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Diet and risk of breast, endometrial and ovarian cancer: UK Women's Cohort Study

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Abstract

This study aimed to investigate associations between diet and the risk of breast, endometrial and ovarian cancer in the UK Women's Cohort Study. 35,372 women aged 35-69 years were enrolled between 1995 and 1998 and completed a validated 217-item food frequency questionnaire. The individual foods were collapsed into 64 main food groups, compared using Cox proportional models, adjusting for potential confounders. Hazard ratio (HR) estimates are presented per portion increase of food items. After approximately 18 years of follow-up, there were 1822, 294, and 285 cases of breast, endometrial and ovarian cancer respectively. A high consumption of processed meat and total meat was associated with an increased risk of breast and endometrial cancer. High intakes of tomatoes (HR: 0.87, 99% confidence interval (CI): 0.75 to 1.00) and dried fruits (HR: 0.60, 99% CI: 0.37 to 0.97) were associated with a reduced risk of breast and endometrial cancer respectively. Mushroom intake was associated with a higher risk of ovarian cancer (HR 1.57, 99% CI: 1.09 to 2.26). Subgroup analysis by pre or post-menopausal cancer further demonstrated an association between processed meat intake and both postmenopausal breast cancer and endometrial cancer. Dried fruits intake was associated with a reduced risk of postmenopausal endometrial cancer (HR: 0.55, 99% CI: 0.31 to 0.98). Our findings suggest that while some foods may trigger the risk of these cancers, some foods may also be protective; supporting the call for further randomised controlled trials of dietary interventions to reduce risk of cancer among pre and postmenopausal women.

Keywords

Diet; food groups; breast cancer; endometrial cancer; ovarian cancer; premenopausal; postmenopausal

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Conflict of Interest
JEC is a director of the University of Leeds spin out company Dietary Assessment Ltd.

Authorship
JEC initiated and developed the cohort. YD was primarily responsible for data analysis and writing the manuscript. All authors were involved in the study design, interpretation of findings, editing and approving the article.

Introduction

In the UK, breast cancer is the most commonly diagnosed cancer among women accounting for almost one-third of all female cancers. Endometrial and ovarian cancers are the next most frequently diagnosed hormone-related cancers among British women(1). These cancers are all age dependent and are commonly diagnosed post menopausally(2). The mechanisms involved in the pathogenesis of these cancers are not completely elucidated. Reproductive and hormonal risk factors such as an early age at menarche, late age at menopause, lack of oral contraceptive use, lack of tubal ligation, postmenopausal hormone therapy, nulliparity, all contribute to the lifetime oestrogen exposure(3, 4) as well as a family history have been consistently associated with these reproductive cancers(5). Moreover, smoking has also been associated with an increased risk of breast and ovarian cancers while it reduces the risk of endometrial cancer(6, 7). In addition, evidence from observational studies have indicated that obesity related metabolic disorders such as diabetes and metabolic syndrome can be linked to the aetiology of these cancers(8). These metabolic disorders are partly outcomes of a poor diet(9).

In addition to being one of the triggering factors in the development of obesity, diet also potentially influence the endogenous hormonal milieu, thereby increasing the risk of these hormone related cancers(10). As demonstrated in previous studies, dietary changes have been linked to changes in menstrual cycle length, circulating sex hormone-binding globulin levels, and also oestradiol levels(11, 12, 13, 14). Even though studies have shown that diet may be related to the risk of breast, endometrial and ovarian cancer, the specific dietary components involved in the aetiology of these cancers remains unclear. For instance, according to the recent World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) report(15), there was strong evidence that alcohol consumption increases both the risk of pre- and postmenopausal breast cancers. In addition, there was suggestive evidence demonstrating that a high consumption of non-starchy vegetables, foods sources of carotenoids, dairy products and calcium rich diets were associated with a decreased risk of breast cancer. On the other hand, the link between other foods and risk of breast cancer remains limited and inconclusive. Likewise, the relationship between diet and endometrial as well as ovarian cancer was sparse and conflicting. Therefore, using data from the UK Women's Cohort study (UKWCS), this study aims to investigate the associations between food intake and the risk of breast, endometrial and ovarian cancer.

The aetiology of these cancers also differ by whether the cancer is pre-or postmenopausal. While evidence suggests a link between endogenous oestrogens and risk of these cancers among postmenopausal women, there is only weak evidence supporting this relationship among premenopausal women(16, 17). In addition, the menstrual cycle variations in circulating sex hormone levels makes deciphering the aetiology behind premenopausal breast, endometrial and ovarian cancer risk a challenge(18). This study thus also seeks to look into the relationship between diet and risk of the hormone-dependent cancers by menopausal status.

Methods

Study design, study population and ethical approval

At baseline, the UKWCS involved 35,372 women across England, Wales and Scotland who responded to a postal questionnaire between 1995 and 1998. The recruitment process has been detailed elsewhere(19). Recruited women were aged between 35 and 69 years. Dietary data, lifestyle as well as health related data were collected at baseline. Approximately four years later, further diet, lifestyle and health related data were collected between the years 1999 and 2002 (40.1% response) which formed the follow-up cohort. Reproductive history including menopausal status was also collected at study baseline and follow-up. At its initiation in 1993, ethical approval was obtained from 174 local research ethics committees (Research Ethics Committee reference number: 15/YH/0027).

Dietary assessment

A detailed validated(20) 217-food item food frequency questionnaire (FFQ) was used to assess dietary intake of the participants over a period of 12 months. Daily intakes of each food item (grams/day) were determined using the frequency categories to estimate the portion size. Using a standard portion size, these were then converted to weights. According to the recent World Cancer Research Fund report, one of the identified critical areas of research included the better characterisation of diet(15) and their cancer prevention recommendations(21) suggest consumption of a fibre rich diet, limiting consumption of foods high in fat, starches or sugars as well as limiting consumption of red and processed meat. Therefore in this study, the individual food items were collapsed into 64 food groups based on their fibre and fat contents, type of meat or according to their culinary uses. Details on grouping of the foods have been described previously(22). The standard portion sizes were estimated by calculating the average portion size of the individual food items within the food group as per the Food Standards Agency(23).

Case definition

Incident cases of invasive breast carcinomas, endometrial and ovarian cancers were identified through linkage to the National Health Service Central Register(24). The International Classification of Diseases 9 and 10 were used to code incident cancer cases. Participants were followed from study entry till diagnosis of the breast cancer (ICD-9 code 174 or ICD-10 code C50), endometrial cancer (ICD-9 code 182 or ICD-10 code C54.1 or C54.9), ovarian cancer (ICD-9 code 183 or ICD-10 code C56), date of death or until the censor date (April 1, 2016) whichever came first.

Statistical analysis

Descriptive statistics were used to describe lifestyle characteristics of participants for breast, endometrial and ovarian cancer separately as well as for women without any incident case of a malignant cancer. Cox proportional hazards regression was used to provide hazard ratios (HRs) and 99% confidence intervals (CIs) to account for potential multiple testing, of breast, endometrial and ovarian cancers in relation to diet. For ease of interpretation, the HRs were presented per standard portion size of the food group per day. The proportional hazards

assumption was tested graphically as well as using the Cox-Snell residuals for all terms in the model. Time in the study was used as the time variable, calculated from the date of questionnaire receipt until either death or censor date.

Risk factors for the cancers previously identified in the literature were considered to build a directed acyclic graph. A parsimonious age-adjusted model was firstly used to estimate associations between each individual food groups and risk of the cancers in separate models (model 1). According to the minimal sufficiency set of adjustments, the final models for risk of breast and ovarian cancer were adjusted for age (years), physical activity (h/day)(25), ethanol intake (g/day)(26), smoking status (never, current or former smoker)(27), cumulative duration of breastfeeding (weeks)(28, 29, 30), menopausal status (pre or post-menopausal), (2) and socioeconomic status (professional/managerial, intermediate or routine and manual) (31) (model 2). For risk of endometrial cancer, history of diabetes(32) and hypertension(33) were also included in model 2. Participants with incomplete data on these variables were excluded.

Subgroup analyses by pre-menopausal cancer and post-menopausal cancer were also performed. A premenopausal cancer was defined as an incident case diagnosed before the last menstrual period while a postmenopausal cancer case was one diagnosed either at or after the last menstrual period. For premenopausal cancer, cases contributed to person-time from age at baseline until diagnosis of the event. If the participant did not have a premenopausal cancer, the age until last menstrual period was considered as the time variable instead. Women who were already postmenopausal at study entry were excluded from the model (adjusted for model 2). For postmenopausal cancer, cases contributed to person-time from age at last menstrual period until diagnosis of the event. Women who were incident cases of premenopausal cancer and those who were still premenopausal at censor date were excluded from the model (adjusted for model 2).

Age at natural menopause was further explored as an effect modifier for the foods that were significantly associated with the risk of the cancers. Previous studies have also demonstrated an increased risk of these cancers with a later age at natural menopause due to longer exposure to oestrogen(34). Age at last period was self-reported at both baseline and phase 2. This variable was grouped as having a menopause either between 40-49 years (n= 10,505) or 50-65 years (n= 6,295). In order to include only postmenopausal women with a natural menopause, those who had a hysterectomy or bilateral oophorectomy as well as those who reported current or ever use of hormone replacement therapy (HRT) prior to their last period were excluded from the analyses. In addition, women who had their last period before the age of 40 years were also excluded as this could be due to other treatments or surgical procedures which could not be ascertained in this study. All statistical analyses were conducted using Stata version 15 statistical software.

