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Research Article

Association between Diet and Breast Cancer Risk in Postmenopausal Women: A Systematic Review

Abrar Abdulfattah Al Yamani[1], Karam Saleh Alharbi[2], Abdullatif Saeed Alqahtani[3], Ahmed Sami Felemban[4], Fotun Sameer Bawayan[5], Fulwah Abdulaziz Alangari[6], Reema Abdulaziz Alghamdi[7], Fahad Saeed Alqahtani[3], Meshari Mari Qitmah[3], Azzam Bandar Almalki[4] and Samar Yahya Al Fadhel[3]

[1]Primary Health Care Center, King Abdullah Medical Complex, Jeddah, Saudi Arabia

[2]College of Medicine, Alfarabi Colleges, Riyadh, Saudi Arabia

[3]College of Medicine, King Khalid University, Abha, Saudi Arabia

[4]College of Medicine, University of Jeddah, Jeddah, Saudi Arabia

[5]College of Medicine, Batterjee Medical College, Jeddah, Saudi Arabia

[6]College of Medicine, Alfaisal University, Riyadh, Saudi Arabia

[7]College of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia

***Corresponding Author:** Abrar Abdulfattah Al Yamani, Primary Health Care Center, King Abdullah Medical Complex, Jeddah, Saudi Arabia.

Received: August 13, 2020; **Published:** September 19, 2020

Abstract

Patterns of diet have long been suspected to impact on health promotion and the protective role of adherence to this dietary pattern on cancer incidence. However, its association with breast cancer risk remains unclear. Therefore, we aim to systematically review the previously published studies that assessed the correlation between the quality of diet and breast cancer in post-menopausal women. A systematic electronic database search was conducted for relevant studies published till 21st July 2020 in seven databases. Finally, 19 studies were included in the current systematic review after all of the screening stages. The overall risk of bias of the included studies was acceptable with less than 25% of the studies showing serious/critical risks. Four cohort studies found a statistically significant association between adherence to a Mediterranean Diet pattern and the reduced risk of breast cancer with the latter three studies that reported statistical significance only with estrogen negative (ER-) breast cancers. Moreover, two case-control studies showed a negative correlation between adherence to a Mediterranean Diet pattern and the occurrence of breast cancer. In terms of the healthy eating index (HEI), a statistically significant association between high HEI scores and reduced incidence of ER- breast cancer although it was not associated with other ER- tumors. In the same context, there were contradicting results regarding the association of the dietary inflammatory index and low-carbohydrate diet scores and the risk of breast cancer. In conclusion, the results are contradicting with no conclusive evidence of the association which requires more studies for the synthesis of high-quality evidence.

Keywords: *Diet; Breast Cancer; Menopause*

Introduction

Breast cancer (BC) is the most prevalent cancer in the United States of America as approximately one in eight women are expected to develop this type of cancer throughout their life. Moreover, it is the most commonly diagnosed cancer globally with an estimate of 25% of all the diagnosed cancers [1]. Therefore, identifying the possible risk factors and boosting the medical care for patients at risk of develop-

ing breast cancer is essential to lower this rate and for better prognosis. It is now known that lifestyle modification plays an important role in decreasing the risk of developing BC. Lifestyle modification includes a healthy, fat-free and plant-based diet [2]. This type of prevention is highly recommended as it is the simplest way that is affordable by every patient even in low and middle-income countries with no adverse outcomes. Besides, obesity and physical activity have been reported to be commonly associated with developing postmenopausal BC [3-7]. However, the mechanism is still of debate and the type and pattern of food intake are still under investigation.

Investigations about the possible risk factors can lower the risk of developing BC by updating more suitable recommendations with proper interventional styles. Although diet quality has been reported to be correlated with the incidence of BC, studies results have been variable in this topic as some reported significance of correlation of certain types with BC [8-11] while others found no association [12,13] and according to the menopausal status of the patient [14,15]. A previously published systematic review suggest that BC is inversely proportional with certain dietary variations that include high intake of fruits, vegetable, legumes, grains and nuts and low intake of sugar and processed meat [13]. On the other hand, other studies stated that no association was found [15,16]. These findings, therefore, lie in line with the 2015 US Dietary Guidelines for Americans which recommend that properties of a good-quality diet are achieved by depending on various healthy, dietary elements not only one [17].

Many dietary pattern and indexes have been assessed by studies in the literature and their correlation with BC have been studies. Some of these patterns include the Mediterranean diet index, the Healthy Eating Index (HEI), the Dietary Inflammatory Index (DII), the Dietary Approach to Stop Hypertension (DASH) score, and Low-Carbohydrate score indices and others [18]. The dietary components of these indexes are consistent with the recommendations of cancer control and prevention [13,19,20]. To define specific dietary recommendations for BC prevention, the 2015 Dietary Guidelines for the American Scientific report, therefore, called for further research investigations to assess the overall quality of diet and its correlation with the development of BC considering the pre- and post-menopausal status of the included patients to exclude the fact that BC might be hormone-dependent [17,20]. Consequently, many studies have been published assessing many dietary patterns but with various heterogenic results.

Aim of the Study

Therefore, we aim to systematically review the previously published studies that assessed the correlation between the quality of diet and breast cancer in post-menopausal women.

