



**RED MEAT AND  
PROCESSED MEAT**

VOLUME 114

This publication represents the views and expert opinions of an IARC Working Group on the Evaluation of Carcinogenic Risks to Humans, which met in Lyon, 6–13 October 2015

LYON, FRANCE - 2018

**IARC MONOGRAPHS  
ON THE EVALUATION  
OF CARCINOGENIC RISKS  
TO HUMANS**

## GENERAL REMARKS

---

This one-hundred-and-fourteenth volume of the *IARC Monographs* presents evaluations of the carcinogenic hazard to humans arising from consumption of red meat and processed meat. Based on the large amount of available literature reporting an elevated risk of cancer of the colorectum associated with the consumption of red meat or processed meat, the Advisory Group to Recommend Priorities for *IARC Monographs* during 2015–2019 recommended that these agents be evaluated with high priority ([IARC, 2014](#); [Straif et al., 2014](#)). A summary of the findings of this volume has been published in *The Lancet Oncology* ([Bouvard et al., 2015](#)).

### Scope of the volume

This volume is concerned with red meat or processed meat as consumed. Occupational exposure to these foods in the course of preparation (e.g. abattoir workers, butchers) was not considered. For red meat, the overwhelming majority of available epidemiological studies were on consumption of cooked meat. For processed meat, certain products are consumed as they are supplied commercially (e.g. ham), while others (e.g. bacon), may be cooked. The carcinogenicity of different methods of cooking meat was also reviewed.

The Working Group evaluated the carcinogenic hazard associated with meat consumption, and did not consider other potential hazards or benefits (e.g. from the nutritional value of meat).

The scientific literature concerning potential carcinogens that may be contained in meat

(e.g. haem iron, heterocyclic aromatic amines, *N*-nitroso-compounds, polycyclic aromatic hydrocarbons) is summarized in this Monograph (see Section 4.5); however, the Working Group did not specifically evaluate these agents in relation to meat consumption.

### Definitions of “red meat” and “processed meat”

For red meat, the definition (see Section 1) centres on the animal species from which the meat was derived. The handling of the red meat between abattoir and butcher’s shop, and subsequent cooking (often involving addition of condiments such as salt and pepper) are not considered in this volume as “processing”. Likewise, meat that has simply been refrigerated is not regarded as processed meat.

Processed meat refers to meat that has been transformed through salting, curing, fermentation, smoking, or other processes to enhance flavour or improve preservation (see Section 1).

For most processed meats, the starting material is red meat, which by definition excludes poultry. However, the definition of processed meat does not exclude products that are partly, or even wholly, derived from poultry or meat products other than red meat.

## Challenges in evaluation of the epidemiological data

The Working Group considered more than 800 epidemiological studies that investigated the association between cancer (at more than 15 organ sites) and consumption of red meat or processed meat. A major strength of this database is that it comprised large cohorts and well-conducted population-based case–control studies in many countries, on several continents, considering diverse ethnicities, and varied diets. The Working Group faced two major challenges: quality of exposure assessment and exposure quantification; and potential confounding.

The quality of the exposure assessments and quantification mostly depended on the questionnaire used. For the evaluation, the Working Group gave greatest weight to validated questionnaires that contained a clear definition of red meat and processed meat, considered them separately, and provided quantitative dietary data.

With regard to confounding, the Working Group considered the established or putative role of a variety of dietary and lifestyle factors as potential confounders, according to cancer site. For example, total caloric intake is a putative risk factor for cancers at several sites, including the colorectum, and red meat and processed meat are significant contributors to total caloric intake. Other potential confounders include

consumption of fruit and vegetables, and alcoholic beverages, tobacco smoking, obesity, physical activity, and diabetes mellitus. An additional complexity to be considered has been the inter-relationships between diet, including meat consumption, overweight/obesity and diabetes mellitus ([Wang & Beydoun, 2009](#); [Micha et al., 2012](#)) (see also Section 4.2.5 (b)).

Based on the above considerations, the Working Group established clear inclusion and exclusion criteria for the systematic evaluation of the available studies; these are detailed in Section 2.1.

## Heterogeneity among types of red meat and processed meat

Although the Working Group established clear definitions of red meat and processed meat, each term encompasses heterogeneous food products (see Section 1). There are potentially important nutritional differences between different types of red meat. These differences include calorie intake, iron content, and fatty acid composition, and vary according to the age, sex, breed, and diet of the animal from which the meat is derived, as well as the cut of meat. Similarly, the different processing methods that may or may not include use of preservatives (e.g. nitrate/nitrite) result in distinct products. However, the available cancer data do not allow a distinction to be made between different types of red meat or processed meat products.

---

## References

- Bouvard V, Loomis D, Guyton KZ, Grosse Y, Ghissassi FE, Benbrahim-Tallaa L et al. International Agency for Research on Cancer Monograph Working Group (2015). Carcinogenicity of consumption of red and processed meat. *Lancet Oncol*, 16(16):1599–600. doi:[10.1016/S1470-2045\(15\)00444-1](https://doi.org/10.1016/S1470-2045(15)00444-1) PMID:[26514947](https://pubmed.ncbi.nlm.nih.gov/26514947/)
- IARC (2014). Report of the Advisory Group to Recommend Priorities for IARC Monographs during 2015–2019. Lyon, France: International Agency for Research on Cancer. Available from: <http://monographs.iarc.fr/ENG/Publications/advisory.php>
- Micha R, Michas G, Mozaffarian D (2012). Unprocessed red and processed meats and risk of coronary artery disease and type 2 diabetes—an updated review of the evidence. *Curr Atheroscler Rep*, 14(6):515–24. doi:[10.1007/s11883-012-0282-8](https://doi.org/10.1007/s11883-012-0282-8) PMID:[23001745](https://pubmed.ncbi.nlm.nih.gov/23001745/)
- Straif K, Loomis D, Guyton K, Grosse Y, Lauby-Secretan B, El Ghissassi F et al. (2014). Future priorities for the IARC Monographs. *Lancet Oncol*, 15(7):683–4. doi:[10.1016/S1470-2045\(14\)70168-8](https://doi.org/10.1016/S1470-2045(14)70168-8)
- Wang Y, Beydoun MA (2009). Meat consumption is associated with obesity and central obesity among US adults. *Int J Obes*, 33(6):621–8. doi:[10.1038/ijo.2009.45](https://doi.org/10.1038/ijo.2009.45) PMID:[19308071](https://pubmed.ncbi.nlm.nih.gov/19308071/)

