Review

Nutritional management for breast cancer patients

Running title: Nutritional management for breast cancer patients

Minjeong Kim[1], Minkyoung Lee[2], Jisun Sa[2]

[1]Ewha Womans University College of Medicine, Seoul, Korea

[2]Nutrition Team, Ewha Womans University Mokdong Hospital, Seoul, Korea

Corresponding author: Jisun Sa

Nutrition Team, Ewha Womans University Mokdong Hospital, Seoul, Korea

Address: 1071 Anyangcheon-ro, Yangcheon-gu, Seoul, Korea, 07985

Tel: 02-2650-5261, Fax: 02-2655-0984

e-mail: 70458@eumc.ac.kr

ORCID

Minjeong Kim, https://orcid.org/0009-0002-5182-5320

Jisun Sa, https://orcid.org/0009-0009-1452-0107

Minkyoung Lee, https://orcid.org/0009-0006-0767-0375

Abstract

Breast cancer is a complex disease influenced by environmental, genetic, dietary, and hormonal factors. This underscores the importance of postoperative nutritional management in supporting recovery, minimizing complications, and enhancing long-term outcomes. This review synthesizes clinical guidelines, expert recommendations, and observational studies to provide a comprehensive overview of dietary interventions for breast cancer patients following surgery. Post-surgical nutritional care is centered around three primary objectives: supporting wound healing through high-quality protein intake, maintaining optimal nutritional status to prevent malnutrition, and promoting healthy lifestyle habits to reduce the risk of recurrence. To achieve these objectives, postoperative dietary strategies focus on several key components: ensuring adequate hydration for metabolic processes and tissue repair, consuming a balanced diet rich in fresh vegetables and fruits to mitigate oxidative stress, incorporating whole grains to support overall healing, and maintaining sufficient intake of high-quality protein from sources such as fish, meat, and dairy products to aid tissue repair and immune system recovery. Patients are also advised to avoid alcohol, limit saturated fats, and reduce intake of salty, sugary, and smoked foods to minimize inflammation. As research progresses, the implementation of personalized dietary plans remains essential for optimizing recovery outcomes in breast cancer patients.

Keywords: Breast Cancer; Diet; Food; Life Style; Nutrition

Introduction

Breast cancer represents a significant health burden, with its incidence consistently rising over the past several decades. In 2021, South Korea reported 28,861 new cases of breast cancer, which represented 10.4% of all cancer diagnoses and 21.5% of cancers in women, making it the second most prevalent cancer among women. Although the rate of increase has slightly declined since 2007, the incidence of breast cancer continues to rise. This trend is influenced by improvements in diagnostic techniques and changes in risk factors, including lifestyle alterations and an aging population. Breast cancer also exhibits a high survival rate, with a 5-year relative survival rate of 93.8%, due to advances in early detection and treatment methods. Nonetheless, breast cancer remains a significant cause of cancer-related mortality among women, accounting for 8.6% of female cancer deaths in 2023 [1].

Breast cancer represents a significant global health challenge, not only in South Korea but worldwide. According to the World Health Organization, approximately 2.3 million women were diagnosed with breast cancer globally in 2022, resulting in 670,000 deaths. In the same year, breast cancer was the most common cancer among women in 157 out of 185 countries, underscoring its widespread impact on women's health [2]. Furthermore, from 1990 to 2019, the number of global breast cancer cases more than doubled, increasing from 876,990 to 2,002,350, with an average annual percentage increase of 0.33%. Although the number of deaths has also risen during this period, advancements in medical care have led to a 0.56% annual decrease in mortality rates worldwide [3]. The high prevalence of breast cancer and its significant impact on public health underscore the urgent need for comprehensive management strategies that include prevention, treatment, and recovery support.

Surgery is the cornerstone of breast cancer treatment and serves as the primary curative intervention. It provides essential local disease control and critical pathological staging information necessary for treatment planning [4]. Although advancements in surgical techniques and therapeutic options have significantly improved outcomes over the years, major surgical complications can still occur. These

complications, which include surgical issues such as bleeding, wound disruption, infection, or foreign body retention, as well as medical complications like myocardial infarction, pulmonary embolism, pneumonia, or acute respiratory distress syndrome, have been linked to worse cancer-specific and overall survival [5]. Additionally, cancer survivors face the risk of accelerated functional decline, which adversely affects physical functioning, recovery, and overall quality of life [6]. Therefore, truly successful treatment must extend beyond the operating room to include a comprehensive recovery process and long-term survivorship support. Within this framework, perioperative strategies, including proper nutritional management, are crucial for supporting immediate recovery. To achieve optimal long-term outcomes, a coordinated multidisciplinary approach is essential. This approach promotes healthy practices, reduces the risks of recurrence and secondary malignancies, and minimizes complications from comorbidities [7]. Nutritional support is a key component of this multidisciplinary approach.