Methods

Search strategy and study selection

The study process was conducted following the accepted methodology recommendations of the PRISMA checklist for systematic review [21]. A systematic electronic database search was conducted for relevant studies published till 21st July 2020 in seven databases including Google Scholar, Scopus, Web of Science (ISI), PubMed, Cochrane Central Register of Controlled Trials (CENTRAL), Embase and CINAHL using keywords, medical subject (MeSH) terms. In databases not supporting MeSH terms, combinations of all possible terms were used. Moreover, We conducted a manual search of references from the included articles by searching the primary studies that had cited our included papers and scanning references of the relevant papers in PubMed and Google Scholar to avoid missing any relevant publications [22].

We included all original relevant studies which are discussing Relationship between diet and breast cancer risk in postmenopausal. Papers were excluded if there was one of the following exclusion criteria: pilot studies, duplicate records, data could not be reliably extracted or incomplete reports, abstract only articles, thesis, books, conference papers. Title and abstract screening were done independently by four reviewers. Then, three independent reviewers performed a full-text screening to ensure the inclusion of relevant papers in our systematic review. Any disagreement was resolved by discussion and referring to the senior author when necessary.

Data extraction

Two authors developed the data extraction sheet using the Microsoft Excel software. Data extraction was performed by three independent reviewers using the excel sheet. The fourth independent reviewer performed data checking to ensure the extracted data accuracy. All the disagreements and discrepancies were resolved by discussion and consultation with the senior author when necessary.

Quality assessment

Three independent reviewers evaluated the risk of bias in the included studies. The ROBINS-I ("Risk of Bias in Non-randomised Studies - of Interventions") was used to determine the quality of the included studies [23]. Any discrepancy between the reviewers was solved through discussion.

Results

Search results

Following the aforementioned search strategy, 4753 records were retrieved with 1365 duplicates. Following the duplicates' removal, 3388 papers were available for the title and abstract screening.; of which, 3186 were excluded. For full-text screening, 202 papers were examined to result in 185 papers exclusion. The manual search of references found an extra two relevant papers to be included. Finally, 19 studies were included in the current systematic review after all of the screening stages (Figure 1).

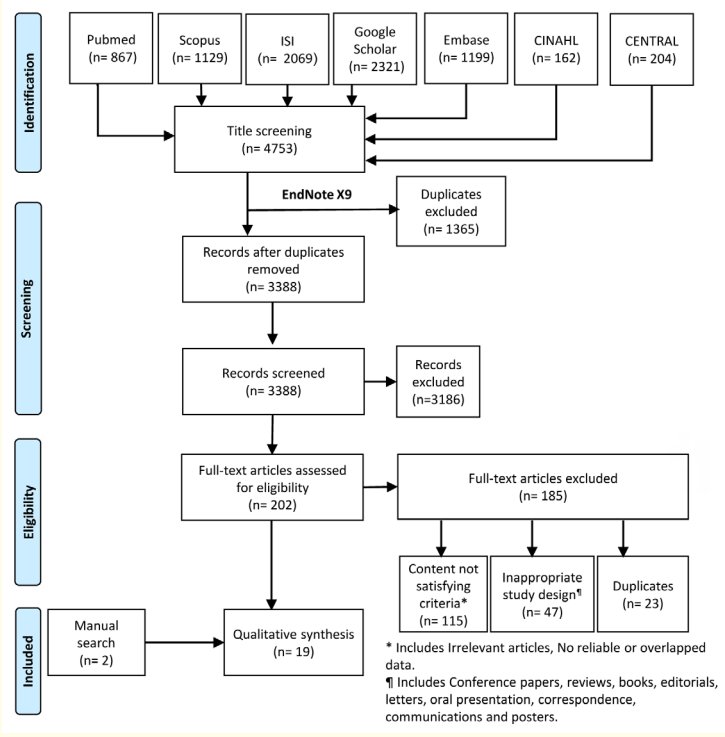

Figure 1: *PRISMA flowchart summarizing the search process in this study.*

Characteristics and bias risk of the included studies

Of the 19 included studies, five studies had a case-control design while the other studies were cohort ones. The sample sizes of the included studies were highly variable ranging from 2034 to 335062 individuals. The same variability was found in patients' ages with wide ranges from only 25 years old and up to 104 years old. Table 1 summarizes different details of the studies included in the current study.

Author, year	Country	Design	sample Size	Age range (years)	Follow-up Duration	Dietary assessment method	Type of diet quality score	Hormone receptor status	Aim	Main conclusion
Castello, 2014 [15]	Spain	Case control	2034	NA	NA	Semi-quantitative FFQ, 117 item	AHEI, aMed	ER+/PR+ and HER2- HER2+ ER-/PR- and HER2-	To evaluate the association between dietary patterns and risk of BC in Spanish women, stratifying by menopausal status and tumor subtype, and to compare the results with those of Alternate Healthy Index (AHEI) and Alternate Mediterranean Diet Score (aMED)	Our results confirm the harmful effect of a Western diet on BC risk, and add new evidence on the benefits of a diet rich in fruits, vegetables, legumes, oily fish and vegetable oils for preventing all BC subtypes, and particularly triple-negative tumors.
Buck, 2011 [46]	Germany	Case control	8393	50–74	NA	FFQ, 176-item	NA	ER+/PR+ ER-/PR- ER+ PR+ ER- PR-	To assess dietary patterns in association with postmenopausal breast cancer risk using an exploratory approach.	We did not find an association of a "healthy" or "unhealthy" dietary pattern with postmenopausal breast cancer risk.

