

| Agents (specification) [synonyms] CAS No. | Publication | Strength of evidence per agent (three star system of RCGP) | Evidence grading, applied to individual study (modified SIGN system); Study type | Occupationally exposed subjects studied, n | Total no. of irritant-induced occupational asthma/ occupational COPD cases per agent | Irritant-induced occupational asthma/ occupational COPD cases, n (prevalence, %) | EVIDENCE (pathological results) | | | | | | | | | Remarks | | |
|--|--------------------------------|--|--|--|--|--|---------------------------------|------|----------|-----------|-------|-------|-------|--|-----|---------|---|------|
| | | | | | | | WORK-RELATED SYMPTOMS | | LFT | | NSBHR | | SFT | | SIC | | | |
| | | | | | | | Asthma | RADS | n/n | % | n/n | % | n/n | % | n/n | | % | i(n) |
| Acids | | | | | | | | | | | | | | | | | | |
| " , not specified | Kipen, Blume et al. 1994 | (*) | 3; Case reports | 4 | 5 | 4 | 4/4 | | | nd | 4/4 | nd | nd | 1 fire inspector and 3 hazardous waste investigators exposed to fumes of acid drum waste | | | | |
| " , " | Brooks, Weiss et al. 1985 | | 3; Case report | 1 | | 1 | 1/1 | + | 1/1 | 1/1 | nd | nd | nd | Welder. Co-exposure to welding fumes | | | | |
| " , various | Tarlo and Broder, 1989 | = | 3; Case report | 1 | 1 | 1 | 1/1 | + | x* | 1/1 | x* | nd | nd | Profession not mentioned. *Individual data for LFT/SFT not given | | | | |
| " , " (hydrochloric, hydrofluoric, nitric, perchloric, sulfuric) | Musk, Peach et al. 1988 | * | 3; Survey | 20 | 4 | 4 (20.0) | 9/20 | | 2/20 | 5/20 | 1/4 | nd | nd | 20 Workers in a mineral analysis laboratory | | | | |
| " , glacial acetic 64-19-7 | Kern 1991 | * | 2; Cross-sectional | 51 | 6 | 4(7.8)* | 15/51 29.4 | + | 4/51 7.8 | 9/24 37.5 | nd | nd | nd | Hospital employees exposed to spill. *Cases for RADS sign. dose-response related, OR for RR in subjects with high exposure 9.8, ns | | | | |
| " , " | Rajan and Davies 1989 | | 3; Case report | 1 | | 1* | 1/1 | | x** | nd | nd | nd | nd | Maintenance fitter exposed to massive spill. *Development of interstitial pneumonitis (P+); **reversible FVC and FEV1 decline | | | | |
| " , " | Kivity, Fireman et al. 1994 | | 3; Case report | 1 | | 1 | 1/1 | | 1/1 | 1/1 | nd | 1/1 | 1 | Cannery worker | | | | |
| " , hydrochloric 7647-01-0 | Deschamps. Soler et al. 1994 | = | 3; Case report | 1 | 3 | 1 | 1/1 | + | 1/1 | 1/1 | nd | nd | nd | Profession not mentioned. Co-exposure to sodium hypochlorite. Resp. symptoms after 5 min inhalation; duration of asthma post exposure > 2 years | | | | |
| " , " | Boulet 1988 | | 3; Case report | 1 | | 1* | 1/1 | + | 1/1 | nd | nd | nd | nd | Pool cleaner; exposure to agent for 1 hour. *Severe work-exacerbated asthma | | | | |
| " , " | Boulet 1988 | | 3; Case report | 1 | | 1 | 1/1 | + | 0/1* | 1/1 | nd | 0/1* | 0/1* | Cleaner. *LFT and SIC normal at examination 2 yrs post exposure | | | | |
| " , sulfuric 7664-93-9 | Gamble, Jones et al. 1984 | * | 2; Cross-sectional | 248 | 25 | 13 | 13/248* 5.2 | | x** | nd | nd | nd | nd | Lead acid battery workers. *WRS ('wheeze') ns vs. controls; **individual data not given; dose-response relationship ns | | | | |
| " , " | El-Sadik, Osman et al. 1972 | | 3+; Survey | 33 | | 11 | 11/33* 33.3 | | x** | nd | nd | nd | nd | Workers of battery manufacturing plants. *Cases defined as chronic bronchitis/chronic asthmatic bronchitis; sign. higher prevalence of cases in smokers (13/20) vs. non-smokers (2/13). **Individual data not given, decline of FEV1 and FVC ns vs. controls | | | | |
| " , " | Boulet 1988 | | 3; Case report | 1 | | 1 | 1/1 | | 0/1* | 1/1 | nd | 0/1* | 0/1* | Cleaner. *LFT and SIC normal at examination 2 yrs post exposure | | | | |
| Acid fluxes | | | | | | | | | | | | | | | | | | |
| " , not specified | Gannon and Burge 1993 | = | 3; Occupational diseases statistics (SHIELD) | 4 | 4 | 4 | 4/4 | | | nd | nd | x | x | 4/500 OA cases in 1989-1991 | | | | |
| Acrylates | | | | | | | | | | | | | | | | | | |
| " , not specified | Chatkin, Tarlo et al. 1999 | = | 3; Occupational diseases statistics (WCB), survey | 2 | 2 | 2 | 2/2 | + | nd | x* | nd | nd | nd | 2/469 asthma claims between mid 1984 and mid 1988, identified by retrospective review; *2/2 NSBHR+ and/or BD+ | | | | |
| " , alkyl cyanoacrylates | Savonius, Keskinen et al. 1993 | (*) | 3+; Case reports | 11 | 13 | 10 | 10/11 | | nd | x* | nd | 10/11 | 1 6 3 | Factory employees working with glue. *Individual data not given. | | | | |
| " , " | Yacoub, Lemièrre et al. 2005 | | 3; Case report | 1 | | 1 | 1/1 | | 0/1 | nd | nd | 1/1 | 1 | Exposure while making miniature planes | | | | |
| " , " | Nakazawa 1990 | | 3; Case report | 1 | | 1 | 1/1 | | 0/1 | 1/1 | nd | 1/1* | 1 1 | Worker of hearing aids industry. *SIC done twice on different days using "Aron Alpha". | | | | |
| " , " | Lozewicz, Davison et al. 1985 | | 3; Case report | 1 | | 1 | 1/1 | | nd | 0/1 | 1/1 | 1/1 | 1 | Forklift operator in loudspeaker production industry | | | | |
| " , cyanoacrylate glue | Chan, Cheong et al. 1994 | = | 3; Case report | 1 | 1 | 1 | 1/1 | | 1/1 | nd | 1/1 | 1/1 | 1 | Door factory worker | | | | |
| " , " [Iocite®] | Toren, Järholm et al. 1999 | * | 2; Population based case referent study | 15 | 21 | 15 | 15 | | nd | nd | nd | nd | nd | 15/251 OA in 1996 (physician-diagnosed). OR 1.8, sign. | | | | |

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|--|-----------------------------------|--|--|--|---|---|-----------------------|------|---------------------------------|---|----------|---|-------|---|---------|---|---|------|------|
| | | | | | | | Asthma | RADS | LFT | | NSBHR | | SFT | | | SIC | | | |
| | | | | | | | | | n/n | % | n/n | % | n/n | % | | n/n | % | i(n) | l(n) |
| " | Quirce, Baeza et al. 2001 | | 3; Case reports | 2 | | 2 | 2/2 | | 0/2 | | 1/2 | | 2/2 | | 2 | 2 Assembly operators in weather strips and rubber-processing factory | | | |
| | Lozewicz, Davison et al. 1985 | | 3; Case reports | 3 | | 3 | 3/3 | | nd | | 0/3 | | 3/3 | | 1 2 | Solderer of electronic industry, 2 factory workers assembling lampshades | | | |
| | Kopp, McKay et al. 1985 | | 3; Case report | 1 | | 1 | 1/1 | | 0/1 | | 1/1 | | 1/1 | | 1 | Accountant and computer representative building remote control model airplanes | | | |
| " | Weytjens, Cartier et al. 1999 | = | 3; Case report | 1 | 4 | 1 | 1/1 | | 0/1 | | 0/1 | | 1/1 | | 1 | Auto bodyshop worker. Preceding rhinitis | | | |
| " | Savonius, Keskinen et al. 1993 | | 3; Case reports | 4 | | 2 | 2/4 | | nd | | x* | | 2/4 | | 1 1 | Factory workers: 1 working with glue, 1 in manufacture of earplugs, 1 producing dental fillings, 1 working with dentin primer. *Individual data not given | | | |
| " | Lozewicz, Davison et al. 1985 | | 3; Case reports | 1 | | 1 | 1/1 | | | | 0/1 | | 1/1 | | 1 | Worker of instrument manufacture | | | |
| " | methacrylates | * | 2-; Cross sectional | 512 | 29 | 29 (5.7)* | 26 5.1 | | x* | | x* | | nd | | | 799 female dental assistants in Finland of whom 512 were exposed. *sign. OR 2.76 for risk of doctor-diagnosed asthma in the last 12 months vs. non-exposed group (n=287) | | | |
| " | methylmethacrylate | = | 3; Case report | 1 | 2 | 1 | 1/1 | | nd | | 0/1 | | nd | | 1 | Dental assistant | | | |
| " | Pickering, Bainbridge et al. 1986 | | 3; Case report | 1 | | 1 | 1/1 | | 0/1 | | nd | | 1/1 | | 1 | Theatre sister handling bone cement | | | |
| Acrylic acid | Savonius, Keskinen et al. 1993 | = | 3; Case report | 1 | 1 | 1 | 1/1 | | x** | | x** | | nd | | 1 | Mechanic in paper mill. *SIC with ink containing acrylic acid (30%), hydroxypropanolic cid (30%), bronze powder (25%), white spirit (4%), ethanol (10%); **Individual data not given. | | | |
| Airbag content | Hambrook, Fink et al. 2006 | = | 3; Case report | 1 | 1 | 1 | 1/1 | + | nd | | 1/1 | | nd | | | Head-on motor vehicle accident | | | |
| Aluminum salt al.fluoride: 7724-18-1 al.sulfate: 10043-01-3 | Simonsson, Sjöberg et al. 1985 | * | 3+; Case series with follow-up | 19 | 19 | 19 | 19/19* | | 2/19*** | | 17/19*** | | 0/2** | | | Aluminum salt workers. *Average of 4.1 months of exposure before having WRS; 2/19 work-exacerbated asthma. **SIC done with al. fluoride (1person) and al. sulfate. ***At follow-up changes of LFT and NSBHR ns. Mean aluminum dust exposure between 0.2 and 4 mg/m ³ | | | |
| 2-Aminoethanol [2-ethanolamine] | Savonius, Keskinen et al. 1994 | = | 3; Case report | 1 | 1 | 1 | 1/1 | | nd | | 0/1 | | 1/1 | | 1 | Cleaner. Subfebrile temperature 7h after SIC | | | |
| Amino-ethyl-ethanolamine 111-41-1 | Pepys, Pickering et al. 1972 | = | 3; Case reports | 3 | 3 | 3 | 3/3 | | 2/3 | | nd | | nd | | 1 2 | Cable joiners | | | |
| 3-Amino-5-mercapto-1,2,4-triazole 16691-43-3 | Hnizdo, Sylvain et al. 2004 | (*) | 3+; Survey of Case series identified by System of Occupational Risks (SENSOR) | 106 | 6 | 6* (5.6) | 6/106 5.6 | | x** | | 6/6 | | 3/6 | | | Chemical plant workers. Co-exposure to N-(2,6-difluorophenyl)-5-methyl-[1,2,4]triazolol (1,5-alpyrimidine-2-sulfonamide); *6/106 physician-diagnosed OA; **individual data not given | | | |
| Ammonia 7664-41-7 | Ali, Ahmed et al. 2001 | * | 2-; Cross-sectional | 73 | ≥ 15 | x* | 33/73 45.2 | | x* | | nd | | nd | | | Ammonia workers. *FEV1 sign. reduced in symptomatic nonsmokers and high cumulative exposure group (> 50 mg/m ³ -of air-years) vs. controls, individual data not given | | | |
| " | Reinisch, Harrison et al. 2001 | | 3+; Occupational diseases statistics (SENSOR), survey | 7 | | 7 | 7/7 | (+) | x* | | nd | | nd | | | 7/430 new-onset asthma in 1993-1996. *Individual data not given | | | |

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|--|---|--|---|--|--|--|--------------------------------------|---------------------|--------------------------------------|------------------------------------|----------------------------------|----------------------------------|----------------------------------|---|---------|-----|---|------|------|
| | | | | | | | Asthma | RADS | LFT | | NSBHR | | SFT | | | SIC | | | |
| | | | | | | | | | n/n | % | n/n | % | n/n | % | | n/n | % | i(n) | l(n) |
| " ", fumes | de la Hoz, Schlueter et al. 1996 Bernstein and Bernstein 1989 Leduc, Gris et al. 1992 Flury, Dines et al. 1983 | | 3; Case reports 3; Case reports 3; Case report with 12 year follow-up 3; Case report | 3 4 1 1 | | 3* 4 1 1 | 3/3 4/4 1/1 1/1 | + + + | 3/3 1/4 1/1 1/1 | 1/1 3/3 nd nd | nd nd nd nd | nd nd nd nd | nd nd nd nd | Factory worker, engine testing operator, truck driver. Exposure to massive leaks of refrigerators/spill of tank. "Development of restr., COPD and small airway disease over the years after accident" Profession not mentioned. Massive accidental exposure, 4/4 P+, resp. symptoms persisted for 12-32 months Soldier of industrial butter plant. Massive accidental exposure; P+; persisting severe airflow obstruction over 12 years Profession not mentioned. Pulmonary edema with acute pulmonary distress after massive exposure | | | | | |
| Ammonium chloride (triple salt) 12125-02-9 | Weir, Robertson et al. 1989 s. Soldering flux | = | 3; Case report | 2 | 2 | 2 | 2/2 | | 2/2 | 2/2 | 2/2 | 1/1 | 1 | 1 tin maker, 1 car radiator repair man; use of soft corrosive soldering fluxes. Co-exposure to zinc chloride (see also zinc chloride). Also 2/2 SIC+ with soldering flux (2 immediate) | | | | | |
| Ammonium thioglycolate 5421-46-5 | Gelfand 1963 | = | 3+; Case series | 14 | 10 | 10 | 14/14 | | nd | nd | nd | 10/10* | | 14 subjects exposed in the beauty culture industry. Co-exposure to monoethanolamine and ethylene diamine; "individual reaction type not given" | | | | | |
| Amprolium hydrochloride 137-88-2 | Greene and Freedman 1976 | = | 3; Case report | 1 | 1 | 1 | 1/1 | + | 0/1 | nd | nd | 1/1 | 1 | Worker of poultry-food additive manufacturing (Pancocin). Massive accidental exposure | | | | | |
| Anhydrides | | | | | | | | | | | | | | | | | | | |
| " ", various ", " ", " | Baur, Czuppon et al. 1995 Drexler, Weber et al. 1994 | * " | 2-; Cross-sectional with follow-up of cases 3+; Survey | 92 110 | 10 | 8* (8.7) 2 (1.8) | 18/92 14/110 | | 11/90 nd | 4/90 nd | nd nd | nd 2/8* | | Chemical workers. *8/18 dyspnoic subjects with sign. obstr.; 15/92 spec. IgE+ Employees of epoxy resin plant. *Individual reaction type not given; 16/109 spec. IgE+ | | | | | |
| " ", dioctyl phthalate 117-81-7 | Cipolla, Belisario et al. 1999 | = | 3; Case report | 1 | 1 | 1 | 1/1 | | 1/1 | | 1/1* | | | Bottle stopper production worker. *SFT+; immediate | | | | | |
| " ", hexahydrophthalic 37226-48-5 | Chee, Lee et al. 1991 | = | 3; Case report | 1 | 1 | 1 | 1/1 | | 0/1 | nd | 1/1* | 1/1 | 1 | Laboratory technician. *SFT done over one month | | | | | |
| " ", himic 2746-19-2 | Rosenman, Bernstein et al. 1987 | = | 3+; Survey | 20 | 3 | 3* (15.0) | 3/20 | | nd | nd | nd | nd | | Chemical plant workers. 3/20 wheezing and spec. IgE+; 7/20 rhinitis | | | | | |
| " ", maleic 31-6 ", " ", " | 108- Lee, Wang et al. 1991 Graneek, Durham et al. 1987 | = " | 3; Case report 3; Case reports | 1 4 | 4 | 1 3 | 1/1 x* | | 0/1 x* | 1/1 3/3 | nd x* | 1/1 3/4 | 1 3 | Assistant technician in chemical plant Profession not mentioned. *Individual data not given | | | | | |
| " ", methyltetrahydrophthalic 26590-20-9 | Nielsen, Welinder et al. 1989 | = | 3; Case report | 1 | 1 | 1 | 1/1 | | 0/1 | 1/1 | nd | nd | | Worker of plastic manufacturing factory. SPT+ and spec. IgE+; resp. symptoms exposure | | | | | |
| " ", phthalic anhydride 85-44-9 | Nielsen, Welinder et al. 1988 Wernfors, Nielsen et al. 1986 Frans and Pahulycz 1993 | ** " ", " | 2-; cross-sectional 3+; Survey 3; Case report | 60 118 1 | 30 | 5* (8.3) 21 (17.8) 1 | 5/60 21/118 1/1 | | nd 8/55 0/1 | nd 7/36 1/1 | nd nd nd | nd 2/2 nd | | Workers of plants producing alkyde and unsaturated polyester resins. Average conc. 0.4 mg/m ³ , peaks 6.6 mg/m ³ ; "all cases in high exposed group; 7/60 chronic bronchitis (6/7 heavily exposed); 4/60 spec. IgE+, exposure-related" 2 Workers of plants producing alkyde and/or unsaturated polyester resins. Average conc. 3-13 mg/m ³ . 3/37 skin scratch test +; 4/54 spec. IgE+ Tanker driver exposed to massive spill. At follow-up after about 1.5 years asymptomatic and NSBHR- | | | | | |

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|---|--|--|--|--|--|--|---------------------------------|------|---|--------|------|-------|-------|--------|------|-----|-----|---|--|---|--|
| | | | | | | | WORK-RELATED SYMPTOMS | | | | LFT | | NSBHR | | SFT | | SIC | | | | |
| | | | | | | | Asthma | RADS | all affected cases: + or at least one out of several cases: (+) | | n/n | % | n/n | % | n/n | % | n/n | % | | i(n) | l(n) |
| ** | Fawcett, Newman Taylor et al. 1977 | | 3; Case reports | 5 | | 2 | 5/5 | | | 2/5 | | nd | | nd | | 2/5 | | 2 | Workers of plastic and paint industry | | |
| | ** | | Maccia, Bernstein et al. 1976 | 3; Case report | | 1 | 1 | 1/1 | | | nd | | nd | | nd | | 1/1 | | 1 | Chemical foreman. SPT+; spec. IgE+ | |
| ** | pyromellitic dianhydride 89-32-7 | Meadway 1980 | 3+; Case series | 7 | 2 | 2 | 2/7 | | | 0/7 | | nd | | 2/4* | | nd | | | Employees working with epoxy resins. *SFT done while exposed to a.) already mixed and b.) while mixing adhesives (a.1 immediate with FEV1 of 15% decline, b.1 late with FEV1 of 18% decline) | | |
| ** | tetrachlorophthalic anhydride 117-08-8 | Venables, Topping et al. 1985 | 3; Survey with follow-up | 330 | 24 | 9* (2.7) | 9*/330 | 2.7 | | nd | | nd | | nd | | nd | | | Factory workers. *9/396 WR chest symptoms, not related to IgE+; 24/300 IgE+, related to smoking | | |
| ** | | Howe, Venables et al. 1983 | 3+; Case series | 7 | | 4 | 7/7 | | | 0/7 | | nd | | nd | | 4/4 | | 2 | 2 | Factory workers with epoxy resin systems. 7/7 spec. IgE+ | |
| ** | | Venables, Topping et al. 1987 | 3+; Case series with follow-up | 7 | | 7 | 7/7 | | | 0/7 | | 5/5 | | nd | | nd | | | | Factory workers with epoxy resin systems. 4 yrs follow-up; 7/7 spec. IgE+ and SPT+; persistent asthmatic symptoms over 4 years in spite of avoidance | |
| ** | | Schlueter, Babaszak et al. 1978 | 3+; Case series | 5 | | 4 | 5/5 | | | 3/5 | | 1/1 | | nd | | 3/5 | | 1 | 2 | 5 plastic industry workers | |
| ** | benzene-1, 2, 4- tricarboxylic acid 1,2-anhydride [trimellitic anhydride] 552-30-7 | Grammer, Zeiss et al. 2000 | 2-; Case control study | 80 | 43 | 12* | 12/80 | 15.0 | | 12/80* | 15.0 | nd | | 12/80* | 15.0 | nd | | | Workers of TMA manufacturing plant. *Individual data not given for LFT/PFT. 17/80 positive for late resp. systemic syndrome. Difference in frequency of any HLA antigens vs. controls ns | | |
| ** | | Grammer, Shaughnessy et al. 1999 | 2-; Survey with follow-up | 286 | | 14* (4.9) | 14*/286 | 4.9 | | x** | | nd | | nd | | nd | | | Workers of TMA manufacturing industry. Average conc. < 0.00045-1.7 mg/m³. *14/286 developed TMA-related resp. symptoms within 3 years; **Individual data not given; 18/286 spec. IgE+; IgG sign. disease- and exposure-related | | |
| ** | | Grammer, Shaughnessy et al. 1998 | 2-; Cross-sectional with 5-year follow-up | 119 | | 10*(9,1%) | x** | | x** | | x** | | x** | | x** | | | | | Workers of TMA factory. *Individual data not given, details of investigation see study above. **Before follow-up, 3 subjects with OA, additionally 7 new OA cases within follow-up; 9/10 spec. IgE+ | |
| ** | | Zeiss, Patterson et al. 1977 | 3+; Case series | 14 | | 6* | 14/14 | | | nd | | nd | | nd | | 1/1 | | 1 | Chemical plant workers. 2/14 asthma-rhinitis syndrome (mediated by spec.IgE for TMA hapten), *4/14 late-onset asthma, 2/14 both diseases; 6/14 irritant syndrome; 3/14 spec. IgE+ | | |
| ** | | Fawcett, Newman Taylor 1977 | 3; Case report | 1 | | 1 | 1/1 | | | 1/1 | | nd | | nd | | 1/1 | | 1 | Maintenance fitter | | |
| ** | Aziridine, polyfunctional (dust) 64265-57-2 | Kanerva, Keskinen et al. 1995 | 3+; Case series | 9 | 8 | 7 | 7/9 | | | nd | | 2/9 | | nd | | 7/9 | | 1 | 5 | 1 | 5 parquet varnishers, 1 spray painter, 2 painters, 1 sales agent. 3 subjects also dermatitis. 4/7 SIC+ also SPT+; 4/7 SIC+ with rhinitis |
| ** | | Leffler and Milton 1999 | 3; Case report | 1 | | 1 | 1/1 | | | 1/1 | | 1/1 | | 0/1* | | nd | | | | Spray painter. *5% across-shift drop in PEF rate; contact dermatitis | |
| ** | Azobisformamide [azodicarbonamide] 123-77-3 | Slovak 1981 | 3+; Survey | 151 | 36 | 28* (18.5) | 28/151 | | | 0/28 | | 13/28 | 46.4 | 0/11 | | nd | | | | Profession not mentioned. Average conc. 2-5 mg/m³. *Asthma type at onset of symptoms: 6 immediate, 16 late, 6 dual | |
| ** | | Kim, Cho et al. 2004 | 3; Case report | 1 | | 1 | 1/1 | | | 1/1 | | 1/1 | | 0/1 | | 1/1 | | | | Factory worker. Resp. symptoms after a latency period of 7 years; SPT negative | |
| ** | | Normand, Grange et al. 1989 | 3; Case reports | 4 | | 4 | 4/4 | | | 1/2* | | nd | | nd | | 2/2 | | 1 | 1 | Workers of plastic industry. *For 2/4 subjects individual data not given. | |
| ** | | Valentino and Comai 1985 | 3; Case report | 1 | | 1 | 1/1 | | | 0/1 | | nd | | nd | | 1/1 | | | | Factory worker | |

