Distribution of Silica-exposed Workers by Province and Industry in Vietnam

TRAN NGOC LAN, MD, PHAN HONG SON, MD, LE VAN TRUNG, MD, PHD, NGUYEN THI HONG TU, MD, MS, MATTHEW KEIFER, MD, MPH, SCOTT BARNHART, MD, MPH

To determine the number and distribution of exposures among workers exposed to silica dust in Vietnam, a cross-sectional study was conducted of the provincial Preventive Medicine Centers (PMCs) of 61 provinces, and data were collected from medical centers (MCs) of the Ministries of Construction, Industry, and Transportation. The PMC survey identified 112,956 exposed workers in 31 provinces. Ministry data identified 240,744 exposed workers. Quang Ninh province, with 50,000–70,000, had the highest concentration. These estimates provide a range of 40,000–350,000 exposed workers, supporting the development of a validated registry of silica-exposed workers, essential to the development of a program for silicosis prevention in Vietnam. *Key words*: silica dust; silicosis; prevention; pneumoconiosis; Vietnam

INT J OCCUP ENVIRON HEALTH 2003;9:128–133

Silicosis remains a common occupational respiratory disease of workers exposed to dust in the developing world. Millions of workers are exposed to crystalline silica, whether they are employed in developed or developing countries. According to results from statistical surveys, about 1.9 million workers in the United States and more than 12 million workers in China are potentially exposed to silica dust[1]. Silica exposure and silicosis have been involved in many industries, including construction, mining, brick making, and foundries.[2-4] Rapid industrialization increases the use of silica-containing materials. Therefore, exposures to crystalline silica in general and to free silica in particular are common in rapidly industrializing countries.[5] Silica exposure can result in occupational lung disease, including simple, acute, and complicated silicosis.[6,7] In addition, the risks of lung cancer[8-10] and tuberculosis[2,6,11] are significantly elevated among silica-exposed workers. These diseases result in excess morbidity and mortality for workers.

Silicosis is one of the most common occupational diseases among workers in Vietnam.[1] Neither the total number of workers exposed to silica dust nor the prevalence of silicosis in Vietnam is currently known. In fact, occupational silica exposure most likely occurs in all 61 provinces in Vietnam, especially in provinces where operations involving coal and rock are common.

Silicosis is the most commonly recognized occupational lung disease in Vietnam, representing 88% of the 21 compensated occupational diseases (cumulated cases during the period from 1976 to 1997.[5] Monitoring, assessment, and management of dust pollution and identification of the numbers of exposed workers, as well as determining the status of pneumoconiosis among exposed workers, are the crucial steps to design effective prevention programs and to approach the elimination of silicosis in Vietnam. A risk assessment of silica exposures and silicosis in Vietnam was conducted to identify: 1) industries and numbers of workers at risk for silicosis in Vietnam; and 2) provinces at highest risk, for targeting silicosis prevention efforts.

MATERIALS AND METHODS

The public health system in Vietnam is organized under the Ministry of Health (MOH) (Figure 1). The MOH includes the National Institute of Occupational and Environmental Health (NIOEH). The NIOEH is the lead agency coordinating the occupational and environmental health in Vietnam. The NIOEH conducts research, provides professional training, and provides information in consultation with the Preventive Medicine Centers (PMCs) of 61 provinces around the nation, as well as conducting inspections and surveillance and reviewing regulations on occupational and environmental health.

The PMCs are responsible for occupational health at the provincial level. Parallel to the PMCs in the province are the medical centers (MCs) of several large ministries such as the Ministry of Industry, the Ministry of Con-

Received from the National Institute of Occupational and Environmental Health, Ministry of Health, Hanoi, Vietnam (TNL, PHS, LVT); the Department of Preventive Medicine, Ministry of Health, Hanoi, Vietnam (NTHT); and the Occupational and Environmental Medicine Program, University of Washington, Seattle, Washington (MK, SB). Supported by Fogarty International Center, National Institutes of Health, Washington, DC, Grant # 5 D43 TW00642-07, and National Institute for Occupational Safety and Health, Center for Disease Control, Grant # 5 R01 OH03728-02.

Address correspondence and reprint requests to: Scott Barnhart MD, Occupational and Environmental Medicine Program, University of Washington, Seattle, WA 98195, U.S.A.