Buckland, 2012 [27]	10 European countries	Cohort	335062	35–70	11 year	Self-administered semi-quantitative FFQ or diet history questionnaire administered through personal interview, and semi-quantitative FFQ combined with a food record	arMED	ER-/PR- ER+/PR+	To assess the association between adherence to an adapted MD, excluding alcohol, and risk of incident BC in both pre and postmenopausal women and in tumors with different hormone receptor status	Findings show that adherence to a MD excluding alcohol was related to a modest reduced risk of BC in postmenopausal women, and this association was stronger in receptor-negative tumors. The results support the potential scope for BC prevention through dietary modification.
Cade, 2011 [28]	UK	Cohort	33731	35–69	9 year	FFQ	MD	NA	To assess the risk of developing breast cancer associated with consumption of two common dietary patterns: a Mediterranean dietary pattern and a dietary pattern, which conforms to the World Health Organization Healthy Diet Index (WHO HDI)	No strong association between the risk of breast cancer and the consumption of either a Mediterranean-type diet or one characterized by adherence to the WHO HDI was observed. In premenopausal, but not postmenopausal women, there was a non-significant inverse association with increasing adherence to the Mediterranean diet pattern.
Cottet, 2009 [29]	France	Cohort	65374	51–55	9.7 year	NA	NA	ER+/PR+ ER-/PR- ER+/PR- ER-/PR+	To investigate the association between dietary pattern and risk of postmenopausal invasive breast cancer, considering potential interactions with known risk factors for breast cancer.	Adherence to a diet comprising mostly fruits, vegetables, fish, and olive/sunflower oil, along with avoidance of Western-type foods, may contribute to a substantial reduction in postmenopausal breast cancer risk.

Couto, 2013 [30]	Sweden	Cohort	44840	30–49	16 year	Self-administered FFQ, 80 items	MD	ER+/PR+ ER-/PR- ER+/PR- ER-/PR+	To investigate whether adherence to a Mediterranean dietary pattern influences breast cancer risk.	Adherence to a Mediterranean dietary pattern did not decrease breast cancer risk in this cohort of relatively young women.
Demetriou, 2012 [31]	Cyprus	Case control	2286	40–70	3 year	FFQ	MD score by pan-agiotakos	NA	To evaluate whether the degree of adherence to a Mediterranean diet pattern modifies breast cancer risk amongst Greek-Cypriot women	results suggest that adherence to some diet pattern rich in vegetables, fish, legumes and olive oil may favorably influence the risk of breast cancer. This study is the first investigation of dietary effects on breast cancer risk in Cyprus, a country whose population has traditionally adhered to the Mediterranean diet.
Fung, 2006 [35]	USA	cohort	71058	30–55	18 year	Self-administered semi-quantitative FFQs, 116 items	HEI, AHEI, DQI-R, RFS, aMed	ER+ ER-	To assess the association between several diet quality scores and the risk of breast cancer in postmenopausal women.	women who scored high in AHEI, RFS, and aMed had a lower risk of ER breast cancer. The HEI and DQI-R appeared to be of limited value in predicting breast cancer risk.

Fung, 2011 [36]	USA	cohort	86621	30–56	26 year	Self-administered semi-quantitative FFQs, 116 items	DASH, Overall LCD, Animal LCD, Vegetable LCD	ER+ ER-	To assess the association between major plant food-group contributors to these diets and their associations with breast cancer	A diet high in fruits and vegetables, such as one represented by the Dietary Approaches to Stop Hypertension diet score, was associated with a lower risk of ER breast cancer. In addition, a diet high in plant protein and fat and moderate in carbohydrate content was associated with a lower risk of ER cancer
Fung, 2012 [47]	USA	cohort	67802	30–55	22 year	Self-administered semi-quantitative FFQs	NA	ER+ ER-	To identify a dietary pattern that is significantly associated with estradiol and estrone sulfate, and applied this pattern to a large cohort of women and assessed its association with postmenopausal breast cancer	these results were null, it should be repeated in other populations as differences in food intake may yield a dietary pattern with stronger association with estrogens
Ge, 2015 [40]	Germany	Case control	8399	50–74	NA	FFQ, 176 food items	E-DII	ER−/PR−	To investigate whether individual diets based on their inflammatory potential are associated with postmenopausal breast cancer risk by employing an energy-adjusted dietary inflammation index	The findings may reflect a real absence of association between dietary inflammatory potential and postmenopausal cancer risk or an underestimation of association due to recall bias.

Haridass, 2018 [26]	USA	Cohort	96959	22–104	NA	Semi-quantitative FFQ	aMED, DASH, AHEI-2010, PALEO	NA	To examine the association between diet quality indexes and pre- and postmenopausal breast cancer risk in a large prospective cohort	Diet quality indexes that emphasize intake of whole grains, vegetables, fruits, legumes, and nuts and seeds and deemphasize red and processed meats and sugar-sweetened beverages were modestly associated with a lower risk of incident postmenopausal breast cancer risk. However, they were not associated with premenopausal breast cancer, and the PALEO score was not associated with cancer risk regardless of menopausal status.
Murtaugh, 2008 [32]	USA	Case control	4119	25–79	5 year	interviewer-administered dietary history questionnaire	Western, Prudent, Native Mexican, Mediterranean, and Dieter diet patterns	NA	To examine the associations of dietary patterns (Western, Prudent, Native Mexican, Mediterranean, and Dieter) with risk for breast cancer in Hispanic women and non-Hispanic white women from the Four-Corners Breast Cancer Study.	Associations of dietary patterns with breast cancer risk varied by menopausal and body mass index status, but there was little difference in associations between non-Hispanic white and Hispanic women.