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|--|---|--|--|--|---|---|-----------------------|--------------|---------------------------------|--------------|-------|-----|-----|---|---------|---|---|
| | | | | | | | Asthma | RADS | LFT | | NSBHR | | SFT | | | SIC | |
| | | | | | | | | | n/n | % | n/n | % | n/n | % | | n/n | % |
| " | Malo, Pineau et al. 1985 | | 3; Case reports | 2 | | 2 | 2/2 | | 2/2 | 2/2 | nd | 2/2 | | 1 | 1 | Profession not mentioned | |
| Benzalkonium chloride (fumes) 8001-54-5 | Purohit, Kopferschmitt-Kubler et al. 2000 | - | 3; Case report | 3 | 4 | 3 | 3/3 | | nd | 2/3 | 3/3 | 3/3 | | 3 | | Medical, surgical and paediatric nurses | |
| " | Bernstein, Stauder et al. 1994 | | 3; Case report | 1 | | 1 | 1/1 | | nd | nd | nd | 1/1 | | 1 | | Worker in cleaning products manufacturing | |
| 1, 2-Benzisothiazoline-3-one (fumes) 2634-33-5 | Moscatto, Omodeo et al. 1997 | = | 3; Case report | 1 | 1 | 1 | 1/1 | | 0/1 | 0/1 | nd | 1/1 | | 1 | | Worker of chemical factory | |
| Bisulfite, SO₂ SO ₂ : 7446-09-5 | Kipen, Blume et al. 1994 | - | 3; Case report | 1 | 1 | 1 | 1/1 | | 1/1 | nd | 1/1 | nd | | | | Profession not mentioned | |
| Bleaching agent (fumes) | Boulet 1988 | - | 3; Case report | 1 | 1 | 1 | 1/1 | + | 1/1 | 1/1 | nd | nd | | | | Acute accidental exposure to fumes, with low density phosphate, sodium metasilicate, chloride 18%. Patient tested 6 years after accident | |
| Bromine, hydrobromic acid | Burns and Linden 1997 | = | 3; Case reports | 2 | 2 | 2/2 | 2/2 | + | nd | 2/2 | nd | nd | | | | Non-occupational exposure during single hot tube bathing for 5-10 min | |
| Bromochlorodifluoromethane (Halon 1211) 353-59-3 | Matrat, Laurence et al. 2004 | - | 3; Case reports | 4 | 3 | 3 | 2/4 | + | 4/4 | 4/4 | nd | nd | | | | Accidental release of fire extinguisher content. 1/4 subjects with exacerbated asthma | |
| Bromotrifluoromethane (Halon 1301) 75-63-8 | de la Hoz 1999 | = | 3; Case report | 1 | 1 | 1 | 1/1 | + | 1/1 | 1/1 | nd | nd | | | | Accidental exposure to fumes, caused by leak of a tank (belonging to a fire extinguishing system). Obstructive lung patterns for > 7 years; BD+ | |
| Cadmium (fumes) 7440-43-9 | Davison, Fayers et al. 1988 | * | 2-; Cross-sectional | 101 | ≥ 36 | 33* (32.7) | 33/ 101 | 32.7 | 33/77 | 42.8 | nd | nd | nd | | | Cadmium workers. *33/101 FEV1 or FEV1/FVC sign. reduced (average 30% below predicted), cumulatively dose-related; lung function and chest X-ray indicate emphysema in 14/75 | |
| " | Chan, Poh et al. 1988 | | 2-; Cross-sectional with 3-year follow-up | 44 | | ** | 14***, (3)* | 31.8; (6.8)* | 6/44; (3/44)* | 13.6; (6.8)* | nd | nd | nd | | | Battery workers. Data consisting of previous and current results (3 years later, see in brackets). sign. reduction of cadmium in-air-levels achieved; sign. reduction of resp. symptoms and sign. improvement of LFT. **Asthma was not a spec. target. ***Definition of WRS not specified | |
| " | Leduc, Francquen et al. 1993 | | 3; Case report | 1 | | 1 | 1/1 | | 1/1 | nd | nd | nd | | | | Furnace worker producing cadmium salts and -oxides. Chest X-ray and lung function indicates emphysema. Severe impairment of symptoms within 10 years of follow-up. Additional development of pulmonary adenocarcinoma | |
| " | De Silva, Donnan et al. 1981 | | 3+; Case series | 11 | | 2* | 3/6 | | 4/11 | nd | nd | nd | | | | Workers of cadmium pigment manufacturing plant. *Asthma cases with moderate and severe emphysema. 6/12 with chronic cadmium poisoning, of these 2/6 with asthma and LFT+ | |
| Calcium Carbonate [chalk powder] | Bohadana, Massin et al. 1996 | * | 3+; Cross-sectional | 158 | | | 5/158 | 3.0 | x* | nd | nd | nd | | | | Workers of chalk powder plant. sign. highest FEV1/FVC decline in workers of chalk sacking correlated with sign. dose-response relationship, *individual data not given | |
| Calcium oxide 1305-78-8 | Tarlo and Broder 1989 | - | 3; Case reports | 2 | 2 | 2 | 2/2 | | x* | 2/2 | nd | nd | | | | Profession not mentioned. Persistent asthmatic symptoms for 1.5 to 3 years; 1/2 co-exposed to welding fumes; *individual data for not given | |
| Captafol (chlorinated thiocarbonyl fungicide) 2425-06-1 | Royce, Wald et al. 1993 | - | 3; Case report | 1 | 1 | 1 | 1/1 | | 0/1 | 1/1 | nd | 1/1 | | 1 | | Chemical worker | |
| Cement dust (see also chromate) | | ** | | | ≥ 267 | | | | | | | | | | | | |

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|---|-------------------------------------|--|--|--|--|--|-----------------------|------|---------------------------------|---------|-------|--------|------|----|--|---|---|
| | | | | | | | Asthma | RADS | LFT | | NSBHR | | SFT | | | SIC | |
| | | | | | | | | | n/n | % | n/n | % | n/n | % | | n/n | % |
| | Mwaiselage, Brätveit et al. 2005 | | 2-; Cross-sectional | 117 | | 22* (18.8) | 22/ 117 | 18.8 | | 22/ 117 | 18.8 | nd | nd | nd | nd | 117 cement workers vs. 105 controls. *22/117 COPD (18.9% vs. 4.8% of controls), sign. dose-response relationship for asthma symptoms (10mg/m ³ daily for ≥ 2 years) and the risk of developing COPD (10mg/m ³ daily for ≥ 10 years) | |
| | Yang, Huang et al. 1996 | | 2-; Cross-sectional | 412 | | | 36/ 412 | 8.7 | | x* | nd | nd | nd | nd | 412 portland cement workers vs. 179 controls. Dyspnea sign. increased (8.7 vs. 7.2% of controls); wheezing also sign. increased (7.6 vs. 6.2% of controls); *LFT sign. reduced (FVC, FEV1, FEF50, FEF75) with individual data not given | | |
| | Abrons, Petersen et al. 1988 | | 2-; Cross-sectional | 2738 | | 112* (4.1) | 148** | 5.4 | | x* | nd | nd | nd | nd | Cement workers. *COPD increased (4.1% vs. 3% of controls); **dyspnea sign. increased (5.4% vs. 2.7% of controls); no sign. lung function changes, individual data not given | | |
| | Fell, Thomassen et al. 2003 | | 3+; Cross-Sectional | 119 | | 17 (14.3)* | 32/119** | | | x* | nd | nd | nd | nd | Former Portland cement workers. *14.3% COPD cases with mean reduction of FEV1/FVC of 74.3%, sign.; prevalence of COPD ns vs. controls (exposed to ammonia, high risk of confounding); **attacks of dyspnea selected as asthma symptoms | | |
| | Al-Neaimi, Gomes et al. 2001 | | 3+; Cross-sectional | 67 | | | 4/ 67 | 6.0 | | x** | nd | nd | nd | nd | 67 cement workers vs. 134 controls. *4/67 asthma symptoms (6% vs. 3% of controls); 9/67 bronchitis; other chronic resp. symptoms: dyspnea 14/67 (20.9% vs. 4.5%). **individual data not given | | |
| | Ali, Ballal et al. 1998 | | 3+; Cross-sectional | 149 | | | nd | | | x* | nd | x* | nd | nd | Cement factory workers. *Sign. post-shift reduction in FEV1, FEV1/FVC, FEF25-75 with exposure related decreases compared to controls. | | |
| | Kalacic 1973 | | 3+; Cross-sectional | 847 | | 95* (11.2) | 95 | 11.2 | | nd | nd | nd | nd | nd | Cement workers. *COPD sign. increased (11.2% vs. 4.3% of controls); wheezing sign. increased (7.4% vs. 3.7% of controls, more pronounced in smokers); *high risk of selection-bias/ confounding because study based on questionnaire | | |
| | Mengesha and Bekele 1998 | | 3+; Comparative survey | 53 | | 17** (32.1) | 17/ 53 | 32.1 | | x* | nd | nd | nd | nd | Workers of a cement factory. 14/53 chronic bronchitis; *individual data not given; high risk of confounding and selection-bias, because inadequate description of controls and **asthma diagnose based on questionnaire (32.1% vs. 8.5% of controls, ns) | | |
| | Prezant, Weiden et al. 2002 | | 3+; Cross-sectional | 348 | | | 55/ 348 | 15.8 | | x* | nd | nd | nd | nd | Portland cement workers; asthma symptoms sign. dose-response related; *individual data not given; high risk of confounding and selection bias. | | |
| | Lockman, 2002 | | 3; Case report | 1 | | 1 | 1/1 | | | nd | nd | nd | nd | nd | Leather tanning worker. SPT+ with potassium dichromate | | |
| | de Raeve, Vandecasteele et al. 1998 | | 3; Case report | 1 | | 1 | 1/1 | | | 0/1 | 1/1 | 1/ 1** | 1/1* | 1 | Floorer. *SIC with potassium dichromate; **SFT done for 50 days (17 days at work, 33 days off work); first symptoms after 34 years of exposure | | |
| | Leroyer, Dewitte et al. 1998 | | 3; Case report | 1 | | 1 | 1/1 | | | nd | 1/1 | nd | 1/1* | 1 | Roofeer. *SIC with potassium dichromate | | |
| | Shirakawa and Morimoto 1996 | | 3; Case and control | 1 | | 1 | 1/1 | | | nd | nd | nd | 1/1 | 1 | Worker of metal plating factory. Spec. IgE+ | | |
| Chloramine T (powder dust) 7080-50-4 | Bourne, Flindt et al. 1979 | | 3+; Case series | 7 | 20 | 7 | 7/7 | | | nd | nd | nd | nd | nd | Brewery workers. Recovery after removal; 7/7 SPT+ done with chlortol | | |
| | Feinberg and Watrous 1945 | (*) | 3+; Case series | 6 | | 6 | 6/6 | (+)* | | nd | nd | nd | nd | nd | Co-exposure to halazone; *1/6 RADS | | |

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|--|----------------------------------|--|--|--|---|---|-----------------------|-------|---------------------------------|---------------|-------|-------|-----|---|--|-----|---|
| | | | | | | | Asthma | RADS | LFT | | NSBHR | | SFT | | | SIC | |
| | | | | | | | | | n/n | % | n/n | % | n/n | % | | n/n | % |
| | Kujala, Reijula et al. 1995 | | 3; Case report | 1 | | 1 | 1/1 | | 1/1 | 1/1 | nd | 1/1 | | 1 | Cleaner | | |
| | Jouannique, Pillière et al. 1992 | | 3; Case reports | 2 | | 2 | 2/2 | | 1/2* | 1/2* | nd | 1/1** | 1 | | Laboratory workers. *1/2 with normal LFT only nasal provocation test (positive) | | |
| | Dijkman, Vooren et al. 1981 | | 3+; Case series | 5 | | 4 | 4/5 | | 1/5 | nd | nd | 3/3 | 1 | 2 | 2 cleaners, 2 technicians, 1 nurse. 4/4 SPT+ | | |
| Chlorhexidine 55-56-1 | Waclawski, McAlpine et al. 1989 | = | 3; Case reports | 2 | 2 | 2 | 2/2 | | 0/2 | 1/2* | 1/2** | 1/2** | 1 | | 1 nursing auxiliary with *NSBHR+ and FEV1 decline of 13% after SIC; 1 midwife with **SIC+ and **SFT+ | | |
| Chlorine 7782-50-5 | Glindmeyer, Lefante et al. 2003 | ** | 2+; Retrospective cohort study | 19601 | 299 | 226 | x* | | nd | nd | nd | nd | | | Workers of U.S.pulp/ paper mills (RR 1.3, sign. for new asthma cases). *Individual data not given. **Annual incidence 0.16 vs. 0.13% of controls. Additionally 5/447 new asthma cases in group of gaseod (highly exposed) workers | | |
| | Andersson, Olin et al. 2003 | | 2-; Cross-sectional | 385 | | 12 | 53/345 15.3 | | nd | nd | nd | nd | | | *99 workers of paper department and 210 workers of bleachery department exposed to gassing (Cl2/ClO2, also to SO2). HR 5.6, sign., for gassing as a strong risk factor of asthma | | |
| | Gautrin, Leroyer et al. 1995 | | 2-; Cross-sectional | 239 | | 9* (3.8) | 38/ 239** 15.9 | | x*** | x*** | nd | nd | | | **38/239 workers from the smelting area with accidental puffs over a 3 year period. *9/239 current asthma; ***LFT (FEV1, FVC, FEV1/FVC) and NSBHR sign. lower and increased respectively in group with >10 puffs compared to other exposed groups; | | |
| | Bhére, Cushman et al. 1994 | | 3+; Survey with follow-up | 64 | | 29*** (45.3) | 58/ 64 90.6 | (+)* | 15/ 51** 31.4 | 29/ 51** 56.9 | nd | nd | | | 3/239 chronic bronchitis 289 contraction workers. After multiple exposures, *71/289 with resp. symptoms and possible RADS; at follow-up 18 to 24 months **51/58 symptomatics underwent pulmonary testing; ***29/51 with obstr. and/ or NSBHR+ | | |
| | Leroyer, Dewitte et al. 1998 | | 3+; Longitudinal study with follow-up of case series | 13 | | 3 | 13/ 13 | (+) | 1/ 13* | 2/ 13* | nd | nd | | | 13/278 workers of metal production plant with accidental exposure. *3/13 transient FEV1 or NSBHR deterioration | | |
| | Chatkin, Tarlo et al. 1999 | | 3+; Occupational diseases statistics (WCB), survey | 5 | | 5 | 5/5 | (+)** | nd | x* | nd | nd | | | 5/469 asthma claims between mid 1984 and mid 1988 identified by retrospective Review. *All 5 cases accident-related with BD+ and/or NSBHR+; **1/5 RADS | | |
| | Chester, Gillespie et al. 1969 | | 3; Survey | 58 | | 2 | 34/ 58 58.6 | | 2/ 58 3.4 | nd | 2/2 | nd | | | 139 men of a chlorine gas-production plant | | |
| | Ferris, Burgess et al. 1967 | | 3+; Survey | 147 | | 8* | 13/67 19.4 | | nd | nd | nd | nd | | | Pulpmill workers. Co-exposure to sulphur dioxide. *7 COPD, *1 asthma (physician-diagnosed) | | |
| | Lemière, Malo et al. 1997 | | 3; Case report | 1 | | 1 | 1/1* | + | 1/1 | 1/1 | nd | 1/1 | 1 | | Worker of water-filtration plant. *Persistent symptoms and steroid medication until 5 months after accidental inhalation; P+ Profession not mentioned. Persistent asthmatic symptoms for 6 months; *individual data for LFT/SFT not given. | | |
| | Tarlo and Broder 1989 | | 3; Case report | 1 | | 1 | 1/1 | | x* | 1/1 | x* | nd | | | Policemen exposed to chlorine gas spill. resp. symptoms > 2.5 years | | |
| | Schönhofer, Voshaar et al. 1996 | | 3; Case reports | 3 | | 3 | 3/3 | + | nd | 3/3 | nd | nd | | | | | |
| Chlorofluorocarbons (degradation products) | Piirilä, Espo et al. 2003 | = | 3+; Case series | 7 | 3 | 3 | 5/7 | + | 0/7 | 3/7 | nd | nd | | | 6 restaurant employees and 1 refrigerator maintenance worker; refrigerator fluid spill | | |

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|--|-------------------------------------|--|--|--|--|--|---------------------------------|------|---|---------|------|-------|----|-----|---|--|---|------|---------|------|
| | | | | | | | WORK-RELATED SYMPTOMS | | | LFT | | NSBHR | | SFT | | SIC | | | | |
| | | | | | | | Asthma | RADS | all affected cases: + or at least one out of several cases: (+) | n/n | % | n/n | % | n/n | % | n/n | % | i(n) | | l(n) |
| Chromate (not specified) [see also cement] | | (*) | | | 38 | | | | | | | | | | | | | | | |
| " | Olaigbel and Basomba 1989 | | 3+; Case series | 5 | 5 | 5/5 | | | nd | 3/5 | nd | 5/5* | 1 | 2 | 2 | 2 workers of concrete industry, 1 tanning, 1 metal plating, 1 construction worker. *SIC done with potassium dichromate | | | | |
| " | Onizuka, Tanabe et al. 2006 | | 3; Case report | 1 | 1 | 1/1 | | | 1/1* | nd | nd | 1/1** | | | | Stone mason. *individual data not given. **SIC done with chrome dust, reaction type not given; asthma onset after 8 years of exposure, contact dermatitis after 3 years; SPT+/spec IgE+ to potassium dichromate and nickel sulfate | | | | |
| " | Fernandez-Nieto, Quirce et al. 2006 | | 3; Case reports | 4 | 4 | 4/4 | | | 0/4 | 4/4 | nd | 4/4* | 1 | 2 | 1 | 2 electro-plating, 1 welder, 1 cement worker. *SIC done with potassium dichromate. 3/4 co-exposure to nickel with 2/3 SIC+ to nickel. 2/4 SPT+ to chromium and nickel | | | | |
| " | Sastre, Fernandez-Nieto 2001 | | 3; Case report | 1 | 1 | 1/1 | | | 1/1 | 1/1 | | 1/1* | | | 1 | Electro-plating employee. Co-exposure to nickel sulfate, gold and silver. SPT+ to NiSO4 and potassium dichromate. *SIC done with potassium dichromate, additionally SIC+ to NiSO4 (dual reaction type) | | | | |
| " | Nagasaka, Nakano et al. 1995 | | 3; Case report | 1 | 1 | 1/1 | + | | nd | 1/1 | nd | 1/1 | | | 1 | 1 worker with accidental exposure of a chrome pellet manufacturing plant. 1/1 SPT+ to potassium dichromate | | | | |
| " | Park, Yu et al. 1994 | | 3; Case reports | 4 | 4 | 4/4 | | | nd | 3/4 | 2/2 | 4/4* | 1 | | 3 | 2 metal plating, 1 construction worker, 1 worker of cement industry. *SIC done with potassium dichromate | | | | |
| " | Novey, Habib et al. 1983 | | 3; Case report | 1 | 1 | 1/1 | | | 1/1 | nd | nd | 1/1* | 1 | | | Metal plating worker. SIC done with chromium sulfate, additionally SIC+ to nickel sulfate (late reaction type) | | | | |
| " | Joules 1932 | | 3; Case report | 1 | 1* | 1/1 | | | nd | nd | nd | nd | | | | Chromium plating. Asthma with subsiding dermatitis; *1/1 SPT+ with potassium dichromate | | | | |
| " | Bernstein and Merget 2006 | | 4; Review | 20 | 20 | 20/20 | | | nd | 20/20 | nd | 20/20 | 7 | 4 | 9 | | | | | |
| Cleaning agents ", (not specified) | | * | | | ≥ 267 | | | | | | | | | | | | | | | |
| " | Mirabelli, Zock et al. 2007 | | 2+; prospective cohort study | 60* | 7* | (11,7) | 7 | 11,7 | nd | nd | nd | nd | | | | Nurses or nurses related occupations. Population-based study in the Community Respiratory Health Survey (ECRHS II). *60/332 nurses exposed to ammonia and/ or bleach with new onset asthma (RR 2.16, sign.) | | | | |
| " | Massin, Hecht et al. 2007 | | 2-; Cross-sectional | 175 | x* | 12/175 | | | 25/175* | 32/165* | nd | nd | | | | Food industry cleaners. *Results vs. controls ns; exposure mainly to chlorine and nitrogen trichloride; sign. dose-response relation between upper resp. symptoms and exposure level | | | | |
| " | Medina-Ramón, Zock et al. 2005 | | 2-; Nested case control | 40 | x* | 24/40 | | | 2/35** | 4/22* | 18.2 | nd | nd | | | Workers of different cleaning professions. *22/40 cases tested for BHR, not clear if cases with NSBHR+ additionally asthma symptoms; **2/35 COPD cases, not clear if work-related; asthma symptoms associated with high level ammonia exposure (OR 3.1, sign.) | | | | |
| " | Medina-Ramón, Zock et al. 2003 | | 3+; Cross-sectional | 4521 | x* | 12.0% vs. 5.0%** | | | nd | nd | nd | nd | | | | 593 women (13%) employed in domestic cleaning work. *Inadequate, because cases not given, asthma sign. more prevalent than in non-cleaning workers (OR 1.46); **prevalence of WR resp. symptoms in cleaning workers 12% vs. 5% in non-cleaning workers | | | | |

