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Estimating number of workers potentially at risk of exposure to hardwood dust in certain industrial sectors in Italy using a national register

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Hardwood dust; exposure assessment; register

Parole chiave
Polvere di legno duro; valutazione dell'esposizione; registro

Summary
Background: *Hardwood dust is a well-known human carcinogen and its use is common in several economic activities.* **Objectives:** *The aim of this study was to assess the extent of occupational exposure to hardwood dust in certain sectors of Italian industry.* **Methods:** *Information on occupational exposures was collected from enterprise exposure registers that must by law be reported to the National Workers' Compensation Authority, as at 31 December 2011. Data stored in the database included economic activity sector, work force size and exposed workers. The number of workers potentially exposed was estimated for some of the industrial sectors from national occupational statistics in Italy.* **Results:** *The economic sector with the highest number of potentially exposed workers to hardwood dust was that classified as the manufacture of other wooden furniture with 15,760 men and 2,771 women, while the highest percentage of enterprises that had sent data (according to the ISTAT 2001 census) was in building and repair of non-metallic ships (21%).* **Conclusions:** *The systematic recording of occupational exposures is a source of data that permits recognition of high risk situations and aids exposure assessment for epidemiological studies.*

Riassunto
«Una stima dei lavoratori potenzialmente esposti al rischio di esposizione a polveri di legno duro in alcuni settori industriali in Italia a partire da un registro nazionale». **Introduzione:** *La polvere di legno duro è un noto cancerogeno per l'uomo e il suo uso è comune in numerose attività economiche.* **Obiettivi:** *Lo scopo di questo studio è quello di valutare l'estensione dell'esposizione professionale a polveri di legno duro in alcuni settori dell'industria italiana.* **Metodi:** *Le informazioni sulle esposizioni professionali in essere sono state ricavate dai registri di esposizione ad agenti cancerogeni inviati dalle aziende per legge all'Istituto Nazionale per l'Assicurazione contro gli Infortuni su Lavoro (INAIL), disponibili al 31 dicembre 2011. I dati memorizzati nel database includono il settore di attività economica, la dimensione della forza lavoro e i lavoratori esposti. Il numero di lavoratori potenzial-*

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mente esposti è stato stimato per alcuni settori industriali tramite l'utilizzo di statistiche nazionali sugli occupati in Italia. **Risultati:** *Il settore economico con maggior numero di lavoratori esposti a polveri di legno duro è risultato essere la fabbricazione di altri mobili con 15.760 uomini e 2.771 donne, mentre la percentuale più alta di aziende che hanno inviato i dati (secondo il censimento ISTAT del 2001) è stata rilevata nei cantieri navali per costruzioni non metalliche (21%).* **Conclusioni:** *La registrazione sistematica delle esposizioni professionali è una fonte di dati che consente il riconoscimento di situazioni ad alto rischio e contribuisce alla valutazione dell'esposizione per studi epidemiologici.*

Introduction

The first available estimate of the number of workers potentially exposed to wood dust dates back to 1990-1993 for Italy and was based on the CAREX project (7). Wood dust was among the first listed carcinogens and the exposed workers in Italy were estimated at about 320,000. The latest estimates refer to the period 2000-2003 and reported about 3.6 million exposures to wood dust at the workplace in 25 member states of the EU (8). In Italy, the latest estimate of exposures to wood dust was made by Mirabelli and colleagues, who quantified occupational exposures at about 280,000 (9). The National Occupational Exposure Survey, conducted from 1981 to 1983, estimated at about 600,000 the number of workers exposed to woods in the U.S.A., while approximately 340,000 Canadians were estimated to be occupationally exposed to wood dust (93% male) (1, 11).Wood dust is classified by the International Agency for Research on Cancer (3) as a human carcinogen and in Italy the establishment of a register of exposed workers to hardwood dust is mandatory by law (5). The term "hardwood" refers generally to deciduous woods such as oak, beech, birch, maple, walnut, mahogany, ash and others. Adverse health effects associated with wood dust exposure include dermatitis, allergic respiratory effects, mucosal and non-allergic respiratory effects, and cancer. The types of cancer associated with wood dust exposure are sinonasal cancer, nasopharynx cancer, pharynx, larynx and lung cancers (3). However, strong epidemiological evidence exists only for the role of wood-dust exposure in development of sinonasal cancer (particularly adenocarcinoma) (12). The European Scientific Committee on Occupational Exposure Limits (SCOEL) does not distinguish between hard and soft woods and specifies that exposure over 0.5 mg/m^3 as total dust (1 mg/m^3 as inhalable dust) should be avoided (15). In Italy, the threshold limit value (TLV) for occupational exposure to hardwood dust, fixed by law (4), is 5 mg/m^3 for the inhalable fraction.

