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Cross-sectional analyses of participation in cancer screening and use of hormone replacement therapy and medications in meat eaters and vegetarians: the EPIC-Oxford study.

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Manuscripts

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3 1 **Cross-sectional analyses of participation in cancer screening and use of hormone**
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5 2 **replacement therapy and medications in meat eaters and vegetarians: the EPIC-Oxford**
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7 3 **study.**
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2
3 18 **ABSTRACT (250 words)**
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6 19 **Objectives:** To examine differences in health-related behaviours such as screening or testing
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8 20 for cancer, use of hormone replacement therapy (HRT), and use of other medications in
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10 21 different diet groups.

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13 22 **Design:** We studied 31,260 participants across four diet groups (18,155 meat eaters, 5,012
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15 23 fish eaters, 7,179 vegetarians, 914 vegans) in the UK EPIC-Oxford cohort. Questions were
16
17 24 asked in follow-up questionnaires regarding participation in breast screening, cervical
18
19 25 screening, prostate specific antigen (PSA) testing, use of HRT, and use of medications for the
20
21 26 past four weeks. Using Poisson regression, we estimated the prevalence ratios (PR) for each
22
23 27 outcome across people of different diet groups, using meat-eaters as the reference group.

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26
27 28 **Results:** Compared to meat-eaters, vegetarian (PR; 95% confidence interval: 0.94; 0.89,
28
29 29 0.98) and vegan (0.82; 0.71, 0.95) women had lower participation in breast screening, and
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31 30 vegetarian men were less likely to undergo PSA testing (0.82; 0.71, 0.96). No differences
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33 31 were observed among women for cervical screening. In women, all non-meat eating groups
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35 32 had lower use of HRT compared to meat-eaters (p heterogeneity <0.0001). Lower reported
36
37 33 use of any medication was observed for participants in all non-meat eating groups with no or
38
39 34 one self-reported illness (p heterogeneity ≤ 0.0002). No heterogeneity was observed across the
40
41 35 diet groups for the reported use of specific medication for high blood pressure, high blood
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43 36 cholesterol, asthma, diabetes, and thyroid disease.

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47 37 **Conclusions:** Differences in breast screening, PSA testing, HRT use and overall medication
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49 38 use were observed across the diet groups. Whether such differences contribute to differential
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51 39 long-term disease risks requires further study.
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Strengths and limitations of this study

- This study is the first to simultaneously examine prevalence of breast and cervical cancer screening, prostate specific antigen testing, hormone replacement therapy (HRT) use and medication use in different diet groups.
- The study includes a large number of participants recruited from across different regions in the United Kingdom, with a high proportion of fish eaters, vegetarians, and vegans.
- Recall bias is possible because assessment of cancer screening or testing, HRT use and medication use was based on self-report, although there is no indication that such misclassification bias should differ by diet group.
- The study is cross-sectional and we cannot infer causality.

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41 INTRODUCTION

42 People of different habitual diet groups have been shown to have different health
43 characteristics. Compared to meat eaters, vegetarians generally have lower BMI, blood
44 pressure, and circulating low density lipoprotein cholesterol levels [1–3], characteristics
45 likely to reduce disease risk. However, evidence on the long-term risk of many non-
46 communicable diseases across people of different diet groups remains inconclusive. For
47 example, although both a United Kingdom (UK) [4] and a United States (US) [5] study
48 reported lower risk of overall cancer incidence with a vegetarian diet, the associations for
49 specific types of cancer are heterogeneous. For cardiovascular diseases, vegetarians in EPIC-
50 Oxford have been observed to have lower ischaemic heart disease risk (hospitalization and
51 death combined) [6], but no significant difference in ischaemic heart disease mortality was
52 observed between diet groups in the same population [7].

53 The reason for this apparent difference in risk of incident ischaemic heart disease and
54 ischaemic heart disease mortality in vegetarians is unclear. One possible explanation could be
55 the differential use of appropriate medications in the different diet groups, which
56 subsequently influence disease mortality. In a Belgian population for example, vegetarians
57 had a lower use of prescription medications compared to non-vegetarians, but similar use of
58 non-prescription drugs [8]. On the other hand, differences in other health related behaviours,
59 such as participation in cancer screening or use of hormone replacement therapy (HRT), may
60 also contribute to differences in cancer risk across the diet groups. Results from a Swedish
61 cohort [9] and a US cohort [10] showed that vegetarians (including vegans and people who
62 ate fish but not meat) had lower odds of attending breast screening and prostate cancer
63 screening respectively, when compared to meat eaters. Overall, literature on participation in
64 screening and use of medication across people of different diet groups is scarce, and to our
65 knowledge no studies have specifically examined the use of HRT in different diet groups.

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3 66 Therefore, the aim of this study was to assess participation in cancer screening or testing, and
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5 67 use of HRT and other medications among people of different diet groups in a large
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7 68 population-based cohort in the UK with a high percentage of vegetarians.
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11 12 13 70 **METHODS**

14 15 16 71 **Study population**

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19 72 The EPIC-Oxford study is a UK based cohort recruited between 1993 and 1999. The study
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21 73 protocol was approved by a Multicentre Research Ethics Committee (Scotland A Research
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23 74 Ethics Committee) and participants gave written informed consent. Details of the recruitment
24
25 75 process have been described previously [1]. In brief, a combination of general practitioner
26
27 76 (GP) recruitment and postal recruitment was used. The GP recruitment invited men and
28
29 77 women aged 35 to 59 years registered with participating GPs and recruited 7,421 participants.
30
31
32 78 The postal recruitment was targeted at vegetarians, vegans, and other people interested in diet
33
34 79 and health, and recruited 57,990 participants aged 20 or above. All participants included in
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36 80 this analysis completed a full recruitment questionnaire which asked about their habitual diet
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38 81 and other health and lifestyle characteristics. A follow-up questionnaire was then sent to
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40 82 surviving participants approximately 5 years after recruitment (mostly from 2000 to 2003),
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42 83 and a second follow-up questionnaire was mailed approximately 10 years after recruitment
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44 84 (mostly in 2007). In the follow-up questionnaires, updated information was gathered on diet,
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46 85 health and lifestyle, including self-reported current health.
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87 **Assessment of diet group**

88 In the recruitment questionnaire and each subsequent follow-up questionnaire, four questions
89 were asked regarding consumption of meat, fish, dairy products, and eggs. Responses to these
90 questions were used to assign participants to one of four diet groups at each time point: meat
91 eaters (participants who ate meat, irrespective of whether they ate fish, dairy products or
92 eggs); fish eaters (participants who did not eat meat but did eat fish); vegetarians (participants
93 who did not eat meat or fish, but did eat one or both of dairy products and eggs), and vegans
94 (participants who did not eat meat, fish, dairy products, or eggs).

96 **Assessment of participation in screening, HRT and medication use**

97 In the follow-up questionnaires, women were asked if they had ever had a breast screening by
98 mammography, cervical screening by the smear test (only on the 5 year follow-up
99 questionnaire), or used HRT, and men were asked if they had ever had a prostate specific
100 antigen (PSA) test (only on the 10 year follow-up questionnaire). On the 10 year follow-up
101 questionnaire, all participants were asked if they had used any medication for most of the last
102 four weeks, with 36 named medications and a free text field for reporting regular use of any
103 medication not on the list; participants were also asked if they had been diagnosed with any
104 of a list of 29 medical conditions, and the year when the condition was first diagnosed. The
105 corresponding question on medication use on the 5 year questionnaire was shorter, with 20
106 named medications and 26 medical conditions.

107 For assessment of specific medication use, five common medical conditions associated with
108 specific medications were identified: high blood pressure (commonly treated with one or
109 more of amlodipine, enalapril, frusemide, propranol, atenolol, bendrofluzide, lisinopril and

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3 110 nifedipine), high blood cholesterol (atorvastatin and simvastatin), asthma (beclomethasone
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5 111 and salbutamol), diabetes (insulin and metformin), and thyroid disease (thyroxine).

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11 113 **Statistical analyses**

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14 114 Information on assignment to diet group and assessment of health behaviour from the 10 year
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16 115 follow-up questionnaire was used for our analyses, except for the assessment of participation
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18 116 in cervical screening which was only asked on the 5 year follow-up questionnaire.
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20 117 Participants were excluded from all analysis if they did not answer the relevant questions to
21
22 118 be assigned to an appropriate diet group (n=28), or if they did not answer the relevant
23
24 119 question on medication use (n=407). For the analyses related to participation in breast
25
26 120 screening, cervical screening, PSA testing or HRT use, only women or men who answered
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28 121 the relevant question and were in the specified age group at questionnaire completion were
29
30 122 included. The age group specifications were as follows: age 50 to 74 years for breast
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32 123 screening, age 25 to 74 years for cervical screening, age 50 to 84 years for PSA testing, and
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34 124 age 50 to 74 years for HRT use. For HRT use, we further restricted the analysis to post-
35
36 125 menopausal women.

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40 126 For each analysis, we used Poisson regression to estimate prevalence ratios (95% confidence
41
42 127 intervals, CI) of cancer screening or testing (breast screening, cervical screening, PSA
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44 128 testing), HRT use, or medication use in different diet groups, using meat eaters as the
45
46 129 reference group. The analyses for cancer screening or testing and use of HRT adjusted for age
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48 130 at follow-up (<40, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, ≥75 years as appropriate
49
50 131 for the age range included in the analysis), region of recruitment (eight geographical regions
51
52 132 across the UK), and self-reported current health (excellent, good, fair, poor, unknown).

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3 133 We estimated prevalence ratios of any medication use in each diet group compared to meat
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5 134 eaters, adjusting for the cross-stratification of sex and age at follow-up, region of recruitment,
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7 135 self-reported current health, and the number of self-reported illnesses or conditions (0, 1, 2, 3,
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9 136 ≥ 4). Additionally, we repeated the analyses stratified by the number of self-reported illnesses
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11 137 or conditions using the above categorisation. Subsequently, for each of high blood pressure,
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13 138 high blood cholesterol, asthma, diabetes, and thyroid disease, we estimated the prevalence
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15 139 ratios of taking appropriate medication by diet group among people diagnosed with each
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17 140 condition in turn, adjusting for covariates as above and additionally for years since reported
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19 141 diagnosis, calculated as year of follow-up questionnaire completion minus reported year of
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21 142 diagnosis (<2, 2-3, 4-5, 6-9, ≥ 10 years, unknown).

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25 143 As sensitivity analyses, we repeated the analyses as follows: using data from the 5 year
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27 144 follow-up questionnaire where available; and further adjusting for smoking status, alcohol
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29 145 consumption, and Townsend deprivation index. All statistical analyses were performed using
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31 146 Stata release 14.1 (StataCorp), and *P* values < 0.05 were considered statistically significant.
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36 37 148 **RESULTS**

38 39 40 149 **Cohort characteristics**

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43 150 After excluding participants who did not answer the relevant questions on diet group or on
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45 151 medication use, data for 31,260 participants who completed the 10 year follow-up
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47 152 questionnaire (18,155 meat eaters, 5,012 fish eaters, 7,179 vegetarians, and 914 vegans) were
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49 153 used for most of the analyses. Characteristics of the participants are presented in **Table 1**.
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51 154 Overall, non-meat eaters were younger, more likely to report having excellent health, less
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3 155 likely to be taking medication in the past four weeks, and less likely to have reported any
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5 156 illnesses or conditions.

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9 10 11 158 **Participation in screening and use of HRT and medications**

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14 159 Overall, 14,016 women were included in the analyses for breast screening, 27,781 women for
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16 160 cervical screening, and 4,783 men for PSA testing (**Table 2**). In women, compared with meat
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18 161 eaters, vegetarians (prevalence ratio; 95% CI: 0.94; 0.89, 0.98) and vegans (0.82; 0.71, 0.95),
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20 162 but not fish eaters (0.96; 0.92, 1.01) had lower prevalence of breast screening, but no
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22 163 significant heterogeneity was observed between the diet groups for participating in cervical
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24 164 screening (P -heterogeneity=0.37). In men, vegetarians (0.82; 0.71, 0.96), but not fish eaters
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26 165 (0.99; 0.85, 1.17) or vegans (0.72; 0.50, 1.02), had significantly lower prevalence of PSA
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28 166 testing compared with meat eaters. For HRT use, women who were non-meat eaters reported
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30 167 lower use (fish eaters: 0.80; 0.73, 0.88; vegetarians: 0.74; 0.68, 0.81; vegans: 0.42; 0.30,
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32 168 0.60) compared with women who were meat eaters (**Table 3**).

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36 169 Irrespective of the number of self-reported illnesses and conditions, non-meat eaters reported
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38 170 lower use of any medication (fish eaters: 0.92; 0.87, 0.96; vegetarians: 0.93; 0.89, 0.98;
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40 171 vegans 0.71; 0.63, 0.81) compared with meat eaters (**Table 4**). When the analyses were
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42 172 stratified by the number of self-reported illnesses or conditions, non-meat eaters with no or
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44 173 one illness or condition had reported lower medication use compared to meat eaters (P -
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46 174 heterogeneity \leq 0.0002), but the association was attenuated and no longer statistically
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48 175 significant among participants with two, three, or four or more illnesses or conditions. For
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50 176 medication use specific to several common illnesses and conditions, no significant
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52 177 differences were observed between the diet groups in the reported use of appropriate
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54 178 medications for high blood pressure, high blood cholesterol, asthma, diabetes, or thyroid

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3 179 disease, among participants diagnosed with each of these conditions (**Table 5**). Results were
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5 180 consistent when we repeated the analyses where possible using data from the 5 year follow-
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7 181 up questionnaire, or when we further adjusted for smoking, alcohol consumption, and
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9 182 Townsend deprivation index (results not shown).
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15 184 **DISCUSSION**

18 185 **Summary of results**

21 186 In this UK population based cohort with a large proportion of participants from different diet
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23 187 groups, we generally observed lower participation in breast screening and lower HRT use
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25 188 among women who were non-meat eaters (separately categorised as fish eaters, vegetarians,
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27 189 and vegans) compared with women who were meat eaters. Vegetarian men had lower
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29 190 participation in PSA testing compared with meat eating men, but no significant difference
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31 191 was observed for cervical screening in women across the diet groups. For medication use,
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33 192 non-meat eaters were less likely to report taking medications than meat eaters overall, but
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35 193 there were no significant differences in people reporting two or more illnesses or conditions,
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37 194 or for people reporting taking specific medications for various self-reported conditions.
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44 196 **Comparison with other studies**

47 197 Few studies have reported on the participation in cancer screening or testing, HRT use or
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49 198 medication use among people of different diet groups, and no study has assessed all these
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51 199 behaviours simultaneously in the same cohort. For breast cancer screening, consistent with
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53 200 our findings, the Swedish Malmö Diet and Cancer Study reported that non-attendance for
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55 201 breast cancer screening was more likely in people who were vegetarians or vegans (odds ratio
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3 202 or OR; 95% confidence interval: 1.49; 1.11, 1.99) [9]. Analyses of data from the Adventist
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5 203 Health Study-2 in the United States and Canada showed that all non-meat eaters were less
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7 204 likely to report PSA testing compared with meat eaters (OR 0.50; 0.42, 0.60 for vegans, 0.76;
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9 205 0.67, 0.86 for vegetarians and 0.79; 0.66, 0.95 for fish eaters) [10], whereas we only observed
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11 206 a lower prevalence among the vegetarians but not the fish eaters (nor the vegans, perhaps
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13 207 because of limited numbers) compared with meat eaters in EPIC-Oxford. However, given the
14
15 208 much higher rates of PSA testing in the Adventist Health Study-2 (73.3% versus 31.5% in
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17 209 EPIC-Oxford), attitudes towards screening are likely to be different in the two populations,
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19 210 and therefore the results might not be directly comparable.
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23 211 For medication use, a cross-sectional study in a Belgian population reported lower use of
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25 212 prescribed medications when comparing vegetarians to a reference Belgian population
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27 213 (25.5% versus 47.3%, $p < 0.001$) [8]. While this is consistent with our findings on overall
28
29 214 medication use, the study did not assess the use of medications stratified by the number of
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31 215 illnesses, nor did they assess appropriate medication use for specific medical conditions. No
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33 216 studies were found which examined prevalence of cervical screening or HRT use among
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35 217 people of different diet groups. Overall, few studies have examined health related behaviours
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37 218 across habitual diet groups.
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44 220 **Interpretation of findings and implications**

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47 221 Our findings indicate differences in some health related behaviours between people of
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49 222 different diet groups, although the reasons behind such differences are unclear. For the
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51 223 observed differences in screening rates, possible explanations could be related to different
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53 224 attitudes towards the screening programmes. In the UK, all women aged 50 to 70 are invited
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55 225 to attend breast cancer screening clinics [11] and all women aged 25 to 64 are invited for
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3 226 cervical screening [12] at regular intervals. On the other hand, there is no national programme
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5 227 for PSA testing, although men over the age of 50 are eligible to arrange for testing via their
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7 228 GP if they wish [13]. In a small Scottish focus group study which asked participants about
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9 229 their attitudes towards cancer screening (n=31 for cervical screening, n=10 for breast
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11 230 screening), the study participants reported that they felt pressure from health care
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13 231 professionals, family and friends to attend cervical screening, and that they also considered it
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15 232 to be normative routine behaviour [14]. On the other hand, they did not report receiving much
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17 233 pressure from health care professionals to attend breast screening, and also said that they felt
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19 234 it was more a matter of personal choice.