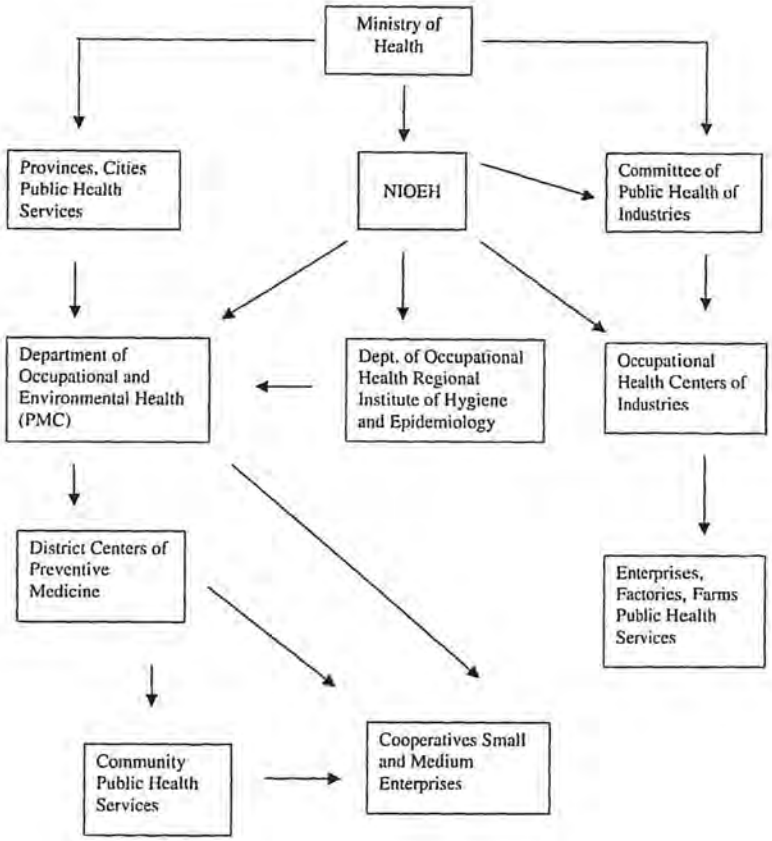

Figure 1—Organization of occupational health services in Vietnam.

struction, the Ministry of Transportation, and the Ministry of Mines and Coal. These MCs are responsible for all activities related to occupational and environmental health at the factories, enterprises, and companies that belong to the Ministries.[6] The provincial PMCs and the MCs of the ministries have had their own projects or programs involved in silicosis and silica prevention.

Study design. A cross-sectional study was done.

Data collection. A questionnaire, with special references to dust exposures and working areas, was designed and sent to the PMCs of 61 provinces in Vietnam. The questionnaire focused on obtaining information about all sources of potential silica exposure in many industries and occupations, numbers of silica-exposed workers in each province by industr, such as: mines, foundries, ceramics and brick making, sandblasting, stone-grinding, and other operations involving silica exposures. The questionnaire was re-sent to non-respondents one month after the initial mailing.

Additional information obtained from the Ministries of Health, Construction, Industry, and Transportation explained what industries were represented in each. The PMC of each Ministry is responsible for surveillance and monitoring the health status of workers who are working at the enterprises belonging to the Ministries. The statistics collected from the Ministries summed up the data reported from the MCs of the individual provinces.

Analysis. Descriptive statistics were used to show the prevalences and geographic distribution of silica exposures to assess a relationship between indicators of silicosis risks and numbers of exposed workers. The provinces and industries were rank ordered to determine the occupations and locations of workers at risk for silicosis.

RESULTS

Of the 61 provinces receiving the questionnaires, 31 (50%) responded.

Industries and Numbers of Exposed Workers at Risk for Silicosis

Source: questionnaire data. The major industries that had activities involving exposures of workers to silica-containing dust are listed in Table 1. This table demonstrates that the total number of exposed workers working in coal mines, foundries, ceramic/brick making, and sandblasting are 112,956. The numbers of workers in coal mines, foundries, ceramic/brick making, and sandblasting were 60,012, 3,030, 2,200, and 16,802, respectively. The percentages by major industry were 53.12%, 2.68%, 14.92%, 1.95%, and 14.87%, respectively. The highest number of exposed workers were working in coalmines. Of the total 60,012 coalmines, 50,000 (83%) were in Quang Ninh Province.

