



Meta-analyses

Association of food groups and dietary pattern with breast cancer risk: A systematic review and meta-analysis

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SUMMARY

Background & aims: We conducted a systematic review and meta-analysis of current evidence for the association between food groups, dietary patterns, and breast cancer risk among the Asian population.

Methods: This systematic review and meta-analysis followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines. We performed a systematic literature search up to December 2022 in English in the PubMed, Web of Science, Embase, and Cochrane databases. Risk ratios (RRs) with 95% confidence intervals (CIs) were extracted as effect sizes. Publication bias was estimated by two different funnel plot methods.

Results: We collected the data from 15 cohort studies and 34 case–control studies meeting the search criteria. The meta-analysis found that the consumption of fruits and, likewise, vegetables were associated with a 29% lower risk of breast cancer, respectively [RR = 0.71 (0.55, 0.93); RR = 0.71 (0.53, 0.95)]. By contrast, no significance was found between meat, soy foods, and green tea consumption and breast cancer risk ($P > 0.05$). However, soy protein and isoflavone intake could lower breast cancer risk by 35% and 32%, respectively [RR = 0.65 (0.51, 0.83); RR = 0.68 (0.55, 0.82)]. As for the dietary pattern, high adherence to a healthy dietary pattern and, similarly, to a healthy eating index was associated with a 38% and 51% reduction in breast cancer risk, respectively [RR = 0.62 (0.44, 0.88; RR = 0.49 (0.27, 0.87)], while high adherence to an unhealthy dietary pattern was associated with a 44% increased risk [RR = 1.44 (1.06, 1.96)]. Considering alcohol consumption, a 75% increased risk of breast cancer was found [RR = 1.75 (1.33, 2.30)].

Conclusion: The present meta-analysis found that high intakes of fruits, vegetables, soy protein, and soy isoflavone significantly reduced the risk of breast cancer, while high intake of alcohol had a significantly increased risk. Meat, soy food, and green tea consumption were not significantly associated with breast cancer risk. Considering dietary patterns, high adherence to a healthy eating index and a healthy dietary pattern may reduce breast cancer risk. Conversely, adherence to unhealthy dietary patterns may increase breast cancer risk. However, further studies are needed to confirm the associations between dietary patterns and breast cancer in the Asian population.

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1. Introduction

Breast cancer is the second most common cancer in the world. Sung et al. reported that the incidence of breast cancer surpassed that of lung cancer, making it the most commonly diagnosed

cancer, with approximately 2.3 million new cases in 2020 (11.7%), followed by lung (11.4%), colorectal (10.0%), prostate (7.3%), and stomach (5.6%) cancers [1]. Moreover, by the end of 2020, breast cancer was the most prevalent cancer worldwide, with 7.8 million women diagnosed in the previous 5 years [1]. Although the highest incidence rates are in North America, Australia, and northern and western Europe, with relatively low incidence rates in Africa and most of Asia, breast cancer incidence has increased sharply in Asia [2]. Breast cancer incidence among Asian women appears to

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converge toward the higher incidence rates observed in Western populations, especially with aging [3].

These increased rates have been linked to a higher prevalence of breast cancer risk factors. Among the non-dietary risk factors are body mass index (BMI), oral contraceptives, a high perceived level of stress, and a low level of physical activity [4]. Dietary factors account for approximately 35% of the risk factors [5]. Diet is widely acknowledged as a modifier of cancer risk, affecting cancer initiation and progression. However, although comprehensive epidemiological studies have examined the relationship between diet and breast cancer incidence, there has been no systematic review of this association in Asian populations [6–8]. In contrast to the Western diet, which focuses on animal-based foods, a traditional Asian diet generally consists of plant-based foods. In addition, breast cancer risk is known to vary significantly according to ethnicity. Moreover, the growth in international trade and cultural exchange has also changed dietary habits and breast cancer risk [3]. Therefore, it is necessary to evaluate the relationship between diet and breast cancer risk with a focus on Asian populations; this will help establish effective strategies for the prevention of breast cancer in this population. Accordingly, this systematic review and meta-analysis aimed to provide an overview of the current evidence on the association among food groups (fruits, vegetables, meat, soy foods, green tea, and alcohol), dietary patterns, and breast cancer risk in Asian populations.

2. Material and methods

2.1. Search strategy

This systematic review and meta-analysis followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines [9]. A search of relevant studies published up to December 2022 in English was carried out in the PubMed, Web of Science, Embase, and Cochrane databases by exploring a combination of keywords: “food groups” (fruits, vegetables, meat, soy foods, green tea, alcohol) OR “dietary pattern” (healthy dietary pattern, unhealthy dietary pattern) AND “breast cancer” AND “incidence” OR “risk.” In addition, only studies from Asian countries were included. Two authors (S.A.S. and J.L.F.) blindly and independently combined the studies from these four databases and then removed duplicate studies.

2.2. Selection criteria

Studies were selected based on the following eligibility criteria: 1. All studies focused on the Asian population; there were no restrictions on the study sample size or participants' ages. 2. Breast cancer incidence as the outcome. For example, it was not considered if the outcome was recurrence or mortality. 3. Case–control or cohort studies. In addition, the following exclusion criteria were applied: 1. Involved non-human participants. 2. Systematic review, meta-analysis, narrative review, or other review-type studies. 3. Study populations have other types of cancer. Two authors (S.A.S. and J.L.F.) screened the title and abstract of the studies fulfilling the selection criteria, then carefully screened the full texts. Any inconsistencies were solved by mutual consensus in the presence of a third author (D.H.K.).

2.3. Data extraction and quality assessment

Two authors (S.A.S. and J.L.F.) extracted the following information from each included study: first author, year of publication, country, study design, sample sizes of cases/controls, duration of follow-up (this is appropriate for cohort studies), exposure intake

of study/control groups, and potential adjustment factors. The quality of the included studies was evaluated using the Newcastle–Ottawa Scale (NOS) criteria. Due to the differences in study design, two NOS criteria were used to assess the quality of the evidence ([Online Appendix](#)). Two authors (S.A.S. and J.L.F.) independently evaluated three domains: selection, comparability, and outcome (for cohort studies) or exposure (for case–control studies). Furthermore, the quality of the evidence (out of 9 points) was divided into three groups: high-quality evidence (≥ 7 points), moderate-quality evidence (5–6 points), and low-quality evidence (≤ 4 points).

2.4. Statistical analyses

In this review, odds ratios (ORs), hazard ratios (HRs), or risk ratios (RRs) with 95% confidence intervals (CIs) were extracted and then pooled by random-effect models. However, it is noted that log-transformed (base 10) values were calculated due to their asymmetry [10]. Quantitative analysis of heterogeneity among the studies was assessed using Cochran's Q test and the I^2 statistic. When heterogeneity was significant ($I^2 \geq 50\%$ or P -value < 0.05), subgroup analyses were further conducted to explore the stability of the primary results. When the number of included studies was ≥ 10 , a funnel plot was used to detect publication bias. Funnel plot asymmetry was assessed by Egger's test and Begg's test [11]. STATA MP 17.0 was used to perform all statistical analyses. A two-tailed P -value < 0.05 was considered significant.

3. Results

3.1. Study characteristics and quality assessment

An initial comprehensive search identified a total of 8279 records ([Fig. 1](#)). After combining records from the four databases, 2954 duplicate studies were removed. Of the 5325 records initially screened from the titles and abstracts, 107 studies remained. Following a careful assessment of the full text, 15 cohort studies and 34 case–control studies were included in the final meta-analysis.

The characteristics and quality scores of the included studies are summarized in [Table 1](#). These studies assessed the association of breast cancer risk with the consumption of specific food groups, such as fruits and vegetables ($n = 11$) [12–22], meat ($n = 7$) [12,13,16,20,21,23,24], soy foods, soy protein, and soy isoflavones ($n = 17$) [19–21,25–38], green tea ($n = 7$) [37,39–44], and alcohol ($n = 6$) [31,39,45–48], and dietary patterns ($n = 10$) [31,49–57] and healthy eating index ($n = 4$) [16,58–60]. Among the included studies, two cohort and 14 case–control studies were conducted in China, 10 cohort and four case–control studies in Japan, six case–control studies in Iran, one cohort and four case–control studies in Korea, three case–control studies in Taiwan, two cohort studies in Singapore, and one case–control study in Malaysia, Vietnam, and Pakistan. The quality assessment scores of the cohort and case–control studies ranged from 5 to 9 ([Supplemental Table 1](#) and [Supplemental Table 2](#)). Among the studies, 10 of the 15 cohort studies and 24 of the 34 case–control studies were stratified as high-quality evidence, and all remaining studies were stratified as moderate-quality evidence based on the quality scores.

