To meat, or not to meat: A longitudinal investigation of transitioning to and from plant-based diets

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ABSTRACT

Concerns over potential negative effects of excessive meat consumption on both the environment and personal health, coupled with long-standing debates over animal rights, have motivated research on the prevalence and predictors of plant-based versus meat-based diets. Yet few studies have examined longitudinal trends in dietary behaviours using large national samples. We address this gap by examining the prevalence, predictors, and annual change in the self-reported dietary behaviour of a large national probability sample of New Zealand adults (categorised as omnivore, vegetarian, or vegan; Ns = 12,259–50,964). Consistent with our pre-registered hypotheses, omnivore was the most prevalent dietary category (94.1%). Moreover, higher levels of conservative ideologies (i.e., political conservatism, Right-Wing Authoritarianism, and Social Dominance Orientation), lower subjective health, lower environmental efficacy, and lower disgust sensitivity predicted having an omnivore (vs. vegetarian or vegan) diet. Longitudinal analyses further revealed that the probability of shifting from an omnivore diet to a vegetarian or vegan diet over a one-year period was low, and that veganism was the least stable dietary category. Both gender (men) and political conservatism predicted lower probabilities of transitioning from meat to no-meat diets over time.

1. Introduction

Human populations have historically consumed meat to satisfy nutritional needs (Leroy & Praet, 2015; Milton, 1999; Stanford & Bunn, 2001), but meat consumption has risen markedly over the past century even as non-meat-based nutrition has become more plentiful. Once a relatively scarce food source due to risks associated with hunting and the resource-intensive nature of raising animals for consumption, high meat consumption has now become normative in most modern societies. To meet these escalating demands, meat production has increased four-fold since the 1960s, faster than the rate of population growth (Ritchie & Roser, 2019). Accordingly, global meat consumption is projected to double the 2008 levels by 2050 (The World Counts, 2020).

Current levels of meat production and consumption raise important environmental, ethical and health considerations related to securing environmental sustainability, minimizing animal suffering, and improving public health (Bastian & Loughnan, 2017; Godfray et al., 2018; Tilman & Clark, 2014). Such considerations are coupled with research indicating that replacing animal-based products with plant-based diets would significantly improve food availability and security (de Boer & Aiking, 2011; Shepon, Eshel, Noor, & Milo, 2018). Although eliminating meat from one’s diet presents numerous challenges (see Sparkman, Macdonald, Caldwell, Kateman, & Boese, 2021), reducing meat consumption and increasing plant-based eating can help to address critical environmental, animal rights and health challenges in the food system. Accordingly, the EAT-Lancet Commission on healthy diets from sustainable food systems suggests reducing red meat consumption by more than 50% by 2050 (Willett et al., 2019). It is therefore encouraging to see that the popularity of plant-based diets has risen in recent years in many Western countries. To illustrate, the number of vegetarians in Portugal rose by 400% from 2007 to 2017 (The Portugal News, 2017), and the number of people eating plant-based diets in the US has increased by almost ten million over the past 15 years (Ipsos Retail Performance, 2020; see also Hryniewski, 2019).

To effectively encourage people to reduce their meat intake and increase plant-based diets, it is important to understand factors related to dietary choices. To these ends, a growing literature has documented factors that may hinder or facilitate a transition from meat-based to...
and to identify the factors that might hinder or facilitate such temporal shifts in diets. Our pre-registered study addresses these goals by analysing longitudinal data to document the transition from meat-based to plant-based diets (or vice versa) over the course of a year, utilizing a nation-wide random sample of the New Zealand population.

Critically, research distinguishes between beliefs concerning the eater (beliefs about the animals we eat), the eaters (beliefs about ourselves and others justifying eating animals), and the eating (beliefs about the physical actions and process of eating animals; Loughnan, Bastian, & Haslam, 2014; Loughnan & Davies, 2020). Here, we focus on the eaters who often express consistent justifications for particular dietary behaviours. To these ends, Piazza et al. (2015; see also Piazza, 2020) identified the “4Ns” summarising beliefs meat eaters express to justify their sustained choice to eat animals: Necessary (people need to eat meat to be healthy), Nice (the enjoyment of eating meat justifies its consumption), Natural (humans have evolved to eat meat and have done so for millennia), and Normal (eating meat is something humans do). Interestingly, these 4Ns help to explain the beliefs underlying the dietary choices of both omnivores and vegetarians (Hopwood, piazza, Chen, &

Table 1
List of variables considered.