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|---|---------------------------------|--|--|--|---|---|---------------------------------|-------|---|------------|------|-------|---------|----|-----|---|--|---|---------|------|------|
| | | | | | | | WORK-RELATED SYMPTOMS | | | | LFT | | NSBHR | | SFT | | SIC | | | | |
| | | | | | | | Asthma | RADS | all affected cases: + or at least one out of several cases: (+)** | | n/n | % | n/n | % | n/n | % | n/n | % | | i(n) | l(n) |
| ** | Rosenman, Reilly et al. 2003 | | 3+; Occupational diseases statistics (SENSOR) | 236 | | 236* | 236/236 | (+)** | x*** | nd | nd | nd | | | | | *236/1915 OA cases 1993- 2001. 189 new-onset asthma including **42 cases of RADS; ***individual data not given | | | | |
| ** | Reinisch, Harrison et al. 2001 | | 3+; Occupational diseases statistics (SENSOR), survey | 22 | | 22 | 22/ 22 | | x* | nd | nd | nd | | | | | 22/430 new-onset asthma in 1993-1996. *Individual data not given. | | | | |
| ** | Kipen, Blume et al. 1994 | | 3; Case report | 1 | | 1 | 1/1 | | x* | nd | nd | nd | | | | | Profession not mentioned. Low dose irritant-induced asthma; *BD+ Worker of bottle-filling process with cleaning agents. Low dose irritant-induced asthma. At follow-up 6 months after leaving the workplace cessation of symptoms and NSBHR | | | | |
| ** | Tabar, Alvarez 1998 | | 3; Case report | 1 | | 1 | 1/1 | | 0/1 | 1/1 | nd | nd | | | | | | | | | |
| *, detergents | Murphy, Fairman et al. 1976 | - | 3; Case report | 1 | 2 | 1 | 1/1 | | | 1/1 | nd | nd | nd | | | | Housewife. Symptoms started 6-8 weeks after mixing several cleansing agents to unstop a kitchen drain | | | | |
| ** | Mapp, Pozzato et al. 2000 | | 3; Case report | 1 | | 1* | 1/1 | | | nd | 1/1 | nd | nd | | | | *22 year old cleaner with preexisting asthma. Immediate-onset asthma followed by toxic lung oedema | | | | |
| Cobalt 7440-48-4 | | ** | | | ≥ 78 | | | | | | | | | | | | | | | | |
| ** | Linna, Oksa et al. 2003 | | 2-; Case-control | 110 | | 15* | 15/ 110 | | | 0/ 110 | nd | nd | 1/1 | | | | Cobalt production workers. Co-exposure to nickel; *15/110 suspected asthma cases by questionnaire (sign.), high risk of confounding | | | | |
| * | Kusaka, Iki et al. 1996 | | 2-; Cross-sectional | 345 | | x* | 41/317** | 12.9 | | nd | nd | nd | nd | | | | Former and current hard metal industry workers. *Asthma cases were not a spec. target. **Low cobalt concentration (<50micg/m³) as a sign. risk factor. Relation between sensitivity to cobalt and asthmatic symptoms not sign. | | | | |
| ** | Kennedy, Chan-Yeung et al. 1995 | | 2-; Cross-sectional | 118 | | x* | 11/118** | 9.0 | | 18/118* | 15.3 | nd | 12/118* | | | | Saw filers. *Asthma cases were not a specified target; **wheezing sign. related to work; ***sign. FEV1<80% only for tungsten carbide wet grinding (current job) with average cobalt exposure of 5,6micg/m³. ****sign. FEV1 drop >5% average change | | | | |
| ** | Sprince, Oliver et al. 1988 | | 2-; Cross-sectional | 1039 | | x* | 113/ 1039** | 10.9 | | 209/ 1039* | | nd | nd | nd | | | Tungsten carbide production workers. *WR wheezing dose-response related (Cobalt>50micg/m³ OR 2.1, sign.); **workers with asthma symptoms more affected with obstr., but no further specification | | | | |
| ** | Roto 1980 | | 2-; Case referend study | 21 | | 6 | 21/ 21 | | | x* | x** | nd | 6/ 15** | | | | Cobalt industry workers. *For a case definition either LFT+ and/or NSBHR+; **5/6 SIC with cobalt chloride, 1/6 SIC with cobalt dust, individual reaction types not given | | | | |
| ** | Pisati and Zedda 1994 | | 3+; Case series with follow-up | 9 | | 9 | 9/9 | | | 5/9 | 9/9 | nd | 9/9 | 8 | 1 | | 9 cobalt industry workers. 3 year follow-up: 1/9 still exposed (with obstr.), 7/9 NSBHR+, 1/1 SIC+ (late reaction type) | | | | |
| ** | Shirakawa, Kusaka et al. 1989 | | 3+; Case series | 8 | | 8 | 8/8 | | | 8/8 | 7/8 | nd | 8/8* | 2 | 4 | 2 | Workers in shaping, grinding, sintering. *SIC with cobalt chloride; 4/8 IgE+ | | | | |
| ** | Shirakawa, Kusaka et al. 1988 | | 3+; Case series | 12 | | 12 | 12/ 12 | | | nd | nd | 12/12 | 12/12* | 5 | 4 | 3 | Workers in grinding, sintering, powdering. *SIC with cobalt chloride; 6/12 spec.IgE+ | | | | |
| ** | Shirakawa, Kusaka et al. 1990 | | 3+; Case series | 8 | | 8 | 8/8 | | | 8/ 8* | 7/8 | nd | 8/8** | 3 | 3 | 2 | Hard metal plant workers. **SIC with cobalt chloride; *NSBHR before SIC with nickel; 6/8 SPT+; 5/8 spec.IgE+; co-sensitization to nickel sulfate | | | | |

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|--|--|--|--|--|--|--|---------------------------------|------|---|-----|----------|------|-------|-----|------|---|--|--|---------|------|------|
| | | | | | | | WORK-RELATED SYMPTOMS | | | | LFT | | NSBHR | | SFT | | SIC | | | | |
| | | | | | | | Asthma | RADS | all affected cases: + or at least one out of several cases: (+) | | n/n | % | n/n | % | n/n | % | n/n | % | | i(n) | l(n) |
| " | Gheysens, Auwerx et al. 1985 | 3 | 3; Case reports | 3 | 3 | 3/3 | | | 1/3 | | 2/3 | | nd | | 3/3* | 1 | 2 | Diamond workers. *SIC done with cobalt powder 4/500 OA cases in 1989-1991 | | | |
| | Gannon and Burge 1993 | | 3; Occupational diseases statistics (SHIELD) | 4 | 4 | 4/4 | | | nd | | nd | | x | | x | | | | | | |
| | Baik, Yoon et al. 1995 | | 3; Case report | 1 | 1 | 1/1 | | | 0/1 | | 1/1 | | nd | | 1/1 | 1 | Worker of glassware factory. After SIC also systemic response Diamond grinder | | | | |
| | Wilk-Rivard and Szeinuk 2001 | | 3; Case report | 1 | 1 | 1/1 | | | nd | | nd | | 1/1 | | nd | | | | | | |
| | Krakowiak, Dudek et al. 2005 | | 3; Case report | 1 | 1 | 1/1 | | | 1/1 | | 1/1 | | 1/1* | | 1 | Diamond polishing disc former. SIC with cobalt chloride; SPT+ with cobalt chloride Largest work population in hard metal industry; *SIC+ (mostly late) | | | | | |
| Bernstein and Merget 2006 | 4; Review | | | | | | nd | | x | | nd | | x* | | | | | | | | |
| Coffee, green (dust) | Jones, Hughes et al. 1982 | * | 2-; Cross-sectional | 372 | 13 | 7 (1.8) | 10/372 | 2.6 | x* | | nd | | nd | | nd | | 7/372 new onset asthma; *exposure-time-related FEV1 decline; 35/362 SPT+; 24/331 IgE+ | | | | |
| " " | Zuskin, Kanceljak et al. 1985 | 3+ | 3+; Case series | 9 | | 4 | 9/9 | | 2/9 | | nd | | nd | 4/9 | 4 | 9 coffee industry workers; SIC done with aqueous extract; 5/9 symptomatics SPT+; 4/9 BD+ | | | | | |
| " " (roasted) | Lemière, Malo et al. 1996 | 3 | 3; Case report | 1 | | 1 | 1/1 | | 1/1 | | nd | | 1/1 | 1 | 1 | Factory worker (at machine roasting green coffee beans). Asthma symptoms after 3-4 years of work. SPT+, spec.IgE+ for roasted coffee beans | | | | | |
| " " | Johansen and Viskum 1987 | 3 | 3; Case report | 1 | | 1 | 1/1 | | 1/1 | | nd | | 1/1 | | nd | | Worker in coffee-roasting establishment. Spec.IgE+, SPT+ | | | | |
| Construction work (dust, agent not specified) | Sauni, Oksa et al. 2003 | ** | 2+; Retrospective cohort study | 7513 | ≥ 179 | 133 | x* | | x* | | x* | | x* | | x* | | Construction workers (CW) with new OA between 1991-1995 in Pirkanmaa region of Finland from register of *Employment Pension Fund of CW and hospital records. OR for OA of male and female workers: 1.81, sign. and 2.5, sign. respectively (compared with Pirkanmaa population); annual incidence 3730/1.000.000 | | | | |
| " " | Ulvestad and Lund 2003 | 2+ | 2+; Prospective cohort study | 212 | | 30 (14.2)* | 56/212 | | x** | | nd | | nd | | nd | | Tunnel workers. *COPD cases: 14.2% vs. 8% of controls with OR 2.5, sign.; **Mean FEV1 decline 74.4% for exposed, individual data not given | | | | |
| " " | Bergdahl, Torén et al. 2004 | 2+ | 2+; Prospective cohort study | 200.735 | | (10.7% overall/ 52.2% never-smokers)* | x* | | x* | | nd | | nd | | nd | | Construction workers exposed to different agents (inorganic dust, irritants, fumes, wood dust). *COPD cases within the follow-up 1971-1999; ** individual data not given; increased mortality rate from COPD, except for wood dust, RR 1.12, sign. (n=523) | | | | |
| " " | Oliver, Miracle-McMahill et al. 2001 | 2- | 2-; Cross-Sectional | 389 | | 16 (4.1)* | 48/389 | 12,3 | 16/330 | 4.1 | nd | | nd | | nd | | Construction workers (laborers, tunnel workers, operating engineers). *Not clear, if obstruction correlates with WRS. | | | | |
| Cotton dust, raw CNT 750 (see also endotoxin) | Christiani, Wang et al. 2001 | ** | 2+; Prospective cohort | 447 | ≥124 | (25%-33%)* | x* | | x** | | nd | | nd | | nd | | 15-yr follow-up of 447 cotton textile workers. *25-33% chest symptoms; 67/447 dyspnea; **across-shift FEV1 decline is correlated with longitudinal FEV1 decline, also FVC decline | | | | |
| " " | Latza, Oldenburg et al. 2004; Oldenburg, Latza et al. 2007 | 2- | 2-; Cross-sectional | 150 | | 12** (8.0) | 12/ 150 | 8.0 | x*** | | 12/ 74** | 13.5 | x* | | nd | | Cotton-spinning mill workers. *74/74 subjects with sign. FEV1/FVC% declines across-shift and current endotoxin exposure-related; **sign. NSBHR+ increase across-shift; ***individual data not given | | | | |

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|--|-------------------------------------|--|--|--|---|---|-----------------------|------|---------------------------------|--------|-------|-------|-----|---|-----|--|---------------|---|------|------|
| | | | | | | | Asthma | RADS | LFT | | NSBHR | | SFT | | | | Reaction type | | | |
| | | | | | | | | | n/n | % | n/n | % | n/n | % | | | n/n | % | i(n) | l(n) |
| " , " | Hayes, Ye et al. 1994 | | 2-; Cross-sectional | 355 | | x* | x** | | x*** | nd | x**** | nd | | | | Workers of textile cotton industry. *Asthma cases not mentioned; **sign. elevation of resp. symptoms (chronic cough 18.3%, chronic bronchitis 21.7%); *** in baseline pre-shift ns; ****sign. FEV1, FVC mean decline across-shift (-2.07 vs. 0.05%) and also sign. in FEF25-75 (-0.03 vs. 0.18) | | | | |
| " , " | Woldeyohannes, Bergevin et al. 1991 | | 2-; cross-sectional | 595 | | 64 (10.8) | 64 | 10.8 | x* | nd | x**,* | nd | | | | Cotton mill workers. *Individual data not given; **dose-response relationship across-shift ns; duration of exposure over years with prevalence of asthma sign. correlated; 100/595 cases with byssinosis 22/294 OA cases in 1996 (textile factory workers) with OR 1.9, sign.; *individual data not given | | | | |
| " , yarn | Toren, Balder et al. 1999 | | 2-; Case control | 22 | | 22 | x* | | x* | x* | nd | nd | | | | Textile cotton workers. **Decline of FEV1 >20.0% ns, 4/34 >10% FEV1 decline after NSBHR testing NSBHR. FEV1 decline dose-response related to endotoxine | | | | |
| " , " | Rylander and Bergström 1993 | | 2-; Cross-sectional | 35 | | | nd | | x* | 0/34** | nd | nd | | | | Cotton mill workers. 31/101 SPT+(atopics); *asthma or asthma symptoms were not a specific target; **sign. longitudinal decline in FEV and FVC in overall group (atopics/ non-atopic) after 12 and 18 months of follow-up; ***sign. FEV1 decline at highest methacholine dose in atopics after 18 months; ****trend of greater FEV1 decline cross shift in atopics. | | | | |
| " , " | Wang, Pan et al. 2003 | | 3+; Longitudinal study with 18 months follow-up. | 225 | | | x* | | x** | x*** | x**** | nd | | | | Workers of a cotton-yarn factory. sign. prevalence of 24/91 subjects with asthma symptoms (26.4% vs. 8.5% in controls) and 25/91 (27.5% vs. 9.5) with chronic bronchitis; *individual data not given | | | | |
| " , yarn | Mengesha and Bekele 1998 | | 3+; Comparative survey | 91 | | 24 (26.4) | 24/91 | 26.4 | x* | nd | nd | nd | | | | Cotton mill workers. *Increase in non-spec. BHR during follow-up in the atopic group (for cotton dust SPT+), -8.1% vs. -4.2%, ns. **FEV1 decline across-shift 3.3% and 5.2% after 1 year for atopics, for NSBHR and SFT individual data not given; exposure range of cotton dust 0.2 - 2.01 mg/m ³ , of endotoxin 0.004-1.73 µg/m ³ | | | | |
| " , " | Li, Zhong et al. 1995 | | 3+; Longitudinal study with 1 year follow-up | 110 | | | nd | | nd | x** | x*** | nd | | | | Cotton mill workers. *SIC with cotton samples in experimental cardroom, sign. mean FEV1 declines in 8/15; FEV1 declines and symptoms related to endotoxin exposure; dose-response relationship between cotton dust level and individual FEV1 changes ns | | | | |
| " , " | Rylander, Haglind et al. 1985 | | 3+; Case series | 15 | | 2 | 15/15 | | 2/15 | nd | nd | x* | | | | Profession not mentioned | | | | |
| Cutting oil | Kipen, Blume et al. 1994 | - | 3; Case report | 1 | 2 | 1 | 1/1 | | nd | 1/1 | nd | nd | | | | Toolsetter. *SFT over a period of 5 months; **also SIC+ with reodorant (immediate), heated colophony (immediate) and artists' turpentine (immediate) | | | | |
| " | Hendy, Beattie et al. 1985 | | 3; Case report | 1 | | 1 | 1/1 | | 1/1 | nd | 1/1* | 1/1** | 1 | | | Assemblers, pressmen and other mold room workers. use of an epoxy resin system; *sign. FEV1 and FEF50 decreases across-shift and cross-week of slightly exposed and symptomatics | | | | |
| 3-(Diamino-amino)propylamine [3-(dimethylamino)propylamine] 109-55-7 | Sargent, Mitchell et al. 1976 | (*) | 2-; Survey | 25 | 5 | 5(20.0) | 5/25 | | x | nd | x* | nd | | | | Salesman selling industrial floor-covering materials | | | | |
| Diamine, aliphatic + cycloaliphatic (hardener) 2855-13-2 (isophorone diamine) | Aleva, Aalbers et al. 1992 | - | 3; Case report | 1 | 1 | 1 | 1/1 | | 0/1 | 1/1 | nd | 1/1 | 1 | | | Workers manufacturing flourine polymer precursor. 9/43 spec.IgE+; *hospital admission 2/45 for LFT and SIC | | | | |
| Diazonium tetrafluoroborate 14239-22-6 | Luczynska, Hutchcroft et al. 1990 | - | 3; Comparative study | 45 | 3 | 2 | 25/45 | 55.6 | 1/2* | nd | nd | 2/2* | 1 | 1 | | | | | | |

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|---|------------------------------------|--|--|--|--|--|-----------------------|---|---------------------------------|-----|-------|------|-----|---|---|----------------------|---|------|------|
| | | | | | | | Asthma n/n % | RADS all affected cases: + or at least one out of several cases: (+) | LFT | | NSBHR | | SFT | | | SIC Reaction type | | | |
| | | | | | | | | | n/n | % | n/n | % | n/n | % | | n/n | % | i(n) | l(n) |
| " | Graham, Coe et al. 1981 | | 3; Case report | 1 | | 1 | 1/1 | | 1/1 | 1/1 | nd | 1/1* | 1 | 1 | Production of photocopy paper. *SIC with diazonium chloride | | | | |
| Dichlorodiethyl sulfide [mustard gas] +505-60-2 | Emad and Rezaian 1997 | * | 3; Cross-sectional | 197 | 15 | 15*(7.6) | 197/197 | | 15/197 | nd | nd | nd | | | Iranian veterans. Single massive exposure 10 years ago; 116 with chronic bronchitis, *89 COPD cases | | | | |
| Dichlorvos (organophosphate) 62-73-7 | Deschamps, Questel et al. 1994 | = | 3; Case report | 1 | 2 | 1 | 1/1 | + | 1/1 | 1/1 | nd | nd | | | Cook. Persistent asthma | | | | |
| " | Barthel 1983 | | 3; Case report | 1 | | 1 | 1/1 | + | 1/1 | 1/1 | nd | nd | | | Cook. First, symptomless in between usages; after repetitive use of insecticide within years, development of asthma symptoms independantly of usage. | | | | |
| Diesel exhaust | Hart, Laden et al. 2006 and 2009** | *[*] | 2-; Retrospective cohort study | 536 (3913**) | 303 | 75* (217**) | nd | | nd | nd | nd | nd | | | *COPD mortality cases of railroad workers. **75/536 conductors and engineers with exposure ≥ 16 years of operating trains had a sign. increase in COPD mortality (OR 1.35 (1.17-2.39)), sign. dose-response relationship.**For workers employed after 1945 after the conversion to diesel locomotives, the risk of COPD mortality increased by 2.5% (sign.) for each additional year of work. | | | | |
| " | Henneberger, Derk et al. 2003 | | 3+; Occupational diseases statistics (SENSOR) | 7 | | 7 | 7/7 | + | x | x | nd | nd | | | 7/424 OA cases between 1993-1995 (7/123 RADS) | | | | |
| " | Wade and Newman 1993 | | 3; Case reports | 3 | | 3 | 3/3* | + | 3/3 | 3/3 | nd | nd | | | Railroad workers. RADS after a high exposure over several hours in second locomotive units 2/3 "reversible restrictive" ventilation pattern; twice hospital administration after high exposure | | | | |
| " | Makker and Ayres 1999 | | 3; Case report | 1 | | 1 | 1/1 | | 1/1 | nd | 1/1* | nd | | | Aircraft engine mechanic.*SFT done over a 50 days' period with sign. PEF decline over 5-day working week and improvement on weekends | | | | |
| Diethanolamine 111-42-2 | Piipari, Tuppurainen et al. 1998 | = | 3; Case report | 1 | 1 | 1 | 1/1 | | nd | 1/1 | 1/1* | 1/1 | 1 | 1 | Metal worker. *SFT for 12 days | | | | |
| 2-Diethylaminoethanol [diethyl aminoethanol] 100-37-8 | Gadon, Melius et al. 1994 | (*) | 3+; Case series | 14 | 7 | 7 | 14/14 | | 4/12 | nd | 10/11 | nd | | | Steam leak in heating system of a State office building. 7 asthma cases and 7 suspected asthma cases | | | | |
| 2-Dimethylaminoethanol [dimethyl ethanolamine] 108-01-0 | Vallières, Cockcroft et al. 1977 | = | 3; Case report | 1 | 3 | 1 | 1/1 | | 0/1 | 1/1 | 1/1 | 1/1 | | 1 | Spray painter | | | | |
| " | Cockcroft, Cotton et al. 1979 | | 3; Case report | 2 | | 2 | 2/2 | | 0/2 | 0/2 | nd | 2/2 | 1 | 1 | Profession not mentioned, occupational exposure to hardeners in paints. Co-exposure to HDI | | | | |
| Diinotrogen tetraoxide [dinitrogen tetraoxide] 10544-72-6 | Conrad, Lo et al. 1998 | (*) | 3+; Case series | 234 | 6 | 6 | 6/6 | + | 4/6 | 6/6 | nd | nd | | | 6/234 symptomatics developed RADS after massive release from a railroad tanker; 207/234 shortness of breath, 151/231 wheezing after massive exposure | | | | |
| ECG ink | Keskinen, Nordman et al. 1981 | = | 3; Case report | 1 | 2 | 1 | 1/1 | | nd | 1/1 | nd | 1/1 | | 1 | Laboratory nurse. Also SIC+ with methyl blue (immediate) and Patent Blau V; SPT+ to methyl blue, Patent Blau V, methylene blue | | | | |
| " | Rodenstein and Stanescu 1982 | | 3; Case report | 1 | | 1 | 1/1 | | nd | 1/1 | nd | 1/1 | 1 | | Technician. SIC+ also with methyl blue (immediate) | | | | |
| Endotoxin (see also cotton dust, swine confinement, poultry confinement, house dust) | Reinisch, Harrison et al. 2001 | * | 3+; Occupational diseases statistics (SENSOR), survey | 8 | 15 | 8 | 8/8 | | x* | nd | nd | nd | | | 8/430 new-onset asthma between 1993-1996. *Individual data not given | | | | |