Sensitivity analysis was also conducted using model 2, further adjusting for both family history of any cancer and family history of breast cancer in first-degree relatives to estimate the associations between food groups and the risk of breast cancer. To estimate associations for the risk of endometrial cancer, family history of endometrial cancer was included in the model, and for the risk of ovarian cancer, a family history of ovarian cancer and breast

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cancer was adjusted for in addition to model 2. Sensitivity analyses also involved adjusting for total energy intake (kJ/d) to account for under and over reporters (model 3). Adjustments were also made for current HRT use(35, 36), use of oral contraceptive pills, and parity(37, 38) (model 4) in addition to model 3 as these are known risk factors of breast, endometrial and ovarian cancers.

Results

Baseline characteristics according to cancer type

Of the 35,372 women at baseline, 695 women who were not flagged on the National Health Services (NHS) digital, 2,340 women reporting history of any previous malignant cancer at baseline (except for non-melanoma of the skin) and women who were diagnosed with breast (n=68), endometrial (n=7) and ovarian (n=12) cancer within 1 year of baseline were excluded. After the exclusions, 32,228 women were eligible for the breast cancer analysis, 32,289 for the endometrial cancer analysis and 32,284 for the ovarian cancer analysis.

Baseline characteristics of the participants according to cancer type are summarised in Table 1. After approximately 18 years of follow-up, there were 1,822 incident cases of breast cancer, 294 and 285 incident cases of endometrial and ovarian cancer respectively. Women with endometrial and ovarian cancer were on average overweight at baseline with a BMI of 27.3 and 25.1 kg/m^2 respectively while women with breast cancer were borderline overweight (24.8 kg/m^2) and women without any cancer had a normal weight (24.4 kg/m^2). Women with endometrial cancer were less likely to be current smokers and had lower ethanol intake in comparison to those with breast and ovarian cancer as well as those without any cancer. A majority of women with incident breast cancer were current users of HRT at baseline (58.3%). Women without any cancer had an earlier natural menopause (mean=47.5 years) as compared to women with breast, endometrial and ovarian cancer. Around 42-46% of women with breast, endometrial and ovarian cancer had a family history of any cancer at baseline as compared to 38.4% for the non-cancer cases. Total energy and fibre intakes were quite similar between the cases of cancer and non-cases.

Diet and risk of breast, endometrial and ovarian cancer

For the association between food intake and risk of breast cancer, in both the age-adjusted model and fully adjusted model, a standard portion of 83g of tomato consumption was associated with a significant risk reduction (HR: 0.87, 99% CI: 0.75 to 0.999). In the fully-adjusted model, a standard portion of processed meat and total meat intake were both associated with higher risk of breast cancer, 36% and 17%, respectively (HR: 1.36, 99% CI: 1.02 to 1.81; HR: 1.17, 99% CI: 1.00 to 1.36) (Table 2). According to the subgroup analysis by pre and post-menopausal breast cancer, consumption of tomatoes reduced the risk postmenopausal breast cancer but not premenopausal breast cancer. Consumption of processed meat and total meat were both associated with a significant higher risk of postmenopausal breast cancer only. In addition, intake of 15g of biscuits per day was associated with a 17% higher risk of premenopausal breast cancer (Table 3).

Similarly, an increased risk of endometrial cancer was observed in the fully adjusted model with consumption of a standard portion of processed and total meat per day (HR: 2.19, 99% CI: 1.34 to 3.60; HR: 1.53, 99% CI: 1.04 to 2.24). Consumptions of 28g of dried fruits per day and 85g of high breakfast cereals were associated with a 40% and 26% reduced risk of endometrial cancer respectively (HR: 0.60, 99% CI: 0.37 to 0.97; HR: 0.74, 99% CI: 0.55 to 0.998) (Table 2). In the subgroup analysis, a standard portion of processed meat per day was associated with a higher risk of post-menopausal endometrial cancer. Consumption of dried fruits was associated with a significant reduced risk of only postmenopausal endometrial cancer (HR: 0.55, 99% CI: 0.31 to 0.98) while a higher intake of low calorie/diet soft drinks was positively associated with the risk of postmenopausal endometrial cancer (HR: 1.27; 99% CI: 1.00 to 1.61). For ovarian cancer, 34g of mushroom intake per day was associated with a significantly higher risk (HR: 1.57, 99%: 1.09 to 2.26). Furthermore, it was found that a higher mushroom intake was associated with an increased risk of postmenopausal ovarian cancer. A higher consumption of citrus fruits and total fruits were associated with an 87% and 37% reduced risk of premenopausal ovarian cancer respectively.

After further adjustment for family history of the respective cancers similar results were obtained to those reported above. In addition, a significantly higher risk of breast and endometrial cancer was observed with frequent consumption of a standard portion of potatoes with added fat (i.e. chips/roast potatoes) (Supplementary Table 1). The associations between diet and risk of breast, endometrial and ovarian cancer after further adjustments for total energy intake and current HRT use, oral contraceptive use and parity were also in agreement with the study's main associations (Supplementary Table 2). We also found that the risk of breast, endometrial and ovarian cancer significantly increased with an increase in age at natural menopause (Supplementary Table 3). Subgroup analysis by age at natural menopause demonstrated that the diet of women with either an earlier or later age at natural menopause did not change the risk of the cancers (Supplementary Table 4).

Discussion

In this prospective investigation of the consumption of food groups in relation to the risk of breast, endometrial and ovarian cancers, we consistently found that consumption of processed meat and total meat was associated with a significantly higher risk of breast and endometrial cancer. In addition, frequent consumption of a standard portion of tomatoes and dried fruits were associated with a reduced risk of breast and endometrial cancer respectively. A higher consumption of mushroom was found to be weakly associated with a higher risk of ovarian cancer. Subgroup analysis showed similar associations between these food items and cancer risk, when differentiating between a pre and post-menopausal cancer as well as when further adjustments for family history of cancer, total energy intake, current HRT use, oral contraceptive use and parity were accounted for in the different models.

Previous studies have also reported an increased risk of breast and endometrial cancer with a higher consumption of processed meat and total meat. According to the recent UK Biobank cohort study(39), a 6% higher risk of breast cancer was reported in relation to processed meat consumption. Similar to our results, they also found a significant increased risk for post-menopausal breast cancer. The EPIC(40) and NutriNet-Santé(41) prospective cohort

studies have also reported an increased risk of breast cancer associated with the consumption of processed meat. Our findings are further supported by a prospective randomised control trial conducted over a period of 8 years(42). Studies investigating the association between processed meat and the risk of endometrial cancer are limited and conflicting. While a case-control study(43) including 274 participants with endometrial cancer found that intake of processed meats such as boiled ham, salami and sausages, and canned meat were associated with an increased risk of endometrial cancer, findings from a cohort study, the National Institutes of Health (NIH-AARP) Diet and Health Study(44) including 1,486 incident cases reported no evidence of an association. Another cancer multisite study from the NIH-AARP Diet and Health Study also reported no association between processed meat consumption and risk of both breast and endometrial cancer(45).

The underlying mechanisms for the pathogenesis of breast cancer are heterogeneous. High levels of nitrates, nitrites and amines, which are precursors of N-nitroso compounds, added in processed meat to enhance its colour and flavour have been consistently reported to be one of the causes of carcinogenicity(46). In addition, cooking especially at high temperatures (e.g. frying, grilling or barbecuing) can lead to the formation of heterocyclic aromatic amines which are also potent mutagens and carcinogens(47). The N-nitro compounds, heterocyclic amines along with other compounds (heme iron, saturated fat and oestradiol) present in meats can directly cause DNA damage and have been associated with mammary tumour development as demonstrated in both animal and human studies(46, 48). We also found that processed meat consumption was positively associated with postmenopausal breast cancer though not for premenopausal breast cancer. Disparities could be due to differing oestrogen metabolism pathways between the two groups. These results could suggest that processed meat influences breast cancer risk by interacting with oestrogen metabolism in scenarios where the levels of circulating oestrogens are lower(20).

Endometrial cancer is a hormone-driven cancer, with approximately 80% potentially arising due to either an excess of oestrogen or a lack of progesterone. In the normal endometrium, the proliferative effects of oestrogen are normally countered by progesterone but in the absence of progesterone, oestrogen can induce oncogenesis, an effect that is amplified in situations of excess oestrogen(49). In addition to being a source of N-nitroso compounds, processed meat is also rich in cholesterol, which can be converted to androgens and oestrogens through varying metabolic pathways(50).

Our study further demonstrated that consumption of a standard portion of tomatoes per day was associated with a reduced risk of breast cancer. The protective association was mainly observed among women with postmenopausal breast cancer. Lycopene, a carotenoid widely available in tomatoes has a very high antioxidant potential, and can thus protect the DNA from damage. In a large pooled analysis which included more than 3000 breast cancer cases, Eliassen et al.(51) also found an inverse association between lycopene and risk of breast cancer. The antiproliferative effect of lycopene has also been demonstrated in mammary cancer cell lines by its inhibitory effect on insulin-like growth factor-I-stimulated cell multiplying(52, 53). The observed inverse association could also be due to the high flavonol content of tomatoes which also confers enhanced antioxidant capacity.