<table>
<thead>
<tr>
<th>Variable</th>
<th>NZAVS Description/Question wording</th>
<th>Coding/Scale range</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-reported dietary behaviour</td>
<td>“How would you describe your dietary behaviour? (e.g., meat &amp; veg, vegetarian, vegan, halal, pescatarian, etc.)”</td>
<td>Open-ended item and responses coded according to the NZAVS coding scheme into different categorical variables. We considered two levels of abstraction: at level 2, categories included “All meat”, “Vegetarian”, “Vegan”, and various dietary restrictions (e.g., “No Chicken”, “Halal”), “Unprocessed Food Diet”); at level 1, responses were coded into “Omnivore”, “No Meat” or “Other/Outside scope”.</td>
<td>Developed for the NZAVS</td>
</tr>
<tr>
<td>Protection of native species</td>
<td>Protection of NZ native species (i.e., “Protecting New Zealand’s native species should be a national priority”)</td>
<td>1 (Strongly Disagree) - 7 (Strongly Agree)</td>
<td>Developed for the NZAVS</td>
</tr>
<tr>
<td>Subjective health</td>
<td>Short-Form Subjective Health Scale (General Health Perception Subscale) (i.e., “in general, would you say your health is … poor/excellent”; “I seem to get sick a little easier than other people”, “I expect my health to get worse”; Cronbach’s alpha = .58)</td>
<td>First items: 1 (Poor) - 7 (Excellent)</td>
<td>Ware and Sherbourne (1992)</td>
</tr>
<tr>
<td>Perceived environmental efficacy</td>
<td>Environmental efficacy (i.e., “By taking personal action I believe I can make a positive difference to environmental problem”; “I feel I can make a difference to the state of the environment”; Cronbach’s alpha = .58)</td>
<td>1 (Strongly Disagree) - 7 (Strongly Agree)</td>
<td>Sharma (2008)</td>
</tr>
<tr>
<td>Gender</td>
<td>What is your gender?</td>
<td>Open-ended item and responses coded according to the NZAVS coding scheme into women, gender diverse, and men.</td>
<td>Fraser, Bulbulia, Geaves, Wilson, and Sibley (2020)</td>
</tr>
<tr>
<td>Political conservatism</td>
<td>Political Orientation - liberal versus conservative (i.e., “Please rate how politically liberal versus conservative you see yourself as being”)</td>
<td>1 (Extremely Liberal) - 7 (Extremely Conservative)</td>
<td>Jost (2006)</td>
</tr>
<tr>
<td>Right-wing ideology</td>
<td>Right-Wing Authoritarianism (e.g., “It is always better to trust the judgment of the proper authorities in government and religion than to listen to the noisy rabblerousers in our society who are trying to create doubt in people’s minds”; “Atheists and others who have rebelled against established religions are no doubt every bit as good and virtuous as those who attend church regularly”, reverse-scored; 6 items, Cronbach’s alpha = .70). Social Dominance Orientation (e.g., “It is OK if some groups have more of a chance in life than others”, and “We should have increased social equality”, reverse-scored; 6 items, Cronbach’s alpha = .76).</td>
<td>1 (Strongly Disagree) - 7 (Strongly Agree)</td>
<td>Altemeyer (1996); Sidanius &amp; Pratto, 1999</td>
</tr>
<tr>
<td>Disgust</td>
<td>Disgust sensitivity (i.e., “Bad smells, messes, dead animals and rotten food absolutely disgust me”)</td>
<td>1 (Strongly Disagree) - 7 (Strongly Agree)</td>
<td>(Haidt, McCauley, &amp; Rozin, 1994; Olatunji et al., 2007)</td>
</tr>
<tr>
<td>Religious (spiritual) beliefs</td>
<td>Belief in a spirit or life force (i.e., “Do you believe in some form of spirit or lifeforce?”)</td>
<td>0 – no, 1 – yes</td>
<td>Eurobarometer (2005)</td>
</tr>
<tr>
<td>Pro-Social Orientation</td>
<td>Agreeableness/Empathy (e.g., “Sympathize with others’ feelings”; “‘Am not interested in other people’s problems”, reverse-scored; 4 items, Cronbach’s alpha = .71)</td>
<td>1 (Very Inaccurate) - 7 (Very Accurate)</td>
<td>Sibley et al. (2011)</td>
</tr>
<tr>
<td>Openness Orientation</td>
<td>Openness to Experience (i.e., “Have a vivid imagination”, “Have difficulty understanding abstract ideas”, reverse-scored; 4 items, Cronbach’s alpha = .70)</td>
<td>1 (Very Inaccurate) - 7 (Very Accurate)</td>
<td>Sibley et al. (2011)</td>
</tr>
</tbody>
</table>

Note: Perceived environmental efficacy and protection of native species were measured at Time 9 (2017), with all other covariates measured at Time 10 (2018). As detailed in the pre-registration plan, all variables were included in the multinomial logistic regression model predicting dietary behaviour, but only the first five were considered in the Markov model with covariates due to theoretical importance and model constraints. NZAVS = New Zealand Attitudes and Values Study.
These justifying beliefs, and the fact that meat-eating behaviour is so pervasive in many societies, likely hinder transitioning from meat-based to plant-based diets. However, reviews of the motivating factors that might foster plant-based diet adoption have identified common factors (for reviews, see Asher et al., 2016; Graça et al., 2019; Rosenfeld, 2018; Ruby, 2012). Graça et al. (2019, Table 1; see also Herzog, 2010, Chapter 7) provide a summary of these factors, including interest in healthier and/or sustainable eating habits; motivation to reduce/avoid animal suffering; weaker tendency to endorse meat eating justifications and greater feelings of worry/guilt towards meat consumption; and interest in trying new foods, to name a few.