Preoperative nutritional support has been demonstrated to reduce hospital stays, complication rates, and cancer recurrence [8]. Protective factors consist of regular consumption of vegetables, fruits, fiber, and carotenoids, as well as consistent physical activity. Conversely, factors that increase risk include obesity, alcohol consumption, high meat intake, and diets high in saturated fats [9]. Addressing these dietary habits is crucial for prevention.

During the postoperative period, proper nutrition plays a crucial role in healing, enhances treatment tolerance, and improves rehabilitation outcomes, establishing it as a fundamental aspect of comprehensive breast cancer management [10]. Given the significant implications, this review concentrates on evidence-based nutritional management strategies for patients who have undergone breast cancer surgery.

Ethics statement

As this study is a literature review, it did not require institutional review board approval or individual consent.

Breast Cancer and Nutritional Factors

Recovery Management

Surgical stress induces the upregulation of glucagon, cortisol, and proinflammatory cytokines, which extensively catabolize hepatic and muscle glycogen to meet the energy requirements of wound healing. This process also involves increased gluconeogenesis in the liver, using lactate, amino acids, and glycerol as the primary substrates. The elevated levels of catabolic hormones hinder insulin secretion and the clearance of blood glucose, leading to insulin resistance and hyperglycemia. If not properly managed, these conditions can impair immune function and heighten the risk of infection. These complex metabolic alterations, which include changes in protein synthesis, energy utilization, and nutrient processing, culminate in a hypermetabolic-catabolic state. To address these challenges, patients need specialized nutritional interventions during recovery that focus on a balanced diet and lifestyle modifications [11].

Post-surgical nutritional care is centered around three main objectives. First, ensuring balanced meals with high-quality protein intake is essential for supporting surgical wound healing and physical recovery [12,13]. Second, maintaining optimal nutritional status and preventing malnutrition are key to facilitating a faster and smoother return to daily activities, as well as enhancing health-related quality of life [14]. Third, adopting proper lifestyle habits is crucial in preventing cancer recurrence [7].

To facilitate rapid recovery following breast cancer surgery, a comprehensive nutritional strategy has been developed (Fig. 1). This strategy aligns with the Korean Dietary Guidelines [15] and underscores the significance of balanced meals. It advocates for the daily intake of fresh vegetables and fruits,

alongside suitable amounts of grains, fish, meat, and dairy products. Adequate hydration, achieved through sufficient water consumption, is also emphasized. Additionally, regular physical activity is crucial for maintaining a healthy body weight and promoting overall recovery.

In the following sections, we will discuss each component of this nutritional strategy in detail. This includes the rationale behind the recommended food groups, hydration guidelines, and the role of physical activity in postoperative recovery.

Nutritional Factors

Water and Hydration

Water is fundamental to human physiology and plays a crucial role in maintaining health. It is the primary component of blood and body tissues, acting as an important carrier for nutrients and waste products. Additionally, water regulates body temperature and supports various metabolic processes [16].

For breast cancer patients, maintaining adequate hydration is crucial during both treatment and recovery phases. Treatments such as chemotherapy, radiation, and surgery can significantly increase the body's water requirements and the risk of fluid loss. Dehydration, a frequent side effect of cancer therapies, can occur due to persistent vomiting, diarrhea, bleeding, prolonged fever, or excessive sweating. These conditions can severely impair the body's ability to heal [17].

Proper hydration is essential for these patients, as it promotes wound healing, alleviates treatment-related side effects, maintains electrolyte balance, and increases overall physiological resilience during recovery [1]. Medical guidelines typically advise adults to drink at least 7 to 8 cups of water per day, although specific needs may vary based on treatment intensity, physical activity, and general health [15]. Besides water, other beneficial beverages include herbal teas, nonfat soymilk, and diluted fruit juice, which not only aid in hydration but also provide additional nutrients. Conversely, the

consumption of alcohol, coffee, decaffeinated coffee, black tea, decaffeinated tea, and caffeinated sodas is discouraged. These beverages may lead to fluid loss, hinder nutrient absorption, or worsen treatment-related side effects [18].

