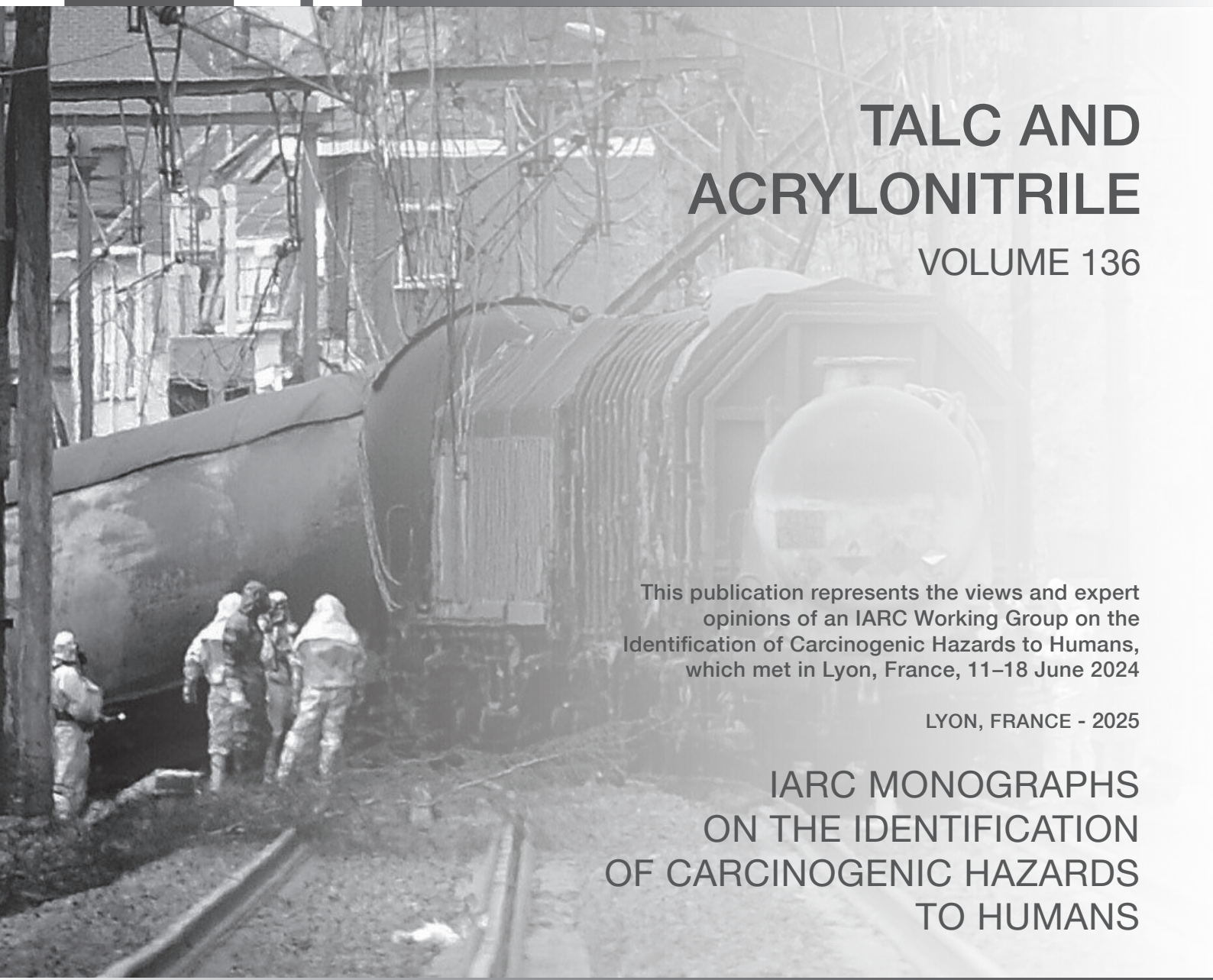
IARC MONOGRAPHS



TALC AND ACRYLONITRILE

VOLUME 136

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IARC MONOGRAPHS ON THE IDENTIFICATION OF CARCINOGENIC HAZARDS TO HUMANS

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World Health Organization

Table S1.19 Exposure assessment review and critique for epidemiological studies on cancer in humans with occupational exposure to talc