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|--|----------------------------------|--|--|--|--|--|-----------------------|------|---------------------------------|---|-------|----------|-----|-----|---------|---|---|------|------|
| | | | | | | | Asthma | RADS | LFT | | NSBHR | | SFT | | | SIC | | | |
| | | | | | | | | | n/n | % | n/n | % | n/n | % | | n/n | % | i(n) | l(n) |
| | Milton, Wypij et al. 1996 | | 3+; Cross-sectional | 37 | | 6* | 14/37 | | x** | | nd | x*** | | nd | | Maintenance and production workers of fiberglass manufacturing. Co-exposure to phenolics and formaldehyde. *6/37 new-onset asthma; **FEV1 and FVC reduction exposure-related; ***endotoxin-related PEF decline across-shift with SFT over 10 days | | | |
| Environmental tobacco smoke 1-09-0 | | ** | | | ≥268 | | | | | | | | | | | | | | |
| | Jaakkola, Piipari et al. 2003 | | 2+; Incident case control | 239 | | 117 | x** | | x** | | x** | x**, *** | | nd | | *49.2% of asthma attributable to ETS (workplace + home) during the past year (among 239 ETS-exposed). 8% attributable fraction for the whole working-age population (n=487), resp. in asthmatics lifetime workplace ETS sign. increased, OR 2.16, > 150 cigarette-years adjusted OR 2.21. In total population for lifetime workplace ETS OR 1.84; **no individual data given.; ***SFT for 2 weeks | | | |
| | Greer, Abbey et al. 1993 | | 2+; Prospective cohort study | 3119 | | 45 | x** | | nd | | nd | nd | | nd | | Cohort of n=3914 in 1977 and again in 1987. ETS in the workplace increases asthma sign., OR 1.45; *45 subjects with new onset asthma between 1977 and 1987; **individual data not given | | | |
| | Eisner, Balmes et al. 2005 | | 2-; Cross-sectional | 2113 | | | x | | 42/47* | | nd | nd | | nd | | Population-based sample. COPD sign. increased (OR for > 23 yrs workplace ETS 1.36); population-attributable fraction of ETS exposure at work = 7%; subpopulation n=47: *42/47(89.4%) obstructive ventilation pattern | | | |
| | Fidan, Cimrin et al. 2004 | | 2-; Cross-sectional | 114 | | 44* (38.6) | 44/ 114* 38.6 | | x** | | nd | x** | | nd | | Coffeehouse workers (86% smokers). *Airway disease cases with sign. higher risk of prevalence vs. controls (OR 5.35, sign.), especially for smoking personal (OR 4.52, sign.); **individual data not given; sign. time exposure relationship (OR 3.59 < 4yrs., sign.; OR 7.89 >13yrs., sign.) | | | |
| | Radon, Büsching et al. 2002 | | 2-; Cross-sectional | 1890 | | | x | | nd | | nd | nd | | nd | | Sample of population-based ECHRS. Increased asthma; OR for ETS at home and in the workplace 1.5; chronic bronchitis (OR 1.9) sign. increased | | | |
| | Chen, Tunstall-Pedoe et al. 2001 | | 2-; Case-control (MONICA) | 294 | | | x** | | x** | | nd | nd | | nd | | Never-smoking workers. Asthma was not a spec. target. **Individual data not given. Sign. dose-response relationship to high level exposure of ETS, increase of resp. symptoms and FEV1-, FVC- declines at work (OR 3.09-3.12 for FEV1, sign., and OR 2.47-2.53, sign.) | | | |
| | Janson, Chinn et al. 2001 | | 2-; Cross-sectional | 7882 | | | x* | | x* | | x* | nd | | nd | | Subjects of 36 centers in 16 countries. ETS in the workplace associated with resp. symptoms and current asthma OR 1.9, sign.; NSBHR+ dose-related trend with ETS; *individual data not given | | | |
| | Blanc, Ellbjär et al. 1999 | | 2-; Cross-sectional; survey (ECHRS) | 1562 | | 61 (3.9) | 61/1562 3.9 | | x* | | x* | nd | | nd | | Population-based sample of ECHRS resp. work disability; increased asthma PR for workplace ETS, OR 1.8; workplace ETS associated with NSBHR+ and WRS; *individual data not given | | | |
| | Flodin, Jönsson et al. 1995 | | 2-; Population-based case-referent study | | | | x* | | x* | | x* | nd | | nd | | ETS in the workplaces increased asthma cases, OR 1.5 sign.; *individual data not given | | | |
| | Lambourn, Hayes et al. 1992 | | 3; Case report | 1 | | 1 | 1/1 | | 0/1 | | 0/1 | nd | | 1/1 | 1 | Mould maker and fitter | | | |

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|--|---|--|--|--|--|--|-----------------------|--|---------------------------------|-----|-------|--------|-----|----|---------|--|---|------|------|
| | | | | | | | Asthma n/n | RADS % all affected cases: + or at least one out of several cases: (+) | LFT | | NSBHR | | SFT | | | SIC | | | |
| | | | | | | | | | n/n | % | n/n | % | n/n | % | | n/n | % | i(n) | l(n) |
| Epoxy resin system see 3-(dimethylamino) propylamine 109-55-7 | | | | | | | | | | | | | | | | | | | |
| Ethylenediamine [ethylene diamine] 107-15-3 | | * | | | ≥ 14 | | | | | | | | | | | | | | |
| " | Aldrich, Stange et al. 1987 | | 3+; Cohort study | 337 | | x* | 44/337* | | nd | nd | nd | nd | | | | Factory workers with EDA exposure of 8 years or more. *High risk of confounding bias, not clear if WR-asthma cases. 38/337 EDA rhinitis, coughing and wheezing; mean latency period for symptoms 15.2 months; 6/38 sensitized had asthma | | | |
| " | Gelfand 1963 | | 3+; Case series | 7 | | 7 | 7/7 | | nd | nd | nd | 7/7* | | | | 6 shellac handlers and 1 rubber industry worker. *Individual reaction types not given | | | |
| " | Casas, Badorrey et al. 2002 | | 3; Case report | 1 | | 1 | 1/1 | | 0/2 | 0/1 | nd | 1/1 | 1 | | | Worker of laundry powder industry with 14 years of work before symptoms started. | | | |
| " | Nakazawa and Matsui 1990 | | 3; Case reports | 2 | | 2 | 2/2 | | 0/2 | 2/2 | nd | 2/2 | 2 | | | 2 chemical workers. 2/2 i.c.+ | | | |
| " | Hagmar, Bellander et al. 1982 | | 3; Case reports | 3 | | 3 | 3/3* | | x** | 1/3 | nd | nd | | | | Chemical workers; co-exposure to other amines. *Asthma type according to onset of symptoms: 1 late, 2 dual; **individual data not given | | | |
| " | Lam and Chan-Yeung 1980 | | 3; Case report | 1 | | 1 | 1/1 | | 0/1 | 1/1 | nd | 1/1 | 1 | | | Photography laboratory worker. SIC+ also with sulphur dioxide (immediate) | | | |
| Ethylene oxide 75-21-8 | Deschamps, Rosenberg et al. 1992 | | 3; Case report | 1 | 2 | 1 | 1/1 | | 1/1 | 1/1 | nd | nd | | | | Worker of railway station | | | |
| " | Dugue, Faraut et al. 1991 | | 3; Case report | 1 | | 1 | 1/1 | | nd | nd | nd | 1/1* | | | | factory worker. 1/3 spec.IgE+; *individual reaction type not given | | | |
| Farming | | *[**] | | | ≥ 944 | | | | | | | | | | | | | | |
| " | Walusiak, Krawczyk-Adamus et al. 2004 | | 2-; Case control | 100 | | 38(38.0) | 100/100 | | x* | x* | nd | 38/100 | 23 | 15 | | Polish farmers. SIC with grain dust, animal epidermis, furs and feathers; sign. risk factors of resp symptoms, cereal farming, animal breeding; 47/100 SPT+; *individual data not given | | | |
| " | Eduard, Douwes et al. 2004 | | 2-; Cross-sectional | 1614 | | | x* | | nd | nd | nd | nd | | | | Norwegian farmers. *asthma sign. elevated in cattle and pig farmers (OR 1.8 or 1.6); exposure to endotoxines, fungal spores and ammonia pos. associated with non-allergic asthma | | | |
| " | Hoppin, Umbach et al. 2003 ; Hoppin, Umbach et al. 2004 | | 2-; cross-sectional (Agricultural Health Study 1994-1997) | 20468/ 20898 | | | 3838*/ 20 898 | 18.4 | nd | nd | nd | nd | | | | 20 468, and 20 898 farmers (pesticide applicators). 3838 wheezing; OR for wheeze 1.26 (dairy), and 1.70 (eggs); wheezing sign. dose-response related for poultry and number of livestock; OR for driving diesel tractor: 1.31 (sign.), for solvents 1.16-1.33 sign. | | | |
| " | Melenka, Hessel et. al 1999 | | 2-; Cross-sectional | 781 | | 36*(4.6) | 108/781 | | x** | nd | nd | nd | | | | Farmers, growing grain crops and raising livestock. *36 asthma cases correlated with cumulative dust exposure with OR 1.05, not sign.; **individual data not given. sign. dose-response relationship associated with reduction of FEV1 and FEV1/FVC (%) and cumulative dust exposure | | | |

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|---|--------------------------------|--|--|--|--|--|-----------------------|--|---------------------------------|---------|-------|--------|-----|---|---------|---|---|------|------|
| | | | | | | | Asthma | RADS <small>all affected cases: + or at least one out of several cases: (+)</small> | LFT | | NSBHR | | SFT | | | SIC | | | |
| | | | | | | | | | n/n | % | n/n | % | n/n | % | | n/n | % | i(n) | l(n) |
| " | Gomez, Hwang et al. 2004 | | 2-; Cross-sectional | 1620 | | | 295/1620* | 18.2 | | nd | nd | nd | nd | | | Farmers of New York State. Data from telephone interviews with questionnaire. *Asthma cases were not a specific target. **Participants were asked for occurrence of wheezing in the past year. Despite smoking and allergic reaction, sign. predictors for wheeze were having goats, more acreage in corn for silage | | | |
| " | Melbostad, Eduard et al. 1998 | | 2-; Cross-sectional | 8482 | | 263*(3.1) | 263*/8482 | 3.1 | x** | nd | nd | nd | | | | Farmers of Norway. *Cases of self-reported asthma with 'current asthma'. sign. relationship between animal production and prevalence of current asthma without family history with OR 2.16, sign. **Individual data not given. Another important risk factor for asthma was an asthma family history | | | |
| " (various) | Dosman, Graham et al. 1987 | | 3+; Survey | 1824 | | 607(33.3) | 607/1824 | | x* | nd | nd | nd | | | | Farmers. 607 dyspnea, 500 wheezing; *sign. declines of FEV1, FVC, FEV1/VCV with individual data not given | | | |
| " animals (pig, beef/veal, dairy, poultry) | Portengen, Preller et al. 2005 | ** | 2-; Cross-sectional | 81 | ≥ 54 | 36(44.4) | 81/81 | | x* | 36/78** | 46.1 | nd | nd | | | Pig farmers. *Individual data not given;** NSBHR sign. increased (46% vs. 17% of controls); FEV1 sign. reduced; endotoxin-associated with BHR or lower lung function | | | |
| " | Monso, Riu et al. 2004 | | 2-; Cross-sectional | 105 | | 18(17.1) | 58/105 | | 11/105 | nd | nd | nd | | | | 58/105 participants of sample of European never-smoking farmers' study reported wheezing. 18 COPD; COPD sign. dust-related | | | |
| " | Radon, Weber et al. 2001 | | 2-; prospective cohort study | 76 | | | 36/67* | | x*** | nd | x*** | nd | | | | 40 pig farmers (Denmark) and 36 poultry farmers (Switzerland), randomly chosen subsample out of a European study (n=3544). Asthma was not a spec. target; *spec. asthma symptoms not given; **individual data not given;***sign. Lower FEV1 and MMEF25-75 of farmers with symptoms; sign. lower lung function (FEV1, FVC, MMEF25-75) of pig farmers with higher temperature (>19°C) inside the pig houses | | | |
| floor sealant (aromatic hydrocarbons) | Brooks, Weiss et al. 1985 | = | 3; Case report | 1 | 1 | 1 | 1/1 | + | 0/1 | 1/1 | nd | nd | | | | Grocery clerk. RADS for 14 months | | | |
| Formaldehyde (gas, dust) 50-00-0 | Nunn, Craigen et al. 1990 | * | 2-; Prospective cohort study with 6-year follow-up. | 125 | ≥53 | * | 33/125** | | x*** | nd | nd | nd | | | | Workers of chemical factory. *Asthma was not a specific target. **Neither wheezing, nor other resp. symptoms were sign. different from controls; ***FEV1/FVC decline in exposed group ns | | | |
| " | Nordman, Keskinen et al. 1985 | | 3+; Cross-sectional with Case reports | 230 | | 12 | 230/230 | | 2/5* | 29/209 | | 12/230 | 6 | 4 | 2 | 230 formaldehyde workers.; 5 Case reports, *individual data only given in 3 cases | | | |
| " | Burge, Harries et al. 1985 | | 3+; Case series | 15 | | 7 | 5/15 | | nd | 4/14 | nd | 7/15 | 4 | 1 | 2 | 1 plastic molder, 1 printer, 1 formaldehyde manufacturer, 1 medicine packer, 1 farmworker, 6 printers/ laminators of flexible packaging, 1 laminated tray worker, 2 core shop workers; 9/15 subjects co-exposed to isocyanates | | | |
| " | Piipari and Keskinen 2005 | | 3; Case reports | 4 | | 4 | 4/4 | | nd | nd | 4/4* | 4/4* | | | | 4/306 OA cases in 2002. *Individual data not given | | | |

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|---|----------------------------------|--|--|--|---|---|---------------------------------|------|-----|-----------|-------|-----|-----|---------|-----|------|------|--|---------|
| | | | | | | | WORK-RELATED SYMPTOMS | | LFT | | NSBHR | | SFT | | SIC | | | | |
| | | | | | | | Asthma | RADS | n/n | % | n/n | % | n/n | % | n/n | % | i(n) | l(n) | |
| | Kim, Song et al. 2001 | | 3; Case report | 1 | | 1 | 1/1 | | | 1/1 | | 1/1 | | nd | | 1/1* | 1 | Textile factory worker. *Workplace challenge; average workplace-conc.: 6 ppm, several short-term peaks of 0.12-0.13 ppm | |
| | Lemière, Desjardins et al. 1995 | | 3; Case reports | 3 | | 3 | 3/3 | | | 0/3 | | 3/3 | | 3/3 | | 1 | 2 | 1 chemist, 1 carpenter, 1 wood chips factory worker | |
| | Porter 1975 | | 3; Case report | 1 | | 1 | 1/1 | | | 1/1 | | nd | | nd | | | | Neurology resident. P+ | |
| | Hendrick and Lane 1975 | | 3; Case report | 1 | | 1 | 1/1 | | | nd | | nd | | nd | | 1/1 | 1 | Nurse | |
| Foundry [see also Isocyanates(MDI)] | | | ** | | ≥ 7 | | | | | | | | | | | | | | |
| | Hansen 1997 | | 2-; historical cohort study with follow-up | 3056 | | x* | x* | | | nd | | nd | | nd | | nd | | Workers of iron- (93%), stell- (3%), or metal- (4%) foundry. Exposure to silica dust, metal fumes, organic combustion products, engine exhaust, pyrolysis products; *within follow-up, 886 deaths with sign. increase of resp. diseases (mainly: chronic bronchitis/emphysema, pneumoconiosis) | |
| | Ahman, Alexandersson et al. 1991 | | 2-; Cross-sectional | 28 | | * | 0/28** | | | 0/28 | | nd | | 0/28*** | | nd | | Foundry workers (molding/core making). *Asthma was not a spec. target; **complaints of upper resp. symptoms which show a dose-response relationship to cumulative furan resin sand exposure; ***24/28 with sign. FVC (but not FEV1) decline over a work shift | |
| | Mastrangelo, Tartari et al. 2003 | | 3; Case control study | 7 | | 7* | 7/7 | | | 0/7 | | nd | | nd | | nd | | Foundry workers. *COPD cases selected for study with sign. increased risk, OR 12.0; exposure mainly to mineral dust and irritant gases | |
| | Hahn, Beck et al. 1986 | | 3; Survey | 265 | | * | x** | | | 50/265*** | 18.8 | nd | | nd | | nd | | Foundry workers. *Asthma was not a spec. target. **sign. prevalence of chronic bronchitis symptoms in exposed group (21.1% vs 10.2%); ***individual data not given | |
| Freon, (freon-22) | Sjögren, Gunnare et al. 2002 | | 3; Case report | 1 | 1 | 0 | 1/1 | | | nd | | nd | | nd | | nd | | Refrigerator company worker. After massive exposure resp. symptoms with dypnoe, cough and blood-stained sputum; development of pulmonary inflammation, death by myocardial infarction one month later | |
| " (heated) | Malo, Gagnon et al. 1984 | | 3; Case report | 1 | | 1 | 1/1 | | | 0/1 | | 1/1 | | nd | | 1/1 | 1 | Refrigerator company worker. Asthma aggravation at work for two years | |
| Fumigating agent | Brooks, Weiss et al. 1985 | | 3; Case report | 1 | 1 | 1 | 1/1 | + | | 1/1 | | 1/1 | | nd | | nd | | Housewife fumigating her kitchen. Duration of symptoms for 6 months | |
| Furan-based binder | Cockcroft, Cartier et al. 1980 | | 3; Case report | 1 | 1 | 1 | 1/1 | | | 1/1 | | 1/1 | | 1/1 | | 1/1* | 1 | Mold maker. *3 SICs+ (late): furfuryl alcohol combined with acid catalyst, sulfuric acid, or butyl alcohol | |
| Glutaraldehyde [glutaral] 11-30-8 | | | ** | | ≥ 105 | | | | | | | | | | | | | | |
| | Vyas, Pickering et al. 2000 | | 2-; Cross-sectional | 318 | | * | 17/318** | | | x*** | | nd | | 0/17 | | nd | | Nurses of endoscopy units throughout the UK. *Asthma was not a specific target. **WR chest tightness. ***Individual data not given. | |
| | Curran, Burge et al. 1996 | | 3+; Cross-sectional | 20 | | 7 | 13/20* | 65.0 | | nd | | nd | | nd | | 7/8* | | Hospital employees. *SIC done in 8/13 with LFT+, individual data on reaction type not given, 2/13 IgE+ and 3/13 false positive IgE | |
| | Ross, Keynes et al. 1997 | | 3+; Occupational diseases statistics (SWORD) | 74 | | 74 | x* | | | x* | | x* | | x* | | x* | | 74/1765 physician-diagnosed asthma cases in 1996 | |

