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Review

Meat consumption and cancer risk: a critical review of published meta-analyses

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ABSTRACT

Dietary habits play a substantial role for increasing or reducing cancer risk. We performed a critical review of scientific literature, to describe the findings of meta-analyses that explored the association between meat consumption and cancer risk. Overall, 42 eligible meta-analyses were included in this review, in which meat consumption was assumed from sheer statistics. Convincing association was found between larger intake of red meat and cancer, especially with colorectal, lung, esophageal and gastric malignancies. Increased consumption of processed meat was also found to be associated with colorectal, esophageal, gastric and bladder cancers. Enhanced intake of white meat or poultry was found to be negatively associated with some types of cancers. Larger beef consumption was significantly associated with cancer, whereas the risk was not increased consuming high amounts of pork. Our analysis suggest increased risk of cancer in subjects consuming large amounts of red and processed meat, but not in those with high intake of white meat or poultry.

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1. Introduction

Cancer is one of the leading causes of morbidity and death around the globe, averaging approximately 14 million new cases and 8.2 million cancer-related deaths each year. Even more importantly, the number of new cancer cases is expected to rise by nearly 70% over the next two decades, up to 22 million new cases per year, which would probably make it the first cause of mortality worldwide (Stewart and Wild, 2014). The five most common types of malignancies are represented by lung, prostate, colorectal, stomach, and liver cancers in men, whereas breast, colorectal, lung, cervix and stomach cancers are the five most common types of malignancies in women, respectively (Stewart and Wild, 2014). Although cancer pathogenesis is challenging and multifaceted, it is now established that genetic and environment factors interplay to promote carcinogenesis. In particular, certain physical (e.g., ultraviolet and ionizing radiation) and biological carcinogens (viral, bacterial or parasitic infections) interact with behavioural and dietary risk factors such as obesity, low fruit and vegetable intake, lack of physical activity, tobacco and alcohol, to favour the transformation of a normal cell into a malignant cell, a phenomenon that can be particularly magnified in genetically predisposed individuals (World Cancer Research Fund, 2007).

Among the various factors, diet habits play a substantial role for increasing or reducing the risk of various cancers. Although the causal link between diet and cancer is complex and can be hardly unravelled due to the fact that conventional diets entail many different foods and nutrients, evidence is being gathered that certain foods may be more harmful than others (Bishop and Ferguson, 2015).

A reasonable amount of meat is part of a balanced humans diet, since it provides valuable nutrients such as proteins and essential amino acids, vitamins, minerals and other micronutrients (Lafarga and Hayes , 2014). In the traditional culinary terminology, meat is conventionally classified as "red" when characterized by a typical red hue, whereas "white" usually defines a lighter-coloured subtype. Although a semantic debate is still opened, the former type defines the meat of most adult mammals (i.e., cow, pork, sheep, horse), whereas the latter is typically used to identify poultry (i.e., chicken, turkey) and rabbit. The meat can be marketed fresh, immediately after slaughter, or processed by means of salting, curing, addiction of spices and non-meat additives, stuffing, fermentation, drying or smoking (Food and Agriculture Organization of the United Nations, 2015).

According to the recent statistics of the Food and Agriculture Organization of the United Nations (FAO), the current worldwide consumption of meat is as high as 311.8 million tonnes/year, and prevalently include pork (115.5 million tonnes), followed by poultry (108.7 million tonnes), beef (68.0 million tonnes) and ovine (14.0 million tonnes) (Food and Agriculture Organization of the United Nations, 2014). Importantly, the worldwide meat production is projected to double by the year 2050, especially in developing countries. Due to the development of societies, urbanization and growth in disposable income levels, the demand for processed meat will also consistently increase (Food and Agriculture Organization of the United Nations, 2014). Therefore, the impact of fresh and processed meat on human health is expected to grow exponentially in the next decades. In a recent meta-analysis including 13 cohort studies and 1,674,272 individuals (Abete et al., 2014), higher intake of processed meat was found to be a significant risk factor for all-cause (relative risk [RR], 1.22; 95% CI, 1.16–1.29) and cardiovascular (RR, 1.18; 95% CI, 1.05–1.32) mortality. A higher intake of total red meat was significantly associated with cardiovascular mortality (RR, 1.16; 95% CI, 1.03–1.32), whereas no significant association was found between all-cause death and total meat intake (RR, 1.04; 95% CI, 0.84–1.30) or total white meat (RR; 0.90; 95% CI, 0.73–1.11). These results were substantially confirmed in another meta-analysis including 9 prospective studies and 1,330,352 individuals (Larsson and Orsini, 2014), in which all-cause mortality was significantly associated with higher intake of total red meat (RR, 1.29; 95% CI, 1.24, 1.35) and processed meat (RR, 1.23; 95% CI, 1.17–1.28), but not of unprocessed meat (RR, 1.10; 95% CI, 0.98–1.22). According to this persuasive epidemiological evidence, the American Institute for Cancer Research published a public health goal, that population average consumption of red meat should be less than 300 g (11 oz) a week, very little (if any) to be processed (World Cancer Research Fund, 2007).

Therefore, to establish whether the consumption of total meat and meat subtypes may be associated with human cancer, we performed a critical review of meta-analyses that have been published so far on this topic.

2. Search methodology

We performed an electronic search on Medline and Scopus, using the keywords "meat" AND "cancer" OR "neoplasm" OR "tumor" OR "malignancy" AND "meta-analysis" OR "critical review" in "Title/Abstract/Keywords"; with no language restriction. The search was limited to recent meta-analyses; i.e.; those published in the past 10 years (between 2005 and 2015). Clinical studies; letters or commentaries; review articles with no data on cancer risk; review articles with no data on meat consumption; and review articles lacking results of meta-analysis were also excluded. The references of the selected articles were also scrutinized in order to identify other pertinent items. After elimination of duplicates across the two scientific databases; a total number of 85 publications could be finally identified. Forty three documents were excluded (5 clinical studies; 3 letters or commentaries; 9 review articles with no data on cancer risk; 14 review articles with no data on meat consumption; and 12 review articles lacking results of meta-analysis). Therefore; 42 eligible meta-analyses were finally included in this review (12 for colorectal cancer; 6 for esophageal cancer; 4 for gastric cancer; 3 for breast and kidney cancers; 2 for lung; pancreatic; bladder and ovarian cancers; 1 for non-Hodgkin lymphoma; endometrial; prostate; thyroid, oral cavity and liver cancer). When available; detailed information on search methodology and the association between meat intake and cancer risk was reported in the following parts of this article.

3. Results

The main outcome of this systematic literature search about meat intake and cancer risk is shown in Tables 1–3.

3.1. Colorectal cancer

Larsson and Wolk (2006) investigated the epidemiological evidence linking red or processed meat intake with the risk of colorectal cancer by searching Medline up to March 2006. Overall, 15 prospective studies were identified and meta-analyzed. The comparison of the highest versus the lowest intake categories revealed the existence of a significant association between colorectal cancer and intake of total red meat (RR, 1.28; 95% CI, 1.15–1.42) or processed meat (RR, 1.20; 95% CI, 1.11–1.31). Increases of 120 g/day of red meat and 30 g/day of processed meat were associated with a 28% (95% CI, 18–39%) and 9% (95% CI, 5–13%) higher risk of colorectal cancer, respectively.

Huxley et al. (2009) evaluated the strength of association between risk factors for colorectal cancer by pertinent studies in Medline and Embase up to December 2008. A total number of 26