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# Non-Occupational Asbestos Exposure: Asbestosis, Mesothelioma and Lung Cancer

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Introduction to Environmental Health  
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## Background

Asbestos is the name given to a group of six different fibrous minerals known as chrysotile, crocidolite, amosite, anthophyllite, tremolite, and actinolite that occur naturally in the environment (Environmental Protection Agency). Chrysotile is the most important. Nearly all asbestos used in North America has been chrysotile from the province of Quebec, Canada (Airborne Asbestos Health Assessment Update). Asbestos is made up of fibrous strands. These strands split into smaller and thinner fibers when disturbed and can become airborne. The strands will continue to split into microscopic pieces. This process is unique to asbestos and is why airborne asbestos is such a health concern. The fibers can become so small that they can pass undetected by respiratory dust defenses (Asbestos Resource Center). When asbestos fibers are inhaled they can become lodged in the lungs and remain there throughout life. Fibers can accumulate and cause scarring and inflammation in the lungs (Environmental Protection Agency). Scarring and inflammation from fibers can affect breathing and lead to disease.

Asbestos has been used worldwide for more than 2,000 years (Asbestos Resource Center). For decades, asbestos was considered an ideal material because of desirable properties such as its heat resistance, low electrical conductivity, flexibility, and high tensile strength (Asbestos Resource Center). Due to this fact it was commonly used in construction materials. Asbestos became widely used in the United States during the Industrial Revolution in the late 1800s (Asbestos Resource Center). At the turn of the twentieth century, researchers began to notice a large number of deaths and lung problems connected to asbestos (Asbestos Resource Center). In 1917 and 1918, it was observed by several studies in the United States that asbestos workers were dying at unusually young ages (Asbestos Resource Center). Asbestos exposure can occur in environments other than the workplace. The U.S. Environmental Protection Agency (EPA) has described the risk of asbestos exposure in homes, including asbestos in products such as attic insulation, wall insulation, plumbing/pipe insulation, cement, bricks, stucco, boilers, furnaces, flooring, ceiling tiles, household products and appliances (Environmental Protection Agency). The risk of asbestos exposure in homes across the United States is very real and is of great concern to public health officials. New use of asbestos has almost completely ended in the United States and in most other developed nations as the result of government bans and market pressures (Environmental Protection Agency). With the elimination of high-dose occupational exposure to asbestos, medical and public health attention has turned to the risks of exposure at lower doses in the general environment. Particular concern focuses on the asbestos that remains as a result of past construction practices in many thousands of schools, homes, and commercial buildings (Airborne Asbestos Health Assessment Update).

## Toxicology

The toxicity of asbestos is related to its shape, size and type. Asbestos is considered toxic when the width of fibrils released into the air is less than five microns (Environmental Protection Agency). Larger fibrils of asbestos may not be as harmful because they are too big to be inhaled into the lungs. Chrysotile is known to be more dangerous than other types of asbestos fibers (Hilerdal). Testing for asbestos exposure varies depending on the level of exposure. Low levels of asbestos fibers can be measured in urine, feces, mucus, or lung washings (Agency for Toxic Substances and Disease Registry). Higher than average levels of asbestos fibers in tissue can confirm exposure however this may not mean an individual will experience adverse health effects. A thorough history, physical exam, and diagnostic test are needed to evaluate asbestos-related disease (Agency for Toxic Substances and Disease Registry).

Chest x-rays are the most common screening tool to identify lung changes resulting from asbestos exposure (Agency for Toxic Substances and Disease Registry). Chest x-rays are useful in that they can show pleural effusion (Agency for Toxic Substances and Disease Registry). Pleural effusion is excess fluid that accumulates in the pleural cavity, the fluid-filled space that surrounds the lungs. Excessive amounts of such fluid can impair breathing by limiting the expansion of the lungs during inhalation (Light, Macgregor, Luchsinger and Ball). Pleural effusion is more common in the right lung than in the left lung. X-rays also show signs of prior non-cancerous asbestos disease in the form of pleural plaques, pleural calcification, or scarring related to asbestosis. (Agency for Toxic Substances and Disease Registry). Computed Tomography (CT) scans are another diagnostic tool used. CT scans show pleural effusion, pleural thickening, pleural calcification, thickening of interlobular fissures, or possible chest wall invasion (Light, Macgregor, Luchsinger and Ball). A CT scan can also aid in needle aspiration of pleural masses for diagnosis. Magnetic Resonance Imaging (MRI) is used to determine the extent of tumor prior to treatment. MRI's are able to provide images in multiple planes and are able to identify tumors. An MRI can also display enlargement of the lymph nodes that are located between the lungs (Agency for Toxic Substances and Disease Registry). Positron Emission Tomography (PET) is highly useful in the diagnosis of mesothelioma, a common disease associated with asbestos exposure. Although PET scans are not always covered under insurance, they are considered the most useful in diagnosing tumor cells. This method of testing aids physicians in determining the stage of cancer (Agency for Toxic Substances and Disease Registry).

