

Asthma in Heavy and Highway Construction Workers Exposed to Silica

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In December, 2000 the federal Occupational Safety and Health Administration (OSHA) carried out a safety and health inspection on a contract site (CO9A4) on Boston's Central Artery/Tunnel (CAT) highway construction project. The inspection was conducted under a National Emphasis Program for silica and a Local Emphasis Program for the CAT. Work on the site involved construction of (1) two tunnels linking Boston's underground central artery to the Massachusetts Turnpike (I-90 West and I-90 East) and (2) an exit ramp connecting I-90 westbound to the central artery.

On November 1, 2, and 3, 2001, a health survey of more than 300 construction workers from the CO9A4 site was carried out by Occupational Health Initiatives and the New England Laborers Health & Safety Fund. The survey was done under the auspices of the Building & Construction Trades Council of the Metropolitan District and local unions representing the trades on the site. The focus of the survey was silica. No definite cases of silicosis were identified. However, review of the

answer to the question, “Do you still have it?,” a participant was included in a subcategory of current physician-diagnosed asthma. Both subcategories of physician-diagnosed asthma (those who don’t and do still have it) were analyzed with regard to self-reported symptoms of asthma.

Participants were classified as *current smokers* if they reported “ever smoking cigarettes” and that they “now smoke cigarettes” (as of one month before the survey). *Former smokers* were those who reported “ever smoked” and “not smoking now.” *Never smokers* were those who reported “no” to ever smoking cigarettes. Pack-years of cigarettes were calculated (for *ever smokers*) by multiplying total number of years of smoking by average number cigarettes per day over the entire time that they smoked, and dividing by 20 (number of cigarettes in a pack).

Work histories

Principal work activities on the construction site studied were related to the construction of the two tunnels and the exit ramp.

The work history obtained from each questionnaire included present occupation/trade, union and local union number, usual occupation/job, years of work at usual occupation, and months of work on the CAT contract site of interest. Because of small numbers, pile drivers were grouped with carpenters; similarly, plumbers, millwrights, and nonunion engineers and managers were grouped with “other” for purposes of data analysis (with a group as small as “other,” statistical results must be interpreted with caution). Included in the questionnaire were questions about work at three specific activities on the site: tunneling/mining, breaking through slurry walls, and chipping or hammering caisson overpour. The activities were selected because personal and area sampling on the site by OSHA and the responsible contractor showed elevated silica levels during each of these activities (silica is found in quartz, other rock, sand and masonry). This study assumed that total dust exposures would be high where silica levels were high, and thus included these three activities in the analyses. (Unlike tunneling and slurry wall breakthrough, most of the chipping or hammering of caisson overpour was done above ground.)

Months of work on the site was determined on the basis of start and stop dates and self-reported total months on the job. For those who had missing information for stop date and who did not report total number of months on the site, it was assumed they were still working on the site and the survey date was used to calculate total number of site and ths and ths(9date.127.455 0 TD0o did not8(m)8. ough slurry woY)9

had been employed in their usual jobs for 14 years, on average, and had been working on the site an average of about 22 months. Of the group as a whole, 36% reported having done tunneling/mining, 45% breaking through slurry wall, and 51% chipping or hammering caisson overpour while on the project.

Respiratory symptoms and physician-diagnosed asthma

The number of workers who reported physician-diagnosed asthma was far less than the number showing symptoms consistent with asthma (table 3). Prevalence of physician-diagnosed asthma and SCA varied by trade (table 4). Higher prevalence of physician-diagnosed asthma was observed among operating engineers, laborers, and carpenters at about 10%, 8%, and 7%, respectively. Carpenters, tunnel workers, and operating engineers were more likely to report SCA: about 35%, 34%, and 32%, respectively.

In the logistic regression analysis, physician diagnosis of asthma, breaking through slurry walls, and number of months on the site were all significantly associated with SCA (table 5).

