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Review Article

The Relationship between Dietary Preference and Food Waste: An Application of the Theory of Planned Behaviour

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Abstract

Food waste is a critical environmental issue, with household food waste representing the largest contributor to overall food loss. While previous research has linked food waste behaviour to psychosocial factors, the influence of dietary preference on food waste remains underexplored. This study applied the Theory of Planned Behaviour (TPB) to examine whether diet type (vegan, vegetarian, or omnivore) predicts household food waste behaviour. A total of 363 participants completed an online survey measuring food-related routines, household skills, TPB constructs, and pro-environmental attitudes. Results indicated that household food waste was significantly predicted by perceived behavioural control, shopping and planning routines, and household skills. Pro-environmental attitudes were weakly associated with reduced food waste but significantly predicted intentions not to waste food. Vegans reported significantly stronger pro-environmental attitudes and less food waste than omnivores, with vegetarians falling in between. These findings support an extended TPB model and highlight the relevance of dietary identity in shaping food waste behaviour. Targeting food-related routines and enhancing perceived control may improve the effectiveness of food waste reduction campaigns, particularly when tailored to dietary groups.

INTRODUCTION

Food Waste

The population of the world is growing exponentially, and with this growth comes an increased demand for resources (such as fossil fuels, freshwater, and food) and an increase in waste production and environmental degradation [1]. These increases are further exacerbated by consumption habits, patterns of social organization, and resource management [2,3], concerns about how to sustainably feed a growing population often places the emphasis on increasing production whilst reducing the use of natural resources and cutting carbon emissions [4]. However, one way of strengthening global food security, while reducing the environmental footprint of food, lies in a different approach: cutting the vast amounts of food wasted every year [4-6].

In the various stages of the food supply chain, large quantities (approximately 33% a year) of food available for human consumption are lost or wasted; this includes uneaten food products that are thrown away by consumers (also known as avoidable food waste) [7,8]. The amount of energy, water, land, and other resources needed to produce food that is then wasted, makes this issue critical [6]. For example, 25% of water used in agriculture is used to grow food that it ultimately being wasted (Department of Agriculture, Water, and the Environment, 2020). Furthermore, food waste has become a leading contributor to climate change, globally generating roughly eight percent of human-caused greenhouse gas emissions [5-9], the aim of this study was to examine household food waste determinants with a focus on the avoidable portion of food waste. This food waste is defined as food and drink, which was edible at some point before being thrown out [8].

An unintentional result of our biological need to procure, prepare and consume food for survival is that a portion of food intended for our consumption becomes waste [10]. Buying food, not consuming it, and then discarding it is becoming a huge global and social issue, with household food waste having a detrimental effect on the planet [11]. According to the Rabobank 2020 Food Waste report, Australians are now wasting 12.7% of their weekly grocery shop. In Australia alone, this waste is costing the average household $1043 per year and totally $10.3 billion nationally. One in ten individuals around the world go to bed hungry yet, developed nations (including USA and Australia) waste about 1.3 billion tonnes of edible food per year [12,13].

These statistics on food waste highlight the need to reduce the amount of food being wasted. Reducing food waste at the consumer stage is highly feasible and therefore critical and necessary to prevent further climate change [11-15]. There is a modest yet rapidly growing body of literature on food waste, however, given its complex nature, the evidence of the drivers of food wastage and barriers to its reduction remain unclear [11]. Although studying consumer behaviours towards food waste is a relatively new area of research, understanding these complex and diverse motivations is critical to identifying effective ways to reduce food waste [7-16].

Qualitative research has mostly dominated the investigation for determinants of food waste [16-18]. This line of inquiry provides important insight into the potential motivational precursors of food waste behaviour, by focusing on variables such as attitudes, social norms, knowledge, and intentions [19]. Previous research indicated that consumers consider throwing away food as improper behaviour, marking it as a significant predictor of an individual's intention to waste food [7-21]. These studies have advanced the field further; however, it remains unclear whether diet preference (an individual's choice of eating an omnivorous or plant-based diet) might have an impact on the amount of food a person wastes.

The aim of this study is to build on the existing knowledge of the psycho-social predictors of food waste by testing additional factors that may predict this complex behaviour. Specifically, this study examined the role diet preference has on household food waste behaviour. The consumption of meat is a complex eating behaviour, with overconsumption resulting in harmful impacts on both health and the environment [22]. Global agriculture production is having a significant negative environmental impact, with animal agriculture being responsible for an estimated 11% of Australia's greenhouse gas emissions, 54% of its land use, and 52% of the nation's freshwater usage [23,24]. Most vegetarians in the West are not raised as such, however due to these harmful effects on the environment, some individuals choose to convert from an omnivorous diet to a vegetarian or vegan diet [25,26]. Vegetarianism can be defined as the avoidance of eating animal flesh, while those that avoid all animal products, and their byproducts are denoted as vegans [26]. The number of Australians following these diets is unclear, although research suggests that there may be up to 2.5 million vegans and vegetarians in Australia in 2022, with approximately 6% of the population describing themselves as strict vegans [22-27]. Research has demonstrated that plant-based diets appear environmentally better than meat-based ones, however it is unclear if undertaking a specific diet will result in less food being wasted [27].

