Vegetarian diet and all-cause mortality: Evidence from a large population-based Australian cohort – the 45 and Up Study

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Vegetarian diet and all-cause mortality: Evidence from a large population-based Australian cohort - the 45 and Up Study

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A B S T R A C T
The vegetarian diet is thought to have health benefits including reductions in type 2 diabetes, hypertension, and obesity. Evidence to date suggests that vegetarians tend to have lower mortality rates when compared with non-vegetarians, but most studies are not population-based and other healthy lifestyle factors may have confounded apparent protective effects. The aim of this study was to evaluate the association between categories of vegetarian diet (including complete, semi and pesco-vegetarian) and all-cause mortality in a large population-based Australian cohort. The 45 and Up Study is a cohort study of 267,180 men and women aged ≥45 years in New South Wales (NSW), Australia. Vegetarian diet status was assessed by baseline questionnaire and participants were categorized into complete vegetarians, semi-vegetarians (eat meat ≤ once/week), pesco-vegetarians and regular meat eaters. All-cause mortality was determined by linked registry data to mid-2014. Cox proportional hazards models quantified the association between vegetarian diet and all-cause mortality adjusting for a range of potential confounding factors. Among 243,096 participants (mean age: 62.3 years, 46.7% men) there were 16,836 deaths over a mean 6.1 years of follow-up. Following extensive adjustment for potential confounding factors there was no significant difference in all-cause mortality for vegetarians versus non-vegetarians [HR = 1.16 (95% CI 0.93–1.45)]. There was also no significant difference in mortality risk between pesco-vegetarians [HR = 0.79 (95% CI 0.59–1.06)] or semi-vegetarians [HR = 1.12 (95% CI 0.96–1.31)] versus regular meat eaters. We found no evidence that following a vegetarian diet, semi-vegetarian diet or a pesco-vegetarian diet has an independent protective effect on all-cause mortality.

C O N T A C T   A U T H O R
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1. Introduction

Vegetarian diets vary worldwide but generally exclude meat, seafood, and products containing these foods. The specific patterns of vegetarian diets vary from vegan (no animal products) through lacto-vegetarian (including dairy products) and ovo-lacto-vegetarians (including eggs and dairy) (Rizzo et al., 2013; Orlich et al., 2014). In some studies those who include fish and seafood in their diet (also referred to as pesco-vegetarian) are also considered vegetarians (Haddad and Tanzman, 2003) and yet other studies have investigated whether a semi-vegetarian diet (where meat is consumed infrequently) has healthful effects (Clarys et al., 2014). The increasing interest in vegetarian dietary patterns for preventing disease is reflected in the position statement by the American Dietetic Association (now the Academy of Nutrition and Dietetics) (Craig et al., 2009) which endorses carefully planned vegetarian and vegan diets as 'healthful, nutritionally adequate and providing health benefits in the prevention and treatment of certain diseases'. They also state that 'well planned vegetarian diets are appropriate for individuals during all stages of the lifecycle, including pregnancy, lactation, infancy, childhood, and adolescence, and for athletes'. The 2015–2020 Dietary Guidelines for Americans (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015) outline a Healthy Vegetarian Diet pattern for vegetarians to follow.

In prospective studies and one meta-analysis of clinical trials the vegetarian dietary pattern has been associated with reductions in risk for type 2 diabetes (Tonstad et al., 2013; Yang et al., 2008), hypertension (Yokoyama et al., 2014; Appleby et al., 2002), and obesity (Yang et al., 2008).
2008; Rosell et al., 2006) when adjusted for covariates, such as age, gender, education, physical activity, alcohol use and smoking. In addition, people following a vegetarian diet have been shown to have lower mortality risk compared to non-vegetarians, particularly from cardiovascular disease (CVD) (Huang et al., 2012; Kwock et al., 2014). There have been a small number of good quality longitudinal studies that have investigated the association, including the Adventist Health Cohort (I and II) and European Prospective Investigation into Cancer-Oxford (EPIC - Oxford). In the Adventist Health Study I (n = 34,198) in California, vegetarian dietary patterns were associated with reduced all-cause mortality and increased longevity (Fraser, 1999) and this was also seen in Adventist Health Study II (n = 96,000) where the adjusted hazard ratio (HR) for all-cause mortality in all vegetarians combined versus non-vegetarians was 0.88 (95% CI, 0.80–0.97) (Orlich et al., 2013). However, in the EPIC-Oxford study, there were no differences in mortality from ischemic heart disease [HR = 0.81, 95% CI, 0.57–1.16] or differences in overall mortality observed between vegetarians versus non-vegetarians [HR = 1.03, 95% CI, 0.90–1.16] (Key et al., 2006, 2009).

