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## Article Examining the Relationship between Consumers' Food-Related Actions, Wider Pro-Environmental Behaviours, and Food Waste Frequency: A Case Study of the More Conscious Consumer

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Abstract: The implications of food waste extend to the environment, society, and the economy. In the Global North, consumers' food waste contributes significantly to the current global levels, with action and practice largely driving this contribution. The resulting policies largely centre around raising awareness amongst consumers. However, awareness is not always found to lead to action, resulting in what is termed the 'value-action gap'. Thus, the focus of this study is on consumers who have demonstrated awareness and knowledge of food waste issues in their willingness to take part in a home food growing campaign. This sample allows us to examine how consumers can be moved beyond awareness and encouraged towards action. This study investigates the actions and practices of consumers that contribute to the likelihood of wasting food while also exploring the relationship between wider pro-environmental behaviour and food waste in the context of social practice theory. Quantitative analysis of survey data (n = 1106) shows that growing food and composting decrease the likelihood of wasting food, supporting a shift in mindset surrounding how food is viewed and reducing the disconnect between consumers and food that is prevalent in modern society. Overall engagement in wider pro-environmental behaviours was found to decrease an individual's likelihood of wasting food. A layered policy approach with a practices perspective is suggested, with recommendations proposed for interventions and initiatives at individual, community, and broader societal levels.

**Keywords:** consumer food waste; food-related actions; wider environmental behaviours; proenvironmental behaviours

#### 1. Introduction

Food waste, in the context of a growing global population and an already pressurised natural environment, is a multi-faceted issue, bringing with it environmental, economic, and societal implications. The magnitude of the problem at hand is contextualised by the estimation that 17% of all food produced may be wasted [1]. Food production is one of the biggest strains on our planet, producing significant levels of greenhouse gas emissions, polluting the air, soil, and waterways and contributing to land-use change, biodiversity loss, and species extinction [2–5]. While economic losses are faced through the inefficient use of resources, the societal and ethical implications of rising hunger levels are also evident. Estimates of global hunger levels report that between 720 and 811 million people faced hunger in 2020, an increase of 161 million since 2019 [6]. The paradox between malnutrition, global hunger, and food insecurity on the one hand and food waste levels on the other highlights the shortcomings of the current global food system and the need to re-evaluate the current norms.



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**Copyright:** © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/). The global food waste crisis and the associated implications has resulted in international policies aimed at reducing current levels. In 2015, the United Nations (UN) announced its Sustainable Development Goals (SDGs), of which SDG 12.3 aims to "halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses" by 2030 [7]. The European Commission (EC) in 2015 echoed this goal in its Circular Economy plan, setting the EUwide target to reduce food waste by 30% by 2025 and 50% by 2030 [8]. With such policies in place, there is a growing need to explore mechanisms to help reach these targets throughout the entire food supply chain.

This study focuses on consumer food waste. In the Global North, a large proportion of food waste occurs at the consumer level, with estimates that 61% of global food waste is derived from households [1]. In the EU, an estimated 53% of food waste is attributed to households per annum, with an associated cost of 98 billion Euros [9]. Central to the issue of consumer food waste is a complex array of actions and practices [5]. Understanding how such actions and practices factor into food waste is valuable in the development of our knowledge, creation of public campaigns and facilitation of policy development, compliance, and revision. With the issue of consumer food waste gaining momentum, there has been a rise in campaigns and initiatives to reduce levels. Much of these measures have centred around raising consumer awareness and education [10–12]. However, awareness does not always equate to action [13–15]. With awareness of the issue of food waste increasing, it is essential to consider how we move beyond awareness and towards action. The literature recognises this lack of follow through, describing it as an example of a 'valueaction gap' [14,16]. We take this gap as the starting point for our research. To examine this, we assess a cohort that has already demonstrated a level of awareness and knowledge through their willingness to participate in a food growing campaign.

In addition, food waste frequencies may be influenced by individuals' wider proenvironmental behaviour through an effect known as 'behavioural spillover'. We draw on social practice theory as a lens through which to explore this interaction, a viewpoint that has remained less explored in previous food waste literature and discussions of proenvironmental behaviour spillover [17,18]. This study aims to explore the influence of consumers' food-related actions on food waste frequencies while also analysing how wider pro-environmental behaviour factors into food waste frequencies. The research questions examined are:

- 1. What is the relationship between food-related actions and frequency of food waste?
- 2. What is the relationship between wider pro-environmental behaviour, food waste, and food-related actions?

#### 2. Background

With consumer food waste in sharp focus amongst policy makers, there has been a subsequent rise in research in the areas of food waste and its behavioural predictors. Emerging research explores socio-demographic influences on food waste [19–22], food-related actions that impact food waste levels [5,23] and quantitative estimates of food waste levels [2].

Academic analysis, however, has yet to come to a consensus on an appropriate definition of food waste. In the context of this study, the definition provided by the FAO ([24], pg. 9) is adopted: "food waste refers to food appropriate for human consumption being discarded, whether or not after it is kept beyond its expiry date or left to spoil". In this study, this term exclusively refers to consumer food waste that occurs within the home. Similarly, previously published literature uses a range of terms when discussing consumers' actions, behaviour, and habits surrounding food and food waste. In the context of this study, the term 'food-related action(s)' will be used, with examples of such actions detailed in Section 2.1.

#### 2.1. The Role of the Consumer in Reducing Food Waste

Consumer food waste is rooted in multiple, interlinking consumer actions, behaviour, and habits that ultimately impact the likelihood or amount of food waste being generated [5]. Understanding these factors and being able to influence action towards more sustainable choices is deemed a critical tactic in the efforts to reduce global food waste [5,25,26].

The key areas of food-related actions that have been heavily linked as predictors of food waste are planning and shopping [3,16,22,23]. Planning behaviour includes making lists, checking inventories, and planning meals. Literature suggests that individuals who make shopping lists are regularly found to be more likely to have reduced levels of food waste. For example, Jörissen et al. found that using a shopping list lowered the amount of food discarded per capita by 20–25% [23]. Both Jörissen et al. and Quested et al. showed that planning meals in advance significantly reduces levels of food waste [5,23].

Shopping refers to several actions in itself, including the location of shops and purchasing habits. The purchasing of promotional offers is a shopping behaviour which highlights a point of contention between studies [16,27]. While multiple studies show that the reduced purchasing of promotional offers, in turn, reduces food waste [3,28], some studies find the opposite effect [22,23]. Studies concluding the latter speculate that, when these promotional deals are availed of due to frugality or money shortages, a higher value is placed on the food, and therefore, less is wasted [22,23]. Similar conclusions have been drawn when discussing the impact of where food is purchased or sourced. When purchased from alternative food networks or home grown, food waste is less when compared to that bought exclusively in large supermarkets [17,23,29]. An explanation for this outcome is offered by Jörissen et al., who hypothesised that those who source their food from alternative food networks or grow their own place a higher value on food and are more aware of the complexities and challenges of food production [23]. The practice of home food growing is thought to encourage more involvement with food and, in turn, reduce the disconnect between consumers and food that is evident in modern society [30].

Composting is a food-related action that has not garnered as much academic exploration in terms of its impact on food waste. Composting has been linked to practices such as home food growing and gardening, with those who grow their own being more likely to compost [17,31]. Composting holds great potential as a policy tool to reduce consumer food waste as it can change how people view food waste, shifting it from that of waste to a resource [17,32].

Several demographic attributes have been found to impact food waste generation, although the strength and predictive power of these influences remains a relatively grey area [16]. While studies have shown a correlation between food waste and factors such as age, gender, household size, and educational level, the direction and strength of such relationships varies across studies [16,21]. Contradictory evidence as to the impact of age on food waste highlights the uncertainty of these impacts: older ages have frequently been associated with lower levels of food waste [21,33,34]. However, Jörissen et al., in a comparative quantitative case study of two locations, found that older consumers (>60 years old) wasted more than their younger counterparts [23]. Moreover, age, gender, and employment status, and household size show a 'modest' predictive power of food waste and food-related actions, having been found to account for only 7.3% of variance in a case study of Denmark [21]. Meanwhile, only age and employment status were found to be associated with food waste in a case study of Spain, explaining 8.1% of variances [21]. Across studies, household size has been found to be a key component of demographics that can be used to predict food waste, with larger households consistently found to waste more food [19,22,33].

#### 2.2. The Influence of Pro-Environmental Behaviour

Pro-environmental behaviour is classed by Kollmuss and Agyeman as behaviour that "consciously seek[s] to minimize the negative impact of one's actions on the natural and built world" ([35], p. 240). Research has shown that, through engaging with one

pro-environmental action, further environmentally friendly action can be promoted within a range of behavioural domains [36–38]. When an initial pro-environmental action is completed, it increases the likelihood of subsequent action being taken [39]. This effect, often referred to as 'behavioural spillover', is complex both in terms of understanding the underlying mechanisms which influence it, and in how it can be measured [37]. Research has examined this effect in several ways. Sintov et al., for example, studied the effect a specific action, namely composting, had on wider consumption behaviour [37]. Results found that those who began composting later displayed an increased occurrence of water and energy saving behaviour [37]. Nash et al. explored the role of previous environmental engagement in mediating the observed effects, finding that those who are more environmentally engaged are more likely to exhibit this effect [40]. In a study exploring the effect of educating users on either the monetary or climate savings of reduced electricity use, Steinhorst et al. found that environmental appeals were more successful in promoting increased intention for wider environmental behaviour [41].

Much of the literature on pro-environmental behaviour and spillover effects focuses on the psychosocial mechanisms that underpin this relationship, drawing on psychological theories such as cognitive dissonance theory [36,42-44], theory of planned behaviour [45], and self-perception theory [36,42–44]. Such theories focus on the individual, with beliefs, attitudes and values used as predictors of behaviour [46]. There is, however, an emerging alternative in exploring pro-environmental behaviour that places focus on the role of action and practice, discussed primarily through social practice theory [17,46]. Social practice theory places the practice and action themselves as the unit of analysis rather than the individuals who carry them out [17,46]. This theory emphasises that, through engaging with action and practice, individuals come to understand the world, and the act of 'doing' is conducive to behavioural change [46]. In using this theory to explore a spillover of pro-environmental behaviour, we look to the discussions of Nash et al. [18]. Nash et al. propose that individuals who engage in environmental practice and action carry specific competencies (skills, techniques), materials (technology, infrastructure) or meanings (understanding, ideas) across different practices, which may lend to this spillover of subsequent practice and action [18]. It is in the context of this theory that we explore the relationship between wider pro-environmental behaviour and food waste.

#### 3. Materials and Methods

#### 3.1. Research Context

The contextual setting of the study is the Republic of Ireland. In terms of food waste, the Environmental Protection Agency (EPA) of Ireland estimates that 1.2 million tonnes of food are wasted per year, 255,000 tonnes of which are from households, with the average Irish family wasting 150 kg of food each year, costing approximately 700 Euros [8,47]. The time period of March to July 2021, in which the data were collected, is of note in the context of this study. In March 2021, movement within Ireland remained heavily restricted, with a 5 km radius limit from homes in force due to the COVID pandemic. This backdrop may shape the findings of this study as the impact of COVID on food behaviour has become well documented within literature, influencing both planning and shopping behaviour [30,48]. This time period noted a trend in increased home food growing as people were openly seeking new hobbies and tasks [49,50]. The findings of this study may therefore exhibit a 'best case scenario' observed during this time.

#### 3.2. Sample Description and Survey Design

This study received approval from the relevant University ethics committee (Log 2021-056). The survey data were gathered from self-selecting participants in an educational and participatory campaign related to growing one's own food, conducted by not-forprofit social enterprise, GIY (Grow it Yourself). The aim of this public campaign, entitled 'Grow it Forward', was to provide participants with seeds and growing guides while also encouraging seed sharing to increase social connection. Participants were self-selecting both in terms of their decision to take part in the campaign and to complete the survey. Two surveys were distributed: an initial registration survey (T1) at the outset of the campaign in March 2021 and a follow-up survey (T2) at the end of the campaign in July 2021. As there was a short time period (3 months) between the two surveys, it was decided to amalgamate the data into one data set. The survey instrument from which the data is sourced is detailed in Section 3.3.

Survey data were collected via Qualtrics [51], with survey development being guided by previous studies [33,37,52–54]. The survey had three sections, the first of which sought to garner participants' demographic information. The second section related to participants' self-reported food waste frequencies over the past month, as well as a range of food-related actions known to impact levels of food waste amongst consumers. Lastly, individuals' wider pro-environmental behaviour was explored. The variables included are explained in further detail in Section 3.3.