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23 235 Such differences in attitudes towards breast screening and cervical screening are of interest. If
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25 236 such attitudes differed by diet groups, this may help to explain the observed differences in
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27 237 participation for breast screening but not cervical screening, since the latter does not appear
28
29 238 to involve so much personal choice. However, relevant evidence is lacking, and both dietary
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31 239 and non-dietary factors which are associated with the participants' decisions to attend either
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33 240 breast screening or PSA testing deserve further study. Moreover, it should also be noted that
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35 241 the GP's attitude towards screening may play a role in influencing the patient's decision to
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37 242 participate even when they are not directly involved with the screening process [15]. The
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39 243 impact of such influences, however, requires further investigation.

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43 244 Reasons for the observed lower prevalence of HRT use and medication use among people of
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45 245 different diet groups are also unclear. Given that non-meat eaters were more likely to rate
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47 246 their health as good or excellent, one possible explanation is that non-meat eaters were
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49 247 healthier overall and therefore less likely to require any form of treatment including HRT or
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51 248 other medications. However, given the observed differences in medication use among people
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53 249 with no (especially) or only one reported illness or condition, better health among non-meat
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55 250 eaters is unlikely to be the only, or a sufficient explanation for the differences. Non-meat
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3 251 eaters may also be reluctant to take medications which are likely to contain animal-derived
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5 252 products [16], or may prefer to use homoeopathic medications [8] or other alternative
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7 253 therapies.
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10 254 Differential participation in screening for breast or prostate cancer, use of HRT, and use of
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12 255 medications for people of distinct diet groups may ultimately lead to differences in disease
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14 256 incidence or prognosis due to possible detection bias and differential post diagnosis
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16 257 treatment. For example, given the lower rates of breast cancer screening among non-meat
17
18 258 eating women, it is possible that the observed incidence of breast cancer in these diet groups
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20 259 underestimates the true incidence owing to detection bias, and that ultimately these women
21
22 260 would have a somewhat higher mortality from breast cancer. At the same time, lower
23
24 261 prevalence of HRT use among non-meat eating women also deserves attention given the
25
26 262 increase in breast cancer risk caused by HRT containing oestrogens and progestogens
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28 263 [17,18]. Further study is warranted to understand why people of different diet groups have
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30 264 differential participation in breast screening or prostate cancer testing, HRT use, and overall
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32 265 medication use, and whether and how these differences are related to future disease risk.
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34 266 Overall, our findings showed some differences in health related behaviours among people of
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36 267 different diet groups, thereby highlighting the need to consider such differences when
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38 268 conducting longitudinal analyses in these populations.
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270 **Strengths and limitations**

271 This study is the first to simultaneously examine prevalence of screening, HRT use and
272 medication use in different diet groups. A strength of the study is the large sample size
273 recruited from across different regions in the UK. Additionally, information was collected on
274 a range of factors which may also be associated with the outcomes of interest, allowing

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3 275 adjustment for these factors. Of potential limitations, recall bias is possible because
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5 276 assessment of the exposures of interest was based on self-report, although there is no
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7 277 indication that such misclassification bias should differ by diet group. Because of the
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9 278 relatively small number of vegans in our study sample, the role of chance in explaining the
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11 279 findings relating to this diet group cannot be ruled out. As with most population cohorts,
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13 280 some degree of self-selection and healthy cohort bias may also be present.
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18 19 282 **CONCLUSIONS**

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21
22 283 In this population, we observed differences in breast screening, PSA testing, HRT use and
23
24 284 overall medication use between meat eaters, fish eaters, vegetarians and vegans, but no
25
26 285 significant differences between diet groups for cervical screening or medication use in people
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28 286 with two or more illnesses or for specific conditions. The reasons for these differences
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30 287 require further investigation. Nonetheless, such differences may be related to differential
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32 288 observed morbidity or mortality from cancer and other diseases across people of different diet
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34 289 groups, and therefore should be considered in future epidemiological studies.
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39 40 41 291 **STATEMENTS**

42 43 44 292 **Acknowledgements**

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46
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50
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53 296 Zealand Health Research Council Fellowship. TJK is a member of the Vegan Society; the
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55 297 other authors had no conflicts of interest.
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56 299 **Availability of data and materials**
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9 300 Data access policies for EPIC-Oxford are available via the study website (<http://www.epic-oxford.org/data-access-sharing-and-collaboration/>).
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17 303 **Author's contributions**
1819
20 304 TYNT, PNA, and TJK conceived and designed the research question. TYNT and PNA
21
22 305 analysed the data. TYNT wrote the first draft of the manuscript, and PNA, KEB and TJK
23
24 306 provided input on data analysis and interpretation of results. All authors revised the
25
26 307 manuscript critically for important intellectual content, and read and approved the final
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28 308 manuscript.
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Table 1 Characteristics by diet group of participants in the EPIC-Oxford study who completed the second follow-up questionnaire (n=31260)¹.

Characteristic	Meat eaters	Fish eaters	Vegetarians	Vegans	Total
Number of participants (% female)	18155 (78.2)	5012 (81.8)	7179 (76.3)	914 (66.1)	31260 (78.0)
Mean (SD) age at questionnaire completion, years	58.9 (12.5)	53.8 (12.5)	51.6 (12.7)	50.7 (12.3)	56.1 (13.0)
Smoking status ² , n (%)					
Never smoker	10073 (55.7)	2786 (55.6)	4339 (60.5)	547 (59.9)	17745 (56.9)
Former smoker	6927 (38.3)	1961 (39.2)	2460 (34.3)	330 (36.1)	11678 (37.5)
Current smoker	1094 (6.0)	260 (5.2)	367 (5.1)	36 (3.9)	1757 (5.6)
Mean (SD) alcohol consumption, g/d	8.7 (9.3)	8.2 (8.7)	7.6 (8.9)	6.7 (9.2)	8.3 (9.1)
Self-reported current health ² , n (%)					
Excellent	3713 (21.9)	1323 (28.1)	1950 (28.7)	325 (37.2)	7311 (24.9)
Good	9962 (58.8)	2688 (57.0)	3851 (56.6)	446 (51.0)	16947 (57.8)
Fair	2858 (16.9)	612 (13.0)	876 (12.9)	80 (9.2)	4426 (15.1)
Poor	400 (2.4)	92 (2.0)	122 (1.8)	23 (2.6)	637 (2.2)
Townsend deprivation index ² , n (%)					
Richest category	4463 (27.6)	984 (21.8)	1542 (23.7)	153 (18.3)	7141 (25.5)
Poorest category	3438 (21.2)	1207 (26.8)	1732 (26.7)	285 (34.1)	6662 (23.8)
In same diet group at recruitment, n (%)	15908 (87.7)	3057 (61.1)	6373 (89.1)	573 (62.7)	25911 (83.0)
Taking medication in the past 4 weeks, n (%)	10196 (56.2)	2105 (42.0)	2829 (39.4)	255 (27.9)	15385 (49.2)
Number of reported illnesses and conditions, n (%)					
None	4455 (24.5)	1635 (32.6)	2603 (36.3)	344 (37.6)	9037 (28.9)
One	4724 (26.0)	1472 (29.4)	2170 (30.2)	291 (31.8)	8657 (27.7)
Two	3682 (20.3)	906 (18.1)	1261 (17.6)	154 (16.8)	6003 (19.2)
Three	2404 (13.2)	524 (10.5)	630 (8.8)	74 (8.1)	3632 (11.6)
Four or more	2890 (15.9)	475 (9.5)	515 (7.2)	51 (5.6)	3931 (12.6)
Reported high blood pressure ² , n (%)	4397 (29.2)	686 (16.2)	944 (15.2)	85 (10.6)	6112 (23.2)
and taking appropriate medication, n (%)	2573 (58.5)	357 (52.0)	430 (45.6)	40 (47.1)	3400 (55.6)
Reported high blood cholesterol ² , n (%)	3351 (23.1)	561 (13.5)	645 (10.5)	44 (5.5)	4601 (18.0)
and taking appropriate medication, n (%)	1646 (49.1)	209 (37.3)	243 (37.7)	14 (31.8)	2112 (45.9)
Reported asthma ² , n (%)	1885 (13.6)	496 (12.1)	758 (12.4)	88 (11.1)	3227 (12.9)
and taking appropriate medication, n (%)	737 (39.1)	169 (34.1)	246 (32.5)	17 (19.3)	1169 (36.2)
Reported diabetes ² , n (%)	707 (5.2)	75 (1.9)	119 (2.0)	7 (0.9)	908 (3.7)
and taking appropriate medication, n (%)	446 (63.1)	41 (54.7)	84 (70.6)	6 (85.7)	577 (63.5)
Reported thyroid disease ² , n (%)	1545 (11.1)	380 (9.2)	465 (7.6)	56 (7.1)	2446 (9.8)
and taking appropriate medication, n (%)	1191 (77.1)	273 (71.8)	337 (72.5)	37 (66.1)	1838 (75.1)

1. Based on participant characteristics at the time of the second follow-up questionnaire (completed approximately 10 years from baseline, around 2007).

2. Unknown for some participants.

Table 2 Participation in screening by diet group of women and men in the EPIC-Oxford study.

Screening/Diet group	Number answering the relevant question	Number (%) answering in the affirmative	Prevalence ratio (95% CI) ¹
Breast screening²			
Meat eaters	9239	8813 (95.4)	1.00 (ref)
Fish eaters	2143	1928 (90.0)	0.96 (0.92,1.01)
Vegetarians	2395	2078 (86.8)	0.94 (0.89,0.98)
Vegans	239	182 (76.2)	0.82 (0.71,0.95)
			<i>P-het=0.004</i>
Cervical screening³			
Meat eaters	15936	15365 (96.4)	1.00 (ref)
Fish eaters	4513	4369 (96.8)	1.00 (0.97,1.03)
Vegetarians	6574	6268 (95.3)	0.98 (0.95,1.01)
Vegans	758	691 (91.2)	0.94 (0.87,1.02)
			<i>P-het=0.37</i>
Prostate specific antigen testing⁴			
Meat eaters	3078	1066 (34.6)	1.00 (ref)
Fish eaters	594	181 (30.5)	0.99 (0.85,1.17)
Vegetarians	947	228 (24.1)	0.82 (0.71,0.96)
Vegans	164	33 (20.1)	0.72 (0.50,1.02)
			<i>P-het=0.023</i>

- All analyses adjusted for age at follow-up (<40, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, ≥75 years, as appropriate according to the age range of included participants), region of residence (eight regions), and self-reported current health (excellent, good, fair, poor, unknown).
- Included women aged 50 to 74 who answered the relevant question on the second (10 year) follow-up questionnaire.
- Included women aged 25 to 74 who answered the relevant question on the first (5 year) follow-up questionnaire.
- Included men aged 50 to 84 who answered the relevant question on the second (10 year) follow-up questionnaire.

Table 3 Use of hormone replacement therapy by diet group of women in the EPIC-Oxford study.

Diet group	Number answering the relevant question	Number (%) answering in the affirmative	Prevalence ratio (95% CI) ¹
Meat eaters	6911	3098 (44.8)	1.00 (ref)
Fish eaters	1614	541 (33.5)	0.80 (0.73,0.88)
Vegetarians	1778	541 (30.4)	0.74 (0.68,0.81)
Vegans	188	31 (16.5)	0.42 (0.30,0.60)
			<i>P-het<0.0001</i>

- Adjusted for age at follow-up (50-54, 55-59, 60-64, 65-69, 70-74 years), region of residence (eight regions), and self-reported current health (excellent, good, fair, poor, unknown). Included post-menopausal women aged 50 to 74 who answered the relevant question on the second (10 year) follow-up questionnaire.

Table 4 Medication use by number of self-reported illnesses or conditions and diet group of participants in the EPIC-Oxford study.¹

Number of self-reported illnesses or conditions / Diet group	Number of participants	Percentage taking any medication	Prevalence ratio (95% CI) ²
Any number³			
Meat eaters	18155	56.2	1.00 (ref)
Fish eaters	5012	42.0	0.92 (0.87-0.96)
Vegetarians	7179	39.4	0.93 (0.89-0.98)
Vegans	914	27.9	0.71 (0.63-0.81)
			<i>P-het</i> <0.0001
None			
Meat eaters	4455	16.9	1.00 (ref)
Fish eaters	1635	11.9	0.80 (0.68-0.94)
Vegetarians	2603	11.5	0.80 (0.70-0.92)
Vegans	344	6.1	0.47 (0.30-0.72)
			<i>P-het</i> <0.0001
One			
Meat eaters	4724	48.9	1.00 (ref)
Fish eaters	1472	39.1	0.87 (0.80-0.96)
Vegetarians	2170	40.5	0.91 (0.84-0.99)
Vegans	291	29.2	0.69 (0.55-0.85)
			<i>P-het</i> =0.0002
Two			
Meat eaters	3682	66.9	1.00 (ref)
Fish eaters	906	58.8	0.94 (0.86-1.04)
Vegetarians	1261	58.1	0.97 (0.89-1.06)
Vegans	154	42.2	0.74 (0.58-0.95)
			<i>P-het</i> =0.082
Three			
Meat eaters	2404	82.6	1.00 (ref)
Fish eaters	524	74.0	0.94 (0.84-1.05)
Vegetarians	630	73.0	0.94 (0.84-1.04)
Vegans	74	59.5	0.78 (0.57-1.05)
			<i>P-het</i> =0.22
Four or more			
Meat eaters	2890	93.0	1.00 (ref)
Fish eaters	475	86.9	0.96 (0.86-1.06)
Vegetarians	515	88.9	0.98 (0.89-1.09)
Vegans	51	78.4	0.87 (0.63-1.19)
			<i>P-het</i> =0.70

1. Refers to medication use for most of the past four weeks on the second (10 year) follow-up questionnaire, excluding HRT and contraceptive pills.
2. Adjusted for the cross-classification of sex and age at follow-up (<40, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, ≥75 years), region of residence (eight regions), and self-reported current health (excellent, good, fair, poor, unknown).
3. Further adjusted for the number of self-reported illnesses or conditions (0, 1, 2, 3, ≥4).