The purpose of this study was to estimate the number of potentially exposed workers to hardwood dust in the woodworking industries as at 31 December 2011 using an occupational exposure database.

Methods

In Italy, starting in 1996 an information system on occupational exposure to carcinogens, called SIREP, was established that records exposed workers and levels of exposure to carcinogens at work. The SIREP system is fully described elsewhere (14). In brief, exposure data are collected by employers and regularly sent (every three years) to SIREP, according to Italian law No. 626 of 19 September 1994 and subsequent amendments (4). Employers are required to report the carcinogens used, data on exposed employees and the exposure levels. The core information provided by employers, for each enterprise, follows a standard pattern: economic activity sector and work force size; personal data and job type; year of measurement and level of exposure. In the present study, information on the industrial activity sector and work force size of enterprises in business recorded in SIREP as at 31 December 2011 were used to make the esti-

mate. Due to the shortage of data in some industrial sectors, the number of workers potentially exposed to hardwood dust was estimated only for those sectors better characterized in the database, for which the percentage of reported work force (exposed together with non-exposed) was consistent (at least 1% of sector enterprises recorded in the database, representing more than 1% of the total sector work force, i.e. $RW_i/W_i>1\%$, where RW_i=SIREP reported workforce, W_i=ISTAT total workforce, and *i*=i-th industrial sector). The total sector work force was estimated using national statistics produced by the Italian Institute of Statistics (6). For the selected industrial sectors, the number of workers potentially exposed to hardwood dust was assessed using the percentage of exposed workers in relation to both the work force size of enterprises recorded in SIREP and the national statistics on work force (i.e.: $PE_i=W_i*(E_i/RW_i)$, where PE_i=potentially exposed workers, W_i=ISTAT total workforce, RW_i=SIREP reported workforce and E_i=SIREP exposed workers). The estimate was stratified by gender, and economic sectors were classified according to the international classification of economic activities NACE (Nomenclature statistique des Activités économiques dans la Communauté Européenne, French acronym) Revision 1. The main characteristics (number of firms and workers) of selected data are reported in table 1.

Results

The most represented sector at risk of exposure to hardwood dust was the manufacture of other furniture (NACE code: 36.14.1) with 15,760 male workers and 2,771 female workers. Detailed data on the number of exposed workers by industrial sector and gender are shown in table 2. As regards major sectors (2 digit code), the manufacture of wood products and products of wood and cork, except furniture (NACE code: 20) showed the largest number of potentially exposed workers (60,073), of whom 52,464 were men and 7,609 women; this is followed by the manufacture of furniture and manufacturing not classified elsewhere (NACE code: 36) with 46,820 potentially exposed workers, of whom 40,238 were males and 6,582 females. Together these two major groups comprised about 87% of total potentially exposed workers to hardwood dust in the selected industrial sectors. Note also subsection DM of the NACE classification (including NACE codes 34 and 35): manufacture of transport vehicle accessories, involving about 9,373 workers, almost all men (9,110). However, assessment of this subsection might have been underestimated due to the lack of data in some sectors (i.e., for which recorded data did not match the selection criteria), such as, for example, the manufacture of parts and accessories for motor vehicles (NACE code: 34.30.0) with only 1 enterprise recorded in the SIREP database. Other major sectors excluded by the adopted selection criteria were in the "Other manufacturing n.c.e." sector, (specifically, NACE codes: 36.63.1-Manufacture of baby strollers, etc., 36.63.2-Manufacture of linoleum, rigid floor coverings, etc., and 36.63.4-Manufacture of roundabouts, swings, shooting galleries and other fairground amusements). Specific activities related to the construction sector were also excluded from the estimate (e.g., NACE codes: 45.22.0-Erection of roof coverings and frames, 45.24.0-Construction of water plants, 45.25.0-Other construction work involving special trades, 45.42.0-Joinery installation, and 45.43.0-Floor and wall coverings) due to shortage of recorded data.