3.2. Meta-analyses

3.2.1. Fruits and vegetables

In this review, one cohort and 10 case–control studies evaluated the association of the consumption of fruits and vegetables with

breast cancer risk (Table 1). The pooled results are shown in Table 2 and Fig. 2. Overall, the RR for high consumption of fruits was 0.71 (95% CI = 0.55–0.93). The RR for high consumption of vegetables was 0.65 (95% CI = 0.47–0.90). Meanwhile, significant heterogeneities were observed (fruits: $I^2 = 74.2\%$; $P < 0.001$; vegetables: $I^2 = 79.5\%$; $P < 0.001$). A reduced risk was observed in the case–control studies (fruits: RR = 0.67, 95% CI = 0.51–0.88, $I^2 = 73.4\%$; vegetables: RR = 0.69, 95% CI = 0.50–0.96, $I^2 = 81.4\%$), while no association was found in the cohort study (fruits: RR = 1.22, 95% CI = 0.76–1.96; vegetables: RR = 0.887, 95% CI = 0.54–1.39).

3.2.2. Meat

One cohort and five case–control studies examined the association between total meat consumption and breast cancer risk (Table 1). The pooled results indicated that high consumption of meat had no association with breast cancer risk (RR = 1.01, 95% CI = 0.84–1.21), and low heterogeneity was observed ($I^2 = 38.8\%$; $P = 0.133$) (Table 2 and Fig. 2). The RR was 1.77 (95% CI = 1.09–2.86) in the cohort study and 0.96 (95% CI = 0.83–1.11) in the case–control studies, without heterogeneity ($I^2 = 0.0\%$).

3.2.3. Soy foods, soy protein, and soy isoflavone

A total of five cohort and 12 case–control studies examined the association of soy foods, soy protein, and soy isoflavone with breast cancer risk (Table 1). The overall results revealed that there was no statistical significance between the consumption of soy foods and breast cancer risk (RR = 0.90, 95% CI = 0.67–1.20), and high

heterogeneity was detected ($I^2 = 71.6\%$; $P = 0.001$). This non-significant association was also observed after analysis of the cohort studies (RR = 1.01, 95% CI = 0.72–1.43, $I^2 = 52.2\%$) and case–control studies (RR = 0.83, 95% CI = 0.54–1.28, $I^2 = 75.0\%$) separately. However, concerning the intake of soy protein and isoflavone, the pooled results indicated that their high intake might reduce breast cancer risk by 35% and 32%, respectively (soy protein: RR = 0.65, 95% CI = 0.51–0.83; isoflavone: RR = 0.68, 95% CI = 0.55–0.82). The studies concerning soy protein had low heterogeneity ($I^2 = 45.0\%$; $P = 0.122$), while those reporting on soy isoflavone demonstrated a considerable level of heterogeneity ($I^2 = 62.8\%$; $P = 0.004$) (Table 2 and Fig. 3). In the cohort studies, the RR of soy protein was 0.89 (95% CI = 0.67–1.17, $I^2 = 0.0\%$), and the RR of isoflavone was 0.85 (95% CI = 0.73–0.99, $I^2 = 20.6\%$). In the case–control studies, the RR of soy protein was 0.58 (95% CI = 0.46–0.72, $I^2 = 0.0\%$), and the RR of isoflavone was 0.54 (95% CI = 0.43–0.68, $I^2 = 26.4\%$).

3.2.4. Green tea

Three cohort studies and four case–control studies focused on the association between green tea consumption and breast cancer risk (Table 1). The summary RR indicated no statistical significance (RR = 0.95, 95% CI = 0.76–1.18), with significant heterogeneity ($I^2 = 79.4\%$; $P < 0.001$) (Table 2 and Fig. 4). When the cohort and case–control studies were analyzed separately, no correlation was found for either (cohort studies: RR = 1.10, 95% CI = 0.93–1.31, $I^2 = 0.0\%$; case–control studies: RR = 0.84, 95% CI = 0.61–1.16, $I^2 = 83.9\%$).

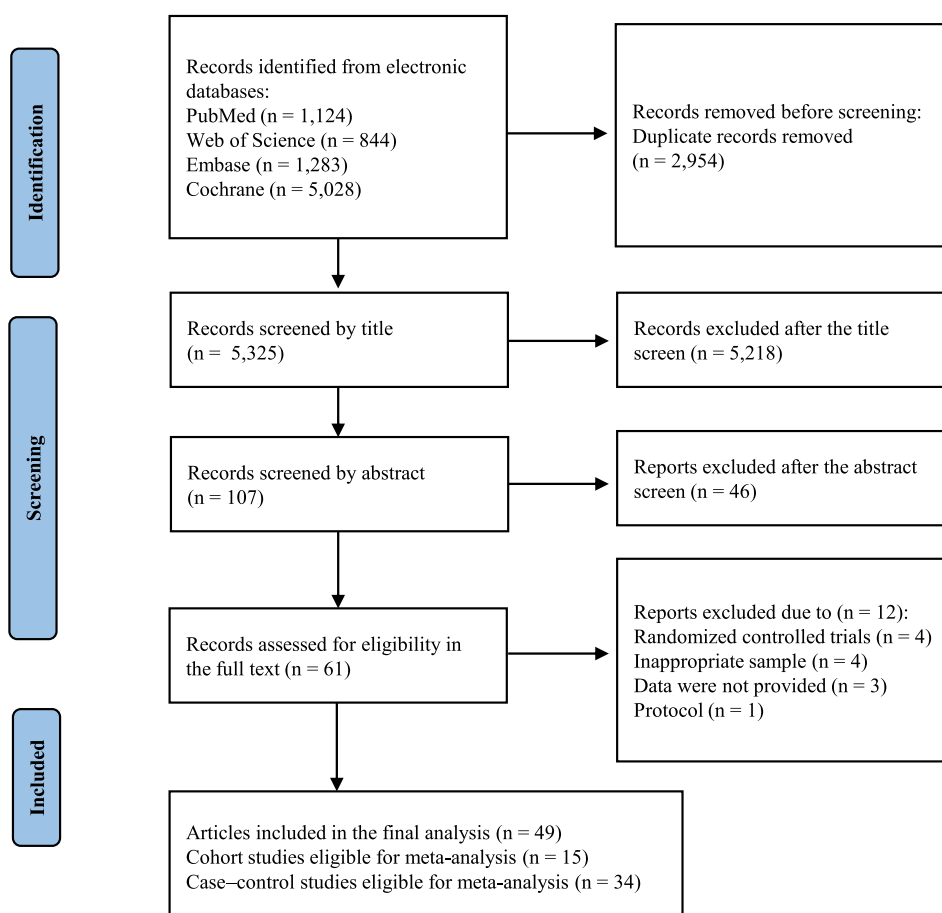


Fig. 1. Flow chart of study identification and selection.

Table 1

Summary of studies on associations of consumption of food groups and healthy/unhealthy dietary patterns with breast cancer risk.