Protein Intake

Protein plays a crucial role in the post-surgical recovery of breast cancer patients. It aids in various processes including wound healing, muscle preservation, blood cell production, immune system strengthening, and overall recuperation [12]. However, surgical stress significantly increases protein catabolism. The hypercortisolemia associated with surgery inhibits protein synthesis and accelerates protein breakdown, leading to a net loss of amino acids from skeletal muscle [13]. This shift results in the loss of skeletal muscle, which directly diminishes strength and functionality, thereby impeding the recovery process. To mitigate these catabolic effects and enhance recovery, it is essential to maintain adequate protein intake.

Lean meats are an excellent source of high-quality protein, providing a balanced profile of amino acids that fulfill human physiological needs. To minimize health risks, it is recommended that meat consumption be limited to 500 grams per week [19], which amounts to small portions roughly the size of a ping-pong ball [20]. Patients should opt for lean cuts such as skinless poultry or those with minimal fat, rather than fattier options like ribs, pork belly, or chicken skin. Conversely, the consumption of red meats such as beef, lamb, and pork, along with processed meats like ham and sausages, has been associated with an increased risk or exacerbation of cancer outcomes. These meats may contain carcinogenic compounds such as heterocyclic amines and polycyclic aromatic hydrocarbons, which form during cooking at high temperatures. Red meat also includes hormone residues and pro-inflammatory molecules such as N-glycolylneuraminic acid, which may contribute to chronic inflammation and tumor growth. Additionally, processed meats often contain nitrites and nitrates that can transform into carcinogenic nitrosamines [21]. Therefore, red meat consumption

should be restricted to one serving per meal and no more than two servings per week, and processed meats should be avoided due to their potential health risks [22].

Cooking techniques significantly influence the nutritional value and potential carcinogenic properties of protein sources. It is advisable to use indirect cooking methods such as grilling, steaming, baking, or preparing light stir-fries. These methods help preserve the nutritional integrity of foods while minimizing health risks by reducing the formation of harmful compounds like heterocyclic amines and benzopyrene, which are produced when protein is subjected to high direct heat or charring [23]. To limit the intake of excessive saturated fats, patients should avoid deep-frying or pan-frying with excessive oil. Healthier cooking options, such as steaming or braising, are preferable [24]. It is also beneficial to incorporate unsaturated fats from sources like blue-backed fish, sesame oil, perilla oil, and olive oil, which offer nutritional advantages [25]. Furthermore, patients should avoid reusing cooking oils [26] and consuming smoked foods [27], as these practices can lead to the formation of carcinogenic compounds.

Instead of high-fat meats, patients are encouraged to opt for healthier protein options such as a single fish fillet or dishes made with soy-based ingredients [20]. Soy products, rich in isoflavones, function as phytoestrogens and offer hormonal balance as well as antioxidant and anticancer properties. It is advisable to consume these in whole food forms, including tofu, edamame, and traditional soy products, while avoiding concentrated soy supplements that may contain harmful compounds [28]. For portion control, about two tablespoons of black beans or one-fifth of a tofu block per serving is recommended to achieve health benefits [20].

Vegetable and Fruit Consumption

Consuming a wide variety of colorful fruits and vegetables is crucial for breast cancer patients because each color represents different phytochemicals, each with unique health-protective properties.

These phytochemicals are bioactive compounds that plants naturally produce as a defense mechanism. Beyond their protective role in plants, these compounds provide numerous health benefits for humans, including anti-inflammatory, antioxidant, and anticancer effects, and they help prevent chronic conditions such as heart disease and metabolic disorders [29].

Table 1 highlights key anti-breast cancer phytochemicals, their dietary sources, and their health benefits. Flavones, present in red and yellow fruits and vegetables, are linked to lower risks of coronary heart disease, various cancers, and chronic inflammation. They also help reduce estrogen levels, potentially inhibiting the growth of breast tumors. Isoflavones, found in foods such as sour cherry, tomato, broccoli, and carrot, play a role in cancer prevention by suppressing metastasis and inducing apoptosis in breast cancer cells. Prenylated flavonoids, found in *Morus alba*, *Artocarpus heterophyllus*, *Glycine max*, and *Ficus carica*, have been shown to induce apoptosis and reduce cytotoxicity in breast cancer cells. Lignans, present in potatoes, broccoli, and berries, are associated with a reduced risk of postmenopausal breast cancer and other chronic conditions. Lastly, sitosterol, commonly found in fat-rich vegetables like avocado, has demonstrated significant anticancer and anti-inflammatory effects by inhibiting the growth of breast cancer cells and inducing apoptosis.

