THE LINK BETWEEN DIET AND CANCER

Cancer has gradually become one of the most important pathologies associated with both significant physical or psychological suffering and important financial costs that put a strain on economy. Identifying cancer risk factors is a constant goal of many epidemiological studies and recent data indicates that lifestyle is a major contributor to the general increase in cancer incidence. Currently, diet, obesity and the lack of physical exercise are believed to be responsible for at least 35% of all human cancers. In under-developed countries, a diet that lacks certain nutrients and vitamins, together with improper conditions for food storage and other discrepancies between food requirements and daily intake are the main mechanisms responsible for diet-related cancer. In developed countries, high-fat, sugary diet, food additives and obesity are believed to increase cancer risk (1, 2).

The relationship between diet and cancer risk is complex. Diet can (1) represent a source of procarcinogens or carcinogens, (2) increase carcinogen formation through transforming nitrates and nitrites (abundantly found in some types of food and/or in water) in nitrosamines, (3) modulate carcinogenic effects or (4) modify gene expression through epigenetic regulative processes.

Thermal food processing can result in carcinogenic byproducts. For instance, frying or smoking meat can lead to the formation of polycyclic aromatic hydrocarbons such as benzopyrene. Smoked meat and smoked fish consumption have been linked to gastric cancer in countries with high intake, such as Japan. Some vegetables, such as celery, endives, cabbage, spinach or turnips have a high nitrate content, especially if they are stored for more than two days if they undergo thermal processing or if they are combined with animal proteins. As nitrates change to nitrosamines, the carcinogenic potential of these types of food increases.

Most of the processes through which food is conserved can increase the risk of cancer. Both salt and salting as a conservation technique have been linked to gastric cancer. Some additives or food preservers, currently used for adding color, taste, aroma or consistency have mutagenic potential, which is why some have been withdrawn from the food processing industry. Nitrates, sometimes used as food preservers for meat, are transformed in the gastrointestinal tract into nitrites if a Helicobacter Pylori infection is present. Nitrites then combine with secondary amines to form nitrosamines, which is why any type of food that contains nitrates should be consumed in moderation. Also, a high saccharine intake has been linked to bladder cancer in mice. However, currently there is no evidence to link saccharine consumption and cancer risk in humans.

Diet can also act as a protection against cancer. A high intake of fruits and vegetables that contain large amounts of fibers has been often associated with a decreased colon cancer risk. Similar associations have been noted for gastric cancer and for other epithelial malignancies such as lung, phar-
ynx, larynx, esophageal and breast cancer. Consuming large amounts of food that contain phytoestrogens (selective estrogen modulators) may contribute to primary and secondary prophylaxis of endocrine-dependent cancers.

Among xenobiotics, the following associations are currently considered scientifically valid:

- a diet rich in saturated fats is associated with an increase in colon, breast, prostate and endometrial cancer;
- deep-fried meat contains polycyclic amines, linked with gastric, colon, rectal, pancreatic and breast cancers;
- diets which exceed the daily recommended caloric intake increase the risk of biliary, breast, endometrial, colon and prostate cancer;
- an excess of animal proteins, particularly from red meat, are associated with breast, colon and endometrial cancer risk;
- excessive alcohol consumption is linked with oral, pharynx, larynx, liver and esophageal cancers, especially in combination with smoking;
- a high-salt diet and smoked meat consumption is associated with esophageal and gastric cancer;
- food preservers and food additives are associated with intestinal cancer (3, 4).

**Red meat intake**

As previously mentioned, both red meat (beef, pork, lamb, horse) and processed meat (salami, pastrami, ham, or other types of meat preserved by means of salting, smoking, deep frying or adding food preservers) increase the risk for pancreatic, colon, rectal, breast, kidney and prostate cancer. Eating red meat more than one time per week increases colon and rectal cancer risk by approximately 40%, whereas each additional 50g/day of processed meat increases cancer risk by 20%.

One of the most popular theories that explains the relationship between red meat intake and cancer risk is that red meat has a high hemoglobin content which irritates the colon and rectal mucosa and leads to an electrophilic aggression that initiates carcinogenesis. One other mechanism is the transformation of red meat amino acids in aggressive intermediate compounds that react with nitrates and nitrites in the bowel, a chemical reaction catalyzed by the hem from hemoglobin. The recommended amount of red meat intake is 500 g/week (a maximum of 5 meat servings/week). Also, current healthy eating guidelines advice against eating meat prepared by means of deep frying.