Theory of Planned Behaviour

Proposed by [28], the Theory of Planned Behaviour (TPB) has been widely and successfully applied to predict household food waste behaviour [7,21]. The model proposes that behaviour is directly influenced by intentions, which are influenced by three conceptually independent antecedents (attitudes, subjective norms and perceived behavioural control) that determine the strength of a person's intention to carry out a behaviour [10]. In previous research, the range of explained variance intentions explains in relation to food waste behaviour varies from quite [7-29], noted attitudes (through intentions) were the strongest determinants of food waste behaviour. Whilst some research posits that the core values of vegetarians and omnivores differ, other researchers have found less dramatic differences in their beliefs [26-30]. Environmental reasons (including unnecessary waste) are a main motivator for people to convert to a plant-based diet [26-31]. It has also been reported that omnivores are less concerned regarding the environmental impacts of their food compared to vegans [22-33], Despite having a significant difference in the environmental consequences of their food choices, the extent to which omnivores, vegetarians and vegans differ in their concern for the environment and their attitude toward food waste has not been thoroughly investigated. This research will investigate the role of attitudes in food waste.

Subjective norms are also theorised to indirectly impact behaviour through their impact on intentions. In a study by Gatersleben [34], environmental values and identities were shown to be good predictors of pro-environmental behaviours. Environmental identity is a way a person has formed their self-concept as a sense of connection to another collective identity [35]. If becoming a vegan for environmental reasons has created a social and environmental identity for that individual, then they may be less likely to behave in ways that would hurt the environment [36]. In relation to food waste, morality, guilt, and environmental concern are considered key subjective norms [6-37], noted that subjective norms were significantly related to intention only regarding the amount of protein being wasted (i.e.,meat and fish) and none of the other food groups. That study, however, did not discriminate between the different dietary food groups. Visschers et al. [19], confirmed the suggestion of Quested et al. [6], that due to the discrete nature of food waste behaviour (typically only ever seen by the generator)

subjective norms have only been reported to moderately influence intention [16-21].

Perceived behavioural control is thought to both directly predict behaviour and to indirectly predict behaviour through its impact on intentions. Perceived behavioural control has been found to both influence intention and directly influence behaviour [7-21]. In some research, it has been found that perceived behavioural control has a large indirect relationship to food waste behaviour through planning and shopping routines [21]. Perceived behavioural control affects intentions related to situations such as large sizes of food packaging, unexpected meals outside of the home and the conflict between food provisioning and fussy eaters [17-38], found that convenience was a barrier for going vegan/vegetarian for many consumers. If accessibility differs between the three dietary groups, then it can be hypothesised that their perceived behavioural control will also have a differential influence on food waste. The present study aims to investigate this potential, but untested, predictor of food waste.

Limitations of the TPB

Generally, the more favourable the attitude, the stronger the subjective norms, and the greater the perceived behavioural control, the stronger the individual's intention will be to behave (not waste food). However, the relative importance of each conceptual antecedent is expected to vary across behaviours and situations [28]. Since its conception, the TPB has proved to be a powerful explanatory approach for predicting complex human behaviour. However, there are some limitations and criticisms of the TPB model. It has been noted that it is challenging to apply the TPB to food waste as it is a complex behaviour that is made up of multiple behaviours rather than a singular behaviour [6 -29], further criticises the model at its inability to deal with irrational behaviours and habits which food waste behaviour oftentimes can be. For example, saving money and other personal concerns, elicit a strong motivation to reduce food waste [7-39], both in quantitative research [7-41], and qualitative research [16]. However, this does not explain why (despite the cost) some people are still wasting food and some are not. Researchers found that people who voice a "high environmental concern have a marked aversion towards wasting food" [11-42]. Considering the massive impact household food waste is having on our environment, an environmental concern has the potential to be a predictor of food waste behaviour. Therefore, this study included pro-environmental attitudes as a separate measure to explore the possibility of explaining food waste behaviour further.

