Breast Cancer UK
Prevent the preventable

BCUK Background Briefing | Nutrition and Breast Cancer Risk

Introduction

Breast cancer is the most common cancer in women globally (1). In the UK, in 2015, there were 54,751 new diagnoses of invasive breast cancer in women and 371 in men (2). Current estimates predict 1 in 7 women living in the UK will be diagnosed with breast cancer at some point in their lifetime (3). It is the second most common cause of cancer deaths in females (4), after lung cancer (5). There are many risk factors that are associated with the initiation and spread of breast tumours; some of these are linked to nutrition and lifestyle. There are especially strong links seen with alcohol consumption and obesity (1).

Diet is one of the risk factors that is known to affect breast cancer incidence and mortality, and one that we can personally and proactively control, to make positive changes. Certain foods may contain compounds that are protective against breast cancer and others that may have a cancer promoting effect (6).

This briefing is intended to provide a comprehensive overview of the latest scientific findings on nutrition and breast cancer. Scientific literature published between 1994 and 2019 was considered.

Food and nutrients that may affect breast cancer risk

1) Fats

Results of epidemiological studies investigating the association between total fat intake, or types of fat, with breast cancer risk are inconsistent (7–9).

Total dietary intake of trans fatty acids (10), often found in fried foods (11), was not associated with an overall increased risk of breast cancer. However, paradoxically, in post-menopausal women, higher levels of serum trans fatty acids, which are biomarkers of trans fatty acid uptake in blood (12), significantly increased breast cancer risk.

Circulating trans fatty acids may cause inflammation (13), which could be related to breast carcinogenesis (formation of breast cancer) (10, 14). Researchers came to no conclusion regarding premenopausal breast cancer risk and trans fatty acids. In humans evidence of the impact of cholesterol on breast

SUMMARY: Many factors, including lifestyle and diet, play a role in the development of breast cancer. Dietary factors may be protective or increase risk and exert their effects over long periods of time. There is no ideal diet that will prevent breast cancer. However, a diet with a high consumption of fruit and vegetables (especially non-starchy vegetables and foods high in carotenoids) reduces risk. Sufficient dietary calcium obtained from dairy (or other sources) may also reduce risk. Reducing or eliminating alcohol consumption reduces risk considerably and reducing or eliminating consumption of processed meat reduces risk slightly. Another strong influencing factor is how much food is consumed. When calorie intake exceeds calorie consumption, body weight increases. Higher body fat and adult weight gain are known risk factors for breast cancer in post-menopausal women. An example of a diet that can reduce risk is the Mediterranean diet.

cancer risk is conflicting, and it is unclear whether total (i.e. all types of blood cholesterol) or different types of cholesterol contribute to the disease (1, 15–18). However, in mice*, cholesterol promotes the growth and metastasis of mammary tumours. Furthermore, a substance produced by cholesterol metabolism binds to oestrogen receptors in mammary tissue, which promotes tumour growth (19). At the moment it is unknown whether the same is true for humans.

The relationship between intake of monounsaturated fatty acids (e.g. obtained from olive oil) and polyunsaturated fatty acids (e.g. obtained from oily fish) and breast cancer risk is also unclear. Intake of polyunsaturated fatty acids and monounsaturated fatty acids could help prevent breast cancer (20–23). Mechanisms by which polyunsaturated fatty acids might affect breast cancer risk include regulation of gene expression and antimetastatic and antiangiogenic activity. They are essential precursors of cell membranes and may interfere with the inflammatory response (24). However, some reviews find no association between polyunsaturated fatty acids and monounsaturated fatty acids and risk of breast cancer (1, 25).

More research needs to be done in order to determine the contribution of different types of fatty acids in the development of breast cancer.

Conclusion

Some, but not all, studies suggest trans fatty acids and dietary cholesterol increase breast cancer risk. Others suggest that some types of unsaturated fatty acids are protective against breast cancer. Either way, increasing consumption of certain fats, such as, polyunsaturated fats (for example olive oil or walnuts) for general overall health (21, 26) and reducing intake of others (trans fats, e.g. chips and saturated fats, e.g. bacon) is advisable. For example trans fats create inflammation, which is linked to heart disease (13). Reducing total fat consumption is also recommended (1), as fat also contains the highest calorie content of all nutrients (27) and can lead to excess weight, which is a proven risk factor for postmenopausal breast cancer (1).