Those with physician-diagnosed asthma were ten

Slurry wall breakthrough emerged as a significant risk factor for SCA in the analysis, depending on trade. Participation in this work activity was associated with a sevenfold increase in risk for SCA in carpenters, an increase in risk that was statistically significant (OR 6.87, 95% CI 1.66-28.39).

Silica levels measured during slurry wall breakthrough were high. OSHA's recalculation of sampling data collected by the general contractor during the breaking through of slurry walls revealed that of 11 samples taken, six showed calculated silica levels of 130%, 135%, 200%, 220%, 305%, and 1170% of the OSHA permissible exposure limit (PEL). Area samples taken during slurry wall breakthrough showed silica levels 314% and 397% of the PEL. These data are consistent with high dust exposures during slurry wall breakthrough reported by workers on the site and are an indicator of high-level exposure to cement dust, as silica and cement dust are often fellow travelers. Silica has not been reported to cause asthma. However, Portland cement present in most cement manufactured in the United States has been reported to cause asthma (Alvear-Galindo and others 1999; DeRaeve and others 1998). Portland cement contains hexavalent chromium, a known irritant and sensitizer to the airways and to the skin.

The tunneling operation involved other potential causes of asthma. These included diesel emissions and fumes/vapors from the burning of the steel and HDPE pipes. Diesel emissions are a known cause of asthma, most likely because of irritants in the particulate and the vapor phase (Rudell and others 1996; Wade and Newman 1993; Ulfvarson and others 1991). The level of risk associated with burning HDPE is unknown presently. Polyethylene itself has been reported to burn cleanly, but if polyvinylchloride is an additive – as in the case of HDPE – hydrochloric acid vapors may be generated (Sakata, Uddin, Koizumi, and Murata 1996). If this occurs, the risk for airway inflammation and asthma is high.

Carpenters were found to be at significantly increased risk for SCA compared to laborers. The carpenters were downwind of the jacking box during slurry wall breakthrough and followed along behind the jacking box as the tunnel was bored. These findings suggest bystander exposures that are at least as high as those taken during the jacking of the tunnel at level of risk associated with the jacking of the tunnel.

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2. Work history: participants' time spent at job, site, and selected tasks, by occupation

	Number	%
Present occupation/trade/union		
Laborer	89	28.1
Carpenter	84	26.5
Electrician	21	6.6
Ironworker	47	14.8
Operating engineer	32	10.1
Tunnel worker	40	12.6
Other	4	1.3
Number of years at usual job		
<=5	75	23.7
>5-15	114	36.0
>15-20	57	18.0
>20	59	18.7
Missing information	12	3.8
<i>Mean (SD)=14.0 (9.4)</i>		
<i>Range=1 to 46</i>		
Number of months on C09A4 site		
<=10	88	27.8
> 10-18	73	23.0
> 18-32	80	25.2
> 32	76	24.0
<i>Mean (SD)=21.8 (15.0)</i>		
<i>Range=1.5 to 77</i>		
Tunneled/mined		
Yes	114	36.0
No	188	59.3
Missing information	15	4.7
Broke through slurry walls		
Yes	143	45.1
No	158	49.8
Missing information	16	5.1
Chipped/hammered caisson overpour		
Yes	163	51.4
Yes	139	43.9
No	15	4.7
Missing information		

Note: Total of 317 workers.

3. Relationship of physician-diagnosed asthma and symptoms consistent with asthma

Workers reporting physician-diagnosed asthma	Workers showing symptoms consistent with asthma			
	Yes	No	Missing information	Total
Yes-current	8 (80.0%)	2 (20.0%)	0 (0.0%)	10 (100.0%)
Yes-not current	5 (45.5%)	5 (45.5%)	1 (9.1%)	11 (100.0%)
No	67 (23.3%)	206 (71.8%)	14 (4.9%)	287 (100.0%)
Missing	1 (11.1%)	3 (33.3%)	5 (55.6%)	9 (100.0%)
Total	81	216	20	317

Note: “Physician-diagnosed asthma” includes a diagnosis at any time, not just during the project.