Consumption of dried fruits and high fibre breakfast cereals such as porridge, muesli and bran flakes were inversely associated with risk of endometrial cancer, in particular among women who were incident cases of post-menopausal endometrial cancer. Dried fruits reportedly have a higher total phenolic content, flavonoids and total antioxidant capacity compared to fresh fruits making dried fruits a potential candidate as a chemopreventive food(54, 55). Previous studies have similarly reported an inverse association between wholegrain cereal consumption and endometrial cancer(56, 57). Dietary fibre has been found to interact with the metabolism of oestrogen, causing a reduced bioavailability of the hormone(58). High fibre cereals and dried fruits are also good sources of dietary lignans. Lignans, a type of phyto-oestrogens are plant compounds having structural similarity to 17-oestrodiol. They can lower endogenous oestrogen levels by potentially binding to oestrogen receptors(59), hence reducing the risk of endometrial cancer.

Contrary to a previous case-control study undertaken in Chinese women which demonstrated an inverse association between white button mushroom and risk of ovarian cancer(60), our findings showed weak evidence of an increased risk in relation to consumption of a standard portion of mushroom per day. Furthermore according to a study among Korean women, high mushroom intake was reportedly associated with a lower risk of breast cancer among premenopausal women and a stronger association was reported among premenopausal women with oestrogen receptor positive and progesterone receptor positive tumours(61). However, in this study we do not have this level of detail in terms of types of mushroom consumption and breast cancer by hormone receptor type. This difference could also be attributed to to the fact that Chinese cohorts most commonly consume fresh mushrooms while in Europe use of canned mushrooms are more widespread. In addition, in the UK, there is no other evidence suggesting that mushrooms can increase or decrease risk of cancer(62).

Strengths of this study include the prospective study design, a long follow-up time and large sample size. This is also the first study in the UK looking at multiple food groups in relation to the risk of breast, endometrial and ovarian cancers. We were also able to study the associations with specific types of meat, cereal products (wholegrain or refined), and dairy products (high-fat or low-fat). We adjusted for a wide range of confounders including sociodemographic, and lifestyle using a consistent method (Directed Acyclic Graph). However, as in any observational study residual confounding is still possible. A limitation of our study was the inability to determine whether the associations varied according to the hormone receptor status of tumours, due to lack of these data at present in this cohort. The UKWCS will soon be expanding to include additional details on the tumour types. Moreover, the use of a FFQ for dietary assessment could also be prone to low accuracy due to recall bias. However, the FFQ is a useful tool in providing a snapshot of the dietary habit over a longer period of time.

Regression dilution might also be an issue given participants' diets may have changed over time, potentially introducing further measurement error. This study also does not take into account the use of pesticides which is also a potential carcinogen influencing cancer risk of the women. Our sample was also more health conscious given the high number of vegetarians in our sample population and more well off participants than the general

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population. However, our study still includes women from a range of different backgrounds which implies that these findings could be extrapolated to other countries.

Primary prevention of cancer is important and a matter of consideration in public health. While factors such as parity, age at onset of natural menopause and family history are well established to have a link with the risk of breast, endometrial and ovarian cancer, these are non-modifiable risk factors. However, diet which is also a modifiable risk factor has been shown to either increase or decrease the risk of carcinogenesis, making focus on diet an interesting opportunity in cancer prevention.

To summarise, this study suggests a link between specific foods: processed meat, total meat, tomatoes, dried fruits and wholegrain products and the risk of breast as well as endometrial cancer while a relationship between diet and risk of ovarian cancer is less evident. These findings support the call for further randomised controlled trials of dietary interventions to reduce the risk of these hormone related cancers in relation to both pre and post-menopausal cancer cases.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Office for National Statistics. [accessed May 2018] Statistical bulletin: Cancer registration statistics, England: 2016. 2018. https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/bulletins/cancerregistrationstatisticsengland/final2016
2. Cancer Research UK. [accessed May 2018] Cancer statistics by type. http://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type
3. Kelsey JL, Gammon MD, John EM. Reproductive factors and breast cancer. Epidemiol Rev. 1993; 15:36–47. [PubMed: 8405211]
4. McPherson CP, Sellers TA, Potter JD, et al. Reproductive factors and risk of endometrial cancer: The Iowa Women's Health study. Am J Epidemiol. 1996; 143:1195–1202. [PubMed: 8651218]
5. Hunn J, Rodriguez GC. Ovarian cancer: etiology, risk factors, and epidemiology. Clin Obstet Gynecol. 2012; 55:3–23. [PubMed: 22343225]
6. Cramer DW. The epidemiology of endometrial and ovarian cancer. Hematol Oncol Clin North Am. 2012; 26:1–12. [PubMed: 22244658]
7. Jones ME, Schoemaker MJ, Wright LB, et al. Smoking and risk of breast cancer in the Generations Study cohort. Breast Cancer Res. 2017; 19:118. [PubMed: 29162146]

8. Gallagher EJ, LeRoith D. Epidemiology and molecular mechanisms tying obesity, diabetes, and the metabolic syndrome with cancer. Diabetes care. 2013; 36(Suppl 2):S233–239. [PubMed: 23882051]
9. de Oliveira EP, McLellan KCP, Vaz de Arruda Silveira L, et al. Dietary factors associated with metabolic syndrome in Brazilian adults. Nutr J. 2012; 11:13. [PubMed: 22417631]
10. Henderson BE, Feigelson HS. Hormonal carcinogenesis. Carcinogenesis. 2000; 21:427–433. [PubMed: 10688862]
11. Thomas HV, Davey GK, Key TJ. Oestradiol and sex hormone-binding globulin in premenopausal and post-menopausal meat-eaters, vegetarians and vegans. Br J Cancer. 1999; 80:1470–1475. [PubMed: 10424753]
12. Barnard ND, Scialli AR, Hurlock D, et al. Diet and sex-hormone binding globulin, dysmenorrhea, and premenstrual symptoms. Obstetrics and gynecology. 2000; 95:245–250. [PubMed: 10674588]
13. Gann PH, Chatterton RT, Gapstur SM, et al. The effects of a low-fat/high-fiber diet on sex hormone levels and menstrual cycling in premenopausal women: a 12-month randomized trial (the diet and hormone study). Cancer. 2003; 98:1870–1879. [PubMed: 14584069]
14. Boyd NF, Lockwood GA, Greenberg CV, et al. Effects of a low-fat high-carbohydrate diet on plasma sex hormones in premenopausal women: results from a randomized controlled trial. Canadian Diet and Breast Cancer Prevention Study Group. Br J Cancer. 1997; 76:127–135. [PubMed: 9218745]
15. World Cancer Research Fund/American Institute for Cancer Research. [Access date: 16 April 2018] Diet, Nutrition, Physical Activity and Cancer: a Global Perspective. Continuous Update Project Expert Report 2018. 2018. Available atdietandcancerreport.org
16. Samavat H, Kurzer MS. Estrogen metabolism and breast cancer. Cancer Lett. 2015; 356:231–243. [PubMed: 24784887]
17. Allen NE, Key TJ, Dossus L, et al. Endogenous sex hormones and endometrial cancer risk in women in the European Prospective Investigation into Cancer and Nutrition (EPIC). Endocr Relat Cancer. 2008; 15:485–497. [PubMed: 18509001]
18. Lukanova A, Kaaks R. Endogenous Hormones and Ovarian Cancer: Epidemiology and Current Hypotheses. Cancer Epidemiol Biomarkers Prev. 2005; 14:98–107. [PubMed: 15668482]
19. Cade JE, Burley VJ, Alwan NA, et al. Cohort Profile: The UK Women's Cohort Study (UKWCS). Int J Epidemiol. 2015; 46(2):e11.
20. Taylor EF, Burley VJ, Greenwood DC, et al. Meat consumption and risk of breast cancer in the UK Women's Cohort Study. Br J Cancer. 2007; 96:1139–1146. [PubMed: 17406351]
21. World Cancer Research Fund/American Institute for Cancer Research. [accessed June 2018] Changes since the 2007 Second Expert Report: Important shifts in emphasis. 2018. https://www.wcrf.org/dietandcancer/changes-since-2007-second-expert-report
22. Dunneram Y, Greenwood DC, Burley VJ, et al. Dietary intake and age at natural menopause: results from the UK Women's Cohort Study. J Epidemiol Community Health. 2018; 72:733–740. [PubMed: 29712719]
23. Food Standards Agency. Food Portion Sizes. London: The Stationary office; 2002.
24. Cade JE, Taylor EF, Burley VJ, et al. Does the Mediterranean dietary pattern or the Healthy Diet Index influence the risk of breast cancer in a large British cohort of women? Eur J Clin Nutr. 2011; 65:920–928. [PubMed: 21587285]
25. Clague J, Bernstein L. Physical activity and cancer. Curr Oncol Rep. 2012; 14:550–558. [PubMed: 22945451]
26. Bagnardi V, Rota M, Botteri E, et al. Alcohol consumption and site-specific cancer risk: a comprehensive dose–response meta-analysis. Br J Cancer. 2015; 112:580–593. [PubMed: 25422909]
27. Stockwell HG, Lyman GH. Cigarette smoking and the risk of female reproductive cancer. Am J Obstet Gynecol. 1987; 157:35–40. [PubMed: 3605266]
28. Wang L, Li J, Shi Z. Association between Breastfeeding and Endometrial Cancer Risk: Evidence from a Systematic Review and Meta-Analysis. Nutrients. 2015; 7:5697–5711. [PubMed: 26184301]
29. Zhan B, Liu X, Li F, et al. Breastfeeding and the incidence of endometrial cancer: A meta-analysis. Oncotarget. 2015; 6:38398–38409. [PubMed: 26384296]

