

TOPICS

Do vegetables and fruits affect breast cancer risk?

Why has the risk decrease linked to vegetables and fruits changed?

Do some vegetables and fruits affect breast cancer risk?

What's in vegetables and fruits that could affect breast cancer?

How might vegetables and fruits influence breast cancer?

Are vegetarian diets linked to changes in breast cancer risk?

Is the effect different for pre- and postmenopausal women?

Could some women benefit more from vegetables and fruits?

Is eating vegetables and fruits helpful for breast cancer survivors?

Is eating vegetables and fruits linked to changes in other cancer risks?

What are the other health benefits of vegetables and fruits?

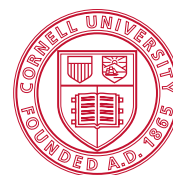
Vegetables and Fruits and the Risk of Breast Cancer

Recent studies have challenged prior thinking about the relationship between vegetable and fruit consumption and breast cancer risk. The addition of the results of recent cohort studies to the body of evidence on this subject has brought into question the existence of a strong association between vegetable and fruit consumption and decreased breast cancer risk. It now looks as if fruit consumption is not associated with breast cancer risk. The role of vegetable consumption is unclear; it may or may not be associated with a decrease in breast cancer risk. It appears that if an association of vegetable consumption with breast cancer risk exists, it is small. Comparisons of women eating a Western-style vegetarian diet compared to those eating conventional Western diets have also not detected any association with breast cancer risk. However, high consumption of vegetables after breast cancer diagnosis shows promise for decreasing the risk of death for survivors, but more study is needed before this effect is established.

Numerous health benefits are associated with eating vegetables and fruits. A diet high in vegetables and fruits is likely to be linked to a decrease in the risk of cancer of the mouth, esophagus, stomach, lung, colon, rectum and possibly other cancers. Eating large amounts of vegetables and fruits has been clearly linked to a decrease in the risk of cardiovascular disease. Eating vegetables and fruits may also help improve bone health, diabetes control, and the maintenance of a healthy body weight.

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Does the total amount of all vegetables and fruits consumed affect breast cancer risk?

Recent cohort epidemiological studies examining the association between vegetables and fruits consumption and breast cancer risk present two new findings. First, breast cancer risk appears to be unrelated to the total amount of fruit consumed. Second, the relationship of total vegetable consumption to breast cancer risk is uncertain. If a relationship does exist, it is relatively small, on the order of a 10 percent to 20 percent decrease in risk. It is important to recognize that this conclusion is based on studies of vegetables and fruits as entire food groups and that a number of scientists are critical of this conclusion. Studies that group all types of vegetables or fruits and treat the groups as one would not show the effects of specific vegetables and fruits (see *“Are there certain vegetables and fruits that may affect breast cancer risk?”* below). In addition, there are clear health benefits associated with vegetable and fruit consumption (see *“Is eating vegetables and fruits associated with other health benefits?”* and *“Is eating vegetables and fruits associated with changes in the risk of other types of cancer?”* below).

Previously vegetables and fruits were thought to be linked to a decrease in breast cancer risk. Why has this idea changed?

Thought about the relationship between breast cancer risk and vegetables and fruits changed largely because of the results of recent cohort studies. Cohort studies have almost uniformly found no association between total consumption of fruits or vegetables and breast cancer risk. Previous thinking had been based largely on case-control studies. Although the results of the case-control studies varied, the majority had reported a decrease in breast cancer risk. Case-control and cohort studies have different designs. Case-control studies compare the past diet as remembered by women with breast cancer with the past diets of similar women without breast cancer. Cohort studies assess the diets of healthy women and then follow them over time for the appearance of breast cancer and other diseases. The data obtained using this approach is less likely to be biased and these studies are considered more reliable. The results of the cohort studies have led many researchers to reevaluate the link between vegetables and fruits and decreased breast cancer risk.

Are there certain vegetables and fruits that may affect breast cancer risk?