Although there are many motivating factors, reviews by Ruby (2012) and Rosenfeld (2018) identify concerns about animals, health and the environment, and being socio-politically liberal as key factors that encourage plant-based diets. Women are also disproportionately more likely than men to report abstaining from animal products. That is, compared to their counterparts, individuals who are women, endorse a more liberal political orientation and express greater levels of concern about their health, as well as greater levels of concern about other animals and the natural environment, are more likely to shift from meat-based to plant-based diets.

In this pre-registered study, we make four main contributions to the literature examining transitions from meat-to-plant-based diets. We report analyses from both cross-sectional and longitudinal data to: (1) provide the prevalence of distinct dietary categories (i.e., omnivores, vegetarians and vegans; henceforth collectively designated as veg*ns; see, e.g., Hudson & Earle, 2018) of a nationwide random sample of the New Zealand population, (2) identify demographic and psychological variables associated with self-reported dietary behaviours, (3) provide information about the number of New Zealanders who transitioned from meat-based to plant-based diets (or vice versa) within a one-year period, and (4) examine whether five variables (i.e., support for protection of native animals; subjective health; perceived environmental efficacy; gender; and conservatism) predict the likelihood of transitioning from one dietary category to another.

To answer these questions, we analyse data from the New Zealand Attitudes and Values Study (NZAVS), which is a national panel study that has assessed socio-political attitudes of New Zealanders annually since 2009. New Zealand is a major player both in meat production and consumption, and the availability of meat in the diet of New Zealanders is a notable historical characteristic of the country (Potts & White, 2008; Wilson, 2005). Compared to other countries, New Zealand ranks 126th in population size and 76th in land area, but ranks 27th in meat production (NationMaster, 2020) and fourth in combination with Australia in terms of meat consumption (Ritchie & Roser, 2019). In 2018 alone, the country produced 1.45 million tons of meat, including cattle, poultry, sheep/mutton, goat, pig, and wild game (Ritchie & Roser, 2019). While the world average meat consumption was 41.90 kg per person in 2009, the average meat consumption in New Zealand was 106.4 kg per person (ChartsBin, 2013). In short, New Zealand has a strong culture of meat-based diets.

2. The present study

This article presents information on self-reported dietary behaviour and its predictors, the prevalence of intradividual transitions across dietary categories (i.e., omnivores and veg*ns), and predictors of intradividual transitions of dietary categories. In this section, we detail the pre-registered hypotheses and analytical strategies to test each prediction. The pre-registration is available at the Open Science Framework: https://osf.io/KeqP/. Multinomial logistic regressions examined the predictors of self-reported dietary behaviour, and Markov models assessed the probabilities of maintaining vs. transitioning between different dietary categories. All main analyses were conducted in Mplus version 8.4. Mplus syntax for all models are available at the NZAVS page (http://www.nzvalues.org/).

**Dietary Behaviour and Categories.** The NZAVS employed an open-ended question to assess dietary behaviour in 2017 and 2018. These responses were coded into a broad range of specific categories as possible (coding level 3), and then subsequently coded into more general focal categories (e.g., “Omnivore”, “Vegetarian”, or “Vegan” at level 2, and “Omnivore” or “No-meat” at level 1). Levels 1 and 2 were then used in our analyses (see details below). Because eating meat is highly normative in New Zealand (and globally), we expected that meat-based diets would be the most common diet identified in our analyses (Confirmatory Hypothesis 1, CH1). Predictors of Dietary Behaviour and Categories. To investigate demographic and psychological predictors of self-reported dietary behaviour, we conducted a multinomial logistic regression to assess the associations between a range of variables included in the NZAVS and membership in the veg*n diet categories, relative to the omnivore diet category. We selected NZAVS variables based on two review articles describing the psychology of vegetarianism (Rosenfeld, 2018; Ruby, 2012). As reviewed above, the most common motivations vegetarians give for pursuing a vegetarian diet are concerns about animals, health and the environment; with gender and liberal political orientation also noted as key predictors. We thus place greater emphasis on variables related to these aspects in our analysis, particularly for the transition model. Other relevant variables are ideological attitudes including right-wing authoritarianism (Altemeyer, 1996) and social dominance orientation (Sidanius & Pratto, 1999), disgust sensitivity (Rozin, Markwith, & Stoes, 1997) and spiritual beliefs (Asher et al., 2014), as well as pro-social and openness orientations as indexed by the Big Five’s Agreeableness and Openness to Experience, respectively (Forestell &...
In brief, research indicates that individuals adopting a veg*n diet tend to report greater concerns about animals, their health and the natural environment, tend to be women, hold more liberal political views, be more prone to feel disgust, be more spiritual, and are more prosocial and open to new experiences. Although we only had proxy measures of concerns about animals, their health and the natural environment, we expected to observe all these associations in our study (CH2).

