SPRECHER INSTITUTE for Comparative Cancer Research

Program on Breast Cancer & Environmental Risk Factors

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TOPICS

Dietary Carbohydrates and Breast Cancer Risk

Although it is recommended that carbohydrates make up more than half our intake of calories, there are certain aspects of their metabolism that have been examined for an association with breast cancer risk. Carbohydrates in our diets affect the body's levels of blood glucose (blood sugar) and the hormone insulin. Several lines of evidence suggest that insulin levels may directly or indirectly affect breast cancer risk. This hypothesis has prompted research on dietary carbohydrates and their possible relationship to breast cancer risk.

Aspects of carbohydrate metabolism that have been examined for a relationship to breast cancer risk can be divided into three categories: studies of the direct effect of dietary carbohydrates themselves, studies of the effect of carbohydrates that can potentially lead to large changes in blood glucose levels, and studies of the effect of insulin levels. At this point, all of these aspects of carbohydrate metabolism have an uncertain relationship to breast cancer risk. There is evidence of a weak association between type 2 diabetes and breast cancer risk, but this association needs to be confirmed in further research. This potential association may be due to the diabetes itself or may possibly arise from diabetes-related conditions such as obesity. A moderate increase in breast cancer risk is associated with obesity in postmenopausal women. More study is needed in this area but the dietary recommendation that carbohydrates from whole grains, fruits, vegetables and other high fiber foods make up the major source of calories in a healthful diet still rings true.

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What are carbohydrates?

Carbohydrates are energy producing nutrients found largely in plant-derived foods such as grains, fruits, and vegetables. Plants use carbohydrates as a way to store energy. The main sources of carbohydrates in the American diet are wheat, potatoes, rice, and sugar. These products are available in both unrefined and refined forms. For example white flour is a refined product of whole wheat flour. BCERF fact sheet #36, Whole Grains, Fiber, and Breast Cancer Risk examines whole grains and breast cancer risk. This fact sheet will examine dietary carbohydrates in general and evidence for their possible links to breast cancer risk.

Why are carbohydrates an important part of our diets?

The Dietary Guidelines for Americans 2005 recommends that 45-65% of caloric intake be in the form of carbohydrates. Dietary carbohydrates are our major source of food energy or calories. They are also a source of glucose which has an important role as the sole source of fuel or energy for the brain and other nervous tissue. This takes on further importance as these tissues are unable to make or store glucose which must be continually provided to the nervous tissues by circulating blood. Because of this, glucose concentrations are tightly regulated in the blood by hormones which control its storage and production in the body. The two main hormones that regulate blood glucose are insulin and glucagon.

Why might dietary carbohydrates be related to breast cancer risk?

Whether there is a link between dietary carbohydrates and breast cancer risk is not clear. It has been hypothesized that such a link might be related to the effect of glucose on insulin levels in the body. The glucose absorbed into the blood stream after the digestion of carbohydrates stimulates the release of the hormone insulin from the pancreas. Insulin affects the action of other hormones in the body including insulin-like growth factor (IGF) and possibly estrogen. A number of studies have suggested that higher blood levels of IGF may be linked to an increased risk of premenopausal but not postmenopausal breast cancer risk. Increased levels of estrogen in the body have been clearly linked to increased breast cancer risk.

In laboratory studies, insulin has been shown to increase the proliferation of normal and cancerous breast cells. So far, studies of the relationship of insulin and its metabolic products to breast cancer have been inconsistent (discussed in more detail below). Much more research is needed to understand this relationship.

What are the results of studies that have examined the association of eating carbohydrates and breast cancer risk?

There is currently little evidence that eating carbohydrates, in general, is associated with breast cancer risk. This relationship has been evaluated in 17 case-control studies and seven cohort studies. The results from both types of studies have shown no clear association between carbohydrates and breast cancer risk. Some of these studies have looked at the source of the carbohydrate, whether it was derived from sugars or starches. But no consistent difference in type of carbohydrate has been found either.