It is possible that specific vegetables and fruits or combinations of vegetables and fruits may decrease breast cancer risk. Vegetables and fruits contain a number of chemicals, such as the dithiolthiones and glucosinolates from cruciferous vegetables, which have been demonstrated to inhibit the growth of cancer cells and cancer formation in animals. These chemicals have also been linked to decreased risk of other cancers. (See *“What do vegetables and fruits contain that could influence the risk of breast cancer?”* below). However, most existing studies of large groups of women have not examined vegetables and fruits individually. The results of those studies that have looked at individual foods are conflicting. One notable study, a pooled analysis, which gathered, combined, and reanalyzed the data from eight different cohort studies (total of 7,377 breast cancer cases) did not find a change in breast cancer risk when vegetables or fruits were examined as botanical families. They did observe decreases in risk linked to broccoli, Brussels sprouts, and spinach. But none of these reductions in risk were statistically significant, which decreases confidence in the results. Some case-control studies have shown promise for carrots and spinach as well as members of the broccoli (cruciferous) family. Some of these studies also found a significant dose response (eating more vegetables lead to greater reductions in risk). Both green and yellow vegetables have also shown promise in some studies. In addition, there is limited evidence that raw vegetables may be more protective against the development of breast and other cancers than cooked vegetables. This may be because some of the potentially protective chemicals found in vegetables are damaged by heat.

Citrus fruits have also been studied individually. The results of these studies have been variable. Any connection between citrus consumption and a change in breast cancer risk is uncertain.

What do vegetables and fruits contain that could influence the risk of breast cancer?

Researchers have identified and isolated many natural chemicals in vegetables and fruits (phytochemicals) that affect cancer risk. Some of these chemicals are shown in Table 1 below. Although these chemicals are available as supplements, it is important to recognize that supple-

Table 1: Natural chemicals in vegetables and fruits (phytochemicals) that affect cancer risk

Phytochemical	Major Dietary Sources	Potential Action
Carotenoids	Yellow and orange vegetables and fruits, and dark green leafy vegetables	Act as antioxidants. Help maintain immune function.
Ascorbic Acid (Vitamin C)	Citrus fruits, green peppers, cauliflower, broccoli, tomatoes, strawberries, cabbage, and leafy green vegetables	Acts as an antioxidant.
Folic Acid	Leafy green vegetables, asparagus, lima beans, broccoli, beets, and citrus fruits	Involved in the synthesis, repair and function of DNA.
Selenium	Mineral found in soil. Levels in vegetables depend on amount in soil.	Acts as an antioxidant. May also slow tumor growth, as well as stimulate the immune system.
Dietary Fiber	High amount in apples, blackberries, citrus, raspberries, broccoli, and legumes. Also found in whole grains.	May aid in the elimination of estrogens.
Dithiolthiones and Glucosinolates	Cruciferous vegetables, such as Brussels sprouts, cauliflower, cabbage, rutabaga and turnips	Stimulate detoxification systems in the body.
Phytoestrogens	Soy products, beans, peas, and bean sprouts	Potentially act as weak estrogens and decrease estrogenic activity. However, some studies have demonstrated an increase in estrogenic activity.

ments have, in most cases, not shown the benefits of the whole foods containing these chemicals.

There are many other natural chemicals in vegetables and fruits that researchers are currently studying. Information on the cancer preventing properties of these chemicals is preliminary and their concentration in various vegetables and fruits is still being determined. These natural chemicals include isothiocyanates and thiocyanates (in Brussels sprouts), flavonoids (in berries), coumarins (in citrus fruits), phenols (in almost all vegetables and fruits), protease inhibitors (in legumes), plant sterols (in vegetables), isoflavones, saponins, and inositol hexaphosphate (in soybeans), allium compounds (in garlic), limonene (in citrus fruit oils), and resveratrol (in grapes).

How might vegetables and fruits influence the risk of breast cancer?

It is biologically feasible that vegetable and fruit consumption could affect breast cancer risk. There are several ways that the natural chemicals found in vegetables and fruits might help reduce the risk of breast cancer and other cancers. Some of the mechanisms are listed below.

- **Stimulate cell differentiation and stop cell proliferation**

Cell differentiation is the process by which a cell in the body becomes functionally mature. Differentiated cells have a low proliferation rate. Cancer arises largely from proliferating cells which are not differentiated. Compounds in vegetables and fruits, such as

carotenoid-derived vitamin A, can encourage cells to differentiate and potentially protect against cancer formation.

- **Act as antioxidants**

Cells are exposed to oxidants from oxygen, some products of metabolism and from oxidant-producing toxins. Oxidants can damage various parts of cells including their DNA. Such damage can potentially lead to cancer formation. Vegetables and fruits contain many antioxidants, such as vitamin C and carotenoids. These chemicals can neutralize oxidants.

- **Increase activity of protective detoxifying enzymes**

Cells in the body are exposed to various toxins including cancer-causing compounds. These toxins can be deactivated and eliminated from the body by protective enzyme systems. Some chemicals in vegetables and fruits, such as dithiolthiones in broccoli, have been shown to increase the activity of the protective enzyme systems in the body.