**Vegetable products**

Most types of food believed to protect against cancer have vegetable origin. Starch-free vegetables protect against upper gastro-intestinal cancers: oral cancers, pharynx, larynx, epidermoid esophageal cancers, gastric adenocarcinomas, colon and rectal cancers, pancreatic, breast and bladder cancer. A high fruit intake protects against oral and pharynx cancers, esophageal, lung, colon and rectal cancers. There is some evidence suggesting that garlic intake protects against colon and rectal cancers and a high tomato intake protects against prostate cancer (most likely due to the high amount of lycopene found in tomatoes).

The protective effect against cancer found for both fruits and vegetables is most likely due to a high content of vegetable
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fibers, specific vitamins and certain bioactive compounds such as carotene (found in “red vegetables”), folates (found in “green vegetables”), glycosylates (brassica) and alkyl sulfates (garlic).

Current guidelines recommend a daily vegetable intake of 600-800 g/day and eating at least two fruits to decrease breast, colon, rectal and pancreatic cancer risk. Of these, at least 400 g/day (preferably divided into five portions) should consist in starch-free vegetables, fruits or unprocessed seeds (6). Some additional information regarding the choice of fruits and vegetables:

- the highest number of antioxidants can be found in strawberries, raspberries, blackberries and wild berries (“small red fruits”);
- vitamins C, E and A, together with Q coenzyme, lycopene, melatonin, quercetin, Selenium and Zinc represent natural antioxidants;
- vitamin C has a strong antioxidant and anticancer effect and can be found in several types of fruits such as: blackberries, cranberries, broccoli or red cabbage. Because most of the vitamins are photosensitive, fruits should be stored in a dark dry place;
- vitamin A is found as β-carotene in: carrots, spinach, broccoli and green cabbage. Heavy smokers (more than one pack of cigarettes/day) should avoid vitamin A supplements because they have been linked with an increase in lung cancer incidence for this population group;
- vitamin E can be found together with unsaturated fatty acids in eggs, meat, fish, cereals, seeds, nuts and soy. Some studies have linked a high vitamin E intake with a protective effect against prostate cancer;
- starch-free vegetables have a low caloric count and a diet rich in these vegetables also protects against gain weight.

Other types of food and cancer risk

Phosphoric calcium may reduce colon cancer risk through its ability to bind biliary acids and free fatty acids, thus blocking their effects on the gastro-intestinal tube.

A high milk intake could increase prostate cancer risk through increasing blood Calcium levels and insulin-growth factor 1 (IGF-1) (5, 6). High Calcium levels inhibit 1,25-dihydroxyvitamin D formation, which could in turn stimulate prostate cell proliferation.

Omega-3 unsaturated fatty acids that are found in high concentrations in fish oil protect against several types of cancer and exhibit cardiovascular protective effects. However, there is one study that linked a high fatty acid intake to prostate cancer.

Obesity

After reviewing all epidemiological studies performed in the past thirty years, the International Agency for Research on Cancer (IARC) has recently determined that obesity is an important risk factor for several types of cancer. Obesity is responsible for the death of one in seven males and one in five females in the United States and accounts for 4% of male cancers and 7% of female cancers in the European Union. The link between cancer and obesity is quite complex (1, 3). Each five-kilogram weight gain is associated with a 1.08 increase in breast cancer in menopausal women. Each one-unit increase in the Body Mass Index increases breast cancer risk by 3%. In the United States, obesity is responsible for 20% of all breast cancers in men-
opausal women and 50% of all breast cancer-related deaths in this population group.

Being overweight is one of the most important risk factors for several types of cancers such as: colon cancer, breast cancer (in menopausal women), endometrium cancer, esophageal adeno-carcinoma, pancreatic and kidney cancer and, to a certain extent, biliary cancer (4).

Some more information regarding obesity-related cancers:

a) endometrial cancer risk in women with a more than twenty-kilogram weight gain after the age of eighteen is five times higher than in the normal population;

b) colon cancer incidence is significantly higher in both men and women that are obese;

c) obesity increases likelihood of kidney cancer especially in women, although the exact mechanism is not yet understood;

d) esophageal cancer: obese individuals have a higher incidence of gastro-esophageal reflux disease (GERD), which is associated with Barret’s esophagus, a precursor metaplastic lesion. People with Barret’s esophagus have a higher risk for esophageal adenocarcinoma. However, some studies indicate that the link between esophageal cancer and obesity is independent of GERD;

e) other cancers for which the link with obesity is not yet fully certified: pancreatic cancer (risk is increased 2x for obese individuals), hepatic cancer, cancer of the cardia (most likely due to Barret metaplasia), ovarian and cervical cancer (limited data) and lymphoma. Additional epidemiological studies are required to firmly link these cancers to obesity.

Lucian Miron, M.D., Ph.D.,
Professor of Oncology
“Grigore T. Popa” University of Medicine and Pharmacy Iasi

REFERENCES