Discussion

Estimation of the number of exposed workers to carcinogens in the workplace is a necessary component of epidemiological studies, especially when evaluating the fraction attributable to exposure for occupational cancers. The attributable fraction is a fundamental metric in quantifying the contribution of a risk factor (exposure) to a disease. Inadequate or lack of exposure assessment and low statistical power are the main concerns. The circumstances of exposure to hardwood dust are generally evident and easy to identify, especially in some specific industrial sectors. The present study utilized data sources from the Italian Information System on Occupational Exposure to Carcinogens (SIREP) to

Table 1. Main characteristics of selected data by sector of economic activity (SIREP, 2011)

Sector of economic activity (NACE code)	Sirep Firms	Istat Firms	% of Firms[a]	Sirep Workers	Istat Workers	% of Workers[b]
Thinning and conservation of forests and timber tracts (02.01.2)	5	27	19	28	71	39
Forestry and logging related service activities (02.02.0)	10	688	1	252	622	41
Sawmilling and wood planning; impregnation of wood (20.10.0)	449	2,350	19	5,056	13,720	37
Manufacture of veneer sheets; manufacture of plywood, laminboard, particle board, fibre board and other panels and boards (20.20.0)	109	537	20	4,845	11,248	43
Manufacture of wooden doors and windows (except armoured doors) (20.30.1)	768	18,087	4	11,029	25,204	44
Manufacture of other items of builders' carpentry and joinery (20.30.2)	519	15,697	3	5,017	26,123	19
Manufacture of wooden containers (20.40.0)	79	1,915	4	1,119	10,041	11
Manufacture of other products of wood (except furniture) (20.51.1)	411	6,701	6	7,576	20,896	36
Workshops of framers (20.51.2)	34	4,272	1	1,462	2,328	63
Iron casting (27.51.0)	3	314	1	266	13,682	2
Steel casting (27.52.0)	3	51	6	541	2,638	21
Manufacture of safes, strong-boxes, armoured doors (28.75.2)	12	398	3	756	3,334	23
Manufacture of machinery for working wood or for manufacture of products of these materials (29.56.4)	13	640	2	1,904	8,197	23
Manufacture of weapons and ammunition (29.60.0)	6	171	4	1,153	3,921	29
Manufacture of watches and clocks (33.50.0)	3	128	2	201	1,195	17
Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers (34.20.0)	10	361	3	508	14,030	4
Building and repairing of non-metallic ships (35.11.2)	26	126	21	663	1,205	55
Ship repair yards (35.11.3)	9	997	1	117	5,685	2
Building and repairing of pleasure and sports boats (35.12.0)	110	2,094	5	4,346	7,587	57
Repair of railway rolling stock (35.20.3)	8	157	5	2,476	13,783	18
Manufacture of chairs and seats, including those for transport vehicles (36.11.1)	55	1,364	4	700	14,551	5
Manufacture of armchairs and sofas (36.11.2)	60	9,767	1	1942	30,440	6
Manufacture of other office and shop metal furniture (36.12.1)	19	1,285	1	771	14,788	5
Manufacture of other office and shop metal furniture (36.12.2)	282	2,462	11	5,755	17,751	32
Manufacture of other kitchen furniture (36.13.0)	170	1,056	16	7,223	13,099	55
Manufacture of other wooden furniture (36.14.1)	1,670	18,262	9	37,595	62,262	60
Manufacture of rattan furniture, wicker and other similar material (36.14.2)	9	355	3	97	2,363	4
Manufacture of musical instruments (36.30.0)	21	695	3	429	1,851	23
Manufacture of sports goods (36.40.0)	5	639	1	83	4,353	2
Manufacture of brooms and brushes (36.62.0)	3	373	1	120	2,917	4
Recycling and processing of municipal solid waste, industrial waste and biomass (37.20.2)	8	783	1	46	3,978	1
Wholesale of wood, unfinished wood and artificial wood (51.53.1)	69	2,905	2	961	6,223	15

[a]Percentage of firms in SIREP according to last industry census data (ISTAT); [b]Percentage of workers in SIREP according to last industry census data (ISTAT); Note: public and non-profit institutions are excluded.