Pan, 2019 [45]	USA	Cohort	61335	50–79	11.4 years	NA	NA	NA	To examine relationships among weight loss, diet composition and breast cancer incidence and outcome in postmenopausal women.	moderation regarding dietary composition and body weight maintenance can reduce a postmenopausal woman's risk of being diagnosed with breast cancer and of dying after breast cancer.
Peterson, 2020 [44]	USA	Cohort	183548	50-71	12.8 years	self-administered FFQ, 124-item	AGE intake	ER+/PR+, ER-/PR-, ER+/PR-	To evaluate the association of dietary AGE intake and the risk of postmenopausal invasive breast cancer	Dietary AGEs may play a role in the development of postmenopausal breast cancer.
Sun, 2018 [39]	USA	Cohort	2295	50–79	12 years	self-administered FFQ, 122 items	HEI-2010	ER+, ER-, PR+, PR-, Unknown	To examine the associations of changes in overall diet quality, indicated by the Healthy Eating Index (HEI)-2010 score, with mortality in breast cancer survivors	Among women with breast cancer, decreased diet quality after breast cancer diagnosis was associated with higher risk of death from breast cancer.
Tabung, 2016 [41]	USA	Cohort	70998	50–79	16–21 y	Self-administered FFQ, 122 food items	DII	ER−/PR−/HER2− and ER−/PR−/HER+	To investigate associations between a dietary inflammatory index (DII) and invasive breast cancer incidence and death	Future studies are needed to examine the inflammatory potential of post-diagnosis diet given the suggestion from the current study that dietary inflammatory potential before diagnosis is related to breast cancer death

Trichopoulou, 2010 [33]	Greece	Cohort	14807	20–86	9.8 y	FFQ, 150 items	MD	NA	To study the relation of conformity to the Mediterranean diet with breast cancer risk in the context of the European Prospective Investigation into Cancer and Nutrition cohort in Greece	Conformity to the traditional Mediterranean diet may be associated with lower breast cancer risk among postmenopausal women and could explain, in part, the lower incidence of this disease in Mediterranean countries
van den Brandt, 2017 [34]	Netherlands	Cohort	62573	55–69	20.3 y	Self-administered semi-quantitative FFQ, 150 items	aMedr and mMEDr	ER+, ER-, PR+, PR-, ER+PR+, ER-PR-	To investigate the relationship between adherence to MD and risk of postmenopausal breast cancer (and estrogen/progesterone receptor subtypes, ER/PR)	Our findings support an inverse association between MD adherence and, particularly, receptor negative breast cancer. This may have important implications for prevention because of the poorer prognosis of these breast cancer subtypes
NA: Not Available; HEI: Healthy Eating Index; AHEI: Alternate Healthy Eating Index; DQI-R: Diet Quality Index- Revised; RFS: Recommended Food Score; aMed: Alternate Mediterranean Diet Score; MD: Mediterranean diet; arMED: alternative relative Mediterranean diet; AGEs: Advanced glycation end products; mMEDr: modified Mediterranean Diet Score excluding alcohol; DASH: Dietary Approaches to Stop Hypertension diet; LCD: Low-Carbohydrate Diet; ER: Estrogen receptor; PR: Progesterone receptor; FFQ: Food Frequency Questionnaire, and BC: Brest Cancer.										

The overall risk of bias of the included studies was acceptable with less than 25% of the studies showing serious/critical risks. The domains with the biggest problems are a deviation from the intended intervention, selective reporting of the results, and missing data, respectively (Figure 2A). On the level of the individual studies, four studies showed a serious/critical risk of bias, eight showed a moderate risk of bias, and seven had a low risk of bias (Figure 2B).