Table 5 Medication use for specific conditions by diet group of participants in the EPIC-Oxford study.¹

Condition/ Diet group	Number reporting the condition (mean years since reported diagnosis)	Number (%) taking appropriate medication	Prevalence ratio (95% CI) ²
High blood pressure³			
Meat eaters	4397 (9.8)	2573 (58.5)	1.00 (ref)
Fish eaters	686 (9.3)	357 (52.0)	0.97 (0.86-1.08)
Vegetarians	944 (9.0)	430 (45.6)	0.91 (0.82-1.01)
Vegans	85 (9.0)	40 (47.1)	0.92 (0.67-1.26)
			<i>P-het=0.37</i>
High blood cholesterol⁴			
Meat eaters	3351 (6.3)	1646 (49.1)	1.00 (ref)
Fish eaters	561 (5.3)	209 (37.3)	0.88 (0.76-1.01)
Vegetarians	645 (5.5)	243 (37.7)	0.94 (0.81-1.08)
Vegans	44 (7.1)	14 (31.8)	0.74 (0.44-1.26)
			<i>P-het=0.20</i>
Asthma⁵			
Meat eaters	1885 (25.3)	737 (39.1)	1.00 (ref)
Fish eaters	496 (23.2)	169 (34.1)	0.98 (0.82-1.17)
Vegetarians	758 (23.4)	246 (32.5)	0.97 (0.84-1.14)
Vegans	88 (27.9)	17 (19.3)	0.67 (0.41-1.09)
			<i>P-het=0.45</i>
Diabetes⁶			
Meat eaters	707 (10.0)	446 (63.1)	1.00 (ref)
Fish eaters	75 (14.8)	41 (54.7)	0.78 (0.56-1.08)
Vegetarians	119 (10.6)	84 (70.6)	1.05 (0.81-1.35)
Vegans	7 (13.2)	6 (85.7)	1.07 (0.45-2.51)
			<i>P-het=0.46</i>
Thyroid disease⁷			
Meat eaters	1545 (13.2)	1191 (77.1)	1.00 (ref)
Fish eaters	380 (11.6)	273 (71.8)	0.95 (0.83-1.09)
Vegetarians	465 (11.2)	337 (72.5)	0.97 (0.85-1.10)
Vegans	56 (11.8)	37 (66.1)	0.88 (0.63-1.22)
			<i>P-het=0.78</i>

- Refers to medication use for most the past four weeks specific to the condition described, among participants who reported diagnosis for the condition on the second (10 year) follow-up questionnaire.
- Adjusted for the cross-classification of sex and age at follow-up (<40, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, ≥75 years), region of residence (eight regions), self-reported current health (excellent, good, fair, poor, unknown), years since reported diagnosis (calculated as year of follow-up questionnaire completion minus reported year of diagnosis; <2, 2-3, 4-5, 6-9, ≥10 years, unknown), and number of self-reported illnesses or conditions (1, 2, 3, ≥4).
- Reported use of at least one of amlodipine, enalapril, frusemide, propranolol, atenolol, bendrofluazide, lisinopril and nifedipine.
- Reported use of at least one of atorvastatin and simvastatin.
- Reported use of at least one of beclomethasone and salbutamol.
- Reported use of at least one of insulin and metformin.
- Reported use of thyroxine.

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract P.1 (b) Provide in the abstract an informative and balanced summary of what was done and what was found P.2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported P.4
Objectives	3	State specific objectives, including any prespecified hypotheses P.5 Lines 66-68
Methods		
Study design	4	Present key elements of study design early in the paper P.5 Lines 72, P.7 Lines 114-116
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection P.5-7 Lines 71-111
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants P.5 Lines 75-79 (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable P.6-8 Lines 87-111, 129-131, 134-136, 140-142
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group P.5-7 Lines 75-111
Bias	9	Describe any efforts to address potential sources of bias P.7 Lines 119-124
Study size	10	Explain how the study size was arrived at P.5 Lines 76-79, P.7 Lines 117-119
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why P.7-8 Lines 129-131, 134-136, 140-142
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding P.7-8 Lines 114-146 (b) Describe any methods used to examine subgroups and interactions P.8 Lines 143-144 (c) Explain how missing data were addressed P.7-9 Lines 132, 142 (d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed

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2 *Cross-sectional study*—If applicable, describe analytical methods taking account of
3 sampling strategy P.7 Lines 114-116

(e) Describe any sensitivity analyses P.8 Lines 143-145

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For peer review only

Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed P.8-9 Lines 150-153, 159-160 (b) Give reasons for non-participation at each stage P.8 Lines 150-151 (c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders P.8-9 Lines 150-156 (b) Indicate number of participants with missing data for each variable of interest P.8-9 Lines 150-153, 159-160 (c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —Report numbers of outcome events or summary measures P.17-19
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included P.17-19 (b) Report category boundaries when continuous variables were categorized P.17-19 (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses P.10 Lines 179-182

Discussion

Key results	18	Summarise key results with reference to study objectives P.10 Lines 185-194
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias P.14 Lines 275-280
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence P.10-14
Generalisability	21	Discuss the generalisability (external validity) of the study results P.10-14

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based) P.14 Lines 294-296
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*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Cross-sectional analyses of participation in cancer screening and use of hormone replacement therapy and medications in meat eaters and vegetarians: the EPIC-Oxford study.

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Manuscripts

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3 1 **Cross-sectional analyses of participation in cancer screening and use of hormone**
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5 2 **replacement therapy and medications in meat eaters and vegetarians: the EPIC-Oxford**
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7 3 **study.**
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3 18 **ABSTRACT**
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6 19 **Objectives:** To examine differences in health-related behaviours such as screening or testing
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8 20 for cancer, use of hormone replacement therapy (HRT), and use of other medications in
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10 21 different diet groups.

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13 22 **Design:** We studied 31,260 participants across four diet groups (18,155 meat eaters, 5,012
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15 23 fish eaters, 7,179 vegetarians, 914 vegans) in the UK EPIC-Oxford cohort. Information was
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17 24 collected in 5 (around 2000-2003) or 10 (around 2007) year follow-up questionnaires
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19 25 regarding participation in breast screening, cervical screening, prostate specific antigen (PSA)
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21 26 testing, use of HRT, and use of medications for the past four weeks. Using Poisson
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23 27 regression, we estimated the prevalence ratios (PR) for each behaviour across people of
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25 28 different diet groups, using meat-eaters as the reference group.

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29 29 **Results:** Compared with meat-eaters, vegetarian (PR; 95% confidence interval: 0.94; 0.89,
30
31 30 0.98) and vegan (0.82; 0.71, 0.95) women reported lower participation in breast screening,
32
33 31 and vegetarian men were less likely to report PSA testing (0.82; 0.71, 0.96). No differences
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35 32 were observed among women for cervical screening. In women, all non-meat eating groups
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37 33 reported lower use of HRT compared with meat-eaters (p heterogeneity<0.0001). Lower
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39 34 reported use of any medication was observed for participants in all non-meat eating groups
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41 35 with no (p <0.0001) or one (p =0.0002) self-reported illness. No heterogeneity was observed
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43 36 across the diet groups for the reported use of specific medication for high blood pressure,
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45 37 high blood cholesterol, asthma, diabetes, and thyroid disease.

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49 38 **Conclusions:** Differences in self-reported breast screening, PSA testing, HRT use and overall
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51 39 medication use were observed across the diet groups. Whether such differences contribute to
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53 40 differential long-term disease risks requires further study.
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Strengths and limitations of this study

- This study is the first to simultaneously examine the reported uptake of breast and cervical cancer screening, prostate specific antigen testing, hormone replacement therapy (HRT) use and medication use in different diet groups.
- The study includes a large number of participants recruited from across different regions in the United Kingdom, with a high proportion of fish eaters, vegetarians, and vegans.
- Recall bias is possible because assessment of cancer screening or testing, HRT use and medication use was based on self-report, although there is no indication that such misclassification bias should differ by diet group.
- The study is cross-sectional and we cannot infer causality.

41

42 INTRODUCTION

43 People of different habitual diet groups have been shown to have different health
44 characteristics. Compared to meat eaters, vegetarians generally have lower BMI, blood
45 pressure, and circulating low density lipoprotein cholesterol levels [1–3], characteristics
46 likely to reduce disease risk. However, evidence on the long-term risk of many non-
47 communicable diseases across people of different diet groups is limited.

48 For cancer risk, both a United Kingdom (UK) [4] and a United States (US) [5] study reported
49 lower risk of overall cancer incidence with a vegetarian diet. Because health related
50 behaviours, such as participation in cancer screening [6] or use of hormone replacement
51 therapy (HRT) [7,8], may contribute to the observed rates of cancer, the presence of any
52 differences in these behaviours between diet groups in different populations deserve further
53 investigation. Results from a Swedish cohort [9] and a US cohort [10] showed that
54 vegetarians (including vegans and people who ate fish but not meat) had lower odds of
55 attending breast screening and prostate cancer screening respectively, when compared with
56 meat eaters, and vegetarians also had lower use of HRT compared with non-vegetarians [5].

57 For cardiovascular diseases, vegetarians in EPIC-Oxford have been observed to have lower
58 ischaemic heart disease risk (hospitalization and death combined) [11], but no significant
59 difference in ischaemic heart disease mortality was observed between diet groups in the same
60 population [12]. The reason for this apparent difference between incidence and mortality is
61 unclear. One possible explanation could be the differential use of appropriate medications in
62 the different diet groups, which subsequently influences disease mortality. In a Belgian
63 population for example, vegetarians had lower use of prescription medications compared to
64 non-vegetarians, but similar use of non-prescription drugs [13].

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3 65 The increasing popularity and interest in vegetarian diets [14] prompts research on the long-
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5 66 term health of vegetarians and vegans. Because health behaviour such as screening or
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7 67 medication use may ultimately influence disease risk, the understanding of any differences in
8
9 68 these behaviours by diet group is crucial for the appropriate appraisal of possible differences
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11 69 in disease risk between diet groups. However, current knowledge on this topic is insufficient,
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13 70 because literature on participation in screening and use of medication across people of
14
15 71 different diet groups is scarce. Therefore, the aim of this study was to assess some of these
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17 72 relevant health behaviours, including participation in cancer screening or testing, and use of
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19 73 HRT and other medications among people of different diet groups, in a large population-
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21 74 based cohort in the UK with a high percentage of vegetarians.
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28 76 **METHODS**

31 77 **Study population**

34 78 The EPIC-Oxford study is a UK based cohort recruited between 1993 and 1999. The study
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36 79 protocol was approved by a Multicentre Research Ethics Committee (Scotland A Research
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38 80 Ethics Committee) and participants gave written informed consent. Details of the recruitment
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40 81 process have been described previously [1]. In brief, a combination of general practitioner
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42 82 (GP) recruitment and postal recruitment was used. The GP recruitment invited men and
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44 83 women aged 35 to 59 years registered with participating GPs and recruited 7,421 participants.
45
46 84 The postal recruitment was targeted at vegetarians, vegans, and other people interested in diet
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48 85 and health, by contacting members of The Vegetarian Society, The Vegan Society, and via
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50 86 leaflets enclosed in vegetarian and health food magazines and displayed in health-food shops,
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52 87 and recruited 57,990 participants aged ≥ 20 years. Altogether, 57,443 participants completed a
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54 88 full recruitment questionnaire which asked about their personal details (including postcode to
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3 89 which a Townsend index of area-level deprivation was assigned [15]), habitual diet and other
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5 90 health and lifestyle characteristics, including personal and family medical history, medication
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7 91 use, socio-economic characteristics, smoking and drinking behaviour, and physical activity
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9 92 levels. A follow-up questionnaire was sent to surviving participants approximately 5 years
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11 93 after recruitment (mostly from 2000 to 2003), and a second follow-up questionnaire was
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13 94 mailed approximately 10 years after recruitment (mostly in 2007). In the follow-up
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15 95 questionnaires, updated information was gathered on diet, health and lifestyle, including self-
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17 96 reported current health.
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24 98 **Assessment of diet group**

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27 99 In the recruitment questionnaire and each subsequent follow-up questionnaire, four questions
28
29 100 were asked regarding consumption of meat, fish, dairy products, and eggs, in the form of “Do
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31 101 you eat any meat?” or similar for the other three food groups. Responses to these questions
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33 102 were used to assign participants to one of four diet groups at each time point: meat eaters
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35 103 (participants who ate meat, irrespective of whether they ate fish, dairy products or eggs); fish
36
37 104 eaters (participants who did not eat meat but did eat fish); vegetarians (participants who did
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39 105 not eat meat or fish, but did eat one or both of dairy products and eggs), and vegans
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41 106 (participants who did not eat meat, fish, dairy products, or eggs).
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48 108 **Assessment of participation in screening, HRT and medication use**

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51 109 In the follow-up questionnaires, women were asked if they had ever had a breast screening by
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53 110 mammography, cervical screening by the smear test (only on the 5 year follow-up
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55 111 questionnaire), or used HRT, and men were asked if they had ever had a prostate specific
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3 112 antigen (PSA) test (only on the 10 year follow-up questionnaire). On the 10 year follow-up
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5 113 questionnaire, all participants were asked if they had used any medication for most of the last
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7 114 four weeks, with 36 named medications and a free text field for reporting regular use of any
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9 115 medication not on the list; participants were also asked if they had been diagnosed with any
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11 116 of a list of 29 medical conditions, and the year when the condition was first diagnosed. The
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13 117 full list of the 36 medications and 29 medical conditions is given in Supplementary text 1 and
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15
16 118 2. The corresponding question on medication use on the 5 year questionnaire was shorter,
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18 119 with 20 named medications and 26 medical conditions.

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21 120 For assessment of specific medication use, five common medical conditions associated with
22
23 121 specific medications were identified: high blood pressure (commonly treated with one or
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25 122 more of amlodipine, enalapril, frusemide, propranolol, atenolol, bendrofluazide, lisinopril and
26
27 123 nifedipine), high blood cholesterol (atorvastatin and simvastatin), asthma (beclomethasone
28
29 124 and salbutamol), diabetes (insulin and metformin), and thyroid disease (thyroxine).

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33 34 35 126 **Statistical analyses**

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38 127 Information on assignment to diet group and assessment of health behaviour from the 10 year
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40 128 follow-up questionnaire was used for our analyses, except for the assessment of participation
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42 129 in cervical screening which was only asked on the 5 year follow-up questionnaire.
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45 130 Participants were excluded from all analysis if they did not answer the relevant questions to
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47 131 be assigned to an appropriate diet group (n=28), and in order to ensure that an overlapping
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49 132 population was used for the analyses of all outcomes, they were also excluded if they did not
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51 133 answer the relevant question on medication use (n=407). For the analyses related to
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53 134 participation in breast screening, cervical screening, PSA testing or HRT use, only women or
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55 135 men who answered the relevant question and were in the specified age group at questionnaire

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3 136 completion were included. The age group specifications were as follows: age 50 to 74 years
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5 137 for breast screening, age 25 to 74 years for cervical screening, age 50 to 84 years for PSA
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7 138 testing, and age 50 to 74 years for HRT use. For HRT use, we further restricted the analysis
8
9 139 to post-menopausal women, determined by including only participants who answered yes to
10
11 140 the question ‘Have you been through your menopause?’ on the follow-up questionnaire.