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|---|-------------------------------------|--|--|--|---|---|---------------------------------|------|---|-----|--------|-------|------|-----|-------|-----|---|------|---|------|------|
| | | | | | | | WORK-RELATED SYMPTOMS | | | LFT | | NSBHR | | SFT | | SIC | | | | | |
| | | | | | | | Asthma | RADS | all affected cases: + or at least one out of several cases: (+) | n/n | % | n/n | % | n/n | % | n/n | % | i(n) | | l(n) | d(n) |
| | Gannon, Bright et al. 1995 | | 3+; Case series | 7 | | 7 | 7/7 | | 1/7 | | 3/7 | | 7/7 | | 7/8 | | 5 | 2 | Workers of endoscopy and X-ray departments | | |
| | Gannon and Burge 1993 | | 3+; Occupational diseases statistics (SHIELD) | 6 | | 6 | 6/6 | | nd | | nd | | x | | x | | | | 6/500 asthma cases in 1989-1991 | | |
| | Jachuck and Bound 1989 | | 3+; Survey | 9 | | 1*(11.1) | 1/9* | | nd | | nd | | nd | | nd | | | | Employees of endoscopy unit. *1subject with breathlessness | | |
| | Ong, Tan et al. 2004 | | 3; Case report | 1 | | 1 | 1/1 | | 0/1 | | 1/1 | | 1/1* | | 1/1 | | 1 | | Laboratory technician | | |
| | Cullinan, Hayes et al. 1992 | | 3; Case reports | 2 | | 2 | 2/2 | | 0/2 | | 1/2 | | x* | | 1/2** | | 1 | | Radiographers. *Individual data not given; **SIC done with 11% glutaraldehyde solution in first patient (+); in second patient with SIC-solution of 1 and 2% and additionally with fixative solution (SIC+, imm.), containing acetic/hydrochloric acids | | |
| | Corrado, Osman et al. 1986 | | 3; Case reports | 4 | | 1 | 4/4 | | 0/4 | | nd | | nd | | 1/4* | | 1 | | Nurses of endoscopy units. *SIC with alkaline glutaraldehyde | | |
| Grain dust | | ** | | | ≥ 133 | | | | | | | | | | | | | | | | |
| | Toren, Balder et al. 1999 | | 2-; Case control | 7 | | 7 | x* | | x* | | x* | | nd | | nd | | | | 7/294 OA cases in 1996. OR 4.2, sign.; *individual data not given | | |
| | Post, Heederik et al. 1998 | | 2-; Cross-sectional study with follow-up after 5 years | 140 | | * | 8/ 140 | 6.0 | x** | | nd | | nd | | nd | | | | Workers of grain processing and animal feed industry. sign. higher annual FEV1 decline in workers with 5-10 years of exposure vs. workers <5 years of exposure; sign. dose-response relationship to grain dust (>4mg/m³) / endotoxin (>20ng/m³) and rapid annual FEV1 decline (>90ml/s), OR 3.3/OR 3.2, sign. | | |
| | Schwartz, Thorne et al. 1995 | | 2-; Population based cross-sectional | 410 | | 58(14.1) | 58 | 14.1 | x* | | 45/410 | 11.0 | nd | | nd | | | | Grain workers. *FEV1 sign. reduced and sign. endotoxin dose-related | | |
| | Chan-Yeung, Schulzer et al. 1980 | | 2-; Comparative survey | 610 | | | x* | | x* | | nd | | x* | | nd | | | | Workers of grain elevator terminals. Increased chest symptoms; across-shift and -week decrease in FEV1 and FVC (FEV1 drop of > 10% in 4.3% of the survey) | | |
| | Williams, Skoulas et al. 1964 | | 3+; Survey | 502 | | 35 | 35/ 502 | | nd | | nd | | nd | | nd | | | | Grain elevator industry workers. 78 with WR breathlessness; 35 (7.0%) wheezing and breathlessness without cough, 20 (4.0) with cough, breathlessness and wheezing | | |
| | Skoulas, Williams et al. 1964 | | 3+; Survey | 51 | | 31 | 31* | 61.0 | x* | | nd | | nd | | nd | | | | 51 grain elevator workers out of 175 with resp. symptoms. *Most severe (n=31) symptoms associated with sign. FEV1 decline; 31/51 SPT+(settled barley dust), 61% vs. 32% of controls | | |
| | Pahwa, Senthilselvan et al. 1994 | | 3; Longitudinal study | 1396 | | * | x** | | x** | | nd | | nd | | nd | | | | Grain workers. *Asthma was not a spec. target; **individual data not given; trend of increased annual declines in FEV1 and FVC. Trend of dose-response relationship | | |
| | Baur, Preisser et al. 2003 | | 3; Case reports | 2 | | 2 | 2/2 | | 2/2 | | 2/2 | | nd | | 2/2* | | 2 | | 1 farmer, 1 manager of grain warehouse (SIC with wheat dust); *SIC in workplace with rye dust | | |
| | Chan-Yeung, Dimich Ward et al. 1992 | | 4; Review | | | | nd | | nd | | nd | | nd | | nd | | | | across-shift and chronic decreases in lung function exposure-related | | |

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|---|------------------------------------|--|--|--|--|--|-----------------------|------|---------------------------------|--------|-------|-------|-----|---|---------|---|---|
| | | | | | | | Asthma | RADS | LFT | | NSBHR | | SFT | | | SIC | |
| | | | | | | | | | n/n | % | n/n | % | n/n | % | | n/n | % |
| rice dust | Ye, Huang et al. 1998 | [*] | 2-; Cross-sectional | 474 | 20 | 20 (4.2)* | x** | | x*** | nd | nd | x**** | nd | | | Rice handlers, processors from granaries. *Asthma cases: 4.2%(n=20) vs. 3.0%(n=7) of controls, ns. **sign. higher prevalences of resp. symptoms (e.g chronic cough/bronchitis/phlegm.) in exposed group. ***Individual data not given, no sign. FEV1/FVC changes in exposed vs. controls.****Trend of higher FEV1 decrements across-shift in exposed. Range of rice dust concentration at workplace 6.6mg/m3-59.8mg/m3. | |
| Hairdressing chemicals | Piipari and Keskinen 2005 | (*) | 3+; Occupational diseases statistics Finland | 6 | 6 | 6 | x* | | nd | nd | 6/6* | 6/6* | | | | 6/306 OA cases in 2002. *Individual data not given | |
| Health Care Workers | Kogevinas, Zock et al. 2007 | * | 2-; prospective cohort study (ECRHS II) | 913* | 332 | 27(3.0)* | 27/913* | | nd | nd | nd | nd | | | | High risk occupations for WRA. *sign. increase for workers exposed to agents with low-molecular-weight, OR 1.58; Highest sign. risk of WRA was nursing, OR 2.22; exposure to cleaning products also associated with sign. high risk of WRA, OR 1.80 | |
| | Pechter, Davis et al. 2005 | | 3+; Occupational disease statistics (SENSOR 1993-1997) | | | 305* | 305 | | x** | nd | nd | nd | nd | | | *Majority of cases were nurses (63%) working in hospitals. **Individual data not given. Nurses affected by latex (33%), cleaning products (21%), glutaraldehyde/ formaldehyde (19%) | |
| Hexachlorophene 70-30-4 | Nagy and Orosz 1984 | = | 3; Case report | 1 | 1 | 1 | 1/1 | | nd | 1/1 | nd | 1/1 | 1 | | | Children's nurse | |
| Hexamethylenetetramine 100-97-0 | Merget, Topcu et al. 1999 | * | 3+ ; Cross-sectional | 17 | ≥ 15 | x** | 3/17* | 11.8 | 0/17 | 4/17** | 24 | nd | nd | | | HMT production workers. *Results ns different from controls; **not clear if workers with NSBHR+ additionally asthma symptoms; 0/17 SPT+ | |
| | Gamble, McMichael et al. 1976 | | 3+; Comparative survey | 52 | | 8 (15.4) | 8/52 | 15.4 | x* | nd | x | nd | | | | Workers of tire manufacturing plant. 8/52 wheezing, 14/52 chest tightness, 10/52 dyspnea; *LFT reduction ns | |
| | Gelfand 1963 | | 3; Case series | 7 | | 7 | 7/7 | | nd | nd | nd | 7/7* | | | | Laquer handlers with asthma. 7/7 SPT+ | |
| Hydrazine 302-01-2 | Brooks, Weiss et al. 1985 | = | 3; Case report | 1 | 1 | 1 | 1/1 | + | 1/1 | 1/1 | nd | nd | | | | Power plant utility worker. Massive exposure to pouring of 35% solution; symptoms for 34 months | |
| Hydrogen chloride [hydrochloric acid] 7647-01-0 | Promisloff, Lechner et al. 1990 | = | 3; Case reports | 3 | 5 | 3 | 3/3 | + | 0/3 | 3/3 | nd | nd | | | | Members of police department. Massive exposure by truck accident | |
| | Tarlo and Broder 1989 | | 3; Case report | 1 | | 1 | 1/1 | | x* | 1/1 | x* | nd | | | | Profession not mentioned. Asthmatic symptoms persistent for 2 years | |
| | Boulet 1988 | | 3; Case report | 1 | | 1 | 1/1 | + | 0/1 | 1/1 | nd | nd | | | | Profession not mentioned. BD+ | |
| Hydrogen fluoride [hydrofluoric acid] 7664-39-3 | Franzblau and Sahakian 2003 | = | 3; Case report | 1 | 1 | 1 | 1/1 | + | 1/1 | 1/1 | nd | nd | | | | Cleaning with HF containing rust stain remover once. Asthmatic symptoms persistent for > 3 years | |
| Iridium salt | Bergman, Svedberg et al. 1995 | = | 3; Case report | 1 | 1 | 1 | 1/1 | | x* | x* | nd | nd | | | | Worker of electrochemical factory. SPT+ (immediate); individual data not given | |
| Isocyanates, Isocyanurate | | | | | (≥ 1737) | | | | | | | | | | | | |
| " , various (HDI, MDI, TDI) □ | Mastrangelo, Paruzzolo et al. 1995 | ** | 2-; Cross-sectional | 121 | 1220 | 7(5.8) | 7/121 | 5.8 | nd | nd | nd | nd | | | | Workers of wooden furniture industry. Exposure to two-component paint (polyalcohols and polyisocyanates) with sign. higher prevalence of WRA vs. non-exposed (n=609), OR 4.61, sign. | |

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|--|--|--|--|--|--|--|-----------------------|-------|---------------------------------|---------|---------|-----------|-----|-----|---------|-----|--|
| | | | | | | | Asthma | | LFT | | NSBHR | | SFT | | | SIC | |
| | | | | | | | n/n | % | n/n | % | n/n | % | n/n | % | | n/n | % |
| " | Baur, Dewair et al. 1984 | | 2-; Case series/ cross-sectional | 621 | | 179 (28.8) | 247/621 | 39.8 | | 179/621 | 28.8 | nd | nd | nd | | | Isocyanate workers of different companies. 26/247 symptomatics exposure-related COPD; spec.IgE+ (14% symptomatic vs. 0.3% asymptomatic isocyanate workers); 26.4% (14/53) symptomatics SPT+ vs. 0% (n=150) asymptomatics |
| " | Piirilä, Nordman et al. 2000 | | 3+; Case series | 244 | | 236 | 244/244 | | x* | 3/3** | 14/14** | 219/219** | 101 | 118 | | | Asthma cases diagnosed 1976-1992. Mainly exposed to polyurethane foams production or spray painting;"individual data not given;" case diagnosed by NSBHR or SFT or SIC (mainly); 91 patients re-examined in 1995 with sign. impairment of FEV1 |
| " | O'Brien, Harries et al. 1979 | | 3+; Case series | 24 | | 16 | 24/24 | | nd | 12/24 | nd | 16/24 | 5 | 11 | | | Profession not mentioned. 8/16 SIC+ also SIC+ with MDI (4 immediate, 4 dual), 3/8 SIC+ with 3rd agent HDI (1 immediate, 2 late) |
| " | Cartier, Grammer et al. 1989 | | 3+; Case series | 62 | | 29 | 62/62 | | 14/62 | 46/62 | nd | 29/62 | 7 | 15 | 7 | | Workers of foam industry (spray painters and others. 8/29 SIC+ with spec.IgE+ and |
| " | Meredith, Bugler et al. 2000 | | 3+; Case-referent study | 78 | | 27* | 27 | | x** | nd | x** | nd | | | | | Workers of foam industry. Asthma cases of SWORD-study between 1989-1993.24/27 TDI, 3/27 MDI-exposed. Higher TWA-exposures for cases vs. referents: 1.5ppb vs. 1.2 ppb respectively. OR (for 0.1ppb increase in 8h TWA-exposures) 1.08, ns. |
| " | Ross, Keynes et al. 1997 | | 3+; Occupational diseases statistics (SWORD) | 310 | | 310 | x* | | x* | x* | x* | x* | | | | | 310/1765 physician-diagnosed asthma cases in 1996 |
| " | Piipari and Keskinen 2005 | | 3+; Occupational diseases statistics Finland | 6 | | 6 | 6/6* | | nd | nd | 6/6* | 6/6* | | | | | 6/306 OA cases in 2002. *Individual data not given. |
| " | Latza and Baur 2005 | | 3+; Occupational diseases statistics | 54 | | 54 | x* | | x* | nd | nd | x* | | | | | 54/835 OA cases in 2003 (54/210 irritant asthma cases). *Individual data not given. |
| " | Chatkin, Tarlo et al. 1999 | | 3+; Occupational diseases statistics (WCB), survey | 9 | | 9 | 9/9 | (+)** | nd | 9/9* | nd | nd | | | | | 9/465 asthma claims between mid 1984 and mid 1988 identified by retrospective Review. **9/9 BD+ and/or NSBHR+; **2/9 RADS |
| " | Tarlo, Liss et al. 2002 | | 3+; Retrospective review of new OA claims of occupational diseases statistics, (WCB) between 1980-1993 | 425 | | 425 | x* | | x* | x* | nd | x* | | | | | Review of Ontario Workers' compensation board. Diisocyanates represented 50% of all OA claims. *Individual data not given. |
| " | Diphenylmethane diisocyanate [MDI] 5873-54-1 | Bernstein, Korbee et al. 1993 | ★★ | 2-; Cross-sectional | 243 | 137 | 2* (0.8) | 9/243 | | nd | nd | 3*/9 | nd | | | | Workers of urethane mold plant. *At follow-up, 2/3 physician diagnosed OA, additionally showed NSBHR+. |
| " | Liss, Bernstein et al. 1988 | | 3+; Comparative survey | 26 | | 7 (26.9) | 7/26 | | x**,** | nd | x** | nd | | | | | Current mould and core room (foundry) workers. *sign. FEV1 decrease across-shift; **individual data not given; 1/26 IgE+ |
| " | Woellner, Hall et al. 1997 | | 3+; Case series | 18 | | 15 | 18/18 | | x* | 15/16 | nd | nd | | | | | Workers of a wood products plant. *Individual data not given. |
| " | Mapp, Boschetto et al. 1988 | | 3+; Case series | 162 | | 93 | 162/162 | | 15/93 | 93/162* | nd | 93/162 | 27 | 32 | 34 | | Profession not mentioned. *NSBHR sign. lower in 93 SIC+ vs. 69 SIC- |
| " | Zammit-Tabona, Sherkin et al. 1983 | | 3+; Case series | 78 | | 6 | 12/78 | | 5/11 | 9/11* | nd | 6/11 | 4 | 2 | | | Foundry workers. 0/6 with SIC+ spec.IgE- |

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|---|---------------------------------------|--|--|--|--|--|---------------------------------|------|---|--------|------|-------|------|-----|--------|-----|---|--|--|------|------|
| | | | | | | | WORK-RELATED SYMPTOMS | | | LFT | | NSBHR | | SFT | | SIC | | | | | |
| | | | | | | | Asthma | RADS | all affected cases: + or at least one out of several cases: (+) | n/n | % | n/n | % | n/n | % | n/n | % | i(n) | | l(n) | d(n) |
| " " | Perfetti, Brame et al. 2003 | | 3; Case report | 1 | | 1 | 1/1 | | + | 1/1 | | 1/1 | | nd | 1/1 | | 1 | Spray painter. RADS after accidental spill | | | |
| " " prepolymers | Vandenplas, Malo et al. 1993 | = | 3+; Case series | 8 | 2 | 2 | 8/8 | | | 0/8 | | 1/8 | | nd | 2/8* | | | Workers of woodchip board manufacturing; 8/8 SIC+ with sign. declines of FEV1 and FVC, only *2/8 with sign. obstr. (no individual reaction type not given); 7/8 spec IgE+; 4/8 BD+ | | | |
| " " HDI biuret plus 4035-89-6 | Vandenplas, Cartier et al. 1993 | (*) | 3+; Case series | 20 | 12 | 10 | 20/20 | | | 6/20 | | 15/20 | | nd | 10/20* | 4 | 2 | 4 | Profession not mentioned; *SIC with monomer and prepolymers of HDI (4 only with HDI prepolymers, 1 only with HDI monomer, 5 with both) | | |
| " " Hexamethylene diisocyanate [HDI]; plus isodurane diisocyanate 822-06-0 | Lemière, Malo et al. 1996 | | 3; Case report | 1 | | 1 | 1/1 | | + | 0/1 | | 1/1 | | nd | 0/1 | | | Mechanic; co-exposure to several organic solvents; P+ | | | |
| " " | Belin, Hjortsberg et al. 1981 | | 3; Case report | 1 | | 1 | 1/1* | | | 1/1 | | 1/1 | | nd | nd | | | Gasoline station manager; spec.IgE+; *severe asthma symptoms after exposed to high concn.of car (polyurethane) paint twice within | | | |
| " " 3-Isocyanatomethyl-3,5,5-trimethylcyclohexyl isocyanate [isophorone diisocyanate, IPDI] 4098-71-9 | Clarke and Aldons 1981 | = | 3; Case report | 1 | 1 | 1 | 1/1 | | | 1/1 | | nd | | nd | 1/1* | | 1 | Spray painter; asthma associated with abnormal chest X-ray (interstitial infiltration); *SIC by increasing exposure on following days | | | |
| " " Methyl isocyanate [MIC] 624-83-9 | Kamat, Patel et al. 1992 | * | 3+; Longitudinal study, follow-up of cases | 113 | ≥ 144 | 97 | 97/97 | | | x* | | nd | | nd | nd | | | Persistently symptomatic residents exposed to MIC at Bhopal tragedy 1984. 97/113 dyspnea; 32% with lung function fluctuations; *sign. FEV1/FVC decline after 18 months, also gradual FEF25-75 decline over 24 months, in a previous study 24/82 subjects; predominating restr.s; 97/97 BD+ | | | |
| " " | Baur, Chen et al. 2001 | | 3+; Case series | 6 | | 3 | 5/6 | | | nd | | 3/5* | | nd | 3/5* | 1 | 1 | 1 | 1 elastomer-, 5 synthetic resin production workers. 1/6 rhinitis; *SIC+ workers also NSBHR+ | | |
| " " | Vijayan and Sankaran 1996 | | 3+; Case series | 54 | | 17 | 54/54 | | | 17/54 | | nd | | nd | nd | | | | Bhopal tragedy. 17 subjects investigated symptomatic and moderately or severely exposed subjects with obstructive lung pattern; FEV1/FVC sign. negatively related to exposure and to BAL neutrophils (P+) | | |
| " " | Kamat, Mahashur et al. 1985 | | 3+; Case series | 82 | | 24 | 82/82 | | | 24/82* | | nd | | nd | nd | | | | Exposed residents at Bhopal tragedy. Predominating restr.s (64/82); 24/82 BD+ | | |
| " " | Harries, Burge et al. 1979 | | 3; Case reports | 3 | | 3 | 3/3 | | | 2/3 | | 1/3 | | nd | 3/3 | 2 | 1 | | 1 chemist, 1 foreman, 1 polyurethane caster of plastic mould factory | | |
| " " | Mehta, Mehta et al. 1990 | | 4; Review | 41 | | | nd | | + | nd | | nd | | nd | nd | | | | Bhopal tragedy; Mainly mixed resp ailments | | |
| " " 1,5-Naphthylene diisocyanate [NDI] 3173-72-6 | Fuortes, Kiken et al. 1995 | * | 2; Survey | 46 | 24 | 13* | 17/46 | | | x* | | 2/3 | 66.6 | 3/8 | 37.5 | nd | | | Workers of wheel factory employed in production and administrative section. Co-exposure to MDI; *7 cases reported to NIOSH and 6 additional cases identified by questionnaire; *individual data not given. | | |
| " " | Baur and Marczynski, 2000 | | 3; Case series | 5 | | 5 | 5/5 | | | 3/5 | | 3/5 | | nd | 3/5 | 1 | 1 | 1 | Workers in production of car equipment | | |
| " " | Alexandersson, Gustafsson et al. 1986 | | 3+; Survey | 23 | | | 8/23 | | | nd | | nd | | nd | nd | | | | Production of tires. * 12/17 eye irritation, 6/17 productive cough, 2/17 chronic bronchitis, 6 exertional dyspnoe. Significant DV decline in 8 workers after 2 days of work. | | |
| " " Polymethylene polyphenyl isocyanate 9016-87-9 | Séguin, Allard et al. 1987 | * | 2; Survey | 42 | 6 | 6 (11.8) | 14/ 42 | 33.3 | | 4/ 10 | 40.0 | nd | | nd | 6/ 10 | 60 | 2 | 4 | Paint shop workers | | |
| " " Toluene diisocyanate, TDI 2.4: 584-84-9; 2.6:91-08-7 | Butcher, Jones et al. 1977 | ** | 2; Prospective cohort | 103 | ≥ 152 | 9 | 26/ 89 | | | x** | | 8/ 11 | | | 9/ 13 | 5 | * | * | 103 TDI workers of Longitudinal study 1973-1975. 89/103 became continuously/intermittently exposed; *4/9 SIC reaction type late or dual; **LFT not sign. | | |