Several methodological limitations apply to these longitudinal studies and underpin the need for these results to be investigated further. First, most of these studies were designed to recruit vegetarians or occurred in populations with higher proportions of vegetarians (such as the Adventists, who may have other lifestyle factors and health-enhancing behaviours responsible for the observed protective effects), therefore previous findings may have limited generalizability. Second, vegetarians usually engage in an overall healthier lifestyle compared with their non-vegetarian counterparts, such as a lower prevalence of smoking and excessive alcohol consumption (Key et al., 2009) and have higher levels of physical activity (Bedford and Barr, 2005). Therefore the protective effects observed could be due to the other concurrent behaviours.

The primary objective of this study is to examine the association between vegetarian diet and all-cause mortality in a large Australian mid–older age population-based cohort. A secondary objective is to compare different types of vegetarian diets (complete vegetarian, semi-vegetarian, pesco-vegetarian) to meat eaters in their risk of all-cause mortality.

2. Methods

The Sax Institute’s 45 and Up Study is a longitudinal cohort study of a large sample (n = 267,180) of men and women based in New South Wales, the most populous State in Australia (where Sydney is the largest city). The primary aim of the study is to investigate a wide range of exposures and outcomes of public health importance for the ageing population. The cohort profile and research protocol has been published (Banks et al., 2008) and is briefly described here.

2.1. Description of the cohort

Participants were 45 years or older at the time of recruitment from February 1, 2006, through November 30, 2008. Participants were randomly sampled from the Medicare Australia database (a national health care database, which includes all citizens and permanent residents of Australia and some temporary residents and refugees), and were invited via mail to be part of the study. The overall response rate was estimated to be 18% and approximately 10% of the entire New South Wales population 45 years or older was included in the final sample (Banks et al., 2008). Baseline data were collected via self-reported questionnaire. For this analysis we used data from participants who had non-missing data on vegetarian diet status, age, gender, education, marital status, geographic remoteness, SEIFA (Socio-Economic Index for Area, a Census-based ecologic measure of socio-economic disadvantage), smoking status, physical activity, alcohol intake, and comorbidities including cancer, hypertension, and cardiovascular disease (CMD) which includes Type 2 diabetes, stroke and heart disease. The final sample for this analysis included 243,096 participants with non-missing data on the confounders listed above. Data was analyzed in September 2016. The study was approved by the New South Wales Population and Health Services Research Ethics Committee (reference No. 2010/05/234).

2.2. Outcome data

The outcome variable, all-cause mortality, was determined by linking data from the New South Wales Registry of Births, Deaths, and Marriages from February 1, 2006 to 17 June 2014. The mortality data were linked to the baseline data from the 45 and Up Study by the Centre for Health Record Linkage (Eveleigh, New South Wales, Australia) using probabilistic record linkage methods and commercially available software (ChoiceMaker; ChoiceMaker Technologies Inc.).

2.3. Dietary data

The baseline questionnaire included brief questions on dietary behaviours (see http://www.45andUp.org.au). The main exposure variable, vegetarian diet, was assessed using the question ‘About how many times each week do you eat…’, categories were 1) beef, lamb or pork; 2) chicken, turkey or duck; 3) processed meat including bacon, sausages, salami, devon, burgers; and 4) fish or seafood. If a value > 1 was placed in any of the first three categories they were classified as ‘regular meat eaters’. Vegetarian diet was further verified using a follow-up question which asked which food the participants never ate. These categories included red meat, any meat, fish chicken/poultry, eggs, seafood, pork/ham, sugar, cream, dairy products, wheat products, and cheese. The responses to this question were used to further delineate the categories of diet status. For the first objective, complete vegetarians were compared with a combined group of ‘non-vegetarian’ (which included pesco-vegetarians, semi-vegetarians and regular meat eaters). For the second objective, complete vegetarians were separately compared with pesco-vegetarians, semi-vegetarians (eat meat ≤ 1 week), and regular meat eaters. We were not able to distinguish between further categories such as vegans and lacto-ovo vegetarians because our dietary variables were based on brief questions and not on a 24-h recall or a food frequency questionnaire. Table 1 gives the definitions of the different categories of vegetarians and non-vegetarians used for this analysis.

