A Case-Control Study of Mesothelioma and Employment in the Hawaii Sugarcane Industry

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We conducted a case-control study of 93 mesothelioma cases and 281 cancer controls to determine whether sugarcane workers exposed to biogenic silica fibers were at increased risk of mesothelioma. We found no important excess risk of mesothelioma in sugarcane workers [odds ratio (OR) = 1.3; 95% confidence interval (CI) = 0.4-3.8] when we excluded all control subjects with cancer of sites suspected of being associated with asbestos exposure. We could not identify any sugarcane workers who developed mesothelioma and worked in jobs where high exposure levels to biogenic silica fibers have been measured. We did confirm that mesothelioma risk in Hawaii is associated with probable occupational asbestos exposure. Work at the Pearl Harbor Naval Shipyard was associated with a 10-fold increase in mesothelioma when we excluded controls with cancer of sites related to asbestos exposure (OR = 10.1; 95% CI = 2.6-56.6). Work in the medical industry was also associated with an unexpected increased risk for mesothelioma (OR = 4.2; 95% CI = 1.2-15.5). (Epidemiology 1994;5:466-468)

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Mesothelioma, a fatal cancer of the mesothelial cells that line the pleura, peritoneal cavity, and pericardium, is thought to be predominantly caused by exposure to asbestos fibers.[1-3] The mineral fiber zeolite has also been associated with mesothelioma.[4] It is unknown whether exposures to other naturally occurring fibers are related to mesothelioma risk.

Recently, citizen groups in Hawaii and California have expressed alarm over exposure to smoke from burning sugarcane and rice straw. This concern originates from a case series[5] of five Indian sugarcane workers who had mesothelioma but were not thought to have been exposed to asbestos. It has been speculated that insoluble, amorphous biogenic silica fibers (BSF), found in many plants, could be responsible.[6] Sugarcane workers are exposed to respirable biogenic silica fibers at levels as high as 0.712 BSF/cc.[7-9]

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The purpose of this work was to determine whether mesothelioma is associated with exposure to biogenic silica fibers as determined by employment in the sugarcane industry.

Subjects and Methods

We conducted a case-control study using as cases all Hawaii residents who developed mesothelioma from 1960 to 1987 and were listed in the Hawaii Tumor Registry, a statewide registry that participates in the Surveillance, Epidemiology, and End Results (SEER) program. The registry is estimated to include more than 95% of all incident cancers diagnosed in the state of Hawaii since 1960.

We randomly selected category-matched cancer-controls from the same source using decade-at-diagnosis, age-at-diagnosis (5-year categories), and gender-specific strata. We included three times as many controls as cases from each stratum. We analyzed these data using all controls as well as a subset of controls that excluded those diagnosed with cancers associated with asbestos exposure (for example, larynx, trachea, bronchus, lung, and stomach).

We used three data sources to establish employment in the sugarcane industry: (1) death certificates; (2) the 1942-1943 Hawaii population census; and (3) the 1961-1988 lists of active and retired members of the International Longshoremen's and Warehousemen's Union

(ILWU). The local Union has represented 95% of all Hawaii sugarcane workers since 1946. We collected personnel records of sugarcane workers when possible.

We controlled for asbestos exposure by categorizing as exposed or unexposed occupation and job titles listed in the 1942–1943 Hawaii census and on death certificates using a job-exposure matrix.[10] We also determined whether cases and controls were members of a previously studied group of Pearl Harbor Naval Shipyard workers[11] with a high likelihood of asbestos exposure.

Statistical analyses included univariate and multivariate analysis using maximum likelihood statistics generated from unconditional logistic regression.[12] We included in a multivariate model variables representing employment in the sugarcane industry, occupational asbestos exposure, and a history of working in medical or science-related jobs.

Results

We identified a total of 93 Hawaii residents with mesothelioma. The tumor registry provided a histologic diagnosis for 92 cases. We obtained death certificates for 85 of the 88 dead cases. Data on 281 controls were included in the analysis. Microscopic examination confirmed the histologic diagnosis for 258 controls. We obtained death certificates for 175 of the 189 controls known to have died.

The estimated risk for mesothelioma associated with having worked in the sugarcane industry varied by data source (Table 1). The odds ratios ranged from 1.1 to 2.3. We identified 7 cases and 19 controls as having worked in the sugarcane industry (OR = 1.1; 95% CI = 0.4–2.9). This odds ratio increased slightly to 1.3 (95% CI = 0.4–3.8) when we excluded control subjects with cancers of the trachea, bronchus, lung, or stomach.