| Agents (specification) [synonyms] CAS No. | Publication | Strength of evidence per agent (three star system of RCGP) | Evidence grading, applied to individual study (modified SIGN system); Study type | Occupationally exposed subjects studied, n | Total no. of irritant-induced occupational asthma/occupational COPD cases per agent | Irritant-induced occupational asthma/occupational COPD cases, n (prevalence, %) | WORK-RELATED SYMPTOMS | | EVIDENCE (pathological results) | | | | | | Remarks | | | | |
|---|---|--|--|--|---|---|-----------------------|------|---------------------------------|--------|-------|-------|-----|----|---------|---|---|------|------|
| | | | | | | | Asthma | RADS | LFT | | NSBHR | | SFT | | | SIC | | | |
| | | | | | | | | | n/n | % | n/n | % | n/n | % | | n/n | % | i(n) | l(n) |
| " | Ott, Klees et al. 2000 | | 3+; Cohort study | 313 | | 19 | x* | | x* | nd | nd | nd | | | | TDI production employees between 1967-1992. *Individual data not given. | | | |
| " | Omae, Higashi et al. 1992 | | 3+; Cross-sectional study with follow-up | 57 | | * | ** | | x* | nd | nd | nd | | | | Workers of polyurethane foam industry. *Asthma and asthma symptoms were not a spec. target; **individual data not given; sign. increase of average annual loss of pulmonary function (FEV1,FEF75, PEF) in high exposuregroup(n=15) with mean and maximal TWA conc. of 8.2 and 30ppb | | | |
| " | Chatkin, Tarlo et al. 1999 | | 3+; Occupational diseases statistics (WCB) | 5 | | 5 | 5/5 | + | nd | x* | nd | 2/5** | | | | 5/469 asthma claims between mid 1984 and mid 1988 identified by retrospective review; 5/5 BD+ and/or NSBHR+; for SIC individual reaction type not given | | | |
| " | Marabini, Brugnamini et al. 1994 | | 3+; Case series with follow-up | 40 | | 40 | x* | | x**,** | nd | nd | 40/40 | 9 | 25 | 6 | Profession not mentioned. *Individual data not given.; **at follow-up 4-8 years after first diagnosis sign. decline of FEV1 and FVC of workers with SIC+ (late) | | | |
| " | Karol, Tollerud et al. 1994 | | 3+; Case series | 63 | | 34 | 63/63 | | nd | 32/34* | nd | 34/63 | 12 | 13 | 9 | 63 asthmatic isocyanate workers. *NSBHR+ associated with SIC+ | | | |
| " | Paggiaro, Bacchi et al. 1990 | | 3+; Case series with follow-up | 10 | | 10 | 10/10 | | 5/10 | 10/10 | nd | 10/10 | | 4 | 6 | Profession not mentioned. At follow-up 3-39 months after cessation no sign. difference in FEV1 and NSBHR. Biopsy of bronchial mucosa with inflammatory changes in 8/8 (P+) | | | |
| " | Axford, McKerrow et al. 1976 | | 3+; Case series with 4 year follow-up | 35 | | 30 | 30/35 | (+)* | x** | nd | nd | nd | | | | 35 firemen at accidental exposure. 20/35 persistent resp. symptoms 4 years later with small **FEV1/FVC decline; *8/35 chest tightness during the fire (immediate), additionally 22 within 8 hours to 3 weeks (delayed symptoms); 7/33 asthmatic symptoms after 6 months, 2/32 after 44 months | | | |
| " | Vandenplas, Cartier et al. 1992 | | 3; Case reports | 2 | | 2 | 2/2 | | 1/2 | 2/2 | nd | 2/2* | | 2 | | Workers of wood roof industry. *SIC with TDI prepolymers, TDI monomers negative | | | |
| " | Luo, Nelsen et al. 1990 | | 3; Case reports | 2 | | 2 | 2/2 | + | 1/2 | 2/2 | nd | nd | | | | Police officers exposed to spill. Persistent asthmatic symptoms > 7years with considerable improvement | | | |
| " | Tarlo and Broder 1989 | | 3; Case report | 1 | | 1 | 1/1 | + | x* | 1/1 | x* | nd | | | | RADS lasting for 1.5 years | | | |
| " | Wisniewski, Liu et al. 2005 | | 4; Review | | | | | | | | | | | | | Accelerated loss of FEV1 within 4-year-period. Dose-response relationship remains unclear | | | |
| " | Triglycidil isocyanurate 2451-62-1 | Piirilä, Estlander et al. 1997 | 3; Case report | 1 | 1 | 1 | 1/1 | | nd | 1/1 | 1/1 | 1/1 | 1 | | | Laboratory technician. Spec.IgE+ | | | |
| " | Triphenylmethane trisocyanate | Buick and Todd 1997 | 3; Case report | 1 | 1 | 1 | 1/1 | | 1/1 | nd | nd | nd | | | | Salesman, dealing with rubber products. Initially, exacerbation of interstitial lung disease | | | |
| " | Isothiazolinone 55965-84-9 | Bourke, Convery et al. 1997 | 3; Case report | 1 | 1 | 1 | 1/1 | | 1/1 | 1/1 | 1/1* | nd | | | | Chemical plant operator; *SFT on 3 consecutive days with I. (asthma onset late) | | | |
| " | Lauryl dimethyl benzyl ammonium chloride 139-07-1 | Burge and Richardson 1994 | 3; Case report | 1 | 1 | 1 | 1/1 | | nd | 1/1 | 1/1 | 1/1 | 1 | | | Pharmacist | | | |
| " | Lubricants (not specified) | Henneberger, Derk et al. 2003 | 3+; Occupational diseases statistics (SENSOR) | 46 | 54 | 46 | 46/46 | | x | x | nd | nd | | | | 46/424 OA cases in 1993-1995 | | | |
| " | | Latzka and Baur 2005 | 3; Occupational diseases statistics | 8 | | 8 | x* | | x* | nd | nd | x* | | | | 8/835 OA cases in 2004. 3 classn.ed as allergic asthma, 5 as irritant asthma (total irritant asthma cases = 210); *individual data not given | | | |
| " | Metal coat remover (coating removing chemical) | Brooks, Weiss et al. 1985 | 3; Case report | 1 | 1 | 1 | 1/1 | + | 1/1 | 1/1 | nd | nd | | | | Remover of coatings from metals and plastics. RADS for 39 months | | | |

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|--|----------------------------------|--|--|--|--|--|---------------------------------|--------|---|--------------|------|-----|--------|----|-----|----|---|---|---------|------|------|
| | | | | | | | WORK-RELATED SYMPTOMS | | | | LFT | | NSBHR | | SFT | | SIC | | | | |
| | | | | | | | Asthma | RADS | all affected cases: + or at least one out of several cases: (+) | | n/n | % | n/n | % | n/n | % | n/n | % | | i(n) | l(n) |
| Metal oxide fume | Dube, Puruckharr et al. 2002 | = | 3; Case report | 1 | 1 | 1 | 1/1 | + | 1/1 | nd | nd | nd | nd | nd | nd | nd | Metal industry worker. RADS associated with metal fume fever | | | | |
| Metal working fluids [MWF] | Zacharisen, Kadambi et al. 1998 | = | 3+; Survey | 30 | 12 | 12 (40.0) | 30/30 100.0 | | 5/30 16.7 | 12/30 40.0 | nd | nd | nd | nd | nd | nd | 30 workers of an automobile engine manufacturing plant: 12 OA, 6 industrial bronchitis, 7 hypersensitivity pneumonitis | | | | |
| Metam sodium [methylthiocarbamate] 144-54-7 | Cone, Wugofski et al. 1994 | = | 3+; Retrospective case series | 197 | 20 | 20 (10.1) | 48/ 197 24.3 | (+)* | 15/30 50.0 | 23/ 23 100.0 | nd | nd | nd | nd | nd | nd | Massive spill of pesticide, 197 out of c. 3,000 exposed subjects clinically examined. 20 new onset asthma (*17/20 RADS) plus 10 work-exacerbated asthma | | | | |
| Methylmercaptan 74-93-1 | Chatkin, Tarlo et al. 1999 | = | 3; Occupational diseases statistics (WCB) | 1 | 1 | 1 | nd | + | nd | x* | nd | nd | nd | nd | nd | nd | 1/469 asthma claims between mid 1984 and mid 1988 identified by retrospective review; *1/1 BD+ and/or NSBHR+ | | | | |
| Monoethanolamine 141-43-5 | Gelfand 1963 | = | 3+; Case series | 14 | 10 | 10 | 14/14 | | nd | nd | nd | nd | 10/10* | nd | nd | nd | Subjects exposed in the beauty culture industry. Co-exposure to ammonium thioglycolate and ethylene diamine; *individual data not given | | | | |
| Mustard gas (see dichlorodiethyl sulfide) | | | | | | | | | | | | | | | | | | | | | |
| N-methylmorpholine 109-02-4 | Belin, Wass et al. 1983 | [*] | 3; Comparative survey | 48 | | | x* | 13/ 48 | nd | 8/44 | nd | nd | nd | nd | nd | nd | Polyurethane foam industry workers; 13/48 wheezing and dyspnea (27 vs. 17% of controls, ns); NSBHR sign. increased, *not clear if 8/44 with BHR+ have asthma symptoms; co-exposure to 1,4-diaza-bicyclo-(2,2,2) octane and to isocyanates | | | | |
| Nickel sulphate →anhydrous 7786-81-4 →hexahydrate 10101-97-0 | Estlander, Kanerva et al. 1993 | (*) | 3; Case report | 1 | 5 | 1 | 1/1 | | 0/1 | 0/1 | 1/1 | 1/1 | 1/1 | 1 | 1 | 1 | Manual grinding of metal casting. Co-exposure to chromium; spec. IgE+; allergic contact dermatitis | | | | |
| " | Block and Yeung 1982 | | 3; Case report | 1 | | 1 | 1/1 | | 0/1 | 1/1 | 1/1 | 1/1 | 1/1 | 1 | 1 | 1 | Metal polisher. SPT+; contact dermatitis | | | | |
| " | Malo, Cartier et al. 1982 | | 3; Case report | 1 | | 1 | 1/1 | | 0/1 | 0/1 | 1/1 | 1/1 | 1/1 | 1 | 1 | 1 | Metal plating factory worker. **SFT for 2 weeks; spec. IgE+ | | | | |
| " | Novey, Habib et al. 1983 | | 3; Case report | 1 | | 1 | 1/1 | | 1/1 | nd | nd | nd | 1/1 | 1 | 1 | 1 | Metal plating worker. Co-exposure to chromium; spec. IgE+ | | | | |
| " | McConnell, Fink et al. 1973 | | 3; Case report | 1 | | 1 | 1/1 | | nd | nd | nd | nd | 1/1 | 1 | 1 | 1 | Metal plating worker. SPT+; contact dermatitis | | | | |
| Ninhydrin 485-47-2 | Piirilä, Estlander et al. 1997 | = | 3; Case report | 1 | 1 | 1 | 1/1 | | 1/1 | 1/1 | 1/1 | 1/1 | 1/1 | 1 | 1 | 1 | Forensic laboratory worker; preceding rhinitis; spec. IgE+ (low); SPT+ | | | | |
| Nitrogen chloride [nitrogen trichloride, trichloramine] 10025-85-1 | Jacobs, Spaan et al. 2007 | [*] | 2-; Cross-sectional | 624 | ≥ 3 | | x* | x* | nd | x** | nd | nd | nd | nd | nd | nd | Swimming-pool employees. *sign. elevation of asthma attacks during the last 12 months compared to the general Dutch population (OR 2.6 sign.); 60% of pool employees completed questionnaire; **ns | | | | |
| " | Thickett, McCoach et al. 2002 | | 3; Case reports | 3 | | 3 | 3/3 | | 1/3 | 0/3 | 2/2* | 3/3 | 2 | 1 | 1 | 1 | 2 life guards of indoor swimming pools, 1 swimming teacher. Latency periods 10-14 years; *SFT over 4 weeks | | | | |
| Oil (spill) | Zock, Rodrigues-Tigo et al. 2007 | * | 2-; Cross-sectional | 6700 | | | x* | x* | nd | nd | nd | nd | nd | nd | nd | nd | Fishermen who participated in clean-up work after wreckage of oil tanker Prestige next to Spanish coast. sign. prevalence for lower resp. symptoms, i.e. wheeze and breathlessness, OR 1.73; sign. dose-resp. relationship (i.e. number of exposed days) | | | | |
| Ozone (gassings) 10028-15-6 | Mehta, Henneberger et al. 2005 | * | 2-; cross-sectional with follow up | 66 | 9 | 9* | nd | | 9/66* 13.6 | nd | nd | nd | nd | nd | nd | nd | Pulp mill workers. *Asthma was not a spec. target but chronic airflow limitation (FEV1/FVC <70%); higher risk of chronic airflow limitation in group with pre-baseline survey and both pre-baseline and interval of follow-up survey with ozone gassings (PR 4.3-5.5 for chronic airflow limitation, sign.) | | | | |

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|---|---|--|--|--|--|--|-----------------------|------|---------------------------------|----------|---------|------|--------|--|---|--|--------------|--|--|
| | | | | | | | Asthma | | LFT | | NSBHR | | SFT | | | SIC | | | |
| | | | | | | | n/n | % | n/n | % | n/n | % | n/n | % | | n/n | % | i(n) | l(n) |
| Paint (fumes) | Wieslander, Norbäck, et al. 1997 | * | 2-; Longitudinal study | 175 | 26 | 7(4.0) | 7/175 | 4.0 | | x* | 35 | 20.0 | nd | nd | House painters, working with water based and solvent-based paints. Sign. dose-response relationship; highest TVOC 100-380mg/m ³ ; *individual data not given | | | | |
| | Wieslander, Janson et al. 1994 | | 3+; Survey and clinical study | 415 | | 18 (4.3) | 28* | 6.7 | | 18/23 | 20/23 | nd | nd | House painters, working with water based paint. *28 with self-reported asthma, 23/28 took part in clinical study | | | | | |
| | Tarlo and Broder 1989 | | 3; Case report | 1 | | 1 | 1/1 | | | x* | 1/1 | x* | nd | Consecutive worker; asthmatic symptoms persistent for 3 months | | | | | |
| Palladium 7440-05-3 | Daenen, Rogiers et al. 1999 | = | 3; Case report | 1 | 1 | 1 | 1/1 | | | 1/1 | 1/1 | nd | 1/1 | 1 | Electric industry worker. SPT+ | | | | |
| Paper dust A111 | Toren, Balder et al. 1999 | (*) | 2-; Case control | 32 | 32 | 32 | x* | | | x* | x* | nd | nd | | 32/294 OA cases in 1996. OR 2.1, sign.; *individual data not given. | | | | |
| Paraphenyldiamine 106-50-3 | Silberman and Sorrell 1959 | (*) | 3+; Case series | 80 | 37 | 37 | 59/80 | | | nd | nd | nd | *37/50 | | 80 fur industry workers. Patch test (2% PPD)+: 12/33; 18/80 contact dermatitis; individual reaction type not given | | | | |
| Paraquat 4685-14-7 | Schenker, Stoecklin et al. 2004 | (*) | 2-; cross-sectional (SALUD) | 219 | | | 41/338** | 12.1 | | 10/338* | 3.0 | nd | nd | nd | Workers of banana, coffee and palm oil farms. sign. shortness of breath and wheeze associated with cumulative paraquat exposure, OR 2.3; *association to paraquat exposure ns; **data for overall group: 219 exposed, 119 not exposed | | | | |
| | Castro-Gutiérrez, McConnell et al. 1997 | | 2-; Cross-sectional | 134 | | | 20/71* | 28.2 | | 14/134** | 10.5 | nd | nd | nd | Workers of banana farms. *Group with intense exposure, OR 2.9 sign.; **NSBHR+ OR 0.93-1.3, ns; dose-response relationship between intensity of exposure and exertional dyspnea, grade 3, OR 2.8-4.6, sign. | | | | |
| Perfume agents (research lab) | Kipen, Blume et al. 1994 | = | 3; Case report | 1 | 2 | 1 | 1/1 | | | nd | nd | 1/1* | nd | | Profession not mentioned. "Low dose RADS"; *BD+ | | | | |
| | Baur, Schneider et al. 1999 | | 3; Case report | 1 | | 1 | 1/1 | | | 1/1 | nd | nd | 1/1* | 1 | Saleswoman. *SIC with perfume "Must de Cartier"; SPT- and spec.IgE- | | | | |
| Persulfate | | | | | | | | | | | | | | | | | | | |
| *, not specified | Moscato, Pignatti et al. 2005 | (*) | 3+; Case series | 47 | | 21 | 47/47 | | | 0/21 | 12/21** | 57.1 | nd | 21/47* | 57.0 | 4 | 14 | 3 | Hairdressers. SIC with ammonium persulfate; 11/21 rhinitis; 8/21 dermatitis; 6/21 BD+; **NSBHR+ sign. associated with SIC+ |
| *, * | Pankow, Hein et al. 1989 | | 3; Case report | 1 | 22 | 1 | 1/1 | | | * | 1/1 | nd | 1/1 | 1 | | Hairdresser. *LFT could not be finished, because of non-compliance | | | |
| *, ammonium | Harth, Raulf-Heimsoth et al. 2006 | = | 3; Case report | 1 | 1 | 1 | 1/1 | | | 0/1 | 1/1 | nd | 1/1 | 1 | | Hairdresser | | | |
| *, potassium [7727-21-1] and ammonium peroxydisulfate [7727-54-0] | Wrbitzky, Drexler et al. 1995 | [*] | 3; Cross sectional | 52 | | | 15/52* | | | x** | nd | nd | nd | | | Workers of persulfate producing factory (ammonium- and potassium- persulfate). *Resp. symptoms not specified; **trend (ns) of lung function decline in workers with SPT+ (8/52), compared to workers with SPT- | | | |
| *, alcalic | Therond, Géraut et al. 1989 | = | 3+; case series | 5 | 4 | 4 | 1/5 | | | 1/5 | nd | nd | 4/5 | 2 | 2 | | Hairdressers | | |
| *, Sodium persulfate 7775-27-1 | Parra, Igea et al. 1992 | = | 3; Case report | 1 | 1 | 1 | 1/1 | | | nd | 1/1 | nd | 1/1 | 1 | | Hairdresser; SPT+, spec.IgE- | | | |
| *, Dipotassium peroxyperoxydisulfate [potassium persulfate] 7727-21-1 | Muñoz, Cruz et al. 2003 | (*) | 3; Follow-up of cases | 8 | 7 | 7 | 8/8 | | | 5/6 | 7/8 | nd | 7/7 | 1 | 5 | 1 | 3 | cosmetic industry workers, 5 hairdressers | |
| *, Diammonium peroxydisulfate [ammonium persulfate] 7727-54-0 | Schwaiblmair, Vogelmeier et al. 1997 | * | 3; Survey | 55 | 16 | 9 (16.4) | 38/55 | 69.1 | | 3/55 | 32/53 | nd | 9/41 | 28.0 | 5 | 4 | | Hairdressers; 13/54 SPT+ | |
| | Blainey, Ollier et al. 1986 | | 3; Survey | 23 | | 4 (17.4) | 7/23 | 30.4 | | 0/23 | 6/23 | 1/12 | 4/9 | | 4 | | | Hairdressers. SIC with bleach, 3/4 SIC+ also challenged with potassium peroxydisulfate (3/3 late); 1/23 SPT+ | |
| | Gamboa, de la Cuesta et al. 1989 | | 3; Case report | 1 | | 1 | 1/1 | | | 0/1 | 1/1 | nd | 1/1 | 1 | | | | Hairdresser | |

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|--|-------------------------------------|--|--|--|---|---|---------------------------------|------|---|----------|------|--------|-------|-----|-----|--------|-----|---|---------|------|------|---|
| | | | | | | | WORK-RELATED SYMPTOMS | | | | LFT | | NSBHR | | SFT | | SIC | | | | | |
| | | | | | | | Asthma | RADS | all affected cases: + or at least one out of several cases: (+) | | n/n | % | n/n | % | n/n | % | n/n | % | | i(n) | l(n) | d(n) |
| " | Baur, Fruhmann et al. 1979 | | 3; Case reports | 2 | | 2 | 2/2 | | | 1/2 | | nd | | 2/2 | | nd | | | | | | Chemical factory workers |
| Pesticides (not specified) | Jones, Burks et al. 2003 | ★ | 2-; Prospective case-control | 135 | ≥ 83 | x* | 22/135** | 16.3 | | 11/135** | 8.0 | nd | | nd | | nd | | | | | | Pesticide aviators. *Not clear if 11/135 with LFT+ additionally asthma symptoms; **symptoms and LFT sign. different vs. controls (community selected). At follow-up, dose-response relationship ns |
| " | Senthilselvan, McDuffie et al. 1992 | | 2-; Cross-sectional | 1939 | | 83 (4.3)* | x** | | | x*** | | nd | | nd | | nd | | | | | | Farmers. *Asthmatic group, asthma physician diagnosed; **sign. higher prevalence of wheezing and shortness of breath in asthmatics; ***sign. reduction of FEV1/FVC ratio in asthmatics; sign. association of carbamate insecticide use with asthma, POR 1.8; co-exposure to grain dust as possible cause for asthma |
| " | Lings 1982 | | 3+; Survey | 274 | | * | x** | | | 8/181*** | 4.4 | nd | | nd | | nd | | | | | | Fruit growers. *Neither asthma nor **asthmatic symptoms were a spec. target (only resp. symptoms: cough, expectoration, dyspnea); ***difference of resp. symptoms in group that used masks compared to group of non-users ns |
| " | Barthel 1983 | | 3; Case reports | 2 | | 2 | 2/2 | | (+) | 2/2 | | 1/2 | | nd | | nd | | | | | | Midwife and insecticide worker. |
| Phenylglycine acid chloride 39478-47-2 | Kammermeyer and Mathews 1973 | (*) | 3+; Case series with controls | 24 | 15 | 15 | 15/24 | | | x* | | nd | | nd | | 2/2 | 2 | | | | | Plant workers. 7/24 allergic, 8/24 irritant resp. symptoms; 9/24 SPT+; *individual data not given |
| Phosgene 75-44-5 | Tarlo and Broder 1989 | - | 3; Case report | 1 | | 1 | 1/1 | | | x* | | 1/1 | | nd | | nd | | | | | | Profession not mentioned. co-exposure to hydrochloric acid; duration of symptoms 2 years; *individual data not given |
| " | Wyatt and Allister 1995 | | 4; Case report | 1 | 2 | 1 | 1/1 | | + | nd | | nd | | nd | | nd | | | | | | Refrigeration worker. Asthma symptoms immediate while using hot welding torch to cut refrigeration pipe containing freon (gas); exertional dyspnoe for further 2 weeks |
| Piperazine dihydrochloride 142-64-3 | Hagmar, Bellander et al. 1982 | ★ | 3+; Survey | 130 | 185 | 13 (10.0) | 13/130* | 10.0 | | nd | | 6/15 | | nd | | 1/1 | 1 | | | | | Factory workers with co-exposure to other amines. *According to WRS, 12 late and 1 dual asthma type; additionally 16 former employees had suspected OA, exposure-related; also bronchitis increased (24/117) |
| " | Hagmar, Bellander et al. 1984 | | 3+; Cross-sectional | 516 | | 170 (32.9) | 170/516 | 32.9 | | nd | | nd | | nd | | nd | | | | | | Chemical workers. 33% WR attacks of dyspnea, 27% WR wheezing, 12% chronic bronchitis; sign. dose-response relationship |
| " | Pepys, Pickering et al. 1972 | | 3; Case reports | 2 | | 2 | 2/2 | | | 0/2 | | nd | | nd | | 2/2 | 2 | | | | | Chemical industry workers |
| Platinum salts (7440-06-4) | Merget, Kulzer et al. 2000 | ★★ | 2+; Prospective cohort study | 227 | ≥ 131 | 6*(2.6) | 9/227 | | | x | | 11/187 | | nd | | nd | | | | | | Catalyst production employees. Exposure related resp. symptoms, lung function decline and NSBHR+; 9/14 with new chest symptoms within 5 yrs, smoking-related; 14/227 SPT+; *6/227 SPT- with new chest symptoms |
| " | Calverley, Rees et al. 1995 | | 2+; Prospective cohort study | 78 | | 7 (9.0) | 32/78 | 41.0 | | 7/10* | 70.0 | nd | | nd | | nd | | | | | | New recruits of refinery workers. 32/78 new-onset symptoms (bronchospasm, rhinitis etc.) within 24 months; *10/32 PSS with SPT-; 22/30 SPT+; dose-related increase of risk of asthma for smokers |
| " | Hnizdo, Esterhuizen et al. 2001 | | 3+; Occupational diseases statistics (SORDSA) | 29 | | 29 | x* | | | x* | | x* | | nd | | x* | | | | | | 29/324 OA cases due to platinum in 1997-1999. Individual data not given |
| " | Merget, Reineke et al. 1994 | | 3+; Case series with follow-up | 24 | | 24 | 23/24 | | | 2/24 | | 23/24 | | nd | | 24/24* | | | | | | Refinery workers. *Individual reaction type not given; at follow-up change in NSBHR and SIC ns after removal from exposure for 19 months (1-77) |

