Consumption of Processed Red Meat Increases the Risk of Colorectal Cancer

**Tag Words:** Colorectal cancer, Red Meat, Processed Meat, N-nitroso compounds, Heterocyclic amines, Polycyclic Aromatic Hydrocarbons, Protein-rich Diet, Paleolithic Diet, Mediterranean Diet

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**Summary:**
Epidemiological studies have shown that populations that consume high amounts of red and processed meats are at an elevated risk for developing colorectal cancer. This risk can be lowered by reducing or eliminating from one’s diet, the consumption of processed meat and by properly cooking fresh red meat; including cooking at lower temperatures and marinating the meat prior to cooking. We shared this information on the Wikipedia ‘Red Meat’ page.

**Video Link:** [https://www.youtube.com/watch?v=ORknRwQXcmw](https://www.youtube.com/watch?v=ORknRwQXcmw)

**Cancer and the influence of diet and genetics (NA)**

In the USA, one of the leading causes of death is cancer (1). According to the 2002 World Health Report, cancer is a prevalent health problem that is responsible for about 7.1 million deaths every year worldwide. In 2003, World Cancer Report predicted that in the next 20 years, the deaths due to cancer will increase by 50% (2).

Environmental factors can generate spontaneous cancers. In addition, having a genetic predisposition to cancer can increase the incidence of certain types of cancers in specific populations (3). However, many types of cancer can be prevented by making wise lifestyle choices. Therefore, if possible, there is a need to find ways to prevent the occurrence of cancer. As the saying goes, ‘Prevention is better than cure’. In developed countries, the disease trends have shifted from the infectious diseases killing the population to the chronic maladies such as cancer, diabetes and heart disease. Prophylactic medicine is the primary form of assurance to prevent an epidemic of deaths due to cancer.

**Colorectal Cancer (SM)**

Colorectal cancer is present in the cells of the colon and the rectum in humans. These structures are part of the large intestine. The most common cells that become malignant are the epithelial cells of these structures, due to a defect in the ‘Wnt’ signaling pathway. This is a crucial pathway when it comes to the study of oncogenesis, the production of tumors. It is a signal transduction pathway that through the cell surface receptor transforms signals from the outside to the inside of the cell (4). This is one of the causes of colorectal cancer; what leads to the initial mutation is thought to be caused by variety of reasons.

The prognosis of colorectal cancer is quite grim. Therefore, the need to prevent its onset is crucial. In the USA, in a lifetime, there is 4.7% risk of developing a colorectal cancer and the 5
year survival rate is about 64.7% (5). In the African countries, 1 in 3 people diagnosed with the
disease die and in the European countries, the 5 year survival rate is slightly about 55% (1).

The most common symptoms associated with colorectal cancer are blood in the stool, dramatic
weight loss, and constant fatigue. Procedures like colonoscopy or sigmoidoscopy are used to
confirm the incidence of colorectal cancer by either visualization through the scope or collecting
a tissue sample of the colon and sending it to the laboratory for microscopic analysis (3).
Once confirmed, the procedures to remove the cancer are similar to the most other forms of
cancer with some differences. Chemotherapy is usually employed to lower the size of the tumor
and then laparoscopically, a tumor can be removed from the large intestine. Once this is done,
cancer is handled via follow ups like colonoscopy procedure to make sure it does not re-emerge
in the body (6). A few drugs, like Aspirin and Celecoxib (an NSAID), have been shown to lower
the incidence of colorectal cancer (1).

Inflammatory bowel syndrome (IBS) in the form of either ulcerative colitis or Crohn’s disease
can lead to colorectal cancer. The longer someone is affected with IBS, the higher the risk of
getting colorectal cancer (3).

Genetic Predisposition (NA)
A person’s genetic make-up depends on the genes passed on by his parents. Genetic factors
cannot be altered. Genetic predisposition to colorectal cancer contributes to about 5% of all the
colorectal cancer cases. Certain genetic variations inherited from either of the parent result in
genetic predisposition. However, weightage of each factor varies from person to person. An
entire family might be predisposed, however, only few members of the family or a single
member might actually get the disease.