#### 3.3. Variables

#### 3.3.1. Food Waste Frequency

Food waste frequency is the dependent variable for the analysis. This variable was created based on a survey question in T2 which asked how often an individual produced food waste in the past month. The available responses to this question were 'Never', 'Rarely', 'Sometimes', 'Often', or 'Most Mealtimes'. During analysis, these responses were collapsed into 'Never/Rarely', 'Sometimes', or 'Frequently' to create larger categories and strengthen the power of analysis.

#### 3.3.2. Wider Pro-Environmental Behaviour

The wider pro-environmental behaviour variable was created based on survey data (T2) asking a number of questions related to an individual's wider environmental behaviour. These included questions on whether an individual would turn lights off when they left a room, cycle or walk instead of drive, turn off the tap when brushing their teeth, unplug devices, take shorter showers, improve their recycling habits, bring reusable bags for shopping, and reduce reliance on single-use plastics.

We sought to use the above variables to derive an understanding of the general environmental behaviour of participants. To develop this variable, a polychoric principal components analysis (PCA) was used. This method captures the maximum variation between the variables in question. The variables were first standardised. The Pearson correlation coefficient between each of the variables was calculated and a covariance matrix was created which detailed the level of correlation between each variable in a matrix format. The eigenvalue of each eigenvector within the matrix was then calculated. The eigenvector with the largest eigenvalue was multiplied by the original standardised data to indicate the scores of the principal components. This yielded a single variable which captured the greatest possible variation within these highly correlated variables. This variable was labelled as 'Environmental Behaviour'.

In order to categorise this variable into three distinct categories, the data were examined at the tertile level which allowed individuals to be categorised based on their wider environmental behaviour. The PCA scores were then broken down into tertiles to make the variable structure comparable with other variables in the dataset. The resulting categories were 'good', 'neutral', and 'poor' environmental behaviour. Table A1 (see Appendix A) describes the results of the principal components analysis (PCA), which indicates the level of correlation of each of the variables with the first principal component derived from the analysis. The eigenvalue for the first eigenvector was 2.83. This suggests that the variance captured by the analysis would be the equivalent information of 2.83 variables from the original underlying data.

#### 3.3.3. Demographic Factors

We sought to address and consider the role of demographic factors to inform the analysis of the behavioural variables of interest. These wider covariates included gender, age, household size, type of residence (rural, urban, suburban), and level of education (up to secondary-level, post-secondary-level, and third-level qualification).

#### 3.3.4. Food-Related Action Variables

A range of food-related action variables were assessed. The variables are summarised by name, description, and scale in Table 1 below.

| Variable                                 | Source of Data | Description   | Scale   | Note   |
|--|----------------|---|---|--|
| Growing experience                       | Survey T1      | Level of experience growing food at the outset of the campaign  | 5-point Likert scale (No<br>experience—Extremely<br>experienced)                      | Collapsed into 3 categories * (a lot<br>of experience, a moderate amount<br>of experience or little or no<br>growing experience) |
| Stage of Growing Achieved                | Survey T2      | Stage of growing achieved with the seeds provided by the campaign   | 4-point Likert scale<br>('Sowed'—'Sowed, seedling,<br>harvest and eaten'              |  |
| Seasonality                              | Survey T1      | Consideration of the seasonality of<br>produce when purchasing fruit<br>and vegetables                        | 5-point Likert scale<br>(Never—Always)  | Collapsed into 3 categories *<br>(Never, rarely, sometimes)  |
| Composting                               | Survey T2      | Individuals were asked whether<br>they composted  | 3-point Likert scale (Yes, no, sometimes)   |  |
| Planning Shopping                        | Survey T2      | including making lists, taking<br>inventories or planning meals in<br>advance                                 | 5-point Likert scale (strongly disagree to strongly agree)                            | Collapsed into 3 categories *<br>(disagree, neutral, agree)  |
| Buying More with Offers                  | Survey T2      | Purchase more food than needed<br>when promotional offers such as<br>'Buy One Get One Free' were<br>available | 5-point Likert scale (strongly disagree to strongly agree)                            | Collapsed into 3 categories *<br>(disagree, neutral, agree)  |
| Diet                                     | Survey T1      | Individuals were asked to characterise their diet   | 7-point Likert scale (Eat<br>everything (red meat, poultry,<br>fish)—vegan and other) | Collapsed into 3 categories * (eat<br>everything, reduced meat intake,<br>vegan/vegetarian)                                      |
| Economic Worry of Food<br>Waste          | Survey T1      | Feel there was good economic<br>reasoning to reduce their food<br>waste                                       | 5-point Likert scale (strongly disagree to strongly agree)                            | Collapsed into 3 categories *<br>(disagree, neutral, agree)  |
| Environmental Awareness of<br>Food Waste | Survey T1      | Feel there was good<br>environmental reasoning to<br>reduce their food waste                                  | 5-point Likert scale (strongly disagree to strongly agree)                            | Collapsed into 3 categories *<br>(disagree, neutral, agree)  |
| Perceived Avoidability of<br>Food Waste  | Survey T1      | Consider food waste to be avoidable   | 5-point Likert scale (strongly disagree to strongly agree)                            | Collapsed into 3 categories *<br>(disagree, neutral, agree)  |
| Social Connection                        | Survey T2      | Feeling of social connection at the<br>time of the survey   | 5-point Likert scale (strongly<br>disagree to strongly agree)                         | Collapsed into 3 categories *<br>(disagree, neutral, agree)  |

Table 1. Breakdown of Food-related Action Variables.

\* These categories were collapsed down to 3 categories to provide larger categories and strengthen the power of the analysis.

#### 3.4. Model

To understand the effect of food-related actions on an individual's likelihood of wasting food, an ordered logistic regression was employed. This method determines the effect of these other factors on an individual's probability of reaching the next threshold level of food waste. This model was deemed suitable as it provides a method to estimate a model based on a categorical dependent variable with multiple ordered categories. The functional form of the model is described by the equation below.

$$\ln\left(\frac{p_n}{1-p_n}\right) = \beta_0 + \beta_D X_D + \beta_S X_S + \beta_G X_G + \beta_B X_B \tag{1}$$

$$\ln\left(\frac{p_{\rm m}}{1-p_{\rm n}-p_{\rm m}}\right) = \beta_0 + \beta_{\rm D}X_{\rm D} + \beta_{\rm S}X_{\rm S} + \beta_{\rm G}X_{\rm G} + \beta_{\rm B}X_{\rm B}$$
(2)

While Equation (1) derives the likelihood that an individual will enter the second category (wastes food sometimes), Equation (2) models the likelihood that an individual will be in the third category (wastes food frequently).

In Equation (1),  $p_n$  represents the probability of an individual reporting that they have 'some' food waste. Similarly,  $p_m$  in Equation (2) represents the probability of an individual reporting that they have 'a lot' of food waste. The equations determine the log of the odds of this occurring, which is a linear function of  $\beta_0$ , the intercept value. The independent variables  $X_D$  take account of variation in demographic variables,  $X_S$  which takes account of variation in the spillover activities,  $X_G$  which takes account of variation in the growth variable and  $X_B$  which takes account of variation in the behavioural variable. The effect associated with the variation in behavioural variables is determined by the estimated  $\beta_D$ which is the effect associated with the matrix of demographic variables described in this study. Similarly,  $\beta_S$  is the coefficient associated with spillover activities,  $\beta_G$  is the coefficient associated with growth and  $\beta_B$  the coefficient associated with behaviour. Based on these  $\beta_S$ , it is possible to calculate odds ratios that indicate the relative chance of an individual falling into a particular category given the value of a dependent variable. The base value of the odds ratio, which is 1, is assigned to the base category of each variable.

To provide further context to the effects associated with the different variables used in the equations, three distinct models were investigated. The first model analysed the effect of the spillover variable in the context of only demographic variables such as age and gender. The second model added the effects associated with participants engaging in growing their own food as this was a key area of interest within the survey. The third model included all the variables detailed in Tables 1 and 2 and was considered relevant by the research team.

|                             | Variable                      | Categories                                | Frequencies | Percentage (%) |
|-----------------------------|-------------------------------|---|-------------|----------------|
|                             |                               | Never/Rarely                              | 539         | 48.73%         |
| Food Waste                  | Food Waste Frequency          | Sometimes                                 | 422         | 38.16%         |
|                             | 1 2                           | Always                                    | 145         | 13.11%         |
|                             | Easting and a lal Rahamiana   | Tertile 1: Most environmentally friendly  | 372         | 33.63%         |
| Pro-Environmental Behaviour | Variables (PCA tartiles)      | Tertile 2: Neutral                        | 371         | 33.54%         |
|                             | variables (PCA tertiles)      | Tertile 3: Least environmentally friendly | 363         | 32.82%         |
|                             | Caradan                       | Female                                    | 933         | 84.36%         |
|                             | Gender                        | Male                                      | 173         | 15.64%         |
|                             |                               | 25-44                                     | 475         | 42.95%         |
|                             | Age Range                     | 45-64                                     | 544         | 49.19%         |
|                             |                               | 65+                                       | 87          | 7.87%          |
|                             |                               | 1   | 87          | 7.87%          |
|                             |                               | 2   | 299         | 27.03%         |
| Democratica                 | Household Composition         | 3   | 214         | 19.35%         |
| Demographics                | *                             | 4   | 283         | 25.59%         |
|                             |                               | More than 4                               | 223         | 20.16%         |
|                             | Residence Type                | Rural                                     | 512         | 46.29%         |
|                             |                               | Suburban                                  | 371         | 33.54%         |
|                             |                               | Urban                                     | 223         | 20.16%         |
|                             |                               | Up to Secondary Level                     | 112         | 10.13%         |
|                             | Education                     | Post-Secondary Level                      | 159         | 14.38%         |
|                             |                               | Third level qualification                 | 835         | 75.50%         |
|                             |                               | No experience                             | 152         | 13.74%         |
|                             | Growing Experience            | Moderate experience                       | 354         | 32.01%         |
|                             | 0                             | A lot of experience                       | 635         | 57.41%         |
|                             |                               | Sowed                                     | 31          | 2.80%          |
|                             | Character Consultant Ashiered | Sowed and seedling                        | 231         | 20.89%         |
|                             | Stage of Growing Achieved     | Sowed, seedling and harvested             | 138         | 12.48%         |
|                             |                               | Sowed, seedling, harvest and eaten        | 706         | 63.83%         |
| E 1 1 . 1                   | Considering Seasonality       | Never/Rarely                              | 239         | 21.61%         |
| Food-related Actions        | when Purchasing Fruit and     | Sometimes                                 | 475         | 42.95%         |
|                             | Vegetables                    | Often/ Regularly                          | 392         | 35.44%         |
|                             | 0                             | No  | 119         | 10.76%         |
|                             | Composting                    | Sometimes                                 | 72          | 6.51%          |
|                             | . 0                           | Yes                                       | 915         | 82.73%         |
|                             |                               | Disagree                                  | 37          | 3.35%          |
|                             | Economic Attitude Towards     | Neutral                                   | 182         | 16.46%         |
|                             | Food Waste                    | Agree                                     | 887         | 80.20%         |
|                             |                               | ÷   |             |                |

Table 2. Sample Summary Statistics.

|  | Variable                  | Categories               | Frequencies | Percentage (%) |
|--|---------------------------|--------------------------|-------------|----------------|
|  |                           | Disagree                 | 37          | 3.35%          |
|  | Environmental Attitude    | Neutral                  | 88          | 7.96%          |
|  | Iowards Food Waste        | Agree                    | 981         | 88.70%         |
|  | D 1 1 4 1 1 1 1 1 4 4     | Disagree                 | 149         | 13.47%         |
|  | Perceived Avoidability of | Neutral                  | 179         | 16.18%         |
|  | Food Waste                | Agree                    | 782         | 70.71%         |
|  |                           | Disagree                 | 116         | 10.49%         |
|  | Planning Shopping         | Neutral                  | 149         | 13.47%         |
|  |                           | Agree                    | 841         | 76.04%         |
|  | <b>D</b> 1 1 1 1          | Disagree                 | 406         | 36.71%         |
|  | Buying More with          | Neutral                  | 239         | 21.61%         |
|  | Promotional Offers        | Agree                    | 461         | 41.68%         |
|  |                           | Eat everything           | 801         | 72.42%         |
|  | D: /                      | Reduced meat consumption | 197         | 17.81%         |
|  | Diet                      | Vegan/Vegetarian         | 66          | 5.97%          |
|  |                           | Other                    | 42          | 3.80%          |
|  |                           | Disagree                 | 87          | 7.87%          |
|  | Social Connection         | Neutral                  | 274         | 24.77%         |
|  |                           | Agree                    | 745         | 67.36%         |
|  | Number of Observations    |                          | 1106        | 100.00         |

Table 2. Cont.