The Mediterranean Diet (MeDi), which emphasizes the daily consumption of fruits and vegetables, has been shown to provide an optimal intake of polyphenols (phenolic acids, flavonoids, stilbenes, lignans) and fiber. These components, abundantly found in these foods, are linked to improved outcomes in breast cancer survivors [30].

To achieve these benefits, patients should be encouraged to consume 5–9 servings of fruits (approximately 150 g per serving) and vegetables (approximately 75 g per serving) daily [36]. This can be accomplished by including at least two plates of diverse vegetables per meal, prepared in various styles such as *namul*, salads, or stir-fries, and by consuming 1–2 portions of fruit daily. These fruit portions should be divided into 1–2 servings, each roughly the size of an apple, to manage sugar intake [19].

Physical Activity and Weight Management

Maintaining an appropriate body weight is crucial in strategies for breast cancer recovery and prevention. Being overweight or obese after a breast cancer diagnosis is associated with an increased risk of cancer recurrence, mortality, and second primary contralateral breast cancer [37].

Higher weekly energy expenditure through exercise has been shown to significantly improve physical functioning in survivors. Additionally, cancer patients have reported positive effects of physical activity on mental well-being. It helps alleviate common treatment-related side effects, such as fatigue, and supports overall health, resilience, quality of life, and physical functioning [38].

Patients are encouraged to engage in physical activity at least five times per week, with each session lasting 30 minutes or more, while also balancing their dietary intake. Combining physical activity with a balanced diet amplifies the benefits of each, enhancing overall health and supporting weight management. Providing structured programs and tailored guidance can further enhance patients' motivation and engagement, leading to more effective outcomes [39].

Dairy Products

Dairy products are rich in essential nutrients such as calcium, vitamin D, butyrate, lactoferrin, and conjugated linoleic acid, all of which have shown anticarcinogenic properties [40]. These nutrients are vital in reducing the risk of breast cancer as they support cellular health and inhibit carcinogenic pathways. For breast cancer patients, particularly postmenopausal women, maintaining adequate calcium intake is crucial to prevent osteoporosis [41]. It is advisable to consume at least one serving of milk or dairy products daily, either with a meal or as a snack, to ensure adequate calcium levels [19]. Additionally, incorporating a variety of calcium sources, such as dried anchovies and seaweed, can provide dietary flexibility and balance [42].

Due to the high saturated fat content in dairy products, it is advisable to choose low-fat or non-fat options [9]. For individuals who experience difficulty digesting milk, alternatives like lactose-free milk, soy milk, yogurt, or yogurt drinks serve as excellent substitutes. Yogurt, in particular, provides superior nutritional benefits compared to milk, including probiotics, protein, calcium, and essential vitamins such as B6 and B12. Additionally, the probiotic Lactobacillus acidophilus found in yogurt has shown potential in enhancing the immune response to breast cancer, underscoring its importance in a balanced post-surgical diet [43].

Alcohol Consumption

Alcohol is metabolized into acetaldehyde, a carcinogenic compound, in the body. This process increases the secretion of estrogen and androgen, which in turn promotes the development of breast cancer, irrespective of the type of alcohol consumed or the age of the individual. Ethanol intensifies this risk by encouraging tumor growth and the formation of metastases. It also enhances the effects of estrogens on breast tissue through various pathways [44]. Additionally, alcohol impairs the immune system and depletes essential nutrients, including folate, which is vital for DNA synthesis and repair to maintain genomic stability. As a folate antagonist, alcohol diminishes the bioavailability of folate, thereby undermining cellular health and elevating cancer risk [45].

Evidence shows that alcohol consumption, regardless of the type of alcoholic beverage or menopausal status, is consistently linked to a higher risk of breast cancer. A dose-response meta-analysis revealed that for every 10 grams of ethanol consumed daily, the risk of breast cancer rises by about 5% in premenopausal women and 9% in postmenopausal women [46].