References	What methods were used for the exposure assessment? (incl. data source, environmental measurements etc.)	What was the exposure context? Specify period over which exposure data gathered, and how historical exposures were accounted for (if relevant)	Was exposure assessment qualitative, semiquantitative or quantitative?	What exposure metrics were derived for use in analyses (e.g. average exposure, exposure duration, cumulative exposure etc.)? (specify units)	Was latency or induction time accounted for?	Was there potential for co-exposures to other carcinogens? If yes, were these accounted for in analyses?	Was there potential for differential exposure misclassification? Was there potential for non-differential exposure misclassification? (Likely/unlikely)
Mining cohort studies							
Honda et al. (2002)	Detailed work histories from personnel and tax records for talc miners and millers used with a respirable dust JEM developed using assessments by long-term employees and both current and historic exposure measurements. Details found in: Oestenstad et al. (2002)	Cohort of 782 talc miners and millers from New York, USA, employed for ≥ 1 day, 1948–1989	Quantitative	Work area (miners, millers, others) Duration of employment Cumulative exposure (mg/m^3-days)	Yes, years since first employment assessed	Non-asbestiform amphibole in ore mentioned by the authors. [The Working Group noted that the Gouverneur District deposits in upstate New York are known to be contaminated with both anthophyllite asbestos and tremolite asbestos, as well as crystalline silica (see Section 1.2, Table 1.1)]	Non-differential likely
Wild et al. (2002)	Detailed work histories from personnel from talc miners and millers. Exposure was assessed using a JEM developed by occupational physicians based on personal measurements collected at the mill 1986–1987 and mine 1988–1989 See also Wild et al. (1995)	Cohort study of 1070 French talc milling workers 1945–1994, and 541 miners form three Austrian sites, 1972–1995	Quantitative	Cumulative exposure (mg/m^3-years)	Yes, latency assessed with a 10-year lag	[The Working Group noted that the deposits in the French Pyrenees and Austria did not contain asbestos (see Section 1.2, Table 1.1).] Crystalline silica assessed in a similar manner to talc and used in analysis.	Non-differential likely
Wergeland et al. (2017)	Work histories from company payroll lists, union records, and a registry of silica-exposed workers were used with individual assignment of dust exposure intensity. Jobs were classified as low, medium, high,	Cohort of 390 Norwegian talc miners and millers, 1953–2011. Only 344 had duration and intensity information	Semiquantitative [Note analyses by exposure intensity were only presented for non-malignant diseases]	Results for cancer only were presented for miners, millers, and combined and by length of employment	Yes, years since first employment assessed	"High purity" talc, containing trace amounts of tremolite and anthophyllite (asbestos) and quartz. Benzidine-based pigments may have been used 1955–1960	Non-differential very likely

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	or unexposed by local trade union leader for mine jobs and two long-time employees for mill jobs. See also Wergeland et al. (1990)						
Ciocan et al. (2022)	Detailed work histories from personnel records for talc miners and millers used to assess duration only. Air measurement results published by Pira et al. (2017)	Cohort of 1749 talc miners and millers from Val Chisone, Italy, employed ≥ 1 month, 1946–1995	Talc exposure not assessed Employment used as a surrogate for exposure	Work area (miners, millers, others) Duration of employment	Not assessed	[The Working Group noted that no asbestos has been reported in the Val Chisone deposits (see Section 1.2, Table 1.1).] No asbestos fibres detected in bulk samples. Limited air measurements for silica, radon, and surrogates of diesel exhaust exposure. No adjustment for other exposures	Non-differential likely. Duration of employment a poor surrogate for exposure
Fordyce et al. (2019)	Work histories form talc miners and millers used to assess duration of employment	Cohort of 427 talc miners and millers from Vermont, USA, employed 1+ years, 1930–1983. No assessment of talc exposure	Talc exposure not assessed. Employment used as a surrogate for exposure	None, only overall results reported.	Not assessed	[The Working Group noted that Vermont (Blackwall talc) may be contaminated with asbestos (actinolite, tremolite, anthophyllite, and chrysotile) and that quartz was present (see Section 1.2, Table 1.1).] No information on other exposures	Non-differential likely. Duration of employment a poor surrogate for exposure
Fu and Zhang (1992)	Job histories were from company records. [based on Chang et al., 2017]	A cohort study of 1357 male miners and millers employed for ≥ 1 year as of January 1974 and without	The authors state that dust exposure history was based on health records, pneumoconiosis	Stratified results were presented for all workers, miners, millers, those with or without pneumoconiosis	Not assessed (based on the translation available)	The Working Group noted that chrysotile asbestos was probably present, tremolite possibly present, and that quartz was present in the Chinese deposits (see Section 1.2,	Non-differential likely based on miners/millers as a surrogate. Unable to assess potential for differential misclassification, but based on the sources of data