The three most common diseases from asbestos exposure is asbestosis, mesothelioma and lung cancer (O'Reilly, McLaughlin, Backett, and Sime). Asbestosis is a breathing disorder caused by inhaling asbestos fibers (Asbestos Resource Center). It is not a form of cancer. Prolonged accumulation of these fibers in the lungs can cause scarring of lung tissue and shortness of breath. Asbestosis symptoms can range from mild to severe, and usually don't appear until years after exposure. The latency period

for asbestosis ranges from ten to twenty years after the initial exposure (Asbestos Resource Center). Mesothelioma is a rare cancer that occurs in the thin layer of tissue that covers most of the internal organs (National Cancer Institute). Almost all mesotheliomas are caused by exposure to asbestos (National Cancer Institute). Mesothelioma causes the cells of the mesothelium to become abnormal and infinitely reproduce (Asbestos Resource Center). Mesothelioma has a long latency period of about ten to sixty years (Asbestos Resource Center). During this time period it is present but not evident or active. Due to this fact, it is often hard to determine the cause of mesothelioma. Diagnosing mesothelioma is difficult because symptoms of mesothelioma are similar to various other conditions (National Cancer Institute). Lung cancer, another disease caused by asbestosis, is a malignant tumor that invades and obstructs the lung's air passages (National Cancer Institute). Cigarette smoking greatly increases the likelihood of a person developing lung cancer (National Cancer Institute). Research has shown a clear link between exposure to asbestos, lung cancer and mesothelioma (International Agency for Research on Cancer).

### **Environmental Health Risk Assessment/ Impact**

There are many vulnerable populations of asbestos exposure. This is due to the fact that asbestos can be found almost anywhere. However, certain individuals are more likely to be exposed to higher levels of asbestos than others. There are various types of non-occupational exposures to asbestos. One common pathway of asbestos exposure is domestic exposure. An individual who works with asbestos material may carry asbestos fibers home on work clothing which predisposes other family members. Another non-occupational pathway of exposure is air pollution from asbestos mines, factories and dock yards. Asbestos fibers can spread over a distance of many kilometers from mines (Hilerdal). Consumer goods have also been known to contain asbestos. Such goods include paints, spackling and jointing compounds. Blow dryers was another product mass produced in the United States that millions of consumers purchased that contained asbestos (Hilerdal). Individuals who live in older homes are at an increased risk of asbestos exposure. Many homes built before 1980 contain asbestos in old floor tiles, ceiling tiles, roof shingles and siding (Asbestos Resource Center). Asbestos may have been used as insulation around boilers, ducts, pipes, sheeting, fireplaces, pipe cement, and joint compound used on seams between pieces of sheetrock. Many older homes contain vermiculate attic insulation contaminated with asbestos (Hilerdal). Urban air pollution is another common source of asbestos exposure. The air in cities contains a very low concentration of asbestos (Hilerdal). These concentrations are higher near construction or demolition sites. Asbestos is also used to make brake pads. Asbestos is released on braking which increases the concentrations of asbestos in the air near highways. Drinking water contains asbestos from natural sources of pollution (Hilerdal).

Asbestos occurs naturally in the environment. For individuals living in areas of naturally occurring asbestos, there are many potential pathways for airborne exposure (Environmental Protection Agency). Exposures to soil dust containing asbestos can occur under a variety of scenarios. Children may be at risk when playing outside in dirt. Dust may also be released into the air from unpaved roads and driveways covered with crushed serpentine. Other pathways of exposure include uncontrolled quarry emissions, grading and construction associated with the development of new housing, gardening and other daily human activities (Environmental Protection Agency). For homes built on asbestos outcroppings, asbestos can be tracked into the home and can enter as fibers suspended in outdoor air. Once such fibers are indoors they can become airborne by normal household activities. Vacuuming does not help to remove asbestos fibers because the fibers are small enough to pass through vacuum cleaner bags. Evidently there are many non-occupational pathways of exposure to asbestos.