Moreover, studies have reported that high alcohol intake, defined as more than 20 grams per day, is associated with increased breast cancer mortality, and a dose–response relationship has been observed [47]. Among breast cancer survivors, consuming more than one drink daily has been found to increase

the risk of late recurrence (i.e., occurring more than 5 years after diagnosis) by 28% [48]. Therefore, abstinence from alcohol, regardless of the type, is recommended.

Caffeine

Coffee consumption has not been strongly correlated with cancer recurrence in breast cancer patients [49]. However, because caffeine may hinder calcium absorption and impact the prevention of osteoporosis, it is advisable to limit coffee intake to one or two cups per day. Including a small amount of milk in coffee may help mitigate the effects of caffeine on calcium absorption [50].

Conclusion

While no single food can definitively prevent breast cancer or its recurrence, maintaining a balanced diet, consuming high-quality protein, adopting proper lifestyle habits, and engaging in regular physical activity can significantly promote overall health and may offer valuable support in managing cancer.

Authors' contributions

Conceptualization: Jisun Sa

Writing – Original Draft: Minjeong Kim, Minkyoung Lee, Jisun Sa

Writing – Review & Editing: Minjeong Kim, Jisun Sa

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Funding

Not applicable

Data availability

Not applicable.

Acknowledgments

Not applicable.

References

1. Center NCI. Cancer information [Internet]. Seoul: Ministry of Health and Welfare. [cited.2024 Aug 23]. Available from: https://www.cancer.go.kr/.
2. Organization WH. Breast Cancer Fact Sheet [Internet]. 2024. [cited. Available from: https://www.who.int/news-room/fact-sheets/detail/breast-cancer.
3. Xu Y, Gong M, Wang Y, Yang Y, Liu S, Zeng Q. Global trends and forecasts of breast cancer incidence and deaths. *Sci Data* 2023;10(1):334.
4. Wang J, Wu SG. Breast Cancer: An Overview of Current Therapeutic Strategies, Challenge, and Perspectives. *Breast Cancer (Dove Med Press)* 2023;15:721-730.
5. de Boniface J, Szulkin R, Johansson ALV. Medical and surgical postoperative complications after breast conservation versus mastectomy in older women with breast cancer: Swedish population-based register study of 34 139 women. *Br J Surg* 2023;110(3):344-352.
6. Demark-Wahnefried W, Morey MC, Sloane R, Snyder DC, Cohen HJ. Promoting healthy lifestyles in older cancer survivors to improve health and preserve function. *J Am Geriatr Soc* 2009;57 Suppl 2(Suppl 2):S262-264.
7. Lustberg MB, Kuderer NM, Desai A, Bergerot C, Lyman GH. Mitigating long-term and delayed adverse events associated with cancer treatment: implications for survivorship. *Nature Reviews Clinical Oncology* 2023;20(8):527-542.
8. Martínez-Ortega AJ, Piñar-Gutiérrez A, Serrano-Aguayo P, González-Navarro I, Remón-Ruíz PJ, Pereira-Cunill JL, et al. Perioperative Nutritional Support: A Review of Current Literature. *Nutrients* 2022;14(8).
9. Karimi Z, Jessri M, Houshiar-Rad A, Mirzaei HR, Rashidkhani B. Dietary patterns and breast cancer risk among women. *Public Health Nutr* 2014;17(5):1098-1106.
10. Otero K, Ferri C, Araya C. Chapter 5 - Nutritional Rehabilitation of Breast and Gynecologic Cancer Patients. In: Cristian A, editor. Breast Cancer and Gynecologic Cancer Rehabilitation. St. Louis: Elsevier; 2021. p.51-61.

11. Ho CY, Ibrahim Z, Abu Zaid Z, Mat Daud ZA, Mohd Yusop NB, Mohd Abas MN, et al. Postoperative Dietary Intake Achievement: A Secondary Analysis of a Randomized Controlled Trial. *Nutrients* 2022;14(1).

12. Quintero KJ, Resende AdS, Leite GSF, Lancha Junior AH. An overview of nutritional strategies for recovery process in sports-related muscle injuries. *Nutrire* 2018;43(1):27.

13. Gillis C, Carli F. Promoting perioperative metabolic and nutritional care. *Anesthesiology* 2015;123(6):1455-1472.

14. H YSASCDM. Impact of postoperative dietary types on nutrition and treatment prognosis in hospitalized patients undergoing oral and maxillofacial surgery: a comparative study. *Korean Journal of Community Nutrition* 2024;29(2):129-143.