TABLE 1. Data Obtained from the Preventive Medicine Center of Provinces in Vietnam by Questionnaire Survey

Province	Mines	Foundries	Ceramic/ Brick	Sandblasting	Stone Grinding	Others	Silica-exposed
An Giang					604		604
Ba Ria-Vung Tau	600		200	800	200		1,800
Bac Thai							
Ben Tre							
Binh Dinh	1,056		800		510	652	3,018
Binh Thuan							
Can Tho	20	10	200	40		50	320
Cao Bang	896	92	477	20	300		1,785
Da Nang	608	20	391			439	1,458
Dac Lac	185	0	1,171	419	8,365	141	10,281
Dong Nai	753	514	326			186	1,779
Dong Thap							
Gia Lai					1,670	1,075	2,745
Ha Bac							
Ha Giang	123		113		452		688
Nam Ha			436		575	2,668	3,679
Hanoi		420	1,350	230		720	2,720
Ha Tay							
Ha Tinh	1,300		200		250	100	1,850
Hai Hung							
Hai Phong	800	450	750	200	500	1,200	3,910
Ho Chi Minh							
Hoa Binh	0	0	0	0	180	0	180
Khanh Hoa							
Kien Giang							0
Kon Tum			54		53		107
Lai Chau	170				50		230
Lam Dong	227	48	205		24		50
Lang Son	720	40	793	326	928		2,807
Lao Cai							
Long An							
Minh Hai							
Nam Ha							3,,679
Nghe An	534		1,800		450		2,784
Ninh Binh	350	250	541				1,141
Ninh Thuan							
Phu Yen							
Quang Binh	210		630		186		1,026
Quang Nam							
Quang Ngai							
Quang Ninh	50,000	200					50,200
Quang Tri	146				66	186	398
Soc Trang			36			20	56
Son La			30			49	79
Song Be							
Tay Ninh							
Thai Binh							
Thanh Hoa		50	2,000		100	5,000	7,150
Thua Thien Hue	1,000	800	1,500		300	150	3,750
Tien Giang							
Tra Vinh							
Tuyen Quang	40				250		290
Vinh Long							
Vinh Phu	310	136	2,861	165	753	1,392	5,617
Yen Bai							
TOTAL	60,012	3,030	16,861	2,200	16,802	14,028	112,956

Source: Ministries of Construction, Industry, and Transportation. Table 2 shows the distribution of silica-exposed workers identified by the Ministries of Construction, Industry, and Transportation. The total number of exposed workers working in the factories, enterprises, and companies of these three ministries was 240,744. The numbers of workers in construction, industry, and transportation were 45,350, 172,815, and 22,579, while the percentages of exposed workers were 18.71%, 71.41%, and 9.33%, respectively. The industry

TABLE 2. Data Obtained from the Ministries of Construction, Industry, and Transportationin Vietnam

Province	Construction	Industry	Transportation	Total
Hanoi	10,290	10,730	14,999	36,019
Quang ninh	960	70,000		70,960
Vinh phuc	1,570			1,572
Phu tho		8,800		8,800
Cao bang		1,200		1,200
Lang son		280		280
Tuyen quang		100		100
Ha nam	320	1,200		1,520
Ninh binh	450	1,300		1,750
Thanh hoa	3,360	300		3,660
Nghe an	170	2,800	1,671	4,641
Ha tinh			1,079	1,079
Quang binh			343	343
Quang tri	3,000			3,000
Thua thien-Hue		1,200		1,200
Da nang	980	2,500	1,215	4,695
Binh dinh			200	200
Khanh hoa		800		800
Can tho		850	323	1,173
Dong nai	1,720	4,130		5,850
Kon tum			270	270
Gia lai	6,000		580	6,580
Dac lac			183	183
Kien giang	1,500			1,500
Ho chi minh	2,750	36,950	1,234	40,934
Hai duong	3,220			3,220
Hai phong	3,420	2,150		5,570
Hoa binh	440	400		840
Ha bac	2,200	3,300		5,500
Hai hung		2,525		2,525
Long an			170	170
Song be			312	312
Lao cai		3,300		3,300
Bac thai		16,050		16,050
Ha tay		1,950		1,950
Others	3,000			3,000
TOTAL	45,350	172,815	22,579	240,744

that had the highest percentage of exposed workers was coal mining, in Quang Ninh Province, at about 40.50%, compared with 21.38% from Ho Chi Minh City and 6.20% from Ha Noi.