Different types of asbestos differ in their ability to cause adverse health effects. This implication is more of a concern in the development of mesothelioma than other diseases associated with asbestos. The likelihood of developing mesothelioma is dependent upon the type of asbestos an individual is exposed to. Many studies have shown that chrysotile is a weak carcinogen for humans (Hilerdal). Chrysotile can be slowly dissolved by enzymes, other types of asbestos cannot. The half-life of chrysotile is seven to eight years. The half-life of other types of asbestos is much longer if ever. Crocidolite is considered very dangerous in comparison to other types of asbestos. Evidence has also shown in research that there is a dose-response relationship to asbestos. The longer an individual is exposed, the more at risk they are to experience negative health outcomes. There has been much debate on whether there is a minimum exposure for the development of asbestos related diseases specifically mesothelioma (Hilerdal). There is no proof of a minimal lower limit where asbestos may not cause mesothelioma or other adverse health effects (Hilerdal). Smoking is known to increase the risk of developing mesothelioma, lung cancer or asbestosis. Consequently, smokers are at a higher risk of experiencing negative health outcomes from asbestos exposure. Individuals who are most vulnerable would include those who had long exposure to high levels of asbestos, those exposed to crocidolite and smokers. This vulnerable group has an increased risk of developing asbestosis, mesothelioma, and lung cancer. It is estimated that by 2030 approximately 200,000 deaths will have occurred due to asbestos (Environmental Protection Agency).

### **Resolution**

Many steps have been done to resolve problems associated with asbestos exposure. The use of asbestos was banned in 1973 (Environmental Protection Agency). However, asbestos still remains in many products such as automobile brake pads and

clutches, roofing materials, vinyl tile, imported cement pipe and corrugated sheeting, contaminant in vermiculite insulation and potting soil. Commercial and residential construction before the mid-1980s still contains asbestos. The Consumer Product Safety Commission and the Environmental Protection Agency help to regulate asbestos exposure. The Consumer Product Safety Commission is responsible for the regulation of asbestos in consumer products and the Environmental Protection Agency protects the general public from airborne asbestos exposure. The EPA has two different asbestos laws, the Clean Air Act and the Toxic Substances Control Act (Environmental Protection Agency). The Clean Air Act is the federal law designed to make sure that all Americans have air that is safe to breathe (Environmental Protection Agency). The Toxic Substances Control Act (TSCA) of 1976 provides the EPA with the authority to require reporting, record-keeping and testing requirements, and restrictions relating to chemical substances and/or mixtures (Environmental Protection Agency).

Asbestos cleanup varies depending on the location of asbestos. Asbestos in homes, apartment buildings, schools and commercial buildings is a difficult problem to resolve. Asbestos in these areas is often best left alone if the asbestos is in good condition. Removal is usually the most expensive method and, unless required by state or local regulations, should be the last option considered in most situations. Removal poses the greatest risk of fiber release. However, removal may be required when remodeling or making major changes to a home that will disturb asbestos material. In addition, removal may be called for if asbestos material is damaged extensively and cannot be otherwise repaired. Removal is complex and must be done only by a contractor with special training. Improper removal may actually increase health risks.

Removing asbestos from homes can be dangerous if not done properly. The US Environmental Protection Agency as well as the US Department of Labor Occupational Safety and Health Act (OSHA) regulate how asbestos abatement is to be handled. Professional asbestos abatement workers can be hired to remove asbestos from homes. However, it is against the law to hire any form of workers other than a professional abatement team (Environmental Protection Agency). Anyone removing asbestos should be aware of state and federal regulations. Permits are needed from state regulators if an individual decides not to hire professionals. Permits are documents that guide individuals on how to proceed with the abatement process and proper disposal after removal of material is complete. Most states require an application process in order to remove asbestos.

