

NUTRIENTS

THE ASSESSMENT OF RED MEAT AND CANCER RISK

A summary of findings from an independent research assessment

The Bottom Line

An independent scientific review of the existing epidemiological research found no conclusive evidence of a causal relationship between red meat and any of the cancers studied (breast cancer, prostate cancer, kidney cancer, pancreatic cancer, stomach cancer and colorectal cancer).

Introduction

Understanding relationships between diet and chronic disease is challenging. Because of the multitudes of causes and risk factors associated with cancer, the task becomes even more complex for this disease.

Recently, a team of expert epidemiologists with Exponent — a leading multidisciplinary scientific consulting firm that performs in-depth, independent research — examined the existing epidemiologic literature on red meat and cancer. Specifically, Exponent scientists with more than 40 years of combined experience in nutrition and epidemiology conducted this research assessment of red meat and cancer risk to provide a comprehensive and objective summary and evaluation.

In its scientific review, Exponent evaluated 12 exposure variables (total meat, red meat, processed meat, animal fat, animal protein, cooking methods, doneness of meat, heterocyclic amines, nitrosamines, polycyclic aromatic hydrocarbons, dietary patterns and genetics) against each of six cancer sites: colorectal, prostate, pancreatic, stomach, breast and kidney.

To summarize, Exponent took the following steps in order to provide an unbiased critical interpretation and evaluation of the existing epidemiologic literature on red meat and cancer: 1) comprehensively searched the literature to identify available epidemiologic studies on meat consumption and cancers of interest; 2) synthesized the results of the relevant individual studies; and 3) assessed the evidence for/against causality using the well-established Bradford-Hill criteria.

Methodology

In this systematic and comprehensive assessment that evaluated the totality of the epidemiological evidence, Exponent epidemiologists identified more than 14,000 scientific studies on meat and cancer, and of these, more than 500 studies met eligibility criteria and were evaluated. Exponent evaluated causality based solely on cohort and case-control studies and meta and pooled analyses of these studies.

Exponent considered only epidemiologic studies conducted on human populations, thus, experimental animal studies were not examined. Although Exponent recognized experimental laboratory studies may allow for investigations not possible in an observational setting, the application of results from animal studies to human populations is often questionable. In most experimental animal studies, exposures are administered at higher doses and for shorter durations than those experienced by humans. Furthermore, findings from experimental animal studies are difficult to generalize to humans because of a variety of metabolic, physiologic and anatomic differences among species. Thus, Exponent's assessment of human causation was based on studies of humans.

Exponent analyzed the evidence for and against causality based on the long-standing Bradford-Hill criteria for epidemiologic science review. Exponent included research published from 1950 to July 2007.

Limitations of Studies

When analyzing the research studies, Exponent reviewed the methodological limitations of the studies, including potential for various types of bias. These represent the common concerns that should be considered when interpreting conclusions from any nutrition epidemiology study.

Publication bias: Research published in peer-reviewed journals tends to be biased toward studies where associations were found. When no associations are found in a research study, researchers and journal editors may not be interested in publication. Studies likely exist that analyzed data related to red meat and the cancers of interest, and when finding no association, researchers did not (or could not) publish the results. Additionally, Exponent researchers identified several studies where authors noted that no associations were observed between meat and a particular type of cancer or cancers, but the complete data was not reported. These studies often are overlooked by other researchers when making an overall assessment of the literature.

Self-reported food intake: Accurately determining an individual's dietary intake is arguably the most challenging aspect of nutritional epidemiologic studies. In individual studies, the use of a food frequency questionnaire (FFQ), although a generally reliable and efficient method for obtaining dietary information, may be affected by bias. FFQs can be particularly problematic in case-control studies because people with cancer may report dietary intake differently than people without cancer in an attempt to rationalize disease through diet. In cohort studies, dietary data are collected before the onset of disease, reducing bias.

Confounding factors: As with most cancers, all factors involved in the cause(s) of the cancers evaluated by Exponent are not known. Therefore, uncontrolled confounding by these unknown factors could likely affect results. Even when cancer-causing factors have been established, such as obesity, physical activity or alcohol consumption, not all studies adequately controlled for the potential confounding effects of these variables.