There are signs that may indicate that a person or family is predisposed to bowel cancer; some of
these are as follows (7):

- Many individuals on either maternal or paternal side of the family have a history of CRC
  or other cancers like stomach, ovary, uterus, or urinary tract.
- Incidence of CRC usually occurs after the age of 50. However, an early diagnosis below
  the age of 50 can raise some questions.
- Occurrence of multiple polyps in the large intestine. Lynch syndrome and familial
  adenomatous polyposis (FAP) are two inherited syndromes characterized by numerous
  polyps.

In a study performed by scientists from England, the stool samples from high red meat eating
volunteers and vegan diet eating volunteers were collected and then tested. What was found is
that high red meat eating volunteers had higher levels of these chemicals called N-nitroso
compounds or NOCs. The possible link may be due to the NOCs and, in genetically predisposed
population (in which an individual has had 1-2 first degree relatives) this may exponentially
increase the risk of CRC. The reason may be because NOCs cause extensive oxidative stress and
genetic damage; a mixture of these two things disrupting pathways and regular function of cells
in the colon/rectum of the large intestine may overall cause cancer. It has been shown that the
body can repair the DNA for some of the damage caused but if there is already a genetic
predisposition and then the constant and recurring damage caused by a high red meat diet, the
body may not be able to repair the tissue. It has been shown that with Vitamin D, fiber and calcium in the diet, the amount of NOCs secreted by high meat eating individuals was reduced to intermediate levels (7).

Factors which affect the incidence of colorectal cancer (SM)
Genetic factors, environmental factors and lifestyle all contribute to the development of colorectal cancer. As multiple factors are responsible for the occurrence of the disease, it is termed as ‘multifactorial’ (2). However, modification of lifestyle and environmental factors can reduce the disease risk in genetically predisposed populations (8). For example, risk for colorectal cancer increases with an increased consumption of diet that includes a high amount of red and processed meats (9). Therefore, the risk of developing colorectal cancer can be reduced if individuals are willing to make educated decisions about their diet and lifestyle. In addition, the onset of colorectal cancer may be prevented by various supplements like calcium and vitamin D, not smoking, lower intake of processed red meat, and getting adequate physical exercise (10).

Relationship between diets high in red & processed meats and increased risk of colorectal cancer

1. Epidemiological Studies (NA)
In 2005, two large studies were done in Europe and the United States. In Europe, the research was done on about 478,000 people who were cancer-free during the beginning of the study. They were divided into two main groups, one that consumed an average of 5 or more ounces of red meat per day and the other that consumed an average of one or less ounce of red meat per day. They found that the group that consumed more red meat was about a 1/3rd more likely to get colon cancer. However, the colorectal cancer risk reduced by the same amount in the people from this group when they consumed more fish. White meat like chicken did not appear to be associated with colorectal cancer. The US study presented similar results as they reported an increased incidence of colorectal cancer in the 148,000 subjects studied that consumed high amounts of red and processed meats. A meta-analysis of 29 studies suggested that the colorectal cancer risk increases by 20% and 28% by the consumption of processed and red meat respectively (9). In 2001, another meta-analysis of 13 studies conducted until 1999 suggested that an increase in consumption of processed meat by 25 g/day and red meat by 100 g/day is linked to an increase in about 49% and 12-17% of colorectal cancer cases respectively (11).

A study at the University of Southern California reported a relationship between processed meat consumption and the occurrence of colorectal cancer. An analysis of genetic variants and the consumption of processed red meat was studied in about 18,000 people from the United States, Canada, Australia, and European countries. In humans, GATA3 is a gene present on chromosome 10, encoding a transcription factor that plays an important part in the immune system. Various forms of cancer are linked with this gene. From this study, it was found that processed meat interacts with a genetic variant present near the GATA3 gene. The exact mechanisms are unknown; however, this finding represents a possible interaction between diet and DNA. Further analysis is required in order to know the molecular mechanisms (12).

2. The culprit: the processing and cooking of red meat (NA)
Meat that is deep-red in color mostly comes from adult mammals like cow and sheep. Myoglobin is a protein present in the muscle tissues of vertebrates that gives it a distinct red color. It contains heme and its concentration is directly proportional to the intensity of the red color. The darker the meat, the higher the concentration of the protein, and therefore, the higher the concentration of heme (13). Pale, light colored meat such as poultry is considered white. There are no studies that relate white meat to the risk of colorectal cancer. Heme iron from animal sources is known to be absorbed more readily than the iron from plant sources (14).