2) Carbohydrates and glycaemic index

Studies examining a possible association between glycaemic index (or GI, which measures how quickly foods cause increases in blood glucose levels), consumption of certain carbohydrate (i.e. sugar molecules such as simple sugars or disaccharides - sugars formed of two single sugar molecules), or dietary fibre and breast cancer risk show inconsistent results, with some studies suggesting increased GI or sugar levels increase breast cancer risk, and others showing no association (28–34).

One meta-analysis found GI showed a weak positive linear association with risk of postmenopausal breast cancer. Another found glycaemic load (which takes into account both the GI of the food and the amount of carbohydrates present) and total carbohydrate

* Breast Cancer UK do not support research projects which involve animal experiments or materials derived from animal experiments.

intake were associated with increased risk of hormone receptor–negative tumours only (35). Another review that examined the roles of total sugar, added sugars (during food production and processing), fructose, sucrose, sugary foods, and sugar-sweetened beverages in relation to female cancers, including breast cancer, generated inconsistent results, with some studies reporting significantly increased risks, while others reporting null findings (36).

High-sugar diets may potentially increase cancer risk. Consuming lots of sugar activates the insulin signalling pathway by elevating levels of glucose, insulin, and inflammatory cytokines (proteins which favour inflammation). Chronically elevated levels of insulin and insulin-like growth factor 1 (IGF-1; type of cytokine) favour survival and proliferation instead of apoptosis (programmed cell death) in DNA-damaged cells (36). DNA damage is an abnormal alteration in the chemical structure of DNA. The ability to trigger apoptosis in the presence of un-repaired DNA damage is critical for prevention of cancer (37).

Several older observational studies examined the association between dietary fibre intake and risk of breast cancer and found inconclusive results, with mostly weak (for example an increment of 10 g fibre/day lowered breast cancer risk by 5% (38)) or no association between reduced fibre intake and breast cancer (39). However, one meta-analysis found that in postmenopausal women, dietary fibre consumption was significantly associated with a reduced breast cancer risk (40) and one review found that those consuming the highest amounts of dietary fibre may benefit from a small reduction in breast cancer risk (41). Fruit and fibre intakes were correlated with decreased breast cancer risk in yet another study, but the decreased risk was more evident among women who were not overweight or obese (42). There are several mechanisms that explain how fibre could play a role in lowering risk of breast cancer. One suggests that a high fibre diet can increase excretion of oestrogens and decrease plasma concentrations of oestradiol (the most active and prevalent form of oestrogen) and inhibit absorption of oestrogens in the gut, thereby reducing the total body pool of oestrogen (43).

Conclusion

There is insufficient evidence to conclude that a diet low in total carbohydrates, simple sugars such as sucrose, starch, low glycaemic index or high in dietary fibre will lower breast cancer risk, although some studies support this. However, consuming large amounts of sugar can promote weight gain, often without the added benefit of vitamins and minerals, so-called "empty calories," and being overweight or obese increases the risk of postmenopausal breast cancer (1). Similarly, there are many other reasons to indicate a diet high in fibre is beneficial. A recent meta-analysis suggests a diet low in fibre intake contributes to a range of chronic diseases, including cardiovascular diseases, type 2 diabetes and pancreatic cancer (44). Another meta-analysis found dietary fibre was protective against colon cancer (45).

3) Fruits and vegetables

There is strong evidence that suggests a diet

rich in vegetables and fruits reduces breast cancer risk (46–49).

A large-scale study from 2019 found that the consumption of more than 5.5 portions of fruit and vegetables per day was associated with a lower risk of breast cancer compared to women consuming 2.5 portions or less. Interestingly eating cruciferous vegetables (e.g. cauliflower) and orange and red coloured vegetables was especially beneficial (48). The intake of certain fruits and vegetables, for example citrus fruits, may be inversely associated with breast cancer according to another study (47). The *World Cancer Research Fund* concluded that there was limited, but suggestive evidence that the consumption of non-starchy vegetables decreases the risk of oestrogen-receptor-negative (ER-) breast cancer and consumption of foods containing carotenoids (red, orange and yellow coloured vegetables) decreases the risk of breast cancer. Evidence for an association between decreased breast cancer risk and fruit consumption was considered to be more limited (1). Consuming whole plant foods instead of single phytochemicals, such as those found in supplements, is also suggested. A mixture of phytochemicals with a variety of biological activities present in whole plant-derived foods could have added or synergistic effects against breast cancer (46). Several mechanisms that might explain the anti-cancer properties of phytochemicals have been proposed, including antioxidant activity, trapping of oxygen radicals, induction of drug metabolising and detoxifying enzymes, promotion of DNA repair, and modulating tumour-suppressor genes (50).