Exponent Findings

In its systematic and exhaustive review of the epidemiologic literature, Exponent found no

conclusive evidence of a causal relationship between red meat and any of the cancers studied (breast, prostate, kidney, pancreatic, stomach and colorectal). Collectively, most exposure-disease associations (total meat, red meat, processed meat, animal fat, animal protein, cooking methods, doneness of meat, heterocyclic amines, nitrosamines, polycyclic aromatic hydrocarbons, dietary patterns and genetics) that were evaluated in the Exponent report did not appear to play an important role in the development for any of the types of cancer.

Dietary patterns: It has been argued that dietary patterns may be more relevant to understanding the relationship between diet and chronic diseases, including cancer, because they offer a broader representation of the diet than individual nutrients or foods. However, separating the potential effects of any one food in dietary patterns studies is challenging because a particular pattern may be composed of numerous food items. Nonetheless, for dietary patterns, Exponent found either the available epidemiologic evidence did not support a causal association with the cancers studied (colorectal and breast cancers) or it was not possible to conduct a comprehensive assessment of causality due to sparse data (stomach, pancreatic, kidney and prostate cancers).

Animal fat: Similarly, when a specific component of red meat, animal fat, was analyzed, Exponent found for all six cancers studied, either the available epidemiologic evidence did not support a causal association (colorectal, stomach, prostate and breast cancers) or it was not possible to conduct a comprehensive assessment of causality due to sparse data (pancreatic and kidney cancers).

Total meat, red meat and processed meat: Overall, the available epidemiologic evidence did not support a causal association between total meat, red meat and processed meat and cancer. See below for specific discussion of the results for red meat and colorectal cancer in men, processed meat and colorectal cancer in men and processed meat and stomach cancer.

Animal protein, cooking methods, doneness of meat, heterocyclic amines, nitrosamines, polycyclic aromatic hydrocarbons and genetics: Additionally, Exponent found animal protein, cooking methods, doneness of meat, heterocyclic amines, nitrosamines, polycyclic aromatic hydrocarbons and genetics did not appear to play an important role in the development of any of the types of cancer. For all these exposure variables, 1) the epidemiologic evidence did not support a causal association; or 2) it was not possible to conduct a comprehensive assessment of causality due to sparse data; or 3) no studies were identified.

Of the six cancer sites and 12 exposure variables studied in each site (over 70 evaluations), Exponent noted patterns of associations in only three areas. In all three areas — red and processed meat and colorectal cancer in men and processed meat and stomach cancer — the independent assessment of the research concluded that available data from the relevant epidemiologic studies was not sufficient to conclusively support or refute a causal association. Additionally, Exponent concluded that further research was needed because of inconsistencies in the literature and limitations in interpreting the data due to possible confounding factors, as well as the weakness and variability of the associations.

Implications

The Exponent findings and recent published studies are further evidence that the most important dietary advice people can follow to decrease cancer risk are the 2005 *Dietary Guidelines*, which recommend a nutrient-rich, balanced diet from all five food groups. A healthy diet as recommended by the *Dietary Guidelines* includes a variety of nutrient-rich foods within and among all food groups, such as: colorful fruits and vegetables; whole, fortified and enriched breads, pastas and cereals; low- and nonfat milk, cheese and yogurt; and lean meats, including lean beef, pork, poultry, eggs, fish and beans.

Specifically, the results of a clinical trial published in the October 2007 *Journal of Nutrition* show adherence to the 2005 *Dietary Guidelines* and to the USDA Food Guide, both of which include lean beef, reduced the risk of colorectal adenoma, a precursor of colorectal cancer, in a large sample of U.S. men and women.

Diet as it relates to chronic diseases like cancer is an ever-expanding area of research. Discoveries of new methods, such as efficient methods for genotyping large populations, and refinements of existing methods, such as determining diet using visual stimuli and biomarkers, will continue to enhance current methodological approaches in conducting studies of diet and cancer. Thus, future publication of additional studies should facilitate a more complete interpretation of the relationship between diet and cancer. It is important to continually monitor and update the collection of studies and to re-evaluate whether the patterns of associations are modified or if they remain unchanged by additional research. Understanding of potential casual associations will become clearer as research becomes more sophisticated.

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