Table 1: Sources of heme iron (14)

<table>
<thead>
<tr>
<th>Food (3 oz)</th>
<th>Iron (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver of beef - braised</td>
<td>5.8</td>
</tr>
<tr>
<td>Lean sirloin - broiled</td>
<td>2.9</td>
</tr>
<tr>
<td>Lean ground beef - broiled</td>
<td>1.8</td>
</tr>
<tr>
<td>Chicken breast without skin, dark meat roasted</td>
<td>1.1</td>
</tr>
<tr>
<td>Chicken breast without skin, white meat roasted</td>
<td>0.9</td>
</tr>
<tr>
<td>Lean, pork, roasted</td>
<td>0.9</td>
</tr>
<tr>
<td>Bone canned salmon</td>
<td>0.7</td>
</tr>
</tbody>
</table>

The redder the meat, the more heme, the higher the risk of carcinogenesis (NA)
Cohort studies have shown that heme iron increases the risk of colorectal cancer. Metabolism of heme in the colon promotes the production of carcinogenic compound N-nitroso (NOCs), which increases the proliferation of cells and the production of cytotoxic aldehydes by the process of lipid peroxidation (15). Exact mechanisms are unknown yet. However, a recent cohort study in Netherlands suggests that dietary intake of heme iron causes mutations in APC and KRAS genes (see Table 2) (16). APC (adenomatous polyposis coli) is a tumor suppressor gene (17) and KRAS (Kirsten ras) gene is involved in the regulation of cell division (18).

Table 2: Basic characteristics of the group and the data table from the Netherlands Cohort Study: (16)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Sub cohort</th>
<th>Colorectal cancer cases</th>
<th>Colon cancer cases</th>
<th>Rectum cancer cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>4026</td>
<td>644</td>
<td>435</td>
<td>140</td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>61.3±4.2±</td>
<td>62.8±4.1</td>
<td>62.9±4.1</td>
<td>62.3±4.0</td>
</tr>
<tr>
<td>Sex (male)</td>
<td>49.8%</td>
<td>56.5%</td>
<td>54.1%</td>
<td>65.7%</td>
</tr>
<tr>
<td>Total heme iron intake (mg/day)</td>
<td>1.1 ± 0.5</td>
<td>1.1 ± 0.5</td>
<td>1.1 ± 0.5</td>
<td>1.1 ± 0.4</td>
</tr>
<tr>
<td>Characteristics</td>
<td>Sub cohort</td>
<td>Colorectal cancer cases</td>
<td>Colon cancer cases</td>
<td>Rectum cancer cases</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>------------</td>
<td>-------------------------</td>
<td>--------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Total fresh meat intake (g/day)</td>
<td>99.5 ± 41.7</td>
<td>99.0 ± 37.5</td>
<td>99.5 ± 36.3</td>
<td>96.2 ± 38.4</td>
</tr>
<tr>
<td>Total processed meat intake (g/day)</td>
<td>14.3 ± 15.6</td>
<td>14.9 ± 16.3</td>
<td>14.8 ± 15.9</td>
<td>14.8 ± 13.8</td>
</tr>
<tr>
<td>Chlorophyll (mg/day)</td>
<td>52.2 ± 29.5</td>
<td>52.3 ± 27.4</td>
<td>51.3 ± 26.9</td>
<td>52.1 ± 27.4</td>
</tr>
<tr>
<td>Vegetables (g/day)</td>
<td>194.1 ± 82.1</td>
<td>193.6 ± 85.0</td>
<td>191.6 ± 81.5</td>
<td>193.1 ± 92.0</td>
</tr>
<tr>
<td>Energy intake (kJ/day)</td>
<td>8072 ± 2161</td>
<td>8094 ± 2018</td>
<td>8057 ± 2007</td>
<td>8343 ± 1891</td>
</tr>
</tbody>
</table>