**Intraindividual transitions.** We also investigated the number of respondents who transitioned from a meat-based diet to a plant-based diet, or vice versa. For this longitudinal analysis, we used Time 9 (2017) and Time 10 (2018) of the NZAVS. Two Markov models are presented. The first examines stability and transitions between omnivore, vegetarian, and vegan diets. The second focuses on stability and transitions between the two broader categories, omnivore and no-meat. Markov models are a type of categorical variable modelling that allows the identification of transition probabilities of switching from one condition/state at Time T (e.g., being atheist) to another condition/state at Time T+1 (e.g., becoming religious), given the state at Time T (see Kaplan, 2006). The model estimates the probability of holding a consistent condition/state over time, as well as the probability of transitioning between conditions/states. We employed Markov models to estimate the probability of holding a consistent diet over time and the probability of transitioning between a meat-based diet to a plant-based diet, and vice versa (for other applications, see Grassly, Ward, Ferris, Mabey, & Bailey, 2008; Satherley, Yogeeswaran, Osborne, & Sibley, 2018).

Although eating meat is normative in New Zealand, there is a documented rise in the adoption of plant-based diets (e.g., Woolf, 2019, 2020). We thus expected the prevalence of individuals transitioning from a meat-based diet to a plant-based diet to be higher than the reverse transition (CH3).

**Predictors of Intraindividual Transitions.** Beyond documenting the proportion of individuals who have transitioned from one diet to another, we also examine covariates that predict these transitions. As reviewed above, concerns about animals, health and the environment, plus being women and endorsing liberal political views correlate positively with vegetarianism (Rosenfeld, 2018; Ruby, 2012). Due to limitations of the measures included in the survey and the complexity of our model, we focus on five pre-registered covariates that are proxy or direct measures of these variables: support for protection of native species, subjective health, perceived environmental efficacy, gender, and political orientation. That these characteristics correlate with meat abstention may not mean they are the foundation for transitions between dietary categories, however. Longitudinal analyses allow tentative inferences to be drawn about likely causal relationships.

Given the small sample size for the vegan category, the Markov model with covariates focuses on the omnivore and no-meat distinction. We thus added the five covariates to a Markov model estimating the likelihood of transitioning between the omnivore and no-meat categories over time. We report the extent to which a unit-increase in each covariate is associated with the change (increase/decrease) in log-odds (and, hence, change in the probability) of transitioning between (vs. remaining consistent in) each diet state over time. Transitioning from a meat-based diet to a plant-based diet may be more likely for individuals who support protection of native species, express greater concern about their general health, have greater perceived environmental efficacy, and who are women and more liberal. These longitudinal predictions overlap with the cross-sectional predictions (see CH2); however, since we could not locate research examining this research question over time, we treat the covariate effects on intraindividual transitions as exploratory (BH1).

### 3. Results

#### 3.1. Dietary prevalence

**Table 2** displays the prevalence of different eating behaviours at the most specific level of coding (Level 3) at Time 10 (2018). Those who ate any meat with no restrictions comprised 86.1% of the sample (88.7% of valid responses, excluding missing, unclear, and misunderstood responses). The second largest category, vegetarian, comprised 4.5% (4.6% valid) of the sample, while vegans were less common (1.1% of the total and valid sample, although a further 0.1% of the total sample was whole foods/plant-based vegan). These results support our pre-registered confirmatory hypothesis (CH1) that meat-based diet would be the most prevalent diet due to the normative nature of eating meat in New Zealand.

#### 3.2. Predictors of dietary prevalence

To examine the characteristics of those who have meat, vegetarian, and vegan diets, we conducted a multinomial logistic regression in which our covariates were used to predict the odds of being a vegetarian ($n = 2032; 4.6\%$) or vegan ($n = 548; 1.2\%$), relative to being an omnivore ($n = 41421; 94.1\%$). Consistent with our second pre-registered confirmatory hypothesis (CH2), **Table 3** shows that several covariates were associated with eating behaviour.

