude, norms, perceived behavioural control, and intention are based upon the guidelines provided by Fishbein and Ajzen [42] (appendix). Lastly, four different ad hoc items were used to assess two different food management behaviours, namely "use of leftovers" and "reduction of servings". All the constructs showed adequate/good reliability, with a Cronbach's Alpha ranging between 0.63 and 0.77.

**Table 2.** Reliability and validity of measurement model.

Constructs and Measuring Items	Mean (SD)
<b>Covid-19 Pandemic Concern</b>	
<i>Currently, how concerned are you about the Coronavirus/Covid-19?</i>	4.76 (1.52)
<b>Attitude towards Food Waste (Cronbach's <math>\alpha = 0.77</math>)</b>	
<i>For me, throwing away food is ... (Useless—Useful)</i>	1.71 (1.29)
<i>For me, throwing away food is ... (Negative—Positive)</i>	1.35 (0.71)
<i>For me, throwing away food is ... (Unpleasant—Pleasant)</i>	1.61 (0.96)
<i>For me, throwing away food is ... (Bad—Good)</i>	1.70 (1.01)
<b>Injunctive Subjective Norms (Cronbach's <math>\alpha = 0.72</math>)</b>	
<i>Most people who are important to me believe that I should not throw food away.</i>	5.30 (1.83)
<i>Other people expect me not to throw food away</i>	5.45 (1.62)
<i>Most people whose opinion is important to me approve my avoidance of throwing away food.</i>	5.86 (1.49)
<b>Descriptive Subjective Norms (Cronbach's <math>\alpha = 0.66</math>)</b>	
<i>Most people close to me do not throw away food.</i>	5.28 (1.69)
<i>My friends tend to throw food away (R)</i>	4.15 (1.71)
<i>In general, I think most people who are important to me don't throw away as much food.</i>	4.99 (1.58)
<b>Perceived Behavioural Control (Spearman-Brown <math>\rho = 0.82</math>)</b>	
<i>I am able not to throw food away</i>	5.58 (1.57)
<i>I feel capable of not throwing food away</i>	5.82 (1.41)
<b>Intention to Not Throw away Food (Cronbach's <math>\alpha = 0.75</math>)</b>	
<i>In general, I try to avoid throwing food away.</i>	6.32 (0.98)
<i>I strive to avoid throwing away food</i>	6.15 (1.26)
<i>My general intention is avoid throwing away food.</i>	6.61 (0.73)
<i>I do everything to avoid throwing away food</i>	6.12 (1.17)
<b>Food Management Behaviours (Cronbach's <math>\alpha = 0.70</math>)</b>	
<b>(a) Use of Leftovers (Spearman-Brown <math>\rho = 0.81</math>)</b>	
<i>I always try to use leftover food</i>	5.86 (1.32)
<i>I always try to use leftovers in a creative way</i>	6.06 (1.16)
<b>(b) Reduction of Portioning (Spearman-Brown <math>\rho = 0.63</math>)</b>	
<i>I try to prepare and serve the right portions to avoid leftovers</i>	5.23 (1.5)
<i>I always try not to put more food on the table than I have to</i>	5.37 (1.58)

Note: Answers were collected on a 7-point scale anchored from 1 = totally disagree to 7 = totally agree; R = Item is reverse coded;  $n = 201$ .

A preliminary analysis of correlations, means, and standard deviations (Table 3) showed that participants scored high on intention to reduce food waste and both related behaviours, namely reducing servings and using leftovers. Participants scored high also on Covid concern, which did not correlate with waste-related intention and behaviours. In

line with the theoretical framework, the TPB major constructs (attitude, norms, PBC) were significantly correlated among them and with intention and behaviours.