Author and Year	Country	Study design	Case/Subject Case/Control Follow-up	Group comparisons	Adjustment factors	NOS
Fruits and vegetables						
Kim et al., 2017 [12]	Korea	Cohort	72/5046 7 years	Fruits: daily vs. ≤ 4 –6 times/week Light-colored vegetables: daily vs. ≤ 4 –6 times/week Green-yellow vegetables: ≥ 4 –6 vs. ≤ 2 –3 times/week	Age, BMI, family history of breast cancer, smoking status, alcohol consumption, physical activity, age at menarche, parity, oral contraceptive use, benign breast tumor history, hormone use, and age at menopause	8
Nguyen et al., 2022 [13]	Vietnam	Case–control	476/454	Fruits: Highest vs. lowest tertile Vegetables: Highest vs. lowest tertile	Age, education level, average annual per capita income, study site, recruitment month of year, family history of cancer first degree, number of children level menopausal status, BMI level, regular exercise, intensity of exercise, frequencies of grilled vegetables, frequencies of grilled meat/fish consumption, intake of total fruit, and total energy intake	7
Safabakhsh et al., 2022 [14]	Iran	Case–control	150/150	Fruits: Highest vs. lowest tertile Vegetables: Highest vs. lowest tertile	BMI, physical activity, energy intake, education, marital status and menopause status, socioeconomic status, alcohol use, smoking, vitamin supplements use and medication use, comorbidities, length of oral contraceptives use, hormone replacement therapy, systolic blood pressure, diastolic blood pressure, age at menarche, time since menopause in postmenopausal women, weight at age 18 years old, number of child, breast feeding ages, family history of breast cancer	6
Marzbani et al., 2019 [15]	Iran	Case–control	212/408	Fruits: daily vs. 2–3 servings/month Vegetables: daily vs. 2–3 servings/month	Age, education level, and BMI	6
Shahril et al., 2013 [16]	Malaysia	Case–control	382/382	Fruits: ≥ 0.8 vs. 0 cup/1000 kcal Vegetables: ≥ 1.1 vs. 0 cup/1000 kcal	Age, ethnicity, marital status, education, working status, household income, age at menarche, age at menopause, pregnancy history, age at first childbirth, number of live births, history of breastfeeding, duration of breastfeeding, history of oral contraceptive usage, history of hormone replacement therapy, smoking habit, alcohol consumption, physical activity level, family history of breast cancer, BMI, and energy intake	9
Yu et al., 2010 [17]	Korea	Case–control	358/360	Fruits and vegetables: ≥ 743.89 vs. ≤ 330.27 g/day Fruits: ≥ 345.70 vs. ≤ 102.64 g/day Vegetables: ≥ 410.23 vs. ≤ 182.73 g/day	Age, BMI, family history of breast cancer, use of dietary supplements, education, occupation, smoking, alcohol intake, physical activity, menopausal status, age at menarche, total energy intake, and postmenopausal hormone use	8
Zhang et al., 2009 [18]	China	Case–control	438/438	Fruits: Highest vs. lowest quartile Vegetables: Highest vs. lowest quartile	Age at menarche, BMI, history of benign breast disease, mother/sister/daughter with breast cancer, physical activity, passive smoking, and total energy intake	7
Do et al., 2007 [19]	Korea	Case–control	359/708	Fruits: >192.01 vs. <82.28 g/day Vegetables: >193.24 vs. <65.49 g/day	Age, education, income, age at menarche, parity, age at first live birth, history of breastfeeding, use of hormones, family history of breast cancer in a first-degree relative, frequency of exercise, physical activity, cigarette smoking, and alcohol consumption	8
Hirose et al., 2005 [20]	Japan	Case–control	167/854	Fruits: Highest vs. lowest tertile Vegetables: Highest vs. lowest tertile	Age, motives for consultation, smoking, drinking, exercise, total energy intake, family history, age at menarche, parity, age at first full-term pregnancy, BMI,	8

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Table 1 (continued)

Author and Year	Country	Study design	Case/Subject Case/Control Follow-up	Group comparisons	Adjustment factors	NOS
Shannon et al., 2005 [21]	China	Case–control	378/1070	Fruits and vegetables: ≥ 3.8 vs. ≤ 2.3 s/d Fruits: ≥ 1.2 vs. ≤ 3.9 servings/day Vegetables: ≥ 2.6 vs. ≤ 1.5 servings/day	and age at menopause for postmenopausal women Age, total energy intake, and breastfeeding	7
Malin et al., 2003 [22]	China	Case–control	1459/1556	Fruits: Highest vs. lowest quintile Vegetables: Highest vs. lowest quintile	Age, education, family history of breast cancer, history of breast fibroadenoma, WHR, menarche age, physical activity, number of live births, age at first live birth, and total energy intake compared to the lowest quintile group	9
Meat						
Kim et al., 2017 [12]	Korea	Cohort	72/5046 7 years	Grilled meat: $\geq 2-3$ vs. ≤ 1 times/month	Age, BMI, family history of breast cancer, smoking status, alcohol consumption, physical activity, age at menarche, parity, oral contraceptive use, benign breast tumor history, hormone use, and age at menopause	8
Nguyen et al., 2022 [13]	Vietnam	Case–control	476/454	Fruits: Highest vs. lowest tertile Vegetables: Highest vs. lowest tertile	Age, education level, average annual per capita income, study site, recruitment month of year, family history of cancer first degree, number of children level menopausal status, BMI level, regular exercise, intensity of exercise, frequencies of grilled vegetables, frequencies of grilled meat/fish consumption, intake of total fruit, and total energy intake	7
Shahril et al., 2013 [16]	Malaysia	Case–control	382/382	Meat and beans: ≥ 71 g/1000 kcal vs. 0	Age, ethnicity, marital status, education, working status, household income, age at menarche, age at menopause, pregnancy history, age at first childbirth, number of live births, history of breastfeeding, duration of breastfeeding, history of oral contraceptive usage, history of hormone replacement therapy, smoking habits, alcohol consumption, physical activity level, family history of breast cancer, BMI, and energy intake	9
Zhang et al., 2009 [23]	China	Case–control	438/438	Total meat: Highest vs. lowest quartile Red meat: Highest vs. lowest quartile Processed meat: Highest vs. lowest quartile Poultry: Highest vs. lowest quartile	Age at menarche, number of live births and age at first live birth, BMI, history of benign breast disease, mother/sister/daughter with breast cancer, physical activity, passive smoking, use of deep-fried cooking method, and total energy, vegetable, fruit, and soy food intakes	8
Hirose et al., 2005 [20]	Japan	Case–control	167/854	Meat: Highest vs. lowest tertile	Age, motives for consultation, smoking, drinking, exercise, total energy intake, family history, age at menarche, parity, age at first full-term pregnancy, BMI, and age at menopause for postmenopausal women	8
Shannon et al., 2005 [21]	China	Case–control	378/1070	Total meat: ≥ 5.9 vs. ≤ 2.9 servings/week Red meat: ≥ 6.1 vs. ≤ 3.0 servings/day Poultry: ≥ 1.2 vs. ≤ 2.0 servings/month	Age, total energy intake, and breastfeeding	7
Dai et al., 2002 [24]	China	Case–control	1459/1556	Total meat: Highest vs. lowest quintile	Age, education, family history of breast cancer, history of breast fibroadenoma, WHR, age at menarche, physical activity, number of live births, age at first live birth, menopausal status, age at menopause, and total energy intake	9
Soy foods, soy protein, and soy isoflavone						
Shirabe et al., 2021 [25]	Japan	Cohort	825/47,614 5 years	Soy foods: Highest vs. lowest quartile Isoflavone: Highest vs. lowest quartile	Age, area, smoking status, number of cigarettes smoked per day, alcohol consumption, BMI, height, total energy intake, physical activity, history of	7

Table 1 (continued)