Pro-Environmental Attitudes

Traditionally, the TPB focuses on the attitudes towards the specific behaviour (in this case, household food waste). The inclusion of pro-environmental attitudes in the current study, is an attempt to give more depth into the attitudes that drive intention and behaviour. To understand the ideology of the human/environment relationship, previous research has focused on environmental awareness and concern. The concept of a pro-environmental psychological attitude was first developed in the 1970's [43], and was defined as a person's inclination to have concern for human impact on the natural environment [44]. As mentioned, in terms of the relationship between attitude, intention and behaviour; attitude strength is seen as the strongest predictor of intention [16-29]. To make a prediction that is consistent with the TPB, pro-environmental attitude was expected to positively correlate with pro-environmental behaviours [28]. Research has consistently shown that pro-environmental attitude is positively related to pro-environmental behaviour [45,46]. This reflects the notion that people who have more environmental concerns will act in ways to protect it [47,48], Under an umbrella of ecologically responsible behaviours, reducing waste is considered a pro-environmental behaviour [49], therefore this research will attempt to determine if pro environmental attitudes are positively related to reduced food waste.

Some studies have suggested that concerns about the environmental impacts of food waste have only minimal impact on an individual's motivations to reduce their wasteful behaviour [39]. This weak association of food waste and environmental concern could be explained by a lack of awareness and knowledge between food waste and its ecological impacts [6-21]. This lack of knowledge was also highlighted in a qualitative study by Watson and Meah [18], where none of their respondents suggested any sort of link between greenhouse gas emissions and food. However, in environmentally educated households it was found that these consumers wasted less food [37]. Given this finding, it is further hypothesised that omnivores, vegetarians, and vegans are likely to differ in food waste (behaviour and intention) and in pro-environmental attitudes as a reflection of the disconnection between what a person eats and the environment. The rationale of this study was to build on existing research and expand the understanding of food waste behaviour with a focus on the role of pro-environmental attitudes and dietary preference as motivators of food waste in the context of the TPB. The following was hypothesised:

Hypothesis 1: In accordance with the TPB, it was predicted that intentions to not waste food would be predicted by higher scores on attitudes, subjective norms, and perceived behavioural control of household food waste.

Hypothesis 2: Pro-environmental attitudes will predict household food waste behaviours.

Hypothesis 3: Vegans will score higher on pro-environmental attitudes than omnivores and vegetarians.

Hypothesis 4: Vegans will report less food wastage than omnivores and vegetarians.

METHOD

Procedure

Ethics approval was first obtained by CQ University Human Research Ethics Committee before data collection (approval number 2020-110). The study procedure consisted of participants responding to a web-based survey developed in the Qualtrics software [50]. Before recruitment, a power analysis was conducted in G*Power to determine needed sample size. Hypothesis 1 (which tested the predictive validity of the TPB [28], was estimated to have the smallest anticipated effect. The needed sample size for this hypothesis was calculated for a multiple linear regression with a medium effect size of 0.15, error probability 0.04, power 0.8 with two predictors (behaviour and intention). Correlational studies show that intentions are reliably associated with behaviour [51], therefore a medium (conservative) effect size was chosen. There were 363 participants who completed the online questionnaire (conducted from October 2020 till November 2020).

Participants were recruited online through a Facebook group created to engage omnivores, vegetarians, and vegans. This targeting recruitment was conducted to ensure that the relatively low prevalence group in the general population of those with plant-based diets would be represented in the sample to an extent such that comparisons could be conducted with sufficient cell sizes. A link to the survey was posted in the group with a plain language statement offering a clear description of the research aims and the incentive. As reward for participation, respondents went into a draw to win a $150 voucher.

Participants

There were 363 participants who completed the online questionnaire which far exceeded the minimum required sample of 68 (see power analysis above). Participants were required to be older than the age of 18 years, which was the only exclusionary criterion for being included in this study. The sample contained persons aged between 18 and 74 years of age and vastly more females compared to males (~83% vs ~17%). The socio-demographic characteristics of the final sample are presented in Table 1.

MATERIALS

The first part of the survey consisted of items to collect demographic characteristic data; items for the participants to indicate age, gender, socioeconomic and employment status. A single item was used for participants to self-identify as either a vegan, vegetarian, or omnivore.

Pro-environmental Attitudes

Pro-environmental attitudes were assessed with the Ecologically Conscious Consumer Behaviour (ECCB) Scale [52]. Subscale of Pro-environmental Attitudes. This sub-test consisted of 35 items recorded on a 5-point Likert scale (anchored by 'strongly disagree' [one point] and 'strongly agree' [five points]) to gauge attitudes towards the environment such as: "Overconsumption is highly responsible for the environments destruction" and "Natural resources must be preserved, even if people have to do without some products." Following reverse-coding where relevant, responses to items were summed/averaged to form a total pro-environmental attitude score for each participant. In its entirety, the scale had poor internal reliability (<.50). Following a 2-step factor analysis, those items that poorly loaded onto a single factor were omitted (k = 9) and those with loadings more than .32 were included in the revised scale score (k = 29). The final scale had a Cronbach's alpha of .88.