Conclusion

Evidence suggests that a high consumption of fruit and vegetables helps protect against breast cancer. The correlation is strongest between non-starchy vegetables (for example cruciferous vegetables such as broccoli) and decreased risk of ER- breast cancer, and intake of foods high in carotenoids and decreased risk of breast cancer.

4) Red and processed meat consumption

Several meta-studies provide evidence for an increase in breast cancer risk from certain types of meat consumption (51–54).

High consumption of processed meat was found to be associated with an overall increased risk of breast cancer, especially for post-menopausal women (51, 53). One review found consumption of 50 g/day of processed meat (for example approx. 1.5 rashers of thick bacon) was associated with an increase in risk of 9% (52).

Most studies conclude that red meat consumption is not associated with an overall risk of breast cancer (51, 53). However, one review that examined studies of breast cancer risk and red meat found consumption of 100 g/day (use size of pack as measuring guide) varied from having no effect to an 11% increase in risk (52). Another meta-analysis examining red meat consumption and breast cancer risk in premenopausal women also found consuming red meat did increase risk (54). Further studies are needed to establish whether red meat consumption increases breast cancer risk.

There are several mechanisms that explain a possible link between meat consumption and

cancer risk. For example, cooking red meat at high temperature leads to the formation of heterocyclic amines and polycyclic aromatic hydrocarbons which are carcinogens that have been associated with colorectal cancer (55, 56). They might also play a role in breast cancer (53). In addition, the haem iron in red meat has been shown to promote tumorigenesis (57). For processed meat it is likely that a combination of mechanisms contributes to a higher risk of breast cancer. Processed meat is rich in saturated fat, cholesterol, and haem iron, which may promote tumorigenesis. It is also a source of N-nitroso compounds, which have carcinogenic potential (53, 55).

Conclusion

These findings show that higher consumption of processed meat is associated with higher risk of breast cancer. There is limited evidence of a link between the consumption of red meat and an increased risk of breast cancer.

5) Vitamin D

Low levels of vitamin D are correlated with an increased risk of breast cancer, but it is unclear whether this is a direct causative factor or marker of risk.

Vitamin D is a secosteroid which is synthesised within human skin, in the liver and kidneys (58) or can be found in some foods. Between 80-100% of vitamin D is produced following exposure of our skin to UV in sunlight. The remainder comes from animal-based food (vitamin D3/cholecalciferol, e.g. from oily fish such as salmon) and certain plants and yeast (vitamin D2/ergocalciferol). Vitamin D may also be obtained from dietary supplements (59). The key function of vitamin D is the regulation of the body's metabolism of calcium, magnesium and phosphate associated with bone health. It also acts as a hormone affecting many organs including the heart, lungs, intestine, skeletal system and breasts (60).

There are many factors that influence vitamin D levels, including physical activity, nutrition, season, menopausal status and place of residence (61).

Some studies show no apparent correlation between naturally low circulating vitamin D levels and risk of breast cancer (62, 63). Furthermore, daily intake of vitamin D supplements and omega-3 fatty acids was not found to reduce risk of cancers (including breast cancer) or serious cardiovascular disease (64).

However, most studies do find an inverse association between vitamin D level and breast cancer risk, and suggest that vitamin D deficiency is associated with increased breast cancer risk (65–67).

There are various mechanisms through which vitamin D could influence cancer risk, for example increasing apoptosis, stimulating cell differentiation, inhibiting angiogenesis, cell invasion and metastasis and having anti-inflammatory and antiproliferative effects (68).

Conclusion

Retrospective and prospective epidemiological studies show that vitamin D deficiency is associated with an increased risk of breast cancer. Numerous studies have investigated whether vitamin D supplements reduce breast cancer risk, but findings are inconsistent, with

most suggesting they do not help to reduce risk. There is an urgent need for better, prospective and randomised studies to determine whether low levels of circulating vitamin D is a breast cancer risk factor or, rather, a consequence of having the disease and finally, whether increased levels of vitamin D supplements can be protective against breast cancer.

6) Dairy and Calcium

There is evidence of an association between a diet rich in dairy and a reduced breast cancer risk, and of a dose-response association between increased calcium intake and reduced breast cancer risk (i.e. increasing levels of calcium intake are associated with a decreasing breast cancer risk) (69–71).