| Alcohol (%)                           |            |                        |                    |                    |
| 0 (g/day)                             | 23.3        | 23.1                   | 25.5               | 19.3               |
| 0.1–29.9 (g/day)                      | 67.6        | 64.6                   | 62.8               | 65.7               |
| ≥30 (g/day)                           | 9.1         | 12.3                   | 11.7               | 15.0               |

| Family history of colorectal cancer (% yes) |            |                        |                    |                    |
|                                            | 5.7         | 11.0                   | 12.0               | 10.7               |

| Body mass index (kg/m²)                | 25.0±3.1    | 25.5±3.1               | 25.5±3.2           | 25.2±2.9           |

| Smoking status (%)                     |            |                        |                    |                    |
| Never                                 | 35.3        | 32.3                   | 35.6               | 29.3               |
| Former                                | 36.4        | 45.3                   | 44.1               | 45.0               |
| Current                               | 28.4        | 22.4                   | 20.2               | 25.7               |

| Non-occupational physical activity (%) |            |                        |                    |                    |
| <30min/day                            | 20.4        | 20.4                   | 20.7               | 22.1               |
| 30–60min/day                          | 31.6        | 31.1                   | 32.0               | 27.9               |
| 60–90min/day                          | 20.9        | 21.5                   | 20.7               | 22.1               |
| >90min/day                            | 27.0        | 27.2                   | 26.7               | 27.9               |

a = Mean ± SD
b = Intake of fresh meat items were based on raw meat weights

**The Dangers of Processed Meats (SM)**

Processed meat contains additives that can be further broken down in the body to become carcinogenic. A safe parameter for the amount of daily intake for processed meat should be <20 g/day (19). Just one serving of many of the processed meats such as hot dogs and pork tenderloins exceed this suggested amount.

Colorectal cancer cases can increase with an increased consumption of processed meat. The addition of preservatives in the processing of meat increases its shelf life. Processes like salting, addition of compounds like nitrates and nitrites, and smoking are used. Research studies have implied that these compounds get converted into nitrosamines in the colon our body, which are known to function as carcinogens. These cause mutations in DNA of the cells of the colon and the rectum (20).

**Nitrites and Nitrates (SM)**
The daily accepted intake of nitrates should be no more than 289 g/day for a 70 kg individual (21). Although it seems like a majority of these are far below the accepted amount so it may be okay to binge eat some of these more processed meats. But be weary, this is a misconception. Our nitrate intake is already satisfied by a majority of vegetables; this is a good thing because vegetables contain ‘good’ nitrates, the nitrates that metabolize to nitric oxide. Processed meat, no matter how small the amount, depending on the method of cooking a majority of their nitrate count will be converted into nitrosamines, a carcinogenic byproduct of the metabolism of this compound (21).

Table 3: Nitrate/Nitrite Count based on type of processed meat (21)

<table>
<thead>
<tr>
<th>Type</th>
<th>Nitrates: (mg/100 g)</th>
<th>Average weight</th>
<th>Nitrite: a(mg/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacon</td>
<td>5.5</td>
<td>18.7g/strip</td>
<td>0.38</td>
</tr>
<tr>
<td>Ham</td>
<td>0.90</td>
<td>57g/slice</td>
<td>0.89</td>
</tr>
<tr>
<td>Hot-Dog</td>
<td>9.0</td>
<td>37.83g/hot dog</td>
<td>0.05</td>
</tr>
<tr>
<td>Pork Tenderloin</td>
<td>3.3</td>
<td>907.2 g/ whole</td>
<td>0</td>
</tr>
</tbody>
</table>

Another aspect that is something to consider when consuming meat is to have some idea how the animal was fed. Livestock fed a beef pulp diet, for example, will have higher concentrations of nitrates and other cancer-forming compounds in the meat (see Figure 1). (SM)

Figure 1. Cattle feed and Nitrate count (22)
Unprocessed meat, in general, has a much lower (if not negligible) amount of nitrate and nitrites relative to processed meat. This drastic difference determined in unprocessed meat is because it is not infused with preservatives (the key preservative in meats are nitrates and nitrites). The only amount of nitrates and nitrites present in unprocessed meat is from the consumption of nitrate infused feed throughout the life of the animal (23). However, even the most nitrate-fed cow will have little nitrite in the meat when compared to the nitrate and nitrite count in processed meat.