Table 1: Socio-demographic characteristics of the sample (N = 363)

	N	%
Gender		
Female	303	83.5
Male	59	16.3
Other	1	0.3
Occupation		
Working full time	157	43.3
Working part-time/casual	109	30
Not currently employed/ looking for work	18	5
Retired	25	6.9
Homemaker	24	6.6
Disabled (not working because of permanent or temporary disability)	12	3.3
Student	18	5
Household Income		
$0 - $18,200	34	9.4
$18,201 - $45,000	66	18.2
$45,000 - $120,00	148	40.8
$120,001 - $180,000	76	20.9
$180,000 and over	39	10.7
Age		Mean/SD
Pro-Environmental Attitude		40.3/13.9
(Maximum Score 120)		101.8/9.5

TPB: Food Waste Behaviour

Food waste was assessed with the self-reported consumer food waste scale based on the TPB. This scale was first developed by Stefan et al. [21], and then replicated and validated by Stancu et al. [7], Stancu et al. [7], and Stefan et al. [21], utilised a mixture of 3-point, 5-point and 7-point Likert scales. The current study adapted the scale so that it used a consistent 5-point scale throughout. To accommodate for vegans and vegetarians, the inclusion of plant-milks, faux meat and fish were included in questions that specifically related to food. Past research in pro-environmental behaviour operationalized habits as past behaviour (Russell et al. [29]. Past food waste behaviour was operationalized as an indicator of food waste habit. The questions varied in their wording, but most included the instructions "thinking about your household" please rate your disagreement (strongly disagree [1]) vs agreement (strongly agree [5]).

Food waste behaviour (self-reported): Food waste was defined as, "all food and drink which at some point prior to being thrown away was edible." The items were self-reported and four sub-categories of food were utilised, these were dairy (including vegan dairy products), fresh fruit and vegetables, meat and fish (including faux meat and fish) and bakery products. Responses from this portion of the questionnaire were summed to form a total food waste score for each individual. Following this, the scale was further comprised of items that measured participants' intentions not to waste food, food-related routines, household skills, attitudes towards food waste, moral and injunctive norms, and perceived behavioural control in line with the TPB. Responses from this portion of the questionnaire were worded as "How much (insert food sub-category) is thrown away in your household of what you buy/grow, in a regular week" with the scale: hardly any (1), less than a tenth (less than 10%) (2), more than a tenth but less than a quarter (between 10% and 20%) (3), more than a quarter but less than a half (between 25% and 50%) (4), more than half (more than 50%) (5).

TPB: Intention not to waste food: As wasting food was considered an odd purposeful behaviour, intention not to waste food was measured rather than an intention to, which was introduced by "Please answer the following question thinking about the near future (e.g next one/two weeks) and your household". The intention was measured using three items on a 5-point Likert scale such as "I intend not to throw food away" on a scale from strongly disagree (1) to strongly agree (5) developed by Stancu et al. [7], following the TPB [28], guidelines. The items from this portion were summed to form a total intention score.

TPB: Attitudes towards food waste: General attitudes towards food waste were measured using 3 items rated on 5-point scales. One item referred to loading the environment with one's household food waste "In my opinion loading the environment with my waste is…" (from not at all harmful/negative [1] to extremely harmful/negative [5]), while the other two items referred to throwing away food (measured on a 5-point Likert scale from avoidable [1] to unavoidable [5]). These items were developed by Stancu et al. [7], in accordance with the TPB [28], guidelines.

TPB: Social (Moral) norms: Moral norms were measured with a 3-item 5-point Likert scale. Each item that measured from strongly disagree (1) to strongly agree (5) and were questions such as "Wasting food would… give me a bad conscience." These questions were adapted from prior literature on food related behaviours and environmental behaviours by Stancu et al.

TPB: Social (Injunctive) norms: Injunctive norms were measured with a 4-item 5point Likert scale referring to what one ought to do regarding food waste in general ("One should never waste any food" and food waste in relation to the environment ("One should not load the environment with food waste"). These represented social injunctive norms. The items were measured from strongly disagree (1) to strongly agree (5).

: Perceived behavioural control: Perceived behavioural control was measured with a 3-item 5-point Likert scale that was developed in line with the TPB [28], and prior studies on household food waste [53]; 7 Two items asked how avoidable/unavoidable food waste was in general (avoidable [1], unavoidable [5]) and in relation to the environment. One item asked about the ease/difficulty of not wasting food (easy [1], difficult [5]).

Antecedents to food waste

. Shopping routines: This 3-item scale on shopping routines regarded the purchase of larger amounts of food than needed; such as "We often buy unintended products when shopping". These items were measured on a 5-point Likert scale from strongly disagree (1) to strongly agree (5). It was developed based on shopping routine measures in previous literature [7-21].