12
13
14 141 For each analysis, we used Poisson regression to estimate prevalence ratios (95% confidence
15
16 142 intervals, CI) of cancer screening or testing (breast screening, cervical screening, PSA
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18 143 testing), HRT use, or medication use in different diet groups, using meat eaters as the
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20 144 reference group. For analyses of cancer screening or testing and use of HRT, we adjusted for
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22 145 age at follow-up (<40, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, ≥ 75 years as
23
24 146 appropriate for the age range included in the analysis), region of recruitment (eight
25
26 147 geographical regions across the UK), and self-reported current health (excellent, good, fair,
27
28 148 poor, unknown). For analyses of any medication use, we adjusted for the cross-stratification
29
30 149 of sex and age at follow-up, region of recruitment, self-reported current health, and the
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32 150 number of self-reported illnesses or conditions (0, 1, 2, 3, ≥ 4). To further assess whether any
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34 151 variation in medication use by diet group varied by health status, we repeated the analyses
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36 152 stratified by the number of self-reported illnesses or conditions using the above
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38 153 categorisation. Subsequently, for each of high blood pressure, high blood cholesterol, asthma,
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40 154 diabetes, and thyroid disease, we estimated the prevalence ratios of taking appropriate
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42 155 medication by diet group among people diagnosed with each condition in turn, adjusting for
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44 156 covariates as above and additionally for years since reported diagnosis, calculated as year of
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46 157 follow-up questionnaire completion minus reported year of diagnosis (<2, 2-3, 4-5, 6-9, ≥ 10
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48 158 years, unknown).

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54 159 As sensitivity analyses, we repeated the analyses as follows: using data from the 5 year
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56 160 follow-up questionnaire where available; and further adjusting for smoking status (never,

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3 161 former, current, unknown), alcohol consumption (<1 g/day, 1-7 g/day, 8-15 g/day, ≥16
4
5 162 g/day), Townsend index of area-level deprivation (quartiles and unknown), and education
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7 163 level (no qualifications, basic secondary e.g. O level, higher secondary e.g. A level, degree,
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9 164 unknown). All statistical analyses were performed using Stata release 14.1 (StataCorp), and *P*
10
11 165 values < 0.05 were considered statistically significant.

166

167 **RESULTS**

168 **Cohort characteristics**

169 Overall, 57,443 participants in EPIC-Oxford cohort completed a full recruitment
170 questionnaire, of whom 38,043 (66%) completed the 5 year follow-up questionnaire, and
171 31,695 (55%) completed the 10 year follow-up questionnaire. After excluding participants
172 who did not answer the relevant questions on diet group or on medication use, data for 31,260
173 participants who completed the 10 year follow-up questionnaire (18,155 meat eaters, 5,012
174 fish eaters, 7,179 vegetarians, and 914 vegans) were used for most of the analyses.
175 Characteristics of the participants are presented in **Table 1**. Overall, non-meat eaters were
176 younger, more likely to report having excellent health, less likely to report taking medication
177 in the past four weeks, and less likely to have reported any illnesses or conditions.

178

179 **Participation in screening and use of HRT and medications**

180 Overall, 14,016 women were included in the analyses for breast screening, 27,781 women for
181 cervical screening, and 4,783 men for PSA testing (**Table 2**). In women, compared with meat
182 eaters, vegetarians (prevalence ratio; 95% CI: 0.94; 0.89, 0.98) and vegans (0.82; 0.71, 0.95),
183 but not fish eaters (0.96; 0.92, 1.01) had lower reported attendance of breast screening, but no

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3 184 significant heterogeneity was observed between the diet groups for reported participation in
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5 185 cervical screening (P -heterogeneity=0.37). In men, vegetarians had lower reported uptake of
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7 186 PSA testing (0.82; 0.71, 0.96) than meat eaters, while the difference in uptake appeared lower
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9 187 but did not reach statistical significance in vegans (0.72; 0.50, 1.02), and was not
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11 188 significantly different in fish eaters (0.99; 0.85, 1.07). For HRT use, women who were non-
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13 189 meat eaters reported lower use (fish eaters: 0.80; 0.73, 0.88; vegetarians: 0.74; 0.68, 0.81;
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15 190 vegans: 0.42; 0.30, 0.60) compared with women who were meat eaters (**Table 3**).

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18 191 Irrespective of the number of self-reported illnesses and conditions, non-meat eaters reported
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20 192 lower use of any medication (fish eaters: 0.92; 0.87, 0.96; vegetarians: 0.93; 0.89, 0.98;
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22 193 vegans 0.71; 0.63, 0.81) compared with meat eaters (**Table 4**). When the analyses were
23
24 194 stratified by the number of self-reported illnesses or conditions, non-meat eaters with no
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26 195 ($P<0.0001$) or one ($P=0.0002$) illness or condition reported lower medication use compared
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28 196 with meat eaters, but the association was attenuated and no longer statistically significant
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30 197 among participants with two, three, or four or more illnesses or conditions. For medication
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32 198 use specific to several common illnesses and conditions, no significant differences were
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34 199 observed between the diet groups in the reported use of appropriate medications for high
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36 200 blood pressure, high blood cholesterol, asthma, diabetes, or thyroid disease, among
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38 201 participants diagnosed with each of these conditions (**Table 5**). Results were consistent when
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40 202 we repeated the analyses where possible using data from the 5 year follow-up questionnaire,
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42 203 or when we further adjusted for smoking, alcohol consumption, Townsend deprivation index,
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44 204 and education level (results not shown).

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206 **DISCUSSION**

207 **Summary of results**

208 In this UK population-based cohort with a large proportion of participants from different diet
209 groups, we generally observed lower participation in breast screening and lower HRT use
210 among women who were non-meat eaters (separately categorised as fish eaters, vegetarians,
211 and vegans) compared with women who were meat eaters. Vegetarian men had lower
212 participation in PSA testing compared with meat eating men, but no significant difference
213 was observed for cervical screening in women across the diet groups. For medication use,
214 non-meat eaters were less likely to report taking medications than meat eaters overall, but
215 there were no significant differences in medication use among people reporting two or more
216 illnesses or conditions, or for people reporting taking specific medications for various self-
217 reported conditions.

218

219 **Comparison with other studies**

220 Few studies have reported on the participation in cancer screening or testing, HRT use or
221 medication use among people of different diet groups, and no study has assessed all these
222 behaviours simultaneously in the same cohort. For breast cancer screening, consistent with
223 our findings, the Swedish Malmö Diet and Cancer Study reported that non-attendance for
224 breast cancer screening was more likely in people who were vegetarians or vegans (odds ratio
225 or OR; 95% confidence interval: 1.49; 1.11, 1.99) [9]. Analyses of data from the Adventist
226 Health Study-2 in the United States and Canada showed that all non-meat eaters were less
227 likely to report PSA testing compared with meat eaters (0.79; 0.66, 0.95 for fish eaters; 0.76;
228 0.67, 0.86 for vegetarians; and OR 0.50; 0.42, 0.60 for vegans) [10], whereas we only

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3 229 observed a lower reported uptake among the vegetarians but not the fish eaters (nor the
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5 230 vegans, perhaps because of limited numbers) compared with meat eaters in EPIC-Oxford.
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7 231 However, given the much higher rates of PSA testing in the Adventist Health Study-2 (73.3%
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9 232 versus 31.5% in EPIC-Oxford), attitudes towards screening are likely to be different in the
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11 233 two populations, and therefore the results might not be directly comparable. Similar to our
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13 234 study, the Adventist Health Study-2 also reported lower ever use of HRT (adjusted for age
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15 235 and race) in pesco-vegetarians (21.0%) and lacto-vegetarians (20.4%), and the lowest use in
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17 236 vegans (16.2%), when compared with non-vegetarians (22.4%) [5].
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21 237 For medication use, a cross-sectional study in a Belgian population reported lower use of
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23 238 prescribed medications when comparing vegetarians to a reference Belgian population
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25 239 (25.5% versus 47.3%, $p < 0.001$) [13]. While this is consistent with our findings on overall
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27 240 medication use, the study did not assess the use of medications stratified by the number of
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29 241 illnesses, nor did they assess appropriate medication use for specific medical conditions. No
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31 242 studies were found which examined participation of cervical screening among people of
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33 243 different diet groups.
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39 245 **Interpretation of findings and implications**

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43 246 Our findings indicate differences in some health related behaviours between people of
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45 247 different diet groups, although the reasons behind such differences are unclear. For the
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47 248 observed differences in screening rates, possible explanations could be related to different
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49 249 attitudes towards the screening programmes. In the UK since 1988 [6,16], all women aged 50
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51 250 to 70 are invited to attend breast cancer screening clinics [17] and all women aged 25 to 64
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53 251 are invited for cervical screening [18] at regular intervals. On the other hand, there is no
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55 252 national programme for PSA testing, although men over the age of 50 are eligible to arrange
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3 253 for testing via their GP if they wish [19]. In studies which assessed attitudes towards cancer
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5 254 screening or testing, common reasons which affect people's participation in screening include
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7 255 their education level and knowledge of the procedure, recommendation by their doctor, fear
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9 256 of the procedure or the outcome, or their perceived risk of cancer [20–23]. If vegetarians and
10
11 257 vegans felt their diets or lifestyles were protective against cancer for example, they might be
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13 258 more likely to forgo cancer screening as a result of lower perceived risk. However, no
14
15 259 information was found on whether or how such attitudes may vary by diet group.

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18 260 In a small focus group study in Scotland which asked participants about their attitudes
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20 261 towards cancer screening (n=31 for cervical screening, n=10 for breast screening), the study
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22 262 participants reported that they felt pressure from health care professionals, family and friends
23
24 263 to attend cervical screening but not breast screening, and that they also considered cervical
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26 264 screening to be normative routine behaviour [24]. Such differences in attitudes towards breast
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28 265 screening and cervical screening are of interest, as this may help to explain the differences we
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30 266 observed in participation for breast screening but not cervical screening, if the latter was
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32 267 considered routine behaviour. However, relevant evidence is lacking, and both dietary and
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34 268 non-dietary factors which are associated with attendance for either breast screening or PSA
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36 269 testing deserve further study.

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41 270 Reasons for the observed lower prevalence of HRT use and medication use among people of
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43 271 different diet groups are also unclear. The prevalence of medication use in meat eaters (56%)
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45 272 in EPIC-Oxford was slightly higher than the UK average of 43% of men and 50% of women
46
47 273 aged 16 or above who reported taking at least one prescribed medicine in the last week [25],
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49 274 confirming the relatively low prevalence of medication use in the vegetarians (39%) and
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51 275 vegans (28%). However, given the differences in age ranges and possible differences in
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53 276 medications accounted for, strict comparisons cannot be made. Because lower reported use of
54
55 277 medications was observed even in people with no (especially) or only one reported illness or

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2
3 278 condition, better health among non-meat eaters is unlikely to be the only, or a sufficient
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5 279 explanation for the differences. Non-meat eaters may also be reluctant to take medications
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7 280 which are likely to contain animal-derived products [26], or may prefer to use homoeopathic
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9 281 medications [13] or other alternative therapies. Since information on medication use in this
10
11 282 study was based on a pre-specified list from the follow-up questionnaire, it was not possible
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13 283 to assess the use of alternative therapies or any other named medications, despite their
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15 284 possible contributions to prevalence of overall medication use.

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18 285 Differential participation in screening for breast or prostate cancer, use of HRT, and use of
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20 286 medications for people of distinct diet groups may ultimately lead to differences in disease
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22 287 incidence or prognosis due to possible detection bias and differential post diagnosis
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24 288 treatment. For example, breast cancer screening results in higher incidence but reduced
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26 289 mortality from breast cancer among those who are screened [6]. Prostate cancer testing is also
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28 290 linked to increased incidence in those who are tested [27,28]. Therefore, using breast cancer
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30 291 as an example, given the lower rates of breast cancer screening among non-meat eating
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32 292 women both in EPIC-Oxford and in the Swedish Malmö Diet and Cancer Study [9], it is
33
34 293 possible that the observed incidence of breast cancer in these diet groups underestimates the
35
36 294 true incidence owing to detection bias, but that ultimately these women would be expected to
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38 295 have a somewhat higher mortality from breast cancer. Therefore, future work on assessing
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40 296 breast cancer risk in people of different diet groups should take into account any differences
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42 297 in screening rates between diet groups.

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47 298 Similarly, it is not clear why there was differential use of HRT in the four diet groups, for
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49 299 example whether it was because non-meat eaters were less likely to have symptoms, or
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51 300 because they were less likely to seek treatment when symptoms appear. Regardless of the
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53 301 underlying reason, the observed lower reported use of HRT among non-meat eating women
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55 302 deserves attention, because use of HRT may confound any observed associations between

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3 303 diet group and breast cancer, given that HRT preparations containing oestrogens and
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5 304 progestogens have been shown to increase the risk of breast cancer [7,8].
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8 305 Overall, our findings showed some differences in health related behaviours between people
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10 306 of different diet groups, thereby highlighting the need to consider such differences when
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12 307 conducting longitudinal analyses in these populations. Further study is warranted to
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14 308 understand why people of different diet groups have differential participation in breast
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16 309 screening or prostate cancer testing, HRT use, and overall medication use, and whether or
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18 310 how these differences are related to future disease risk.
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23 24 312 **Strengths and limitations**

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26
27 313 This study is the first to simultaneously examine participation in cancer screening or testing,
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29 314 HRT use and medication use in different diet groups. A strength of the study is the large
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31 315 sample size recruited from across different regions in the UK. Additionally, information was
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33 316 collected on a range of factors which may also be associated with the behaviours of interest,
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35 317 allowing adjustment for these factors. Of potential limitations, recall bias is possible because
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37 318 assessment of the behaviours of interest (i.e. breast screening, PSA testing, HRT use and
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39 319 overall medication use) as well as existing medical conditions was based on self-report,
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41 320 although there is no indication that such misclassification bias should differ by diet group.
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43 321 The reasons for which people adhered to each diet group were not recorded, although such
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45 322 reasons may be relevant to the other health behaviours studied. Because of the relatively
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47 323 small number of vegans in our study sample, the role of chance in explaining the findings
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49 324 relating to this diet group, especially subgroup analyses related to medication use, cannot be
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51 325 ruled out. As with most population cohorts, some degree of self-selection and healthy cohort
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53 326 bias may also be present.
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56 328 **CONCLUSIONS**
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8 329 In this population, we observed differences in breast screening, PSA testing, HRT use and
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10 330 overall medication use between meat eaters, fish eaters, vegetarians and vegans, but no
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12 331 significant differences between diet groups for cervical screening, or medication use in
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14 332 people with two or more illnesses or for specific conditions. The reasons for these differences
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16 333 require further investigation. Nonetheless, such differences may be related to or could
17
18 334 confound any differences in observed morbidity or mortality from cancer and other diseases
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20 335 between people of different diet groups, and therefore should be considered in future
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22 336 epidemiological studies.
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27 337
2829 338 **STATEMENTS**
3031 339 **Acknowledgements**
32

33 340 We thank all participants in the EPIC-Oxford cohort for their invaluable contribution. The
34
35 341 work is supported by the UK Medical Research Council MR/M012190/1 and Cancer
36
37 342 Research UK 570/A16491 and C9221/A19170. KEB is supported by the Girdlers' New
38
39 343 Zealand Health Research Council Fellowship. TJK is a member of the Vegan Society; the
40
41 344 other authors had no conflicts of interest.
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4748 346 **Availability of data and materials**
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50 347 The data access policy for EPIC-Oxford is available via the study website (<http://www.epic-oxford.org/data-access-sharing-and-collaboration/>).
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6 350 **Author's contributions**
7

8 351 TYNT, PNA, and TJK conceived and designed the research question. TYNT and PNA
9
10 352 analysed the data. TYNT wrote the first draft of the manuscript, and PNA, KEB and TJK
11
12 353 provided input on data analysis and interpretation of results. All authors revised the
13
14 354 manuscript critically for important intellectual content, and read and approved the final
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16 355 manuscript.
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Table 1 Characteristics by diet group of participants in the EPIC-Oxford study who completed the second follow-up questionnaire (n=31260)¹.