Temperature (NA)
Meat cooked at high temperatures tends to produce carcinogenic compounds like polycyclic aromatic hydrocarbons (PAH) and heterocyclic amines (HCA). Temperatures above 300°F is considered high and processes like pan-frying, and grilling use such high temperatures. When sugars, creatine, and amino acids from meat metabolize at such temperatures, they form HCA. When fats and juices from meat drip onto open fire like during grilling, flames are produced which contain PAH which get attached to the meat. In addition, smoking and charring also add to the formation of PAH. In animal rodent studies, it is found that HCA and PAH cause DNA mutations when activated by certain enzymes in the body. (24)

Salting (NA)
Salting is one of the oldest methods used to preserve food by increasing its shelf life and inhibiting the development of food-borne pathogens. Food products that have more than 500 mg
sodium /100 mg of food are considered high salt content foods. Processed meat contains more than 800 mg of sodium for every 100 mg of meat (25). According to the data and statistics, the Center for Disease Control recommends about 1500 mg of sodium per day (26). High sodium puts a person at risk for high blood pressure, stomach cancer, and heart and kidney disease (6).

Figure 2: Source of meat-related mutagen (11)

**Marinating** (NA)
The methods of cooking that can lower your risk of carcinogens while eating red meat is to first avoid consuming nitrate-containing processed meat, and second, to marinate your meat prior to cooking. Marinating is very effective in inhibiting the formation of heterocyclic amines (a carcinogen). Marination will soak into the muscle tissue of the meat and act as a lubricant to block the production of heterocyclic amines. A special marinade recipe that includes garlic, cider vinegar, brown sugar, mustard, olive oil, salt and lemon juice designed by Lawrence Livermore laboratories reduces HCA production from 56 ng/g – 1.7 ng/g when grilling over 20 minutes (28). Nitrosamines are found in pink meats: ham, pork, sausage etc. but also in red meat that is cooked at very high temperature. Slow cook your meat, ensure that it is open for oxygenation, and you can create red meat meals that are healthy (5). (SM)

Marinating means to soak food into a marinade in order to enrich food flavor and tenderize it. Marinade is an acidic liquid that, in general, has 3 components: acid, oil, and seasoning. It usually consists of lemon juice, vinegar, oil, vine, herbs or spices. It is best to marinate food in the refrigerator to prevent bacterial growth at room temperature. It is made thin so that it can be
easily absorbed by food. Meats are often marinated. For every pound of meat, it is suggested to use \( \frac{1}{2} \) cup of marinade. However, timing differs with the cut and type of meat (Table 4) (29).

Table 4: Approximate marinating time for different types of meat. (29)

<table>
<thead>
<tr>
<th>Type of Meat</th>
<th>Cut of Meat</th>
<th>Approximate Marinating time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef, lamb, and pork</td>
<td>Steaks, Chops</td>
<td>2 - 4 hrs</td>
</tr>
<tr>
<td></td>
<td>Beef Flank Steak</td>
<td>2 hrs - overnight</td>
</tr>
<tr>
<td></td>
<td>Whole Roast</td>
<td>4 - 6 hrs (or else overnight)</td>
</tr>
<tr>
<td></td>
<td>Brisket</td>
<td>1 day</td>
</tr>
<tr>
<td>Poultry</td>
<td>Chicken breasts without bones and skin</td>
<td>2 hrs - overnight</td>
</tr>
<tr>
<td></td>
<td>Chicken thighs without bones and skin</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Duck breasts without bones and skin</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Whole Roast or Chicken</td>
<td>4 - 6 hours (or overnight)</td>
</tr>
<tr>
<td>Seafood</td>
<td>Shrimp</td>
<td>15 - 30 mins</td>
</tr>
<tr>
<td></td>
<td>Scallops</td>
<td>5 mins</td>
</tr>
<tr>
<td>Fish</td>
<td>Steaks, Fillets</td>
<td>15 - 30 minutes</td>
</tr>
</tbody>
</table>

Table 5: Studies suggest that marinating meat with certain chemicals reduces the production of HCA, a potential carcinogen (28)