Leftovers reuse routines: Reuse of leftovers routines were measured with a 3-item 5point Likert scale (from strongly disagree [1] to strongly agree [5]) that referred to the storage and reuse of leftovers. Responses were made from questions such as "The leftovers are stored in appropriate conditions, so they last." These items were

developed by Stancu et al. [7], based on previous literature [53,54].

Planning routines: Planning referred to shopping trips and future meals. These two items were adapted from previous studies on consumer food waste [7-54]. The questions "The shopping trips are normally planned in advanced (shopping lists are made, inventories are checked, etc)" and "The home meals are usually planned for a couple days ahead" were measured on a 5-point Likert scale from strongly disagree (1) to strongly agree (5).

Household skills: Five items on a 5-point Likert scale such as "How would you rate your households skills on planning the meals" (from very poor [1] to very good [5]) were used to measure perceived capabilities to deal with household skills, they referred to how poor/good people perceive their skills related to several specific household related activities.

These items were developed based on previous studies on household food waste [7-54].

The published reliability for these constructs and the reliability calculated can be found in Table 2.

DATA ANALYSES

Of the 460 respondents that commenced the survey, 97 participants did not provide sufficient data to allow for inclusion in the analyses.

Hypothesis 1

To test our first hypothesis that the TPB was a sufficient theory to predict food waste, the data analyses were conducted in two stages, First, assumptions of linearity, homoscedasticity and normality were all measured and met. Secondly, the conceptual models were tested. A multiple linear regression was run on intentions, shopping routines, leftovers reuse routines, planning routines, household skills, attitudes, moral norms, perceived behavioural control, and injunctive norms. Next, a linear regression was used to determine if intention predicted behaviour. After this, a multiple linear regression was applied to determine if the main conceptual components (attitudes, norms and perceived behavioural control) predicted intention. Finally, a linear regression was performed to determine if perceived behavioural control had a direct effect on food waste behaviour.

Table 2: Previously published reliability and present reliability scores

Factors and items	Published CR	Present CA
Food Waste Behaviour	.85	.73
Intention not to waste food	.94	.82
Shopping routines	.56	.63
Leftovers reuse routines	.59	.55
Planning routines	.75	.91
Household skills	.86	.82
Attitudes towards food waste	.82	.85
Moral Norms	.87	.82
Perceived behavioural control	.80	.66
Injunctive Norms	.70	.73

Hypothesis 2

To test the second hypothesis, a Pearson Correlation was used to examine the relationship between pro-environmental attitudes and food waste. Before determining if a correlation exists between pro-environmental attitudes and household food waste, the researchers first checked for any assumptions visually. The data appeared to violate the assumption of heteroscedasticity, so the researchers used Spearman's rho to determine an association between the two variables. To explore pro-environmental attitudes within the scope of the TPB, a second correlation was performed to investigate the relationship between pro-environmental attitudes and intentions not to waste food.

Hypothesis 3

An independent between groups analysis of variance (ANOVA) was planned initially to analyse the difference of pro-environmental attitudes as a function of the categorical independent variable of diet preference. All the assumptions were tested and Levene's test of homogeneity of variance was violated. Due to this assumption, a Kruskall-Wallis test was conducted to compare the groups.

Hypothesis 4

To generate data for the fourth hypothesis, first the data were inspected visually to check the assumption of linearity and heteroscedasticity. An independent between groups ANOVA was planned initially to analyse the difference of food waste as a function of the categorical independent variable diet preference. This produced a significant result for the Levene's test of homogeneity of variance ($F[2,360] = 5.01$, $p < .01$). Due to the violation of this assumption, a Kruskal-Wallis test was conducted to compare the groups. An independent between-groups ANOVA and a subsequent Tukey's post hoc test was run to investigate the differences between vegans, vegetarians, and omnivores on the conceptual model of the TPB.

RESULTS

Hypothesis 1

Food waste was significantly predicted by the overall model ($F [9,353] = 28.75$, $p < .01$), with an R^2 of .42. These results can be found in Table 3.

Intention to not waste food was significantly predicted by attitudes not to waste food, norms, and perceived behavioural control (F [4,362] = 34.46, p < .001), with an R^2 of .53. The results for this are found in Table 4.

Hypothesis 2

There was a very weak, significant, negative relationship between pro-environmental attitudes and food waste (r = -.16, p = .001) therefore, it can be concluded that there is a significant correlation between pro-environmental attitudes and food waste in the population and we accept our second hypothesis, although note the size of the effect is small.

There was a moderate, significant, positive relationship between pro-environmental attitudes and intentions to not waste food (r = .28, p < .001) therefore, it can be concluded that there is a significant correlation between pro-environmental attitudes and intentions not to waste food in the population.