Based on the effect of these variables on the log of the odds of an individual reporting that they waste food, odds ratios are calculated. These indicate the likelihood of an individual reporting that they waste food relative to 1, where 1 is having no effect.

#### 4. Results

#### 4.1. Descriptive Statistics

Summary statistics for the sample are presented in Table 2.

#### 4.2. Robustness Checks

To assess the validity of our model, post-estimation checks were carried out (See Appendix C). To test for goodness of fit, the likelihood-ratio test (p > chi2 = 0.000) and the pseudo R<sup>2</sup> (0.162) were considered. These test statistics indicated that the model explained some of the variation in food waste frequency. Similarly, the Hosmer Lemeshow test and the Limitz test were used to assess goodness of fit (see Table A3). These tests failed to reject their null hypotheses which indicated that the model had an appropriate fit.

To determine whether the model violated the parallel lines assumption, a Brant test was carried out (see Table A4). It indicated that the model, as a whole, did not violate this assumption. However, it did indicate that a small minority of control variables (namely gender, social connection, and diet) violated the assumption. To account for these violations, a generalised ordered logistic regression model was implemented. The generalised ordered logistic regression model (see Appendix E, Table A8) indicated that these had no effects on the significance of these, or other variables. Given this result, it was not felt necessary to relax the parallel lines assumption for this analysis. Finally, a logistic regression was performed, the results of which are in line with the model used (see Appendix F, Table A9).

#### 4.3. Food-Related Actions

The role of food-related actions in an individual's likelihood of wasting food was examined, and results displayed in Table 3, with key variables further illustrated in Figure 1. Our analysis concluded that those who had little to no growing experience were found to be significantly more likely to waste food more regularly than those who had a lot of growing experience (Odds Ratio (OR) 1.54) (Table 3). In a similar vein, those who did not engage in composting were 1.592 times as likely to waste food more regularly than those who did. Those who perceived food waste to be avoidable were 0.301 times less likely to waste food and those who agreed that they planned their shop in advance were 0.322 times less likely to waste food (Table 3). However, those who bought more when items were on offer were 1.60 times as likely to waste food more regularly. In examining the role of demographic characteristics on the likelihood of individuals wasting food, we found

individuals aged between 45 and 64 to be 0.62 times less likely to waste food more regularly than those aged 25 to 44 (Table 3). Meanwhile, those in larger households were significantly more likely to waste food more frequently. Those in a household of a greater size than 4 were 2.93 times as likely to report wasting food more regularly than those residing in a household alone (Table 3).

 Table 3. Results of ordered logistic regression on how often an individual wastes food in a month.

| Food Waste Frequency (PCA Analysis)                   | Reference Category                                  | Basic                | Growth               | Full Model           |
|---|---|----------------------|----------------------|----------------------|
| Model   |   | 1                    | 2                    | 3                    |
| Tertiles: Neutral PCA.                                | Tertiles: Poor PCA.                                 | 0.652 **<br>(0.094)  | 0.667 **<br>(0.097)  | 0.844<br>(0.132)     |
| Tertiles: Good PCA.                                   | Tertiles: Poor PCA.                                 | 0.321 ***<br>(0.049) | 0.34 ***<br>(0.053)  | 0.419 ***<br>(0.071) |
| Age: 45–64  | Age: 25–44  | 0.515 ***<br>(0.065) | 0.54 ***<br>(0.069)  | 0.62 ***<br>(0.085)  |
| Age: 65+  | Age: 25–44  | 0.43 **<br>(0.116)   | 0.481 **<br>(0.132)  | 0.866<br>(0.159)     |
| Male  | Female  | 0.775<br>(0.134)     | 0.836<br>(0.147)     | 0.662<br>(0.189)     |
| Household: 2 people                                   | Household: 1 person                                 | 1.04<br>(0.269)      | 1.035<br>(0.269)     | 1.136<br>(0.308)     |
| Household: 3 people                                   | Household: 1 person                                 | 2.139 **<br>(0.564)  | 2.122 **<br>(0.562)  | 2.261 **<br>(0.628)  |
| Household: 4 people                                   | Household: 1 person                                 | 2.778 ***<br>(0.713) | 2.75 ***<br>(0.709)  | 2.674 ***<br>(0.721) |
| Household: More than 4                                | Household: 1 person                                 | 2.942 ***<br>(0.780) | 2.946 ***<br>(0.784) | 2.934 ***<br>(0.820) |
| Residence: Suburban                                   | Residence: Rural                                    | 1.596 ***<br>(0.219) | 1.529 **<br>(0.212)  | 1.638 ***<br>(0.240) |
| Residence: Urban                                      | Residence: Rural                                    | 1.288<br>(0.209)     | 1.223<br>(0.200)     | 1.31<br>(0.224)      |
| Education: Post-Secondary                             | Education: Up to Secondary Level                    | 1.301<br>(0.329)     | 1.317<br>(0.334)     | 1.361<br>(0.367)     |
| Education: 3rd level degree                           | Education: Up to Secondary Level                    | 1.358<br>(0.283)     | 1.361<br>(0.285)     | 1.518<br>(0.336)     |
| Growing Experience: A moderate amount                 | Growing Experience: A great deal/A lot              |                      | 1.289<br>(0.273)     | 1.269<br>(0.281)     |
| Growing Experience: A little/none                     | Growing Experience: A great deal/A lot              |                      | 1.721 **<br>(0.348)  | 1.54 *<br>(0.329)    |
| Stage of Growing: sowed and seedling                  | Stage of Growing: sowed                             |                      | 0.965<br>(0.372)     | 0.867<br>(0.353)     |
| Stage of Growing: sowed, seedling and<br>harvest      | Stage of Growing: sowed                             |                      | 0.815<br>(0.327)     | 0.871<br>(0.368)     |
| Stage of Growing: sowed, seedling, harvest<br>and ate | Stage of Growing: sowed                             |                      | 0.866<br>(0.322)     | 0.906<br>(0.355)     |
| Seasonality: Rarely                                   | Seasonality: Never/Rarely                           |                      |                      | 0.935<br>(0.155)     |
| Seasonality: Often/Regularly                          | Seasonality: Never/Rarely                           |                      |                      | 1.129<br>(0.206)     |
| Composting: No  | Composting: Yes                                     |                      |                      | 1.592 *<br>(0.329)   |
| Composting: Sometimes                                 | Composting: Yes                                     |                      |                      | 1.682 *<br>(0.419)   |
| Economic attitude: Neutral                            | Economic attitude: Strongly<br>disagree/Disagree    |                      |                      | 1.482<br>(0.569)     |
| Economic attitude: Agree/Strongly agree               | Economic attitude: Strongly<br>disagree/Disagree    |                      |                      | 1.449<br>(0.531)     |
| Environment attitude: Neutral                         | Environment attitude: Strongly<br>disagree/disagree |                      |                      | 1.744<br>(0.724)     |
| Environment attitude: Agree/Strongly<br>Agree         | Environment attitude: Strongly<br>disagree/disagree |                      |                      | 1.515<br>(0.560)     |
| Avoidable attitude: Neutral                           | Avoidable attitude: Strongly<br>disagree/disagree   |                      |                      | 1.051<br>(0.233)     |

| Food Waste Frequency (PCA Analysis)                             | Reference Category  | Basic    | Growth  | Full Model           |
|---|---|----------|---------|----------------------|
| Model   |   | 1        | 2       | 3                    |
| Avoidable attitude: Agree/Strongly Agree                        | Avoidable attitude: Strongly<br>disagree/disagree                       |          |         | 0.301 ***<br>(0.057) |
| Plan shop: Neutral  | Plan shop: Strongly disagree/Disagree                                   |          |         | 0.62<br>(0.154)      |
| Plan shop: Agree/Strongly Agree                                 | Plan shop: Strongly disagree/Disagree                                   |          |         | 0.322 ***<br>(0.067) |
| Buy more when offers: Neutral                                   | Buy more when offers: Strongly<br>Disagree/Disagree                     |          |         | 1<br>(0.176)         |
| Buy more when offers: Agree/Strongly agree                      | Buy more when offers: Strongly<br>Disagree/Disagree                     |          |         | 1.600 **<br>(0.238)  |
| Feeling of social connection increased:<br>Neutral              | Feeling of social connection increased:<br>Strongly disagree / Disagree |          |         | 0.68<br>(0.157)      |
| Feeling of social connection increased:<br>Agree/Strongly Agree | Feeling of social connection increased:<br>Strongly disagree / Disagree |          |         | 0.633 * (0.146)      |
| Social Connection: Fair   | Social Connection: Very poor/Poor                                       |          |         | 1.282<br>(0.342)     |
| Social Connection: Good/Excellent                               | Social Connection: Very poor/Poor                                       |          |         | 1.121 (0.276)        |
| Diet: Limited meat  | Diet: Eat most meat   |          |         | 0.722 (0.126)        |
| Diet: Vegan/Vegetarian  | Diet: Eat most meat   |          |         | 0.737                |
| Diet: Other   | Diet: Eat most meat   |          |         | 0.98<br>(0.337)      |
| Ν   |   | 1106     | 1106    | 1106                 |
| Log likelihood  |   | -1000.84 | -995.44 | -913.24              |

p < 0.05 \*, p < 0.01 \*\*, p < 0.001 \*\*\*, Standard errors in parentheses. Analysis carried out using Stata v16.1. Model 1, referred to as the 'Basic Model', includes PCA tertiles and demographic variables (including age, gender, household size, residential area, and education). Model 2, referred to as the 'Growth Model', includes variables from Model 1 as well as the growth variables: growing experience and stage of growing achieved within the campaign. Model 3, referred to as the 'Full Model', includes variables from Models 1 and 2 as well as the remaining food-related action variables: considering seasonality, composting, economic attitude, environmental attitude, avoidable attitude, planning shopping, buying more with promotional offers, diet, and social connection. All variables listed are outlined in further detail in Section 3.



# **Figure 1.** Diagram of regression results for key variables, illustrating odds ratios (bars) and confidence intervals (whiskers).

#### Table 3. Cont.

The marginal effects of these variables of interest are displayed in Tables 4–6. Tables that display the marginal effects of all variables on the likelihood of being in any category of food waste frequency can be found in Appendix D (Tables A5–A7).

**Table 4.** Marginal effects associated with variables of interest for the 'Never/ Rarely' category of food waste.

| Food Waste Frequency                                  | Reference Category  | Marginal Effects of Full Model |  |  |  |  |
|---|---|--------------------------------|--|--|--|--|
| Marginal Effect on Likelihood of Being in the 'Never/ | Marginal Effect on Likelihood of Being in the 'Never/Rarely' Category |                                |  |  |  |  |
| Tertiles: Neutral PCA.                                | Tertiles: Poor PCA.   | 0.033<br>(0.030)               |  |  |  |  |
| Tertiles: Good PCA.                                   | Tertiles: Poor PCA.   | 0.169 ***<br>(0.033)           |  |  |  |  |
| Growing Experience: A moderate amount                 | Growing Experience: A great deal/A lot                                | -0.046<br>(0.042)              |  |  |  |  |
| Growing Experience: A little/none                     | Growing Experience: A great deal/A lot                                | -0.083 *<br>(0.041)            |  |  |  |  |
| Stage of Growing: sowed and seedling                  | Stage of Growing: sowed   | 0.027<br>(0.077)               |  |  |  |  |
| Stage of Growing: sowed, seedling and harvest         | Stage of Growing: sowed   | 0.026<br>(0.080)               |  |  |  |  |
| Stage of Growing: sowed, seedling, harvest and ate    | Stage of Growing: sowed   | 0.019<br>(0.075)               |  |  |  |  |
| Economic attitude: Neutral                            | Economic attitude: Strongly disagree/Disagree                         | -0.074<br>(0.072)              |  |  |  |  |
| Economic attitude: Agree/Strongly agree               | Economic attitude: Strongly disagree/Disagree                         | -0.074<br>(0.072)              |  |  |  |  |
| Environment attitude: Neutral                         | Environment attitude: Strongly disagree/disagree                      | -0.07<br>(0.069)               |  |  |  |  |
| Environment attitude: Agree/Strongly Agree            | Environment attitude: Strongly disagree/disagree                      | -0.079<br>(0.069)              |  |  |  |  |
| Avoidable attitude: Neutral                           | Avoidable attitude: Strongly disagree/disagree                        | -0.009<br>(0.040)              |  |  |  |  |
| Avoidable attitude: Agree/Strongly Agree              | Avoidable attitude: Strongly disagree/disagree                        | 0.239 ***<br>(0.036)           |  |  |  |  |
| Plan shop: Neutral                                    | Plan shop: Strongly disagree/Disagree                                 | 0.088<br>(0.045)               |  |  |  |  |
| Plan shop: Agree/Strongly Agree                       | Plan shop: Strongly disagree/Disagree                                 | 0.217 ***<br>(0.037)           |  |  |  |  |
| N   |   | 1106                           |  |  |  |  |

p < 0.05 \*, p < 0.001 \*\*\*, Standard errors in parentheses. Analysis carried out using Stata v16.1. This analysis includes variables from the Full Model, as detailed in Table 3. Variables included are: PCA tertiles, demographic variables (age, gender, household size, residential area, and education), growth variables (growing experience and growing stage achieved within the campaign), and food-related actions (considering seasonality, composting, economic attitude, environmental attitude, avoidable attitude, planning shopping, buying more with promotional offers, diet and social connection). All variables are outlined in further detail in Section 3.