30. Su D, Pasalich M, Lee AH, et al. Ovarian cancer risk is reduced by prolonged lactation: a case-control study in southern China. Am J Clin Nutr. 2013; 97:354–359. [PubMed: 23283498]
31. Liu L, Deapen D, Bernstein L. Socioeconomic status and cancers of the female breast and reproductive organs: a comparison across racial/ethnic populations in Los Angeles County, California (United States). Cancer Causes Control. 1998; 9:369–380. [PubMed: 9794168]
32. Friberg E, Mantzoros CS, Wolk A. Diabetes and Risk of Endometrial Cancer: A Population-Based Prospective Cohort Study. Cancer Epidemiol Biomarkers Prev. 2007; 16:276–280. [PubMed: 17301260]
33. Aune D, Sen A, Vatten LJ. Hypertension and the risk of endometrial cancer: a systematic review and meta-analysis of case-control and cohort studies. Sci Rep. 2017; 7:44808. [PubMed: 28387226]
34. Persson I. Estrogens in the causation of breast, endometrial and ovarian cancers - evidence and hypotheses from epidemiological findings. J Steroid Biochem Mol Biol. 2000; 74:357–364. [PubMed: 11162945]
35. Simin J, Tamimi R, Lagergren J, et al. Menopausal hormone therapy and cancer risk: An overestimated risk? Eur J Cancer. 2017; 84:60–68. [PubMed: 28783542]
36. Beral V. Breast cancer and hormone-replacement therapy in the Million Women Study. Lancet. 2003; 362:419–427. [PubMed: 12927427]
37. Salazar-Martinez E, Lazcano-Ponce EC, Lira-Lira GG, et al. Reproductive Factors of Ovarian and Endometrial Cancer Risk in a High Fertility Population in Mexico. Cancer Res. 1999; 59:3658–3662. [PubMed: 10446978]
38. Tsilidis KK, Allen NE, Key TJ, et al. Oral contraceptive use and reproductive factors and risk of ovarian cancer in the European Prospective Investigation into Cancer and Nutrition. Br J Cancer. 2011; 105:1436–1442. [PubMed: 21915124]
39. Anderson JJ, Darwis NDM, Mackay DF, et al. Red and processed meat consumption and breast cancer: UK Biobank cohort study and meta-analysis. Eur J Cancer. 2018; 90:73–82. [PubMed: 29274927]
40. Pala V, Krogh V, Berrino F, et al. Meat, eggs, dairy products, and risk of breast cancer in the European Prospective Investigation into Cancer and Nutrition (EPIC) cohort. Am J Clin Nutr. 2009; 90:602–612. [PubMed: 19491385]
41. Fiolet T, Srour B, Sellem L, et al. Consumption of ultra-processed foods and cancer risk: results from NutriNet-Santé prospective cohort. BMJ. 2018; 360:k322. [PubMed: 29444771]
42. Pouchieu C, Deschasaux M, Hercberg S, et al. Prospective association between red and processed meat intakes and breast cancer risk: modulation by an antioxidant supplementation in the SU.VI.MAX randomized controlled trial. Int J Epidemiol. 2014; 43:1583–1592. [PubMed: 24994839]
43. Fabio L, Carlo LV, Silvia F, et al. Dietary factors and the risk of endometrial cancer. Cancer. 1993; 71:3575–3581. [PubMed: 8490907]
44. Arem H, Gunter MJ, Cross AJ, et al. A prospective investigation of fish, meat and cooking-related carcinogens with endometrial cancer incidence. Br J Cance. 2013; 109:756–760.
45. Cross AJ, Leitzmann MF, Gail MH, et al. A prospective study of red and processed meat intake in relation to cancer risk. PLoS medicine. 2007; 4:e325. [PubMed: 18076279]
46. Inoue-Choi M, Sinha R, Gierach GL, et al. Red and processed meat, nitrite, and heme iron intakes and postmenopausal breast cancer risk in the NIH-AARP Diet and Health Study. Int J Cancer. 2016; 138:1609–1618. [PubMed: 26505173]
47. Zheng W, Gustafson DR, Moore D, et al. Well-Done Meat Intake and the Risk of Breast Cancer. J Natl Cancer Inst. 1998; 90:1724–1729. [PubMed: 9827527]
48. Nagao M, Ushijima T, Wakabayashi K, et al. Dietary carcinogens and mammary carcinogenesis. Induction of rat mammary carcinomas by administration of heterocyclic amines in cooked foods. Cancer. 1994; 74:1063–1069. [PubMed: 8039140]
49. Carlson MJ, Thiel KW, Yang S, et al. Catch it before it kills: progesterone, obesity, and the prevention of endometrial cancer. Discov Med. 2012; 14:215–222. [PubMed: 23021376]

50. Bremer, AA, Miller, WL. Chapter 13 - Regulation of Steroidogenesis A2 - Ulloa-Aguirre, AlfredoCellular Endocrinology in Health and Disease. Conn, PM, editor. Boston: Academic Press; 2014. 207–227.
51. Eliassen AH, Hendrickson SJ, Brinton LA, et al. Circulating Carotenoids and Risk of Breast Cancer: Pooled Analysis of Eight Prospective Studies. J Natl Cancer Inst. 2012; 104:1905–1916. [PubMed: 23221879]
52. Levy J, Bosin E, Feldman B, et al. Lycopene is a more potent inhibitor of human cancer cell proliferation than either alpha-carotene or beta-carotene. Nutr Cancer. 1995; 24:257–266. [PubMed: 8610045]
53. Karas M, Amir H, Fishman D, et al. Lycopene interferes with cell cycle progression and insulin-like growth factor I signaling in mammary cancer cells. Nutr Cancer. 2000; 36:101–111. [PubMed: 10798222]
54. Lutz M, Hernández J, Henríquez C. Phenolic content and antioxidant capacity in fresh and dry fruits and vegetables grown in Chile. CyTA - Journal of Food. 2015; 13:541–547.
55. Capanoglu E. Investigating the Antioxidant Potential of Turkish Dried Fruits. Int J Food Prop. 2014; 17:690–702.
56. Goodman MT, Wilkens LR, Hankin JH, et al. Association of soy and fiber consumption with the risk of endometrial cancer. Am J Epidemiol. 1997; 146:294–306. [PubMed: 9270408]
57. Bidoli E, Pelucchi C, Zucchetto A, et al. Fiber intake and endometrial cancer risk. Acta Oncol. 2010; 49:441–446. [PubMed: 20148644]
58. Sowers MR, Crawford S, McConnell DS, et al. Selected Diet and Lifestyle Factors Are Associated with Estrogen Metabolites in a Multiracial/Ethnic Population of Women. J Nutr. 2006; 136:1588–1595. [PubMed: 16702326]
59. Kuiper GGJM, Lemmen JG, Carlsson B, et al. Interaction of Estrogenic Chemicals and Phytoestrogens with Estrogen Receptor β. Endocrinology. 1998; 139:4252–4263. [PubMed: 9751507]
60. Lee AH, Pasalich M, Su D, et al. Mushroom intake and risk of epithelial ovarian cancer in southern Chinese women. Int J Gynecol Cancer. 2013; 23:1400–1405. [PubMed: 24257554]
61. Shin A, Kim J, Lim SY, et al. Dietary mushroom intake and the risk of breast cancer based on hormone receptor status. Nutr Cancer. 2010; 62:476–483. [PubMed: 20432168]
62. Cancer Research UK. [accessed 20 June 2018] Mushrooms in cancer treatment. 2015. http://www.cancerresearchuk.org/about-cancer/cancer-in-general/treatment/complementary-alternative-therapies/individual-therapies/mushrooms-in-cancer-treatment

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Table 1

Baseline characteristics from the UK Women's Cohort Study according to cancer type (Mean values and standard deviations; numbers and percentages)