15. Ministry of Health and Welfare TKNS. Dietary reference intakes for Koreans 2020 Seoul: Ministry of Health and Welfare; 2020.

16. Case LP, Daristotle L, Hayek MG, Raasch MF. Chapter 1 - Energy and Water. In: Case LP, Daristotle L, Hayek MG, Raasch MF, editors. Canine and Feline Nutrition (Third Edition). Saint Louis: Mosby; 2011. p.3-12.

17. Hwa YL, Kull MR. The why and how of maintaining hydration during cancer therapy. *Curr Opin Support Palliat Care* 2020;14(4):324-332.

18. Health U. Breast Cancer Self-Care and Recovery: Hydration [Internet]. [cited.2025-01-02]. Available from: https://www.ucsfhealth.org/education/breast-cancer-self-care-and-recovery-hydration.

19. Center AM. Healthy meal therapy for cancer patients [Internet]. 2025. [cited.2025-01-02]. Available from: https://www.amc.seoul.kr/asan/healthinfo/mealtherapy/mealTherapyDetail.do?mtId=86.

20. Society MoHaWTKN. Dietary Reference Intakes for Koreans 2020 Sejong: Ministry of Health and Welfare; 2020.

21. Farvid MS, Stern MC, Norat T, Sasazuki S, Vineis P, Weijenberg MP, et al. Consumption of

red and processed meat and breast cancer incidence: A systematic review and meta-analysis of prospective studies. *Int J Cancer* 2018;143(11):2787-2799.

22. World Cancer Research Fund AIfCR. Limit consumption of red and processed meat [Internet]. World Cancer Research Fund; 2023. [cited. Available from: https://www.wcrf.org/research-policy/evidence-for-our-recommendations/limit-red-processed-meat/.

23. Nadeem HR, Akhtar S, Ismail T, Sestili P, Lorenzo JM, Ranjha M, et al. Heterocyclic Aromatic Amines in Meat: Formation, Isolation, Risk Assessment, and Inhibitory Effect of Plant Extracts. *Foods* 2021;10(7).

24. Zainordin NH, Abd Talib R, Shahril MR, Sulaiman S, N AK. Dietary Changes and Its Impact on Quality of Life among Malay Breast and Gynaecological Cancer Survivors in Malaysia. *Asian Pac J Cancer Prev* 2020;21(12):3689-3696.

25. Virani S, Afreen S, Perthiani A, Sangster E, Lanka N, Acharya P, et al. The Impact of Dietary Unsaturated Fat or the Mediterranean Diet on Women Diagnosed With Breast Cancer: A Systematic Review. *Cureus* 2024;16(7):e65362.

26. Ganesan K, Sukalingam K, Xu B. Impact of consumption of repeatedly heated cooking oils on the incidence of various cancers- A critical review. *Crit Rev Food Sci Nutr* 2019;59(3):488-505.

27. Sugimura T, Wakabayashi K, Nakagama H, Nagao M. Heterocyclic amines: Mutagens/carcinogens produced during cooking of meat and fish. *Cancer Sci* 2004;95(4):290-299.

28. Reinwald S, Akabas SR, Weaver CM. Whole Versus the Piecemeal Approach to Evaluating Soy12. *The Journal of Nutrition* 2010;140(12):2335S-2343S.

29. Zhang L, Tian Y, Zhang L, Zhang H, Yang J, Wang Y, et al. A Comprehensive Review on the Plant Sources, Pharmacological Activities and Pharmacokinetic Characteristics of Syringaresinol. *Pharmacol Res* 2024 Dec 30 [Epub].

https://doi.org/10.1016/j.phrs.2024.107572.107572.

30. Hardt L, Mahamat-Saleh Y, Aune D, Schlesinger S. Plant-Based Diets and Cancer Prognosis: a Review of Recent Research. *Curr Nutr Rep* 2022;11(4):695-716.

31. Barakat R, Park CJ, Perez PA, Chiu K, Ko C. Female Antiestrogens. In: Skinner MK, editor. Encyclopedia of Reproduction (Second Edition). Oxford: Academic Press; 2018. p.740-747.

32. Bustamante-Rangel M, Delgado-Zamarreño MM, Pérez-Martín L, Rodríguez-Gonzalo E, Domínguez-Álvarez J. Analysis of Isoflavones in Foods. *Compr Rev Food Sci Food Saf* 2018;17(2):391-411.