**Table 5.** Marginal effects associated with variables of interest for the 'Sometimes' category of food waste.

| Food Waste Frequency                                   | Reference Category   | Marginal Effects of Full Model |  |  |  |
|--|--|--------------------------------|--|--|--|
| Marginal Effect on Likelihood of Being in the 'Sometim | Marginal Effect on Likelihood of Being in the 'Sometimes' Category |                                |  |  |  |
| Tertiles: Neutral PCA.                                 | Tertiles: Poor PCA.  | -0.015<br>(0.014)              |  |  |  |
| Tertiles: Good PCA.                                    | Tertiles: Poor PCA.  | 0.169 ***<br>(0.033)           |  |  |  |
| Growing Experience: A moderate amount                  | Growing Experience: A great deal/A lot                             | 0.026<br>(0.025)               |  |  |  |
| Growing Experience: A little/none                      | Growing Experience: A great deal/A lot                             | 0.045<br>(0.024)               |  |  |  |
| Stage of Growing: sowed and seedling                   | Stage of Growing: sowed  | -0.013<br>(0.037)              |  |  |  |
| Stage of Growing: sowed, seedling and harvest          | Stage of Growing: sowed  | -0.013<br>(0.038)              |  |  |  |
| Stage of Growing: sowed, seedling, harvest and ate     | Stage of Growing: sowed  | -0.009<br>(0.035)              |  |  |  |

| Food Waste Frequency                       | Reference Category                               | Marginal Effects of Full Model |
|--|--|--------------------------------|
| Economic attitude: Neutral                 | Economic attitude: Strongly disagree/Disagree    | 0.04<br>(0.041)                |
| Economic attitude: Agree/Strongly agree    | Economic attitude: Strongly disagree/Disagree    | 0.038<br>(0.040)               |
| Environment attitude: Neutral              | Environment attitude: Strongly disagree/disagree | 0.056<br>(0.044)               |
| Environment attitude: Agree/Strongly Agree | Environment attitude: Strongly disagree/disagree | 0.043<br>(0.041)               |
| Avoidable attitude: Neutral                | Avoidable attitude: Strongly disagree/disagree   | 0.002<br>(0.008)               |
| Avoidable attitude: Agree/Strongly Agree   | Avoidable attitude: Strongly disagree/disagree   | -0.111 ***<br>(0.015)          |
| Plan shop: Neutral                         | Plan shop: Strongly disagree/Disagree            | -0.024<br>(0.013)              |
| Plan shop: Agree/Strongly Agree            | Plan shop: Strongly disagree/Disagree            | (0.012)                        |
| N  |  | 1106                           |

p < 0.001 \*\*\*, Standard errors in parentheses. Analysis carried out using Stata v16.1. This analysis includes variables from the Full Model, as detailed in Table 3. Variables included are: PCA tertiles, demographic variables (age, gender, household size, residential area, and education), growth variables (growing experience and growing stage achieved within the campaign), and food-related actions (considering seasonality, composting, economic attitude, environmental attitude, avoidable attitude, planning shopping, buying more with promotional offers, diet and social connection). All variables are outlined in further detail in Section 3.

**Table 6.** Marginal effects associated with variables of interest for the 'Frequent' category of food waste.

| Food Waste Frequency                                   | Reference Category  | Marginal Effects of Full Model |  |  |  |  |
|--|---|--------------------------------|--|--|--|--|
| Marginal Effect on Likelihood of Being in the 'Frequer | Marginal Effect on Likelihood of Being in the 'Frequent' Category |                                |  |  |  |  |
| Tertiles: Neutral PCA.                                 | Tertiles: Poor PCA.   | -0.018                         |  |  |  |  |
| Tertiles: Good PCA.                                    | Tertiles: Poor PCA.   | -0.077 ***<br>(0.015)          |  |  |  |  |
| Growing Experience: A moderate amount                  | Growing Experience: A great deal/A lot                            | 0.02                           |  |  |  |  |
| Growing Experience: A little/none                      | Growing Experience: A great deal/A lot                            | 0.039<br>(0.018)               |  |  |  |  |
| Stage of Growing: sowed and seedling                   | Stage of Growing: sowed   | -0.014                         |  |  |  |  |
| Stage of Growing: sowed, seedling and harvest          | Stage of Growing: sowed   | (0.041)<br>-0.013<br>(0.042)   |  |  |  |  |
| Stage of Growing: sowed, seedling, harvest and ate     | Stage of Growing: sowed   | -0.01<br>(0.039)               |  |  |  |  |
| Economic attitude: Neutral                             | Economic attitude: Strongly disagree/Disagree                     | 0.034 (0.031)                  |  |  |  |  |
| Economic attitude: Agree/Strongly agree                | Economic attitude: Strongly disagree/Disagree                     | 0.032<br>(0.029)               |  |  |  |  |
| Environment attitude: Neutral                          | Environment attitude: Strongly disagree/disagree                  | 0.049<br>(0.034)               |  |  |  |  |
| Environment attitude: Agree/Strongly Agree             | Environment attitude: Strongly disagree/disagree                  | 0.035<br>(0.028)               |  |  |  |  |
| Avoidable attitude: Neutral                            | Avoidable attitude: Strongly disagree/disagree                    | 0.007<br>(0.032)               |  |  |  |  |
| Avoidable attitude: Agree/Strongly Agree               | Avoidable attitude: Strongly disagree/disagree                    | -0.128 ***<br>(0.025)          |  |  |  |  |
| Plan shop: Neutral                                     | Plan shop: Strongly disagree/Disagree                             | -0.064<br>(0.034)              |  |  |  |  |
| Plan shop: Agree/Strongly Agree                        | Plan shop: Strongly disagree/Disagree                             | -0.13 ***<br>(0.029)           |  |  |  |  |
| N  |   | 1106                           |  |  |  |  |

p < 0.001 \*\*\*, Standard errors in parentheses. Analysis carried out using Stata v16.1. This analysis includes variables from the Full Model, as detailed in Table 3. Variables included are: PCA tertiles, demographic variables (age, gender, household size, residential area, and education), growth variables (growing experience and growing stage achieved within the campaign), and food-related actions (considering seasonality, composting, economic attitude, environmental attitude, avoidable attitude, planning shopping, buying more with promotional offers, diet and social connection). All variables are outlined in further detail in Section 3.

#### 4.4. Wider Pro-Environmental Behaviour

Wider pro-environmental behaviour and how it relates to food waste frequency was explored. As illustrated in Table 3, overall, those who display good environmental behaviour are less likely to frequently waste food. Those in the highest tertile of good environmental behaviour are 0.419 times as likely to waste food more frequently.

The role that food-related actions play in determining wider pro-environmental behaviour and overall environmental friendliness was explored, with results displayed in Table A2 (See Appendix B). The results showed that those who regularly shopped with seasonality of produce in mind and those who planned their shopping were twice as likely to exhibit environmentally friendly behaviour than those who do not (OR 2.651 and 1.956 respectively). Additionally, Table A2 identifies demographic factors that were found to be important in understanding whether an individual was likely to display good wider environmental behaviour. Age was shown to be significant in determining an individual's wider pro-environmental behaviour. Those aged 65 and over were 0.53 times as likely to be in a more environmentally friendly tertile compared to those aged 25–44. This suggests that younger people are more likely to act in an environmentally friendly fashion.

#### 5. Discussion

The aim of this study was to examine the food-related actions that contribute to food waste amongst participating consumers, as well as explore the correlation between food-related actions and wider pro-environmental behaviour. Our findings demonstrate that, even amongst a cohort that the authors assume to be more environmentally aware and engaged based on their willingness to participate, underlying issues regarding food-related actions emerge. It is within this context that we examine and discuss our findings.

#### 5.1. The Sample

Summary statistics of the sample, as detailed in Table 2, show findings of note. It is seen that almost half (48.73%) of the sample reported that they never or rarely waste food, while 'sometimes' and 'always' account for 38.16% and 13.11% of responses, respectively. However, it is important to note that self-reported food waste is commonly found to be underestimated by consumers [55].

It is seen that the sample largely comprises females (84.36%) compared to males (15.64%). As participants were self-selecting, we propose two explanations for this. First, we look to the highly cited work of Smith, who found a significant gender bias towards females in online survey response behaviour [56]. Smith uses social exchange theory to explain this finding, stating that the imbalance shows differences in the way genders make decisions and value actions online [56]. Second, we point to the gender dynamics surrounding food-related actions. The practice and action surrounding food and food waste are largely carried out by women, giving weight to the reasonable assumption that women may be more aware of and interested in the subject matter of the survey [57,58].

Lastly, the sample is also seen to largely comprise individuals with third level qualifications (75.50%). While this is likely a result of the self-selecting nature of survey participation, some studies suggest that higher educational levels are associated with increased environmental concern [59] and increased concern for food waste [60] and thus, may be more interested in the subject matter of the survey.

#### 5.2. Factors Associated with Food Waste

Food-related action was found to be associated with food waste frequency. A key finding is the impact of growing experience on food waste: those who had little or no experience growing their own food were significantly more likely to waste food than those with higher levels of experience. These findings echo those of Ganglbauer et al. and Keegan and Breadsell [14,17]. The time and energy dedicated to growing food is thought to promote a deeper appreciation as growing one's own food requires a physical engagement with food production not present on supermarket shelves [14,17]. In a similar vein, those

who do not compost were found to be more likely to waste food more frequently than those who do. Composting prompts reflection on the circularity of the food system [14], with the action of composting changing the nature of food waste to that of a useful and valuable resource [17].

Those who planned their shopping were less likely to waste food than those who did not. Our findings also suggest that individuals who purchase more items due to promotional offers (e.g., 'Buy One Get One Free') are more likely to waste food than those who do not. As found by Mondéjar-Jiménez et al., promotional offers promote surplus purchasing, directly impacting food waste levels [28]. It can be argued, however, that the impact of promotional offers on food waste may vary amongst individuals depending on their socio-economic circumstances, although such relationships were not explored within this study.

While economic awareness and environmental concerns for food waste held no predictive power over the frequency of food waste, perceiving food waste to be avoidable was found to be associated with a decreased likelihood of wasting food. This result points to several possible conclusions. It suggests that these individuals may possess skills that make reducing food waste easier, such as cooking with leftovers [61]. This result suggests that actions perceived as easy are more likely to be implemented and sustained by individuals. This, in turn, opens an opportunity to encourage further environmental action, as action considered by the consumer to be 'easy' increases the likelihood of further environmental action [62].

Lastly, the analysis shows that certain demographic attributes were found to be useful predictors of food waste. Individuals in the age range 45–64 were less likely to waste food than those aged 25–44, similar to the findings of Jörissen et al. [23]. Studies have come to differing conclusions regarding the impact of age, with many finding that those aged 65 and older are less likely to waste food [5,27,34]. This is theorised to be connected to a post-Second World War upbringing in which food security was uncertain, rationing was the norm [5,27], and skills to utilise leftovers were more developed [34]. This study found that household size significantly increases the likelihood of food waste, with households of more than four people being more likely to waste food. These findings support those of numerous previous studies [19,22,33]. Individuals living in suburban areas were found to be less likely to waste food, although this significance is moderate, and a limitation is highlighted in the complications which arise in interpreting this result. Specifically, individuals may have differing opinions on how to define a 'suburban' area, and no definition was provided within the survey.