Dairy products are a source of dietary calcium but are also rich in vitamin D and conjugated linoleic acids, which may protect against development of breast cancer. Calcium can play an important role in carcinogenesis by regulating cell proliferation, cell differentiation and apoptosis. It has been shown to reduce fat-induced mammary cell proliferation in rats, through its role in maintaining intracellular calcium concentrations. Vitamin D and calcium are metabolically linked, and evidence shows that calcium might exert anti-carcinogenic effects through vitamin D. For example, calcium is one of the key mediators of apoptosis induced by vitamin D compounds in breast cancer cells (72). Dairy products are good sources of calcium, zinc and iodine as well as vitamins B2 and B12 (69). Yogurt also contains beneficial bacterial cultures, making it a potential source of probiotics which can be helpful for general health (73). Animal studies suggest that probiotics may slow the growth rate of mammary tumours and have anti-inflammatory effects. However, data in humans is lacking (74).

Conclusion

Dairy products and dietary calcium might be beneficial in decreasing breast cancer risk. Dairy products are good sources of vitamins and minerals and natural yogurt contains general health promoting bacterial cultures. More research is needed to understand the precise mechanisms by which dairy foods and dietary calcium may reduce breast cancer risk.

7) Soy

Currently it is unclear if a soy-rich diet might protect healthy women against breast cancer, although some studies suggest it may. Importantly, it does not appear to increase risk (75–79).

Soy contains isoflavones, which are phytoestrogens with structural similarity to human oestrogen. Because of their oestrogen-like effects, we discuss whether soy isoflavones might increase the risk of breast cancer, especially among high-risk women, or whether they might worsen the prognosis of women with this disease.

Soy isoflavones bind to both oestrogen receptors (ER-α and ER-β), although they preferentially bind to and activate ER-β and can exert oestrogen-like effects such as increased cell growth and division. The concern that soy foods might increase the risk of breast cancer is supported by studies showing that in mice implanted with oestrogen-sensitive human

breast cancer cells, isoflavones stimulate the growth of existing tumours (78, 80). However, clinical data show isoflavone exposure is safe for all women (79), and epidemiologic data suggests isoflavone exposure can improve the prognosis of breast cancer patients. Isoflavones also possess non-hormonal properties that are associated with the inhibition of cancer cell growth.

Most studies suggest that a high intake of soy foods has a beneficial role in reducing the risk of breast cancer (76, 81), although more studies are needed before any conclusions may be drawn. Some studies also suggest soy foods may also benefit women who have breast cancer (76), although this needs to be investigated further. Eating soy during childhood/adolescence may be particularly beneficial in reducing cancer risk later in life (82, 83).

An evaluation by the *German Research Foundation* showed that intake of around 100 mg/day soy isoflavones (e.g. 100g soy beans (raw), 300g soy yogurt (84)) is safe for healthy women. However, it suggests that women with breast cancer or with a history of breast cancer should abstain from the intake of isoflavone supplements and dietary intake should not exceed around 50 mg/day (77). For healthy, postmenopausal women, there is no evidence that isoflavones in concentrations commonly found in dietary supplements are harmful. However, for women in the perimenopause (the two to eight years preceding menopause and one year following final menses (85)), data assessing the safety of these substances are lacking (86).

There are several possible mechanisms by which soy may reduce the risk of breast cancer (79). Isoflavones can block tumorigenesis by inhibiting enzymes required for DNA replication, metastasis, and signal transduction; disabling growth factors that promote angiogenesis and by activating the immune system (82).

Conclusion

Epidemiological studies show inconsistent results as to whether the consumption of soy or isoflavones can protect against breast cancer and further studies are needed to conclude they help to reduce risk. Moderate consumption of soy (one to two portions of soy food per day (isoflavone content approx. 25 - 50 mg)) is generally considered positive for our health.

8) Organic Food

Some studies suggest consuming organic food is linked to reduced breast cancer risk, but most find that there is no association (87–90). Currently there is not enough evidence to draw firm conclusions about whether organic food reduces risk.

Organic food has fewer pesticide residues than conventionally produced food because the use of pesticides is prohibited in organic farming (91). Certain pesticides are endocrine disrupting chemicals (EDCs) which mimic oestrogen and increase breast cancer risk (92). However, many pesticides have not been adequately studied for their endocrine disrupting effects in humans (90). Furthermore, different EDCs may interact and have additive or synergistic effects (93).