- **Enhance immune function**

The consumption of vegetables and fruits may strengthen the immune system, which is the body's defense against various diseases including cancer.

- **Alter estrogen levels**

Estrogen is a hormone that is necessary for childbearing, but higher lifetime exposure to estrogen's actions is associated with higher breast cancer risk. Estrogen is normally metabolized to forms that have different strengths of action. Vegetables and fruits have compounds, such as glucosinolates in broccoli, that increase the metabolism of estrogen to weaker forms. This effect may change the lifetime exposure to estrogen's actions and decrease breast cancer risk.

- **Compete with naturally produced estrogen**

Phytoestrogens, or plant estrogens, may be weaker than the estrogens which occur naturally in the body. The weaker phytoestrogens may compete with naturally occurring estrogens and block their effects (some of which are linked to breast cancer risk). However, some studies have raised concern that phytoestrogens may not be so weak, and they may increase

rather than block estrogen activity (see BCERF Fact Sheet #1, *Phytoestrogens and the Risk of Breast Cancer*).

Are vegetarian diets associated with changes in breast cancer risk?

No clear link between vegetarian diets and a change in breast cancer risk has been found. Most studies have examined Western-style vegetarianism in women in the U.S., United Kingdom, and Germany. Five cohort studies have evaluated the risk of death from breast cancer in vegetarians compared to non-vegetarians. The data from these studies has been pooled and reanalyzed. This analysis found no association between death from breast cancer and eating a vegetarian diet. Although these results are weakened because the researchers did not account for known breast cancer risk factors in their analysis, all but one of the included studies came to the same conclusion. Further, the one conflicting study reported a statistically significant increase in breast cancer risk.

A problem with this area of research is that western style vegetarian diets are quite varied. Few studies have examined more defined vegetarian diets. One such study examined non-western vegetarian women living in England who had migrated there from India or east Africa. Most of these women were of the Hindu religion and did not eat any meat or eggs but did consume dairy products. In this study, women who were lifelong vegetarians or vegetarians since adulthood had a decreased risk of breast cancer compared to lifelong meat eaters. However, these results were weakened by a lack of statistical significance. Nonetheless, there were significant decreases in risk for women with high consumption of either vegetable dishes or dishes with peas, beans or lentils. Both these results were also supported by the demonstration of a significant dose-response effect for the relationship of the decrease in risk and the amount of the foods typically eaten.

Other studies of vegetarians have evaluated their levels of the hormone estradiol and one of its protein carriers in the blood. Estradiol is the most potent estrogen and its levels in the body have been associated with breast cancer risk. The steroid hormone binding globulin, one of the estrogen protein carriers, can strongly bind to estradiol and decrease its biological availability and action. Several studies have examined

the levels of estradiol and the steroid hormone binding globulin in premenopausal vegetarians and non-vegetarians. None of these studies have found a difference that was statistically significant between the vegetarians and non-vegetarians. The largest and best conducted of these studies reported that body mass index differences may have an important role in any differences found between these groups. Vegetarians have been shown to have less body fat and women's body fat can affect the levels of estradiol and the binding protein.

Does the consumption of vegetables and fruits have different effects among premenopausal versus postmenopausal women?

The relationship between vegetable and fruit consumption and breast cancer risk does not appear to be affected by women's menopausal stage. The causes of pre- and postmenopausal breast cancer, although not well understood, may be different. Thus, it is possible that their risk factors could be different. Several studies have reported that premenopausal women who ate a lot of vegetables had a larger decrease in breast cancer risk than postmenopausal women who ate a lot of vegetables. But most studies, including a pooled analysis of cohort studies, have not detected any risk difference between pre- and postmenopausal women.

Could some women benefit more than others from eating vegetables and fruits?

There are suggestions but no clear demonstration that some women may benefit more than others from eating vegetables and fruits. For example, one cohort study conducted as part of the Nurses Health Study examined the breast cancer risk of premenopausal women with a family history of breast cancer. This study found that women with a family history of breast cancer who ate the most vegetables and fruits had a relative risk of breast cancer which was less than one third (29 percent) that of similar women who ate the least vegetables and fruits.