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|---|--|--|--|--|---|---|-----------------------|------|---------------------------------|---|-------------------|--------------------|--------|---|---------|-----|--|------|------|
| | | | | | | | Asthma | RADS | LFT | | NSBHR | | SFT | | | SIC | | | |
| | | | | | | | | | n/n | % | n/n | % | n/n | % | | n/n | % | i(n) | l(n) |
| | Baker, Gann et al. 1990 | | 3+; Cross-sectional | 107 | | x** | 28/107 | | 6/107 | | 3/107* | nd | nd | | | | Current workers in metal industry. 15/107 SPT+; *NSBHR+ done with cold air; **not clear if people with LFT+ and/or BHR+ additionally combined with asthma symptoms | | |
| | Venables, Dally et al. 1989 | | 3+; Survey with follow-up | 91 | | 49 (53.8) | 49/91 | | nd | | nd | nd | nd | | | | Refinery workers; 22/49* SPT+, related to smoking | | |
| | Pickering 1972 | | 3+; Case series | 12 | | 6 | 12/12 | | nd | | nd | nd | 6/12* | 5 | 1 | | Platinum refinery workers; *SIC done with ammonium hexachlorplatinate, 6/7SPT+; SIC additionally done with a.tetra-cl-pl: 4/6 imm., 2/6 late; Sodium hexa-cl-pl:3/7 imm. | | |
| | Pepys, Pickering et al. 1972 | | 3+; Case series | 16 | | 10 | 16/16 | | 5/16 | | nd | nd | 10/16 | 7 | 2 | 1 | Platinum refinery workers; 10/16 SPT+; 7/11 nasal challenges+ | | |
| Polyamines, aliphatic | Ng, Lee et al. 1995 | | [*] 3+; Cross-sectional | 12 | 1 | 1 | 4/12 | | 0/12 | | nd | 4/12* | 1/2* | | | 1 | Polyamide resin factory workers. *SFT for 1-2 weeks with sign. greater diurnal variation (in DV-PEFR%) compared to unexposed workers | | |
| Polyester | Zuskin, Mustajbegovic et al. 1998 | | (*) 3+; Comparative survey | 400 | 5 | 4 (1.0) | 4/400 | | x**,** | | nd | x** | nd | | | | Synthetic textile workers. Dyspnea sign. increased in male workers (32/92); *sign. FEF75 decline; **individual data not given | | |
| | Cartier, Vandenplas et al. 1994 | | 3; Case report | 1 | | 1 | 1/1 | | 1/1 | | 1/1 | 1/1* | 1 | | | | Painter. Exposure to powder paint, containing polyethylene terephthalate and polybutylene terephthalate; *SIC done with granulated polyester (bisphenol based epoxide); after SIC, additionally occurrence of alveolitis-type reaction with leukocytosis, fever and declines of DL _{co} plus FVC | | |
| Polyethylene 9002-88-4 ", heated to 140 °C ", heated to 160 °C ", heated to 200 °C | Sternton, Kelly et al. 1989 Gannon, Burge et al. 1992 Skerfving, Akesson et al. 1980 | | 3; Case report 3; Case report 3; Case report | 1 1 1 | 3 | 1 1 1 | 1/1 1/1 1/1 | | 1/1 1/1 1/1 | | 1/1 1/1 1/1 | 1/1* 1/1* nd | 1 1 | | | | Electric cable repairer; *SIC with heated repair tape Paper packer; *SIC with heated polyethylene (76 °C) Food industry worker. Lowest values of LFT after 5 day working week, normal values of LFT after 5 days holiday | | |
| Polymethyl-methacrylate [plexiglas powders] 9011-14-7 | Kennes, Garcia-Herreros et al. 1981 | | 3; Case report | 1 | 1 | 1 | 1/1 | | 1/1* | | nd | nd | 1/1** | 1 | | | Plexiglass factory worker. *BD+, **SIC done with plexiglas dust, additionally hemoptysis, re-SIC+ (dual) 2 days later | | |
| Polypropylene , heated to 250 °C 9003-07-0 | Atis, Tutluoglu et al. 2005 | | [*] 2+; Cross-sectional | 50 | ≥ 1 | x* | 13/50** | 26.0 | x*** | | nd | nd | nd | | | | Workers of polypropylene flock processing plant. *Asthma was not a spec. target; **asthma symptoms not spec.; ***individual data only partly given; sign. pulmonary function decline (FEV1, FVC, FEF25-75) in exposed group vs. controls; sign. time-exposure relationship in years for lung function decline. Dust concentration < 0.2 - 4.4mg/m ³ | | |
| | Malo, Cartier et al. 1994 | | 3; Case report | 1 | | 1 | 1/1 | | 1/1 | | 1/1 | nd | 1/1 | 1 | | | Bag factory worker | | |
| Polyvinyl chloride (fume) 9002-86-2 | Tuomainen, Stark, Seuri et al. 2006 | | ** 3+; Survey | 10 | ≥ 8 | | 0/10 | | 0/10 | | 0/10 | nd | 0/10 | | | | PVC workers. SIC done with 2-ethylhexanol, sign. increase of resp symptoms next morning after SIC (n=5) compared to morning after control exposure (n=0) | | |
| | Lee, Ng et al. 1991 | | 3+; Survey | 48 | | x* | 8/48** | 16.7 | x*** | | nd | x**** | nd | | | | Workers of PVC industry, mixers (n=24) with high PVC exposure (mean conc. 1.6 mg/m ³) and non mixers (n=24) with low exposure (mean conc. 0.4 mg/m ³). *Asthma was not a spec. target; **sign. wheezing in mixers (n=7/8); ***individual data not given; ****sign. higher diurnal variation (6.5%) of mixer group. | | |

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|---|--|--|--|--|--|--|-----------------------|--|---------------------------------|-----|-------|-----|------|---|---------|-----|--|--|------|
| | | | | | | | Asthma | RADS <small>all affected cases: + or at least one out of several cases: (+)</small> | LFT | | NSBHR | | SFT | | | SIC | | | |
| | | | | | | | | | n/n | % | n/n | % | n/n | % | | n/n | % | i(n) | l(n) |
| | Wegman, Eisen et al. 1987 | | 3+; Cross-sectional | 230 | | x* | x* | | 24/230* | | nd | | | | | | Food store workers. *5% higher prevalence of obstr. vs. unexposed control group; resp symptoms not investigated. At follow-up, lung function decline sign. associated with exposure to PVC-fumes of "hot-wire" cutting of meat wrap | | |
| | Baser, Tockman et al. 1985 | | 3+; Cross-sectional | 163 | | | 57/163* | 34.9 | x** | | nd | x** | | | | | Workers of PVC industry. * Trend of increasing prevalence over a 5-day week: Monday 16.2% and Friday 34.9%; sign. increase of chronic wheeze in non-smoking workers (3.54-fold higher than community population prevalence); **pre and post shift spirometry with reduction of FEV1/FVC across-shift, ns | | |
| | Andrasch, Bardana et al. 1976 | | 3+; Survey with case series | 96 | | 3 | 33/96* | | 14/14 | | nd | | 3/11 | | 3 | | Meatwrappers. *33/96 with bronchospasm at work | | |
| | Muñoz, Cruz et al. 2003 | | 3; Case report | 1 | | 1 | 1/1 | | 1/1 | | 1/1 | | 1/1 | | 1 | | Fish-processing factory worker | | |
| " (resin dust) | Lee, Yap et al. 1989 | | 3; Case report | 1 | | 1 | 1/1 | | nd | | 1/1* | | 1/1 | | 1 | | Bottle caps factory worker. SIC with PVC dust; *SFT for 3 weeks | | |
| " (fume and dust) | Sokol, Aelony et al. 1973 | | 3; Case reports | 3 | | 3 | 3/3 | | 2/3 | | nd | | 3/3* | | 2 | 1 | Meatwrappers; *SIC at workplace; BD+ 2/2 | | |
| Potassium dichromate 7778-50-9 (see also chromium; cement) | Bright, Burge et al. 1997 | | (*) 3+; Case series | 7 | 7 | 7 | 7/7 | | 4/7 | | nd | | 4/4 | | 7/7 | 2 | 1 | 4 Electroplating industry workers. 2/7 SPT+; in 2 subjects co-sensitization to nickel chloride proven | |
| Potassium aluminum tetrafluoride 14484-69-6 | Hjortsberg, Nise et al. 1986 | | (*) 3+; Case series | 7 | 5* | 5 | 5/7 | | nd | | 5/7* | | nd | | 2/2* | | | Soldering workers. More spec. data not given | |
| Potroom aluminum smelting | Musk, de Klerk et al. 2000 | | *[**] 2+; cross-sectional | 2388 | ≥ 470 | * | x** | | x** | | nd | | nd | | | | | Alumina refinery workers. **sign. higher prevalence of WRS (wheeze) in digestion, precipitation and calcification workers, PR 2.2 -2.9.sign. WRS sign. associated with decline of FEV1,FVC and FEV1/FVC ratio. | |
| | Kongerud, Grønnesby et al. 1990 | | 2+; Longitudinal study | 641 | | 122 (19.1) | 122/641 | 19.1 | x* | | nd | | nd | | | | | Employees with > 10 yrs of exposure. *FEV1 sign. negatively related to duration of exposure | |
| | Saric, Godnic-Cvar et al. 1986 | | 3+; Survey | 227 | | 7 (3.1) | 7/227* | 3.1 | 20/227 | 8.8 | 5/7 | | nd | | | | | Workers of aluminum smelter; **7/227 wheezing and dyspnea; 54/227 chronic bronchitis; | |
| | Chan-Yeung, Wong et al. 1983 | | 3+; Comparative survey | 797 | | 126 (15.1) | 126/797* | 15.1 | x*** | | nd | | x** | | | | | Workers of aluminum smelter. *Wheezing (15.1% vs. 10.5% of controls); **SFT not sign. vs. controls; resp. symptoms sign. higher and ***FEV1 decreased in workers with >50% working time in potroom. Evidence for healthy worker effect | |
| | Sorgdrager, de Loeff et al. 1998; Sorgdrager, de Loeff et al. 2001 | | 3+; Case series with follow up | 179 | | 179 | x** | | x*,** | | x** | | nd | | | | | 179 cases in 1970-1990 (during 2845 person years); incidence density 6.1/1000 workers; 122/179 workers at follow up 5 years later ; *sign. FEV1 decline after more than 1 year of exposure; **individual data not given | |
| | O'Donnell, Welford et al. 1989 | | 3+; Case series | 57 | | 34 | 57/57 | | 7/57 | | 34/57 | | x** | | | | | Workers of aluminium smelter ; *7/7 BD+; **individual data not given. | |
| | Burge, Scott et al. 2000 | | 3; Case report | 1 | | 1 | 1/1 | | 1/1 | | 1/1 | | 0/1* | | 1/1 | | 1 | Caster of molten aluminium. SIC with aluminum chloride; *SFT with positive occupational effect (OASYS-2 score 2.67) | |
| | Desjardins, Bergeron et al. 1994 | | 3; Case report | 1 | | 1 | 1/1 | | 0/1 | | 1/1 | | 1/1* | | | | | Worker of aluminum plant. SFT for 3 weeks | |
| | Bernstein and Merget 2006 | | 4; Review | | | | x* | | x* | | | | | | | | | First asthma symptoms between 1 week and 10 years after first exposure. *Individual data not given; about 40% of former workers continue to have asthma; association to RADS possible. The causative agent(s) are unknown | |

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|---|--|--|--|--|---|---|-----------------------|---|---------------------------------|---|----------|------|-----------|---|---------|--|---|
| | | | | | | | Asthma | | LFT | | NSBHR | | SFT | | | SIC | |
| | | | | | | | n/n | % | n/n | % | n/n | % | n/n | % | | n/n | % |
| Poultry confinement | Rylander and Carvalheiro 2006 | [**] | 2-; Cross-sectional | 42 | 54 | x* | x**,** | | x**,*** | | x**,**** | nd | nd | | | Poultry workers. *Asthma and asthma symptoms were not a spec. target. **Individual data not given; ***sign. FEV1-decline in exposed group; ****sign. FEV1 decline in exposed group after methacholine-challenge; endotoxin range between 10 - 1003ng/m ³ in poultry house | |
| " | Hagmar, Schütz et al. 1990 | | 3+; Cross-sectional | 23 | | 2 (8.6) | 2/23 8.6 | | 0/23 | | nd | x* | nd | | | Shacklers of poultry slaughter houses. 2/23 chest symptoms; *sign. VC and FEV1 declines across-shift | |
| " | Danuser, Wyss et al. 1988 | | 3+; Survey | 26 | | 10 (38.0) | 14/26 53.8 | | 10/26 38.0 | | nd | nd | nd | | | Swiss poultry farm workers. FEV1 decline sign. related to duration of occupation | |
| " | Danuser, Weber et al. 2001 | | 3+; Case series (representative sample) | 37 | | 37 | 37/37 | | nd | | nd | nd | nd | | | Swiss poultry farm workers. Asthma OR 2.87, ns | |
| " slaughtery house | King, Page et al. 2006 | * | 2-; cross-sectional | 68 | 5 | 0 | 18/68* 26.0 | | nd | | nd | 0/34 | nd | | | Poultry processing workers of evisceration department. *Asthma symptoms ns different vs. controls. At follow-up (n=34) upper resp. symptoms sign. associated to trichloramine/soluble chlorine mean TWA concentration | |
| " " | Borghetti, Magarolas et al. 2002 | | 2-; Cross-sectional | 15 | | 1 (7.1) | 5/14 35.7 | | 2/5 40.0 | | nd | nd | 1/5* 20.0 | | 1 | Spanish poultry farmers who participated in the European Farmers' Project. *Subject with SIC+ also allergic to storage mite | |
| " " | Perfetti, Cartier et al. 1997 | | 3; Case reports | 4 | | 4 | 4/4 | | 0/4 | | nd | 4/4 | nd | | | Slaughterhouse workers. 4/4 SPT+ to chicken feathers | |
| Powder paints | Blomqvist, Düzakin-Nystedt et al. 2005 | (*) | 2-; Cross-sectional | 118 | 23 | 23 (21.9) | 23/105* 30.5 | | x** | | nd | nd | nd | | | Employees of powder paint shops. *WR asthmatic symptoms (according to physician) sign. exposure-related; IgE-; co-exposure to various organic acid anhydrides and to triglycidyl isocyanurate; **LFT declines ns; 32/119 asthmatic symptoms (according to questionnaire) | |
| Pyrazolone (s.reactive dye) | Nakano, Tsuchiya et al. 2000 | = | 3; Case report | 1 | | 1 | 1/1 | | 1/1 | | 1/1 | 1/1 | 1/1* | | 1 | Chemical manufacturing worker, making silver halide photographic paper. SIC done with pyrazolone-derivative. | |
| Reactive dyes | Nilsson, Nordlinder et al. 1993 | * | 3; Survey | 162 | | 4* (2.5) | 6/162 3.7 | | 2/15 13.3 | | 3/6 50.0 | 0/2 | nd | | | Workers of textile plants in dye houses. *4 workers with asthma symptoms and LFT+ or NSBHR+ | |
| " | Park, Lee et al. 1991 | | 3; Survey | 309 | | 13 (4.2) | 78/309 | | nd | | 38/78 | nd | 13/78 | | 5 1 7 | Korean workers in dye-industry. 55 SPT+(5 with SIC+ had SPT-); 53/309 spec.IgE+ (23/53 also SIC+ were asymptomatic) | |
| " | Romano, Sulotto et al. 1992 | | 3; Case report | 1 | | 1 | 1/1 | | 0/1 | | 0/1 | nd | 1/1* | | 1 | Worker of textile manufacturing; *SIC with lanasal yellow 4G and anaphylactic reaction; SPT+ | |
| " | Park, Lee, et al. 1990 | | 3; Case reports | 3 | | 3 | 3/3 | | 0/3 | | 1/3 | nd | 3/3* | | 3 | Workers of dye industries. Exposure to "Black GR" with 3/3 SPT+ and spec.IgE+. SIC done with "Black GR" | |
| " | Alanko, Keskinen et al. 1978 | | 3; Case reports | 4 | | 4 | 4/4 | | nd | | 3/4 | nd | 4/4* | | 4 | Workers of dye industry. *SIC with levafix brilliant yellow E-36, drimaren brilliant yellow K-GL, cibachrome brilliant scarlet 3 R, drimaren brilliant blue K-BL; 3/4 spec.IgE+; 4/4 SPT+ | |
| Refractory ceramic fibers [RCF] | Lemasters,Lockey et al. 1998 | * | 2-; Cross-sectional and longitudinal study | 742 | ≥ 1 | x* | x** | | x** | | nd | nd | nd | | | Refractory ceramic fibers industry workers. *Asthma was not a spec. target. **Individual data not given. sign. resp symptoms: dyspnea 1° in males (15.7% vs. 2.5% of controls), dyspnea 2° in females (10.5% vs. 0.0% of controls). sign. FEV1 and FVC declines in exposed male smokers per 10 years of work | |

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|--|------------------------------------|--|--|--|--|--|-----------------------|------|---------------------------------|--------|-------|----|---------|-----|---------|--|---|
| | | | | | | | Asthma | RADS | LFT | | NSBHR | | SFT | | | SIC | |
| | | | | | | | | | n/n | % | n/n | % | n/n | % | | n/n | % |
| " , phosphoric acid binder mixture | Forrester 1997 | | 3; Case report | 1 | | 1 | 1/1 | + | 1/1 | | nd | | nd | | | Millwright in steel mill exposed to spill (dust). Asthma symptoms persistent for > 4 years | |
| Rosin core solder , thermal decomposition [colophony] 8050-09-7 | Burge, Edge et al. 1981 | * | 2-; cross-sectional | 45 | ≥ 178 | 5 (11.1) | 5/45 | 11.1 | x | | nd | | nd | | | Solder manufacturers. Prevalence of asthma dose-related (4% in lowest exposure group, 21% in highest and intermediate exposure group) | |
| " | Burge, Harries et al. 1980 | | 3+; Case series | 51 | | 34 | 51/51* | | nd | 16/ 31 | | nd | 34/51** | 34 | | Electric industry workers. *34/51 with OA and 17/51 with asthmatic symptoms before survey. **only sensitized with SIC+; SIC also with abietic acid (5/6 immediate) | |
| " | Ross, Keynes et al. 1997 | | 3+; Occupational disease statistics (SWORD) | 94 | | 94 | x* | | x* | x* | | x* | | | | *94/1765 physician-diagnosed asthma cases in 1996; *Individual data not given | |
| " | Gannon and Burge 1993 | | 3+; Occupational diseases statistics (SHIELD) | 41 | | 41 | 41/ 41 | | nd | nd | | x | | | | 41/500 OA cases in 1989-1991 | |
| " | Maestrelli, Alessandri et al. 1985 | | 3; Case reports | 4 | | 4 | 4/4 | | 4/4 | 4/4 | | | 3/4 | 2 | 1 | Female electronic factory workers. Persisting resp symptoms after avoidance | |
| " | Malo, Park et al. 2006 | | 4; Review | 237 | | | x | | x | | | | x | | | | |
| Smoke (fires, pyrolysis products) | Almeida, Duarte et al. 2007 | * | 2-; Cross-sectional | 203 | 62 | 24* | x** | | 24/203 | 11.8 | | nd | | nd | | Firefighters. *11/24 non-smoking; **individual data not given | |
| " | Reinisch, Harrison et al. 2001 | | 3+; Occupational diseases statistics (SENSOR), survey | 34 | | 34 | 34/34 | | x* | | nd | | nd | | | 23/430 new-onset asthma in 1993-1996; *individual data not given | |
| " | Moisan 1991 | | 3; Case reports | 3 | | 3 | 3/3 | + | 1/3 | 1/1 | | nd | | nd | | 1 fire fighter, 2 accidental exposures. Persistent asthma symptoms | |
| " | Brooks, Weiss et al. 1985 | | 3; Case reports | 1 | | 1 | 1/1 | + | nd | 1/1 | | nd | | nd | | Accidental smoke exposure in burning book store. RADS for 13 months | |
| " , (oil fire and dust storm) | Kalsall, Sim et al. 2004 | * | 2-; Cross-sectional | 1424 | | 141* (10.2) | 171 | 12.4 | 68/ 1341** | 6.4 | | nd | | nd | | Australian Gulf War veterans. *Asthma by ECRHS definition; **lung function decline ns compared to controls | |
| " , (biomass, indoor) | Ekici, Ekici et al. 2005 | (*) | 3+; Cross-sectional | 397 | 113 | 113 (28.5) | 113/397 | | x | | nd | | nd | | | Stove smoke-exposed non-smoking women. COPD prevalence 28.5% vs. 13.6% of controls | |
| Sodium azide (powder dust) 26628-22-8 | Weiss 1996 | - | 3; Case reports | 2 | 2 | 2 | 2/2 | | + | 2/2 | 2/2 | | nd | | | Material handlers exposed to massive spill. Asthmatic symptoms > 2 years | |
| Sodium iso-nanonyl oxybenzene sulphonate [SINOS] 123354-92-7 | Stenton, Dennis et al. 1990 | (*) | 3; Case reports | 3 | 5 | 3 | 3/3 | | | 0/3 | 2/3 | | nd | 3/3 | 3 | Development technicians | |
| " | Hendrick, Connolly et al. 1988 | | 3; Case report | 1 | | 1 | 1/1 | | | nd | 1/1 | | 0/1 | 1/1 | 1 | Laboratory technician | |
| " | Ferguson, Thomas et al. 1990 | | 3; Case report | 1 | | 1 | 1/1 | | | nd | nd | | nd | 1/1 | 1 | Research worker with high exposure over 18 months | |
| Sodium metabisulfite [metabisulfite sodium] 7681-57-4 | Merget and Korn 2005 | - | 3; Case report | 1 | 4 | 1 | 1/1 | | | 0/1 | 1/1 | | 1/1 | 1 | | Radiographer | |
| " | Madsen, Sherson et al. 2004 | | 3; Case report | 1 | | 1 | 1/1 | | | 1/1 | 1/1 | | nd | 1/1 | 1 | Fisherman | |
| " | Malo, Cartier et al. 1995 | | 3; Case report | 1 | | 1 | 1/1 | | | 0/1 | 0/1 | | nd | 1/1 | 1 | Agricultural producer | |