We collected the personnel records of two cases and seven controls who worked in the sugarcane industry. Both cases worked at jobs in which they would have been exposed to asbestos. One case worked for 36 years as a truck mechanic and was most likely exposed to asbestos when working on brake linings. The second case worked 2 years as a plumber around the sugarcane boilers. None of the cases or controls operated a harvesting tractor, the job considered to have the greatest exposure to biogenic silica fibers.[9]

We observed the expected association between occupational asbestos exposure and mesothelioma (OR = 1.8; 95% CI = 1.0–3.2). We noted an exceptionally high risk of mesothelioma associated with work at the Pearl Harbor Naval Shipyard (OR = 8.2; 95% CI = 2.6–30.3), presumably due to asbestos exposure. The exclusion of cancer-controls with asbestos-related cancers increased the observed risk estimate measures.

We noted that the risk of mesothelioma was increased among people employed in construction (OR = 2.7; 95% CI = 1.3–5.7), machinery (OR = 7.1; 95%

TABLE 1. Risk of Mesothelioma Related to Having Worked in the Sugarcane Industry and to Occupational Exposure to Asbestos

Type of Worker and Source of Data	Cases (N = 93)	Controls (N = 281)	Control Subset* (N = 207)	Odds Ratio	95% Confidence Interval
Sugarcane workers					
Union records	4	9		1.4	0.3–5.0
			4	2.3*	0.4–12.5
1942 Census	4	10		1.2	0.3–4.4
			7	1.3*	0.3–5.2
Death certificates	4	6		2.1	0.4–8.9
			5	1.8*	0.4–8.6
Any sugarcane worker	7	19		1.1	0.4–2.9
			12	1.3*	0.4–3.8
Asbestos workers					
Shipyard†	12	5		8.2	2.6–30.3
			3	10.1*	2.6–56.6
1942 Census	8	21		1.2	0.5–2.9
			10	1.8*	0.6–5.3
Death certificates	16	30		1.7	0.8–3.5
			19	2.9*	1.3–6.2
Any asbestos exposure	26	50		1.8	1.0–3.1
			31	2.2*	1.2–4.2

* Excludes subjects with cancer of the larynx, trachea, bronchus, lung, or stomach.
† Worked at the Pearl Harbor Naval Shipyard.[11]

CI = 1.2-72.4), or transportation industries (OR = 2.3; 95% CI = 1.2-4.7). We believe that this increase in risk is related to asbestos exposure and not to any possible biogenic silica fiber exposure. We found that six cases (three nurses, two physicians, and one office worker) and four controls had worked in medical or science-related jobs (OR = 3.4; 95% CI = 0.8-17.7). We know of no exposure peculiar to the medical field that would influence the risk of mesothelioma.

The multivariate analysis included sugarcane employment, potential occupational asbestos exposure, and work in the medical field. The odds ratio for work in the sugarcane industry did not change after adjustment for the other variables (OR = 1.13, 95% CI = 0.46-2.80 for all controls; OR = 1.37, 95% CI = 0.52-3.65 for the subset of controls excluding asbestos-related cancers). The model that best predicted mesothelioma included exposure to asbestos (OR = 2.4; 95% CI = 1.3-4.3) and employment in the medical industry (OR = 4.2; 95% CI = 1.2-15.5).

Discussion

In this study, we found that exposure to biogenic silica fibers, as determined by employment in the sugarcane industry, does not appear to be an important risk factor for mesothelioma. We found a slight increased risk for sugarcane workers, which could be the result of exposure to asbestos or chance. The lack of a carcinogenic effect of biogenic silica fibers may be explained by chemical or physical differences (that is, diameter) between asbestos and biogenic silica fibers[13] or the small number of sugarcane workers who are highly exposed to biogenic silica fibers.

The results of earlier studies confirm these findings. Sugar beet workers in Sweden have an increased risk of mesothelioma[14] that has been attributed to asbestos.[15] A case-control study of mesothelioma in South Florida did not find an association with work in the sugarcane industry.[16] Researchers who reported the case series from India[5] did not attempt to measure biogenic silica fiber exposure, did not use a comparison group, and did not consider the risks associated with zeolite.

The Hawaiian islands provided a unique setting for this investigation. We identified all incident mesothelioma cases through the Hawaii Tumor Registry. The sugarcane industry was large (46,000 active workers in 1946 and 6,000 in 1988), and the workers could be identified from available data. Biogenic silica fiber exposures to sugarcane workers were also documented.[9] Nevertheless, none of the mesothelioma cases held jobs with a great opportunity for biogenic silica fiber exposure. Although it would appear that biogenic silica fibers do not present an important risk of mesothelioma, we did not collect detailed employment histories for all cases and controls. Our use of cancer-controls for comparison purposes may also have introduced a possible selection bias into this study.[17,18]

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