The *UK Department for Environment, Food and Rural Affairs* has found pesticide residues are

present in many fruit and vegetables available in the UK and EU. One example is triadimefon (94, 95), a pesticide which is known to be oestrogenic (96) and which was classified as a "Possible Human Carcinogen" (97).

Findings of an epidemiological study did not support the hypothesis that breast cancer risk is reduced with lower pesticide exposure (88), however two more recent studies do suggest that consumption of organic foods may lower risk (87, 89).

Conclusion

There is not enough evidence to conclude that consumption of organic food, compared to conventionally grown produce, offers protection against breast cancer. However, an association is feasible as some pesticides are oestrogen mimics which may increase breast cancer risk (98).

9) Alcohol

Alcohol is classified as a carcinogen by the *International Agency for Research on Cancer* (99), however many women are unaware of the link between alcohol and breast cancer (100). It is estimated that 23,000 cases of cancer could be prevented each year if everyone in the UK stopped drinking alcohol (101).

There is strong evidence that consumption of alcoholic drinks is a contributing factor in both pre- and postmenopausal breast cancer. There is a strong, consistent dose-response relationship between alcohol and breast cancer incidence, even at low levels of consumption. Increasing levels of alcohol intake are associated with an increasing breast cancer risk (102).

How exactly alcohol influences the development of cancer is still being researched. It is assumed that various substances that are produced during the breakdown of alcohol in the body play a role in carcinogenesis. One example is acetaldehyde, which is very reactive and readily binds to other molecules, including DNA, leading to mutations. Alcohol can also increase the levels of some hormones, such as oestrogen, which is known to increase breast cancer risk (103).

Alcohol also contains many "empty calories" because most alcoholic drinks do not contain vital nutrients such as vitamins, protein or fibre. Consumption of alcohol can therefore promote weight gain, a risk factor for postmenopausal breast cancer (1). Following the UK Chief Medical Officer's low risk drinking guidelines (104) drinking no more than 14 units/week is recommended. The lower the alcohol consumption, the lower the risk. It is best not to drink alcohol at all.

Conclusion

There is strong evidence that the consumption of alcoholic drinks is a contributing factor to pre- and postmenopausal breast cancer

10) Which diet is the right one?

There is no ideal diet for breast cancer prevention. It is more important to pay attention to the proportions of individual foods. Many diets can be healthy and help reduce risk, including the Mediterranean diet (105), as well as vegan and vegetarian diets (106). They all combine certain basic features, e.g. no or low red meat consumption and a high proportion of fruit and vegetables.

The Mediterranean diet is an example of a dietary food pattern that is characterized by high intake of olive oil, vegetables, fruits, plant protein, fish and other seafood, whole grains, nuts, and low-fat dairy, accompanied by moderate alcohol intake and low red meat consumption (107). There is evidence suggesting an overall small decrease in breast cancer risk (108). A moderately strong inverse association with risk of ER- (oestrogen-receptor-negative) and [ER- PR- (progesterone-receptor-negative)] breast cancers, and weak inverse associations with ER+ (oestrogen-receptor-positive) and total postmenopausal breast cancer have been found. Researchers estimated that 32.4% of ER- breast cancers, and 2.3% of total and ER+ breast cancers could be avoided if the population followed a Mediterranean dietary pattern (109). A Mediterranean diet could be beneficial to health in general and help protect against breast cancer risk and recurrence in particular (110).

The American Institute for Cancer Research concluded that the intake of mainly whole plant foods (vegetables, fruits, whole grains, beans) decreases the risk of many cancers, including breast cancer (111). Plant foods can also help to maintain a healthy weight because many of them are lower in energy density. By maintaining a healthy body weight, limiting alcohol, and eating mostly plant-based foods, a 62% decreased risk of breast cancer was achieved (112).

Conclusion

Looking at dietary patterns instead of single nutrients or foods appears to have advantages in every respect, since foods are not consumed in separation and their health-related effects could be additive or even synergistic (108). The Mediterranean diet is popular and includes many foods that are considered healthy and can serve as an orientation for a varied and healthy diet, but it is not the only plant-based approach. A specific and controversial "ingredient" of a Mediterranean diet is alcohol, usually in the form of red wine. Since studies have proven that any amount of alcohol can increase breast cancer risk, it should not be part of a diet to decrease risk of breast cancer. Regular consumption of fruits and vegetables also facilitates weight management in overweight individuals to counter excess weight/obesity as a risk factor for breast cancer.