<table>
<thead>
<tr>
<th>Item</th>
<th>% reduction of HCA production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teriyaki and turmeric-garlic marinade</td>
<td>60% in beef steaks soaked for 15 minutes</td>
</tr>
<tr>
<td>20 g of garlic / 100 g marinade</td>
<td>70% in ground beef</td>
</tr>
<tr>
<td>0.05% of extracts of rosemary herb</td>
<td>( &gt; 90% )*</td>
</tr>
</tbody>
</table>

\* = In beef shawerma, rosemary herb increases HCA production
In grilled chicken and fried liver, this herb reduces HCA production
Beer and virgin olive oil have also shown to reduce the production in beef patties.

**Recommendations** (NA)
Healthier meat choices can minimize the risk of getting colorectal cancer. It is better to eat meat devoid of preservatives. Fresh red meat contains little or no nitrates and therefore won’t be metabolized by the body to produce nitrosamines. However, it is recommended that red meat be first marinated prior to cooking and to cook at lower temperatures to inhibit the production of the carcinogenic compounds polycyclic aromatic hydrocarbons (PAH) and heterocyclic amines (HCA). Most processed meats, on the other hand, do contain nitrates and nitrites and other preservatives which can readily be converted into nitrosamines when eaten, producing potential carcinogenic byproducts. When at a grocery store, look on the label of the meat packaging for ‘Nitrate-Free’ or ‘No Nitrites Added or ‘No Preservatives Added’. There are other forms of labeling that are imposed by the USDA on manufacturers of food; one of which is ‘Natural’ (30). According to the USDA dictionary, when products are labelled as ‘Natural’, it means that they are only processed minimally. The word ‘Natural’ fails to give any information on how animal was raised (31). Also consider healthy protein-rich substitutes for red meat like fish, nuts, beans, turkey, chicken, and whole grains. Studies have shown that swapping one serving of red meat by any of the mentioned above reduces the rate of mortality by about 7 to 19% (27).

**Being a healthy carnivore: Changing ones diet to promote healthy eating**

There are many incentives stated above that will require an individual to begin to think about the diet they choose. Staying away from processed meat, moving to consuming more fresh meat, and reducing the consumption of red meat are healthier carnivorous choices. In addition, follow one of the diets that are displayed to you below so that your red meat and nutrient intake remains satisfactory with health as the priority. Also consider possible diets that allow for healthy lifestyles without eliminating meat from the diet. (SM)

**The Mediterranean diet (SM)**

According to many scientific studies (32), the Mediterranean diet is very conducive to gastrointestinal health and cardiovascular well-being. Although it holds many similarities to the Paleolithic diet (below), the primary difference is the focus on seafood. The overall message of the Mediterranean diet is that seafood and the addition of a mix of grains, nuts, beans and legumes is a flavorful, healthy alternative to high meat diets (32).

There is a heavy focus on eating more like a vegetarian:

1. High seafood intake
2. Fruits, vegetables, grains, olive oil, nuts, beans and legumes should be daily
3. Poultry and dairy products should be moderately taken
4. Meats and sweet intake should be kept to a minimum

The protein in the diet comes from various sources but this diet contains many good omega-3 fatty acids. However, the meat intake is very small. This is an alternative that would also lead to decline of colorectal cancer and the ease at which digestion for a majority of these foodstuffs take place.

**The Paleolithic Diet**

In recent years, there has been a noticeable rise in interest for a diet known as the Paleolithic Diet. It argues that in times of the cavemen there is no evidence of heart disease or cancers so perhaps the basic diet of those days are conducive to more healthful living (33). Paleolithic diets completely avoid the consumption of processed meats. There is also a general avoidance of
salts, sugars, grains, potatoes, beans and dairy products. The focus is on eating fresh foods with a mix of vegetable, eggs, seafood, organic meats and healthy oils (34). (SM)

A study was recently published which stated that the Paleolithic diet reduces the occurrence of adenoma polyps in the colon and the rectum (35). A polyp is an abnormal growth of tissue that projects from the mucous membrane of the colon. Adenoma polyps are the common precursors of CRC. The participants that showed the reduced risk of CRC consumed diet that consisted of high amounts of vegetables, fruits, lean meats like skinless chicken and turkey, fish, nuts, and calcium. Red and processed meats, sodium, and alcohol were kept to minimum (35). (NA)