2.4. Covariate data

Covariates included age, sex, country of birth (Australia vs other), educational level (≤ 12 years vs degree/higher), marital status (single, widowed, divorced/separated vs married/de facto), location of residence (regional/remote vs major cities), socio-economic status quintiles based on Socio-Economic Indexes For Area [SEIFA] which summarizes census obtained socio-economic indicators for geographic areas including income, educational attainment, unemployment and proportion of people in unskilled occupations (Australian Bureau of Statistics, 2011). Other covariates included smoking status (never, past, or current), alcohol intake (categorized as high if > 14 drinks per week vs mid-low ≤ 14 drinks per week), physical activity (categorized as meeting the Australian guidelines ≥ 150 min per week or not). Body mass index was derived from self-reported height (m²) and weight (kg) and categorized as underweight (< 18.5 kg/m²), normal weight (18.5–25.0 kg/m²), overweight (25.0–30.0 kg/m²), or obese (≥ 30.0 kg/m²). Diagnosed comorbidities included ever diagnosed cardiovascular disease (including Type 2 diabetes, heart disease and stroke) and diagnosis of cancers in the last 10 years (excluding non-melanoma skin cancer). As stated above, some data for these potential confounders were missing and this reduced the sample size by 24,012 (9.1% missing). Cases who had missing data were compared with the cohort that completed follow up on age, sex and education status and we found that they were comparable (Appendix A).
2.5. Statistical analysis

The association between vegetarian diet and all-cause mortality was analyzed using Cox proportional hazards regression models. The proportional hazards assumption was checked for each independent factor in the model by inspecting the Kaplan-Meier survival curves, the Schoenfeld residuals, as well as using the supremum test for the proportional hazard assumption using a method based on Lin, Wei and Zing (Lin et al., 1999). Survival time, measured as the time from baseline to death or the censor point (17 June 2014), was the outcome variable, with the vegetarian status as a categorical exposure variable. Hazard ratios (HRs) were reported for two levels of analysis. These were vegetarian versus non-vegetarian and also for the different categories of vegetarian status relative to regular meat eaters to assess a possible graded association. A number of sequential incremental models were created. Model 1 was adjusted for diet status, sex and age group; Model 2 additionally adjusted education level, marital status, rural/urban residence, and SEIFA; Model 3 additionally adjusted for health behaviours, including smoking status, level of physical activity, alcohol consumption; Model 4 additionally adjusted for ever diagnosis of hypertension and CMD, and diagnosis of cancer within the last 10 years and any significant interactions between main the effect and gender, age group, CMD, cancer and hypertension. The introduction of BMI into the models would have decreased the sample size by 16,692 so we did not use this variable in the analysis presented. A separate analysis was conducted using models adjusted for BMI and adjustment for this variable did not alter the results and changed the HR by <2%.

Two separate sensitivity analyses were conducted. The first excluded all follow-up time for the first two years for all participants. This addresses the issue of ‘reverse causality’ due to occult disease. Data is excluded for all participants not just those who died to avoid immortal time bias. The second limited the analysis to a relatively healthy sample by excluding participants with CMD or cancer (except for non-melanoma skin cancer) at baseline. Statistical analysis was conducted in SAS v 9.3 (SAS Institute Inc.).

Table 1
Responses used to define vegetarian and non-vegetarian diet used for this analysis of the 45 and Up Study, NSW Australia.