33. Lv HW, Wang QL, Luo M, Zhu MD, Liang HM, Li WJ, et al. Phytochemistry and pharmacology of natural prenylated flavonoids. *Arch Pharm Res* 2023;46(4):207-272.

34. Durazzo A, Lucarini M, Camilli E, Marconi S, Gabrielli P, Lisciani S, et al. Dietary Lignans: Definition, Description and Research Trends in Databases Development. *Molecules* 2018;23(12).

35. Babu S, Jayaraman S. An update on β-sitosterol: A potential herbal nutraceutical for diabetic management. *Biomedicine & Pharmacotherapy* 2020;131:110702.

36. Limon-Miro AT, Lopez-Teros V, Astiazaran-Garcia H. Dietary Guidelines for Breast Cancer Patients: A Critical Review. *Advances in Nutrition* 2017;8(4):613-623.

37. Chan DSM, Vieira R, Abar L, Aune D, Balducci K, Cariolou M, et al. Postdiagnosis body fatness, weight change and breast cancer prognosis: Global Cancer Update Program (CUP global) systematic literature review and meta-analysis. *Int J Cancer* 2023;152(4):572-599.

38. Misiąg W, Piszczyk A, Szymańska-Chabowska A, Chabowski M. Physical Activity and Cancer Care-A Review. *Cancers (Basel)* 2022;14(17).

39. Browall M, Mijwel S, Rundqvist H, Wengström Y. Physical Activity During and After Adjuvant Treatment for Breast Cancer: An Integrative Review of Women's Experiences. *Integr Cancer Ther* 2018;17(1):16-30.

40. Do TM, Nguyen QHN, Le NHD, Nguyen HD, Phung AHT, Tran TS, et al. Association

between dietary factors and breast cancer risk: a matched case-control study in Vietnam. *BMC Cancer* 2024;24(1):1224.

41. Hodges JK, Cao S, Cladis DP, Weaver CM. Lactose Intolerance and Bone Health: The Challenge of Ensuring Adequate Calcium Intake. *Nutrients* 2019;11(4).

42. Safitri FR, Sari EM, Nurfajriah S. Analysis Of Calcium Levels in Wet and Dried Anchovies at Traditional Markets in Bekasi City. *Chempublish Journal* 2023;7(2):88-98.

43. Thu MS, Ondee T, Nopsopon T, Farzana IAK, Fothergill JL, Hirankarn N, et al. Effect of Probiotics in Breast Cancer: A Systematic Review and Meta-Analysis. *Biology (Basel)* 2023;12(2).

44. De Cicco P, Catani MV, Gasperi V, Sibilano M, Quaglietta M, Savini I. Nutrition and Breast Cancer: A Literature Review on Prevention, Treatment and Recurrence. *Nutrients* 2019;11(7).

45. Meadows GG, Zhang H. Effects of Alcohol on Tumor Growth, Metastasis, Immune Response, and Host Survival. *Alcohol Res* 2015;37(2):311-322.

46. World Cancer Research Fund AIfCR. Third Expert Report on "Diet, Nutrition, Physical Activity and Cancer: A Global Perspective" [Internet]. 2018. [cited.27 September 2018]. Available from: https://www.wcrf.org/dietandcancer/breast-cancer.

47. Gou YJ, Xie DX, Yang KH, Liu YL, Zhang JH, Li B, et al. Alcohol Consumption and Breast Cancer Survival: A Meta- analysis of Cohort Studies. *Asian Pac J Cancer Prev* 2013;14(8):4785-4790.

48. Nechuta S, Chen WY, Cai H, Poole EM, Kwan ML, Flatt SW, et al. A pooled analysis of post-diagnosis lifestyle factors in association with late estrogen-receptor-positive breast cancer prognosis. *Int J Cancer* 2016;138(9):2088-2097.

49. Jiang W, Wu Y, Jiang X. Coffee and caffeine intake and breast cancer risk: an updated dose-response meta-analysis of 37 published studies. *Gynecol Oncol* 2013;129(3):620-629.