Other supportive studies have examined the effects of diet in women with differences in genes which are thought to protect against cancer. Three studies support the idea that one form of the gene for the enzyme manganese superoxide dismutase is linked to increased breast cancer risk. The enzyme product of this gene can

inactivate toxic free radicals and is thought to play a role in the defense against cancer. One of these studies also examined vegetable and fruit consumption in women who had and did not have the high risk form of the gene. They found that women who ate large amounts of vegetables and fruits and had the high risk gene still had elevated risk of breast cancer but their risk was substantially less than women with the high risk gene who ate small amounts of vegetables and fruits. Similar suggestions for other genes and types of cancer exist in this area of research which is rapidly expanding.

Is eating vegetables and fruits helpful for women who already have breast cancer?

Studies of the effect of diet after diagnosis on the survival of women with breast cancer show promise for vegetables but not fruits. While the increase in survival has only been evaluated in two studies and is not established, it was of reasonable size. One of these studies examined the Nurses Health Study cohort and reported that in a group of 1,237 women whose breast cancer had not metastasized to the lymph nodes, the highest levels of vegetable consumption were significantly associated with as much as a 47 percent decrease in the risk of death. A smaller study of 377 women reported an even more substantial but not statistically significant decrease in the risk of death. Some studies which evaluated diet before diagnosis have also reported a beneficial effect. More study is needed to confirm this effect. For more information please see BCERF Fact Sheet #44 *Diet and Lifestyle and Survival from Breast Cancer*.

Is eating vegetables and fruits associated with changes in the risk of other types of cancer?

The International Agency for Research on Cancer recently evaluated the evidence for a link between a diet rich in fruit and vegetables and decreased cancer risk. They concluded that the evidence from human studies, animal studies, and mechanistic studies, indicates: "that higher intake of fruit *probably* lowers the risk of cancers of the esophagus, stomach and lung, while a higher intake of vegetables *probably* lowers the risk of cancers of the esophagus and colon-rectum. Likewise, a higher intake of fruit *possibly* reduces the risk of cancers of the mouth, pharynx, colon-rectum, larynx, kidney and urinary bladder. An increase in consumption of vegetables *possibly* reduces the risk of cancers of the

mouth, pharynx, stomach, larynx, lung, ovary and kidney.”

Recent studies have changed the prevailing view of the association of a diet high in vegetables and fruits with the risk of cancer, in general. The idea that the relationship is strong and that it broadly affects many cancers has been brought into question. The prevailing opinion is that a decrease in risk exists for the cancers listed above and that there is potential for diets high in vegetables and fruits to have modest benefits for cancer prevention in general.

Is eating vegetables and fruits associated with other health benefits?

A diet high in vegetables and fruits has been clearly linked to a decrease in the risk of the major cause of death in this country, cardiovascular disease. Both types of cardiovascular disease, coronary heart disease and stroke, are affected. Several studies of the largest cohorts have found a statistically significant 20 percent decrease in the risk of heart disease and a 30 percent decrease in the risk of stroke for a group that included men and women. There also appeared to be a trend or dose-response for this effect, that is, eating more of these foods was progressively linked to a greater decrease in risk. The lowest risk of coronary heart disease and stroke was reported for the group that ate the most servings of vegetables a day. Intermediate changes in the risk of both of these diseases were linked to eating smaller amounts of vegetables and fruit.

A positive effect of vegetable and fruit consumption on bone health has also been demonstrated in recent years. The size of this effect remains to be seen. Although vegetables and fruits are not directly involved in diabetes and obesity, a diet high in vegetables and fruits is frequently recommended as a prudent preventive measure for these diseases.

What can women do now?

Although the health benefits of vegetables and fruits, especially against cancer, are not as great as once thought, they still remain substantial. It makes good sense to increase the number of servings and variety of vegetables and fruits eaten daily. In addition, eating plenty of vegetables and fruits helps in maintaining a healthy weight.

There are many ways to easily and conveniently add more vegetables and fruits to our diets.

Easy examples would include the following:

- Keeping prepared vegetables in the refrigerator for snacks
- Substituting spinach or another dark green leafy vegetable for iceberg lettuce in salads or sandwiches
- Eating a sweet potato instead of a white potato
- Eating fruit as a snack
- Drinking fruit or vegetable juice instead of soda
- Think of lentil and bean soups when your menu calls for a hearty meal.

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We hope you find this fact sheet to be informative. We welcome your comments. (BCERF, Sprecher Institute for Comparative Cancer Research, Vet Box 31, Cornell University, Ithaca, NY 14853-6401; phone (607) 254-2893, FAX: (607) 254-4730, Email: breastcancer@cornell.edu).