Some carbohydrate-containing foods have a larger effect on blood glucose levels. Do these foods have a different association with breast cancer risk?

Some scientists have hypothesized that the effect of dietary carbohydrates on health may be related to the ability of a food containing carbohydrates to change blood glucose levels. To study this effect, scientists have measured what is known as the glycemic index of foods. The glycemic index of a food is a measure of the potential of foods to lead to a change in the blood glucose levels. Blood glucose levels are important to the health of people with diabetes, and this measure

was developed to help diabetics with food choices. Understanding the glycemic index of foods may also be helpful in understanding the relationship of carbohydrates to breast cancer because blood glucose levels affect insulin levels in the body.

The glycemic index of a food involves the comparison of a test food to a standard or reference food. It compares: 1) the change in blood glucose after consumption of the amount of a test food that contains 50 grams of carbohydrates; to 2) the change in blood glucose after consumption of the amount of a reference food which also contains 50 grams of carbohydrates. Different foods contain varying amounts of carbohydrates and since the glycemic index is based on changes after eating 50 grams worth of carbohydrates (not food) the amounts of the two foods consumed for determination of this index can be very different. Thus, the glycemic index of a food can also be seen as a measure of the availability of glucose from the test food after digestion.

Two reference foods are typically used in measuring glycemic index, white bread and glucose itself. They were chosen because they are known to lead to a large and rapid increase in blood glucose. The glycemic index of a food is determined over a two hour period so the rate of digestion of foods to produce glucose is an important factor in its determination. White bread and glucose, the references, are assigned a glycemic index value of 100. Foods with a glycemic index less than 100 produce a smaller total change in blood glucose over the two hour period than the reference food. Foods with a glycemic index greater than 100 lead to a larger total change in blood glucose than the reference food over this period.

The use of the glycemic index has been criticized. First, the reports of glycemic index values of food are quite variable. This is not surprising as blood glucose levels can be affected by a number of conditions including: what reference food is used, differences between the people who participate in the research, differences in the time of day when people are tested, differences in a person from one day to another, the chemical nature of the test food's glucose source, the form of the food (including its processing and cooking), how fast the food is consumed, and the amount and volume of the test food.

Second is the criticism that meals and diets are made up of multiple, not singular, foods. Protein, fat and fiber may have a small effect on blood glucose levels. Effects on carbohydrate digestion and metabolism by other food components such as fat can also affect the resulting blood glucose levels and the actual glycemic index of the diet.

Third, there is also the criticism that the glycemic index is not very practical. The glycemic index is based on the amount of the test food that contains 50 grams of carbohydrate. This amount may be very different from a typical serving of the food. Using an extreme example, a high glycemic index food could contain very little carbohydrate per unit weight of the food but the glucose within the food could be very available following digestion. While the glucose within the food is readily available, the typically sized serving of the food contains much less carbohydrate (and glucose) than the 50 grams that was originally tested. For this reason, it would have little effect on blood glucose. A related measure, the glycemic load, takes these features into account and is discussed below.

Is there a relationship between the glycemic index of women's diets and their breast cancer risk?

Epidemiologic studies have examined whether the glycemic index of women's diets is associated with breast cancer risk. Two case control studies and seven cohort studies have examined this issue. The results of these studies have not been consistent. Most of these studies have divided the women under study into subgroups based on their menopausal status, their physical activity, their body weight and height, or the

estrogen and progesterone status of breast tumors (if they have developed breast cancer). Results from some of these studies did report an increase in breast cancer risk among groups who also consumed a diet with a high glycemic index. However, there are currently not enough studies of any one type to draw any solid conclusions about the relationship of breast cancer risk to the glycemic index of the diet.

What is glycemic load?