The avoidance of the aforementioned foods tends to decrease the occurrence of bowel cancer (35). The incorporation of omega 3 good fats is believed to sufficiently provide individuals with the needed fats in a healthful way. In addition, the lack of processed food helps lower the concentration of nitrates and nitrites (molecules conducive to carcinogen transformation) in an individual consuming the Paleolithic diet. The Paleolithic diet assists in the formation of more cancer-fighting micronutrients (33). This diet is vital to ensuring that people who enjoy meats can effectively avoid bowel pathologies. (SM)

**Community Action: Spread the knowledge we gathered through Wikipedia**

In an attempt to spread the information that has been gathered by our group during the course of our literature review on colorectal cancer, we have decided to edit the most widely used free encyclopedia on the internet, Wikipedia. We feel that this is the best course of action because we know that many people read Wikipedia to rapidly acquire information about various topics. The topic that we have chosen to write beneath is under “red meat”.

At this point we have successfully edited the red meat page but we would also like to also edit the colorectal cancer page in the future as well. Wikipedia relies on the community of academics to edit and keep their pages up to date and we can get our information out there while assisting them in expanding their knowledge bank.

Or when on Wikipedia, go to Red meat → Human Health → Cancer → Mechanisms.
Following is the page from Wikipedia. The bolded version represents our groups editing of the original document.

**Human health[edit]**

*See also: Beef & Health concerns*

Red meat is not a uniform product; its health effects can vary based on fat content, processing and preparation. Processed red meat is strongly linked to higher mortality, mainly due to cardiovascular diseases and cancer.⁹⁹ There is some evidence too that the consumption of unprocessed red meat may be bad for human health.⁹⁹
Cancer[edit]

The World Cancer Research Fund (WCRF) and American Institute for Cancer Research (AICR) classify red meat consumption as carrying an increased risk of contracting bowel cancer. In the United Kingdom approximately 21% of bowel cancers are associated with red meat consumption. The WCRF recommends limiting intake of red meat to less than 300g (11 oz) cooked weight per week, "very little, if any of which to be processed."

Red meat consumption also increases the risk of lung cancer.

There is suggestive evidence that red meat intake might increases the risk of esophageal, pancreatic, stomach, endometrial and bladder cancer.

There is no good evidence that red meat consumption increases breast cancer or prostate cancer risk.

Mechanisms[edit]

Epidemiological studies have found that an increased consumption of processed and red meat is associated with an increased risk of colorectal cancer. The risk is not associated with white meat like chicken. Processed meats (like bacon, ham, salami, pepperoni, hot dogs, and some sausages) are preserved by smoking, salting, and addition of certain chemicals like nitrates and nitrites. Nitrates and nitrites can be converted by our body into nitrosamines that can be carcinogenic, causing mutation in the colorectal cell line, thereby causing tumorigenesis and eventually leading to cancer. Cooking red meat at high temperature and smoking produces the carcinogens polycyclic aromatic hydrocarbon compounds (PAHs) and heterocyclic amines (HCA). Red meat itself contains certain factors that, under certain conditions, produce carcinogens like N-nitroso compounds (NOCs). Additionally, the heme iron that gives meat its red color may promote carcinogenesis due to its ability to increase cell proliferation in the mucosa, through lipid peroxidation and/or cytotoxicity of fecal water. Both marinating fresh lean red meat and thoroughly cooking the meat at low temperature will reduce the production of carcinogenic compounds and thereby lower the risk of colorectal cancer.