Hypothesis 3

The independent between-groups ANOVA on pro-environmental attitudes yielded a statistically significant effect, F(2,360) = 24.46, p < 0.001. Thus, the null hypothesis of no differences between the means was rejected. A Tukey's post hoc showed that the significant differences were represented between omnivores and vegans and omnivores and vegetarians. There was no significant difference between vegans and vegetarians. Table 5 below presents the means, standard deviations for each diet preference group on pro-environmental attitudes.

Hypothesis 4

The independent between-groups ANOVA on food waste yielded a statistically significant effect (F [2,360] = 8.56, p < .001, η 2 = .04). The significant Levene's indicated the use of Kruskal-Wallis test. Household food waste behaviour was significantly different for the three dietary preference groups, H (2) = 17.28, p < .001. The pairwise comparison shows that there is no significant difference in food waste behaviour between vegetarians and omnivores (p = .496) or vegetarians and vegans (p = .098). The means and standard deviations for each diet preference can be found in Table 6.

The results of independent between-groups ANOVA testing dietary preference on the conceptual model of the TPB can be found in Table 7.

DISCUSSION

The current study aimed to build on previous research to expand an understanding of food waste behaviour by utilising the TPB [28], The study's first hypothesis was supported, the TPB demonstrated ability to predict household food waste behaviour. The second hypothesis

Table 3: Results of the Multiple Linear Regression on Food Waste. Overall Model (n=363)

Variables	B	SE	Beta	t	p
Intention not to waste food	-.07	.06	-.05	-1.12	.262
Shopping routines	.12	.04	.13	3.01	.003
Leftovers reuse routines	-.10	.06	-.08	-1.66	.097
Planning routines	.15	.06	.14	2.70	.007
Household skills	-.21	.04	-.29	-4.76	.000
Attitudes towards food waste	.02	.04	.04	.65	.519
Moral Norms	-.02	.05	-.02	-.45	.656
Injunctive Norms	-.07	.05	-.07	-1.42	.158
Perceived behavioural control	-.89	.12	-.37	-7.60	.000

The results show that, shopping routines (β = .12 p < .001), planning routines (β = .15, p < 0.01), household skills (β = -.21, p < .001), and perceived behavioural control (β = -.89, p < .001) were significant predictors of food waste behaviour in the overall model.

Food waste was significantly predicted by intention (F[8,362] = 7.39, p < .001), with an R^2 of .42.

Table 4: Results of the Multiple Linear Regression on Intention. Overall Model (n=363)

Variables	β	SE	Beta	t	p
Attitudes towards food waste	0.81	.04	.14	2.28	.023
Moral Norms	.13	.04	.16	3.01	.003
Injunctive Norms	.15	.04	.20	3.76	.000
Perceived Behavioural Control	.39	.09	.22	4.30	.000

Food waste was significantly predicted by perceived behavioural control (F[1,362] = 63.35, p < .001), with an R^2 of .56.

Table 5: Means and Standard deviations for Pro-environmental Attitudes

	Omnivore (O)	Vegetarian (Vt)	Vegan (Vg)	Tukey outcome
Variable	Mean (SD)	Mean (SD)	Mean (SD)	O < Vt, Vg
Pro-Environmental Attitudes	98.72 (9.76)	104.61 (7.07)	105.46 (8.25)	Vt = Vg

Table 6: Means and Standard deviations for Food Waste

Variable	Omnivore (O) Mean (SD)	Vegetarian (Vt) Mean (SD)	Vegan (Vg) Mean (SD)	Tukey outcome
Food Waste	7.65 (2.38)	7.62 (2.81)	6.65 (1.88)	Vg < Vt, O Vt = O

There was a statistically significant difference between vegans and omnivores (p < .001) with vegans wasting significantly less food than omnivores.

Table 7: Independent between-groups ANOVA for each construct of the TPB

Variables	F	Sig
Intention not to waste food	9.84	.000
Shopping routines	.42	.661
Leftovers reuse routines	5.00	.029
Planning routines	1.14	.320
Household skills	2.52	.082
Attitudes towards food waste	10.86	.000
Moral Norms	9.54	.000
Perceived behavioural control	7.52	.001
Injunctive Norms	8.95	.000

that pro-environmental attitudes would significantly predict household food waste was supported. The third hypothesis that vegans would report higher on pro-environmental attitudes than vegetarians and omnivores was partially supported. The vegans/vegetarians differed significantly from omnivores but did not differ significantly from each other when it came to environmental concern. The fourth hypothesis was supported, vegans reported the least amount of food waste whilst omnivores reported the most food waste. These results confirm predictions that there is a significant relationship between pro-environmental attitudes, dietary preference, and food waste.