Author and Year	Country	Study design	Case/Subject Case/Control Follow-up	Group comparisons	Adjustment factors	NOS
Wada et al., 2013 [26]	Japan	Cohort	134/15,607 16 years	Soy foods: Highest quartile vs. lowest quartile Isoflavone: Highest quartile vs. lowest quartile	diabetes, family history, received mammography, age at menarche, age at first birth, number of deliveries, menopausal age, hormone use, and breastfeeding Age, BMI, physical activity score, smoking status, alcohol consumption, education years, age at menarche, age at first delivery, menopausal status, parity number, history of hormone replacement therapy, and total energy intake	6
Lee et al., 2009 [27]	China	Cohort	592/73,223 7.4 years	Soy protein: ≥ 12.8 vs. ≤ 4.87 g/day Isoflavone: ≥ 44.24 vs. ≤ 15.93 mg/day	Age, education, physical activity, age at first live birth, BMI, season of recruitment, family history of breast cancer, and total energy intake	8
Wu et al., 2008 [28]	Singapore	Cohort	629/34,028 9.6 years	Isoflavone: ≥ 10.6 vs. < 10.6 mg/1000 kcal	Age, year of recruitment, dialect, education, family history of breast cancer, parity, age when period became regular, menopausal status, BMI, and omega-3 fatty acid intake	8
Nishio et al., 2007 [29]	Japan	Cohort	145/30,454 7.6 years	Tofu: almost daily vs. < 3 times/week Boiled beans: ≥ 3 vs. < 1 times/day miso soup: ≥ 2 cups/day vs. < 1 times/dy	Age, study area, family history of breast cancer, age at menopause, age at first birth, parity, use of exogenous female hormones, smoking, consumption of green leafy vegetables, walking time, BMI, and total energy intake	6
Cao et al., 2022 [30]	China	Case–control	818/935	Soy foods: Highest quartile vs. lowest quartile	Age, area, education, tobacco smoking, moderate physical activity, oral contraceptives use, hormone replacement therapy, family history of breast cancer, history of benign breast disease, age at menarche, number of full-term births, age at first full-term delivery, breastfeeding, body mass index, and menopausal age for postmenopausal women.	8
Chang et al., 2017 [31]	Taiwan	Case–control	233/236	Isoflavone: > 22 vs. ≤ 22 mg/day	Age and regular exercise	7
Toi et al., 2013 [32]	Japan	Case–control	306/662	Isoflavone: ≥ 43.75 vs. < 18.76 mg/day	Age, educational background, physical activity level, benign mammary tumor, family breast cancer history, age at menarche, number of births, breastfeeding experience, use of female sex hormones before menopause, birth weight, BMI around the age of 20, smoking, and total energy intake	9
Zhu et al., 2011 [33]	China	Case–control	183/192	Soy protein: > 13.03 vs. < 2.12 g/day Isoflavone: > 28.83 vs. < 7.56 mg/day	Age, smoking, passive smoking, drinking, family history of cancer, history of breast disease, intake of vegetables, and intake of fruits	7
Zhang et al., 2010 [34]	China	Case–control	438/438	Soy protein: > 4.66 vs. < 0.93 g/day Isoflavone: > 16.89 vs. < 3.26 mg/day	Age at menarche, BMI, history of benign breast disease, mother/sister/daughter with breast cancer, physical activity, passive smoking, total energy intake, total vegetable intake, and total fruit intake	7
Iwasaki et al., 2009 [35]	Japan	Case–control	390/390	Isoflavone: Highest vs. lowest tertile	Age and area for Japanese, number of births, family history of breast cancer, smoking status, moderate physical activity in the past 5 years, and vitamin supplement use	7
Kim et al., 2008 [36]	Korea	Case–control	362/362	Soy protein: ≥ 10.55 vs. < 4.24 g/day	Alcohol consumption, multivitamin use, number of children, breastfeeding, quintile of carbohydrate intake, and dietary factors (quintiles of energy, vitamin E, and folate)	6
Do et al., 2007 [19]	Korea	Case–control	359/708	Soy foods: > 28.81 vs. < 6.82 g/day	Age, education, income, age at menarche, parity, age at first live birth, history of breastfeeding, use of hormones, family history of breast cancer in a first-degree relative, frequency of exercise, physical activity, cigarette smoking, alcohol consumption	8

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Table 1 (continued)

Author and Year	Country	Study design	Case/Subject Case/Control Follow-up	Group comparisons	Adjustment factors	NOS
Hirose et al., 2005 [20]	Japan	Case–control	167/854	Soy foods: Highest vs. lowest tertile Isoflavone: Highest vs. lowest tertile	Age, motives for consultation, smoking, drinking, exercise, total energy intake, family history, age at menarche, parity, age at first full-term pregnancy, BMI, and age at menopause for postmenopausal women	8
Lee et al., 2005 [37]	Taiwan	Case–control	250/219	Soy foods: >341 vs. <114 g/week	Age and total calories other than fat	6
Shannon et al., 2005 [21]	China	Case–control	378/1070	Soy foods: ≥ 1.1 vs. ≤ 2.6 servings/week	Age, total energy intake, and breastfeeding	7
Dai et al., 2001 [38]	China	Case–control	1459/1556	Soy protein: >139.1 vs. ≤ 18.6 g/week	Age, education, first-degree family history of breast cancer, history of breast fibroadenoma, WHR, age at menarche, physical activity, number of births, age at first birth, menopausal status, age at menopause, intakes of meat, fish, and total energy	9
Green tea						
Sinnadurai et al., 2020 [39]	Japan	Cohort	255/33,396 13 years	Daily drinker vs. non-daily drinker	Age, educational level, BMI, green vegetable intake, red meat intake, physical activity, smoking habits, parity, family history of breast cancer, age at menarche, green tea intake, coffee intake, and alcohol intake	7
Dai et al., 2010 [40]	China	Cohort	614/72,816 7.3 years	>5 vs. ≤ 1.67 g/day	Age, educational achievement, income, family history of breast cancer, history of fibroadenoma, BMI, WHR, physically active, smoking status, alcohol consumption status, passive smoking status, ginseng intake, age at menarche, age at first live birth, menopausal status, age at menopause, use of hormone replacement therapy, and dietary intake of total energy, fruits, vegetables, red meat, fish, and isoflavones	9
Iwasaki et al., 2010 [41]	Japan	Cohort	581/43,639 13.6 years	≥ 5 vs. <1 cups/day	Age, area, age at menarche, menopausal status at baseline, number of births, age at first birth, height, BMI, alcohol intake among regular drinkers, smoking status, leisure time physical activity, exogenous hormone use, family history of breast cancer, oolong tea intake, black tea intake, and coffee intake	7
Iwasaki et al., 2014 [42]	Japan	Case–control	369/369	>600 vs. <120 ml/day	Age, area, menopausal status, number of births, family history of breast cancer, smoking status, moderate physical activity in the past 5 years, vitamin supplement use, oolong tea consumption, black tea consumption, coffee consumption, and canned coffee consumption	7
Shrubsole et al., 2009 [43]	China	Case–control	3371/3380	Drinker vs. non-drinker	Age, study phase, education, family history of breast cancer, personal history of fibroadenoma, age at menarche, parity, age at first live birth, age at menopause, physical activity, WHR, total energy intake, total fruit and vegetable intake, and fat intake	8
Zhang et al., 2007 [44]	China	Case–control	1009/1009	≥ 2 vs. <1 cups/day	Residential area, education, BMI, age at menarche, number of children breastfed, menopausal status, oral contraceptive use, hormone replacement therapy, biopsy-confirmed benign breast diseases, breast cancer in first-degree relatives, total energy intake, passive smoking, alcohol consumption, coffee consumption, physical activity, soy intake, vegetable intake, and fruit intake	7

Table 1 (continued)