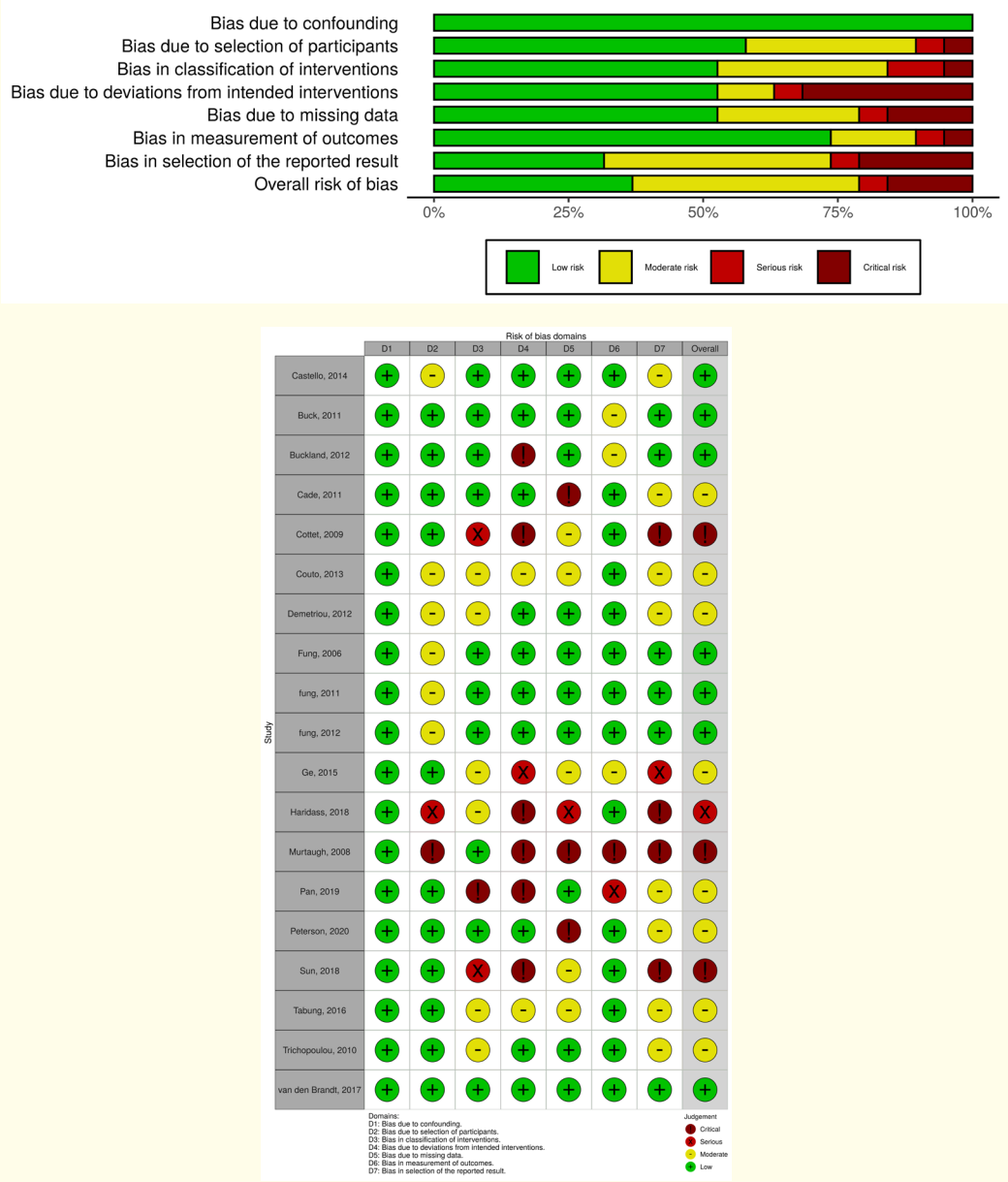

Figure 2: *Quality of the included studies. A: Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies; B: Risk of bias summary: review authors' judgements about each risk of bias item for each included study.*

Outcomes and Discussion

In this study, our systematic search and screening in including 19 relevant studies, of whom 14 were cohort studies while only five were case-control studies that studied the relationship between diet and breast cancer development. The variations of the study designs between cohort and case-control studies with large populations made the magnitudes of association were large and moderate between the bottom and top scores. Moreover, plenty of diets have reported and their association with breast cancer in different populations has been studied as discussed as follows.

Mediterranean diet

This type of diet contains the following eight elements: alcohol, vegetables, monounsaturated-to-saturated fat ratio, fruits, cereals, legumes, dairy, and meat products, and therefore, it is considered as a healthy diet pattern. It was originally developed for the Greek population. Many approaches have been made to develop similar indexes that resemble the Mediterranean Diet index for different populations and were all noticed to be similar to the components of the Mediterranean pattern. The higher the scores, the closer it resembles the Mediterranean diet index [24]. Moreover, a study proposed the Alternate Mediterranean Diet as an update of the Mediterranean diet score [24,25]. Of the included studies, eleven of them [15,26-35] including eight cohorts [26-30,33-35] and three case-control [15,31,32] studies reported the Mediterranean Diet and the Alternate Mediterranean Diet (AMED) association with breast cancer.

Amongthe cohort studies, Couto., *et al*. [30], Cade., *et al.* [28], Haridass., *et al.* [26] and Trichopoulou., *et al.* [33] found no significant association between the decreased incidence of breast cancer in postmenopausal women that stuck to a Mediterranean Diet pattern. On the other hand, Cottet., *et al*. [29], van den Brandt., *et al.* [34], Buckland., *et al.* [27] and Fung., *et al*. [35] found a statistically significant association between adherence to a Mediterranean Diet pattern and the reduced risk of breast cancer with the latter three studies that reported significance only with estrogen negative (ER-) breast cancers which is consistent with the results of previously published meta-analysis studies [25,34]. Furthermore, Fung., *et al*. [35] found no statistically significant association between women with aMED patterns and the incidence of estrogen-positive (ER+) breast cancers. Among the case-control studies, only two of them [32,36] showed a negative correlation between the adherence to a Mediterranean Diet pattern and the occurrence of breast cancer. Castello., *et al*. [15] reported an odds ratio (OR) for the Mediterranean pattern of 0.56 (95% CI, 0.40 - 0.79) while the western pattern in the other group was associated with increased risks of developing breast cancer (OR = 1.46; 95% CI, 1.06 - 2.01). Similarly, Murtaugh., *et al*. [32] in their large study that included women from four different states, found that the Mediterranean and the Mexican native pattern groups significantly decreased breast cancer risk incidence (P for trend < 0.01). On the other hand, Demetriou., *et al*. [31] results showed no significance in the association between this pattern and breast cancer incidence reduction. However, the same study reported that, according to a Principal Component Analysis (PCA), high consumption of vegetables, fruit, fish and legumes were significantly associated with reduced breast cancer risks (P < 0.0001). Besides, a previously published trial showed that adding extra virgin olive oil to the Mediterranean pattern was significantly associated (P = 0.02) with a lower incidence of breast cancer while adding mixed nuts to the same diet showed to have a negative correlation but with no significance (P = 0.24) [37].