50. Heaney RP. Effects of caffeine on bone and the calcium economy. *Food and chemical toxicology* 2002;40(9):1263-1270.

Table 1. Major anti-breast cancer phytochemicals, their sources, and the related benefits

Anticancer phytochemicals	Sources	Benefits	References
Flavones	Red and yellow fruits and vegetables (watermelons, bell peppers…)	Reduced risk of coronary heart diseases, cancers, chronic inflammation, osteoporosis and other age-related diseases. Lowering estrogen levels that can help inhibit breast tumor growth and reduces the risk of recurrence.	[31]
Isoflavones	Sour cherries, tomatoes, broccoli, and carrots	Inhibition of cancer cell growth, suppression of metastasis, and induction of apoptosis. Inhibits the proliferation of breast cancer cells by inducing cell cycle	[32]

		arrest.	
Prenylated flavonoids	*Morus alba, Artocarpus heterophyllus, Glycine max,* and *Ficus carica*	Anti-cancer, anti-inflammatory, neuroprotective, anti-diabetic, anti-obesity, cardioprotective effects, and anti-osteoclastogenic activities. Induced apoptosis suppresses cytotoxicity against human breast cancer cells.	[33]
Lignans	Potatoes, broccoli, berries	Resolves immunodeficiency, cancer, inflammation, hypertension, hyperlipidemia. Reduced risks of postmenopausal breast cancer.	[34]
Sitosterol	Fat-rich vegetables	Reduces	[35]

	(avocados)	immunomodulatory, antimicrobial, anticancer, anti – inflammatory, and lipid-lowering effect. Inhibits breast cancer cell growth and induces apoptosis

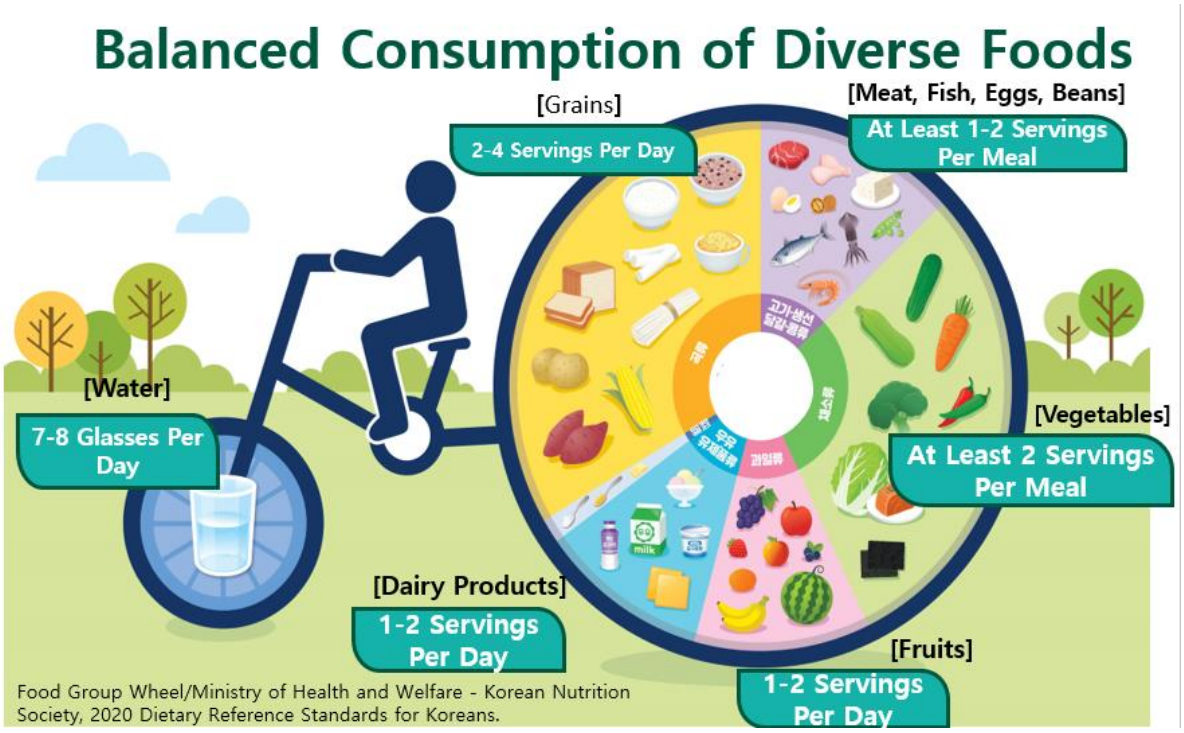

Fig. 1. Food group wheel [15]. The figure illustrates the recommended daily intake of diverse foods, emphasizing balanced consumption to support recovery and overall health. It provides guidance on the types of foods to be consumed and their appropriate portions for each day.