Table 2. Estimates of workers potentially exposed to hardwood dust by gender in the selected sectors of economic activity (SIREP, 2011)

Sector of economic activity (NACE code)	% of E_i/RW_i[a] (Men)	No. of PE_i[b] (Men)	% of E_i/RW_i[a] (Women)[c]	No. of PE_i[b] (Women)	No. of PE_i[b] (All)	CI95% of PE_i[b] (All)
Thinning and conservation of forests and timber tracts (02.01.2)	96	57	0	-	57	50-63
Forestry and logging related service activities (02.02.0)	52	284	10	7	291	267-316
Sawmilling and wood planing; impregnation of wood (20.10.0)	57	5,826	28	945	6,771	6,657-6,886
Manufacture of veneer sheets; manufacture of plywood, laminboard, particle board, fibre board and other panels and boards (20.20.0)	61	4,781	46	1543	6,324	6,221-6,427
Manufacture of wooden doors and windows (except armoured doors) (20.30.1)	59	12,897	28	952	13,849	13,694-14,003
Manufacture of other items of builders' carpentry and joinery (20.30.2)	66	14,789	30	1106	15,895	15,741-16,050
Manufacture of wooden containers (20.40.0)	61	5,051	54	971	6,022	5,926-6,118
Manufacture of other products of wood (except furniture) (20.51.1)	54	8,224	30	1694	9,918	9,777-10,059
Workshops of framers (20.51.2)	60	897	48	397	1,293	1,246-1,340
Iron casting (27.51.0)	5	622	0	-	622	575-670
Steel casting (27.52.0)	1	24	0	-	24	15-34
Manufacture of safes, strong-boxes, armoured doors (28.75.2)	11	298	4	20	318	285-352
Manufacture of machinery for working wood or for manufacture of products of these materials (29.56.4)	10	687	2	17	704	654-753
Manufacture of weapons and ammunition (29.60.0)	8	261	7	47	308	275-341
Manufacture of watches and clocks (33.50.0)	9	61	20	109	170	146-194
Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers (34.20.0)	22	2,756	8	108	2,865	2,771-2,958
Building and repairing of non-metallic ships (35.11.2)	38	402	0	-	402	370-434
Ship repair yards (35.11.3)	62	3,214	0	-	3,214	3,141-3,287
Building and repairing of pleasure and sports boats (35.12.0)	40	2,601	12	129	2,730	2,648-2,812
Repair of railway rolling stock (35.20.3)	1	137	2	25	162	137-187
Manufacture of chairs and seats, including those for transport vehicles (36.11.1)	68	6,239	37	1,959	8,198	8,081-8,315
Manufacture of armchairs and sofas (36.11.2)	25	4,116	4	515	4,632	4,509-4,755
Manufacture of other office and shop metal furniture (36.12.1)	15	1,792	1	43	1,835	1,757-1,914
Manufacture of other office and shop furniture (36.12.2)	45	6,434	9	301	6,735	6,608-6,862
Manufacture of other kitchen furniture (36.13.0)	33	3,346	11	325	3,671	3,570-3,771
Manufacture of other wooden furniture (36.14.1)	34	15,760	17	2,771	18,531	18,308-18,755
Manufacture of rattan furniture, wicker and other similar material (36.14.2)	70	1,133	21	158	1,290	1,243-1,337
Manufacture of musical instruments (36.30.0)	38	418	24	179	597	558-636

(continued)

Table 2. Estimates of workers potentially exposed to hardwood dust by gender in the selected sectors of economic activity (SIREP, 2011)

Sector of economic activity (NACE code)	% of E_i/RW_i[a] (Men)	No. of PE_i[b] (Men)	% of E_i/RW_i[a] (Women)[c]	No. of PE_i[b] (Women)	No. of PE_i[b] (All)	CI95% of PE_i[b] (All)
Manufacture of sports goods (36.40.0)	34	885	19	332	1,216	1,158-1,274
Manufacture of brooms and brushes (36.62.0)	9	115	0	-	115	94-135
Recycling and processing of municipal solid waste, industrial waste and biomass (37.20.2)	73	2,200	0	-	2,200	2,138-2,261
Wholesale of wood, unfinished wood and artificial wood (51.53.1)	40	1,930	15	207	2,137	2,063-2,210

