

5. Summary of Data Reported and Evaluation

5.1 Exposure data

Wood is one of the world's most important renewable resources. At least 1700 million m³ are harvested for industrial use each year. Wood dust, generated in the processing of wood for a wide range of uses, is a complex substance. Its composition varies considerably according to species of tree. Wood dust is composed mainly of cellulose, polyoses and lignin and a large and variable number of substances of lower relative molecular mass which may significantly affect the properties of the wood. These include non-polar organic extractives (fatty acids, resin acids, waxes, alcohols, terpenes, sterols, steryl esters and glycerols), polar organic extractives (tannins, flavonoids, quinones and lignans) and water-soluble extractives (carbohydrates, alkaloids, proteins and inorganic material).

Trees are characterized botanically as gymnosperms (principally conifers, generally referred to as softwoods) and angiosperms (principally deciduous trees, generally referred to as hardwoods). Roughly two-thirds of the wood used commercially worldwide belongs to the group of softwoods. Hardwoods tend to be somewhat more dense and have a higher content of polar extractives than softwoods.

It is estimated that at least two million people are routinely exposed occupationally to wood dust worldwide. Nonoccupational exposure also occurs. The highest exposures have generally been reported in wood furniture and cabinet manufacture, especially during machine sanding and similar operations (with wood dust levels frequently above 5 mg/m³). Exposure levels above 1 mg/m³ have also been measured in the finishing departments of plywood and particle-board mills, where wood is sawn and sanded, and in the workroom air of sawmills and planer mills near chippers, saws and planers. Exposure to wood dust also occurs among workers in joinery shops, window and door manufacture, wooden boat manufacture, installation and refinishing of wood floors, pattern and model making, pulp and paper manufacture, construction carpentry and logging. Measurements are generally available only since the 1970s, and exposures may have been higher in the past because of less efficient (or non-existent) local exhaust ventilation and other measures to control dust.

The wood species used in wood-related industries vary greatly by region and by type of product. Both hardwoods and softwoods (either domestically grown or imported) are used in furniture manufacture. Logging, sawmills and plywood and particle-board manufacture generally involve use of trees grown locally. Most of the wood dust (by mass) found in work environments has a mean aerodynamic diameter of more than 5 µm. Some investigators have reported that the dust generated in operations such as sanding and during the processing of hardwoods results in a higher proportion of smaller particle sizes, but the evidence is not consistent.

Within the furniture manufacturing industry, exposure may occur to solvents and formaldehyde in glues and surface coatings. Such exposures are usually greatest for workers with low or negligible exposure to wood dust and are infrequent or low for workers with high

exposure to wood dust. The manufacture of plywood and particle-board may entail exposure to formaldehyde, solvents, phenol, wood preservatives and engine exhausts. Sawmill workers may also be exposed to wood preservatives and fungal spores. Exposures to chemicals in industries where other wood products are manufactured vary but are in many cases similar to those in the furniture manufacturing industry.

5.2 Human carcinogenicity data

The risk for cancer, and particularly cancer of the nasal cavities and paranasal sinuses, among woodworkers has been investigated in many epidemiological studies. Some of the studies provided specific information on cancer risk associated with exposure to wood dust, and those studies were given greatest weight in the evaluation.

Most of the available cohort and case-control studies of cancer of the nasal cavities and paranasal sinuses have shown increased risks associated with exposure to wood dust. These findings are supported by numerous case reports. Very high relative risks for adenocarcinoma at this site, associated with exposure to wood dust, have been observed in many countries, particularly in Europe. The lower risks observed in the studies in the United States may be due to differences in concentration or type of wood dust, but in one of these studies the more heavily exposed groups had significantly increased risks. A pooled analysis of 12 case-control studies revealed a clearly increasing risk with increasing estimated levels of exposure to wood dust, overall and in most individual studies. The excess appears to be attributable to wood dust *per se*, rather than to other exposures in the workplace, since the excess was observed in various countries during different periods and among different occupational groups, and because direct exposures to other chemicals do not produce relative risks of the magnitude associated with exposure to wood dust.