Table 3 provides a comparison of the total numbers of exposed workers obtained from the two data sources, the questionnaire and the Ministries of Construction, Industry, and Transportation. They are 112,956, and 242,002, respectively. The total number of workers obtained from Ministry data is about twice that from the survey.

Provinces at Highest Risk for Silicosis

Provinces at highest risk from the questionnaire. Table 4 (a,b,c) identifies the top ten provinces that had exposed workers by industry according to the two data sources. Table 4a lists the top ten provinces based on the data obtained from the survey. The total number of exposed workers for these ten provinces is 93,196, is about 83% of the total fir 31 provinces participating in the survey. According to these data, Quang Ninh is ranked number one.

Provinces at highest risk from Ministry: data. Table 4b demonstrates the top ten provinces at highest risk for silica exposure based on the data from the Ministries. The total number of exposed workers of these top ten is 200,029, about 83% of the total of 240,744 in 36 provinces. Quang Ninh still ranks number one, with 70,960 exposed workers.

Table 4c shows that from either data source Quang Ninh province had the most exposed workers. In this table, the top ten provinces represent 86.5% of the estimated 240,744 exposed workers. Furthermore, the top five provinces represent 72.4% of the estimated total 240,744 exposed workers.

DISCUSSION

Silica exposure is recognized as a major hazard in Vietnam.[5,6,12] Prevention of silicosis requires hazard identification and risk assessment for a rapidly industrializing

TABLE 3. Comparison of Total Exposed Workers Estimated by Questionnaire and Ministry

Occupation	Questionnaire	Ministry
Mining	60,012	
Foundry	3,030	
Ceramic/brick	16,861	
Sandblasting	2,200	
Stone grinding	16,802	
Other	14,028	
Construction		45,667
Industry		173,752
Transportation		22,583
TOTAL	112,956	242,002

country such as Vietnam. The distribution of silica risk by province and industry is a key contribution to developing an effective silicosis control program in Vietnam.

This study identified a range of between 112,956 and 240,744 silica-exposed workers. Assuming that 50% of the population in Vietnam is in the workforce (50% of 75,000,000 Vietnamese population), this represents a rate of up to 0.64%. This may be compared with estimates for other industrializing nations, such as People's Republic of China, of up to 0.12% (14 million exposed workers).[1]

These data identify silica exposure as a major occupational risk in Vietnam; especially in coal mining where the number of exposed workers was 172,815. Because Vietnam is an industrializing country, the demand of raw materials for development of infrastructure is the key factor in increasing risks to workers. Quang Ninh is the province where workers are at highest risk of silicosis: the numbers of workers at risk range between 50,200 and 70,960. In fact, Quang Ninh is a province with many large coal mines. Almost all of them are surface coal mines, and mining is the principal industry of the province.

There are several limitations in this study. The response rate to the questionnaire was only about 50%. This suggests that the number of exposed workers is underestimated. There are no data that characterize the dust level or silica content or the health outcomes for many of these exposed workers. As a result, these data must be viewed with caution. The identification of up to 240,744 exposed workers is of substantial concern and argues for better characterization of the numbers of exposed workers, severities of the exposures, outcomes, and resources for prevention. The NIOEH of the MOH, in conjunction with the Ministries of Labor, Industry, Construction, and Transportation and the National Institute for Labor Protection, are closely working together to develop a comprehensive silica-risk orientation and prevention program. The data from this study support the agency in those efforts and point to a need

TABLE 4. Top Ten Provinces of Exposed Workers by Industry from Questionnaire and from Ministry Data Sources