Final conclusion

Reliable study results are particularly difficult to obtain in the field of nutrition and breast cancer. It is the sum of multiple risk and protective dietary factors which exert their effects over decades. There is no ideal diet that will prevent breast cancer. However, there are many ways we can reduce our risk of developing this and other diseases, including a high intake of fruit, non-starchy vegetables, dairy and calcium and maintaining a healthy body weight.

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Summary Table [1, 113–116]

	Evidence for a link to breast cancer according to *Cancer Australia* and *WCRF*	*WHO* and *WCRF* recommended intake	General recommendations for a healthy diet (*WHO* and *WCRF*)
Fats	*Dietary fat intake (total)* and risk of breast cancer: inconclusive (s. "*Criteria for grading evidence*" in the glossary)	Less than 30% of total energy intake from fats; Less than 10% of total energy intake as saturated fats; Less than 1% of total energy intake as trans fat	Consume unsaturated fats (e.g. found in olive oils; fish); Avoid saturated fats (e.g. found in fatty meat and palm oil) Limit intake of trans-fats of all kinds (e.g. found in doughnuts and baked goods)
Carbohydrates	*Dietary fibre, sugar (sucrose); other sugars; sugary foods and drinks; carbohydrate; starch; glycaemic index; glycaemic load* and risk of breast cancer: inconclusive	Less than 10% (preferably less than 5%) of total energy intake from free sugars. Recommended amount of dietary fibre: 30 g/day	Consume natural, minimally processed foods and whole grains (e.g. whole wheat bread); Avoid highly processed foods made with refined flour (e.g. white bread) and sugary foods (e.g. cookies and soft drinks)
Fruits & Vegetables	*Fruit intake* and breast cancer risk: inconclusive; *Vegetables (non–starchy)* and decreased risk of breast cancer: suggestive; *Foods containing carotenoids* and decreased risk of breast cancer: suggestive	At least 400 g (i.e. five portions) of fruit and vegetables per day (excluding potatoes, sweet potatoes, cassava and other starchy roots)	Consume large quantities of vegetables especially those that contain carotenoids found in green leafy vegetables (e.g. kale, spinach) and coloured fruits (e.g. kiwi, tomatoes), especially in the presence of fats as well as non-starchy vegetables e.g. aubergine and leek
Meat & other protein	*Processed meat* and increased risk of breast cancer: suggestive (Cancer Australia conclusion only); *Red meat* and risk of breast cancer: inconclusive	No more than 3 portions (350–500g (about 12–18oz cooked weight) of cooked red meat per week; Very little, if any, processed meat	Reduce meat consumption and replace it with other protein sources, e.g. legumes, nuts, eggs, fish, tofu or mycoprotein
Vitamin D	*Vitamin D* and risk of breast cancer: inconclusive	Depending on your skin type: 9-25 min. of sunlight/day in the UK at lunchtime to meet vitamin D requirements for year-round needs (forearms and lower legs are exposed); In the absence of endogenous production: 600 IU/day (15 µg/day) supplement for children and adults up to 50 years of age	Get vitamin D through moderate sunlight on skin and from a balanced diet *(March-September)*; No need to take a vitamin D supplement during these months; Get vitamin D from your diet *(Autumn and winter)*; If you can't, consider taking a daily supplement during this time 25-Hydroxyvitamin D (25[OH]D) serves as a marker for the assessment of the vitamin D supply; Recommended serum concentration of 25(OH)D: 20 ng/ml
Dairy & Calcium	*Dairy intake and dietary calcium* and decreased risk of breast cancer: suggestive	No specific guidelines	Consume dairy products with as few additives as possible, e.g. natural yogurt with no added sugar
Soy	*Soy* and breast cancer risk: inconclusive	One to two portions of soy food/day (isoflavone content approx. 25-50mg) are considered safe for everyone (incl. breast cancer patients and breast cancer survivors); 1 portion = 100 g tofu or 250 ml soymilk	Reach for natural, not highly processed soy products such as tofu, edamame and tempeh (fermented soybeans)
Alcohol	Alcohol and increased risk of breast cancer: suggestive	Do not drink alcohol	If you drink, then drink as little as possible; (Check out UK Guidelines for more information)
Salt	*Salt* intake and breast cancer: evidence of no association	Keep salt intake to less than 5g per day	Reduce salt intake for other health reasons (e.g. hypertension)
Body weight	*Higher adult body fatness throughout adulthood* and increased risk of postmenopausal breast cancer: convincing; *Adult weight gain* and increased risk of postmenopausal breast cancer: convincing	Energy intake (calories) should be in balance with energy expenditure	Be at a healthy weight: Body Mass Index (BMI) is a simple way to find out whether you're a healthy weight for your height (BMI of 18.5–24.9); Be physically active for at least 30 minutes every day, and sit less

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About Breast Cancer UK

Who are we?