References used in Wikipedia:


References


http://www.geneticseducation.nhs.uk/genetic-conditions-54/677-inherited-bowel-cancer-new


http://www.plosgenetics.org/article/info%3Adoi%2F10.1371%2Fjournal.pgen.1004228


https://huhs.harvard.edu/assets/File/OurServices/Service_Nutrition_Iron.pdf


19) How much is too much bacon?  
http://www.advisory.com/Daily-Briefing/2013/03/08/More-than-a-strip-of-bacon-each-day-may-kill-you-study-says


21) Food sources of nitrates and nitrites: the physiologic context for potential health benefits  
http://ajcn.nutrition.org/content/90/1/1

22) Beef cattle handbook  

23) Eating processed meats, but not unprocessed red meats, may raise risk of heart disease and diabetes  


http://www.cdc.gov/features/dssodium/

http://www.health.harvard.edu/blog/6-healthy-protein-choices-when-cutting-back-on-red-meat-201206084865


http://whatscookingamerica.net/MarinatingSafely.htm

30) Labeling/Label Approval – USDA  
http://www.fsis.usda.gov/wps/portal/fsis/topics/regulatory-compliance/labeling
Dear Editor,

As a former student of Middlesex County College, I wish to share some of the facts that I have discovered from the study of relationship between processed meat and the occurrence of colorectal cancer.

While selecting certain type of diet, it is very important to have knowledge about it. These days, ‘Paleo diet’ is common among the muscle builders. It is based on caveman’s diet that is high in proteins and low in carbohydrates. As meat is rich in proteins, it is a top choice. According to the literature, it is known that processed meat increases the risk of colorectal cancer by about 20%. This cancer of large intestine and rectum is the third leading cause of cancer-related deaths in the United States. Many factors are involved, one such being the processed meat. Processed meats like bacon, ham, salami, pepperoni, hot dogs, and some sausages are preserved by smoking, salting, and addition of certain chemicals like nitrates and nitrites. Smoking produces polycyclic aromatic compounds that are carcinogenic. Nitrates and nitrites are frequently converted by our body into nitrosamines that are carcinogenic, causing mutation in the colorectal cell line, thereby causing tumorigenesis and eventually leading to cancer. It is crucial to make healthier meat choices like organic and grass-fed. It is better to eat raw and minimally cooked meat devoid of preservatives.

College students tend to go to gym regularly for strenuous exercises to make muscles. It is essential for this community to have knowledge about the diet that they consume. I hope that you can assist in spreading this information through your publication.

Sincerely,
Dear Editor,

‘Eating Well’ is a great magazine that circulates to those interested in the well-being of their human body. As an avid reader, I have noticed that there is a lack of information on dietary tips and studies pertinent to certain diets. I thought perhaps I would email you guys to voice my opinion and state some facts in the case of oncogenesis and dietary restrictions. At Rutgers University, I am a member of a group of students who are currently doing research into the causes of oncopathologies in genetically predisposed groups of people as a result of bad dietary habits. In specific, we are looking at colorectal cancer and the correlations that have been found between diets and incidence.

To be more specific, it has been deduced by our literature review that high red meat diets (HRM diets) are causative agents for higher occurrence of colorectal cancer. The group of people we are attempting to look at are those who engage in diets that are deceptively weight losing but actually cause cancer to occur at a higher rate; once this population is deduced and our literature review is complete, a program to advocate better living habits for the specific population will hopefully be able to assist people in making better decisions.

The advocacy program is a major component of it all, although there is the literature review which is of utmost importance to solidify the correlation between dietary habits, genetics and colorectal cancer. Our public advocacy program will be paramount in ensuring that this study has an impact. This is going to be a collaborative effort of using social media and an attempt to create some form of an advocacy that is specific to a deceptive diet such as the ‘paleo diet’.

The major issue is that there is a proven group of individuals who are genetically predisposed to colorectal cancer. The specific genetic mutation is existent in the Wnt pathway, which in normal terms is a signal transduction pathway that directs the cell to proliferate in certain manners or to transcribe certain genes. This is simply the genetic component. Individuals who have this mutation can still live cancer free, but only if they are able to control their diets. The dietary restrictions include primarily a cut down of red meat intake. High red meat diets will already cause heart disease, obesity, and a slew of other diseases, now we want to prove a correlation with cancer so that people can know what may cause these pathologies.

The reason I am writing to you today is because I hope to get some exposure to ensure the masses know of the research that is being done by our group. The research being done is directly correlative to their quality and duration of life, so it should be something that is important to them to read about.
Thanks for your time and also thank you for constantly keeping my mind intrigued with all of your thought provoking stories. I hope that you find this letter to lead to another thought provoking story about red meat and cancer.

Regards,

Samir Mehta, Rutgers University