Diet was predicted by support for animal protection (i.e., protecting New Zealand’s native species) and subjective health (i.e., perception of one’s own health), as well as perceived environmental efficacy (i.e., the belief that one’s own efforts have a positive impact on the environment). Surprisingly, those who expressed greater support for protecting native species were less likely to be vegan ($B = -0.143, OR = 0.867, p = 0.031$). But as expected, those with higher levels of environmental efficacy were more likely to be vegetarian ($B = 0.116, OR = 1.123, p = 0.001$) and vegan ($B = -0.477, OR = 1.612, p < .001$) than to be an omnivore. Also as predicted, those reporting greater subjective health were more likely to...
be vegetarian \( (B = 0.052, \text{OR} = 1.053, p = .016) \) and vegan \( (B = 0.128, \text{OR} = 1.137, p = .004) \) relative to being an omnivore.

Also as hypothesised, men were less likely than women to be vegetarian \( (B = -0.634, \text{OR} = 0.531, p < .001) \) or vegan \( (B = -0.427, \text{OR} = 0.652, p < .001) \) relative to being an omnivore. Political conservatism was negatively associated with the likelihood of being vegetarian \( (B = -0.270, \text{OR} = 0.909, p < .001) \) and vegan \( (B = -0.381, \text{OR} = 0.683, p < .001) \) relative to being an omnivore. Conservative ideological attitudes (assessed with RWA and SDO) was consistently negatively associated with no-meat diets. Specifically, both RWA \( (B = -0.063, \text{OR} = 0.939, p = .017) \) and SDO \( (B = -0.185, \text{OR} = 0.831, p < .001) \) were negatively associated with the likelihood of being a vegetarian, as well as being a vegan \( (\text{RWA}; B = -0.183, \text{OR} = 0.833, p < .001); \text{SDO}; B = -0.354, \text{OR} = 0.702, p < .001) \), relative to being an omnivore.

Also consistent with our predictions, disgust sensitivity was positively associated with the likelihood of being vegetarian \( (B = 0.071, \text{OR} = 1.074, p < .001) \) and vegan \( (B = 0.093, \text{OR} = 1.097, p < .001) \) relative to being an omnivore. Personality traits were also predictive of eating behaviour. Higher scores on Agreeableness predicted lower likelihood of being a vegan \( (B = -0.169, \text{OR} = 0.844, p = .001) \) relative to being an omnivore, but was not predictive of the odds of being a vegetarian \( (p = .876). \) Conversely, Openness to Experience was associated with higher odds of being a vegetarian relative to an omnivore \( (B = 0.071, \text{OR} = 1.074, p = .002) \), but not with the odds of being vegan relative to being an omnivore \( (p = .376) \). Finally, having spiritual beliefs were not associated with eating behaviour \( (p > .430). \)

### 4.3. Transitions in eating behaviour over time

Fig. 1 displays the probabilities of remaining consistent in vs. changing one’s dietary category over a one-year period. Omnivores were highly stable in their dietary behaviour over time (i.e., \( \text{P(omnivore|omnivore)} = 0.988 \)), whereas vegetarians \( (\text{P(vegetarian|vegetarian)} = 0.743) \) and vegans \( (\text{P(vegan|vegan)} = 0.705) \) were less stable. Vegetarians who changed their diet over time were more likely to become omnivores \( (\text{P(omnivore|vegetarian)} = 0.226) \) than vegans \( (\text{P(vegetarian|vegan)} = 0.031) \), whereas vegans were roughly just as likely to become omnivores \( (\text{P(omnivore|vegan)} = 0.161) \) or vegetarians \( (\text{P(vegetarian|vegan)} = 0.134) \) over time.

Fig. 2 displays the transition probabilities focusing on the meat/no-meat distinction. Although both omnivore and no-meat diets were stable over time, no-meat eaters were more likely to become omnivores over time \( (\text{P(omnivore|no-meat)} = 0.212) \) than vice versa \( (\text{P(no-meat| omnivore)} = 0.012) \). This refutes our pre-registered hypothesis that more people would transition from a meat-based diet to a plant-based diet than vice-versa (CHZ).

### 4.4. Predictors of transitions in eating behaviour over time

As planned in our pre-registration, the Markov model with covariates focused on the omnivore and no-meat categories and considered only five covariates: protection of native species, subjective health, perceived environmental efficacy, gender, and political orientation. The results of this model are displayed in Table 4. As shown here, only gender and

<table>
<thead>
<tr>
<th>Vegetarian vs. Omnivore</th>
<th>Vegan vs. Omnivore</th>
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<tbody>
<tr>
<td><strong>B</strong></td>
<td><strong>SE</strong></td>
</tr>
<tr>
<td>Threshold</td>
<td>-3.388</td>
</tr>
<tr>
<td>Protection of native species</td>
<td>0.073</td>
</tr>
<tr>
<td>Subjective health</td>
<td>0.052*</td>
</tr>
<tr>
<td>Perceived environmental efficacy</td>
<td>0.116</td>
</tr>
<tr>
<td>Gender ( (0 = \text{Women, 1 = Men}) )</td>
<td>-0.634***</td>
</tr>
<tr>
<td>Political conservatism</td>
<td>-0.270***</td>
</tr>
<tr>
<td>Right/Wing Authoritarianism</td>
<td>-0.063**</td>
</tr>
<tr>
<td>Social Dominance Orientation</td>
<td>-0.185***</td>
</tr>
<tr>
<td>Disgust sensitivity</td>
<td>0.071***</td>
</tr>
<tr>
<td>Spiritual beliefs ( (0 = \text{no, 1 = yes}) )</td>
<td>0.027</td>
</tr>
<tr>
<td>Agreeableness (empathy)</td>
<td>0.004</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>0.071***</td>
</tr>
</tbody>
</table>

