REVIEW OF CARCINOGENIC RISKS IN THE PAPER AND PULP INDUSTRY

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Abstract

Scientific literature on the health hazards associated with employment in the pulp and paper industry indicate that workers may have an increased risk of neoplasms of the stomach, lung and the lymphatic tissue. The evidence is however not convincing and most of the data derive from proportional mortality studies using death certificate information.

Introduction

The paper and pulp industry is spread world-vide, engaging hundreds of thousands of workers; approximately 360,000 workers were employed in this industry in Western Europe in 1988. An International Agency for Research on Cancer (IARC) working group evaluated in 1987 the evidence concerning carcinogenic risk in humans as inadequate (1,2).

Exposures

The main processes used in the pulp mills are the sulphite (acidic) and the sulphate or Kraft (alkaline); the latter is the prevailing process universally. Technology in the paper mills is more diverse and has undergone changes recently. The main exposures in the pulp and the paper mills are gaseous sulphur compounds (SO_2, hydrogen sulphite, organic sulphites, mercaptans), chlorine, chlorine compounds. Exposure to many other chemicals occurs, e.g. urea formaldehyde resins, dyes, asbestos, chlorophenols, wood dust. Type and intensity of exposure differs according to process and according to the specific department/job within the process.

Studies

We searched the published scientific literature through the major computerised data libraries and the IARC archives. Only three prospective studies with exposure specific information have been conducted to date. Robinson and colleagues examined the mortality of 3572 pulp and paper mill male workers in the USA (3). Workers were classified by process (sulphite, sulphate); a subgroup with potential exposure to formaldehyde vas identified. Jappinen et al. examined cancer incidence of 3520 pulp and paper mill workers of both sexes in Finland (4). Workers were classified into six subcohorts: sulphite, sulphate, paper mill, board mill, maintenance and power plant. A study in New Hampshire investigated the mortality of 883 male workers in one pulp and paper industry (5). Results are presented for workers in the sulphite process, the paper mill and other paper works.

Seventeen further studies (6-22) were identified. Most of them were based on data from vital statistics, some were case-control studies; only one provides information by type of process (sulphite/sulphate) (14). Occupation was usually abstracted from death certificates and in many occasions the occupational groups are wide.

Two ecological studies (23-24) investigated lung and oral cancer mortality in U.S. counties according to the proportion of the population employed in the paper industry.

Results

Table 1 summarises results of prospective studies for major neoplasms. Overall cancer mortality was significantly lower than expected in the analysed cohorts (Table 1), as well as in two other studies (6,14). However, two other studies found a non-significant increase in cancer mortality (15,16), and two further studies a significant increase (10,22).

Lung cancer risk appears to be significantly elevated in paper and board mill workers, mainly because of an increase in risk among board mill workers in the Finnish study (4). An increase in lung cancer mortality was found in three further studies (9,12,22) and one ecological study (23). Eight studies (6,10,11,13-16,21) did not confirm this association. One of these studies (11) suggested an increase in larynx cancer risk. A study suggested an increased risk of pleural mesothelioma among pulp and paper workers (20), and exposure to asbestos was found for most cases: no other study investigated this association.

Risk of cancer of the oral cavity was low in all prospective studies; an increase was suggested by some (11,21,24) but not all studies (10,14) which investigated this site. An increase in stomach cancer mortality was reported by four studies based on vital statistics (11,15,17,21); other studies did not confirm this (6,10,14,16,19,22): prospective studies suggest an increase in risk among workers of the sulphite process and among paper (but not board) mill workers. Few reports of non-significant increase in colon and/or rectum cancer risk are available (10,11,14,21,22): results of prospective studies show an increased risk among paper and board mill workers (Table 1). Results on pancreas cancer are sparse and mainly negative. Two studies suggested an association between employment in the paper industry and biliary tract cancer (10,18), a disease which was not studied by any other author. A study from Japan (8) suggested an association between pulp and paper industry and liver cancer, not confirmed by a U.S. study (10).

No consistent pattern of increased risk of kidney, bladder, or prostate cancer arises from studies based on vital statistics: a non-significant increase of kidney and bladder cancer risk can be derived from prospective studies (Table 1), and it is higher among sulphite workers.

A number of studies found an increase in lymphosarcoma and reticulosarcoma risk (10,15,16,19,22); two studies (14,21), however, as well as the three prospective studies, did not confirm this finding. Similarly, risk of Hodgkin disease was higher in three studies based on vital statistics (7,10,22): however, three other studies (14,15,21) and all prospective studies (Table 1) were negative. An increase in leukemia risk was noted in three studies (10,21,22), as well as among workers of paper (but not board) mills enrolled in two prospective studies (4,5). Negative studies (11,14,15) have also been published. The number of lymphatic cancer deaths were in most cases very low.

Conclusions

The few prospective epidemiological studies in the paper and pulp industry indicate that cancer risk may be elevated for workers in this industry but evidence is still not convincing. Compared to other large industrial sectors, there appears to be a lack of high standard epidemiological studies and there is a need for more investigation.

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Table 1

Combined results of cohort studies on pulp and paper workers (3,4,5). Only cancer sites with data from at least two studies are reported.

	All workers (3,4,5)		Sulphite pr. (3,4,5)		Sulphate pr. (3,4)		Paper mill (a) (4,5)	
Cancer site	Obs	SMR	Obs	SMR	Obs	SMR	Obs	SMR
Oral cavity	8	44*	1‡	20*	-	-	-	-
Stomach	46	98	18	134	13	90	13	105
Colon	24	67*	9	62	6	53	10	167
Rectum	3‡	31*	-	-	-	-	-	-
Pancreas	13‡	78	7‡	90	-	-	-	-
Digestive t.	122	81*	21‡	116	-	-	34	104
Larynx	10	98	3‡	120	-	-	-	-
Lung	153	100	46	89	41	84	61	173*
Kidney	9‡	125	6‡	176	-	-	-	-
Bladder	23	135	7‡	146	-	-	-	-
Prostate	26‡	110	12‡	109	-	-	-	-
LRS	13	119	4‡	118	6	133	-	-
Hodgkin d.	2	36	1‡	63	-	-	-	-
Leukemias	14	82	5	79	1	18*	4	129
All cancers	453	90*	157	91	127	80*	121	108

Notes: Obs: observed deaths
SMR: standardized mortality ratio
LRS: lymphosarcoma and reticulosarcoma
*: $p<0.05$
‡: based on two studies only
(3) Robinson et al., 1986
(4) Jappinen et al., 1987
(5) Henneberger et al., 1989
(a) The study by Jappinen et al. also includes board mill workers