Characteristic	Meat eaters	Fish eaters	Vegetarians	Vegans	Total
Number of participants (% female)	18155 (78.2)	5012 (81.8)	7179 (76.3)	914 (66.1)	31260 (78.0)
Mean (SD) age at questionnaire completion, years	58.9 (12.5)	53.8 (12.5)	51.6 (12.7)	50.7 (12.3)	56.1 (13.0)
Smoking status ² , n (%)					
Never smoker	10073 (55.7)	2786 (55.6)	4339 (60.5)	547 (59.9)	17745 (56.9)
Former smoker	6927 (38.3)	1961 (39.2)	2460 (34.3)	330 (36.1)	11678 (37.5)
Current smoker	1094 (6.0)	260 (5.2)	367 (5.1)	36 (3.9)	1757 (5.6)
Mean (SD) alcohol consumption, g/d	8.7 (9.3)	8.2 (8.7)	7.6 (8.9)	6.7 (9.2)	8.3 (9.1)
Self-reported current health ² , n (%)					
Excellent	3713 (21.9)	1323 (28.1)	1950 (28.7)	325 (37.2)	7311 (24.9)
Good	9962 (58.8)	2688 (57.0)	3851 (56.6)	446 (51.0)	16947 (57.8)
Fair	2858 (16.9)	612 (13.0)	876 (12.9)	80 (9.2)	4426 (15.1)
Poor	400 (2.4)	92 (2.0)	122 (1.8)	23 (2.6)	637 (2.2)
Townsend deprivation index ² , n (%)					
Richest category	4463 (27.6)	984 (21.8)	1542 (23.7)	153 (18.3)	7141 (25.5)
Poorest category	3438 (21.2)	1207 (26.8)	1732 (26.7)	285 (34.1)	6662 (23.8)
In same diet group at recruitment, n (%)	15908 (87.7)	3057 (61.1)	6373 (89.1)	573 (62.7)	25911 (83.0)
Taking medication in the past 4 weeks, n (%)	10196 (56.2)	2105 (42.0)	2829 (39.4)	255 (27.9)	15385 (49.2)
Number of reported illnesses and conditions, n (%)					
None	4455 (24.5)	1635 (32.6)	2603 (36.3)	344 (37.6)	9037 (28.9)
One	4724 (26.0)	1472 (29.4)	2170 (30.2)	291 (31.8)	8657 (27.7)
Two	3682 (20.3)	906 (18.1)	1261 (17.6)	154 (16.8)	6003 (19.2)
Three	2404 (13.2)	524 (10.5)	630 (8.8)	74 (8.1)	3632 (11.6)
Four or more	2890 (15.9)	475 (9.5)	515 (7.2)	51 (5.6)	3931 (12.6)
Reported high blood pressure ² , n (%)	4397 (29.2)	686 (16.2)	944 (15.2)	85 (10.6)	6112 (23.2)
and taking appropriate medication, n (%)	2573 (58.5)	357 (52.0)	430 (45.6)	40 (47.1)	3400 (55.6)
Reported high blood cholesterol ² , n (%)	3351 (23.1)	561 (13.5)	645 (10.5)	44 (5.5)	4601 (18.0)
and taking appropriate medication, n (%)	1646 (49.1)	209 (37.3)	243 (37.7)	14 (31.8)	2112 (45.9)
Reported asthma ² , n (%)	1885 (13.6)	496 (12.1)	758 (12.4)	88 (11.1)	3227 (12.9)
and taking appropriate medication, n (%)	737 (39.1)	169 (34.1)	246 (32.5)	17 (19.3)	1169 (36.2)
Reported diabetes ² , n (%)	707 (5.2)	75 (1.9)	119 (2.0)	7 (0.9)	908 (3.7)
and taking appropriate medication, n (%)	446 (63.1)	41 (54.7)	84 (70.6)	6 (85.7)	577 (63.5)
Reported thyroid disease ² , n (%)	1545 (11.1)	380 (9.2)	465 (7.6)	56 (7.1)	2446 (9.8)
and taking appropriate medication, n (%)	1191 (77.1)	273 (71.8)	337 (72.5)	37 (66.1)	1838 (75.1)

1. Based on participant characteristics at the time of the second follow-up questionnaire (completed approximately 10 years from baseline, around 2007).

2. Unknown for some participants.

Table 2 Participation in screening by diet group of women and men in the EPIC-Oxford study.

Screening/Diet group	Number answering the relevant question ¹	Number (%) answering in the affirmative ¹	Prevalence ratio (95% CI) ¹
Breast screening²			
Meat eaters	9239	8813 (95.4)	1.00 (ref)
Fish eaters	2143	1928 (90.0)	0.96 (0.92,1.01)
Vegetarians	2395	2078 (86.8)	0.94 (0.89,0.98)
Vegans	239	182 (76.2)	0.82 (0.71,0.95)
			<i>P-het=0.004</i>
Cervical screening³			
Meat eaters	15936	15365 (96.4)	1.00 (ref)
Fish eaters	4513	4369 (96.8)	1.00 (0.97,1.03)
Vegetarians	6574	6268 (95.3)	0.98 (0.95,1.01)
Vegans	758	691 (91.2)	0.94 (0.87,1.02)
			<i>P-het=0.37</i>
Prostate specific antigen testing⁴			
Meat eaters	3078	1066 (34.6)	1.00 (ref)
Fish eaters	594	181 (30.5)	0.99 (0.85,1.17)
Vegetarians	947	228 (24.1)	0.82 (0.71,0.96)
Vegans	164	33 (20.1)	0.72 (0.50,1.02)
			<i>P-het=0.023</i>

1. Number answering the relevant question and number (%) answering in the affirmative were as observed. Prevalence ratios were adjusted for age at follow-up (<40, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, ≥75 years, as appropriate according to the age range of included participants), region of residence (eight regions), and self-reported current health (excellent, good, fair, poor, unknown).
2. Included women aged 50 to 74 who answered the relevant question on the second (10 year) follow-up questionnaire.
3. Included women aged 25 to 74 who answered the relevant question on the first (5 year) follow-up questionnaire.
4. Included men aged 50 to 84 who answered the relevant question on the second (10 year) follow-up questionnaire.

Table 3 Use of hormone replacement therapy by diet group of women in the EPIC-Oxford study.

Diet group	Number answering the relevant question ¹	Number (%) answering in the affirmative ¹	Prevalence ratio (95% CI) ¹
Meat eaters	6911	3098 (44.8)	1.00 (ref)
Fish eaters	1614	541 (33.5)	0.80 (0.73,0.88)
Vegetarians	1778	541 (30.4)	0.74 (0.68,0.81)
Vegans	188	31 (16.5)	0.42 (0.30,0.60)
			<i>P-het<0.0001</i>

1. Number answering the relevant question and number (%) answering in the affirmative were as observed. Prevalence ratios were adjusted for age at follow-up (50-54, 55-59, 60-64, 65-69, 70-74 years), region of residence (eight regions), and self-reported current health (excellent, good, fair, poor, unknown). Included post-menopausal women aged 50 to 74 who answered the relevant question on the second (10 year) follow-up questionnaire.

Table 4 Medication use by number of self-reported illnesses or conditions and diet group of participants in the EPIC-Oxford study.¹

Number of self-reported illnesses or conditions / Diet group	Number of participants ²	Percentage taking any medication ²	Prevalence ratio (95% CI) ²
Any number³			
Meat eaters	18155	56.2	1.00 (ref)
Fish eaters	5012	42.0	0.92 (0.87-0.96)
Vegetarians	7179	39.4	0.93 (0.89-0.98)
Vegans	914	27.9	0.71 (0.63-0.81)
			<i>P-het</i> <0.0001
None			
Meat eaters	4455	16.9	1.00 (ref)
Fish eaters	1635	11.9	0.80 (0.68-0.94)
Vegetarians	2603	11.5	0.80 (0.70-0.92)
Vegans	344	6.1	0.47 (0.30-0.72)
			<i>P-het</i> <0.0001
One			
Meat eaters	4724	48.9	1.00 (ref)
Fish eaters	1472	39.1	0.87 (0.80-0.96)
Vegetarians	2170	40.5	0.91 (0.84-0.99)
Vegans	291	29.2	0.69 (0.55-0.85)
			<i>P-het</i> =0.0002
Two			
Meat eaters	3682	66.9	1.00 (ref)
Fish eaters	906	58.8	0.94 (0.86-1.04)
Vegetarians	1261	58.1	0.97 (0.89-1.06)
Vegans	154	42.2	0.74 (0.58-0.95)
			<i>P-het</i> =0.082
Three			
Meat eaters	2404	82.6	1.00 (ref)
Fish eaters	524	74.0	0.94 (0.84-1.05)
Vegetarians	630	73.0	0.94 (0.84-1.04)
Vegans	74	59.5	0.78 (0.57-1.05)
			<i>P-het</i> =0.22
Four or more			
Meat eaters	2890	93.0	1.00 (ref)
Fish eaters	475	86.9	0.96 (0.86-1.06)
Vegetarians	515	88.9	0.98 (0.89-1.09)
Vegans	51	78.4	0.87 (0.63-1.19)
			<i>P-het</i> =0.70

1. Refers to medication use for most of the past four weeks on the second (10 year) follow-up questionnaire, excluding HRT and contraceptive pills.
2. Number of participants and percentage taking any medication were as observed. Prevalence ratios were adjusted for the cross-classification of sex and age at follow-up (<40, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, ≥75 years), region of residence (eight regions), and self-reported current health (excellent, good, fair, poor, unknown).
3. Prevalence ratios for this category were further adjusted for the number of self-reported illnesses or conditions (0, 1, 2, 3, ≥4).

Table 5 Medication use for specific conditions by diet group of participants in the EPIC-Oxford study.¹

Condition/ Diet group	Number reporting the condition (mean years since reported diagnosis) ²	Number (%) taking appropriate medication ²	Prevalence ratio (95% CI) ²
High blood pressure³			
Meat eaters	4397 (9.8)	2573 (58.5)	1.00 (ref)
Fish eaters	686 (9.3)	357 (52.0)	0.97 (0.86-1.08)
Vegetarians	944 (9.0)	430 (45.6)	0.91 (0.82-1.01)
Vegans	85 (9.0)	40 (47.1)	0.92 (0.67-1.26)
			<i>P-het=0.37</i>
High blood cholesterol⁴			
Meat eaters	3351 (6.3)	1646 (49.1)	1.00 (ref)
Fish eaters	561 (5.3)	209 (37.3)	0.88 (0.76-1.01)
Vegetarians	645 (5.5)	243 (37.7)	0.94 (0.81-1.08)
Vegans	44 (7.1)	14 (31.8)	0.74 (0.44-1.26)
			<i>P-het=0.20</i>
Asthma⁵			
Meat eaters	1885 (25.3)	737 (39.1)	1.00 (ref)
Fish eaters	496 (23.2)	169 (34.1)	0.98 (0.82-1.17)
Vegetarians	758 (23.4)	246 (32.5)	0.97 (0.84-1.14)
Vegans	88 (27.9)	17 (19.3)	0.67 (0.41-1.09)
			<i>P-het=0.45</i>
Diabetes⁶			
Meat eaters	707 (10.0)	446 (63.1)	1.00 (ref)
Fish eaters	75 (14.8)	41 (54.7)	0.78 (0.56-1.08)
Vegetarians	119 (10.6)	84 (70.6)	1.05 (0.81-1.35)
Vegans	7 (13.2)	6 (85.7)	1.07 (0.45-2.51)
			<i>P-het=0.46</i>
Thyroid disease⁷			
Meat eaters	1545 (13.2)	1191 (77.1)	1.00 (ref)
Fish eaters	380 (11.6)	273 (71.8)	0.95 (0.83-1.09)
Vegetarians	465 (11.2)	337 (72.5)	0.97 (0.85-1.10)
Vegans	56 (11.8)	37 (66.1)	0.88 (0.63-1.22)
			<i>P-het=0.78</i>

1. Refers to medication use for most the past four weeks specific to the condition described, among participants who reported diagnosis for the condition on the second (10 year) follow-up questionnaire.
2. Number reporting the condition (mean years since reported diagnosis) and number (%) taking appropriate medication were as observed. Prevalence ratios were adjusted for the cross-classification of sex and age at follow-up (<40, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, ≥75 years), region of residence (eight regions), self-reported current health (excellent, good, fair, poor, unknown), years since reported diagnosis (calculated as year of follow-up questionnaire completion minus reported year of diagnosis; <2, 2-3, 4-5, 6-9, ≥10 years, unknown), and number of self-reported illnesses or conditions (1, 2, 3, ≥4).
3. Reported use of at least one of amlodipine, enalapril, frusemide, propranolol, atenolol, bendrofluzide, lisinopril and nifedipine.
4. Reported use of at least one of atorvastatin and simvastatin.
5. Reported use of at least one of beclomethasone and salbutamol.
6. Reported use of at least one of insulin and metformin.
7. Reported use of thyroxine.

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3 **Supplementary text 1:** List of 36 named medications on the EPIC-Oxford 10 year follow-up
4 questionnaire.
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6 Alendronate, amlodipine, amitriptyline, aspirin, atenolol, atorvastatin, beclomethasone,
7 bendrofluazide, co-codamol/co-dydramol, contraceptive pill, co-proxamol, diclofenac,
8 digoxin, enalapril, etidronate, frusemide, HRT, ibuprofen, insulin, lisinopril, lithium,
9 Losec/Zoton, metformin, nifedipine, paracetamol, paroxetine, prednisolone, propranolol,
10 Prozac, risedronate, salbutamol, simvastatin, sleeping pills, tamoxifen, thyroxine, warfarin
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16 **Supplementary text 2:** List of 29 named medical conditions asked on the EPIC-Oxford 10
17 year follow-up questionnaire.
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19 Cancer (type of cancer), blood clot in leg, blood clot in lung or elsewhere, stroke, transient
20 ischaemic attack, angina, heart attack, palpitations/irregular heart beat (cardiac arrhythmia),
21 diabetes, high blood cholesterol, high blood pressure, asthma, emphysema/chronic bronchitis,
22 thyroid problem, cataract in eye, stomach or duodenal ulcer, bowel polyps, diverticular
23 disease, Crohn's disease/ulcerative colitis, coeliac disease, osteoporosis, rheumatoid arthritis,
24 osteoarthritis, depression/anxiety, gallstones, gallbladder removed, epilepsy, multiple
25 sclerosis, enlarged prostate (men only)
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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract P.1 (b) Provide in the abstract an informative and balanced summary of what was done and what was found P.2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported P.4
Objectives	3	State specific objectives, including any prespecified hypotheses P.5 Lines 71-74
Methods		
Study design	4	Present key elements of study design early in the paper P.5 Lines 78, P.7 Lines 127-129
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection P.5-7 Lines 77-124
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants P.5-6 Lines 80-87 (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable P.6-9 Lines 98-124, 141-165
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group P.5-7 Lines 81-119
Bias	9	Describe any efforts to address potential sources of bias P.7-8 Lines 133-140
Study size	10	Explain how the study size was arrived at P.5 Lines 82-87, P.9 Lines 169-171
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why P.8-9 Lines 144-164
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding P.7-9 Lines 126-165 (b) Describe any methods used to examine subgroups and interactions P.8 Lines 159-160 (c) Explain how missing data were addressed P.8-9 Lines 148, 158, 160-164 (d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy P.7 Lines 127-129

(e) Describe any sensitivity analyses P.8-9 Lines 159-164

Continued on next page

For peer review only

Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed P.9 Lines 169-174 (b) Give reasons for non-participation at each stage P.9 Lines 169-174 (c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders P.9 Lines 175-177, Table 1 (b) Indicate number of participants with missing data for each variable of interest P.9 Lines 171-174, 180-181 (c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —Report numbers of outcome events or summary measures P.9-10, Table 2-5
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included P.9-10, Table 2-5 (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses P.10 Lines 201-204

Discussion

Key results	18	Summarise key results with reference to study objectives P.11 Lines 208-217
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias P.15 Lines 317-326
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence P.12-15
Generalisability	21	Discuss the generalisability (external validity) of the study results P.11-12, P.15 Lines 322-326

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based) P.16 Lines 341-343
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*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Cross-sectional analyses of participation in cancer screening and use of hormone replacement therapy and medications in meat eaters and vegetarians: the EPIC-Oxford study.