Breast Cancer UK aims to prevent breast cancer through scientific research, collaboration, education and policy change. We educate and raise awareness of the risk factors for breast cancer and provide practical information to help people reduce these risks. We campaign to ensure government policies support the prevention of breast cancer. We fund scientific research that helps to better understand what risk factors contribute to breast cancer and how to address them.

For further information on breast cancer risk factors visit our website www.breastcanceruk.org.uk

To view this information in a more accessible format or to provide feedback, please contact us.

Disclaimer

This brief is for information purposes only and does not cover all breast cancer risks. Nor does it constitute medical advice and should not be used as an alternative to professional care. If you detect a lump or have any concerns, seek advice from your GP. Breast Cancer UK has made every effort to ensure the content of this leaflet is correct at the time of publishing, but no warranty is given to that effect nor any liability accepted for any loss or damage arising from its use.

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We welcome your feedback, if you have any comments or suggestions about this brief please contact us via email at info@breastcanceruk.org.uk or call us on 0845 680 1322

Glossary [117–123]

Angiogenesis: Formation of new blood vessels; plays a critical role in the growth of cancer because solid tumours need a blood supply for growth.

Antioxidant: Substance that protects cells from damage caused by free radicals (unstable molecules generated by oxidation during normal metabolism). Examples include beta-carotene, lycopene, vitamins A, C, and E. Free radicals may play a role in cancer, heart disease, and other diseases of ageing.

Apoptosis: Method the body uses to get rid of unneeded or abnormal cells; this process may be blocked in cancer cells.

Biomarker: Biological molecule found in blood, other body fluids, or tissues that is a sign of a normal or abnormal process, or of a condition or disease. A biomarker may be used to see how well the body responds to a treatment for a disease or condition.

Carbohydrates: Sugar molecules which can be small and simple (for example, glucose) or they can be large and complex (for example, polysaccharides such as starch, chitin or cellulose).

Carotenoid: Yellow, red, or orange substance found mostly in plants, including carrots, dark green leafy vegetables, many fruits, grains, and oils. Some carotenoids are changed into vitamin A in the body and some are being studied in the prevention of cancer.

Cholesterol: Sterol compound found in most tissues. Cholesterol and its derivatives are important constituents of cell membranes and precursors of other steroid compounds.

Criteria for grading evidence: Convincing: There is compelling and consistent evidence that the factor is associated with risk of breast cancer. **Probable**: The factor is likely to be associated with risk1 of breast cancer, but the evidence is not as strong as for Convincing. **Suggestive**: The evidence is suggestive of an association between the factor and risk1 of breast cancer but there is not sufficiently strong evidence to be more certain. Inconclusive: The evidence is too limited to determine the likelihood of an association with risk of breast cancer. **Evidence of no association**: There is consistent evidence from good quality studies to show that the factor neither increases nor decreases the risk of breast cancer.

Differentiation: Processes by which immature cells become mature cells with specific functions.

Dose–response: Relationship between exposure/dose and response/effect that can be established by measuring the response relative to an increasing dose.

ER-: see "**Oestrogen-receptor-negative"**

Er+: see **"Oestrogen-receptor-positive"**

Glycaemic index (GI): Value assigned to foods based on how slowly or how quickly those foods cause increases in blood glucose levels. Foods low on the GI scale tend to release glucose slowly and steadily.

Glycaemic load (GL): Value that takes into account both the GI of the food and the amount of carbohydrate in a portion. GL is based on the idea that a high GI food consumed in small quantities would have the same effect on

blood glucose levels as larger quantities of a low GI food. GL is calculated by multiplying the GI by the amount of carbohydrates (in grams) in a serving of food.

Haem iron: Iron bound to haemoglobin and found in animal tissue. Iron is an important dietary mineral that is involved in various bodily functions, including transport of oxygen in the blood.

Heterocyclic amine: Carcinogen that is formed when meat, poultry, or fish is cooked at high temperatures, such as frying, broiling, and barbecuing.

Hormone receptor negative: Cells that do not have a group of proteins that bind to a specific hormone. For example, some breast cancer cells do not have receptors for the hormones oestrogen or progesterone. These cells are hormone receptor negative and they do not need oestrogen or progesterone to grow.