Author and Year	Country	Study design	Case/Subject Case/Control Follow-up	Group comparisons	Adjustment factors	NOS
Lee et al., 2005 [37] Alcohol	Taiwan	Case–control	250/219	>664 vs. <16 g/week	Age and total calories other than fat	6
Sinnadurai et al., 2020 [39]	Japan	Cohort	255/33,396 13 years	Daily drinker vs. non-drinker	Age at baseline, educational level, BMI, green vegetable intake, red meat intake, physical activity, smoking habit, parity, family history of breast cancer, age at menarche, green tea intake, and coffee intake	7
Nitta et al., 2016 [45]	Japan	Cohort	273/38,610 13 years	≥15 vs. 0 g/day	Age at baseline survey, age at menarche, number of live births, and age at first delivery	6
Suzuki et al., 2010 [46]	Japan	Cohort	572/50,757 13.8 years	>150 vs. 0 g/week	Age timescales, area, height, BMI, smoking status, leisure time physical activity, age at menarche, age at first birth, parity, age at menopause, use of exogenous female hormones, energy-adjusted intake of isoflavones, energy-adjusted intake of folate	7
Lin et al., 2005 [47]	Japan	Cohort	151/35,844 7.6 years	>23 vs. <11.5 g/week	Age, BMI, study area, family history of breast cancer, walking, use of hormones, age at menarche, age at first birth, age at menopause, and number of births	7
Chang et al., 2017 [31]	Taiwan	Case–control	233/236	Drinker vs. non-drinker	Age and regular exercise	7
Zhang and Holman 2011 [48]	China	Case–control	1009/1009	≥30 vs. 0 g/day	Age, education, BMI, oral contraceptive use, hormone replacement therapy, breast cancer in first-degree relatives, total energy intake, folate intake, tea drinking, and menopausal status	7
Dietary pattern						
Kojima et al., 2017 [49]	Japan	Cohort	119/23,172 16.9 years	Vegetable pattern: Highest vs. lowest tertile Animal food pattern: Highest vs. lowest tertile	Age, area, tobacco smoking status, alcohol consumption status, family history of breast cancer, age at menarche, age at first birth, parity, energy intake, hormone therapy, daily walking, education, and BMI	7
Shin et al., 2016 [50]	Japan	Cohort	718/49,552 14.6 years	Prudent pattern: Highest vs. lowest quartile Western pattern: Highest vs. lowest quartile	Age, public healthcare center area, log-transformed energy intake, BMI, smoking status, leisure time physical activity, total physical activity, age at menarche, parity, age at first birth, menopause status, and use of exogenous female hormones	6
Butler et al., 2010 [51]	Singapore	Cohort	629/34,028 10.7 years	Vegetable pattern: Highest vs. lowest quartile Meat pattern: Highest vs. lowest quartile	Age at interview, dialect group, interview year, education, parity, first-degree relative with a diagnosis of breast cancer, and total daily energy intake	6
Heidari et al., 2018 [52]	Iran	Case–control	134/267	Healthy pattern: Highest vs. lowest quartile Unhealthy pattern: Highest vs. lowest quartile	Age, BMI, energy intake, MET, age at first live birth, day bra use, vitamin D supplements, and family history of cancer	6
Chang et al., 2017 [31]	Taiwan	Case–control	233/236	Vegetable pattern: 1 vs. 0 times/day Meat pattern: 1 vs. 0 times/day Processed meat pattern: 1 vs. 0 times/day Sugar pattern: 1 vs. 0 times/day Fermented food pattern: 1 vs. 0 times/day	Age, BMI, albumin, triglyceride, total cholesterol, estradiol, smoking habit, alcohol intake, and family history of breast cancer	7
Karimi et al., 2014 [53]	Iran	Case–control	100/174	Healthy pattern: Highest vs. lowest tertile	Age, age at menarche, age at first full-term pregnancy, smoking status, oral contraceptive drug use, BMI, energy intake, physical activity, and family history of breast cancer	7
Wu et al., 2013 [54]	Taiwan	Case–control	98/103	Vegetable pattern: Highest vs. lowest tertile Meat pattern: Highest vs. lowest tertile	Age and BMI	6
Zhang et al., 2011 [55]	China	Case–control	438/438	Vegetable pattern: Highest vs. lowest quartile	Age at menarche, number of live births, age at first live birth, months of	7

(continued on next page)

Table 1 (continued)

Author and Year	Country	Study design	Case/Subject Case/Control Follow-up	Group comparisons	Adjustment factors	NOS
Cho et al., 2010 [56]	Korea	Case–control	357/357	Meat pattern: Highest vs. lowest quartile Vegetable pattern: Highest vs. lowest tertile Meat pattern: Highest vs. lowest tertile	breastfeeding, BMI, history of benign breast disease, mother/sister/daughter with breast cancer, physical activity, passive smoking, and total energy intake Age, BMI, family history of breast cancer, use of dietary supplements, education, occupation, smoking, alcohol intake, physical activity, menopausal status, age at menarche, parity, total energy intake, and postmenopausal hormone use for postmenopausal women	6
Cui et al., 2007 [57]	China	Case–control	1459/1556	Vegetable pattern: Highest vs. lowest quartile Meat pattern: Highest vs. lowest quartile	Age, total energy, family history of breast cancer, personal history of fibroadenoma, age at menarche, number of live births and age at first live birth, menopausal status and age at menopause, regular physical activity during last 10 years, WHR, BMI, and level of education	7
Healthy eating index						
Shamsi et al., 2022 [58]	Pakistan	Case–control	374/750	Healthy eating index: Highest vs. lowest tertile	BMI menopausal status and socioeconomic status	5
Kord-Varkaneh et al., 2020 [59]	Iran	Case–control	134/265	Healthy eating index: >79.94 vs. ≤72.73	Age, age at menarche, oral contraceptive drug use, menopausal status, material status, BMI, smoking, and education	6
Sedaghat et al., 2018 [60]	Iran	Case–control	134/267	Healthy eating index: >75.7 vs. <67.2	Age, age at first pregnancy, height, family history of cancer, and anti-inflammatory drugs and vitamin D supplement use	6
Shahril et al., 2013 [16]	Malaysia	Case–control	382/382	Healthy eating index: Highest vs. lowest quartile	Age, ethnicity, marital status, education, working status, household income, age of menarche, age of menopause, pregnancy history, age at first childbirth, number of live births, history of breastfeeding, duration of breastfeeding, history of oral contraceptive usage, history of hormone replacement therapy, smoking habit, alcohol consumption, physical activity level, family history of breast cancer, BMI, and total energy intake	9

vs.: versus; BMI: body mass index; WHR: waist hip ratio; MET: metabolic equivalent of task.

3.2.5. Alcohol

Four cohort and two case–control studies assessed the association between alcohol consumption and breast cancer risk (Table 1). The pooled RR was 1.75 (95% CI = 1.33–2.30), with low heterogeneity ($I^2 = 32.6\%$; $P = 0.191$) (Table 2 and Fig. 4). The RR was 1.84 (95% CI = 1.43–2.38) in the cohort studies, with no heterogeneity. In the case–control studies, the RR was 1.47 (95% CI 0.59–3.65) with high heterogeneity ($I^2 = 76.7\%$).

3.2.6. Dietary pattern

Three cohort and seven case–control studies assessed the association between a healthy dietary pattern and breast cancer risk, three cohort and six case–control studies focused on an unhealthy dietary pattern, and four case–control studies focused on a healthy eating index (Table 1). By checking the loading factors of each pattern and objective food group classification, vegetables and prudent dietary patterns were unified as the healthy dietary pattern. The meat and animal food dietary patterns were unified as the unhealthy dietary pattern. The pooled results are shown in Table 2 and Fig. 5. Significant inverse associations were observed between the healthy dietary pattern and breast cancer risk

(RR = 0.62, 95% CI = 0.44–0.88; $I^2 = 88.2\%$) and between a healthy eating index and breast cancer risk (RR = 0.49, 95% CI = 0.27–0.87; $I^2 = 71.7\%$). The RR of the healthy dietary pattern was 0.50 (95% CI = 0.28–0.87; $I^2 = 91.9\%$) in the case–control studies, whereas no relationship was indicated (RR = 0.89, 95% CI = 0.75–1.06, $I^2 = 0.0\%$) in the cohort studies. By contrast, the unhealthy dietary pattern was positively associated with a high risk of breast cancer (RR = 1.44, 95% CI = 1.06–1.96, $I^2 = 81.5\%$). The RR was 1.04 (95% CI = 0.74–1.48; $I^2 = 66.6\%$) in the cohort studies, and the RR was 1.74 (95% CI = 1.16–2.61; $I^2 = 78.7\%$) in the case–control studies.

3.3. Subgroup analysis

As shown in Figure 2–5, the pooled results of fruits, vegetables, soy foods, isoflavone, green tea, a healthy dietary pattern, an unhealthy dietary pattern, and a healthy eating index showed significant heterogeneity. Subgroup analyses were performed according to the publication year and sample size (Supplemental Table 3). For studies with sample sizes less than 1,000, the consumption of fruits was associated with a 41% reduced risk of breast cancer (RR = 0.59, 95% CI = 0.46–0.74), with low heterogeneity ($I^2 = 33.8\%$) and the

Table 2

Pooled results of studies on associations of consumption of food groups and healthy/unhealthy dietary patterns with breast cancer risk.