Healthy eating index (HEI)

Unlike the Mediterranean pattern, this index was to assess the overall healthy diet and not the adherence to it. It was originally developed according to the USDA Food Guide Pyramid which is mainly based on the 1995 American Dietary Guidelines [38]. It consists of the following ten food ingredients: fruits, vegetables, grains, milk, meat, total fat, saturated fat, cholesterol, sodium, and diet variations. According to this index, a potential 0-10 score was given for each food component with a total of 0-100 HEI score based on the frequency of consumption of these elements. A side score from the HEI which was adapted to assess the quality of food subgroups is the Alternate Healthy Eating Index (AHEI). Modifications were made to the food ingredients to include fruits, vegetables without potatoes, nuts and soy, white-to-red meat ratio, trans fat, and polyunsaturated fat and saturated fat ratio, cereal fiber, longterm multivitamin use, and alcohol

intake and the overall score ranged between 0 - 87.5 [35]. A healthier diet was generally associated with higher scores. Among all of our included studies, only four [15,26,35,39] reported using this index.

Fung., *et al*. [35] reported a statistically significant association between high HEI scores and reduced incidence of ER- breast cancer although it was not associated with other ER- tumors. Even though high AHEI scores were inversely associated with lower estrogen levels, it is believed that AHEI likely affected breast cancer risk through other mechanisms than lowering estrogen levels as it is unlikely that ER- breast cancer subtype is heavily influenced by estrogen levels. Similar to their results with the Mediterranean pattern, Castello., *et al*. [15] reported an inverse association between AHEI high scores and breast cancer incidence although smaller effect sizes were associated with the AHEI group. Sun., *et al*. [39] reported that decreased diet quality increases the mortality risk from breast cancer, however, no association was found with increased diet quality and patients' mortalities from breast cancer and other cancers. Moreover, in their large cohort study with a sample size of 96,959 women, aged 22 - 104y, Haridass., *et al*. [26] stated that high scores of AHEI were inversely proportional to high risks of developing breast cancer.

Dietary inflammatory index (DII)

This was used by two studies only [40,41] including one cohort [41] and one case-control [40] studies to assess the inflammatory potentials of 32 and 26 types of food, respectively. According to this index, higher scores were associated with high incidences of systemic inflammation and elevated levels of high-sensitivity C-reactive protein and plasma IL-6 [40]. Both of the included studies showed contra-indicated results as Tabung., *et al*. [41] results showed that high DII levels were associated with ER−/PR− breast cancer (HR = 2.37; 95% CI, 1.08 - 5.20) when Ge., *et al*. [40] showed no association for the same subtypes.

DASH and low-carbohydrate diet (LCD) scores

The Dietary Approaches to Stop Hypertension (DASH) [42] which include eight food components including fruits, vegetables, nuts and legumes, low-fat dairy products, whole grains, sodium, sweetened beverages, and red and processed meats has been adjusted to assess its relation to developing breast cancer [36]. Patients were assessed on an 8 - 40 score with a range of 1 - 5 points for each score component. It was used by two studies only [26,36] among all of our studies. Fung., *et al*. [36] reported statistical significance in the relationship between the DASH diet scores and decreased ER-breast cancer (RR = 0.80; 95% CI, 0.64 - 1.01; P = 0.02). On the other hand, Haridass., *et al*. [26] showed a modest inverse association between breast cancer incidence and high DASH score levels (HR = 0.89; 95% CI, 0.80 - 1.00; P = 0.03).

As for the LCD score, it was developed to assess the variations in the different food components that include animal and plant proteins [43]. Fung., *et al*. [36] used three versions of LCD index including an animal, vegetable and total LCD indexes. The study reported no association between the overall and animal scores with breast cancer incidence, but a significant one with the elevated LCD vegetable scores and reduced breast cancer incidence (RR = 0.81; 95% CI, 0.65 - 1.01; P = 0.03). Besides, Peterson., *et al*. [44] conducted a food-frequency questionnaire to estimate Advanced glycation end products (AGEs) and their correlation with the incidence of breast cancer. Increased risk of having breast cancer was associated with high AGEs intake (HR = 1.09; 95% CI, 1.02 - 1.16; P = 0.03). Pan., *et al*. [45] and Buck., *et al*. [46] were the only two studies that did not report the use of any specific indices. Pan., *et al*. [45], however, assessed the association of waist circumference and breast cancer in the Women's Health Initiative (WHI). The authors reported that reduced breast cancer incidence was significantly associated with women with weight loss (≥ 5%) than those who did not witness any weight loss. Buck., *et al.* [46] found no significance between healthy (high vegetable and vegetable oil intake) or unhealthy (high meat and deep-frying fat intake) diets with breast cancer incidence.

Limitation of the Study

Limitations to our study include the various diet quality indices that were used by all of the included studies with a small number of them comparing the different indices. Also, the designs of the included studies include observational studies only, and some case-control studies that may be associated with a recall-bias, which indicates the need to develop randomized trials for better assessment of the various tools.