[a]Percentage of exposed workers in SIREP (E_i/RW_i); [b]Number of estimated exposed workers (PE_i); CI95%: 95% Confidence Interval of estimate.

assess the extent of hardwood dust exposure in Italian industrial settings, estimating the potential number of exposed workers. The major sector involving risk of exposure to hardwood dust, based on the number of workers exposed, was the manufacture of wood and wood products both in men and women. Occupational exposures recorded in SIREP were limited to inhalatory exposure, thereby workers with only dermal contact with wood or wood dust were excluded from the estimate.

To estimate the number of workers potentially exposed, only sectors that were better characterized were taken into account, excluding those with limited information on the size of the reported work force. Major economic sectors, that cover a large number of enterprises and workers, were excluded by this restriction (i.e., to limit the selection of sectors to those for which the percentage of reported work force was >1% of total sector work force), as they might have been excluded only because of their size. The number of exposed workers in each sector was calculated assuming the same ratio between exposed and non-exposed workers in enterprises reporting exposure data and those that did not. This assumption is likely to have introduced bias in the estimates. A point of strength of the current study is that the analysis was stratified by gender and, as previously highlighted, there are potential gender-related differences in exposures (2). A self-selection bias might have occurred, due to the fact that firms more attentive to health and safety issues in general (mainly bigger firms) are more likely to send data to SIREP. Thus bigger firms may have been over-represented, resulting in having a non-probability sample. However, since the transmission of exposure data is mandatory by law, this bias could have been minimized by this condition. Currently the SIREP exposure surveillance system covers a large part of the industrial sectors involving carcinogen exposure risk in recent years. Weaknesses and strengths of the SIREP system have been described extensively elsewhere (13). In brief, major limit is that the data are not evenly distributed among industrial sectors or by enterprise size (e.g., small enterprises were under-reported). Conversely, the magnitude of the sample and the large size of the SIREP database increase the level of precision and accuracy of the estimates. The possible misclassification of the industrial sector was reduced by the use of standard international classifications, which permits meaningful comparisons between studies.

A detailed estimate of workers exposed to wood dust for Italian industry was made within the framework of the WOODEX project (8), which estimated about 351,106 exposed workers in the period 2000-2003. The WOODEX estimate is not so different from the assessment reported here, taking into account that our estimate was limited to hardwood dust exposure and only to some selected activity sectors. Moreover, differences may be due also to the fact that our estimate was gen-

der-based. Comparing the two studies in detail, data on macro sectors are in close accordance, resulting in good confidence for the validity of our study. As an example, the WOODEX project (10) estimated 8,413 exposed workers in the ships and boats building sector (NACE 35.1) versus 6,346 in our study. In other sectors (e.g., NACE 20.1-Sawmilling and wood planing; impregnation of wood) our estimate seems to differ a little more from that of WOODEX (6,771 versus 12,793) due also to gender differences in assessing the prevalence of exposed workers (in our study the prevalence of exposed workers was 57% for men and 28% for women, in WOODEX the prevalence was 64.5% for men and women together). The same applies to the NACE sector 36.1-Manufacture of furniture (45,316 versus 84,677) for which our estimate (and thus the prevalence of exposed workers) was more in-depth than that of WOODEX (we assessed prevalence for each sub-sector and it was also gender-based).

In conclusion, this study provides detailed estimates of the workers exposed to hardwood dust in the woodworking industries in Italy as at 31 December 2011, broken down to the last level of the international classification of economic activities (NACE Revision 1). However, due to the wide difference in data size among different industrial sectors, caution should be used in the interpretation of results especially in the presence of limited data on work force. Exposure data are not always available at national level and, in most cases, job exposure matrices or indirect measures are used as a surrogate of exposure assessment. Detailed data on the proportion of exposed workers by industry sector presented here, combined with relative risk measurements, may be useful for estimating the attributable fraction due to workplace exposure. Policy makers and local health authorities should use our data to plan regulatory and inspection interventions for improving health and safety working conditions in industrial settings. The development of a comprehensive occupational exposure database (SIREP) is a challenge for the near future, so as to improve epidemiological knowledge and the efficiency of health surveillance and insurance systems.

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