#### 5.3. Wider Pro-Environmental Behaviour

Engaging in wider pro-environmental behaviour was found to decrease an individual's likelihood of wasting food. Those in the highest tertile of environmental behaviour are less likely to waste food than those in the lower two tertiles. However, this study reveals an apparent gap in environmental action amongst consumers with the nuances observed within this result. The results suggest that being vigilant in one area of pro-environmental behaviour does not consistently equate to being vigilant in others. This was particularly apparent when considering home food growing and composting. We identified both home food growing and composting as important actions in reducing food waste, however they were not found to translate into whether or not an individual is likely to act in a positive pro-environmental manner in a wider sense. This raises a number of questions including, what drives and motivates action and what motivates a choice to act in one area of environmental protection and not another?

We postulate that several factors contribute to answering this question. First, a noted complexity within food-related action that may contribute, is the temporal disconnect between the action and the result. As stated by Quested et al., by the time food waste has been generated, the opportunity to take action to prevent or reduce food waste is hours, if not days, in the past [5]. This leads to a conceptual disconnect between the action

relevant to food waste and the outcome [5]. Amongst both food-related actions and wider environmental behaviour, a range of factors can help in explaining this gap. Availability and access to appropriate resources that can promote and foster environmental action are one such factor, including for example, required infrastructure (e.g., available recycling services, access to public transport) [35]. Personal circumstances, such as available financial resources, are another, having been identified as a barrier to environmental action, with greener purchasing options often being less affordable [63]. Finally, education is found to play a large part in explaining the gap, often in terms of individuals lacking 'procedural knowledge' which includes practical education about how individual action can be taken, such as how to efficiently plan shopping trips or how to begin composting [63].

In a broader sense, food-related action found to be important in understanding whether an individual was likely to show positive wider pro-environmental behaviour wase identified within our analysis. Planning food shops was found to be linked to wider pro-environmental behaviour, with those who planned their shopping twice as likely to display good environmental behaviour. While growing and composting are found to be important indicators of an individual's likelihood to waste food, they are not found to be associated with good wider pro-environmental behaviour. However, considering seasonality when purchasing fruit and vegetables is. Those who consider the seasonality of the produce they are purchasing are found to be twice as likely to display good environmental behaviour.

The analysis concluded that age was an important factor in understanding whether an individual showed positive wider pro-environmental behaviour. Results suggest that individuals aged 65 years and over are less likely to be in a more environmentally friendly tertile. Such a finding provides an interesting point of discussion in terms of the relationship between age and wider pro-environmental behaviour and attitude and is not unlike that of other studies. In a meta-analysis review, Wiernik et al. found environmental attitude to be negatively related to age, suggesting that, on average, younger people have a somewhat more positive environmental attitude [64]. Similarly, Lorenzini et al. found younger generations to be, on average, more likely to be favourable to the environment than older generations [65].

#### 5.4. Policy Implications

Ireland's current food waste policy is largely dictated by wider EU policies. 'Ireland's National Food Waste Prevention Roadmap', developed as part of Ireland's National Waste Policy 2020–2025, sets out a plan for the reduction of national food waste levels [66]. The authors argue that there is limited attention attributed to consumers' household food waste, given the known national statistics [47]. Moreover, the main focus of consumer food waste prevention is awareness and education, delivered primarily through the 'Stop Food Waste' initiative managed by the EPA. Given our findings (Figure 2), we conclude there is a justifiable need for the integration of a more layered policy approach to appropriately address and mobilise consumers with varying levels of awareness and engagement. This study has examined a cohort of consumers that the authors can reasonably assume to be environmentally aware and engaged, based on their willingness to participate in a food growing campaign. Our novel contributions show that, even amongst this group, there are still underlying issues regarding food-related action. For a cohort that is already demonstrating awareness and engagement, but which lacks in action, we propose ingraining a practices perspective into policy, focusing on practices and actions to positively influence changes in mindsets.



Figure 2. Summary of Key Findings and Resultant Policy Implications.

In designing such a policy approach, we set out the following recommendations: At an individual level, home food growing and composting were found to be associated with lower levels of food waste and are therefore suggested as areas of focus of future policies and initiatives. While home food growing offers a leverage point for a behavioural shift in consumers, composting presents an area of opportunity to educate individuals on the circularity of the food system. There is scope for further initiatives at a community level and within local contexts, such as establishing allotments in suburban and urban areas to include those of varying socio-economic circumstances and who may have limited access to growing space. These findings, and proposed areas of focus for policy, support a movement from a disconnected system to an interconnected one. At present, there is an emphasis on a fragmented view of food waste, with focus placed on isolated tasks rather than 'whole system thinking' [67]. In promoting and encouraging home food growing and composting, there is opportunity for a shift, not just in behaviour but also in mindset, through an increased appreciation of the interconnected nature of the food system.

On a broader level, our findings show support for educational interventions focusing on the procedural knowledge around food-related action and practice. Increasing consumers' skills and proficiencies to avoid food waste, as well as their knowledge on the ease with which they can avoid food waste, may be beneficial to national food waste levels. As larger households were found to be associated with higher levels of food waste, our findings also indicate that specific and targeted education and support for such households are needed. Older participants were found to have lower levels of food waste, and thus, a future campaign area could encourage intergenerational knowledge sharing within families and communities. As the above initiatives are in danger of only reaching those who are already environmentally inclined, wider scale public communication campaigns should also be considered. Information on the nature and volume of food waste, including the economic cost and environmental impact, should be shared on a national scale on the radio, on television, and in schools and supermarkets.

#### 5.5. Limitations

This research has some limitations. Participants were self-selecting, both in terms of their willingness to take part in the campaign and their involvement in the survey. This willingness is taken to demonstrate a level of knowledge and awareness surrounding the issue of food waste, making our sample a case study of the more conscious consumer. Additionally, we note the temporal context of COVID which aided in facilitating access to this consumer cohort as it led to a noted increase in consumers growing their own food [49,50]. The findings may therefore present a best-case scenario in terms of food waste behaviour. Methodological limitations include the use of self-reported food waste frequencies (commonly found to be underestimated [55], and the exclusion of certain variables (such as income levels and employment status). Finally, analysis suggested that a lack of an accompanying definition regarding the word 'suburban' may have created uncertainty among respondents which complicated our interpretation of findings regarding this variable.

#### 5.6. Future Research

While this study has noted limitations, it also provides scope for future research. As this research relied on self-reported food waste frequencies, an opportunity for future research lies in replicating the study with an additional measure for food waste frequency to limit possible under-estimations. Further, the inclusion of additional demographic variables such as household income and employment status may provide additional insights into this cohort in terms of their food-related actions and their wider environmental behaviour. Further opportunity lies in broadening the range of food-related practices that are included in analysis, for example, a more in-depth analysis of shopping habits. Lastly, the study presents the lessons learnt within the context of Ireland. However, there is scope to replicate the study in other regions. The replicability will rely on taking a similar approach in participant selection, in selecting a cohort that has demonstrated a level of awareness and engagement in terms of tackling food waste. This would allow researchers from other regions and countries to identify a sample of people who have moved beyond awareness and need to be mobilised towards action. Opportunities arising from the replication of this study include the incorporation of additional demographic and food practice variables to deepen our understanding, as well as comparison across various countries.

#### 6. Conclusions

The study presents an investigation of food-related action that contributes to food waste amongst participating consumers. While our results emphasise food-related action that contributes to an increased likelihood of wasting food, we also shed light on areas that hold potential to decrease consumer food waste. The actions of growing food and composting were found to decrease the likelihood of wasting food, supporting a shift in mindset surrounding how food is viewed and reducing the disconnect often perpetuated by supermarkets. Alongside this, we have explored the correlation between food-related actions and wider pro-environmental behaviour. We found that, overall, engaging in wider pro-environmental behaviour decreases an individuals' likelihood of wasting food. In assessing this interaction, nuances were observed in terms of what motivates environmental actions and food waste, education and access to resources as means to explain this finding. Theoretically, this study adds to the discussion of social practice theory in informing the spillover of wider pro-environmental behaviour. Moreover, our findings support a layered policy approach, informed by social practice theory, focusing on prac-

tices and actions on individual, community, and societal levels to reduce consumer food waste levels.

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#### Appendix A

| Variable                         | Category          | Comp1     | Comp2     | Comp3     |
|----------------------------------|-------------------|-----------|-----------|-----------|
|                                  | Strongly Disagree | -1.156589 | 0.995677  | 0.665199  |
|                                  | Disagree          | -0.83515  | 0.718959  | 0.480327  |
| Turning lights off               | Neutral           | -0.47127  | 0.405704  | 0.271046  |
| 0.0                              | Agree             | -0.171714 | 0.147824  | 0.098759  |
|                                  | Strongly Agree    | 0.277944  | -0.239275 | -0.159856 |
|                                  | Strongly Disagree | -0.759257 | 0.74899   | 0.606431  |
|                                  | Disagree          | -0.500313 | 0.493548  | 0.399608  |
| Turn off tap when brushing teeth | Neutral           | -0.316563 | 0.312282  | 0.252844  |
| 1 0                              | Agree             | -0.128904 | 0.127161  | 0.102958  |
|                                  | Strongly Agree    | 0.274028  | -0.270323 | -0.218871 |
|                                  | Strongly Disagree | -0.803506 | 0.84746   | -0.267329 |
|                                  | Disagree          | -0.419925 | 0.442897  | -0.139711 |
| Unplug devices                   | Neutral           | -0.1554   | 0.163901  | -0.051702 |
|                                  | Agree             | 0.057745  | -0.060904 | 0.019212  |
|                                  | Strongly Agree    | 0.418842  | -0.441754 | 0.13935   |
|                                  | Strongly Disagree | -0.79011  | 0.422441  | -0.590644 |
|                                  | Disagree          | -0.421805 | 0.225522  | -0.315319 |
| Shorter showers                  | Neutral           | -0.130078 | 0.069548  | -0.09724  |
|                                  | Agree             | 0.133231  | -0.071233 | 0.099596  |
|                                  | Strongly Agree    | 0.490129  | -0.262052 | 0.366394  |
|                                  | Strongly Disagree | -0.450637 | -0.318363 | -1.346433 |
|                                  | Disagree          | -0.188817 | -0.133394 | -0.564156 |
| Walk instead of drive            | Neutral           | 0.002605  | 0.00184   | 0.007783  |
|                                  | Agree             | 0.158811  | 0.112196  | 0.474501  |
|                                  | Strongly Agree    | 0.381475  | 0.269502  | 1.139788  |
|                                  | Strongly Disagree | -1.031736 | -1.11156  | -0.085054 |
|                                  | Disagree          | -0.759894 | -0.818686 | -0.062644 |
| Improve recycling behaviours     | Neutral           | -0.416413 | -0.44863  | -0.034328 |
|                                  | Agree             | -0.098761 | -0.106402 | -0.008142 |
|                                  | Strongly Agree    | 0.322259  | 0.347192  | 0.026566  |

Table A1. Covariance matrix of eigenvalues for the principal component/factor analysis.

| Variable            | Category  | Comp1   | Comp2   | Comp3   |
|---------------------|---|---|---|---|
| Bring bags shopping | Strongly Disagree<br>Disagree<br>Neutral<br>Agree<br>Strongly Agree | $\begin{array}{c} -0.996086\\ -0.878543\\ -0.673256\\ -0.401468\\ 0.11345\end{array}$ | $\begin{array}{c} -1.482217 \\ -1.307309 \\ -1.001834 \\ -0.597401 \\ 0.168818 \end{array}$ | 1.224691<br>1.080172<br>0.827771<br>0.493606<br>-0.139487 |
| Reuse plastics      | Strongly Disagree<br>Disagree<br>Neutral<br>Agree<br>Strongly Agree | -1.005331<br>-0.681388<br>-0.354319<br>-0.043848<br>0.362226                          | -1.012827<br>-0.686469<br>-0.356961<br>-0.044175<br>0.364927                                | 0.23989<br>0.162591<br>0.084547<br>0.010463<br>-0.086433  |

## Table A1. Cont.

## Appendix B

 Table A2. Table displaying regression of general environmental behaviour.