<table>
<thead>
<tr>
<th>Vegetarian</th>
<th>Semi-vegetarian</th>
<th>Pesco-vegetarian</th>
<th>Regular meat eater</th>
</tr>
</thead>
<tbody>
<tr>
<td>How many times a week do you eat:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beef, lamb, pork</td>
<td>0</td>
<td>0 or ≤ 1</td>
<td>0</td>
</tr>
<tr>
<td>Chicken, turkey, duck</td>
<td>0</td>
<td>0 or ≤ 1</td>
<td>0</td>
</tr>
<tr>
<td>Processed meat*</td>
<td>0</td>
<td>0 or ≤ 1</td>
<td>0</td>
</tr>
<tr>
<td>Fish or seafood</td>
<td>0</td>
<td>0 or ≤ 1</td>
<td>≥ 1</td>
</tr>
<tr>
<td>Total of above 4 categories = 0</td>
<td>Total of above categories ≤ 1</td>
<td>Total of above categories ≥ 1</td>
<td></td>
</tr>
<tr>
<td>Put a cross in the box if you never eat:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red meat</td>
<td>X</td>
<td>N/A</td>
<td>X</td>
</tr>
<tr>
<td>Any meat</td>
<td>X</td>
<td>N/A</td>
<td>X</td>
</tr>
<tr>
<td>Fish</td>
<td>X</td>
<td>N/A</td>
<td>Blank</td>
</tr>
<tr>
<td>Chicken/poultry</td>
<td>X</td>
<td>N/A</td>
<td>X</td>
</tr>
<tr>
<td>Seafood</td>
<td>X</td>
<td>N/A</td>
<td>Blank or X</td>
</tr>
<tr>
<td>Pork/ham</td>
<td>X</td>
<td>N/A</td>
<td>X</td>
</tr>
</tbody>
</table>

N/A not used for coding into categories. * Such as bacon, sausages, salami, devon, burgers.

3. Results

During a mean follow-up period of 6.1 years (total 1,480,509 person year follow-up) among 243,096 participants there were 16,836 (6.9% of total) deaths. The crude mortality rate was 1137 per 100,000 person years. Table 2 compares the baseline characteristics of the three different variations of diets (complete vegetarian, pesco-vegetarian, semi-vegetarian) with regular meat eaters. A total of 98.1% of the population were classified as regular meat eaters, with 0.63% classified as vegetarians, 0.46% pesco-vegetarian and 0.82% semi-vegetarian. Compared with regular meat eaters, complete vegetarians were younger, less likely to be overweight or obese, more likely to be female, and less likely to have cardiovascular and metabolic diseases (including Type 2 diabetes, heart disease or stroke) and hypertension at the time of recruitment. They were also more likely to have healthy lifestyle behaviours such as a lower prevalence of smoking and risky alcohol intake. With regard to socio-demographic factors, complete vegetarians were more likely to have completed higher education, less likely to be married, and more likely to be born overseas than regular meat eaters.

Out of 16,836 deaths in total (6.9%) there were 80 deaths in vegetarians (5.3%) and 16,756 deaths (6.9%) in others (which includes pesco-vegetarians and semi-vegetarians). Table 3 shows the comparison of hazard ratios for mortality between vegetarians and non-vegetarians. The minimally adjusted model (Model 1) and all the subsequent models showed no statistically significant difference in the risk of mortality between vegetarians and non-vegetarians.

When deaths in people with different variations of vegetarian diets were compared, there were 46 deaths in pesco-vegetarians (4.1%) and 158 deaths in semi-vegetarians (7.8%). Table 4 shows the hazard ratios for three different variations of vegetarian diet status compared with regular meat eaters. In Model 1, pesco-vegetarians showed a reduced risk of death compared with regular meat eaters, however there was no difference in the risk of death between complete vegetarians, semi-vegetarians or regular meat eaters. In Model 2, after the introduction of socio-demographic variables, the significant reductions in risk of mortality among pesco-vegetarians remained. By Model 3, after adjustment for health behaviours, all differences between categories approached the null and became non-significant. Results from the sensitivity analyses did not change the main findings (Appendix Tables B–E). None of the four models had any significant interactions (all p > 0.1) after controlling for all other covariates.

4. Discussion

This is a large population-based prospective cohort study, with comprehensive data on potential confounders, which investigates the association between vegetarian diet and all-cause mortality. The results show no significant differences in mortality between vegetarians and non-vegetarians. There was also no difference in risk of mortality between different sub-groups of vegetarian status after adjustment for potential confounders.

Our results are in agreement with other studies (Appleby et al., 2002; Key et al., 2009; Crowe et al., 2013; Thorogood et al., 1994; Chang-Claude et al., 2005) and two recent meta-analyses (Kwok et al., 2014; Dinu et al., 2016) which have shown that vegetarians do not have a statistically lower all-cause mortality than their non-vegetarian counterparts. In most studies, before adjustments for potential confounders, there is a reduction in risk and this may be because vegetarian status is positively correlated with a number of other healthy factors.
behaviours such as higher levels of physical activity, less smoking and less risky alcohol consumption (Bedford and Barr, 2005; Farmer et al., 2011). They are also more likely to have healthier food choices (Orlich et al., 2014).