Exposure, Study design	Heterogeneity				
	Studies (n)	Pooled RR (95% CI)	P-value ^a	I ² , %	P-value ^b
Fruit consumption					0.034
Cohort	1	1.22 (0.76, 1.96)	/	0.0%	
Case–control	10	0.67 (0.51, 0.88)	0.000	73.4%	
Overall	11	0.71 (0.55, 0.93)	0.000	74.2%	
Vegetable consumption					0.432
Cohort	1	0.87 (0.54, 1.39)	/	0.0%	
Case–control	10	0.69 (0.50, 0.96)	0.000	81.4%	
Overall	11	0.71 (0.53, 0.95)	0.000	79.5%	
Meat consumption					0.017
Cohort	1	1.77 (1.09, 2.86)	/	0.0%	
Case–control	6	0.96 (0.83, 1.11)	0.537	0.0%	
Overall	7	1.01 (0.84, 1.21)	0.133	38.8%	
Soy foods consumption					0.484
Cohort	3	1.01 (0.72, 1.43)	0.123	52.2%	
Case–control	5	0.83 (0.54, 1.28)	0.003	75.0%	
Overall	8	0.90 (0.67, 1.20)	0.001	71.6%	
Soy protein intake					0.017
Cohort	1	0.89 (0.67, 1.17)	/	0.0%	
Case–control	4	0.58 (0.46, 0.72)	0.661	0.0%	
Overall	5	0.65 (0.51, 0.83)	0.122	45.0%	
Isoflavone intake					0.002
Cohort	4	0.85 (0.73, 0.99)	0.286	20.6%	
Case–control	6	0.54 (0.43, 0.68)	0.236	26.4%	
Overall	10	0.68 (0.55, 0.82)	0.004	62.8%	
Green tea consumption					0.142
Cohort	3	1.10 (0.93, 1.31)	0.769	0.0%	
Case–control	4	0.84 (0.61, 1.16)	0.000	83.9%	
Overall	7	0.95 (0.76, 1.18)	0.000	79.4%	
Alcohol consumption					0.637
Cohort	4	1.84 (1.43, 2.38)	0.493	0.0%	
Case–control	2	1.47 (0.59, 3.65)	0.038	76.7%	
Overall	6	1.75 (1.33, 2.30)	0.191	32.6%	
Healthy dietary pattern					0.051
Cohort	3	0.89 (0.75, 1.06)	0.680	0.0%	
Case–control	7	0.50 (0.28, 0.87)	0.000	91.9%	
Overall	10	0.62 (0.44, 0.88)	0.000	88.2%	
Unhealthy dietary pattern					0.058
Cohort	3	1.04 (0.74, 1.48)	0.050	66.6%	
Case–control	6	1.74 (1.16, 2.61)	0.000	78.7%	
Overall	9	1.44 (1.06, 1.96)	0.000	81.5%	
Healthy eating index					/
Cohort	0	/	/	/	
Case–control	4	0.49 (0.27, 0.87)	0.014	71.7%	
Overall	4	0.49 (0.27, 0.87)	0.014	71.7%	

^a P-value for heterogeneity within groups.^b P-value for heterogeneity between groups.

pooled result remained relatively stable. For soy isoflavone intake, heterogeneity was significantly reduced (all $I^2 < 50\%$) after stratified analysis, according to sample size, and reached a consistent result of an inverse association with breast cancer risk. For green tea, a null association was found among studies published after 2010 (RR = 1.12, 95% CI = 0.95–1.31; $I^2 = 0.0\%$), and for sample sizes less than 1000 (RR = 1.12, 95% CI = 0.78–1.60; $I^2 = 0.0\%$). For the healthy dietary pattern, an inverse association was found among studies with a sample size of less than 1000 (RR = 0.43, 95% CI = 0.19–0.95; $I^2 = 0.0\%$). For a healthy eating index, the RR was still consistent with the overall result and had low heterogeneity after deletion of the study with a sample size of more than 1000 (RR = 0.38, 95% CI = 0.22–0.67; $I^2 = 36.6\%$). Concerning the consumption of vegetables and the unhealthy dietary pattern, the subgroup still had high heterogeneity (all $I^2 > 50\%$).

3.4. Publication bias

Owing to the small number of included studies, publication bias was only conducted for studies that assessed the association of the

consumption of fruits, consumption of vegetables, isoflavone intake, and the healthy dietary pattern with breast cancer risk. No evidence of publication bias was detected by the funnel plot, and funnel plot asymmetry was confirmed by Egger's and Begg's tests (fruits: Egger's test: $P = 0.910$, Begg's test: $P = 0.755$; vegetables: Egger's test: $P = 0.553$, Begg's test: $P = 0.755$; isoflavone: Egger's test: $P = 0.080$, Begg's test: $P = 0.107$; healthy dietary pattern: Egger's test: $P = 0.082$, Begg's test: $P = 0.049$) (Supplemental Figs. 1–4).

4. Discussion

Our present review was performed to explore the association of the consumption of specific food groups (fruits, vegetables, meat, soy foods, green tea, and alcohol) and dietary pattern and healthy eating index with breast cancer risk based on cohort and case–control studies. Inverse associations were found for the consumption of fruits, vegetables, soy protein, and soy isoflavone, and the healthy dietary pattern and healthy eating index, while positive associations were found for alcohol consumption and the unhealthy dietary pattern. However, we failed to observe

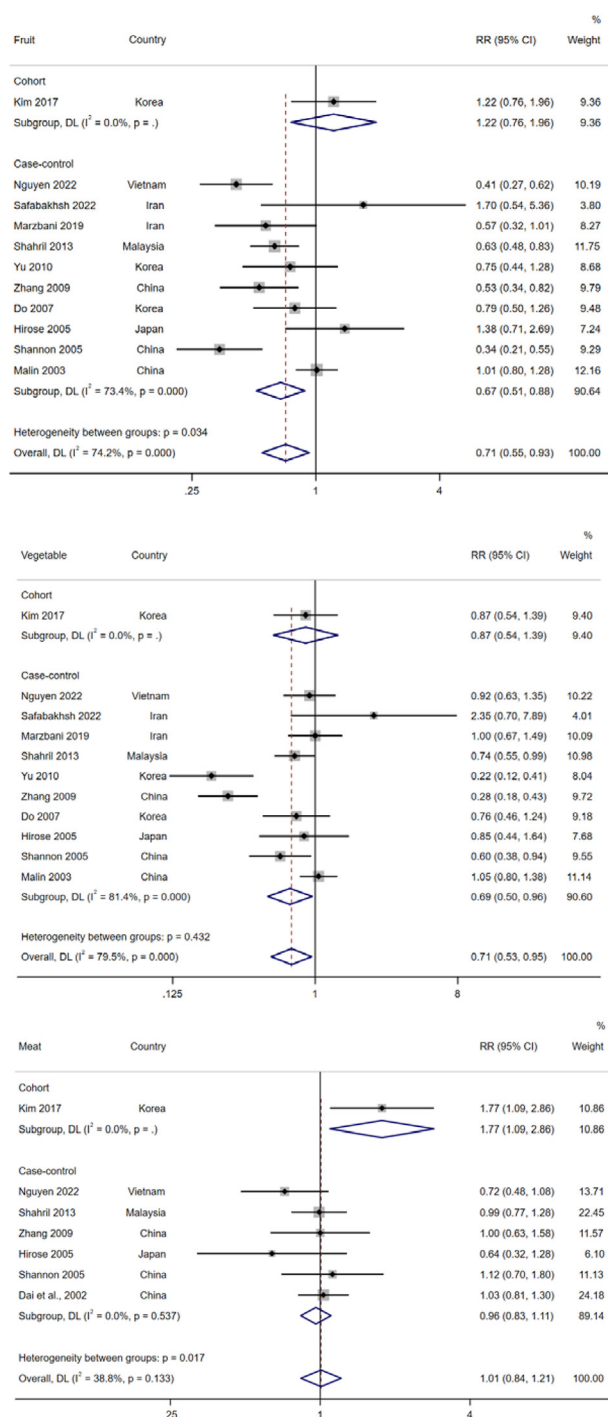


Fig. 2. Meta-analysis for associations of the consumption of fruits, vegetables, and meat with breast cancer risk.

associations between the consumption of meat, soy foods, and green tea and breast cancer risk.