**Table 3.** Mean, standard deviations and correlations of model variables.

	1	2	3	4	5	6	7	8
(1) Intention	6.30 (0.80)							
(2) Use of Leftover	0.576 **	5.62 (1.33)						
(3) Reduce Servings	0.323 **	0.344 **	5.65 (1.14)					
(4) Attitude	−0.478 **	−0.401 **	−0.142 *	1.59 (0.78)				
(5) Injunctive Social Norms	0.274 **	0.252 ***	0.056	−0.345 **	5.54 (1.33)			
(6) Descriptive Social Norms	0.272 **	0.242 ***	0.123	−0.215 **	0.497 **	3.42 (0.98)		
(7) PBC	0.459 **	0.387 ***	0.243 **	−0.288 **	0.266 **	0.259 **	5.79 (1.37)	
(8) COVID Concern	0.107	0.103	0.052	−0.236 **	0.284 **	0.153	0.123	4.76 (1.52)

Note: The table shows Pearson's *r* correlation coefficients. Diagonal cells report the means (standard deviation in parentheses). \*\*\* =  $p < 0.001$ ; \*\* =  $p < 0.01$ ; \* =  $p < 0.05$ .

Subsequently, we analysed the direct effect of TPB main constructs on the intention to reduce food waste. We entered Covid-concern as an additional predictor; participants' gender, income and household components' number were entered as control variables. Intention was regressed on attitude, injunctive norm, descriptive norm, perceived behavioural control, Covid concern, gender, income, household. The model explained a significant proportion of variance:  $R^2 = 0.374$ ,  $F(8, 200) = 14.35$ ,  $p < 0.001$ . Attitude and PBC were significantly associated with intention, whereas subjective norms and covid-concern were not. None of the sociodemographic variables showed a significant association with intention. Results of the regression model are summarized in Table 4.

**Table 4.** Direct effect of TPB construct on the Intention to reduce food waste.

	Coeff.	SE	<i>p</i>
COVID Concern	−0.027	0.033	0.410
Attitude	−0.372	0.066	0.000
Injunctive SN	0.012	0.043	0.783
Descriptive SN	0.080	0.055	0.150
PBC	0.192	0.036	0.000
Gender	0.108	0.098	0.274
Household	0.001	0.041	0.974
Income	−0.024	0.039	0.532
constant	5.479	0.410	0.000

In order to test the hypotheses formulated in the previous section, and in particular whether the covid-related concern moderates the relation between intention to reduce food waste and selected behaviours, we conducted a moderation analysis. Behaviour 1 (use of leftovers) and Behaviour 2 (reduction of servings) were regressed on intention, attitude, subjective norm, perceived behavioural control, covid-concern, and the multiplicative term intention\*Covid-concern. Participants' gender, income and household components' number were entered again as control variables.

Results of the analyses are reported in Table 5 (Model 1, referred to Behaviour 1 = use of leftovers; Model 2, referred to Behaviour 2 = reduction of servings).

With reference to the use of leftovers, the model explained a significant and substantive proportion of variance:  $R^2 = 0.404$ ,  $F(10, 188) = 12.76$ ,  $p < 0.001$ . As expected, intention and perceived behavioural control were significantly associated with the behaviour, whereas attitude and subjective norms were not. The effect of gender, income and household was not significant. In contrast with our hypothesis, the interaction between intention and covid-concern was not significant.

**Table 5.** Direct effect of TPB constructs upon Behaviours.

	Model 1—Use of Leftovers			Model 2—Reduce Servings		
	Coeff.	SE	<i>p</i>	Coeff.	SE	<i>p</i>
COVID Concern	−0.030	0.054	0.576	−0.023	0.055	0.679
Intention	0.685	0.118	0.000	0.397	0.119	0.001
Covid concern*intention	−0.065	0.069	0.353	1.156	0.070	0.027
Attitude	−0.196	0.119	0.099	−0.050	0.119	0.676
Injunctive SN	0.012	0.070	0.856	−0.078	0.076	0.269
Descriptive SN	0.056	0.091	0.536	0.080	0.092	0.384
PBC	0.139	0.063	0.029	0.129	0.064	0.043
Gender	0.283	0.160	0.078	0.301	0.161	0.063
Household	−0.069	0.067	0.304	0.062	0.067	0.357
Income	−0.123	0.063	0.052	−0.052	0.064	0.413
constant	5.016	0.665	0.000	4.559	0.673	0.000

As regards Behaviour 2, the reduction of servings, the model explained a significant proportion of variance:  $R^2 = 0.171$ ,  $F(10, 188) = 3.90$ ,  $p < 0.001$ . Also in this second model, attitude and subjective norms were not significantly associated with behaviour, whereas the effect of intention and perceived behavioural control was significant. Gender, income and household again were not significantly associated with behaviour.