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Manuscripts

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3 1 **Cross-sectional analyses of participation in cancer screening and use of hormone**
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5 2 **replacement therapy and medications in meat eaters and vegetarians: the EPIC-Oxford**
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7 3 **study.**
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9

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47 17 Keywords: vegetarians; cancer screening; hormone replacement therapy; medication use
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1
2
3 18 **ABSTRACT**
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6 19 **Objectives:** To examine differences in health-related behaviours such as screening or testing
7
8 20 for cancer, use of hormone replacement therapy (HRT), and use of other medications in
9
10 21 different diet groups.

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12
13 22 **Design:** We studied 31,260 participants across four diet groups (18,155 meat eaters, 5,012
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15 23 fish eaters, 7,179 vegetarians, 914 vegans) in the UK EPIC-Oxford cohort. Information was
16
17 24 collected in 5 (around 2000-2003) or 10 (around 2007) year follow-up questionnaires
18
19 25 regarding participation in breast screening, cervical screening, prostate specific antigen (PSA)
20
21 26 testing, use of HRT, and use of medications for the past four weeks. Using Poisson
22
23 27 regression, we estimated the prevalence ratios (PR) for each behaviour across people of
24
25 28 different diet groups, using meat-eaters as the reference group.

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28
29 29 **Results:** Compared with meat-eaters, vegetarian (PR; 95% confidence interval: 0.94; 0.89,
30
31 30 0.98) and vegan (0.82; 0.71, 0.95) women reported lower participation in breast screening,
32
33 31 and vegetarian men were less likely to report PSA testing (0.82; 0.71, 0.96). No differences
34
35 32 were observed among women for cervical screening. In women, all non-meat eating groups
36
37 33 reported lower use of HRT compared with meat-eaters (p heterogeneity <0.0001). Lower
38
39 34 reported use of any medication was observed for participants in all non-meat eating groups
40
41 35 with no ($p<0.0001$) or one ($p=0.0002$) self-reported illness. No heterogeneity was observed
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43 36 across the diet groups for the reported use of specific medication for high blood pressure,
44
45 37 high blood cholesterol, asthma, diabetes, and thyroid disease.

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49 38 **Conclusions:** Differences in self-reported breast screening, PSA testing, HRT use and overall
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51 39 medication use were observed across the diet groups. Whether such differences contribute to
52
53 40 differential long-term disease risks requires further study.
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Strengths and limitations of this study

- This study is the first to simultaneously examine the reported uptake of breast and cervical cancer screening, prostate specific antigen testing, hormone replacement therapy (HRT) use and medication use in different diet groups.
- The study includes a large number of participants recruited from across different regions in the United Kingdom, with a high proportion of fish eaters, vegetarians, and vegans.
- Recall bias is possible because assessment of cancer screening or testing, HRT use and medication use was based on self-report, although there is no indication that such misclassification bias should differ by diet group.
- The study is cross-sectional and we cannot infer causality.

41

42 INTRODUCTION

43 People of different habitual diet groups have been shown to have different health
44 characteristics. Compared to meat eaters, vegetarians generally have lower BMI, blood
45 pressure, and circulating low density lipoprotein cholesterol levels [1–3], characteristics
46 likely to reduce disease risk. However, evidence on the long-term risk of many non-
47 communicable diseases across people of different diet groups is limited.

48 For cancer risk, both a United Kingdom (UK) [4] and a United States (US) [5] study reported
49 lower risk of overall cancer incidence with a vegetarian diet. Because health related
50 behaviours, such as participation in cancer screening [6] or use of hormone replacement
51 therapy (HRT) [7,8], may contribute to the observed rates of cancer, the presence of any
52 differences in these behaviours between diet groups in different populations deserve further
53 investigation. Results from a Swedish cohort [9] and a US cohort [10] showed that
54 vegetarians (including vegans and people who ate fish but not meat) had lower odds of
55 attending breast screening and prostate cancer screening respectively, when compared with
56 meat eaters, and vegetarians also had lower use of HRT compared with non-vegetarians [5].

57 For cardiovascular diseases, vegetarians in EPIC-Oxford have been observed to have lower
58 ischaemic heart disease risk (hospitalization and death combined) [11], but no significant
59 difference in ischaemic heart disease mortality was observed between diet groups in the same
60 population [12]. The reason for this apparent difference between incidence and mortality is
61 unclear. One possible explanation could be the differential use of appropriate medications in
62 the different diet groups, which subsequently influences disease mortality. In a Belgian
63 population for example, vegetarians had lower use of prescription medications compared to
64 non-vegetarians, but similar use of non-prescription drugs [13].

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3 65 The increasing popularity and interest in vegetarian diets [14] prompts research on the long-
4
5 66 term health of vegetarians and vegans. Because health behaviour such as screening or
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7 67 medication use may ultimately influence disease risk, the understanding of any differences in
8
9 68 these behaviours by diet group is crucial for the appropriate appraisal of possible differences
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11 69 in disease risk between diet groups. However, current knowledge on this topic is insufficient,
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13 70 because literature on participation in screening and use of medication across people of
14
15 71 different diet groups is scarce. Therefore, the aim of this study was to assess some of these
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17 72 relevant health behaviours, including participation in cancer screening or testing, and use of
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19 73 HRT and other medications among people of different diet groups, in a large population-
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21 74 based cohort in the UK with a high percentage of vegetarians.
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28 76 **METHODS**

31 77 **Study population**

34 78 The EPIC-Oxford study is a UK based cohort recruited between 1993 and 1999. The study
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36 79 protocol was approved by a Multicentre Research Ethics Committee (Scotland A Research
37
38 80 Ethics Committee) and participants gave written informed consent. Details of the recruitment
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40 81 process have been described previously [1]. In brief, a combination of general practitioner
41
42 82 (GP) recruitment and postal recruitment was used. The GP recruitment invited men and
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44 83 women aged 35 to 59 years registered with participating GPs and recruited 7,421 participants.
45
46 84 The postal recruitment was targeted at vegetarians, vegans, and other people interested in diet
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48 85 and health, by contacting members of The Vegetarian Society, The Vegan Society, and via
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50 86 leaflets enclosed in vegetarian and health food magazines and displayed in health-food shops,
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52 87 and recruited 57,990 participants aged ≥ 20 years. Altogether, 57,443 participants completed a
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54 88 full recruitment questionnaire which asked about their personal details (including postcode to
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3 89 which a Townsend index of area-level deprivation was assigned [15]), habitual diet and other
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5 90 health and lifestyle characteristics, including personal and family medical history, medication
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7 91 use, socio-economic characteristics, smoking and drinking behaviour, and physical activity
8
9 92 levels. A follow-up questionnaire was sent to surviving participants approximately 5 years
10
11 93 after recruitment (mostly from 2000 to 2003), and a second follow-up questionnaire was
12
13 94 mailed approximately 10 years after recruitment (mostly in 2007). In the follow-up
14
15 95 questionnaires, updated information was gathered on diet, health and lifestyle, including self-
16
17 96 reported current health. Due to the changing research focus over the course of data collection,
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19 97 slight variations existed between questions asked on the 5 and 10 year follow-up
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21 98 questionnaires.
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28 100 **Assessment of diet group**

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31 101 In the recruitment questionnaire and each subsequent follow-up questionnaire, four questions
32
33 102 were asked regarding consumption of meat, fish, dairy products, and eggs, in the form of “Do
34
35 103 you eat any meat?” or similar for the other three food groups. Responses to these questions
36
37 104 were used to assign participants to one of four diet groups at each time point: meat eaters
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39 105 (participants who ate meat, irrespective of whether they ate fish, dairy products or eggs); fish
40
41 106 eaters (participants who did not eat meat but did eat fish); vegetarians (participants who did
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43 107 not eat meat or fish, but did eat one or both of dairy products and eggs), and vegans
44
45 108 (participants who did not eat meat, fish, dairy products, or eggs).
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110 **Assessment of participation in screening, HRT and medication use**

111 In the follow-up questionnaires, women were asked if they had ever had a breast screening by
112 mammography, cervical screening by the smear test (only on the 5 year follow-up
113 questionnaire), or used HRT, and men were asked if they had ever had a prostate specific
114 antigen (PSA) test (only on the 10 year follow-up questionnaire). On the 10 year follow-up
115 questionnaire, all participants were asked if they had used any medication for most of the last
116 four weeks, with 36 named medications and a free text field for reporting regular use of any
117 medication not on the list; participants were also asked if they had been diagnosed with any
118 of a list of 29 medical conditions, and the year when the condition was first diagnosed. The
119 full list of the 36 medications and 29 medical conditions is given in Supplementary text 1 and
120 2. The corresponding question on medication use on the 5 year questionnaire was shorter,
121 with 20 named medications and 26 medical conditions.

122 For assessment of specific medication use, five common medical conditions associated with
123 specific medications were identified: high blood pressure (commonly treated with one or
124 more of amlodipine, enalapril, frusemide, propranolol, atenolol, bendrofluzide, lisinopril and
125 nifedipine), high blood cholesterol (atorvastatin and simvastatin), asthma (beclomethasone
126 and salbutamol), diabetes (insulin and metformin), and thyroid disease (thyroxine).

127

128 **Statistical analyses**

129 Information on assignment to diet group and assessment of health behaviour from the 10 year
130 follow-up questionnaire was used for our analyses, except for the assessment of participation
131 in cervical screening which was only asked on the 5 year follow-up questionnaire.
132 Participants were excluded from all analysis if they did not answer the relevant questions to

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3 133 be assigned to an appropriate diet group (n=28), and in order to ensure that an overlapping
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5 134 population was used for the analyses of all outcomes, they were also excluded if they did not
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7 135 answer the relevant question on medication use (n=407). For the analyses related to
8
9 136 participation in breast screening, cervical screening, PSA testing or HRT use, only women or
10
11 137 men who answered the relevant question and were in the specified age group at questionnaire
12
13 138 completion were included. The age group specifications were as follows: age 50 to 74 years
14
15 139 for breast screening, age 25 to 74 years for cervical screening, age 50 to 84 years for PSA
16
17 140 testing, and age 50 to 74 years for HRT use. For HRT use, we further restricted the analysis
18
19 141 to post-menopausal women, determined by including only participants who answered yes to
20
21 142 the question 'Have you been through your menopause?' on the follow-up questionnaire.
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25 143 For each analysis, we used Poisson regression to estimate prevalence ratios (95% confidence
26
27 144 intervals, CI) of cancer screening or testing (breast screening, cervical screening, PSA
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29 145 testing), HRT use, or medication use in different diet groups, using meat eaters as the
30
31 146 reference group. For analyses of cancer screening or testing and use of HRT, we adjusted for
32
33 147 age at follow-up (<40, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, ≥ 75 years as
34
35 148 appropriate for the age range included in the analysis), region of recruitment (eight
36
37 149 geographical regions across the UK), and self-reported current health (excellent, good, fair,
38
39 150 poor, unknown). For analyses of any medication use, we adjusted for the cross-stratification
40
41 151 of sex and age at follow-up, region of recruitment, self-reported current health, and the
42
43 152 number of self-reported illnesses or conditions (0, 1, 2, 3, ≥ 4). To further assess whether any
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45 153 variation in medication use by diet group varied by health status, we repeated the analyses
46
47 154 stratified by the number of self-reported illnesses or conditions using the above
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49 155 categorisation. Subsequently, for each of high blood pressure, high blood cholesterol, asthma,
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51 156 diabetes, and thyroid disease, we estimated the prevalence ratios of taking appropriate
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53 157 medication by diet group among people diagnosed with each condition in turn, adjusting for
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3 158 covariates as above and additionally for years since reported diagnosis, calculated as year of
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5 159 follow-up questionnaire completion minus reported year of diagnosis (<2, 2-3, 4-5, 6-9, ≥10
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7 160 years, unknown).
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10 161 As sensitivity analyses, we repeated the analyses as follows: using data from the 5 year
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12 162 follow-up questionnaire where available; and further adjusting for smoking status (never,
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14 163 former, current, unknown), alcohol consumption (<1 g/day, 1-7 g/day, 8-15 g/day, ≥16
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16 164 g/day), Townsend index of area-level deprivation (quartiles and unknown), and education
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18 165 level (no qualifications, basic secondary e.g. O level, higher secondary e.g. A level, degree,
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20 166 unknown). All statistical analyses were performed using Stata release 14.1 (StataCorp), and *P*
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22 167 values < 0.05 were considered statistically significant.
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29 169 **RESULTS**

32 170 **Cohort characteristics**

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35 171 Overall, 57,443 participants in EPIC-Oxford cohort completed a full recruitment
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37 172 questionnaire, of whom 38,043 (66%) completed the 5 year follow-up questionnaire, and
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39 173 31,695 (55%) completed the 10 year follow-up questionnaire. After excluding participants
40
41 174 who did not answer the relevant questions on diet group or on medication use, data for 31,260
42
43 175 participants who completed the 10 year follow-up questionnaire (18,155 meat eaters, 5,012
44
45 176 fish eaters, 7,179 vegetarians, and 914 vegans) were used for most of the analyses.
46
47 177 Characteristics of the participants are presented in **Table 1**. Overall, non-meat eaters were
48
49 178 younger, more likely to report having excellent health, less likely to report taking medication
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51 179 in the past four weeks, and less likely to have reported any illnesses or conditions.
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181 **Participation in screening and use of HRT and medications**

182 Overall, 14,016 women were included in the analyses for breast screening, 27,781 women for
183 cervical screening, and 4,783 men for PSA testing (**Table 2**). In women, compared with meat
184 eaters, vegetarians (prevalence ratio; 95% CI: 0.94; 0.89, 0.98) and vegans (0.82; 0.71, 0.95),
185 but not fish eaters (0.96; 0.92, 1.01) had lower reported attendance of breast screening, but no
186 significant heterogeneity was observed between the diet groups for reported participation in
187 cervical screening (P -heterogeneity=0.37). In men, vegetarians had lower reported uptake of
188 PSA testing (0.82; 0.71, 0.96) than meat eaters, while the difference in uptake appeared lower
189 but did not reach statistical significance in vegans (0.72; 0.50, 1.02), and was not
190 significantly different in fish eaters (0.99; 0.85, 1.07). For HRT use, women who were non-
191 meat eaters reported lower use (fish eaters: 0.80; 0.73, 0.88; vegetarians: 0.74; 0.68, 0.81;
192 vegans: 0.42; 0.30, 0.60) compared with women who were meat eaters (**Table 3**).

