Health surveillance of asbestos workers

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1. Background

Asbestos is the common name for a variety of silicate materials that are fibrous in structure and are more resistant to acid and fire than other materials (Figure 1).

Figure 1. Asbestos fibers

Asbestos has been used for more than 2,000 years. It was named by the Ancient Greeks, its name meaning "inextinguishable". The Greeks also noted its harmful biological effects. The Greek geographer Strabo and the Roman naturalist Pliny the Elder both observed the "sickness of the lungs", in the slaves that wove asbestos into cloth. The use of asbestos declined during the Middle Ages.

Asbestos use was brought back in the 1700s, but did not become popular until the Industrial Revolution during the late 1800s. It then began to be used as insulation for steam pipes, turbines, boilers, kilns, ovens, and other high-temperature products.

Asbestos was used for everything from fire-proof vests, to home and commercial construction (Figure 2).

Figure 2. Examples of the countless industrial uses of asbestos and their presence in professional and household products.

At the turn of the twentieth century, researchers began to notice a large number of deaths and lung problems in asbestos mining towns. In 1917 and 1918, it was observed by several studies in the United States that asbestos workers were dying unnaturally young. In the 1930s major medical journals began to publish articles that linked asbestos to cancer.

In the 1970s, after asbestos was proved to cause cancer, governments began taking steps to regulate it.

Nowadays, asbestos is banned in 55 countries worldwide (not in China, Russia, India, Canada or the United States) (Figure 3 and Figure 4).

Figure 3. Advertisement in Asbestos Magazine, an industry publication, in 1981, that lauded the use of asbestos in the construction of the World Trade Center.

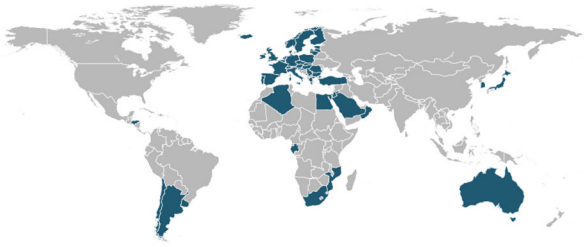

Figure 4. Asbestos bans around the world (in blue)

2. Health risks of asbestos

Exposure to asbestos increases the risk of developing lung disease. Three of the major health effects associated with asbestos exposure are:

- lung cancer
- mesothelioma, a rare form of cancer that is found in the thin lining of the lung, chest and the abdomen and heart
- asbestosis, a serious progressive, long-term, non-cancer disease of the lungs

Asbestos fibers may be released into the air by the disturbance of asbestos-containing material during product use, demolition work, building or home maintenance, repair, and remodeling. In general, exposure may occur only when the asbestos-containing material is disturbed or damaged in some way to release particles and fibers into the air (Figure 5).

Asbestos is extremely hazardous. According to the US National Institute for Occupational Health and Safety (NIOSH) "*all levels of asbestos exposure studied to date have demonstrated asbestos-related disease*" and "*there is no level of [asbestos] exposure below which clinical effects do not occur.*" Therefore, all avoidable exposures to

asbestos should be prevented whenever possible. However, the Occupational Safety and Health Commission (OSHA) has set a so-called "permissible asbestos exposure limit" (PEL) of 0.1 fiber per cubic centimeter (f/cc) for work in all industries, including construction, shipyards, and asbestos abatement work.

Figure 5. Workers removing asbestos plaster from a ceiling

3. A case-study

An observational study was carried out to investigate the association between exposure to asbestos and the development of lung disease.

Information on 196 workers and their exposure to asbestos (in f/cc) was collected, as well as information on the prevalence of lung disease, and basic demographics. The data are shown in the Excel file *"Data_asbestos"* (sheet: *"Data_196_subjects"*).

1. Identify demographic characteristics of the workers that are risk (or protective) factors of the disease.

2. Obtain the exposure-response model (both, not adjusted and adjusted for confounders). Interpret the not-adjusted and adjusted odds ratios. Is there a significant association between exposure to asbestos and lung disease?

3. Is there any other potential confounder (not included in the file *"Data_asbestos"*) that should have been considered in the study?

4. Plot the exposure-disease unadjusted (crude) and adjusted models. Comment on the similarities or differences between the two.

5. What is the probability that a 40 yr male who is exposed to more than the PEL, develops lung disease? What will be the probability, 10, 20, 30 and 40 years later? Is this change linear?
6. We obtain information on a new set of workers (17 subjects). Evaluate the predictive performance of the obtained model by calculating the accuracy, sensitivity, specificity and precision of the model using this new dataset. Consider the threshold value for the probability as equal to 0.5. The data for the 17 subjects is in the Excel file *"Data_asbestos"* (sheets: *"Data_17_subjects"* and *"Data_17_subjects_Disease"*).