Characteristics	Breast cancer cases n= 1,822	Endometrial cancer cases n= 294	Ovarian cancer cases n=285	No cancer n=28,929
Demographic characteristics				
Age (years), mean (SD)	53.2 (9.0)	54.1 (8.3)	55.7 (9.0)	51.7 (9.3)
BMI (kg/m^2), mean (SD)	24.8 (4.3)	27.3 (6.3)	25.1 (4.5)	24.4 (4.2)
Professional/managerial SES, n (%)	1,105 (62.1)	182 (63.4)	171 (61.3)	18262 (63.6)
Medical history				
Family history of any cancer, n (%)	755 (43.7)	127 (46.0)	112 (42.6)	10577 (38.4)
Family history of breast cancer, n (%)	172 (10.0)	23 (8.3)	25 (9.5)	2145 (7.8)
Family history of endometrial cancer, n (%)	17 (1.0)	6 (2.2)	1 (0.4)	274 (1.00)
Family history of ovarian cancer, n (%)	15 (0.9)	6 (2.2)	6 (2.3)	284 (1.0)
Lifestyle characteristics				
Current smoker, n (%)	185 (10.4)	24 (8.4)	40 (14.3)	3093 (10.9)
Physical activity, mean (SD)	0.25 (0.55)	0.24 (0.44)	0.19 (0.34)	0.26 (0.49)
Reproductive history				
Current hormone replacement therapy use, n (%)	433 (58.3)	61 (51.7)	69 (53.1)	5309 (53.2)
Parous, n (%)	1370 (78.1)	227 (79.9)	214 (78.7)	21443 (79.3)
Postmenopausal, n (%)	1,003 (55.5)	160 (54.6)	189 (66.3)	13892 (50.1)
Age last natural menopause, mean (SD)	48.1 (4.5)	50.0 (4.4)	49.1 (3.4)	47.3 (4.5)
Energy and food intake				
Total energy intake (kJ/d), mean (SD)	9586 (3276)	9297 (2992)	9456 (2904)	9586 (3318)
Fibre intake (g/day), mean(SD)	25.5 (11.2)	24.2 (10.3)	25.4 (10.1)	25.6 (10.9)
Ethanol (g/day), mean(SD)	9.1 (10.1)	7.5 (8.7)	9.3 (11.4)	8.7 (10.4)
Total vegetable intake (g/day), mean(SD)	314.7 (208.7)	305.0 (174.7)	322.8 (190.6)	317.7 (191.6)
Total fruit intake (g/day), mean(SD)	319.1 (225.5)	292.4 (198.3)	307.2 (207.7)	316.1 (243.3)
Total meat intake (g/day), mean(SD)	69.1 (61.2)	72.5 (59.5)	66.3 (69.3)	64.5 (63.5)

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Table 2

Hazard ratios (99% confidence intervals) of breast, endometrial and ovarian cancer by food groups

Daily intake/standard portion size	Breast Cancer Cases				Endometrial cancer cases				Ovarian cancer cases			
	Model 1 n=1796/32,228 [a]		Model 2 n=1625/29,183 [b]		Model 1 n=285/32,289 [a]		Model 2 n=238/27,338 [c]		Model 1 n=274/32,284 [a]		Model 2 n=251/29,229 [b]	
	HR	99% CI	HR	99% CI	HR	99% CI	HR	99% CI	HR	99% CI	HR	99% CI
Starchy food sources												
Wholegrain products/ 33g	0.99	0.96 to 1.02	0.99	0.96 to 1.03	0.95	0.88 to 1.03	0.92	0.84 to 1.01	1.02	0.94 to 1.10	1.00	0.93 to 1.09
Refined grain products/ 51g	1.03	0.96 to 1.10	1.03	0.95 to 1.11	1.11	0.95 to 1.30	1.15	0.98 to 1.35	1.04	0.87 to 1.24	1.02	0.84 to 1.24
Low fibre breakfast cereals/ 40g	1.00	0.83 to 1.20	1.04	0.85 to 1.26	0.83	0.50 to 1.37	0.76	0.43 to 1.37	1.16	0.76 to 1.75	1.08	0.67 to 1.74
High fibre breakfast cereals/ 85g	1.00	0.92 to 1.08	1.01	0.92 to 1.10	0.82	0.64 to 1.06	0.74	0.55 to 0.998	0.89	0.70 to 1.13	0.89	0.69 to 1.15
Plain Potatoes/ 210g	0.93	0.81 to 1.06	0.94	0.81 to 1.09	0.92	0.66 to 1.30	0.94	0.64 to 1.38	0.79	0.54 to 1.15	0.83	0.56 to 1.23
Potatoes with added fat/ 127g	1.13	0.94 to 1.37	1.28	0.96 to 1.71	1.28	0.97 to 1.68	1.90	1.00 to 3.60	0.78	0.35 to 1.70	0.80	0.35 to 1.84
Refined pasta and rice/ 210g	0.99	0.78 to 1.25	0.94	0.72 to 1.22	0.99	0.55 to 1.78	1.05	0.54 to 2.05	0.69	0.34 to 1.42	0.73	0.34 to 1.54
Wholegrain pasta and rice/ 197 g	1.07	0.82 to 1.40	1.14	0.84 to 1.55	0.72	0.31 to 1.67	0.60	0.23 to 1.60	0.58	0.23 to 1.49	0.70	0.27 to 1.83
Protein and fat food sources												
Low fat dairy products/ 118g	1.01	0.98 to 1.03	1.01	0.98 to 1.03	1.04	0.98 to 1.10	1.03	0.97 to 1.10	0.95	0.90 to 1.02	0.95	0.89 to 1.02
High fat dairy products/ 93g	1.00	0.97 to 1.03	1.00	0.97 to 1.04	0.96	0.88 to 1.04	0.98	0.90 to 1.07	1.05	0.98 to 1.12	1.06	0.99 to 1.13
Butter and hard margarine/ 10g	0.99	0.93 to 1.06	0.98	0.92 to 1.05	0.98	0.83 to 1.16	1.00	0.83 to 1.20	0.92	0.76 to 1.10	0.86	0.69 to 1.06
Margarine/ 9g	0.97	0.91 to 1.03	0.99	0.92 to 1.05	0.95	0.81 to 1.12	0.93	0.77 to 1.11	1.06	0.91 to 1.22	1.03	0.88 to 1.21
Low fat spreads/ 7g	1.03	0.96 to 1.09	1.03	0.96 to 1.10	1.02	0.87 to 1.19	0.98	0.82 to 1.17	0.94	0.79 to 1.13	0.95	0.78 to 1.15
High fat dressing/ 23g	1.00	0.81 to 1.23	0.98	0.78 to 1.22	0.72	0.39 to 1.32	0.77	0.40 to 1.50	0.92	0.53 to 1.61	0.72	0.38 to 1.38
Low fat dressing/ 30g	0.98	0.70 to 1.36	1.02	0.72 to 1.45	0.88	0.37 to 2.08	0.86	0.32 to 2.29	1.02	0.46 to 2.30	1.09	0.47 to 2.54
Soybean products/ 62g	0.97	0.90 to 1.04	0.97	0.90 to 1.05	0.98	0.82 to 1.17	0.98	0.81 to 1.19	0.94	0.75 to 1.16	0.93	0.73 to 1.19
Textured vegetable protein/ 130g	0.44	0.03 to 6.93	0.16	0.01 to 3.50	-	-	-	-	-	-	-	-
Pulses/ 91g	1.00	0.87 to 1.14	1.03	0.89 to 1.19	0.87	0.60 to 1.28	0.81	0.52 to 1.25	1.08	0.79 to 1.48	1.17	0.83 to 1.64
Eggs/eggs dishes/ 88g	0.99	0.76 to 1.27	0.98	0.73 to 1.31	1.29	0.82 to 2.02	1.63	0.88 to 2.99	1.21	0.74 to 1.96	1.21	0.62 to 2.37
Fish and fish dishes/ 140g	1.04	0.76 to 1.43	1.01	0.68 to 1.51	0.90	0.36 to 2.24	0.96	0.34 to 2.71	0.99	0.43 to 2.24	0.86	0.30 to 2.43
Oily fish/ 90g	0.98	0.64 to 1.50	0.98	0.62 to 1.54	0.45	0.12 to 1.68	0.52	0.13 to 2.13	1.06	0.39 to 2.89	1.06	0.36 to 3.14
Shell fish/ 60g	1.17	0.66 to 2.07	1.44	0.56 to 3.70	0.52	0.04 to 6.83	0.72	0.04 to 11.69	0.85	0.11 to 6.65	0.65	0.04 to 10.06
Red meat/ 189g	1.20	0.97 to 1.49	1.28	0.95 to 1.72	1.33	0.87 to 2.02	1.90	0.92 to 3.94	0.91	0.45 to 1.88	0.85	0.38 to 1.92