193 Irrespective of the number of self-reported illnesses and conditions, non-meat eaters reported
194 lower use of any medication (fish eaters: 0.92; 0.87, 0.96; vegetarians: 0.93; 0.89, 0.98;
195 vegans 0.71; 0.63, 0.81) compared with meat eaters (**Table 4**). When the analyses were
196 stratified by the number of self-reported illnesses or conditions, non-meat eaters with no
197 ($P<0.0001$) or one ($P=0.0002$) illness or condition reported lower medication use compared
198 with meat eaters, but the association was attenuated and no longer statistically significant
199 among participants with two, three, or four or more illnesses or conditions. For medication
200 use specific to several common illnesses and conditions, no significant differences were
201 observed between the diet groups in the reported use of appropriate medications for high
202 blood pressure, high blood cholesterol, asthma, diabetes, or thyroid disease, among
203 participants diagnosed with each of these conditions (**Table 5**). Results were consistent when
204 we repeated the analyses where possible using data from the 5 year follow-up questionnaire,

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3 205 or when we further adjusted for smoking, alcohol consumption, Townsend deprivation index,
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5 206 and education level (Supplementary table 1).
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10 208 **DISCUSSION**

13 209 **Summary of results**

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16 210 In this UK population-based cohort with a large proportion of participants from different diet
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18 211 groups, we generally observed lower participation in breast screening and lower HRT use
19
20 212 among women who were non-meat eaters (separately categorised as fish eaters, vegetarians,
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22 213 and vegans) compared with women who were meat eaters. Vegetarian men had lower
23
24 214 participation in PSA testing compared with meat eating men, but no significant difference
25
26 215 was observed for cervical screening in women across the diet groups. For medication use,
27
28 216 non-meat eaters were less likely to report taking medications than meat eaters overall, but
29
30 217 there were no significant differences in medication use among people reporting two or more
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32 218 illnesses or conditions, or for people reporting taking specific medications for various self-
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34 219 reported conditions.
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42 221 **Comparison with other studies**

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45 222 Few studies have reported on the participation in cancer screening or testing, HRT use or
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47 223 medication use among people of different diet groups, and no study has assessed all these
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49 224 behaviours simultaneously in the same cohort. For breast cancer screening, consistent with
50
51 225 our findings, the Swedish Malmö Diet and Cancer Study reported that non-attendance for
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53 226 breast cancer screening was more likely in people who were vegetarians or vegans (odds ratio
54
55 227 or OR; 95% confidence interval: 1.49; 1.11, 1.99) [9]. Analyses of data from the Adventist
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3 228 Health Study-2 in the United States and Canada showed that all non-meat eaters were less
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5 229 likely to report PSA testing compared with meat eaters (0.79; 0.66, 0.95 for fish eaters; 0.76;
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7 230 0.67, 0.86 for vegetarians; and OR 0.50; 0.42, 0.60 for vegans) [10], whereas we only
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9 231 observed a lower reported uptake among the vegetarians but not the fish eaters (nor the
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11 232 vegans, perhaps because of limited numbers) compared with meat eaters in EPIC-Oxford.
12
13 233 However, given the much higher rates of PSA testing in the Adventist Health Study-2 (73.3%
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15 234 versus 31.5% in EPIC-Oxford), attitudes towards screening are likely to be different in the
16
17 235 two populations, and therefore the results might not be directly comparable. Similar to our
18
19 236 study, the Adventist Health Study-2 also reported lower ever use of HRT (adjusted for age
20
21 237 and race) in pesco-vegetarians (21.0%) and lacto-vegetarians (20.4%), and the lowest use in
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23 238 vegans (16.2%), when compared with non-vegetarians (22.4%) [5].
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27 239 For medication use, a cross-sectional study in a Belgian population reported lower use of
28
29 240 prescribed medications when comparing vegetarians to a reference Belgian population
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31 241 (25.5% versus 47.3%, $p < 0.001$) [13]. While this is consistent with our findings on overall
32
33 242 medication use, the study did not assess the use of medications stratified by the number of
34
35 243 illnesses, nor did they assess appropriate medication use for specific medical conditions. No
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37 244 studies were found which examined participation of cervical screening among people of
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39 245 different diet groups.
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46 247 **Interpretation of findings and implications**

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49 248 Our findings indicate differences in some health related behaviours between people of
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51 249 different diet groups, although the reasons behind such differences are unclear. For the
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53 250 observed differences in screening rates, possible explanations could be related to different
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55 251 attitudes towards the screening programmes. In the UK since 1988 [6,16], all women aged 50
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3 252 to 70 are invited to attend breast cancer screening clinics [17] and all women aged 25 to 64
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5 253 are invited for cervical screening [18] at regular intervals. On the other hand, there is no
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7 254 national programme for PSA testing, although men over the age of 50 are eligible to arrange
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9 255 for testing via their GP if they wish [19]. In studies which assessed attitudes towards cancer
10
11 256 screening or testing, common reasons which affect people's participation in screening include
12
13 257 their education level and knowledge of the procedure, recommendation by their doctor, fear
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15 258 of the procedure or the outcome, or their perceived risk of cancer [20–23]. If vegetarians and
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17 259 vegans felt their diets or lifestyles were protective against cancer for example, they might be
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19 260 more likely to forgo cancer screening as a result of lower perceived risk. However, no
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21 261 information was found on whether or how such attitudes may vary by diet group.
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25 262 In a small focus group study in Scotland which asked participants about their attitudes
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27 263 towards cancer screening (n=31 for cervical screening, n=10 for breast screening), the study
28
29 264 participants reported that they felt pressure from health care professionals, family and friends
30
31 265 to attend cervical screening but not breast screening, and that they also considered cervical
32
33 266 screening to be normative routine behaviour [24]. Such differences in attitudes towards breast
34
35 267 screening and cervical screening are of interest, as this may help to explain the differences we
36
37 268 observed in participation for breast screening but not cervical screening, if the latter was
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39 269 considered routine behaviour. However, relevant evidence is lacking, and both dietary and
40
41 270 non-dietary factors which are associated with attendance for either breast screening or PSA
42
43 271 testing deserve further study.
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47 272 Reasons for the observed lower prevalence of HRT use and medication use among people of
48
49 273 different diet groups are also unclear. The prevalence of medication use in meat eaters (56%)
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51 274 in EPIC-Oxford was slightly higher than the UK average of 43% of men and 50% of women
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53 275 aged 16 or above who reported taking at least one prescribed medicine in the last week [25],
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55 276 confirming the relatively low prevalence of medication use in the vegetarians (39%) and
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3 277 vegans (28%). However, given the differences in age ranges and possible differences in
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5 278 medications accounted for, strict comparisons cannot be made. Because lower reported use of
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7 279 medications was observed even in people with no (especially) or only one reported illness or
8
9 280 condition, better health among non-meat eaters is unlikely to be the only, or a sufficient
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11 281 explanation for the differences. Non-meat eaters may also be reluctant to take medications
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13 282 which are likely to contain animal-derived products [26], or may prefer to use homoeopathic
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15 283 medications [13] or other alternative therapies. Since information on medication use in this
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17 284 study was based on a pre-specified list from the follow-up questionnaire, it was not possible
18
19 285 to assess the use of alternative therapies or any other named medications, despite their
20
21 286 possible contributions to prevalence of overall medication use.

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25 287 Differential participation in screening for breast or prostate cancer, use of HRT, and use of
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27 288 medications for people of distinct diet groups may ultimately lead to differences in disease
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29 289 incidence or prognosis due to possible detection bias and differential post diagnosis
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31 290 treatment. For example, breast cancer screening results in higher incidence but reduced
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33 291 mortality from breast cancer among those who are screened [6]. Prostate cancer testing is also
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35 292 linked to increased incidence in those who are tested [27,28]. Therefore, using breast cancer
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37 293 as an example, given the lower rates of breast cancer screening among non-meat eating
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39 294 women both in EPIC-Oxford and in the Swedish Malmö Diet and Cancer Study [9], it is
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41 295 possible that the observed incidence of breast cancer in these diet groups underestimates the
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43 296 true incidence owing to detection bias, but that ultimately these women would be expected to
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45 297 have a somewhat higher mortality from breast cancer. Therefore, future work on assessing
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47 298 breast cancer risk in people of different diet groups should take into account any differences
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49 299 in screening rates between diet groups.

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54 300 Similarly, it is not clear why there was differential use of HRT in the four diet groups, for
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56 301 example whether it was because non-meat eaters were less likely to have symptoms, or

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3 302 because they were less likely to seek treatment when symptoms appear. Regardless of the
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5 303 underlying reason, the observed lower reported use of HRT among non-meat eating women
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7 304 deserves attention, because use of HRT may confound any observed associations between
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9 305 diet group and breast cancer, given that HRT preparations containing oestrogens and
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11 306 progestogens have been shown to increase the risk of breast cancer [7,8].
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14 307 Overall, our findings showed some differences in health related behaviours between people
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16 308 of different diet groups, thereby highlighting the need to consider such differences when
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18 309 conducting longitudinal analyses in these populations. Future work should also consider
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20 310 possible differences in other health behaviours between diet groups, such as attendance of
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22 311 colorectal screening. Further study is warranted to understand why people of different diet
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24 312 groups have differential participation in breast screening or prostate cancer testing, HRT use,
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26 313 and overall medication use, whether these differences vary by reasons for adhering to each
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28 314 diet group, and whether or how these differences are related to future disease risk.
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35 316 **Strengths and limitations**

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38 317 This study is the first to simultaneously examine participation in cancer screening or testing,
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40 318 HRT use and medication use in different diet groups. A strength of the study is the large
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42 319 sample size recruited from across different regions in the UK. Additionally, information was
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44 320 collected on a range of factors which may also be associated with the behaviours of interest,
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46 321 allowing adjustment for these factors. Of potential limitations, recall bias is possible because
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48 322 assessment of the behaviours of interest (i.e. breast screening, PSA testing, HRT use and
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50 323 overall medication use) as well as existing medical conditions was based on self-report,
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52 324 although there is no indication that such misclassification bias should differ by diet group.
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55 325 The reasons for which people adhered to each diet group were not recorded, although such
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3 326 reasons may be relevant to the other health behaviours studied. Because of the relatively
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5 327 small number of vegans in our study sample, the role of chance in explaining the findings
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7 328 relating to this diet group, especially subgroup analyses related to medication use, cannot be
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9 329 ruled out. As with most population cohorts, some degree of self-selection and healthy cohort
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11 330 bias may also be present.

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15 16 17 332 **CONCLUSIONS**

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20 333 In this population, we observed differences in breast screening, PSA testing, HRT use and
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22 334 overall medication use between meat eaters, fish eaters, vegetarians and vegans, but no
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24 335 significant differences between diet groups for cervical screening, or medication use in
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26 336 people with two or more illnesses or for specific conditions. The reasons for these differences
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28 337 require further investigation. Nonetheless, such differences may be related to or could
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30 338 confound any differences in observed morbidity or mortality from cancer and other diseases
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32 339 between people of different diet groups, and therefore should be considered in future
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34 340 epidemiological studies.

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39 40 41 342 **STATEMENTS**

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46
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6 350 **Availability of data and materials**7
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9 351 The data access policy for EPIC-Oxford is available via the study website (<http://www.epic-oxford.org/data-access-sharing-and-collaboration/>).
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17 354 **Author's contributions**18
19 355 TYNT, PNA, and TJK conceived and designed the research question. TYNT and PNA
20
21 356 analysed the data. TYNT wrote the first draft of the manuscript, and PNA, KEB and TJK
22
23 357 provided input on data analysis and interpretation of results. All authors revised the
24
25 358 manuscript critically for important intellectual content, and read and approved the final
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Table 1 Characteristics by diet group of participants in the EPIC-Oxford study who completed the second follow-up questionnaire (n=31260)¹.

Characteristic	Meat eaters	Fish eaters	Vegetarians	Vegans	Total
Number of participants (% female)	18155 (78.2)	5012 (81.8)	7179 (76.3)	914 (66.1)	31260 (78.0)
Mean (SD) age at questionnaire completion, years	58.9 (12.5)	53.8 (12.5)	51.6 (12.7)	50.7 (12.3)	56.1 (13.0)
Smoking status ² , n (%)					
Never smoker	10073 (55.7)	2786 (55.6)	4339 (60.5)	547 (59.9)	17745 (56.9)
Former smoker	6927 (38.3)	1961 (39.2)	2460 (34.3)	330 (36.1)	11678 (37.5)
Current smoker	1094 (6.0)	260 (5.2)	367 (5.1)	36 (3.9)	1757 (5.6)
Mean (SD) alcohol consumption, g/d	8.7 (9.3)	8.2 (8.7)	7.6 (8.9)	6.7 (9.2)	8.3 (9.1)
Self-reported current health ² , n (%)					
Excellent	3713 (21.9)	1323 (28.1)	1950 (28.7)	325 (37.2)	7311 (24.9)
Good	9962 (58.8)	2688 (57.0)	3851 (56.6)	446 (51.0)	16947 (57.8)
Fair	2858 (16.9)	612 (13.0)	876 (12.9)	80 (9.2)	4426 (15.1)
Poor	400 (2.4)	92 (2.0)	122 (1.8)	23 (2.6)	637 (2.2)
Townsend deprivation index ² , n (%)					
Richest category	4463 (27.6)	984 (21.8)	1542 (23.7)	153 (18.3)	7141 (25.5)
Poorest category	3438 (21.2)	1207 (26.8)	1732 (26.7)	285 (34.1)	6662 (23.8)
In same diet group at recruitment, n (%)	15908 (87.7)	3057 (61.1)	6373 (89.1)	573 (62.7)	25911 (83.0)
Taking medication in the past 4 weeks, n (%)	10196 (56.2)	2105 (42.0)	2829 (39.4)	255 (27.9)	15385 (49.2)
Number of reported illnesses and conditions, n (%)					
None	4455 (24.5)	1635 (32.6)	2603 (36.3)	344 (37.6)	9037 (28.9)
One	4724 (26.0)	1472 (29.4)	2170 (30.2)	291 (31.8)	8657 (27.7)
Two	3682 (20.3)	906 (18.1)	1261 (17.6)	154 (16.8)	6003 (19.2)
Three	2404 (13.2)	524 (10.5)	630 (8.8)	74 (8.1)	3632 (11.6)
Four or more	2890 (15.9)	475 (9.5)	515 (7.2)	51 (5.6)	3931 (12.6)
Reported high blood pressure ² , n (%)	4397 (29.2)	686 (16.2)	944 (15.2)	85 (10.6)	6112 (23.2)
and taking appropriate medication, n (%)	2573 (58.5)	357 (52.0)	430 (45.6)	40 (47.1)	3400 (55.6)
Reported high blood cholesterol ² , n (%)	3351 (23.1)	561 (13.5)	645 (10.5)	44 (5.5)	4601 (18.0)
and taking appropriate medication, n (%)	1646 (49.1)	209 (37.3)	243 (37.7)	14 (31.8)	2112 (45.9)
Reported asthma ² , n (%)	1885 (13.6)	496 (12.1)	758 (12.4)	88 (11.1)	3227 (12.9)
and taking appropriate medication, n (%)	737 (39.1)	169 (34.1)	246 (32.5)	17 (19.3)	1169 (36.2)
Reported diabetes ² , n (%)	707 (5.2)	75 (1.9)	119 (2.0)	7 (0.9)	908 (3.7)
and taking appropriate medication, n (%)	446 (63.1)	41 (54.7)	84 (70.6)	6 (85.7)	577 (63.5)
Reported thyroid disease ² , n (%)	1545 (11.1)	380 (9.2)	465 (7.6)	56 (7.1)	2446 (9.8)
and taking appropriate medication, n (%)	1191 (77.1)	273 (71.8)	337 (72.5)	37 (66.1)	1838 (75.1)

1. Based on participant characteristics at the time of the second follow-up questionnaire (completed approximately 10 years from baseline, around 2007).