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|--|---------------------------------|--|--|--|--|--|-----------------------|-------|---------------------------------|------|---------|------|--------|---|---|-----|---|
| | | | | | | | Asthma | RADS | LFT | | NSBHR | | SFT | | | SIC | |
| | | | | | | | | | n/n | % | n/n | % | n/n | % | | n/n | % |
| " | Valero, Bescos et al. 1993 | | 3; Case report | 1 | | 1 | 1/1 | | 1/1 | nd | 1/1 | 1/1 | 1 | 1 | Factory worker. Work-exacerbated asthma | | |
| Soldering flux (fumes) | Lee, Koh et al. 1994 | ★ | 2-; Cross-sectional | 150 | 19 | 0* | 5/144 | 3,5 | x** | nd | 9/134** | nd | | | Solderers of electronic factory manufacturing computers.*OA cases were not found; **FEV1/FVC sign. lower in workers with exposure duration > 5 years; all other pulmonary function tests ns | | |
| " | Burge, Perks et al. 1979 | | 2-; Cross-sectional survey | 106 | | 16 | 58 | | x* | nd | 16/48** | 33,0 | 9/9*** | | Workers of electronic factory. OA cases defined by symptoms(30), taking asthma medication for at least 12 months(13) and asthma symptoms over the week (all); *FEV1 sign. reduced before exposure on Monday mornings compared to controls; **SFT with FEV1 decline more than 10% compared to controls (5%); ***individual data not given. | | |
| " | Weir, Robertson et al. 1989 | | 3; Case reports | 2 | | 2 | 2/2 | | 2/2 | 2/2 | 2/2 | 2/2 | 1 | 1 | 1 tin maker and 1 car radiator repair man. Use of soft corrosive soldering fluxes; co-exposure to zinc chloride, see also zinc chloride;1/1 SIC+ (ammonium chloride); immediate | | |
| " | Stevens 1976 | | 3; Case report | 1 | | 1 | 1/1 | | 0/1 | nd | nd | 1/1 | 1 | | Electronic assembler developing resp. symptoms within days after exposure | | |
| Solvents (not specified) | Toren, Balder et al. 1999 | ★ | 2-; Case control study | 294 | ≥ 46 | 38 | x* | | x* | x* | nd | nd | | | 38/294 OA cases in 1996. OR 2.1. sign.; *individual data not given | | |
| " | Cakmak, Ekici et al. 2004 | | 3+; Cross-sectional | 411 | | * | 202/411* | 49,1 | x* | nd | nd | nd | | | Gun factory workers.*Group with definite asthma not mentioned, asthma-related symptoms not specified. | | |
| " | Henneberger, Derk et al. 2003 | | 3+; Case series | 8 | | 8 | 8/8 | | + | x | x | nd | nd | | 8/424 OA cases in 1993-1995. 8/131 RADS cases | | |
| " glue | Chatkin, Tarlo et al. 1999 | (*) | 3+; Occupational diseases statistics (WCB) | 5 | 5 | 5 | 5/5 | (+)** | nd | x* | nd | nd | | | 5/469 asthma claims between mid 1984 and mid 1988 identified by retrospective review: 4 cases with work-exacerbated asthma; *5/5 BD+ and /or NSBHR+; **1/5 RADS | | |
| Spray paint | Brooks, Weiss et al. 1985 | - | 3; Case reports | 3 | 3 | 3 | 3/3 | + | 3/3 | 3/3 | nd | nd | | | Painters. 2 RADS for 4 months, 1 RADS for 56 months | | |
| Styrene monomer 100-42-5 | Lorimer, Lillis et al. 1976 | ★ | 3+; Survey | 488 | ≥ 3 | x* | 56/488* | 11,0 | 163/451* | 36,1 | nd | nd | nd | | Production workers. Sign. correlation of dose-response relationship and recurrent episodes or severity of WRS. *No specified information if workers with LFT+ also had asthma symptoms. | | |
| " | Hayes, Lambourn et al. 1991 | | 3; Case report | 1 | | 1 | 1/1 | | 0/1 | 1/1 | 1/1 | 1/1 | 1 | | RAF air frame technician | | |
| " | Moscato, Biscaldi et al. 1987 | | 3; Case reports | 2 | | 2 | 2/2 | | 0/2 | 2/2 | nd | 2/2 | 2 | | Plastic factory workers | | |
| Sulfur dioxide 7446-09-5 | Andersson, Knutsson et al. 2006 | ★ [★] | 2-; Cross-sectional | 674 | 86 | 35 (5.2) | 35/674 | 5,2 | nd | nd | nd | nd | | | Sulfite mill workers. Asthma incidence rate sign. increased; attributable fraction of incident asthma due to SO2 exposure 63%, and 75% due to SO2 gassing | | |
| " | Koksal, Hasanoglu et al. 2003 | | 3+; Survey | 69 | | 10 (14.5) | 55/69* | 79,7 | nd | nd | 10/69** | nd | | | Workers of apricot farms. *55/69 dyspnea; **SFT+ with sign. declines also as a group in FVC, FEV1, FEV1/VC | | |
| " | Andersson, Nilsson et al. 1998 | | 3+; Case reference study | 186 | | 33** | x* | | x* | x* | x* | x* | | | Sulfite mill workers. Mortality study of deceased workers aged 40-75 years. * physician diagnosed with individual data not given; **sign. increased mortality from asthma (n=13) and COPD (n=20), OR1.6; other sign. increased causes of death were brain tumors (n=5), OR 3.3 | | |

| Agents (specification) [synonyms] CAS No. | Publication | Strength of evidence per agent (three star system of RCGP) | Evidence grading, applied to individual study (modified SIGN system); Study type | Occupationally exposed subjects studied, n | Total no. of irritant-induced occupational asthma/ occupational COPD cases per agent | Irritant-induced occupational asthma/ occupational COPD cases, n (prevalence, %) | WORK-RELATED SYMPTOMS | | EVIDENCE (pathological results) | | | | | | Remarks | | | | |
|--|---|--|--|--|--|--|-----------------------|------|---------------------------------|-----|-------|-----|-------|------|---------|-----|---|------|------|
| | | | | | | | Asthma | RADS | LFT | | NSBHR | | SFT | | | SIC | | | |
| | | | | | | | | | n/n | % | n/n | % | n/n | % | | n/n | % | i(n) | l(n) |
| | Härkönen, Nordman et al. 1983; Piirilä, Nordman et al. 1996 | | 3+; Case series with follow-up | 9 | | 7 | 9/9 | (+)* | 6/9 | | 4/7 | | nd | | | | Men accidentally exposed to SO2 in pyrite mine in 1977. *7/9 with RADS; 6/7 re-examined after 4 and 13 years; 1 subject died hours post exposure due to pulmonary edema; 4 subjects with persisting NSBHR; 2/6 with persistent obstr. | | |
| | Tarlo and Broder 1989 | | 3; Case report | 1 | | 1 | 1/1 | | x* | | 1/1 | | x* | | | | Profession not mentioned; persistent asthma symptoms; co-exposure to sulphuric acid and chlorine; *individual data not given.. | | |
| Sulfathiazole 72-14-0 | Rosberg 1946 | = | 3; Case reports | 2 | | 2 | 2/2 | | | nd | | nd | | | | | Nurses; *individual reaction type not given. | | |
| Swine confinement | | ** | | | ≥ 371 | | | | | | | | | | | | | | |
| | Vogelzang, v. d. Gulden et al. 2000 | | 2-; Cohort study with 3-years follow-up. | 171 | | 12* | 82/171 | | x** | | 12/82 | 15 | x** | | | | Pig farmers. *Asthma or COPD cases; **individual data not given; long term average exposure to dust: 2.63mg/m³, to endotoxin 105ng/m3, to ammonia 150mg/m3 | | |
| | Reynolds, Donham et al. 1996 | | 2-; Longitudinal study with 5years follow-up | 151 | | | x* | | x* | | nd | | x* | | | | Swine production workers. *Individual data not given; **sign. across-shift change in FEV1 for 46 workers with exposure of 10-13 years; levels of 2.5 mg/m³ for total dust and 7.5 ppm for ammonia are associated with sign. across-shift decrease in FEV1. | | |
| | Schwartz, Donham et al. 1995 | | 2-; Population based longitudinal cohort study | 168 | | | x**,* | | x**,* | | nd | | x**,* | | | | Pig farmers. *sign. longitudinal declines in FEV1, FVC, and FEF25-75 related to across-shift declines, additionally sign. relationship of FEV1 and FEF25-75 decline to endotoxin exposure; **individual data not given | | |
| | Preller, Heederik et al. 1995 | | 2-; Cross-sectional | 194 | | x* | 94/194 | 48.4 | x* | | nd | | nd | | | | Pig farmers.*Sign. decline of baseline lung function (FVC,FEV1, PEF, FEF25-75) vs. controls. Sign. and positive association between resp. symptoms and duration (OR 4.2 for >10min) of disinfection procedure (medium and high pressure: OR 7.1); average exposure to dust: 2.7 mg/m³; endotoxins: 112 ng/m³; ammonia: 1.7mg/m³ | | |
| | Radon, Büsching et al. 2002 | | 2-; Cross-sectional | 2278 | | 554 (24.3)* | x | | x** | | nd | | nd | | | | Pig farmers in the European Farmers' Project. *24.3% with WR resp. symptoms, sign. exposure-related; **individual data not given | | |
| | Vogelzang, van der Gulden et al. 1998 | | 3+; Longitudinal study with follow-up | 171 | | | 82/171 | | x* | | nd | | nd | | | | Pig farmers. *sign. FEV1 decline 73 mL/yr, sign. related to endotoxin exposure | | |
| | Dosman, Lawson et al. 2004 | | 3; Case reports | 4 | | 4 | 4/4 | | 0/4 | | 3/4 | | nd | | | | Intensive swine facility workers. Onset of first resp symptoms between 4.5 and 48 months; 1/1 BD+ | | |
| | Cormier, Coll et al. 1996 | | 3; Case report | 1 | | 1 | 1/1 | | + | | 1/1 | | nd | | | | Profession not mentioned. Massive exposure | | |
| Tall oil | Tarlo 1992 | = | 3; Case report | 1 | 1 | 1 | 1/1 | | | 0/1 | | 1/1 | 1/1** | 1/1* | 1 | | Rubber tyre industry worker. SIC with Pamtac 1500 (heated); **SFT for 2 weeks | | |
| Tear gas | Hill, Silverberg et al. 2000 | = | 3; Case report | 1 | 4 | 1 | 1/1 | | + | | 1/1 | | nd | | | | Prisoner. Massive exposure with generalized symptoms (spongiotic lichenoid dermatitis, fever); SPT+; general and resp symptoms over > 6 months | | |
| | Bayeux-Dunglas, Deparis et al. 1999 | | 3; Case report | 1 | | 1 | 1/1 | | | nd | | 1/1 | nd | | | | Teacher with repeated exposure. "Low level RADS"; duration of symptoms over 6 months | | |
| | Roth and Franzblau 1996 | | 3; Case report | 1 | | 1 | 1/1 | | + | | 1/1 | | nd | | | | Prison guard. Agent 'Deep Freeze' containing 1% orthochlorobenzalmonitrile. Persistent symptoms >3 years | | |

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|---|--------------------------------------|--|--|--|---|---|-----------------------|------|---------------------------------|-------|-------|--------|-----|----|---|--|---|------|------|
| | | | | | | | Asthma | RADS | LFT | | NSBHR | | SFT | | | SIC | | | |
| | | | | | | | | | n/n | % | n/n | % | n/n | % | | n/n | % | i(n) | l(n) |
| aluminium | Jafari 2004 | | 2-; Case control | 63 | | 4 | 4/ 63 | | x | nd | nd | nd | | | | Manual steel arc welders. sign. asthma symptoms (6.3% vs. 1.3%) and sign. spirom. declines in VC, FVC, FEV1, FEF 25-75% as a group | | | |
| | Toren, Balder et al. 1999 | | 2-; Case control | 26 | | 26 | x* | | x* | x* | nd | nd | | | | 26/294 OA cases in 1996. OR 2.0, sign.; *individual data not given | | | |
| | Nakadate, Aizawa et al. 1998 | | 2-; Cross-sectional | 143 | | x* | x* | | x* | nd | nd | nd | | | | Electric arc welders. Cumulative exposure sign. associated with chronic cough (11/143) and FEV1/VC decline; *individual data not given | | | |
| | Beach, Dennis et al. 1996 | | 2-; Cross-sectional | 682 | | x* | x* | | x* | x* | nd | nd | | | | Welders. NSBHR+ sign. exposure-related; *individual data not given | | | |
| | Hannu, Piipari et al. 2006 | | 3+; Case series with follow-up | 34 | | 34 | 34/ 34 | | 18/ 34 | 9/ 15 | nd | 34/ 34 | 9 | 16 | 9 | Workers of metal industry | | | |
| | Latza and Baur 2005 | | 3+; Occupational diseases statistics | 28 | | 28 | x* | | x* | nd | nd | x* | | | | 28/835 OA cases in 2003 (28/210 irritant asthma cases); *individual data not given | | | |
| | Piipari and Keskinen 2005 | | 3+; Occupational diseases statistics (SORDSA) | 6 | | 6 | 6/6* | | nd | nd | 6/6* | 6/6* | | | | 6/324 OA cases due to welding fumes in 1997-1999; *individual data not given | | | |
| | Karjalainen, Martikainen et al. 2002 | | 3+; Occupational diseases statistics | 14 | | 14 | 14/ 14 | | 14/ 14 | nd | nd | nd | | | | Construction workers | | | |
| | Reinisch, Harrison et al. 2001 | | 3+; Occupational diseases statistics (SENSOR), survey | 9 | | 9 | 9/9 | | x* | nd | nd | nd | | | | 9/430 new onset asthma in 1993-1996. *individual data not given | | | |
| | Contreras and Chan-Yeung 1997 | | 3+; Case series | 6 | | 3 | 6/6 | | 0/6 | 5/6 | nd | 3/6 | 3 | | | Welders. SIC with mild steel, stainless steel and/or galvanised steel; conc. 3.4-150 mg/m ³ | | | |
| | Hannu, Piipari et al. 2005 | | 3; Case reports | 2 | | 2 | 2/2 | | 0/2 | 0/2 | 1/1* | 2/2** | 2 | | | Metal arc welders on stainless steel. **SIC with SMO steel or duplex steel with an nickel/molybdenum electrode; *SFT for 1 week | | | |
| | Vandenplas, Delwiche et al. 1998 | | 3; Case report | 1 | | 1 | 1/1 | | 0/1 | 1/1 | nd | 1/1 | 1 | | | Welder performing manual metal arc welding on aluminium | | | |
| | Ross, Keynes et al. 1997 | | 3+; Occupational diseases statistics (SWORD) | 22 | | 22 | x* | | x* | x* | x* | x* | | | | 22/1765 physician-diagnosed asthma cases in 1996. *Individual data not given | | | |
| Vandenplas, Dargent et al. 1995 | | 3; Case report | 1 | | 1 | 1/1 | | 1/1 | 1/1 | nd | 1/1* | 1 | | | Welder manufacturing automatic gates. *SIC with gas metal arc welding on mild steel | | | | |
| Keskinen, Kalliomäki et al. 1980 | | 3+; Case series | 7 | | 5 | 5/7 | | 0/7* | 2/7 | nd | 2/3 | 1 | 1 | | Metal arc stainless steel welders. (2 years later, 3 subjects re-examinated, out of them 2/3 SIC+; 1 immediate, 1 late) | | | | |
| Bernstein and Merget 2006 | | 4; Review | | | | [incidence about 3.0 - 5.0] | | | | | | | | | Stainless steel sign. stronger irritant than "mild steel" | | | | |
| World Trade Center disaster 2001 | Wheeler, McKelvey et al. 2007 | ** | 2+; prospektive cohort study | 25748 | ≥ 1355 | 926 (3.6)** | x* | | x* | x* | x* | | | | | Workers and volunteers who were involved at the WTC site from 09/11/01 to 06/30/02. *Individual data not given; **new onset asthma, physician diagnosed after 09/11/01; sign. risk faktor for arrival date(OR 1.81- 1.69) within the first week and >90 days of work at WTC site (OR 1.74); sign. elevated risk for new onset asthma for professionals compared to volunteers (unadjusted OR 1.88- 1.66) | | | |

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|--|--|--|--|--|--|--|-----------------------|---|---------------------------------|---|-----------|---|------|---|-----|---------|---|---|
| | | | | | | | Asthma | | LFT | | NSBHR | | SFT | | | | Reaction type | |
| | | | | | | | n/n | % | n/n | % | n/n | % | n/n | % | | | n/n | % |
| | Banauch, Hall et al. 2006 | | 2+; Longitudinal study | 11766 | | 48 [incidence (0.4)] | x | | x | | nd | | nd | | | | Exposed FDNY rescue workers. Resp. symptoms sign. time of arrival-related. Severity (i.e., greater number) early- > intermediate-> late-arrival; sign. loss of FEV1 after disaster in each group; FEV1 < 60% in 45 exposed before, in 93 after disaster | |
| | Banauch, Alleyne et al. 2003; Banauch, Dhala et al. 2005 | | 2+; Prospective cohort study / review | 123 | | 20 (16.3) | 20/123* | + | 27/ 151 | | 24/ 112 | | nd | | | | 17/83 of highly, 3/40 of moderately exposed fire-fighters developed RADS (diagnosed 6 months after disaster). NSBHR exposure-related (31%, 10%); after 6 mo. persistent NSBHR in 55%; *sign. declines of spirometric parameters post WTC | |
| | Herbstman, Frank et al. 2005 | | 3+; Survey | 119 | | 22 (18.5) | 22/ 119 | | x* | | nd | | nd | | | | Clean-up and recovery workers; 22/119 new-onset wheezing with *sign. decline of FEV1; prevalence of symptoms sign. exposure-related | |
| | Salzman, Moosavy 2004 | | 3+; Survey | 240 | | 55 (18.5) | 55/ 240 | + | 37/ 240 | | nd | | nd | | | | Emergency services police officers. Dyspnea and prevalence of abnormal spirometry sign. related to exposure intensity | |
| | Prezant, Weiden et al. 2002 | | 3+; Survey with follow-up of exposed workers | | | 332 (3.3) | 332/ 9914 | + | 332/ 9914 | | 332/ 9914 | | nd | | | | Firefighters. 332/9914 persistent cough; sign. FEV1 and FVC declines; 315 dyspnea; dose-related cough (8% of high, 3% of moderate, 1% of low exposure), and NSBHR (23% of high, 8% of moderate exposure) | |
| Zinc (fume) 7440-66-6 | Malo and Cartier 1987 | - | 3; Case report | 2 | 4 | 2 | 2/2 | | 2/2 | | 2/2 | | nd | | | | Solderers exposed to fume of galvanized metal. 1 subject with metal fever | |
| | Malo and Cartier 1993 | | 3; Case report | 1 | | 1 | 1/1 | | 0/1 | | 1/1 | | 1/1* | | 1 | | Metal plant worker. *SFT+ (late); **SIC done with zinc sulfate; SPT+ | |
| | Kawane 1988 | | 3; Case report | 1 | | 1 | 1/1 | | 1/1 | | 1/1 | | nd | | nd | | Welder. Presenting additionally metal fume fever. | |
| Zinc chloride (fume) 7646-85-7 | Weir, Robertson et al. 1989 | - | 3; Case reports | 2 | 2 | 2 | 2/2 | | 2/2 | | nd | | 2/2 | | 2 | | 1 worker of tin making industry and 1 car/truck repairer. Use of soldering fluxes, co-exposure to ammonium chloride (see also ammonium chloride) | |

*, **, ***: for details see column "Remarks"; + : positive test result; - : negative test result; BD: significant bronchodilator effect; NSBHR: bronchial hyperresponsiveness; conc.: concentration; IC: significant positive intracutaneous test result; IgE: positive result of specific IgE antibody measurement; LFT: lung function test showing obstructive ventilation pattern; n: number of subjects; n/n: number of subjects with work-related symptoms or positive test results / all investigated subjects; nd: not done; ns: not significant; OA: occupational asthma; obstr.: obstructive ventilation pattern(s); P: pathology; resp.: respiratory; restr. = restrictive ventilation pattern; SFT: Serial peak flow, FEV1 or PEFR showing significant change in follow-up pre-, (during) and post shift; SIC: specific inhalative challenge test, i: immediate, d: dual, l: late response type; spec.: specific; SPT: significant positive skin prick test result; sign.: significant/ significantly; vs.: versus; WR: work-related; WRS: work-related symptoms; x: test done, no individual results listed

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