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Daily intake/standard portion size	Breast Cancer Cases				Endometrial cancer cases				Ovarian cancer cases			
	Model 1 n=1796/32,228 [a]		Model 2 n=1625/29,183 [b]		Model 1 n=285/32,289 [a]		Model 2 n=238/27,338 [c]		Model 1 n=274/32,284 [a]		Model 2 n=251/29,229 [b]	
	HR	99% CI	HR	99% CI	HR	99% CI	HR	99% CI	HR	99% CI	HR	99% CI
Processed meat/ 74g	1.34	1.03 to 1.73	1.36	1.02 to 1.81	1.81	1.16 to 2.83	2.19	1.34 to 3.60	1.22	0.62 to 2.42	1.27	0.60 to 2.69
Poultry/ 143g	1.30	0.90 to 1.87	1.32	0.86 to 2.03	1.35	0.55 to 3.32	1.76	0.60 to 5.18	0.63	0.19 to 2.07	0.62	0.17 to 2.21
Offal/ 100g	2.19	0.44 to 10.89	2.27	0.41 to 12.55	2.70	0.05 to 138.5	-	-	0.10	0.00 to 12.00	0.07	0.00 to 12.00
Total meat/150g	1.12	1.01 to 1.24	1.17	1.00 to 1.36	1.19	0.98 to 1.45	1.53	1.04 to 2.24	0.94	0.65 to 1.37	0.92	0.61 to 1.39
Vegetables												
Vegetable dishes/ 214g	0.97	0.82 to 1.14	0.91	0.75 to 1.10	0.74	0.45 to 1.22	0.67	0.38 to 1.19	1.02	0.70 to 1.49	1.03	0.64 to 1.67
Allium/ 39g	0.98	0.82 to 1.17	0.99	0.82 to 1.20	1.02	0.67 to 1.57	0.97	0.58 to 1.61	0.81	0.49 to 1.33	0.77	0.44 to 1.33
Fresh legumes/ 75g	1.01	0.86 to 1.18	0.96	0.80 to 1.15	1.12	0.80 to 1.56	1.14	0.75 to 1.72	1.03	0.71 to 1.51	1.08	0.73 to 1.60
Mediterranean vegetables/ 60g	0.98	0.87 to 1.10	0.96	0.84 to 1.09	0.98	0.73 to 1.32	0.85	0.58 to 1.23	1.17	0.93 to 1.47	1.18	0.90 to 1.56
Salad vegetables/ 43g	0.97	0.87 to 1.08	0.97	0.87 to 1.09	0.84	0.62 to 1.12	0.84	0.61 to 1.17	0.98	0.76 to 1.28	0.99	0.74 to 1.32
Cruciferous vegetables/ 75g	1.01	0.95 to 1.07	0.99	0.91 to 1.06	0.94	0.78 to 1.14	0.94	0.76 to 1.16	1.01	0.87 to 1.18	1.04	0.88 to 1.24
Tomatoes/ 83g	0.88	0.77 to 1.00	0.87	0.75 to 0.999	0.81	0.57 to 1.15	0.77	0.52 to 1.16	0.94	0.69 to 1.29	0.97	0.70 to 1.35
Mushrooms/ 34g	0.98	0.79 to 1.22	0.96	0.76 to 1.22	1.19	0.77 to 1.85	1.29	0.78 to 2.12	1.40	0.98 to 1.99	1.57	1.09 to 2.26
Roots and tubers/ 66g	0.94	0.83 to 1.05	0.94	0.83 to 1.06	0.96	0.74 to 1.25	0.90	0.66 to 1.25	1.06	0.83 to 1.34	1.12	0.88 to 1.43
Total vegetables/150g	0.98	0.94 to 1.03	0.97	0.91 to 1.02	0.95	0.84 to 1.09	0.93	0.80 to 1.08	1.02	0.91 to 1.14	1.04	0.92 to 1.18
Fruits												
Stone fruits/ 49g	1.00	0.96 to 1.04	1.03	0.86 to 1.23	0.84	0.49 to 1.42	0.94	0.55 to 1.62	0.63	0.32 to 1.22	0.66	0.32 to 1.33
Deep orange & yellow fruits/ 118g	1.03	0.90 to 1.18	1.08	0.92 to 1.26	0.67	0.39 to 1.15	0.75	0.42 to 1.32	0.97	0.65 to 1.44	0.98	0.62 to 1.54
Grapes/ 100g	0.98	0.86 to 1.11	0.96	0.84 to 1.10	0.92	0.66 to 1.29	0.91	0.61 to 1.34	0.84	0.57 to 1.23	0.91	0.62 to 1.32
Citrus family fruits/ 92g	1.03	0.93 to 1.14	1.02	0.92 to 1.14	0.81	0.60 to 1.11	0.77	0.54 to 1.10	0.85	0.63 to 1.15	0.88	0.64 to 1.21
Rhubarb/ 130g	0.96	0.76 to 1.22	0.93	0.71 to 1.24	0.59	0.24 to 1.45	0.74	0.30 to 1.82	1.04	0.61 to 1.77	1.07	0.57 to 2.00
Berries/ 48g	1.02	0.93 to 1.11	1.03	0.94 to 1.14	0.85	0.62 to 1.15	0.85	0.60 to 1.21	0.84	0.61 to 1.15	0.82	0.57 to 1.17
Bananas/ 100g	1.04	0.94 to 1.158	1.07	0.95 to 1.19	0.87	0.65 to 1.18	0.88	0.63 to 1.22	1.10	0.85 to 1.42	1.21	0.92 to 1.59
Pomes/ 116g	0.97	0.90 to 1.04	0.98	0.91 to 1.06	0.97	0.80 to 1.16	0.92	0.75 to 1.15	0.91	0.74 to 1.11	0.97	0.79 to 1.19
Total fruits/150g	1.00	0.96 to 1.04	1.01	0.97 to 1.05	0.91	0.81 to 1.02	0.90	0.79 to 1.03	0.95	0.85 to 1.06	0.98	0.88 to 1.10
Dried Fruits/ 28g	1.03	0.96 to 1.11	1.04	0.98 to 1.13	0.67	0.46 to 0.99	0.60	0.37 to 0.97	1.02	0.86 to 1.22	1.06	0.89 to 1.26
Other food groups												
Sauces/ 83g	1.05	0.63 to 1.74	1.07	0.62 to 1.87	1.46	0.48 to 3.40	1.29	0.31 to 5.37	1.48	0.49 to 4.49	1.78	0.48 to 6.65

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Daily intake/standard portion size	Breast Cancer Cases				Endometrial cancer cases				Ovarian cancer cases			
	Model 1 n=1796/32,228 [a]		Model 2 n=1625/29,183 [b]		Model 1 n=285/32,289 [a]		Model 2 n=238/27,338 [c]		Model 1 n=274/32,284 [a]		Model 2 n=251/29,229 [b]	
	HR	99% CI	HR	99% CI	HR	99% CI	HR	99% CI	HR	99% CI	HR	99% CI
Pickles/Chutneys/ 35g	0.90	0.70 to 1.17	0.89	0.68 to 1.18	1.16	0.68 to 1.97	0.96	0.49 to 1.91	0.72	0.35 to 1.48	0.65	0.29 to 1.44
Soups/ 163g	0.98	0.82 to 1.18	0.98	0.79 to 1.22	0.93	0.57 to 1.51	0.90	0.50 to 1.61	0.95	0.60 to 1.50	1.03	0.62 to 1.70
Confectionary & spreads/ 44g	0.98	0.92 to 1.04	0.99	0.92 to 1.05	0.94	0.79 to 1.12	0.88	0.71 to 1.09	0.98	0.83 to 1.15	0.96	0.81 to 1.15
Nuts and seeds/ 24g	1.01	0.93 to 1.10	1.03	0.94 to 1.13	1.03	0.85 to 1.25	0.77	0.53 to 1.13	1.02	0.83 to 1.25	1.02	0.80 to 1.30
Savoury snacks/ 26g	1.05	0.87 to 1.26	1.06	0.87 to 1.29	1.21	0.79 to 1.85	1.12	0.68 to 1.86	1.05	0.63 to 1.73	1.06	0.63 to 1.81
Biscuits/ 15g	1.00	0.94 to 1.06	1.01	0.94 to 1.08	0.97	0.83 to 1.14	0.97	0.81 to 1.17	0.95	0.80 to 1.13	0.95	0.80 to 1.15
Cakes/ 66g	0.89	0.68 to 1.16	0.88	0.65 to 1.19	0.85	0.43 to 1.68	0.84	0.38 to 1.87	1.01	0.55 to 1.83	0.95	0.47 to 1.92
Pastries and Puddings/ 84g	1.05	0.89 to 1.24	1.12	0.92 to 1.36	0.85	0.51 to 1.43	1.00	0.58 to 1.73	0.78	0.45 to 1.35	0.71	0.37 to 1.34
Drinks and beverages												
Tea/ 260g	0.98	0.95 to 1.02	0.98	0.95 to 1.02	1.04	0.96 to 1.12	1.02	0.93 to 1.11	0.98	0.91 to 1.07	0.98	0.90 to 1.07
Herbal tea/ 260g	0.97	0.90 to 1.04	0.99	0.91 to 1.06	0.96	0.80 to 1.16	0.89	0.71 to 1.12	0.94	0.77 to 1.15	0.93	0.75 to 1.16
Coffee/ 190g	1.01	0.98 to 1.04	1.01	0.97 to 1.04	1.03	0.95 to 1.12	1.03	0.94 to 1.13	1.04	0.96 to 1.13	1.04	0.95 to 1.13
Other hot beverages/ 23g	1.02	0.92 to 1.12	1.03	0.93 to 1.14	1.03	0.81 to 1.31	1.01	0.77 to 1.33	0.99	0.77 to 1.28	1.04	0.80 to 1.35
Juices/ 145g	1.00	0.93 to 1.07	1.01	0.93 to 1.08	0.97	0.80 to 1.16	0.95	0.76 to 1.17	0.95	0.78 to 1.15	0.97	0.79 to 1.18
Soft drinks/ 111g	1.00	0.89 to 1.10	1.00	0.90 to 1.12	1.05	0.83 to 1.33	1.00	0.74 to 1.34	1.03	0.80 to 1.33	1.02	0.78 to 1.33
Low calorie/diet soft drinks/ 161g	1.01	0.91 to 1.12	1.03	0.93 to 1.14	1.10	0.87 to 1.38	1.03	0.79 to 1.35	0.96	0.72 to 1.28	0.98	0.73 to 1.31
Wines/ glass *	1.03	0.94 to 1.12	1.03	0.94 to 1.13	0.90	0.70 to 1.14	0.90	0.69 to1.17	1.06	0.86 to 1.32	1.06	0.85 to 1.32
Beer and cider/ half pint *	1.09	0.93 to 1.28	1.10	0.93 to 1.29	1.13	0.77 to 1.68	0.81	0.42 to 1.56	1.11	0.71 to 1.72	1.10	0.72 to 1.69
Port, sherry, liqueurs/ glass *	0.97	0.75 to 1.26	0.98	0.74 to 1.29	0.93	0.47 to 1.82	1.11	0.57 to 2.17	1.17	0.72 to 1.92	1.20	0.74 to 1.95
Spirits/ measure *	1.11	0.97 to 1.27	1.10	0.95 to 1.27	0.51	0.25 to 1.02	0.54	0.26 to 1.12	1.27	0.97 to 1.67	1.26	0.96 to 1.66