| Variable  | Reference Category                                  | Basic              | Growth             | Full Model           |
|---|---|--------------------|--------------------|----------------------|
| Dependant Variable: Tertile:<br>Environmental Behaviour |   | (1)                | (2)                | (3)                  |
| Age: 45–64  | Age: 25–44  | 0.962<br>(0.114)   | 0.911<br>(0.110)   | 0.804<br>(0.103)     |
| Age: 65+  | Age: 25–44  | 0.905<br>(0.210)   | 0.788<br>(0.187)   | 0.530 *<br>(0.132)   |
| Male  | Female  | 0.72<br>(0.112)    | 0.684<br>(0.107)   | 0.6<br>(0.148)       |
| Household: 2 people                                     | Household: 1 person                                 | 1.115<br>(0.255)   | 1.142 (0.263)      | 0.725 (0.119)        |
| Household: 3 people                                     | Household: 1 person                                 | 1.026<br>(0.245)   | 1.064<br>(0.257)   | 1.239<br>(0.294)     |
| Household: 4 people                                     | Household: 1 person                                 | 1.084<br>(0.252)   | 1.126<br>(0.264)   | 1.133<br>(0.282)     |
| Household: More than 4                                  | Household: 1 person                                 | 1.02<br>(0.243)    | 1.047<br>(0.251)   | 1.191<br>(0.289)     |
| Residence: Suburban                                     | Residence: Rural                                    | 1.583<br>(0.200)   | 1.643<br>(0.210)   | 1.56 ***<br>(0.208)  |
| Residence: Urban  | Residence: Rural                                    | 1.249<br>(0.188)   | 1.34<br>(0.203)    | 1.218<br>(0.193)     |
| Education: Post-Secondary                               | Education: Up to Secondary Level                    | 0.614 *<br>(0.142) | 0.598 *<br>(0.139) | 0.524 **<br>(0.127)  |
| Education: 3rd level degree                             | Education: Up to Secondary Level                    | 0.763<br>(0.145)   | 0.742<br>(0.142)   | 0.628<br>(0.125)     |
| Growing Experience: A lot                               | Growing Experience: A great deal/A lot              |                    | 0.761 ** (0.142)   | 0.905<br>(0.176)     |
| Growing Experience: A moderate amount                   | Growing Experience: A great deal/A lot              |                    | 0.585<br>(0.105)   | 0.77<br>(0.145)      |
| Stage of Growing: sowed and seedling                    | Stage of Growing: sowed                             |                    | 1.205 (0.440)      | 1.458<br>(0.576)     |
| Stage of Growing: sowed, seedling and harvest           | Stage of Growing: sowed                             |                    | 1.663<br>(0.631)   | 1.825<br>(0.748)     |
| Stage of Growing: sowed, seedling, harvest and ate      | Stage of Growing: sowed                             |                    | 1.818<br>(0.639)   | 1.854<br>(0.706)     |
| Seasonality: Sometimes                                  | Seasonality: Never/Rarely                           |                    |                    | 1.686 ***<br>(0.267) |
| Seasonality: Often/Regularly                            | Seasonality: Never/Rarely                           |                    |                    | 2.651 ***<br>(0.456) |
| Composting: No  | Composting: Yes                                     |                    |                    | 0.537 **<br>(0.107)  |
| Composting: Sometimes                                   | Composting: Yes                                     |                    |                    | 0.938                |
| Economic attitude: Neutral                              | Economic attitude: Strongly<br>disagree/Disagree    |                    |                    | 0.838<br>(0.304)     |
| Economic attitude: Agree/Strongly agree                 | Economic attitude: Strongly<br>disagree/Disagree    |                    |                    | 1.104 (0.378)        |
| Environment attitude: Neutral                           | Environment attitude: Strongly<br>disagree          |                    |                    | 1.299                |
| Environment attitude: Agree/Strongly<br>Agree           | Environment attitude: Strongly<br>disagree/disagree |                    |                    | 2.427 *<br>(0.850)   |

| Variable  | Reference Category  | Basic    | Growth   | Full Model           |
|---|---|----------|----------|----------------------|
| Dependant Variable: Tertile:<br>Environmental Behaviour         |   | (1)      | (2)      | (3)                  |
| Avoidable attitude: Neutral                                     | Avoidable attitude: Strongly<br>disagree/disagree                       |          |          | 1.701 *<br>(0.374)   |
| Avoidable attitude: Agree/Strongly Agree                        | Avoidable attitude: Strongly<br>disagree/disagree                       |          |          | 1.192<br>(0.214)     |
| Plan shop: Neutral  | Plan shop: Strongly disagree/Disagree                                   |          |          | 1.094<br>(0.272)     |
| Plan shop: Agree/Strongly Agree                                 | Plan shop: Strongly disagree/Disagree                                   |          |          | 1.956 ***<br>(0.392) |
| Buy more when offers: Neutral                                   | Buy more when offers: Strongly<br>Disagree/Disagree                     |          |          | 0.884 (0.139)        |
| Buy more when offers: Agree/Strongly<br>agree                   | Buy more when offers: Strongly<br>Disagree/Disagree                     |          |          | 0.682 (0.093)        |
| Feeling of social connection increased:<br>Neutral              | Feeling of social connection increased:<br>Strongly disagree / Disagree |          |          | 1.001 (0.228)        |
| Feeling of social connection increased:<br>Agree/Strongly Agree | Feeling of social connection increased:<br>Strongly disagree/ Disagree  |          |          | 1.229<br>(0.278)     |
| Social Connection: Fair   | Social Connection: Very poor/Poor                                       |          |          | 1.029<br>(0.249)     |
| Social Connection: Good/Excellent                               | Social Connection: Very poor/Poor                                       |          |          | 0.98<br>(0.219)      |
| Diet: Limited meat  | Diet: Eat most meat   |          |          | 0.957<br>(0.150)     |
| Diet: Vegan/Vegetarian  | Diet: Eat most meat   |          |          | 1.514<br>(0.375)     |
| Diet: Other   | Diet: Eat most meat   |          |          | 0.783<br>(0.239)     |
| N   |   | 1106     | 1106     | 1106                 |
| Log likelihood  |   | -1203.96 | -1192.25 | -1119.13             |

#### Table A2. Cont.

 $p < 0.05^{*}$ ,  $p < 0.01^{**}$ ,  $p < 0.001^{***}$ , Standard errors in parentheses. Analysis carried out using Stata v16.1.

## Appendix C

 Table A3. Goodness of fit tests for the ordinal regression.

|                      | Number of Groups | Test Statistic | <i>p</i> -Value |
|----------------------|------------------|----------------|-----------------|
| Ordinal HL           | 10               | 14.351         | 0.6421          |
| Lipsitz              | 10               | 6.099          | 0.7299          |
| HL = Hosmer Lemeshow |                  |                |                 |

## Table A4. Brant test for validity of the parallel lines assumption.

|               | Chi <sup>2</sup> Test Statistic | $p > chi^2$ | Degrees of Freedom |
|---------------|---------------------------------|-------------|--------------------|
| All variables | 49.48                           | 0.121       | 39                 |

## Appendix D

 Table A5. Marginal effects on being in the 'Never/ Rarely' category of food waste frequency.

| Food Waste Frequency  | Reference Category  | Marginal Effects of Full Model |  |
|---|---------------------|--------------------------------|--|
| Marginal Effect on Likelihood of Being in the Never/Rarely Category |                     |                                |  |
| Tertiles: Neutral PCA.  | Tertiles: Poor PCA. | 0.033<br>(0.030)               |  |
| Tertiles: Good PCA.   | Tertiles: Poor PCA. | 0.169 ***<br>(0.033)           |  |
| Age: 45–64  | Age: 25-44          | 0.093 ***<br>(0.027)           |  |
| Age: 65+  | Age: 25-44          | 0.08<br>(0.056)                |  |

| ole A5. Cont. |
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| Food Waste Frequency  | Reference Category   | Marginal Effects of Full Model        |
|---|--|---------------------------------------|
| Male  | Female   | 0.027<br>(0.035)                      |
| Household: 2 people   | Household: 1 person  | -0.024<br>(0.051)                     |
| Household: 3 people   | Household: 1 person  | -0.16 **<br>(0.053)                   |
| Household: 4 people   | Household: 1 person  | -0.194 ***<br>(0.051)                 |
| Household: More than 4  | Household: 1 person  | -0.212 ***<br>(0.053)                 |
| Residence: Suburban   | Residence: Rural   | -0.094 ***<br>(0.028)                 |
| Residence: Urban  | Residence: Rural   | -0.052                                |
| Education: Post-Secondary                                       | Education: Up to Secondary Level   | -0.059<br>(0.051)                     |
| Education: 3rd level degree                                     | Education: Up to Secondary Level   | -0.08<br>(0.042)                      |
| Growing Experience: A moderate amount                           | Growing Experience: A great deal/A lot   | -0.046<br>(0.042)                     |
| Growing Experience: A little/none                               | Growing Experience: A great deal/A lot   | -0.083 *<br>(0.041)                   |
| Stage of Growing: sowed and seedling                            | Stage of Growing: sowed  | 0.027 (0.077)                         |
| Stage of Growing: sowed, seedling and harvest                   | Stage of Growing: sowed  | 0.026 (0.080)                         |
| Stage of Growing: sowed, seedling, harvest and ate              | Stage of Growing: sowed  | 0.019<br>(0.075)                      |
| Seasonality: Rarely   | Seasonality: Never/Rarely  | 0.013<br>(0.031)                      |
| Seasonality: Often/Regularly                                    | Seasonality: Never/Rarely  | -0.023<br>(0.034)                     |
| Composting: No  | Composting: Yes  | -0.089 *                              |
| Composting: Sometimes   | Composting: Yes  | (0.037)<br>-0.099 *<br>(0.047)        |
| Economic attitude: Neutral                                      | Economic attitude: Strongly disagree/Disagree                                      | -0.074<br>(0.072)                     |
| Economic attitude: Agree/Strongly agree                         | Economic attitude: Strongly disagree/Disagree                                      | -0.074<br>(0.072)                     |
| Environment attitude: Neutral                                   | Environment attitude: Strongly disagree/disagree                                   | (0.072)<br>-0.07<br>(0.069)           |
| Environment attitude: Agree/Strongly Agree                      | Environment attitude: Strongly disagree/disagree                                   | -0.079                                |
| Avoidable attitude: Neutral                                     | Avoidable attitude: Strongly disagree/disagree                                     | (0.009)<br>-0.009<br>(0.040)          |
| Avoidable attitude: Agree/Strongly Agree                        | Avoidable attitude: Strongly disagree/disagree                                     | 0.239 ***                             |
| Plan shop: Neutral  | Plan shop: Strongly disagree/Disagree  | 0.088                                 |
| Plan shop: Agree/Strongly Agree                                 | Plan shop: Strongly disagree/Disagree  | 0.217 ***                             |
| Buy more when offers: Neutral                                   | Buy more when offers: Strongly Disagree/Disagree                                   | $\begin{pmatrix} 0.037 \end{pmatrix}$ |
| Buy more when offers: Agree/Strongly agree                      | Buy more when offers: Strongly Disagree/Disagree                                   | (0.034)<br>-0.091<br>(0.030)          |
| Feeling of social connection increased: Neutral                 | Feeling of social connection increased: Strongly disagree/                         | 0.073                                 |
| Feeling of social connection increased: Agree/Strongly<br>Agree | Disagree<br>Feeling of social connection increased: Strongly disagree/<br>Disagree | (0.044)<br>0.087 *<br>(0.043)         |
| Social Connection: Fair   | Social Connection: Very poor/Poor  | -0.047<br>(0.051)                     |
| Social Connection: Good/Excellent                               | Social Connection: Very poor/Poor  | -0.022<br>(0.047)                     |
| Diet: Limited meat  | Diet: Eat most meat  | 0.062                                 |
| Diet: Vegan/Vegetarian  | Diet: Eat most meat  | 0.058                                 |
| Diet: Other   | Diet: Eat most meat  | 0.004                                 |
| Ν   |  | 1106                                  |

p < 0.05 \*, p < 0.01 \*\*, p < 0.001 \*\*\*, Standard errors in parentheses. Analysis carried out using Stata v16.1.