A possible reason for the lack of association on mortality is that the traditional vegetarian diet is undergoing a transition in recent years as plant foods and whole grains are being replaced by soybean substitutes, refined carbohydrates with high sugar content, and highly processed snacks and fast foods which may bring dietary risk factors more in line with the ‘normal’ diet (Clarys et al., 2014). It is recognised that the vegetarian diet patterns around the world differ greatly beyond the absence of meat. The content of the vegetarian diet between EPIC-Oxford and AHS cohorts is known to differ substantially (Orlich et al., 2013; Fraser, 2009; Appleby et al., 2016). For example, the vegetarians in AHS-2 cohort consumed more fruit and vegetables, and therefore more fibre and Vitamin C, than those in the EPIC Oxford cohort (Orlich et al., 2013).

Our findings suggest that differences in crude mortality between groups were due to other factors and not the vegetarian diet. Other studies investigating the association were designed to oversample vegetarians (Key et al., 2009; Frisén, 2013) or set in populations with large numbers of vegetarians (Key et al., 2009) or set in populations with large numbers of vegetarians (Key et al., 2009). Our finding that pesco-vegetarians had a substantially reduced risk after the first two levels of adjustment is interesting. A meta-analysis of 17 cohort studies has shown that low fish consumption have a significant association with the cardiovascular disease (Clarys et al., 2014). It is recognised that the vegetarian diet patterns around the world differ greatly beyond the absence of meat. The content of the vegetarian diet between EPIC-Oxford and AHS cohorts is known to differ substantially (Orlich et al., 2013; Fraser, 2009; Appleby et al., 2016). For example, the vegetarians in AHS-2 cohort consumed more fruit and vegetables, and therefore more fibre and Vitamin C, than those in the EPIC Oxford cohort (Orlich et al., 2013).

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non-Adventist studies did not show mortality reductions in vegetarians (Kwok et al., 2014) and the estimated risks were very different. It has been theorised that the population of Seventh Day Adventists may have other important lifestyle characteristics that also impact on cardiovascular disease and mortality outcomes (Kwok et al., 2014). Therefore possible selection bias and confounding in these studies could not be ruled out. Similarly, participants in the 45 and Up cohort are slightly different and are more highly educated, less likely to smoke, more physically active and less overweight/obese than the general population (Mealing et al., 2010). This is consistent with the ‘healthy cohort effect’, which applies to virtually all cohort studies, whereby health conscious people are more likely than others to be recruited and remain in the cohort (Mealing et al., 2010), however the possibility of selection bias cannot be ruled out. Despite differences in the prevalence of exposures and outcomes, the associations between the exposure and outcome are generally robust to differences in response rates and sample representativeness, as demonstrated by a previous study comparing risk factor-outcome associations between the 45 and Up study and a representative sample of the NSW population (Mealing et al., 2010). Recent studies set in countries where vegetarian diets are common such as Indian Migration study (Shridhar et al., 2014) (35% of the Indian population is vegetarian) will be well placed to delineate the competing factors which make the populations different, as vegetarians in this population are more representative of the general population.

4.1. Strengths and limitations

Strengths of this study are the prospective cohort design and a large population-based sample. Because vegetarianism is relatively rare, it is advantageous to have a large sample with sufficient number of participants being vegetarians, and particularly different variations of vegetarian diet. A potential limitation of this analysis was the accuracy of the assessment of vegetarian status and possible measurement error. The variations of vegetarian diet were determined on the basis of response to questions asking about frequency of meat consumption and what they excluded from their diets. These questions have been validated to estimate intake (Roddam et al., 2005) and we believe that because there are two levels of exclusion, our definition of vegetarian is conservative. Another limitation of the current study is that other factors that may be responsible for the association, such as lower energy intake were not collected and could not be adjusted for in the analyses. Because of dietary data was collected using short questions we were not able to consider differences in the food content of the vegetarian diet beyond the absence of meat (for example intake of processed foods or sugar) and we were also not able to adjust for change in diet over time or estimate how long the participants had been vegetarian. Other limitations include limited generalizability and selection bias as discussed above, there was a relatively short follow up time (5–9 years) and the analysis may be strengthened by further follow-up and the availability of cause-specific mortality. As in most cohort studies we are limited in our ability to infer causation and assess the temporality of the association. However, we tested for reverse causation in this analysis (i.e. changing to vegetarian diet as a result of cancer/other serious diagnosis) by controlling for CMD and cancer in the full model, as well as by conducting sensitivity analyses excluding participants who died within the first two years and people with cancer and CMD. We also tested for interactions between CMD and diet and cancer and diet but none of these interactions were significant.