[a] Model 1: adjusted for age

[b] Model 2: adjusted for age, ethanol intake, duration of breastfeeding, physical activity, smoking, social class, menopausal status

[c] Model 2 (endometrial cancer): adjusted for age, ethanol intake, duration of breastfeeding, physical activity, smoking, social class, menopausal status, history of diabetes and history of hypertension

* not adjusted for ethanol intake

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Table 3

Associations between various food groups and risk of breast, endometrial and ovarian cancer by incidence of premenopausal and postmenopausal cancer cases

Daily intake/standard portion size	Breast Cancer Cases[a]				Endometrial Cancer Cases[b]				Ovarian Cancer Cases[a]			
	Premenopausal n=291/3,178		Postmenopausal n=1,030/23,806		Premenopausal n=35/3,024		Postmenopausal n=175/24,118		Premenopausal n=44/3,030		Postmenopausal n=163/24,115	
	HR	99% CI	HR	99% CI	HR	99% CI	HR	99% CI	HR	99% CI	HR	99% CI
Starchy food sources												
Wholegrain products/33g	1.01	0.93 to 1.10	0.98	0.94 to 1.02	1.21	0.84 to 1.76	0.91	0.81 to 1.01	1.21	0.94 to 1.56	1.01	0.91 to 1.12
Refined grain products/51g	0.99	0.83 to 1.18	1.06	0.97 to 1.16	1.06	0.55 to 2.03	1.16	0.95 to 1.42	1.31	0.90 to 1.91	0.84	0.63 to 1.13
Low fibre breakfast cereals/40g	0.90	0.60 to 1.34	1.02	0.80 to 1.30	0.29	0.06 to 1.50	0.75	0.38 to 1.50	0.68	0.17 to 2.80	1.02	0.55 to 1.86
High fibre breakfast cereals/85g	1.06	0.87 to 1.29	1.00	0.90 to 1.12	1.34	0.41 to 4.42	0.86	0.62 to 1.17	1.28	0.63 to 2.58	0.86	0.62 to 1.19
Plain Potatoes/210g	0.98	0.61 to 1.56	0.95	0.79 to 1.14	0.58	0.09 to 3.69	0.98	0.63 to 1.51	0.97	0.27 to 3.47	0.86	0.53 to 1.40
Potatoes with added fat/127g	1.05	0.49 to 2.27	1.31	0.90 to 1.91	0.33	0.03 to 3.29	1.96	0.89 to 4.31	9.87	0.87 to 111.5	0.54	0.17 to 1.70
Refined pasta and rice/210g	1.10	0.60 to 2.01	1.00	0.71 to 1.40	1.04	0.13 to 8.14	1.28	0.62 to 2.63	2.91	0.37 to 22.9	0.72	0.28 to 1.88
Wholegrain pasta and rice/197 g	1.15	0.49 to 2.70	1.29	0.88 to 1.88	4.90	0.51 to 47.3	0.44	0.12 to 1.56	0.06	0.00 to 3.08	1.32	0.51 to 3.42
Protein and fat food sources												
Low fat dairy products/118g	1.03	0.97 to 1.10	1.02	0.99 to 1.05	0.96	0.81 to 1.14	1.04	0.97 to 1.12	1.02	0.85 to 1.22	0.96	0.89 to 1.04
High fat dairy products/93g	1.00	0.93 to 1.08	1.00	0.96 to 1.04	0.94	0.73 to 1.20	0.93	0.82 to 1.05	1.05	0.89 to 1.23	1.04	0.95 to 1.13
Butter and hard margarine/10g	1.00	0.82 to 1.21	0.99	0.91 to 1.09	1.04	0.50 to 2.17	1.02	0.83 to 1.26	0.90	0.57 to 1.43	0.76	0.57 to 1.03
Margarine/9g	1.08	0.91 to 1.28	0.98	0.90 to 1.06	0.75	0.42 to 1.33	0.93	0.75 to 1.15	1.06	0.67 to 1.68	1.08	0.90 to 1.31
Low fat spreads/7g	1.03	0.90 to 1.18	0.98	0.90 to 1.07	1.15	0.64 to 2.06	0.98	0.80 to 1.21	1.46	0.84 to 2.55	0.94	0.74 to 1.19
High fat dressing/23g	1.39	0.69 to 2.82	1.00	0.76 to 1.33	0.25	0.01 to 4.55	0.84	0.40 to 1.78	0.34	0.05 to 2.49	0.99	0.48 to 2.02
Low fat dressing/30g	1.06	0.41 to 2.71	0.99	0.64 to 1.53	0.64	0.02 to 24.3	0.87	0.29 to 2.62	3.31	0.06 to 175.2	1.26	0.49 to 3.23
Soybean products/62g	0.90	0.69 to 1.17	0.99	0.90 to 1.08	0.84	0.42 to 1.65	1.02	0.84 to 1.25	-	-	0.91	0.66 to 1.25
Textured vegetable protein/130g	-	-	0.04	0.00 to 2.55	-	-	-	-	-	-	-	-
Pulses/91g	1.04	0.71 to 1.53	1.06	0.88 to 1.27	0.82	0.23 to 2.90	0.90	0.55 to 1.48	1.31	0.44 to 3.89	1.28	0.84 to 1.94
Eggs/eggs dishes/88g	0.92	0.44 to 1.95	0.94	0.65 to 1.37	1.18	0.07 to 18.4	1.64	0.84 to 3.21	0.70	0.14 to 3.64	0.86	0.33 to 2.22
Fish and fish dishes/140g	0.84	0.29 to 2.38	1.01	0.61 to 1.67	1.88	0.07 to 51.3	0.81	0.23 to 2.91	0.56	0.01 to 31.7	1.04	0.30 to 3.58
Oily fish/90g	0.46	0.11 to 1.81	0.93	0.52 to 1.63	0.46	0.00 to 104.8	0.27	0.04 to 1.64	0.21	0.01 to 6.52	0.95	0.24 to 3.82
Shell fish/60g	0.83	0.04 to 17.7	2.06	0.64 to 6.61	-	-	0.25	0.01 to 11.5	-	-	1.39	0.06 to 33.7
Red meat/189g	0.91	0.40 to 2.05	1.37	0.94 to 1.98	0.44	0.04 to 5.37	1.86	0.80 to 4.30	2.55	0.66 to 9.77	0.62	0.21 to 1.80