| Food Waste Frequency                                  | Reference Category                                | Marginal Effects of Full Model   |
|---|---|----------------------------------|
| Marginal Effect on Likelihood of Being in the Sometin | nes Category                                      |                                  |
| Tertiles: Neutral PCA.                                | Tertiles: Poor PCA.                               | -0.015                           |
| Tertiles: Good PCA                                    | Tertiles: Poor PCA                                | -0.092 ***                       |
| icities. Good i Cry.                                  |   | (0.019)<br>0.048 ***             |
| Age: 45–64  | Age: 25–44  | (0.014)                          |
| Age: 65+  | Age: 25–44  | -0.04<br>(0.031)                 |
| Male  | Female  | -0.014                           |
| Household: 2 people                                   | Household: 1 person                               | 0.016                            |
| Household: 3 people                                   | Household: 1 person                               | (0.035)<br>0.096 **              |
| Howeeholds A more the                                 | II  | (0.034)<br>0.111 ***             |
| Housenoid: 4 people                                   | Housenoid: 1 person                               | (0.033)<br>0.119 ***             |
| Household: More than 4                                | Household: 1 person                               | (0.034)                          |
| Residence: Suburban                                   | Residence: Rural                                  | 0.047 ***<br>(0.014)             |
| Residence: Urban                                      | Residence: Rural                                  | 0.027                            |
| Education: Post Secondary                             | Education: Un to Secondary Loyal                  | 0.033                            |
| Education: Fost-Secondary                             | Education: Op to Secondary Level                  | (0.029)                          |
| Education: 3rd level degree                           | Education: Up to Secondary Level                  | (0.025)                          |
| Growing Experience: A moderate amount                 | Growing Experience: A great deal/A lot            | 0.026                            |
| Growing Experience: A little/none                     | Growing Experience: A great deal/A lot            | 0.045                            |
| Stage of Crowing: sourced and soudling                | Stage of Crowing: coved                           | (0.024)<br>-0.013                |
| Stage of Growing. sowed and seeding                   | Stage of Growing. Sowed                           | (0.037)<br>0.013                 |
| Stage of Growing: sowed, seedling and harvest         | Stage of Growing: sowed                           | (0.038)                          |
| Stage of Growing: sowed, seedling, harvest and ate    | Stage of Growing: sowed                           | -0.009<br>(0.035)                |
| Seasonality: Rarely                                   | Seasonality: Never/Rarely                         | -0.006                           |
| Socoonality, Often / Boordardy                        | Secondity Nava / Paraly                           | 0.016)                           |
| Seasonainy: Onen/ Regularly                           | Seasonanty: Never/ Karely                         | (0.017)                          |
| Composting: No  | Composting: Yes                                   | (0.016)                          |
| Composting: Sometimes                                 | Composting: Yes                                   | 0.045 *<br>(0.018)               |
| Economic attitude: Neutral                            | Economic attitude: Strongly disagree/Disagree     | 0.04                             |
| Economic attitude: Agree/Strongly agree               | Economic attitude: Strongly disagree/Disagree     | 0.038                            |
| Environment attitude: Neutral                         | Environment attitude: Strongly disagree/disagree  | 0.056                            |
| Environment attitude: Agree/Strongly Agree            | Environment attitude: Strongly disagree/disagree  | (0.044)<br>0.043<br>(0.041)      |
| Avoidable attitude: Neutral                           | Avoidable attitude: Strongly disagree/disagree    | (0.041)<br>0.002<br>(0.000)      |
| Avoidable attitude: Agree/Strongly Agree              | Avoidable attitude: Strongly disagree/disagree    | (0.008)<br>-0.111 ***<br>(0.015) |
| Plan shop: Neutral                                    | Plan shop: Strongly disagree/Disagree             | (0.015)<br>-0.024<br>(0.012)     |
| ·<br>Plan shop: Agree/Strongly Agree                  | Plan shop: Strongly disagree/Disagree             | (0.013)<br>-0.087 ***<br>(0.012) |
| Buy more when offers: Neutral                         | Buy more when offers: Strongly Disagree/Disagree  | (0.012)<br>0<br>(0.010)          |
| Buy more when offers: Agree /Strengly agree           | Buy more when offere: Strongly Disagree /Disagree | (0.019)<br>0.046 **              |
| buy more when oners: Agree/ strongly agree            | Feeling of social connection increased. Strongly  | (0.015)<br>-0.033                |
| Feeling of social connection increased: Neutral       | disagree / Disagree                               | (0.018)                          |

 Table A6. Marginal effect of being in the 'sometimes' category of food waste frequency.

| Food Waste Frequency  | Reference Category   | Marginal Effects of Full Model |
|---|--|--------------------------------|
| Feeling of social connection increased:<br>Agree/Strongly Agree | Feeling of social connection increased: Strongly<br>disagree/ Disagree | -0.04 *<br>(0.018)             |
| Social Connection: Fair   | Social Connection: Very poor/Poor                                      | 0.024<br>(0.027)               |
| Social Connection: Good/Excellent                               | Social Connection: Very poor/Poor                                      | 0.011<br>(0.025)               |
| Diet: Limited meat  | Diet: Eat most meat  | -0.033<br>(0.018)              |
| Diet: Vegan/Vegetarian  | Diet: Eat most meat  | -0.031<br>(0.029)              |
| Diet: Other   | Diet: Eat most meat  | -0.002<br>(0.032)              |
| N   |  | 1106                           |

Table A6. Cont.

p < 0.05 \*, p < 0.01 \*\*, p < 0.001 \*\*\*, Standard errors in parentheses. Analysis carried out using Stata v16.1.

| Food waste Frequency Reference Category Marginal Effects of Full M                                  | louei |
|---|-------|
| Marginal Effect on Likelihood of Being in the Frequent Category                                     |       |
| Tertiles: Neutral PCA. Tertiles: Poor PCA0.018  |       |
| $(0.01/) = -0.077^{***}$  |       |
| Iertiles: Good PCA. (0.015)   |       |
| Age: 45–64 -0.046 *** (0.013)   |       |
| Age: 65+ Age: 25-44 -0.04   |       |
| -0.014  |       |
| Male Female (0.017)   |       |
| Household: 2 people Household: 1 person 0.008   |       |
| Household: 3 people 0.065 **  |       |
| 1100seriold. 1 person (0.020)   |       |
| Household: 4 people Household: 1 person (0.020)   |       |
| 0.093 ***   |       |
| Household: More than 4 Household: 1 person (0.022)  |       |
| Residence: Suburban Residence: Rural 0.047 ***  |       |
| Residence: Urban Residence: Rural 0.024   |       |
| (0.016) 0.026   |       |
| Education: Post-Secondary Education: Up to Secondary Level (0.020)                                  |       |
| Education: 3rd level degree Education: Up to Secondary Level 0.036                                  |       |
|   |       |
| Growing Experience: A moderate amount Growing Experience: A great deal/A lot (0.02)                 |       |
| Growing Experience: A little/none Growing Experience: A great deal/A lot 0.039*                     |       |
| (0.018)<br>-0.014   |       |
| Stage of Growing: sowed and seedling Stage of Growing: sowed (0.041)                                |       |
| Stage of Growing: sowed, seedling and harvest Stage of Growing: sowed -0.013                        |       |
| $\begin{array}{c} (0.0 \pm 2) \\ -0.01 \end{array}$   |       |
| Stage of Growing: sowed (0.039)   |       |
| Seasonality: Rarely –0.006  |       |
| (0.015)   |       |
| Seasonality: Often/Regularly Seasonality: Never/Rarely (0.018)                                      |       |
| Composting: No Composting: Yes 0.048 *  |       |
| Composting: Sometimes Composting: Yes 0.054   |       |
| (0.029)   |       |
| Economic attitude: Neutral Economic attitude: Strongly disagree / Disagree (0.031)                  |       |
| Economic attitude: Agree/Strongly agree Economic attitude: Strongly disagree/Disagree 0.032         |       |
| Environment attitude: Neutral Environment attitude: Strengty diseases (diseases 0.049               |       |
| Environment attitude: Strongry disagree/ disagree (0.034)   |       |
| Environment attitude: Agree/Strongly Agree Environment attitude: Strongly disagree/disagree (0.035) |       |
| Avoidable attitude: Neutral Avoidable attitude: Strongly disagree/disagree 0.007                    |       |

## **Table A7.** Marginal effects on being in the 'Frequent' category of food waste frequency.

#### Table A7. Cont.

| Food Waste Frequency  | Reference Category   | Marginal Effects of Full Model |
|---|--|--------------------------------|
| Avoidable attitude: Agree/Strongly Agree                        | Avoidable attitude: Strongly disagree/disagree                         | -0.128 ***<br>(0.025)          |
| Plan shop: Neutral  | Plan shop: Strongly disagree/Disagree                                  | -0.064<br>(0.034)              |
| Plan shop: Agree/Strongly Agree                                 | Plan shop: Strongly disagree/Disagree                                  | -0.13 ***<br>(0.029)           |
| Buy more when offers: Neutral                                   | Buy more when offers: Strongly Disagree/Disagree                       | 0<br>(0.015)                   |
| Buy more when offers: Agree/Strongly agree                      | Buy more when offers: Strongly Disagree/Disagree                       | 0.045 **<br>(0.014)            |
| Feeling of social connection increased: Neutral                 | Feeling of social connection increased: Strongly disagree/<br>Disagree | -0.041<br>(0.026)              |
| Feeling of social connection increased: Agree/Strongly<br>Agree | Feeling of social connection increased: Strongly disagree/<br>Disagree | -0.047<br>(0.026)              |
| Social Connection: Fair   | Social Connection: Very poor/Poor                                      | 0.023<br>(0.024)               |
| Social Connection: Good/Excellent                               | Social Connection: Very poor/Poor                                      | 0.01 (0.022)                   |
| Diet: Limited meat  | Diet: Eat most meat  | -0.029<br>(0.015)              |
| Diet: Vegan/Vegetarian  | Diet: Eat most meat  | -0.028<br>(0.023)              |
| Diet: Other   | Diet: Eat most meat  | (0.020)<br>-0.002<br>(0.034)   |
| N   |  | 1106                           |

p < 0.05 \*, p < 0.01 \*\*, p < 0.001 \*\*\*, Standard errors in parentheses. Analysis carried out using Stata v16.1.

## Appendix E

## Table A8. Generalised ordered logistic regression on frequency of food waste.

| Food Waste Frequency                                | Reference Category                     | Odds Ratio of Full Model |  |  |
|---|--|--------------------------|--|--|
| Odds Ratio of Moving from Never/Rarely to Sometimes |  |                          |  |  |
| Tertiles: Neutral PCA.                              | Tertiles: Poor PCA.                    | 0.848<br>(0.133)         |  |  |
| Tertiles: Good PCA.                                 | Tertiles: Poor PCA.                    | 0.417 *** (0.071)        |  |  |
| Age: 45–64  | Age: 25-44                             | 0.617<br>(0.085)         |  |  |
| Age: 65+  | Age: 25–44                             | 0.678 *** (0.193)        |  |  |
| Male  | Female                                 | 0.708<br>(0.138)         |  |  |
| Household: 2 people                                 | Household: 1 person                    | (0.304)                  |  |  |
| Household: 3 people                                 | Household: 1 person                    | 2.171 **<br>(0.606)      |  |  |
| Household: 4 people                                 | Household: 1 person                    | 2.625 ***<br>(0.712)     |  |  |
| Household: More than 4                              | Household: 1 person                    | 2.932 ***<br>(0.824)     |  |  |
| Residence: Suburban                                 | Residence: Rural                       | 1.645 ***<br>(0.242)     |  |  |
| Residence: Urban                                    | Residence: Rural                       | 1.314<br>(0.225)         |  |  |
| Education: Post-Secondary                           | Education: Up to Secondary Level       | 1.33<br>(0.358)          |  |  |
| Education: 3rd level degree                         | Education: Up to Secondary Level       | 1.514 *<br>(0.335)       |  |  |
| Growing Experience: A moderate amount               | Growing Experience: A great deal/A lot | 1.271<br>(0.282)         |  |  |
| Growing Experience: A little/none                   | Growing Experience: A great deal/A lot | 1.526 *<br>(0.327)       |  |  |
| Stage of Growing: sowed and seedling                | Stage of Growing: sowed                | 0.867<br>(0.355)         |  |  |
| Stage of Growing: sowed, seedling and harvest       | Stage of Growing: sowed                | 0.878<br>(0.374)         |  |  |
| Stage of Growing: sowed, seedling, harvest and ate  | Stage of Growing: sowed                | 0.909<br>(0.359)         |  |  |