5. Conclusions

In conclusion, we have shown in a large population-based Australian cohort that there is no difference in mortality between vegetarians and non-vegetarians. The results of our study seem consistent with other studies and meta-analyses which have shown that in non-selected populations a vegetarian diet is not associated with reduced mortality. Although dietary recommendations cannot be inferred without further research in this area, follow up of this cohort over a longer period and the association of vegetarian diet with cause-specific mortality will be investigated when those data become available.

Author contributions

Study concept and design: Mihrshahi, Ding, Allman-Farinelli, Banks, and Bauman. Acquisition of data: Ding, Gale, Banks and Bauman. Analysis and interpretation of data: Mihrshahi, Ding, Gale, Allman-Farinelli, Banks, and Bauman. Drafting of the manuscript: Mihrshahi, Ding and Gale. Critical revision of the manuscript for important intellectual content: Mihrshahi, Ding, Allman-Farinelli, Banks, and Bauman. Statistical analysis: Gale Obtained funding: Bauman, Banks, Ding, Administrative, technical, or material support: Banks and Bauman. Study supervision: Bauman.

Conflict of interest statement

The authors have no conflict of interest. Margaret Allman-Farinelli has previously received funding from Meat and Livestock Australia Ltd. (MLA) for a separate project. MLA had no involvement in this study or in interpretation of the data.

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Appendix A

Appendix Table A
Comparison of key demographic variables between full dataset (n = 267,180) and analytic dataset (n = 243,096) (45 and Up Study, NSW, Australia).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full dataset 45 and Up n = 267,180</th>
<th>Analytic dataset n = 243,096</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male %</td>
<td>46.40</td>
</tr>
<tr>
<td></td>
<td>Female %</td>
<td>53.60</td>
</tr>
<tr>
<td>Age group</td>
<td>&lt;60</td>
<td>46.20</td>
</tr>
<tr>
<td></td>
<td>60–74</td>
<td>36.86</td>
</tr>
<tr>
<td></td>
<td>≥75</td>
<td>16.94</td>
</tr>
<tr>
<td>Education</td>
<td>≤12 years</td>
<td>76.56</td>
</tr>
<tr>
<td></td>
<td>Degree/higher</td>
<td>23.44</td>
</tr>
</tbody>
</table>

Appendix Table B
Comparison of risk of mortality presented as hazard ratios [HR (95% CIs)] between vegetarians and non-vegetarians (45 and Up Study, NSW, Australia) [Excluding all person time during the first two years of follow-up].

<table>
<thead>
<tr>
<th>Vegetarian n = 1468</th>
<th>Non-vegetarian n = 232,034</th>
<th>P-value (Wald χ²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>0.91 (0.70,1.19)</td>
<td>Ref</td>
</tr>
<tr>
<td>Model 2</td>
<td>0.96 (0.73,1.25)</td>
<td>Ref</td>
</tr>
<tr>
<td>Model 3</td>
<td>1.04 (0.81,1.36)</td>
<td>Ref</td>
</tr>
<tr>
<td>Model 4</td>
<td>1.08 (0.83,1.41)</td>
<td>Ref</td>
</tr>
</tbody>
</table>

Model 1: Vegetarian status adjusted for sex and age group.
Model 2: Model 1 + education level, marital status, remoteness, country of birth and SEIFA.
Model 3: Model 2 + smoking status, physical activity category and alcohol category.
Model 4: Model 3 + cancer, hypertension and CMD.

Appendix Table C
Comparison of risk of mortality presented as hazard ratios [HR (95% CIs)] between different categories of vegetarian status and regular meat eaters (45 and Up Study, NSW, Australia) [Excluding all person time during the first two years of follow-up].