Note: Perceived environmental efficacy and protection of native species were measured at Time 9 (2017), with all other covariates measured at Time 10 (2018). \( N = 50,964 \). \*p < .05, \**p < .01, \***p < .001.
conservatism moderated the probabilities of changing diets over time, providing partial support for our pre-registered exploratory hypothesis (EH1). Men (compared to women, $b = -0.669$, OR = $0.512$, $p < .001$) and those who are more politically conservative ($b = -0.276$, OR = $0.759$, $p < .001$) were less likely to transition from a meat to a no-meat diet over the one-year period. However, none of our focal covariates significantly moderated the probability of transitioning from a no-meat to a meat diet over time ($ps > .242$).

Fig. 3 displays the effects of gender and political orientation on the transition probabilities. This figure presents the transition probabilities based on the model presented in Table 4, solved for men and women, and liberal (+1 SD) and conservative (+1 SD from the mean; $M = 3.57$, SD = 1.38) participants. As shown here, the probability of transitioning over time from an omnivore to no-meat diet was higher for women ($P$(no-meat|omnivore) = 0.013) compared to men ($P$(no-meat|omnivore) = 0.007), and among those who were liberal ($P$(no-meat|omnivore) = 0.015) compared to those who were conservative ($P$(no-meat|omnivore) = 0.007). No variables significantly moderated the probabilities of remaining in vs. transitioning from the no-meat category, perhaps due to the much smaller sample size ($n = 664$) of this category. Overall, however, the probabilities of transitioning over time remained low.

5. Discussion

There are serious environmental, ethical and health issues associated with current levels of meat production and consumption (Bastian & Loughnan, 2017; Godfray et al., 2018; Tilman & Clark, 2014). Scholars have argued that transitioning from meat-based to plant-based diets would help address these issues and also improve food availability and security (de Boer & Alking, 2011; Shepon et al., 2018). Systematic reviews of the growing literature examining factors associated with diet have noted that concerns about animals, health and the environment, as well as gender and political liberalism, often motivate people to pursue plant-based diets (Graça et al., 2019; Rosenfeld, 2018; Ruby, 2012). We have contributed to this literature by reporting pre-registered analyses of data from a nation-wide random sample of the New Zealand population examining four main questions.

First, we identify the prevalence of self-reported dietary behaviour in New Zealand, a major meat-producing, and consuming, nation. In 2019, several popular press outlets reported a steady increase in the percentage of New Zealanders who are always or mostly meat-free, with the percentage increasing from 4% in 2014 to 10% in 2018 (e.g., Woolf, 2019), and ranked New Zealand third in the world for veganism (e.g., The New Zealand Herald, 2019). These and other findings (see Neville, 2019) suggest a rise in plant-based eating in New Zealand. However, these studies are often limited by the size and representativeness of the samples. Here, we report novel dietary prevalence using data from Time 10 (2018) of the NZAVS which contains over 47,000 respondents. Consistent with our pre-registered hypothesis, the vast majority of New Zealanders (94.1%) eat meat. Encouragingly, 5.8% of New Zealanders are veg*n—a category comprised of vegetarians (4.6%), vegans (1.1%), and whole foods/plant-based vegans (0.1%). Based on a smaller (but nationwide) sample of 1326 New Zealanders, Judge and Wilson (2019) report that 4.9% of participants identified as vegetarian, and 0.5% as vegan—figures that closely parallel those reported here.

Although we identify levels of veg*n diets comparable to Judge and Wilson (2019), it is unclear whether these converging data represent an increase in meat abstention relative to prior years. Regardless, considering the open-ended nature of our measure of dietary behaviours and our use of a national probability sample, these data arguably provide the

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**Table 4**

Results of Markov model with covariates predicting the odds of transitioning between (vs. maintaining) each eating behaviour over a one-year period.

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<td>$B$</td>
<td>$se$</td>
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<tr>
<td>Omnivore Time 9</td>
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<tr>
<td>Protection of native species</td>
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Note: Table 1 presents detailed description of the variables. $N = 12,259$. *$p < .05$, **$p < .01$, ***$p < .001$. 