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		previous employment in the chemical industry were followed until 1988	census records, company files, and interviews			Table 1.1).] Radon exposure among the miners. [based on Chang et al., 2017]. Not accounted for in analyses	consulted investigators may have been aware of disease status
Rubber worker cohort studies							
Blum et al. (1979)	Detailed work histories for rubber workers. Three environmental scientists independently rated 100 occupational titles for possible exposure to PAHs, nitrosamines, carbon black and talc	A nested case–control study, 100 cases and 400 controls, within 2 US rubber companies. Source or dates of employment records not stated	Semiquantitative (none/possibility of exposure, low, high, moderate)	Ever/never and high and/or moderate exposure ≥ 2 years high or moderate exposure All results stratified by company	Latency assessed	Possibility for asbestiform material in talc "being investigated." Authors describe detackifiers as mainly talc-type material with, reportedly, is often associated with asbestiform varieties." PAHs, nitrosamines, and carbon black assessed similarly to talc. The 4 exposures not adjusted for each other in analysis	Non-differential likely
Li and Yu (1999)	Work histories were obtained from company records and a questionnaire	A case–cohort study of rubber manufacturing workers employed > 1 year from Shanghai, with 36 cases and 175 controls (12% of full cohort of 1598), 1973–1995	Not assessed, but authors state that talc dust levels were highest in the inner tube department	Four job groups: (1) tyres curing and vulcanizing; (2) compounding, weighing, mixing, reforming, washing, and milling; (3) inner tyre tube production; and (4) general services. Duration of employment	Not assessed	No discussion of other exposures at this facility	Non-differential likely
Zhang et al. (1989)	Work histories collected by a coronary heart disease screening programme	A cohort study of 1624 Shanghai rubber workers, 1972–1984	Not assessed, but the inner tube workshop used talc	Ever/never to one of five job groups examined: (1) curing; (2) inner tyre tube; (3) raw material	Not assessed	No other specific exposures discussed at this facility	Non-differential likely

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			to dust the inner tyre tube	handling, weighing, extruding, calendering; (3) production; (4) assembling and building; and (5) general services			
Straif et al. (2000)	Detailed work histories from company records and exposure assessment conducted by external experts and industrial hygienists from the participating factories	Cohort study of 8933 rubber workers employed > 1 year from five plants in Germany, 1950–1981	Semiquantitative (work areas classified as low, high, moderate)	Three exposure groups: (1) low (including no exposure and < 1 year at medium or high); (2) medium > 1 year; and (3) high > 1 year	Latency assessed using a 10-year lag	The major exposures at this facility were nitrosamines, carbon black, asbestos and talc, which were all assessed by the investigators. Dose–response was assessed for each alone and adjusted for other exposures	Non-differential likely
Monson and Fine (1978)	A limited work history was assembled using data from both company and union records	Cohort of 13 570 rubber workers from one US plant, who worked for ≥ 5 years 1933–1974	Talc was not assessed. Department may be a qualitative surrogate	Ever or usual department and duration for total cohort reported	Talc not discussed in this paper	Carbon black, β-naphthylamine, and benzene discussed	Substantial non-differential exposure likely
Other industry-based cohort studies							
Thomas and Stewart (1987)	Detailed work histories from personnel records. Each job classified on potential for exposure to talc	Cohort study of 2055 US pottery workers, 1939–1966.	Qualitative (none, non-fibrous, fibrous)	Talc exposure category Duration of non-fibrous talc Age at first exposure	Yes, years since first exposure	Talc exposure only occurred in combination with high silica (quartz) dust exposure. Non-fibrous Montana stearite was used since 1955. Tremolitic (fibrous) talc used in some glazes before 1976	Non-differential likely
Chiazze et al. (1993)	Work histories collected through in person and telephone interviews using a questionnaire designed for both subject and proxies. Assessment based on	Nested case–control study of 162 lung cancers and 363 controls among workers employed for	Quantitative, quartiles of exposure to fibrous talc (fibres/ml-days)	Quartiles of cumulative (fibrous talc exposure	Not assessed	Only fibrous talc assessed, no mention of non-fibrous or contamination. Cumulative exposure to talc, respirable fibres, fine fibres, asbestos, formaldehyde,	Likely non-differential