Glycemic load is a measure of the amount of glucose available to the bloodstream from a food or a diet. Glycemic load takes into account both the glycemic index of a food and the amount of carbohydrate in a serving of the food. Many scientists think that glycemic load is a more biologically realistic measure of the effect of carbohydrates in the diet on blood glucose.

Is there a relationship between the glycemic load of women's diets and their breast cancer risk?

Like the studies of glycemic index, the studies looking at glycemic load and breast cancer risk have produced inconsistent findings and any association with breast cancer risk is unclear overall or in any subgroups of women.

Since a possible way for carbohydrates to be linked to breast cancer risk is through their effect on insulin levels, is there a relationship between diabetes and breast cancer risk?

Diabetes mellitus can be broadly distinguished as a group of diseases distinguished by high blood glucose. Type 1 diabetes is characterized by a complete loss of insulin due to immune system destruction of the cells in the pancreas that produce insulin. Type 1 diabetes accounts for 5% to 10% of all cases of diabetes. Type 2 diabetes is characterized by initially high insulin levels due to loss of the body's responses to this hormone. This condition progresses in its later stages to exhaustion of the pancreatic cells that produce insulin and loss of insulin. More than 90% of the cases of diabetes are type 2 diabetes. This disease affects 7% of adults and about 15% of people over 60. Being overweight or obese is a risk factor for type 2 diabetes.

Two cohort studies of the relationship between type 1 diabetes and breast cancer risk found no association. More research has looked at the relationship between type 2 diabetes and breast cancer risk. Six cohort studies and four case-control studies have examined this relationship. The majority of the studies reported a moderate increase in breast cancer risk among women with diabetes. A meta-analysis, or combined reanalysis, of the cohort studies reported a statistically significant relative risk of 1.25. Meta-analysis of the case-control studies reported a similar value of 1.13. These values represent a weak increase in risk and do not lend a great deal of confidence in an association. The current evidence suggests that diabetes may be associated with weak risk of breast cancer. However, it is possible that conditions related to diabetes, such as obesity, may play a role in this effect.

Have other aspects of insulin and its functioning been studied in relation to breast cancer risk?

Three other aspects of insulin and its functioning have been studied for a possible relationship to breast cancer risk. They are the levels of insulin itself, the levels of a breakdown product of insulin (C-peptide), and levels of blood glucose.

Two cohort studies and three case-control studies have examined blood levels of insulin for a relationship to breast cancer risk. Only one of these studies reported a statistically significant association between breast cancer risk and insulin levels. Two other studies reported no association. The lack of an association between the duration or dosage of insulin treatment in diabetics and breast cancer risk has also been reported.

Two case-control studies have examined C-peptide. This compound is a breakdown product of insulin that is slowly eliminated and gives a better idea of insulin production over time than measurement of insulin itself. Both of these studies reported a positive association between C-peptide and breast cancer risk but their study design raises concern about the reliability of these studies.

Three studies have examined blood glucose levels and breast cancer risk. Two of these were cohort studies. Both reported a weak non-significant increase in breast cancer risk with higher blood glucose. The single case-control study reported a statistically significant association with an increase in risk for premenopausal women only.

The inconsistency of these studies does not provide much support for a relationship between the insulin pathways and breast cancer risk.

Have any studies evaluated the effect of carbohydrates on survival from breast cancer?

No studies have reported an influence on survival from breast cancer of the carbohydrate content, glycemic index or glycemic load in women's diets either before or after breast cancer diagnosis.

What can women do now?

Currently, there is little evidence suggesting that women should limit the carbohydrate content of their diets to reduce risk of breast cancer. Carbohydrates from whole grains, fruits, vegetables, and other high fiber foods are a healthful part of our diets and as The Dietary Guidelines for Americans 2005 has recommended should make up 45-65% of our intake of calories consistent with maintaining a healthy weight. ■

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A complete bibliography of references used in the preparation of this fact sheet is available on the BCERF web site at http://envirocancer.cornell.edu

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