![Fig. 3](image-url) Markov model probabilities of remaining consistent in vs. changing diet over time, estimated for women (upper left-hand figure), men (upper right-hand figure), liberals (lower left-hand figure) and conservatives (lower right-hand figure). Arrows between eating behaviour categories reflect patterns of transition (and associated probability of transitioning between given categories) over a one-year period. Arrows on the same eating behaviour category (with associated probabilities) indicate a consistently reported dietary behaviour over a one-year period.
best-estimated prevalence of meat-based and plant-based diets of New Zealand adults. At the same time, Ruby (2012) notes that there is considerable variation in what people mean when they describe themselves as ‘vegetarian’ (in a way that may not apply to ‘vegan’ or ‘omnivore’). Ideally, we would be able to interrogate exactly what participants mean when describing their diet and perhaps complement these data with actual consumption diaries.

Second, we identified demographic and psychological variables associated with self-reported dietary behaviour (categorised as omnivore, vegetarian, or vegan) by selecting a set of theoretically-relevant variables including socio-demographic (gender, political orientation), as well as psychological (personality traits, ideological attitudes), variables. Results from a multinomial logistic regression supported our pre-registered predictions. Compared to omnivores, veg*ns tend to be women, liberal (i.e., low levels of political conservatism, RWA and SDO), report higher levels of environmental efficacy and subjective sense of health, and are more sensitive to disgust. Although findings for most of the socio-demographic and psychological variables were virtually identical in predicting the odds of being a vegetarian or a vegan (relative to being an omnivore), the personality traits of Agreeableness and Openness to Experience showed discriminant results. While vegans tend to report lower levels of Agreeableness relative to omnivores, vegetarians presented greater levels of Openness to Experience. Contrary to our predictions, belief in a spirit or lifeforce was not associated with dietary behaviour. Moreover, those expressing greater support for protecting native species were less likely to be vegan, which might reflect the item wording with ‘native species’ suggesting both animal and non-animal species. This item could also reflect a nationalism aspect; that is, protecting New Zealand native species could be seen as a form of national pride and nationalism in general rather than a facet of support for animal protection.

These results are, generally, unsurprising. Research has previously shown that meat consumption is predicted by attitudes and ideologies that index a preference for hierarchical social and environmental relations (e.g., social dominance orientation: Allen, Wilson, Ng, & Dunne, 2000), and a preference for tradition and convention (e.g., political conservatism: Hodson & Earle, 2018; right-wing authoritarianism: Allen et al., 2000). Further, women tend to endorse these ideologies and attitudes less than men. In short, a push to plant-based diets in contexts such as New Zealand has to compete with hierarchical and historical norms (Potts & White). That beliefs in spirituality are unassociated with dietary behaviour may reflect the role of cultural context – New Zealand is a relatively secular nation with a growing proportion of people who do not identify with any religion (e.g., Hove & Skov, 2008).

Third, we use the opportunity afforded by longitudinal data to examine the number of New Zealanders who transitioned from meat-based to plant-based diets (or vice-versa) from 2017 to 2018. While previous research has hinted at the factors and experiences associated with such a shift (e.g., McDonald, 2000), and investigated retrospective accounts of dietary change (e.g., Hodson & Earle, 2008), this is the first study to directly provide information about longitudinal change. Results from our Markov model showed that omnivores are highly stable in their diet over time, but that veg*ns were slightly less stable. The greater longitudinal stability of omnivores is consistent with our contention that eating meat is normative in New Zealand. However, we expected a higher prevalence of individuals to transition from a meat-based diet to a plant-based diet (CHD). Contrary to this expectation, those who followed a no-meat diet (vegetarian/vegan) in 2017 were more likely to transition to being omnivores in 2018. Indeed, vegetarians who changed their diet over time were more likely to become omnivores than vegans, whereas vegans were roughly just as likely to become omnivores or vegetarians. Considering the robust evidence of meat-eating vegetarians (Herzog, 2010, Chapter 7) and how challenging it is to sustain veg*ns (Hodson & Earle, 2018), these findings are perhaps unsurprising.

Notably, our findings corroborate those from the United States indicating vegetarians are more likely than vegans to lapse in their commitments to a plant-based diet (Asher et al., 2014). Because veganism requires greater behavioural commitments in terms of objecting to the use of nonhuman animal products not only for food but also in other domains such as clothing and scientific research (McDonald, 2000), this could lead to greater attitude-behaviour consistency in transitioning and sticking to a plant-based diet compared to vegetarians. Peer pressure might also be an important differentiating factor considering that current/former vegans are more likely to identify social influence as a reason for following the diet than their vegetarian counterparts (Asher et al., 2016). Future research could explore further why vegetarians are more likely than vegans to backslide.