Conclusion

In this systematic review, we summarized the studies that reported the correlation between breast cancer and the different diet quality indices. Among all of the reported diet quality indexes, the Mediterranean diet index was the most frequently reported and the results showed that the high Mediterranean diet is inversely associated with developing breast cancer in postmenopausal women. The results are contradicting with no conclusive evidence of the association which requires more studies for the synthesis of high-quality evidence.

Bibliography

1. DeSantis C., *et al*. "Breast Cancer Statistics, 2013". *CA: A Cancer Journal for Clinicians* 64.1 (2014): 52-62.

2. Kushi LH., *et al*. "American Cancer Society Guidelines on Nutrition and Physical Activity for Cancer Prevention: Reducing the Risk of Cancer with Healthy Food Choices and Physical Activity". *CA: A Cancer Journal for Clinicians* 62.1 (2012): 30-67.

3. Neuhouser ML., *et al*. "Overweight, Obesity, and Postmenopausal Invasive Breast Cancer Risk: A Secondary Analysis of the Women's Health Initiative Randomized Clinical Trials". *JAMA Oncology* 1.5 (2015): 611-621.

4. Lauby-Secretan B., *et al*. "Body Fatness and Cancer--Viewpoint of the Iarc Working Group". *The New England Journal of Medicine* 375.8 (2016): 794-798.

5. Picon-Ruiz Manuel, *et al*. "Obesity and Adverse Breast Cancer Risk and Outcome: Mechanistic Insights and Strategies for Intervention". *CA: A Cancer Journal for Clinicians* 67.5 (2017): 378-397.

6. Nomura SJ., *et al*. "Wcrf/Aicr Recommendation Adherence and Breast Cancer Incidence among Postmenopausal Women with and without Non-Modifiable Risk Factors". *International Journal of Cancer* 138.11 (2016): 2602-2615.

7. Moore SC., *et al*. "Association of Leisure-Time Physical Activity with Risk of 26 Types of Cancer in 1.44 Million Adults". *JAMA Internal Medicine* 176.6 (2016): 816-825.

8. Link LB., *et al*. "Dietary Patterns and Breast Cancer Risk in the California Teachers Study Cohort". *The American Journal of Clinical Nutrition* 98.6 (2013): 1524-1532.

9. Hirko KA., *et al*. "Healthy Dietary Patterns and Risk of Breast Cancer by Molecular Subtype". *Breast Cancer Research and Treatment* 155.3 (2016): 579-588.

10. Jordan I., *et al*. "Dietary Patterns and Breast Cancer Risk among Women in Northern Tanzania: A Case-Control Study". *European Journal of Nutrition* 52.3 (2013): 905-915.

11. Tabung FK., *et al*. "Patterns of Change over Time and History of the Inflammatory Potential of Diet and Risk of Breast Cancer among Postmenopausal Women". *Breast Cancer Research and Treatment* 159.1 (2016): 139-149.

12. Albuquerque RC., *et al.* "Breast Cancer and Dietary Patterns: A Systematic Review". *Nutrition Reviews* 72.1 (2014): 1-17.

13. Brennan SF., *et al*. "Dietary Patterns and Breast Cancer Risk: A Systematic Review and Meta-Analysis". *The American Journal of Clinical Nutrition* 91.5 (2010): 1294-1302.

14. Baglietto L., *et al*. "Dietary Patterns and Risk of Breast Cancer". *British Journal of Cancer* 104.3 (2011): 524-531.

15. Castelló A., *et al*. "Spanish Mediterranean Diet and Other Dietary Patterns and Breast Cancer Risk: Case-Control Epigeicam Study". *British Journal of Cancer* 111.7 (2014): 1454-1462.

16. Baglietto L., *et al*. "Dietary Patterns and Risk of Breast Cancer". *British Journal of Cancer* 104.3 (2011): 524-531.

17. McGuire Shelley. "Scientific Report of the 2015 Dietary Guidelines Advisory Committee. Washington, Dc: Us Departments of Agriculture and Health and Human Services, 2015". *Advances in Nutrition* 7.1 (2016): 202-204.

18. Harmon BE., *et al*. "Associations of Key Diet-Quality Indexes with Mortality in the Multiethnic Cohort: The Dietary Patterns Methods Project". *The American Journal of Clinical Nutrition (AJCN)* 101.3 (2015): 587-597.

19. Thomson CA. "Diet and Breast Cancer: Understanding Risks and Benefits". *Nutrition in Clinical Practice* 27.5 (2012): 636-650.

20. Patterson RE., *et al*. "Physical Activity, Diet, Adiposity and Female Breast Cancer Prognosis: A Review of the Epidemiologic Literature". *Maturitas* 66.1 (2010): 5-15.

21. Liberati Alessandro., *et al*. "The Prisma Statement for Reporting Systematic Reviews and Meta-Analyses of Studies That Evaluate Health Care Interventions: Explanation and Elaboration". *PLoS Medicine* 6.7 (2009): e1000100.

22. Vassar Matt., *et al.* "Manual Search Approaches Used by Systematic Reviewers in Dermatology". *Journal of the Medical Library Association: JMLA 104*.4 (2016): 302.

23. Sterne Jonathan AC., *et al*. "Robins-I: A Tool for Assessing Risk of Bias in Non-Randomised Studies of Interventions". 355 (2016): i4919.