The prophylactic effect of the consumption of fruits and vegetables on breast cancer risk observed in our review was consistent with a previous meta-analysis [61]. In 2015, Wu et al. [61] summarized the published data among the Chinese population and concluded that the consumption of fruits and vegetables was associated with a reduced breast cancer risk. In addition, our results were consistent with the third expert report from the World

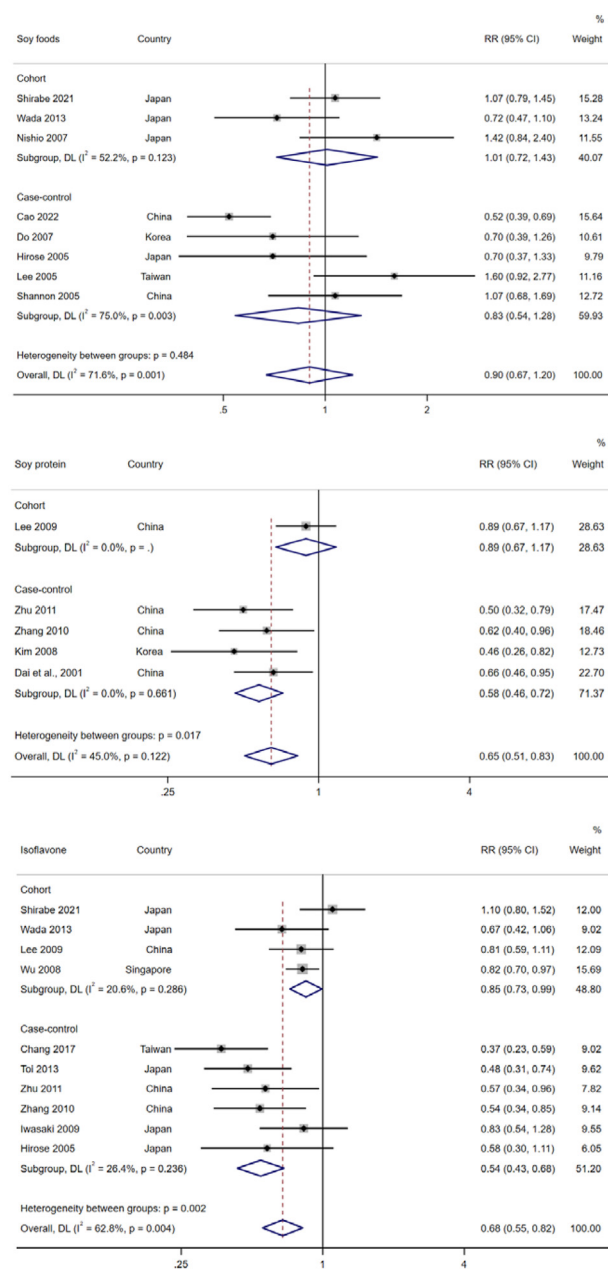


Fig. 3. Meta-analysis for associations of the consumption of soy foods, soy protein, and isoflavone with breast cancer risk.

Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) published in 2018 [62], which recommended the consumption of fruits and vegetables for health promotion. Fruits and vegetables are rich in fiber and antioxidants, such as polyphenols, glycosylates, and indoles, which may help reduce breast cancer risk by inhibiting oxidative stress and inflammation and inducing detoxifying enzymes [63]. However, Liu et al. [64] and Aune et al. [65] found that the consumption of vegetables was unrelated to breast cancer risk. This discrepancy may be because Asians typically consume vegetables after cooking, which might lead to a higher loss of certain nutrients, such as water-soluble and heat-sensitive nutrients, than those available when consuming raw vegetables [66]. Hence, further studies need to be conducted to consider processing methods (cooked or raw) when evaluating

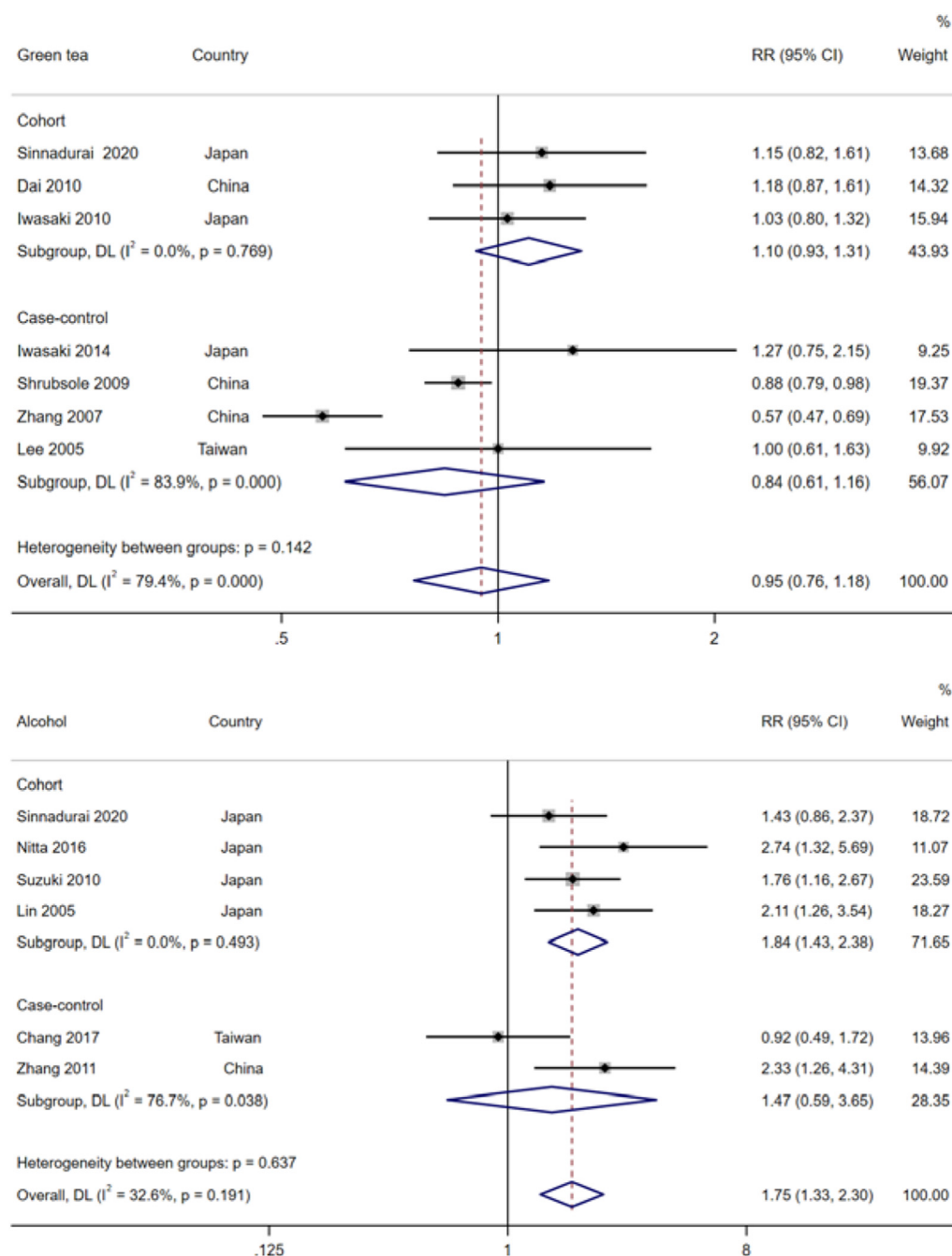


Fig. 4. Meta-analysis for associations of green tea and alcohol consumption with breast cancer risk.

the association between the consumption of vegetables and breast cancer risk. A systematic review and meta-analysis recently conducted by Farvid et al. [67] to examine the association between fiber intake and breast cancer incidence included 20 prospective studies: total fiber consumption was associated with an 8% decrease in breast cancer risk, supporting the WCRF/AICR report [62] that the consumption of foods high in total fiber, including fruits, vegetables, and whole grains, reduces breast cancer risk.

A cohort study of 262,195 women in the UK revealed that the consumption of processed meat, but not red meat, was associated with an increased breast cancer risk [68,69]. This was inconsistent with our results; we found a null association between meat

consumption and breast cancer risk. A possible explanation is that the UK study did not distinguish British Asians from the sample population in consideration of the large difference in meat consumption among Asian and Western populations; meat consumption in Asian populations is relatively low.