2. Unknown for some participants.

Table 2 Participation in screening by diet group of women and men in the EPIC-Oxford study.

Screening/Diet group	Number answering the relevant question ¹	Number (%) answering in the affirmative ¹	Prevalence ratio (95% CI) ¹
Breast screening²			
Meat eaters	9239	8813 (95.4)	1.00 (ref)
Fish eaters	2143	1928 (90.0)	0.96 (0.92,1.01)
Vegetarians	2395	2078 (86.8)	0.94 (0.89,0.98)
Vegans	239	182 (76.2)	0.82 (0.71,0.95)
			<i>P-het=0.004</i>
Cervical screening³			
Meat eaters	15936	15365 (96.4)	1.00 (ref)
Fish eaters	4513	4369 (96.8)	1.00 (0.97,1.03)
Vegetarians	6574	6268 (95.3)	0.98 (0.95,1.01)
Vegans	758	691 (91.2)	0.94 (0.87,1.02)
			<i>P-het=0.37</i>
Prostate specific antigen testing⁴			
Meat eaters	3078	1066 (34.6)	1.00 (ref)
Fish eaters	594	181 (30.5)	0.99 (0.85,1.17)
Vegetarians	947	228 (24.1)	0.82 (0.71,0.96)
Vegans	164	33 (20.1)	0.72 (0.50,1.02)
			<i>P-het=0.023</i>

1. Number answering the relevant question and number (%) answering in the affirmative were as observed. Prevalence ratios were adjusted for age at follow-up (<40, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, ≥75 years, as appropriate according to the age range of included participants), region of residence (eight regions), and self-reported current health (excellent, good, fair, poor, unknown).
2. Included women aged 50 to 74 who answered the relevant question on the second (10 year) follow-up questionnaire.
3. Included women aged 25 to 74 who answered the relevant question on the first (5 year) follow-up questionnaire.
4. Included men aged 50 to 84 who answered the relevant question on the second (10 year) follow-up questionnaire.

Table 3 Use of hormone replacement therapy by diet group of women in the EPIC-Oxford study.

Diet group	Number answering the relevant question ¹	Number (%) answering in the affirmative ¹	Prevalence ratio (95% CI) ¹
Meat eaters	6911	3098 (44.8)	1.00 (ref)
Fish eaters	1614	541 (33.5)	0.80 (0.73,0.88)
Vegetarians	1778	541 (30.4)	0.74 (0.68,0.81)
Vegans	188	31 (16.5)	0.42 (0.30,0.60)
			<i>P-het<0.0001</i>

1. Number answering the relevant question and number (%) answering in the affirmative were as observed. Prevalence ratios were adjusted for age at follow-up (50-54, 55-59, 60-64, 65-69, 70-74 years), region of residence (eight regions), and self-reported current health (excellent, good, fair, poor, unknown). Included post-menopausal women aged 50 to 74 who answered the relevant question on the second (10 year) follow-up questionnaire.

Table 4 Medication use by number of self-reported illnesses or conditions and diet group of participants in the EPIC-Oxford study.¹

Number of self-reported illnesses or conditions / Diet group	Number of participants ²	Percentage taking any medication ²	Prevalence ratio (95% CI) ²
Any number³			
Meat eaters	18155	56.2	1.00 (ref)
Fish eaters	5012	42.0	0.92 (0.87-0.96)
Vegetarians	7179	39.4	0.93 (0.89-0.98)
Vegans	914	27.9	0.71 (0.63-0.81)
			<i>P-het</i> <0.0001
None			
Meat eaters	4455	16.9	1.00 (ref)
Fish eaters	1635	11.9	0.80 (0.68-0.94)
Vegetarians	2603	11.5	0.80 (0.70-0.92)
Vegans	344	6.1	0.47 (0.30-0.72)
			<i>P-het</i> <0.0001
One			
Meat eaters	4724	48.9	1.00 (ref)
Fish eaters	1472	39.1	0.87 (0.80-0.96)
Vegetarians	2170	40.5	0.91 (0.84-0.99)
Vegans	291	29.2	0.69 (0.55-0.85)
			<i>P-het</i> =0.0002
Two			
Meat eaters	3682	66.9	1.00 (ref)
Fish eaters	906	58.8	0.94 (0.86-1.04)
Vegetarians	1261	58.1	0.97 (0.89-1.06)
Vegans	154	42.2	0.74 (0.58-0.95)
			<i>P-het</i> =0.082
Three			
Meat eaters	2404	82.6	1.00 (ref)
Fish eaters	524	74.0	0.94 (0.84-1.05)
Vegetarians	630	73.0	0.94 (0.84-1.04)
Vegans	74	59.5	0.78 (0.57-1.05)
			<i>P-het</i> =0.22
Four or more			
Meat eaters	2890	93.0	1.00 (ref)
Fish eaters	475	86.9	0.96 (0.86-1.06)
Vegetarians	515	88.9	0.98 (0.89-1.09)
Vegans	51	78.4	0.87 (0.63-1.19)
			<i>P-het</i> =0.70

1. Refers to medication use for most of the past four weeks on the second (10 year) follow-up questionnaire, excluding HRT and contraceptive pills.
2. Number of participants and percentage taking any medication were as observed. Prevalence ratios were adjusted for the cross-classification of sex and age at follow-up (<40, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, ≥75 years), region of residence (eight regions), and self-reported current health (excellent, good, fair, poor, unknown).
3. Prevalence ratios for this category were further adjusted for the number of self-reported illnesses or conditions (0, 1, 2, 3, ≥4).

Table 5 Medication use for specific conditions by diet group of participants in the EPIC-Oxford study.¹

Condition/ Diet group	Number reporting the condition (mean years since reported diagnosis) ²	Number (%) taking appropriate medication ²	Prevalence ratio (95% CI) ²
High blood pressure³			
Meat eaters	4397 (9.8)	2573 (58.5)	1.00 (ref)
Fish eaters	686 (9.3)	357 (52.0)	0.97 (0.86-1.08)
Vegetarians	944 (9.0)	430 (45.6)	0.91 (0.82-1.01)
Vegans	85 (9.0)	40 (47.1)	0.92 (0.67-1.26)
			<i>P-het=0.37</i>
High blood cholesterol⁴			
Meat eaters	3351 (6.3)	1646 (49.1)	1.00 (ref)
Fish eaters	561 (5.3)	209 (37.3)	0.88 (0.76-1.01)
Vegetarians	645 (5.5)	243 (37.7)	0.94 (0.81-1.08)
Vegans	44 (7.1)	14 (31.8)	0.74 (0.44-1.26)
			<i>P-het=0.20</i>
Asthma⁵			
Meat eaters	1885 (25.3)	737 (39.1)	1.00 (ref)
Fish eaters	496 (23.2)	169 (34.1)	0.98 (0.82-1.17)
Vegetarians	758 (23.4)	246 (32.5)	0.97 (0.84-1.14)
Vegans	88 (27.9)	17 (19.3)	0.67 (0.41-1.09)
			<i>P-het=0.45</i>
Diabetes⁶			
Meat eaters	707 (10.0)	446 (63.1)	1.00 (ref)
Fish eaters	75 (14.8)	41 (54.7)	0.78 (0.56-1.08)
Vegetarians	119 (10.6)	84 (70.6)	1.05 (0.81-1.35)
Vegans	7 (13.2)	6 (85.7)	1.07 (0.45-2.51)
			<i>P-het=0.46</i>
Thyroid disease⁷			
Meat eaters	1545 (13.2)	1191 (77.1)	1.00 (ref)
Fish eaters	380 (11.6)	273 (71.8)	0.95 (0.83-1.09)
Vegetarians	465 (11.2)	337 (72.5)	0.97 (0.85-1.10)
Vegans	56 (11.8)	37 (66.1)	0.88 (0.63-1.22)
			<i>P-het=0.78</i>

- Refers to medication use for most the past four weeks specific to the condition described, among participants who reported diagnosis for the condition on the second (10 year) follow-up questionnaire.
- Number reporting the condition (mean years since reported diagnosis) and number (%) taking appropriate medication were as observed. Prevalence ratios were adjusted for the cross-classification of sex and age at follow-up (<40, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, ≥75 years), region of residence (eight regions), self-reported current health (excellent, good, fair, poor, unknown), years since reported diagnosis (calculated as year of follow-up questionnaire completion minus reported year of diagnosis; <2, 2-3, 4-5, 6-9, ≥10 years, unknown), and number of self-reported illnesses or conditions (1, 2, 3, ≥4).
- Reported use of at least one of amlodipine, enalapril, frusemide, propranolol, atenolol, bendrofluzide, lisinopril and nifedipine.
- Reported use of at least one of atorvastatin and simvastatin.
- Reported use of at least one of beclomethasone and salbutamol.
- Reported use of at least one of insulin and metformin.
- Reported use of thyroxine.

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3 **Supplementary text 1:** List of 36 named medications on the EPIC-Oxford 10 year follow-up
4 questionnaire.
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6 Alendronate, amlodipine, amitriptyline, aspirin, atenolol, atorvastatin, beclomethasone,
7 bendrofluazide, co-codamol/co-dydramol, contraceptive pill, co-proxamol, diclofenac,
8 digoxin, enalapril, etidronate, frusemide, HRT, ibuprofen, insulin, lisinopril, lithium,
9 Losec/Zoton, metformin, nifedipine, paracetamol, paroxetine, prednisolone, propranolol,
10 Prozac, risedronate, salbutamol, simvastatin, sleeping pills, tamoxifen, thyroxine, warfarin
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16 **Supplementary text 2:** List of 29 named medical conditions asked on the EPIC-Oxford 10
17 year follow-up questionnaire.
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19 Cancer (type of cancer), blood clot in leg, blood clot in lung or elsewhere, stroke, transient
20 ischaemic attack, angina, heart attack, palpitations/irregular heart beat (cardiac arrhythmia),
21 diabetes, high blood cholesterol, high blood pressure, asthma, emphysema/chronic bronchitis,
22 thyroid problem, cataract in eye, stomach or duodenal ulcer, bowel polyps, diverticular
23 disease, Crohn's disease/ulcerative colitis, coeliac disease, osteoporosis, rheumatoid arthritis,
24 osteoarthritis, depression/anxiety, gallstones, gallbladder removed, epilepsy, multiple
25 sclerosis, enlarged prostate (men only)
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Supplementary table 1: Sensitivity analyses using data from the 5 year follow-up questionnaire or with further adjustment for possible confounders.

Sensitivity analyses / Health behaviour of interest	Diet group, prevalence ratio (95% CI)			
	Meat eaters	Fish eaters	Vegetarians	Vegans
Using data from the 5 year follow-up questionnaire				
Breast screening ¹	1.00 (ref)	0.95 (0.90-1.00)	0.94 (0.89-0.99)	0.77 (0.67-0.89)
Hormone replacement therapy use ¹	1.00 (ref)	0.82 (0.76-0.89)	0.73 (0.67-0.80)	0.52 (0.40-0.68)
Further adjustment for confounders				
Breast screening ²	1.00 (ref)	0.97 (0.92-1.02)	0.94 (0.89-0.99)	0.83 (0.71-0.96)
Cervical screening ²	1.00 (ref)	1.00 (0.97-1.03)	0.99 (0.96-1.02)	0.95 (0.99-1.02)
Prostate specific antigen testing ²	1.00 (ref)	1.00 (0.85-1.17)	0.83 (0.72-0.97)	0.76 (0.53-1.08)
Hormone replacement therapy use ²	1.00 (ref)	0.81 (0.73-0.88)	0.76 (0.69-0.84)	0.44 (0.31-0.63)
Any medication use ³	1.00 (ref)	0.92 (0.88-0.97)	0.94 (0.90-0.98)	0.71 (0.63-0.81)

- Adjusted for age at follow-up (<40, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, ≥75 years, as appropriate according to the age range of included participants), region of residence (eight regions), and self-reported current health (excellent, good, fair, poor, unknown).
- Adjusted for age at follow-up (<40, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, ≥75 years, as appropriate according to the age range of included participants), region of residence (eight regions), self-reported current health (excellent, good, fair, poor, unknown), smoking status (never, former, current, unknown), alcohol consumption (<1 g/day, 1-7 g/day, 8-15 g/day, ≥16 g/day), Townsend index of area-level deprivation (quartiles and unknown), and education level (no qualifications, basic secondary e.g. O level, higher secondary e.g. A level, degree, unknown).
- Adjusted for the cross-classification of sex and age at follow-up (<40, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, ≥75 years), region of residence (eight regions), self-reported current health (excellent, good, fair, poor, unknown), number of self-reported illnesses or conditions (0, 1, 2, 3, ≥4), smoking status (never, former, current, unknown), alcohol consumption (<1 g/day, 1-7 g/day, 8-15 g/day, ≥16 g/day), Townsend index of area-level deprivation (quartiles and unknown), and education level (no qualifications, basic secondary e.g. O level, higher secondary e.g. A level, degree, unknown).

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract P.1 (b) Provide in the abstract an informative and balanced summary of what was done and what was found P.2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported P.4
Objectives	3	State specific objectives, including any prespecified hypotheses P.5 Lines 71-74
Methods		
Study design	4	Present key elements of study design early in the paper P.5 Lines 78, P.7 Lines 127-129
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection P.5-7 Lines 77-124
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants P.5-6 Lines 80-87 (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable P.6-9 Lines 98-124, 141-165
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group P.5-7 Lines 81-119
Bias	9	Describe any efforts to address potential sources of bias P.7-8 Lines 133-140
Study size	10	Explain how the study size was arrived at P.5 Lines 82-87, P.9 Lines 169-171
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why P.8-9 Lines 144-164
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding P.7-9 Lines 126-165 (b) Describe any methods used to examine subgroups and interactions P.8 Lines 159-160 (c) Explain how missing data were addressed P.8-9 Lines 148, 158, 160-164 (d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy P.7 Lines 127-129

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(e) Describe any sensitivity analyses P.8-9 Lines 159-164

Continued on next page

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Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed P.9 Lines 169-174 (b) Give reasons for non-participation at each stage P.9 Lines 169-174 (c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders P.9 Lines 175-177, Table 1 (b) Indicate number of participants with missing data for each variable of interest P.9 Lines 171-174, 180-181 (c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —Report numbers of outcome events or summary measures P.9-10, Table 2-5
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included P.9-10, Table 2-5 (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses P.10 Lines 201-204
Discussion		
Key results	18	Summarise key results with reference to study objectives P.11 Lines 208-217
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias P.15 Lines 317-326
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence P.12-15
Generalisability	21	Discuss the generalisability (external validity) of the study results P.11-12, P.15 Lines 322-326
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based) P.16 Lines 341-343

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.