24. Trichopoulou A and P Lagiou. "Healthy Traditional Mediterranean Diet: An Expression of Culture, History, and Lifestyle". *Nutrition Reviews* 55.11 Pt 1 (1997): 383-389.

25. Fung TT., *et al*. "Diet-Quality Scores and Plasma Concentrations of Markers of Inflammation and Endothelial Dysfunction". *The American Journal of Clinical Nutrition 82*.1 (2005): 163-173.

26. Haridass V., *et al*. "Diet Quality Scores Inversely Associated with Postmenopausal Breast Cancer Risk Are Not Associated with Premenopausal Breast Cancer Risk in the California Teachers Study". *Journal of Nutrition* 148.11 (2018): 1830-1837.

27. Buckland G., *et al*. "Adherence to the Mediterranean Diet and Risk of Breast Cancer in the European Prospective Investigation into Cancer and Nutrition Cohort Study". *International Journal of Cancer* 132.12 (2013): 2918-2927.

28. Cade JE., *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?" *European Journal of Clinical Nutrition* 65.8 (2011): 920-928.

29. Cottet V., *et al*. "Postmenopausal Breast Cancer Risk and Dietary Patterns in the E3n-Epic Prospective Cohort Study". *American Journal of Epidemiology* 170.10 (2009): 1257-1267.

30. Couto E., *et al*. "Mediterranean Dietary Pattern and Risk of Breast Cancer". *PLoS One* 8.2 (2013): e55374.

31. Demetriou CA., *et al*. "The Mediterranean Dietary Pattern and Breast Cancer Risk in Greek-Cypriot Women: A Case-Control Study". *BMC Cancer* 12 (2012): 113.

32. Murtaugh MA., *et al*. "Diet Patterns and Breast Cancer Risk in Hispanic and Non-Hispanic White Women: The Four-Corners Breast Cancer Study". *The American Journal of Clinical Nutrition* 87.4 (2008): 978-984.

33. Trichopoulou A., *et al*. "Conformity to Traditional Mediterranean Diet and Breast Cancer Risk in the Greek Epic (European Prospective Investigation into Cancer and Nutrition) Cohort". *The American Journal of Clinical Nutrition* 92.3 (2010): 620-625.

34. Van den Brandt PA and M Schulpen. "Mediterranean Diet Adherence and Risk of Postmenopausal Breast Cancer: Results of a Cohort Study and Meta-Analysis". *International Journal of Cancer* 140.10 (2017): 2220-2231.

35. Fung TT., *et al*. "Diet Quality Is Associated with the Risk of Estrogen Receptor-Negative Breast Cancer in Postmenopausal Women". *Journal of Nutrition* 136.2 (2006): 466-472.

36. Fung TT., *et al*. "Low-Carbohydrate Diets, Dietary Approaches to Stop Hypertension-Style Diets, and the Risk of Postmenopausal Breast Cancer". *American Journal of Epidemiology* 174.6 (2011): 652-660.

37. Toledo E., *et al*. "Mediterranean Diet and Invasive Breast Cancer Risk among Women at High Cardiovascular Risk in the Predimed Trial: A Randomized Clinical Trial". *JAMA Internal Medicine* 175.11 (2015): 1752-1760.

38. McGuire Shelley. "U.S. Department of Agriculture and U.S. Department of Health and Human Services, Dietary Guidelines for Americans, 2010. 7th Edition, Washington, Dc: U.S. Government Printing Office, January 2011". *Advances in Nutrition* 2.3 (2011): 293-294.

39. Sun Y., *et al*. "Changes in Overall Diet Quality in Relation To survival in Postmenopausal Women with Breast cancer: Results from the Women's Health initiative". *Journal of the Academy of Nutrition and Dietetics* 118.10 (2018): 1855-1863.

40. Ge I., *et al*. "Dietary Inflammation Potential and Postmenopausal Breast Cancer Risk in a German Case-Control Study". *Breast* 24.4 (2015): 491-496.

41. Tabung FK., *et al*. "Association between Dietary Inflammatory Potential and Breast Cancer Incidence and Death: Results from the Women's Health Initiative". *British Journal of Cancer* 114.11 (2016): 1277-1285.

42. Sacks Frank M and Hannia Campos. "Dietary Therapy in Hypertension". *New England Journal of Medicine* 362.22 (2010): 2102-2112.

43. Halton TL., *et al*. "Low-Carbohydrate-Diet Score and the Risk of Coronary Heart Disease in Women". *New England Journal of Medicine 355*.19 (2006): 1991-2002.

44. Peterson LL., *et al*. "Dietary Advanced Glycation End Products and the Risk of Postmenopausal Breast Cancer in the National Institutes of Health-Aarp Diet and Health Study". *Cancer* 126.11 (2020): 2648-2657.

45. Pan K., *et al*. "Weight Loss, Diet Composition and Breast Cancer Incidence and Outcome in Postmenopausal Women". *Oncotarget* 10.33 (2019): 3088-3092.

46. Buck K., *et al*. "Dietary Patterns and the Risk of Postmenopausal Breast Cancer in a German Case-Control Study". *Cancer Causes Control* 22.2 (2011): 273-282.

47. Fung TT., *et al*. "A Dietary Pattern Derived to Correlate with Estrogens and Risk of Postmenopausal Breast Cancer". *Breast Cancer Research and Treatment* 132.3 (2012): 1157-1162.

Volume 16 Issue 10 October 2020