Table 4a: Data from Medical Prevention Centers

Rank Order	Province	Mines	Foundries	Ceramic/ Brick	Sand-blasting	Stone Grinding	Others	Total
1	Quang Ninh	50,000	200					50,200
2	Dac Lac	185		1,171	419	8,365	141	10,281
3	Thanh Hoa		50	2,000		100	500	7,150
4	Vinh Phu	310	136	2,861	165	753	1,392	5,617
5	Hai Phong	800	450	750	200	500	1,200	3,910
6	Thua Thien Hue	1,000	800	1,500		300	150	3,750
7	Nam Ha							3,679
8	Binh Dinh	1,056		800		510	652	3,018
9	Lang Son	720	40	793	326	928		2,807
10	Nghe An	534		1,800		450		2,784
TOTAL		54,605	1,672	11,675	1,110	11,906	4,350	93,196

Table 4b: Data from Ministries of Construction, Industry, and Transportation

Rank Order	Province	Construction	Industry	Transportation	Total Exposed Workers
1	Quang Ninh	960	70,000		70,960
2	Ho Chi Minh	2,750	36,950	1,234	40,934
3	Ha Noi	10,290	10,730	14,999	36,019
4	Bac Thai		16,050		16,050
5	Phu Tho		8,800		8,800
6	Gia Lai	6,000		580	6,580
7	Dong Nai	1,720	4,130		5,850
8	Ha Bac	2,200	3,300		5,500
9	Da Nang	980	2,500	1,215	4,695
10	Nghe An	170	2,800	1,671	4,641
TOTAL		25,070	155,260	19,699	200,029

Table 4c: Data of Highest Estimated Workers from Either Data Set

Rank Order	Province	Total Exposed Workers	% of Total 240,744
1	Quang Ninh	70,960	29.5
2	Ho Chi Minh City	40,934	17.0
3	Ha Noi	36,019	14.9
4	Bac Thai	16,050	6.7
5	Dac Lac	10,281	4.3
6	Phu Tho	8,800	3.7
7	Thanh Hoa	7,150	2.9
8	Gia Lai	6,580	2.7
9	Dong Nai	5,850	2.4
10	Ha Bac	5,500	2.3
TOTAL		208,124	86.5

for a national survey to collect more complete information about silica exposures and silicosis in the 61 provinces and then establish an effective and feasible action plan for silicosis prevention in Vietnam. The key element of this plan is surveillance to create a registry to identify high risk industries and exposed workers coupled with measures to reduce workers' exposures to dust. The concentration of silica exposures in a limited number of industries and provinces provides an excellent opportunity for a targeted approach to prevention.

References

1. Health Surveillance's Maintenance in the Workplace. An Occupational Health Continuing Education. NASA, March 1999, 17-18
2. Hnizdo E, Murray J.: Risk of pulmonary tuberculosis relative silicosis and exposure to silica dust in South African gold miners. Occup Environ Med. 1998;55:496-502.
3. Marek , Kujawska A, Stasiow A, Imielska A, Juras A. Analysis of incidence of pneumoconiosis among coal miners. Med Pract. 1992;43:245-50.
4. Aungkasuvapala N, Juengprasert W, Obhasi N. Silicosis and pulmonary tuberculosis in stone-grinding factories in Saraburi, Thailand. J Med Assoc Thai. 1995;78:662-9
5. Tu Nguyen NTH. Silicosis among Coal-mine Workers. Ministry of Health, Vietnam, 1997.
6. Trung L. Silicosis. Medical Publication. Hanoi, Vietnam, 1990.
7. Duchange L, Brichet A, Lamblin C, Tillie J, Tonnel AB. Acute silicosis. Rev Mal Respir. 1998;15:527-34.
8. Cherro NM, et al. Crystalline silica and risk of lung cancer in the potteries. Occup Environ Med. 1998;55:779-85.
9. Finkelstein MM. Radiographic silicosis and lung cancer risk among workers in Ontario. Am J Ind Med. 1998;34:244-51.
10. De Stefanie E, Kogevinas M. Occupation and the risk of lung cancer. Scand J Work Environ Health. 1996; 22:346-52.
11. Chen GX, et al. Tuberculosis mortality and silica exposure: a case–control study based on a national mortality database for the years 1983–1992. Int J Occup Environ Health. 1997; 3:163-170.
12. Trung L. Pneumoconoisis (occupational diseases). Medical Publication. Hanoi, Vietnam, 1994.