IGF-1: see **"Insulin-like growth factor 1"**

Inflammatory cytokines: Type of protein that is made by certain immune and non-immune cells and promotes inflammation.

Insulin-like growth factor 1: Hormone crucial for cell growth. Increased circulatory levels of IGF-1 increase cancer risk.

Insulin signalling pathway: Biochemical pathway, which regulates some fundamental biological functions such as glucose and lipid metabolism, protein synthesis, cell proliferation, cell differentiation and apoptosis.

Invasive breast cancer: Cancer that has spread from where it began in the breast to surrounding normal tissue.

Isoflavones: Type of phytoestrogens found in plants such as soybeans. They may mimic oestrogen and have been shown to reduce tumour cell proliferation and induce tumour cell apoptosis and may reduce the risks of breast cancer, heart disease, and osteoporosis.

Linoleic Acid: Polyunsaturated essential fatty acid found mostly in plant oils and used in the biosynthesis of prostaglandins and cell membranes.

Meta-analysis: Process that analyses data from different studies done about the same subject. The results of a meta-analysis are usually stronger than the results of any study by itself.

Metastasis: Spread of cancer cells from the place where they first formed to another part of the body. They travel through the blood or lymph system and form a new tumour in other organs or tissues of the body.

N-nitroso compounds (NOCs): Compounds found in processed meat and formed endogenously from intake of nitrite and nitrate. Endogenous NOC formation is antagonized by nitrosation inhibitors in fruit and vegetables (e.g. vitamin C) and promoted by haem in red meat.

Non-starchy vegetables: Vegetables that do not contain starch. These are usually lower in sugar and higher in fibre than starchy vegetables. Examples are broccoli, carrots, celery, peppers, tomatoes, and courgettes.

Oestrogen-receptor-negative: Cells that do not have a protein to which the hormone oestrogen will bind and do not need oestrogen to grow. Cancer cells that are oestrogen receptor negative do not need oestrogen to grow, and usually do not stop growing when treated with hormones that block oestrogen from binding. Also known as ER-.

Oestrogen-receptor-positive: Cells that have a receptor protein that binds the hormone oestrogen. Cancer cells that are oestrogen receptor positive may need oestrogen to grow and may stop growing or die when treated with substances that block the binding and actions of oestrogen. Also called ER+.

Phytochemical*:* Certain organic components of plants, that are thought to promote human health. Fruits, vegetables, grains, legumes, nuts and teas are rich sources of phytonutrients.

Phytoestrogen: An oestrogen-like substance found in some plants and plant products. Phytoestrogens may have anticancer effects.

Polycyclic aromatic hydrocarbons (PAHs): Type of chemical formed when e.g. coal, oil or meat are burned. High-temperature cooking, such as grilling, will form PAHs in meat and other foods. Being exposed to them over a long time may cause cancer.

PR-: see "**Progesterone-receptor-negative**"

Progesterone-receptor-negative: Cells that do not have a protein to which the hormone progesterone will bind. Cancer cells that are progesterone receptor negative do not need progesterone to grow, and usually do not stop growing when treated with hormones that block progesterone from binding. Also called PR-.

Proliferation: An increase in the number of cells as a result of cell growth and cell division.

Saturated fatty acids: Type of fat with certain chemical properties that is usually solid at room temperature. Most saturated fats come from animal food products, but some plant oils, such as palm and coconut oil, also contain high levels. Eating saturated fat increases the level of cholesterol in the blood and the risk of heart disease.

Secosteroid: Compound in which the steroid ring structure is broken.

Serum (blood serum): Amber-coloured, protein-rich liquid that separates out when blood coagulates, used for medical purposes.

Trans fat (also called trans-unsaturated fatty acids or trans fatty acids): A type of fat that is produced by hydrogenation and used in margarine and fried foods. Trans fats have been shown in many studies to increase the risk of coronary heart disease by increasing levels of "bad" cholesterol (low-density lipoprotein) and decreasing levels of "good" cholesterol (high-density lipoprotein) in the blood.

Tumour: An abnormal mass of tissue that results when cells divide more than they should or do not die when they should. Tumours may be benign (not cancer), or malignant (cancer).

Unsaturated fatty acids: A type of fat containing a high proportion of fatty acids with at least one double bond. Unsaturated fat or oil is either monounsaturated (single double bonds) or polyunsaturated (many double bonds), found in plants, vegetable oil, and fish, and thought to be better for your health than saturated fat.

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