Finally, we examine whether five theoretically relevant variables predict the likelihood of transitioning from omnivore to no-meat diets (or vice-versa). Based on previous reviews (Rosénfeld, 2018; Ruby, 2012), we focused on related variables available in the survey: support for protection of native species, subjective health, perceived environmental efficacy, gender, and political orientation. Notably, only gender and political orientation moderated the probabilities of changing diets over time. Specifically, men and those who are conservative were less likely than their counterparts who are women and liberal to transition from a meat to a non-meat diet over the one-year period. Notably, none of the five variables moderated the probability of transitioning from a no-meat diet to a diet that included meat over time.

This last finding is inconsistent with Hodson and Earle (2018) who reported that greater self-reported conservatism differentiated former current veg*ns – conservative veg*ns were more likely to fall off the wagon. However, as noted above, Hodson and Earle (2018) rely on a cross-sectional design that may obscure the direction of potentially causal relationships. Moreover, our results may be consistent with the aforementioned literature on the social pressures of maintaining a plant-based diet. That gender and political orientation predicted transitions from meat to plant-based diets, but none of the psychological variables examined predicted transitions from no-meat to meat-based diets, suggests that different motivational processes are involved. Unfortunately, we were unable to examine the social pressures (such as whether household members share the same diet as the participant) that may help to predict lapses from plant to meat-based diets. This could be an important avenue for future research.

By simultaneously examining different motivating factors associated with dietary behaviours, we provide insight into the relative impact of these different factors on shaping people’s diets. Indeed, conservative ideologies, alongside gender, tended to be the strongest predictor of omnivore diets (relative to both vegetarian and vegan diets), whereas personality, subjective health, and protecting New Zealand’s native species were weaker and inconsistent predictors of dietary behaviour. These findings corroborate past research that has identified a positive association between gender (men), RWA and SDO with meat consumption/animal exploitation (e.g., Allen et al., 2000; Dhont & Hodson, 2014; Graça, Calheiros, Oliveira, & Milfont, 2018; Herzog, 2015). Although environmental efficacy was a weaker predictor than conservation of vegetarian (vs. omnivore) diets, it was a stronger predictor of a vegan (vs. omnivore) diet. This suggests that environmental concern and, in particular, a strong sense of efficacy in protecting the natural environment may be especially relevant to understanding vegan diet.

That the NZAVS is based on a nation-wide random sample allows us to make some claims about how commonly people in New Zealand identify with different dietary labels. The size of the sample also allows us to compare and contrast not just omnivores and meat-abstainers, but also to look within categories of meat-abstention. Even in this large sample, ‘only’ 1.1% identified as ‘vegan’, but those 497 participants (along with the 2024 ‘vegetarians’) mean we do not have to aggregate everybody who indicates some form of meat-avoidance under a veg*an umbrella. As a result, we can meaningfully identify, for instance, that Openness to Experience and Agreeableness have differential relationships with veganism vs. omnivorism, and vegetarianism vs. omnivorism (see also Ruby, 2012).
Despite these strengths, some aspects of our findings may be affected by the measures used. Because we analysed pre-existing data that was not specifically designed to assess attitudes toward meat consumption, many of the available measures were general. For example, the measure assessing subjective health may have measured concern about any aspect of one’s health that may not be directly relevant to diet. Support for protecting New Zealand’s native species may have indexed thoughts about both flora and fauna, which could be more or less relevant to dietary behaviour depending on participants’ interpretation of native species. Thus, our models may have been better equipped to assess the impact of ideological variables as opposed to health, environment, and animal concerns as observed in previous studies (Rosenfeld, 2018; Ruby, 2012). Notwithstanding these considerations, our study provides novel information about the prevalence and psychological processes underlying the likelihood of transitioning from a meat-based to a plant-based diet. Future longitudinal studies could explore whether transitioning to plant-based diets is more easily sustained by moral-origin, environmental-origin, or health-origin veg’ns. Since contextual factors including price, availability and food preparation ability shape people’s ease and access to their preferred diet, such factors could also be examined in future studies.

In her examination of a vegan lifestyle in the United States, McDonald (2000) noted that “adopting such a lifestyle is a major change from the normative practice and ideology of human dominance over nonhuman animals” (p. 1). Herzog (2019) has also recently argued that “[b]reaking the meat habit is harder than, say, quitting smoking.” We can extend their conclusions to assert that adopting a plant-based diet represents a major shift in lifestyle from the normative meat-based diet practices in New Zealand. Considering this normative context, it might be easier to convince people to reduce their meat consumption rather than pursuing an absolutist approach of full elimination (see Herzog, 2014).

Ethical statement

The NZAVS is reviewed every three years by the University of Auckland Human Participants Ethics Committee. The New Zealand Attitudes and Values Study was approved by The University of Auckland Human Participants Ethics Committee on 03-June-2015 until 03-June-2018, and renewed on 05-September-2017 until 03-June-2021. Reference Number: 014899. Participants gave informed consent before taking part in the study.

Author contributions


Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2021.105584.

References
