

6. Evaluation and Rationale

6.1 Carcinogenicity in humans

There is *sufficient evidence* in humans for the carcinogenicity of alcoholic beverages.

The occurrence of malignant tumours of the oral cavity, pharynx, larynx, oesophagus, liver, colorectum and female breast is causally related to the consumption of alcoholic beverages.

There is *evidence suggesting lack of carcinogenicity* in humans for alcoholic beverages and cancer of the kidney and non-Hodgkin lymphoma.

There is substantial mechanistic evidence in humans who are deficient in aldehyde dehydrogenase that acetaldehyde derived from the metabolism of ethanol in alcoholic beverages contributes to the causation of malignant oesophageal tumours.

6.2 Carcinogenicity in experimental animals

There is *sufficient evidence* in experimental animals for the carcinogenicity of ethanol.

There is *sufficient evidence* in experimental animals for the carcinogenicity of acetaldehyde.

Overall evaluation

Alcoholic beverages are *carcinogenic to humans (Group 1)*.

Ethanol in alcoholic beverages is *carcinogenic to humans (Group 1)*.

Rationale

The latter evaluation is based on (i) the epidemiological evidence, which showed little indication that the carcinogenic effects depend on the type of alcoholic beverage, (ii) the *sufficient evidence* that ethanol causes cancer in experimental animals; and (iii) the mechanistic evidence in humans who are deficient in aldehyde dehydrogenase that acetaldehyde derived from the metabolism of ethanol in alcoholic beverages contributes to the causation of malignant oesophageal tumours. Identification of ethanol as a known carcinogenic agent in alcoholic beverages does not rule out the possibility that other components may also contribute to their carcinogenicity.

Note added in proof:

In October 2009, the IARC Working Group for Monograph Volume 100E reviewed “Alcohol drinking” as a Group-1 agent. This Working Group considered that acetaldehyde is a genotoxic compound that is detoxified by aldehyde dehydrogenases (ALDH); that the *ALDH2*2* variant allele, which encodes an inactive enzyme, is prevalent in up to 30% of east-Asian populations; and that heterozygous carriers, who have about 10% enzyme activity, accumulate acetaldehyde and have considerably higher relative risks for alcohol-related oesophageal and head and neck cancers compared with individuals with the common alleles. The Working Group for Volume 100E concluded that “Acetaldehyde associated with alcoholic beverages” is *carcinogenic to humans* (Group 1).