Moreover, in line with our hypothesis, the interaction between intention and covid-concern significantly affected behaviour. The interaction alone significantly increased the explained variance of 2.18%,  $F(10, 188) = 4.96$ ,  $p = 0.027$ .

The analysis of conditional effect (Table 6) showed that the influence of intention on behaviour was not significant when covid-concern was one standard deviation under the mean, whereas it became significant at mean, and the coefficient almost doubled when concern was one standard deviation above the mean.

**Table 6.** Conditional effect of intention on reduce servings at different levels of covid-concern.

Covid Concern	Effect	se	t	<i>p</i>
$\mu - \text{std}$	0.1607	0.1546	1.0399	0.2997
$\mu$	0.3971	0.1192	3.3322	0.0010
$\mu + \text{std}$	0.6335	0.1645	3.8516	0.0002

Note:  $\mu = 4.71$ ;  $\text{std} = 1.51$ .

## 5. Discussion and Conclusions

The covid pandemic has changed food purchasing and consumption behaviour in several developed countries [11,15]. These changes are also affecting the amount of food wasted at home. Surveys carried out during the first year of the pandemic have indeed shown a lower perception of household wastage, probably due to increased household time and greater use of home-prepared rather than ready-to-eat food [17]. However, the real consequences for the amount of food wasted remain ambiguous and not predetermined [17,18]. It is therefore important to further investigate and understand the links between covid-related concerns and the positive behaviours individuals can adopt to reduce waste.

This research has been carried out in this specific area and has assessed two distinct behaviours that households can adopt to counter and reduce household waste: using leftovers and reducing portion sizes. For each of these behaviours, the effect of COVID-19 concern and the interaction between this concern and the intention to reduce waste were analysed in a TPB framework. Results about the antecedents of intention supported our hypotheses, which were directly derived from TPB. As expected, attitude was significantly associated with intention but not with behaviours, whereas—in line with the *sufficiency principle* [42]—Covid concern was not. As regards perceived behavioural control, it was significantly associated with both intention and behaviours. On the contrary, subjective



norms, either injunctive or descriptive, are not associated with behaviours—in line with theory—yet also with intention. However, the lack of association between norms and intention has been already documented in literature (e.g., [50,51]; see also the meta-analytic review by [52]), and could be also interpreted with regard to recent recommendations about interactions among TPB's factors [40,45], which may in some cases decrease the influence of subjective norms.

It is important to note that this is the first study to address, in a TPB framework, the issue of compatibility between intention to reduce food waste and concrete behaviours. Research, also recently, mostly focuses on intention to reduce food waste (e.g., [53]); in the smaller number of TPB-based studies which also address behaviour, this is operationalized asking participants to self-report the food they throw away, or they do not throw away [35,54]. It appears clearly that throwing away food could not be interpreted as a behaviour compatible with the intention to reduce food waste. On the other hand, “not throwing food away” is hardly definable as a behaviour, which is definable as a single action or a set of multiple concrete actions individuals implement under volitional control [42]. Therefore, in the current study we provide original insights into the relation of intention to reduce food waste with two relevant positive behaviours, namely reusing leftovers and reducing servings. For both behaviours, the TPB-based model showed a significant explanatory and predictive power. In relation to reusing leftovers, the TPB model explains a significant and substantive proportion of variance. Nevertheless, covid-concern was not directly associated with this behaviour, nor was significant its interaction with intention.

Importantly, in the case of portion reduction, there is instead a significant interaction between concern and intention. The analysis of conditional effects shows that the influence of intention on reducing servings increases as a function of the level of concern.