Food Waste Predictors

In accordance with previous research, this study found evidence to support the growing literature on the predictive utility of the TPB. Those who reported a higher intention to avoid wasting food also reported less food waste in their households. Intention to reduce household food waste was further predicted by attitudes, subjective norms, and perceived behavioural control. Attitudes and subjective norms were not direct significant predictors of food waste behaviour (when included with the extra determinants from Stancu et al. [7], questionnaire). This result was in contrast with previous research as Graham-Rowe et al. [16], Stefan et al. [21], and Visschers et al. [19], who found attitude to be one of (if not the strongest) predictors of intention. It was theorised that social norms may be a poor predictor of food waste behaviour; as household food waste typically has less visibility to other people when compared to other pro-environmental behaviours [29]. Perceived behavioural control had a significant effect on food waste both indirectly through intention and directly on the behaviour. This indicated that individuals who feel confident in their ability to reduce their household food waste, were more likely to intend to reduce their food waste. Similarly, to Bissing-Olson et al. [44], and Werf et al. [10], perceived behavioural control was the strongest predictor of intentions and self-reported household food waste behaviour.

Pro-environmental Attitudes on Predicting Food Wastage

The hypothesis that pro-environmental attitudes would predict food wastage was supported. Several studies have revealed that people with high levels of environmental attitudes tend to act more pro-environmentally [49-57], as was the case in the current study. Pro-environmental attitudes were a significant predictor of both intentions not to waste food and food waste behaviour.

Despite the significant correlation, pro-environmental attitudes and attitudes towards food waste were not the strongest predictors of intention or food waste behaviour when compared to other conceptual antecedents in the model (such as household & food provisioning skills and perceived behavioural control). The benefit of including the extra variables into the TPB [28] model, highlighted the role of habits and domestic skills as strong predictors of household food waste rather than attitudes. Stern et al. [58], found that conservation behaviour was likely to occur with less conscious control and more in a habitual fashion. This finding could be result of several psychological considerations such as personal values [59], and environmental involvement [60]; factors that were further explained by dietary preference.

Omnivores, Vegetarians, Vegans; Environmental Attitudes and Food Waste

A statistically significant difference in environmental attitudes were found between omnivores, vegetarians, and vegans. Reports that omnivores were less concerned regarding the environmental impacts of their food choices [22-33], appears to be related to their overall ecological concern. Furthermore, vegans reported significantly less food wastage than omnivores and vegetarians. There are several factors that could contribute to this significant relationship. Although attitudes were not a significant predictor of food waste within the overall model, when partitioned, vegans' pro-environmental attitudes towards food waste did significantly differ compared to omnivores. This weak association was previously highlighted by Watson & Meah [18], who found respondents did not link their food choices to ecological impacts [18]. Various studies have observed an underestimation of the ecological impact of eating meat which may imply a lack of knowledge about the (extra) environmental consequences of meat consumption [61-63]. Williams et al. [37], found that environmental education led to less food waste. It could be theorized that omnivores have less knowledge about the environmental impact of their choice of food and its related inherent waste. If a motivating factor to becoming vegan is environmental concern [31], then it can be stipulated that vegans may have a more thorough understanding of the consequences associated with food waste and would therefore have a significantly different (pro-environmental) attitude and waste profile to omnivores.

The literature further posits that negative attitudes towards food waste are more financial than environmental [6- 18. Povey et al. [64], indicates that for some there is a financial barrier when it comes to diet choice, with the

vegan diet being suggested as the most expensive of them all [38-64]. It is well known that plant-based alternatives may include a higher price tag. The high cost of meat substitutes, plant milks and other specialist products could potentially elicit a stronger (financial, as well as pro-environmental) motivation for a vegan (or vegetarians) to consume them rather than waste them. Indicating that omnivores are more prone to throw away food they perceive to be less valuable, when compared to vegans who are less inclined to do so, as they value their food more.

Consistent with a greater pro-environmental attitude, vegans reported significantly less food wastage than omnivores and vegetarians. Having an awareness of the ecological and economic consequences of food waste is strongly related to food-related routines [7]. Highlighted in the current study, household food related routines and skills, and perceived behavioural control were all significant predictors of food waste. Intentions, attitudes, moral norms, injunctive norms, perceived behavioural control and leftovers reuse routines were significantly different between omnivores and vegans. Many consumers have reported that a barrier to going vegan is convenience - due to difficult dish preparation and lack of eating out options [38]. Previous research has found that unexpected meals outside of the home and provisioning for fussy eaters to be determinants of food waste [17-37]. If vegans are the "fussy eaters" and have accumulated the knowledge and effort required to buy and prepare their meals, they could be expected to not waste something that has taken them more time to arrange. Furthermore, if they lack places to eat out, then they will have a better awareness of what is in their homes to be used for consumption.