| Table A | 8. Cont. |  |
|---------|----------|--|
|---------|----------|--|

| Food Waste Frequency                                   | Reference Category   | Odds Ratio of Full Model        |
|--|--|---------------------------------|
| Seasonality: Rarely                                    | Seasonality: Never/Rarely  | 0.939                           |
| Seasonality: Often/Regularly                           | Seasonality: Never/Rarely  | 1.121                           |
| Composting: No   | Composting: Yes  | 1.602 *<br>(0.334)              |
| Composting: Sometimes                                  | Composting: Yes  | 1.688 * (0.422)                 |
| Economic attitude: Neutral                             | Economic attitude: Strongly disagree/Disagree                          | 1.575                           |
| Economic attitude: Agree/Strongly agree                | Economic attitude: Strongly disagree/Disagree                          | 1.519                           |
| Environment attitude: Neutral                          | Environment attitude: Strongly disagree/disagree                       | 1.733<br>(0.725)                |
| Environment attitude: Agree/Strongly Agree             | Environment attitude: Strongly disagree/disagree                       | 1.581                           |
| Avoidable attitude: Neutral                            | Avoidable attitude: Strongly disagree/disagree                         | (0.031)<br>1.041<br>(0.232)     |
| Avoidable attitude: Agree/Strongly Agree               | Avoidable attitude: Strongly disagree/disagree                         | 0.3 ***                         |
| Plan shop: Neutral                                     | Plan shop: Strongly disagree/Disagree                                  | 0.612                           |
| Plan shop: Agree/Strongly Agree                        | Plan shop: Strongly disagree/Disagree                                  | 0.32 ***                        |
| Buy more when offers: Neutral                          | Buy more when offers: Strongly Disagree/Disagree                       | 0.993                           |
| Buy more when offers: Agree/Strongly agree             | Buy more when offers: Strongly Disagree/Disagree                       | (0.178)<br>1.598 *<br>(0.239)   |
| Feeling of social connection increased: Neutral        | Feeling of social connection increased: Strongly disagree/             | 0.702                           |
| Feeling of social connection increased: Agree/Strongly | Disagree<br>Feeling of social connection increased: Strongly disagree/ | (0.164)<br>0.639                |
| Agree<br>Social Connection: Fair                       | Disagree   | (0.148)<br>1.103                |
| Social Connection: Cool /Eveningt                      | Social Connection: Very poor/Poor                                      | (0.305)<br>1.092                |
| Dist. Limited most                                     | Dist. Est most most  | (0.272)<br>0.718                |
|  | Diet: Eat most meat  | -0.125<br>0.73                  |
| Diet: vegan/ vegetarian                                | Diet: Eat most meat  | (0.202)<br>0.617                |
| Diet: Other  | Diet: Eat most meat  | (0.239)                         |
| Odds of moving from Sometimes to Frequently            |  | 0.040                           |
| Tertiles: Neutral PCA.                                 | Tertiles: Poor PCA.  | 0.848<br>(0.133)                |
| Tertiles: Good PCA.                                    | Tertiles: Poor PCA.  | (0.071)                         |
| Age: 45–64   | Age: 25–44   | 0.617 ***<br>(0.085)            |
| Age: 65+   | Age: 25–44   | 0.678<br>(0.193)                |
| Male   | Female   | 1.579<br>(0.416)                |
| Household: 2 people                                    | Household: 1 person  | 1.115<br>(0.304)                |
| Household: 3 people                                    | Household: 1 person  | 2.171 **<br>(0.606)             |
| Household: 4 people                                    | Household: 1 person  | 2.625 ***                       |
| Household: More than 4                                 | Household: 1 person  | 2.932 ***                       |
| Residence: Suburban                                    | Residence: Rural   | (0.024)<br>1.645 ***<br>(0.242) |
| Residence: Urban                                       | Residence: Rural   | 1.314                           |
| Education: Post-Secondary                              | Education: Up to Secondary Level                                       | 1.33                            |
| Education: 3rd level degree                            | Education: Up to Secondary Level                                       | (0.336)<br>1.514 *<br>(0.325)   |
|  |  | 1.271                           |
| Growing Experience: A moderate amount                  | Growing Experience: A great deal/A lot                                 | (0.282)<br>1.526 *              |
| Growing Experience: A little/none                      | Growing Experience: A great deal/A lot                                 | (0.327)<br>0.867                |
| Stage of Growing: sowed and seedling                   | Stage of Growing: sowed  | (0.355)<br>0.878                |
| Stage of Growing: sowed, seedling and harvest          | Stage of Growing: sowed  | (0.374)                         |
| Stage of Growing: sowed, seedling, harvest and ate     | Stage of Growing: sowed  | (0.359)                         |

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| Food Waste Frequency                                   | Reference Category   | Odds Ratio of Full Model |
|--|--|--------------------------|
| Seasonality, Rarely                                    | Seasonality: Never/Rarely                                  | 0.939                    |
| ocuorinity, railely                                    |  | (0.156)                  |
| Seasonality: Often/Regularly                           | Seasonality: Never/Rarely                                  | 1.121                    |
|  |  | (0.206)<br>1.602 *       |
| Composting: No   | Composting: Yes  | (0.334)                  |
|  |  | 1.688 *                  |
| Composting: Sometimes                                  | Composting: Yes  | (0.422)                  |
| Economic attitudo: Noutral                             | Economic attitudo: Strongly disagroo / Disagroo            | 1.575                    |
| Economic attitude. Neutral                             | Economic attitude. Strongry disagree/ Disagree             | (0.610)                  |
| Economic attitude: Agree/Strongly agree                | Economic attitude: Strongly disagree/Disagree              | 1.519                    |
| 8,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,                | 8, 8, 8  | (0.562)                  |
| Environment attitude: Neutral                          | Environment attitude: Strongly disagree/disagree           | 1.733                    |
|  |  | (0.723)                  |
| Environment attitude: Agree/Strongly Agree             | Environment attitude: Strongly disagree/disagree           | (0.591)                  |
|  |  | 1.041                    |
| Avoidable attitude: Neutral                            | Avoidable attitude: Strongly disagree/disagree             | (0.232)                  |
| Avoidable attitude: A gree /Strongly A gree            | Avoidable attitude: Strangly disagras (disagras            | 0.3 ***                  |
| Avoluable attitude: Agree/Strongly Agree               | Avoidable attitude: Stroligly disagree/ disagree           | (0.057)                  |
| Plan shop: Neutral                                     | Plan shop: Strongly disagree/Disagree                      | 0.612                    |
| 1 mil onopi i teatiai                                  | That only buongry abalace, biologice                       | (0.154)                  |
| Plan shop: Agree/Strongly Agree                        | Plan shop: Strongly disagree/Disagree                      | 0.32 ***                 |
| 1 0 0 00 0   | 1 07 0 0   | (0.067)                  |
| Buy more when offers: Neutral                          | Buy more when offers: Strongly Disagree/Disagree           | (0.176)                  |
|  |  | 1 598                    |
| Buy more when offers: Agree/Strongly agree             | Buy more when offers: Strongly Disagree/Disagree           | (0.239)                  |
| Fasting of a sist source time in more d. Martual       | Feeling of social connection increased: Strongly disagree/ | 0.702                    |
| Feeling of social connection increased: Neutral        | Disagree   | (0.164)                  |
| Feeling of social connection increased: Agree/Strongly | Feeling of social connection increased: Strongly disagree/ | 0.639                    |
| Agree  | Disagree   | (0.148)                  |
| Social Connection: Fair                                | Social Connection: Very poor/Poor                          | 1.748                    |
|  |  | (0.542)                  |
| Social Connection: Good/Excellent                      | Social Connection: Very poor/Poor                          | 1.092                    |
|  |  | 0.718                    |
| Diet: Limited meat                                     | Diet: Eat most meat  | (0.125)                  |
|  |  | 0.73                     |
| Diet: Vegan/ vegetarian Diet: Eat most meat            | Diet: Eat most meat  | (0.202)                  |
| Diet: Other  | Diet: Fat most meat  | 2.116                    |
| Dieli Guici  | Diet. Eut most meut  | (0.882)                  |
| N  |  | 1106                     |

Table A8. Cont.

p < 0.05 \*, p < 0.01 \*\*, p < 0.001 \*\*\*, Standard errors in parentheses. Analysis carried out using Stata v16.1.

## Appendix F

**Table A9.** Results of logistic regression on whether individuals were in the frequent category of food waste frequency.

| Food Waste Frequency   | Reference Category  | Odds Ratio           |
|------------------------|---------------------|----------------------|
| Category               |                     |                      |
| Tertiles: Neutral PCA. | Tertiles: Poor PCA. | 0.686<br>(0.167)     |
| Tertiles: Good PCA.    | Tertiles: Poor PCA. | 0.366 ***<br>(0.106) |
| Age: 45–64             | Age: 25–44          | 0.618 *<br>(0.137)   |
| Age: 65+               | Age: 25–44          | 0.861<br>(0.450)     |
| Male                   | Female              | 1.573<br>(0.437)     |
| Household: 2 people    | Household: 1 person | 2.290<br>(1.501)     |
| Household: 3 people    | Household: 1 person | 3.031<br>(2.011)     |
| Household: 4 people    | Household: 1 person | 4.545 *<br>(2.915)   |

#### Table A9. Cont.

| Food Waste Frequency                               | Reference Category                                | Odds Ratio           |
|--|---|----------------------|
| Category   |   |                      |
| Household: More than 4                             | Household: 1 person                               | 5.983 **             |
| Residence: Suburban                                | Residence: Rural                                  | 1.472                |
|  |   | (0.352)<br>1.459     |
| Residence: Urban                                   | Residence: Rural                                  | (0.402)              |
| Education: Post-Secondary                          | Education: Up to Secondary Level                  | (1.636)              |
| Education: 3rd level degree                        | Education: Up to Secondary Level                  | 3.312 *<br>(1.675)   |
| Growing Experience: A moderate amount              | Growing Experience: A great deal/A lot            | 1.215<br>(0.484)     |
| Growing Experience: A little/none                  | Growing Experience: A great deal/A lot            | 1.303<br>-0.493      |
| Stage of Growing: sowed and seedling               | Stage of Growing: sowed                           | 0.770                |
|  |   | -0.461<br>0.703      |
| Stage of Growing: sowed, seedling and harvest      | Stage of Growing: sowed                           | (0.455)              |
| Stage of Growing: sowed, seedling, harvest and ate | Stage of Growing: sowed                           | (0.461)              |
| Seasonality: Rarely                                | Seasonality: Never/Rarely                         | 1.185<br>(0.306)     |
| Seasonality: Often/Regularly                       | Seasonality: Never/Rarely                         | 1.627                |
|  |   | (0.475)<br>2.157 **  |
| Composting: No                                     | Composting: Yes                                   | (0.623)              |
| Composting: Sometimes                              | Composting: Yes                                   | (0.679)              |
| Economic attitude: Neutral                         | Economic attitude: Strongly disagree/Disagree     | 1.291                |
| Economic attitude: Agree/Strongly agree            | Economic attitude: Strongly disagree/Disagree     | 1.141<br>(0.606)     |
| Environment attitude: Neutral                      | Environment attitude: Strongly disagree/disagree  | 1.513                |
|  |   | (0.877)<br>1.405     |
| Environment attitude: Agree/Strongly Agree         | Environment attitude: Strongly disagree/ disagree | (0.728)              |
| Avoidable attitude: Neutral                        | Avoidable attitude: Strongly disagree/disagree    | (0.234)              |
| Avoidable attitude: Agree/Strongly Agree           | Avoidable attitude: Strongly disagree/disagree    | 0.27 ***<br>(0.070)  |
| Plan shop: Neutral                                 | Plan shop: Strongly disagree/Disagree             | 0.585                |
|  |   | (0.201)<br>0.337 *** |
| Plan shop: Agree/Strongly Agree                    | Plan shop: Strongly disagree/Disagree             | (0.093)              |
| Buy more when offers: Neutral                      | Buy more when offers: Strongly Disagree/Disagree  | (0.259)              |
| Buy more when offers: Agree/Strongly agree         | Buy more when offers: Strongly Disagree/Disagree  | 1.824 *<br>(0.447)   |
| Feeling of social connection increased: Neutral    | Feeling of social connection increased: Strongly  | 0.631                |
| Feeling of social connection increased:            | Feeling of social connection increased: Strongly  | 0.534                |
| Social Connection: Fair                            | Social Connection: Very poor/Poor                 | 1.543                |
|  |   | (0.645)<br>0.917     |
| Social Connection: Good/Excellent                  | Social Connection: Very poor/Poor                 | (0.364)              |
| Diet: Limited meat                                 | Diet: Eat most meat                               | (0.202)              |
| Diet: Vegan/Vegetarian                             | Diet: Eat most meat                               | 0.824                |
| Diet: Other  | Diet: Eat most meat                               | 2.254                |
| N  |   | (0.973)              |

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p < 0.05 \*, p < 0.01 \*\*, p < 0.001 \*\*\*, Standard errors in parentheses. Analysis carried out using Stata v16.1.

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