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Daily intake/standard portion size	Breast Cancer Cases[a]				Endometrial Cancer Cases[b]				Ovarian Cancer Cases[a]			
	Premenopausal n=291/3,178		Postmenopausal n=1,030/23,806		Premenopausal n=35/3,024		Postmenopausal n=175/24,118		Premenopausal n=44/3,030		Postmenopausal n=163/24,115	
	HR	99% CI	HR	99% CI	HR	99% CI	HR	99% CI	HR	99% CI	HR	99% CI
Processed meat/74g	1.36	0.66 to 2.80	1.50	1.01 to 2.22	0.65	0.03 to 12.1	3.05	1.34 to 6.91	2.13	0.84 to 5.40	0.71	0.23 to 2.18
Poultry/143g	1.08	0.33 to 3.55	1.33	0.78 to 2.28	-	-	1.29	0.35 to 4.81	-	-	0.54	0.11 to 2.66
Offal/100g	-	-	3.67	0.49 to 27.2	-	-	-	-	-	-	0.05	0.00 to 30.6
Total meat/150g	1.03	0.69 to 1.56	1.22	1.00 to 1.47	0.94	0.27 to 3.26	1.50	0.95 to 2.35	1.67	0.89 to 3.13	0.75	0.44 to 1.29
Vegetables												
Vegetable dishes/214g	1.00	0.60 to 1.67	1.00	0.79 to 1.27	1.73	0.39 to 7.72	0.77	0.40 to 1.48	0.36	0.08 to 1.70	1.23	0.72 to 2.10
Allium/39g	0.81	0.46 to 1.42	1.12	0.91 to 1.37	1.28	0.33 to 5.03	0.95	0.53 to 1.72	0.32	0.08 to 1.33	0.96	0.53 to 1.74
Fresh legumes/75g	0.87	0.49 to 1.56	1.09	0.89 to 1.33	1.91	0.39 to 9.24	1.23	0.79 to 1.90	0.54	0.12 to 2.40	1.21	0.78 to 1.87
Mediterranean vegetables/60g	0.98	0.65 to 1.50	1.04	0.89 to 1.22	1.24	0.51 to 3.00	0.93	0.61 to 1.42	0.54	0.21 to 1.35	1.23	0.88 to 1.72
Salad vegetables/43g	0.99	0.68 to 1.44	1.04	0.91 to 1.20	1.34	0.37 to 4.87	0.88	0.61 to 1.28	0.61	0.28 to 1.31	1.00	0.70 to 1.43
Cruciferous vegetables/75g	0.94	0.74 to 1.20	1.03	0.94 to 1.12	1.09	0.46 to 2.60	0.97	0.77 to 1.23	1.06	0.58 to 1.93	1.10	0.93 to 1.30
Tomatoes/83g	0.96	0.62 to 1.48	0.88	0.74 to 1.04	1.85	0.61 to 5.62	0.76	0.48 to 1.22	1.16	0.54 to 2.49	0.91	0.59 to 1.39
Mushrooms/34g	0.94	0.51 to 1.75	1.03	0.77 to 1.38	2.13	0.26 to 14.7	1.24	0.66 to 2.31	0.29	0.06 to 1.43	1.84	1.21 to 2.79
Roots and tubers/66g	0.86	0.60 to 1.22	0.98	0.85 to 1.12	0.69	0.20 to 2.38	0.97	0.69 to 1.37	0.64	0.26 to 1.60	1.20	0.94 to 1.53
Total vegetables/150g	0.94	0.79 to 1.13	1.01	0.94 to 1.08	1.18	0.71 to 1.96	0.96	0.81 to 1.14	0.82	0.58 to 1.18	1.09	0.95 to 1.25
Fruits												
Stone fruits/49g	0.60	0.31 to 1.16	1.13	0.97 to 1.33	8.93	0.38 to 207.5	1.11	0.72 to 1.70	0.14	0.01 to 3.50	0.98	0.52 to 1.87
Deep orange & yellow fruits/118g	0.70	0.44 to 1.11	1.12	0.93 to 1.35	0.65	0.15 to 2.90	0.78	0.41 to 1.49	0.09	0.01 to 1.07	1.20	0.79 to 1.81
Grapes/100g	0.91	0.64 to 1.29	0.95	0.80 to 1.13	1.11	0.20 to 6.05	0.93	0.60 to 1.42	1.08	0.21 to 5.62	1.04	0.73 to 1.49
Citrus family fruits/92g	1.02	0.76 to 1.37	1.06	0.93 to 1.21	0.89	0.16 to 4.97	0.85	0.58 to 1.25	0.13	0.02 to 0.81	1.06	0.76 to 1.48
Rhubarb/130g	0.80	0.29 to 2.17	0.93	0.64 to 1.33	0.26	0.01 to 11.2	0.83	0.31 to 2.21	0.47	0.06 to 3.88	1.19	0.59 to 2.38
Berries/48g	0.87	0.68 to 1.14	1.06	0.95 to 1.18	1.46	0.30 to 7.13	0.89	0.61 to 1.29	0.71	0.37 to 1.36	0.88	0.59 to 1.31
Bananas/100g	0.94	0.72 to 1.24	1.09	0.94 to 1.25	0.65	0.24 to 1.81	0.96	0.67 to 1.39	0.44	0.15 to 1.31	1.32	0.97 to 1.80
Pomes/116g	0.90	0.71 to 1.14	0.99	0.90 to 1.09	1.25	0.60 to 2.61	0.93	0.73 to 1.19	0.62	0.24 to 1.61	1.03	0.82 to 1.30
Total fruits/150g	0.94	0.84 to 1.05	1.02	0.97 to 1.07	0.97	0.64 to 1.47	0.93	0.80 to 1.08	0.63	0.40 to 0.99	1.06	0.94 to 1.19
Dried Fruits/28g	1.06	0.96 to 1.16	1.04	0.94 to 1.15	0.99	0.25 to 3.93	0.55	0.31 to 0.98	0.35	0.04 to 2.86	1.14	0.99 to 1.31
Other food groups												
Sauces/83g	2.52	0.38 to 16.7	1.30	0.66 to 2.58	-	-	1.91	0.40 to 9.12	8.89	0.37 to 215.9	1.28	0.22 to 7.49

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Daily intake/standard portion size	Breast Cancer Cases[a]				Endometrial Cancer Cases[b]				Ovarian Cancer Cases[a]			
	Premenopausal n=291/3,178		Postmenopausal n=1,030/23,806		Premenopausal n=35/3,024		Postmenopausal n=175/24,118		Premenopausal n=44/3,030		Postmenopausal n=163/24,115	
	HR	99% CI	HR	99% CI	HR	99% CI	HR	99% CI	HR	99% CI	HR	99% CI
Pickles/Chutneys/35g	1.35	0.79 to 2.30	0.85	0.60 to 1.22	2.31	0.23 to 22.9	1.01	0.46 to 2.21	2.35	0.18 to 30.5	0.68	0.25 to 1.82
Soups/163g	0.87	0.41 to 1.83	1.08	0.84 to 1.38	-	--	1.00	0.54 to 1.85	1.01	0.32 to 3.17	1.05	0.57 to 1.91
Confectionary & spreads/44g	0.95	0.84 to 1.08	1.00	0.92 to 1.09	0.89	0.51 to 1.55	0.93	0.74 to 1.17	0.89	0.55 to 1.45	0.99	0.80 to 1.23
Nuts and seeds/24g	1.03	0.90 to 1.18	1.04	0.92 to 1.16	1.13	0.54 to 2.36	0.70	0.43 to 1.14	0.39	0.10 to 1.51	1.02	0.76 to 1.38
Savoury snacks/26g	0.85	0.47 to 1.52	1.06	0.82 to 1.38	1.64	0.25 to 10.8	1.31	0.75 to 2.27	1.01	0.19 to 5.34	1.24	0.67 to 2.28
Biscuits/15g	1.17	1.00 to 1.38	1.00	0.93 to 1.09	0.93	0.45 to 1.93	1.01	0.84 to 1.23	1.40	0.75 to 2.60	0.93	0.74 to 1.18
Cakes/66g	0.83	0.45 to 1.52	0.84	0.57 to 1.22	0.06	0.00 to 1.82	0.95	0.41 to 2.21	0.24	0.01 to 5.17	1.06	0.48 to 2.37
Pastries and Puddings/84g	1.47	0.98 to 2.19	1.08	0.83 to 1.39	0.26	0.01 to 4.75	1.16	0.64 to 2.11	1.12	0.06 to 22.0	0.76	0.35 to 1.61
Drinks and beverages												
Tea/260g	0.98	0.90 to 1.06	0.99	0.95 to 1.03	1.14	0.84 to 1.55	1.02	0.92 to 1.13	0.98	0.77 to 1.24	0.94	0.84 to 1.04
Herbal tea/260g	1.06	0.87 to 1.29	1.00	0.91 to 1.09	1.49	0.71 to 3.11	0.89	0.68 to 1.16	0.76	0.34 to 1.72	0.96	0.74 to 1.25
Coffee/190g	1.03	0.95 to 1.11	1.01	0.97 to 1.06	1.03	0.76 to 1.39	1.01	0.91 to 1.13	1.16	0.87 to 1.54	1.07	0.96 to 1.19
Other hot beverages/23g	1.02	0.79 to 1.31	1.01	0.89 to 1.15	0.25	0.04 to 1.47	1.05	0.79 to 1.42	1.18	0.54 to 2.58	1.08	0.80 to 1.46
Juices/145g	0.89	0.72 to 1.10	0.99	0.90 to 1.09	1.09	0.51 to 2.33	0.96	0.76 to 1.23	0.65	0.31 to 1.35	1.02	0.81 to 1.29
Soft drinks/111g	1.04	0.87 to 1.23	1.03	0.90 to 1.19	0.98	0.36 to 2.67	1.15	0.88 to 1.50	1.52	0.80 to 2.88	1.09	0.80 to 1.48
Low calorie/diet soft drinks/161g	1.00	0.78 to 1.29	1.03	0.90 to 1.18	0.34	0.05 to 2.18	1.27	1.00 to 1.61	1.70	0.64 to 4.50	1.01	0.70 to 1.45
Wines/glass *	0.98	0.81 to 1.18	1.03	0.92 to 1.15	1.24	0.40 to 3.79	0.85	0.61 to 1.18	0.89	0.50 to 1.59	1.01	0.75 to 1.36
Beer and cider/half pint *	1.09	0.65 to 1.83	1.15	0.94 to 1.42	4.11	0.44 to 38.4	1.26	0.81 to 1.97	1.81	0.93 to 3.53	1.05	0.56 to 1.97
Port, sherry, liqueurs/glass *	1.23	0.59 to 2.60	1.01	0.73 to 1.39	-	-	0.95	0.42 to 2.15	0.58	0.16 to 2.14	1.31	0.77 to 2.21
Spirits/measure *	1.07	0.80 to 1.43	1.05	0.87 to 1.28	0.76	0.01 to 76.3	0.49	0.20 to 1.21	1.21	0.51 to 2.86	1.12	0.74 to 1.71

[a] Fully adjusted for age, ethanol intake, duration of breastfeeding, physical activity, smoking, social class, menopausal status

[b] Fully adjusted for age, ethanol intake, duration of breastfeeding, physical activity, smoking, social class, menopausal status, history of diabetes and history of hypertension

* not adjusted for ethanol intake