The shelf-life of vegan products are typically lengthier than their animal product equivalents [65].This could indicate why vegans wasted less food and differed significantly from omnivores in relation to leftovers-reuse, as a question of hygiene needs to be taken into consideration. It can be stipulated that individuals would be wary of eating left-over animal derived products as the potential risk of food poisoning is higher [66].

Omnivores differed significantly to vegetarians and vegans on moral norms, however vegetarians and vegans did not significantly differ. Quested et al. [6], and Watson & Meah [18], found that morals and guilt were key subjective norms in the context of food waste. It could be posited that due to the level of morality a vegan or vegetarian hold over their food consumption this would translate into their thoughts on food wastage. If a vegan or vegetarian thinks it is not right to "waste a life" to eat food, perhaps it is just as plausible that they think it is morally reprehensible to waste any food. In a study by Gatersleben et al. [34], environmental values and identities were shown to be good predictors of pro-environmental behaviours. Although food waste was not included in this study, the significant difference between omnivores and vegans/vegetarians on injunctive norms could potentially be related to the latter maintaining a pro-environmental personal identity [34]. If vegans have formed a pro-environmental identity, they would be less likely to engage in behaviours that hurt the environment, which would explain the difference in norms and food waste behaviour between vegans and omnivores.

Practical Implications

There is an increasing need to decrease food waste due its environmental and social consequences. The use of a combined TPB in the present study provides useful information for designing campaigns aimed at reducing food waste at the household level. Stancu et al. [7], and Stefan et al. [21], both recommend campaigns target consumer food planning and shopping routines. The results of the current study also strongly support the approach to targeting households, specifically, their routines associated with shopping and leftover reuse.

Shopping skills, planning routines, household skills and perceived behavioural control were the strongest determinants of reported household food waste, a finding aligned with past literature [7]. Despite the significant association that intention had with food waste, its predictive magnitude of food waste behaviour was weaker when the other predictors were included - this is consistent with the findings of Stancu et al. [7], and Werf et al. [10]. This finding could be explained by the postulate that food waste is embedded in routines for food provisioning and not "driven by conscious intentions" [21]. Debatably, no one intends to deliberately waste food that at some point was available for consumption. In the context of this study and in relation to previous research, food management skills (such as shopping skills, planning routines, household skills) and perceived behavioural control would be better predictors of this behaviour and where initiatives to reduce waste should focus their attention.

In the last decade, numerous phone apps have been developed with the aim to reducing food waste. Utilising the power of technology, these apps are designed to tackle food waste from various strategies such as leftover education, managing food once it has been purchased, and preparing economical meals that are made up of items already located in an individual's fridge [67]. To make an impact, it is necessary to provide advice to improve people's knowledge about food waste and the skills to

improve their food routines for example, household economic campaigns. Perceived improvement in planning, leftover reuse and shopping skills will indirectly result in lower food waste. Improving individual's food literacy by providing them information would allow them to improve their household habits. Providing people with recipes for reuse or repurposing of leftovers would lead to less food being wasted. A way to strengthen these campaigns would be to integrate a change in consumer attitudes.

Limitations

Psychologists have mostly approached the investigation of food waste behaviour through applying the TPB [7-21]. Despite its strong empirical support in explaining environmentally relevant behaviours, the TPB receives criticism due to it underrepresentation of non-cognitive determinants of behaviour, specifically habits and emotions [29]. The TPB assumes that individuals make reasoned and rational choices, however, due to the limited public visibility of household food waste, social normative drivers of food waste are likely to be less important. Therefore, the TPB may not be sufficient to predict household food waste as it does not account processes including habits, routines, and emotions [29].

Future research

The "who and why" of food waste is a relatively new area of research. From an extensive literature review, this exploratory research is the first to determine if dietary preference was a determinant of food waste. Future research should qualitatively or quantitatively determine the specific differences between these three dietary groups. Considering antecedents of moral and injunctive norms would also provide further insight into what makes some people waste food and others not. As wasting food is primarily a socially undesirable habit not under volitional control, future research may aim to eliminate this factor by utilising cameras, waste caddies and scales to get a more quantifiable measure of what and how much food is being measured.

CONCLUSION

In summary, the current study explored dietary preference and pro-environmental attitudes on household food waste through the utilisation of the TPB model. Findings supported the utility of this model, however, some constructs of the TPB were not sufficient to explain food waste behaviour. The importance of including household skills and routines is highlighted in this study. The findings of this study also provide evidence that vegans differ from omnivores in their food waste behaviours, as vegans reported the least amount of food waste whilst omnivores reported the most food waste. Vegans reported higher on pro-environmental attitudes than vegetarians and omnivores. Vegans/vegetarians differed significantly from omnivores but did not differ significantly from each other when it came to environmental concern. This weak association provides limited evidence that these groups differ when larger scale environmental issues are discussed. Future research would benefit from investigating potential antecedents of household food waste behaviour.

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