<table>
<thead>
<tr>
<th>Vegetarian n = 1468</th>
<th>Pesco-vegetarian n = 1059</th>
<th>Semi-vegetarian n = 1784</th>
<th>Regular meat eater n = 216,857</th>
<th>P-value (Wald χ²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>0.91 (0.70,1.19)</td>
<td>0.80 (0.58,1.09)</td>
<td>1.04 (0.85,1.26)</td>
<td>Ref</td>
</tr>
<tr>
<td>Model 2</td>
<td>0.96 (0.73,1.25)</td>
<td>0.76 (0.55,1.05)</td>
<td>0.99 (0.81,1.20)</td>
<td>Ref</td>
</tr>
<tr>
<td>Model 3</td>
<td>1.04 (0.80,1.36)</td>
<td>0.85 (0.62,1.17)</td>
<td>0.97 (0.80,1.19)</td>
<td>Ref</td>
</tr>
<tr>
<td>Model 4</td>
<td>1.08 (0.83,1.41)</td>
<td>0.88 (0.64,1.21)</td>
<td>0.99 (0.82,1.21)</td>
<td>Ref</td>
</tr>
</tbody>
</table>

Model 1: Vegetarian status adjusted for sex and age group.
Model 2: Model 1 + education level, marital status, remoteness, country of birth and SEIFA.
Model 3: Model 2 + smoking status, physical activity category and alcohol category.
Model 4: Model 3 + cancer, hypertension and CMD.

Appendix Table D
Comparison of risk of mortality presented as hazard ratios [HR (95% CIs)] between vegetarians and non-vegetarians (45 and Up Study, NSW, Australia) [Healthy Population (participants with cardio-metabolic disease and cancer excluded)].

<table>
<thead>
<tr>
<th>Vegetarian n = 1144</th>
<th>Non-vegetarian n = 160,297</th>
<th>P-value (Wald χ²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>0.94 (0.68,1.30)</td>
<td>Ref</td>
</tr>
<tr>
<td>Model 2</td>
<td>0.97 (0.70,1.34)</td>
<td>Ref</td>
</tr>
<tr>
<td>Model 3</td>
<td>1.06 (0.77,1.46)</td>
<td>Ref</td>
</tr>
<tr>
<td>Model 4</td>
<td>1.06 (0.77,1.47)</td>
<td>Ref</td>
</tr>
</tbody>
</table>

Model 1: Vegetarian status adjusted for sex and age group.
Model 2: Model 1 + education level, marital status, remoteness, country of birth and SEIFA.
Model 3: Model 2 + smoking status, physical activity category and alcohol category.
Model 4: Model 3 + cancer, hypertension and CMD.

a P-value adjusted for all other factors in the model.
Appendix Table E
Comparison of risk of mortality presented as hazard ratios [HR (95% CIs)] between different categories of vegetarian status and regular meat eaters (45 and Up Study, NSW, Australia) [Healthy Population (cardio-metabolic disease and cancer removed)].

<table>
<thead>
<tr>
<th></th>
<th>Vegetarian n = 1144</th>
<th>Pesco-vegetarian n = 863</th>
<th>Semi-vegetarian n = 1355</th>
<th>Regular meat eater n = 158,079</th>
<th>P-value* (Wald χ²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>0.94 (0.68,1.30)</td>
<td>0.70 (0.46,1.07)</td>
<td>1.28 (1.02,1.61)</td>
<td>Ref</td>
<td>0.058</td>
</tr>
<tr>
<td>Model 2</td>
<td>0.97 (0.70,1.34)</td>
<td>0.66 (0.43,1.00)</td>
<td>1.23 (0.98,1.54)</td>
<td>Ref</td>
<td>0.071</td>
</tr>
<tr>
<td>Model 3</td>
<td>1.06 (0.77,1.46)</td>
<td>0.70 (0.46,1.10)</td>
<td>1.17 (0.93,1.47)</td>
<td>Ref</td>
<td>0.193</td>
</tr>
<tr>
<td>Model 4</td>
<td>1.06 (0.77,1.47)</td>
<td>0.70 (0.46,1.10)</td>
<td>1.18 (0.95,1.48)</td>
<td>Ref</td>
<td>0.178</td>
</tr>
</tbody>
</table>

Model 1: Vegetarian status adjusted for sex and age group.
Model 2: Model 1 + education level, marital status, remoteness, country of birth and SEIFA.
Model 3: Model 2 + smoking status, physical activity category and alcohol category.
Model 4: Model 3 + cancer, hypertension and CMD.

* P-value adjusted for all other factors in the model.

References