Consistent with previous reviews [70,71], the active components of soy foods (soy protein and soy isoflavones) demonstrated an ameliorative effect on breast cancer risk. The anticarcinogenic mechanism of soy isoflavones may be due to genistein, a predominant soy isoflavone, shown to inhibit cancer cell growth and angiogenesis by regulating VEGF and EGFR expression and the PI3–K/Akt, ERK1/2, and NF- κ B signaling pathways [72]. However,

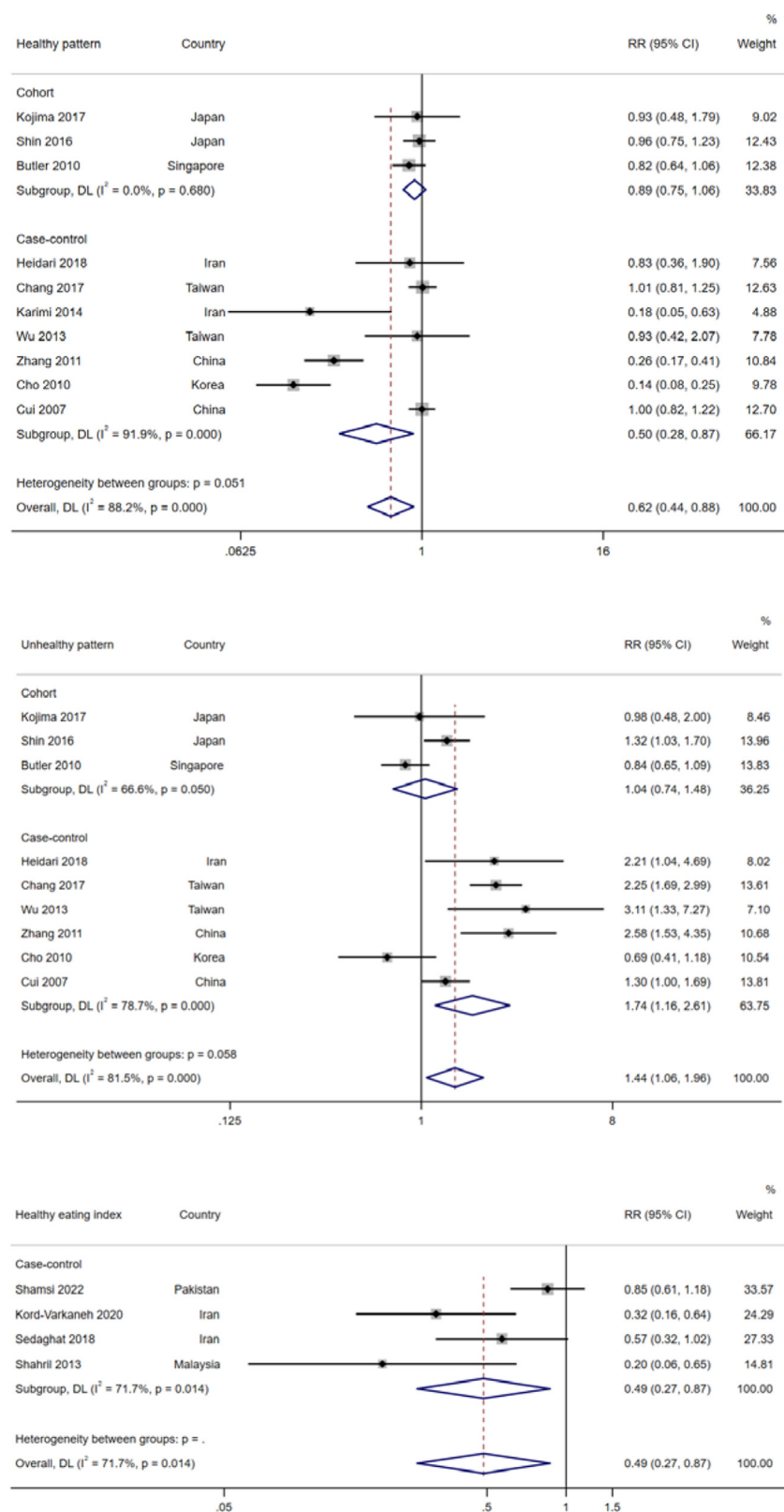


Fig. 5. Meta-analysis for associations of dietary patterns with breast cancer risk.

concerning the effect of the consumption of soy foods, we found no association with breast cancer risk, a finding consistent with the results of a review conducted by Wei et al. focused on Chinese

women [71]. This contradictory outcome between soy protein/isoflavone and soy foods might be partially explained by the food additives (such as artificial sweeteners) and added sugar in soy

products. Evidence shows the negative effect of the carcinogenicity of excessive sugar intake and artificial sweeteners on breast cancer risk [73]. Accordingly, the adverse effect of sugar on breast cancer may neutralize the beneficial effect of isoflavone and soy protein. Another explanation concerns the studies themselves; studies may be affected by measurement and misclassification bias, causing consumption levels to vary across the study and control groups.

Green tea is one of the most popular beverages in Asia, especially in China and Japan. In the previous 20 years, several animal experiments have revealed the beneficial effects of green tea and tea polyphenols in the prevention of breast cancer, reducing the number of invasive tumors and delaying the onset of breast tumors [74,75]. Green tea polyphenol epigallocatechin gallate decreased the expression of VEGF and induced the transformation of JB6 cells in a breast cancer syngeneic model [76]. In addition, findings of the published reviews [77,78] also revealed the ameliorative effects of green tea on breast cancer development. However, despite the popularity of green tea consumption and its promising anticarcinogenic effect, our findings concur with the WCRF/AICR [62], noting a null association between green tea consumption and breast cancer risk [62], possibly due to the limited evidence on this topic.

Alcohol consumption was a convincing risk factor identified by the WCRF/AICR [62], in agreement with our finding; no heterogeneity was observed in our finding, which proved the stability of the results. A possible mechanism for the association of alcohol consumption with breast cancer risk is the conversion of alcohol into carcinogenic substances in the body. The oxidation of ethanol to acetaldehyde and free radicals was studied by Castro et al. [79]. They found that acetaldehyde is a transitional compound in the oxidation of carcinogenic compounds, such as ethanol and acetic acid, and that it is readily oxidized, potentially producing hydroxyl radicals (carcinogens). In addition, because the ingestion of alcohol leads to increased serum estrogen concentrations and estrogen plays a crucial role in breast tissue carcinogenicity, it is hypothesized that estrogen mediates the carcinogenic effects of ethanol [80]. Although numerous studies have established a negative relationship between alcohol consumption and breast cancer risk [81] and considering racial differences, it is noteworthy that this is the first meta-analysis to explore the association with a focus on Asians.

Concerning the dietary pattern and dietary eating index rather than the consumption of single food groups, we found that a healthy dietary pattern and a healthy eating index were beneficial for reducing breast cancer risk by 38% and even 51%, while an unhealthy dietary pattern could increase breast cancer risk by 44%. These results confirm that lifestyle factors could prevent approximately one-third of breast cancer cases [82–84]. The mechanism by which a healthy diet modifies breast cancer risk may involve the reduced intake of pro-inflammatory nutrients and the increased intake of protective nutrients that act as anti-oxidant and anti-inflammatory agents. Inflammation initiates breast tumors through the infiltration of Th2 cells, chronic activation of humoral immunity, and polarization of intrinsic inflammatory cells [85].

In this review, we observed some inconsistencies between different study designs. This discrepancy may be due to differences in methodology; for example, measurement error that may exist in a cohort study and recall bias that may exist in a case–control study.

4.1. Limitations and strengths

This meta-analysis has some limitations. First, there are some variations in the categories of food consumption across the included studies. Second, there are some biases caused by different exposure assessment methods. It is also unavoidable to ignore some adjustment variables, which might bias the association with breast cancer development. However, there are several strengths. One, this is the first meta-analysis to investigate the effect of food consumption on breast cancer risk focusing on the Asian population, a meaningful approach considering the differences between Eastern and Western eating habits. Second, two authors independently performed the literature search to minimize selection errors. Third, no publication bias was found in this review.

5. Conclusion

The present systematic review and meta-analysis of cohort and case–control studies summarized the current evidence for the association of specific food groups and dietary patterns and healthy eating index with breast cancer risk. It showed that high intakes of fruits, vegetables, soy protein, and soy isoflavone were mostly associated with a reduced risk of breast cancer, whereas a high alcohol intake was associated with an increased risk. As for the consumption of meat, soy foods, and green tea, their increased consumption seems to be unrelated to breast cancer risk. In addition, high adherence to a healthy dietary pattern and, likewise, a healthy eating index had a positive effect on lowering breast cancer risk, whereas adherence to an unhealthy dietary pattern may lead to an increased breast cancer risk. However, in the future, more cohort studies on the association between dietary patterns and breast cancer risk with a focus on the Asian population are required to support the establishment of a more consistent and reliable conclusion.

Author contributions

Sangah Shin, Daehee Kang, Jialei Fu: Conceptualization, Methodology. Sangah Shin, Jialei Fu: Data curation, Visualization, Writing-Original draft preparation. Daehee Kang, Woo-Kyoung Shin, Dan Huang, Sukhong Min: Writing-Reviewing and Editing.

Conflicts of interest

The authors declare no potential conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.clnu.2023.01.003>.

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