Adenocarcinoma of the nasal cavities and paranasal sinuses is clearly associated with exposure to hardwood dust; in several series of cases of adenocarcinoma from different countries, a high proportion of cases had been exposed to hardwood, and these findings were confirmed in several case-control studies as well. There were too few studies of any type to evaluate cancer risks attributable to exposure to softwood alone. In the few studies in which exposure was primarily to softwood, the risk for cancer of the nasal cavities and paranasal sinuses was elevated but considerably lower than that in studies of exposure to hardwood or to mixed wood types; furthermore, in the studies of exposure to softwood, exposure to hardwood could not clearly be ruled out. It is more difficult to attribute excess risk to any particular species of wood. The concentration of wood dust and the duration of exposure may also contribute to differences in the risks of workers exposed to different types of wood. These studies consistently indicate that occupational exposure to wood dust is causally related to adenocarcinoma of the nasal cavities and paranasal sinuses.

In studies of squamous-cell carcinoma of the nasal cavities and paranasal sinuses, smaller excesses were generally reported than for adenocarcinomas, and a pooled analysis of 12 case-control studies found no association with exposure to wood dust.

A number of case-control studies on nasopharyngeal cancer have reported an association with employment in wood-related occupations; however, confounding was not ruled out from these studies, and the largest study, from Denmark, in which exposure to wood dust was estimated, did not confirm the association. Case-control studies of laryngeal cancer consistently showed an association with exposure to wood dust or woodworking; however, cohort studies of woodworkers gave consistently negative results. Overall, these studies provide suggestive but inconclusive evidence for a causal role of occupational exposure to wood dust in cancers of the nasopharynx.

Studies of the association between exposure to wood dust and cancers of the oropharynx, hypopharynx, lung, lymphatic and haematopoietic systems, stomach, colon or rectum individually gave null or low risk estimates, gave inconsistent results across studies, and did not analyse exposure-response relationships. The evidence for an association between exposure to wood dust and Hodgkin's disease was somewhat more suggestive, in that some case-control studies showed moderately high risks, but these results were not substantiated by the results of cohort studies or some of the well-designed case-control studies. In view of the overall lack of consistent findings, there is no indication that occupational exposure to wood dust has a causal role in cancers of the oropharynx, hypopharynx, lung, lymphatic and haematopoietic systems, stomach, colon or rectum.

5.3 Animal carcinogenicity data

Dust from beech wood was tested for carcinogenicity by inhalation and for enhancement of carcinogenicity when administered with sidestream cigarette smoke or formaldehyde in two studies in rats, or with *N*-nitrosodiethylamine administered by subcutaneous injection in two studies in hamsters. The studies did not show any significant carcinogenic or co-carcinogenic potential of beech wood dust, but each of the studies suffered from various kinds of limitations and had some inadequacies in reporting of data.

The mutagenic fraction of a methanol extract of beech wood dust was tested for carcinogenicity by skin application in one study in mice. Although a significant, dose-dependent increase in the incidence of skin tumours and a marginally significant, dose-dependent increase in the incidence of mammary tumours were observed, these results cannot be used in an evaluation of the carcinogenicity of wood dust *per se*.

In a preliminary study, beech wood dust was tested for local carcinogenicity by intraperitoneal injection in rats; no peritoneal tumours were reported.

5.4 Other relevant data

General knowledge of particle size indicates that wood dust can be deposited in human upper and lower airways, the deposition pattern depending partly on particle size. Heavy exposure to wood dust may result in decreased mucociliary clearance and, sometimes, in mucostasis. No data were available on clearance of wood dust from the lower airways.

Exposure to wood dust may cause cellular changes in the nasal epithelium. Increased frequencies of cuboidal metaplasia and dysplasia were found in some studies of workers exposed to dust from both hardwood and softwood. These changes can potentially progress to nasal carcinoma.

Impaired respiratory function and increased prevalences of pulmonary symptoms and asthma occur in workers exposed to wood dust, especially that from western red cedar.

There is little reliable information on the effects of wood dusts on the respiratory tract of rodents. One study *in vitro* showed that various wood dusts are cytotoxic and can induce drug metabolizing enzymes.

Constituents of beech that can be extracted with polar organic solvents are genotoxic, as demonstrated by the induction of point mutations in bacteria, DNA single-strand breaks in rat hepatocytes *in vitro* and micronuclei in rodent tissues *in vivo*. Extracts of oak wood showed similar activity, but fewer data were available. Extracts of spruce, the only softwood tested, gave consistently negative results.

5.5 Evaluation¹

There is *sufficient evidence* in humans for the carcinogenicity of wood dust.

There is *inadequate evidence* in experimental animals for the carcinogenicity of wood dust.

Overall evaluation²

Wood dust is *carcinogenic to humans (Group 1)*.