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	historical reconstruction of processes by engineers and expert assessment by current and former employees knowledgeable in industrial hygiene	≥ 1 year in a large US fibreglass plant, 1940–1962				silica, and asphalt fumes. Analyses not adjusted for each other	
Langseth and Andersen (1999)	Work history (departments, job titles and date of start and end of employment in specific work activities) obtained from the mill personnel files	Cohort study of cancer incidence among 4247 women in the Norwegian pulp and paper industry for ≥ 1 year, 1920 and 1993	Not assessed. Employment used as a surrogate for exposure	Not assessed. Talc exposure was mentioned for paper departments, used as a filler, but department-based results not presented. Duration of employment	Not assessed	No exposures were assessed. Exposure to other potential carcinogens, including wood dust	Substantial non-differential
Langseth and Kjaerheim (2004)	Detailed work histories from company. Industrial hygienists and senior employees at each mill identified production processes, use of specific agents, and changes over the years and data from PAPDEM (IARC-coordinated pulp and paper department exposure matrix) used to assess exposure. Non-occupational talc and potential confounding factors were assessed through interviews of cases and controls	Nested case–control study of ovarian cancer within Langseth and Andersen (1999), with follow-up period extended to 1999; 46 ovarian cancer cases and 179 controls	Qualitative (ever/never)	Only ever/never	Not assessed	Exposure to talc, asbestos, and total dust. 1/11 mills had exposure to fibrous talc. Exposure to talc was classified as ever/never. The assessments were specific to mill, work department, and time-period. Most data in PAPDEM were from 1980 or later. Exposures were not adjusted for each other	Non-differential likely
Bulbulyan et al. (1999)	Work histories were abstracted from personnel records and jobs	Cohort study of 3473 women in the Russian	Not assessed, but bookbinders and	Not assessed. Results only presented by job group (:	Not assessed	Other potential exposure to known and suspected carcinogens included	Non-differential exposure likely

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	classified into four groups. There was no discussion of the characteristics of the talc used at the facilities outside of potential asbestos contamination. Analyses were conducted by job group.	printing industry employed as of 1978 and had worked for ≥ 2 years. Follow-up was through 1993	possibly press operators exposed to talc	compositors, press operators, bookbinders, and other (jobs thought generally to be without hazardous exposures)). Russian paper contains talc as a filler, so printing workers probable had exposure to talc, possibly contaminated with asbestos		lead, benzene, benzo[*a*]pyrene and other polycyclic aromatic hydrocarbons, benzidine-based dyes, asbestos, and carbon black. A No specific assessment of talc exposure was performed	
Boffetta and Colin (2001)	Work histories based on department and exposure was assessed using a JEM based on expert assessment, measurement data, and company questionnaires. Exposure assessment methods were described in detail by Kauppinen et al. (2002)	IARC-coordinated international study of pulp and paper workers, which included 103 773 workers employed for ≥ 1 year from 76 facilities in 15 countries	Quantitative	For talc, prevalence (< 5%, 5–50%, 51–95%, > 95%) and level of exposure (low (0.2–0.6 mg/m^3, medium (0.6–2 mg/m^3, and high > 2 mg/m^3)). Also, by duration of exposure and cumulative exposure to talc	Years since first exposure	25 major agents were assessed, including many carcinogens such as asbestos, formaldehyde, welding fumes, and wood dust	Non-differential likely
Ramanakumar et al. (2008)	Very detailed work histories collected through interviews. A team of chemists and industrial hygienists assessed potential exposure to 294 substances	Pooled data from two case–control studies (1979–1986 and 1996–2001) were conducted by the same group of investigators	Semiquantitative	Industrial and cosmetic talc classified by confidence the exposure occurred (possible, probable, definite), frequency during a normal workweek (< 5%, 5–30%, > 30%), and relative level (low, medium, high)	Exposures occurring < 5 years before diagnosis for cases and interview for controls were excluded	Exposure to titanium dioxide and carbon black assessed in the same manner as talc and the reference category was people not exposed to any of the four. Analyses adjusted for exposure toother lung carcinogens (asbestos, silica, cadmium)	Non-differential likely
Leung et al. (2023)	Life-time occupational histories for jobs held for ≥ 6 months	491 cases of ovarian cancer and 897	Semiquantitatively, CANJEM assigns	Ever exposed to cosmetic talc was assigned as > 50%	Not assessed	Adjusted for exposure to mononuclear aromatic	Non differential likely

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	were collected during in-person interviews by trained interviewers, and occupations and industries were coded by an industrial hygienist. Exposure to 258 agents was assessed using CANJEM Siemiatycki and Lavoué (2018)	controls from a population-based case–control study (PROVAQ) conducted in Montreal, Canada (2010–2016)	probability, frequency (hours per week), and concentration of exposure (low medium, and high assigned values of 1, 5, and 25 for calculation of cumulative exposure)	probability of exposure for ≥ 2 years, duration of exposure, and cumulative exposure (duration × concentration/25 × frequency/40)		hydrocarbons and polycyclic aromatic hydrocarbons	

CANJEM, Canadian Job Exposure Matrix; IARC, International Agency for Research on Cancer; JEM, job-exposure matrix; NIOSH, National Institute for Occupational Safety and Health; NOES, National Occupational Exposure Survey; OPCM, Operative Plasterers and Cement Masons; PAH, polycyclic aromatic hydrocarbon; PAPDEM, pulp and paper department exposure matrix; PROVAQ, PRevention of OVArian Cancer in Quebec; US, United States; USA, United States of America.

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