As already mentioned, results can be interpreted and discussed on the basis of what is suggested by the Waste Framework Directive adopted in the European Union [43]. The directive identifies a waste hierarchy to be applied as a priority order in waste prevention and management: (a) prevention, (b) re-use, (c) recycling; (d) other recovery, and (e) disposal. Prevention is the preferred and most efficient option. Indeed, more efficient planning of the production and supply in order to avoid waste, makes it possible to minimise the use of natural resources, thus making them available for alternative uses and for future generations. Re-use, which in the case of food is intended for human consumption and in a subordinate way for animal feed, is a second-best solution because it reduces waste but does not guarantee a fully efficient allocation.

According to this approach, portion reduction is certainly a more ambitious and effective behaviour as it directly produces a reduction in waste through the efficient use of resources. In the same way, the use of leftovers is part of a re-use objective, which is however a second best compared to the first behaviour, as it implies a wrong planning of supplies in the household production function. From this point of view, the objective of reducing portioning appears to prevail over the use of leftovers and the two behaviours are mutually exclusive/alternative: if I reduce portioning, the possibility of reusing leftovers is drastically reduced because leftovers are not generated in the first place.

The effect of pandemic concern on behaviour, as highlighted by our results, shows that the presence of a tension state can address certain behaviours, in this case portion reduction. Although the empirical evidence emerging from the results needs further investigation, it appears to be in line with the proposed interpretation of the two behaviours in the light of the EU directive and consistent with the results of previous research [15,17]. Covid concern increased the feeling of scarcity and uncertainty, and promoted, especially in the early stages of the pandemic, a tendency to hoard food. Concern, coupled with the increased time available, results in more sober and efficient behaviour and thus in reduced portion sizes to maximise the shelf life of food and ingredients stored at home. In accordance with this interpretation, the behaviour of reusing leftovers, which in any case implies an

excessive and inefficient use of resources, is not activated as Covid concern increases and therefore no interaction between concern and intention is evidenced.

Bearing in mind the results discussed so far, some indications can be drawn on how to address food waste policies. Covid-19 highlighted the link between feelings of scarcity, uncertainty and virtuous and more efficient behaviour. In a similar fashion, communication strategies aimed at increasing consumers' awareness of resource scarcity and resource efficiency could have an analogue effect by promoting more efficient behaviour and subsequently, reducing the amount of waste produced in the household. To achieve this goal, increasing the flow of information to consumers on the environmental impact of the food they consume, e.g., through forms of environmental labelling, could be of considerable help.

Lastly, to facilitate consumption behaviour in terms of portioning, it is crucial that the food industry and the food distribution sector are appropriately induced to facilitate good consumer behaviour, too. In this sense, increasing the shelf life of products, using smaller pack sizes, and planning less aggressive price and quantity promotional strategies are all important options.

The present paper suffers some limitations, that are worth to be acknowledged. First, the research has been conducted only in Italy with a small non-probabilistic sample, thus raising some doubts about the external validity of the results. Moreover, information on behaviours have been collected using a self-report measure. Therefore, we emphasize the need to confirm our interpretation of the results in the light of a larger and representative sample of the Italian population jointly with a behavioural measure derived from direct observations of the household practices.

**Author Contributions:** Conceptualization, M.A., F.V., A.C. and F.L.B.; methodology, F.L.B.; formal analysis, F.L.B.; investigation, M.A.; writing—original draft preparation, M.A., F.V., A.C. and F.L.B.; writing—review and editing, M.A., F.V., A.C. and F.L.B.; supervision, F.L.B. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** The study was conducted according to the guidelines of the Declaration of Helsinki, and the ethical guidelines provided by the American Psychological Association ([www.apa.org](http://www.apa.org), accessed on 15 July 2020). The research protocol was approved by the Review Board of Psychological and Social Research Lab R. Gentile, Federico II University of Napoli, research protocol number 0252019.

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

**Conflicts of Interest:** The authors declare no conflict of interest.

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