Many safety precautions should be taken when removing asbestos. Proper work gear including clothing such as overalls, boots, eye protection and gloves should be worn. Breathing respirators are also required for the safety of asbestos abatement workers. When removing asbestos from a designated area, it is imperative to keep the material wet at all times (Cooper). This allows the fibers to settle and not become airborne. The goal of an abatement process is to remove the asbestos without the

particles becoming airborne. The material should be carefully scraped off the surface into bags that are specially designed for asbestos removal, sealed and handed over to other workers to be sealed again (Cooper). The process for removing asbestos differs depending on what kind of asbestos is being removed and what portion of the home it is located in. Removing siding may have different tasks for removal than if a room that had asbestos flooring is being abated. Contained material should be kept in storage bins that are properly sealed and labeled. All waste should be taken to a landfill designed for asbestos. It is important to keep everything wet and out of the air. When workers have completed the job, they must decontaminate themselves by wetting themselves down and removing protective clothing (Cooper). Respirators should be removed last after all garments have been removed. All workers should shower thoroughly after the project is complete. A sample should be taken to make sure all asbestos has been removed from the area (Cooper).

There are various methods that can be taken to reduce exposure to naturally occurring asbestos. Depending on the situation a combination of approaches may be needed to implement an approach to reduce exposures to naturally occurring asbestos. Selecting an approach depends on many factors including accessibility to the naturally occurring asbestos, the types of activities that disturb the material such as construction projects or gardening, climate and weather conditions, current and future land uses, as well as the technical and administrative feasibility of the approach (Environmental Protection Agency). Common controls used to control the spread of naturally occurring asbestos involve the use of covers and caps, vegetation, fencing, landscaping, and in some conditions, the application of water to suppress dust (Environmental Protection Agency). If the naturally occurring asbestos is in an area that is not often disturbed it is best to leave the material undisturbed (Environmental Protection Agency). If the material is likely to be disturbed some methods to help lower the spread of material into the air are to cover or cap the naturally occurring asbestos material, limit dust generating activities, and excavate and dispose of materials (Environmental Protection Agency). Local factors such as climate influence the extent to which these approaches are implemented (Environmental Protection Agency). Dry or windy conditions may need more dust control than those with humid or less windy conditions. Other methods include limiting activities on naturally occurring asbestos containing areas, reducing driving speed on unpaved roads that may contain asbestos, and cleaning vehicles driven over asbestos.

### **Research Needs**

There are many factors which complicate studies of non-occupational exposure, including a lack of data on incidental exposures which may occur, lack of data on non-occupational levels of exposure, and the lack of a control group. Confounding variables such as migration into and from communities and multiple exposures to other toxic chemicals and carcinogens complicate attempts to generalize about the risk of low level

exposure (Boffetta). Uncertainties about asbestos have led to differing regulations and recommendations.

Future research is needed on the effects of low level exposure to asbestos. Many research findings do not clarify what is considered low levels of exposure to asbestos. With asbestos occurring naturally in the environment as well as its continued presence in many products it is impossible to have absolutely no exposure to asbestos. What effects lower levels of exposure have on health is as a result a future health concern. It would be of extreme importance, from a scientific and public health point of view, to know whether exposure to low levels of asbestos is able to induce pleural mesothelioma (Boffetta). There is controversy regarding low levels of exposure and adverse health effects (Boffetta). Additional research is needed on the health effects of the toxicity of different fiber sizes, shapes and which types of asbestos have the greatest potential to enter humans and cause harm. Relevant dose-response relationships and mechanisms of asbestos-related disease should be explored. Although exposure in environmental settings is generally much lower than in occupational settings, the levels may not be insignificant (Boffetta). In studies in which elevated risk of mesothelioma was demonstrated, people usually lived in close vicinity to naturally occurring asbestos sources (Boffetta). It is thus likely that lifelong cumulative exposure may have been as high as in some occupational settings. Non-occupational studies have yet to provide adequate answers to the growing number of research questions (Boffetta). A better understanding of the toxicity of asbestos is greatly needed.

There is limited available data on the exposure of building occupants to airborne asbestos fibers. The assessment of such exposures calls for further research. The research should include studies to improve upon methods for analyzing the numbers, sizes and types of airborne asbestos fibers found in buildings (Camus). Studies are also needed to define the characteristic sources and patterns of exposure of building occupants exposed to asbestos. This is including long-term as well as short-term effects. Furthermore, studies to determine how such patterns of exposure are affected by remediation strategies are needed. Little is known about the exposure of asbestos abatement workers as well as the exposure of individuals near sites in which asbestos was removed. The need to remove asbestos material from homes, schools, and commercial buildings will continue to increase as asbestos material deteriorates in condition over time. Due to this fact, knowing the adverse health effects associated with asbestos removal is imperative. There are a growing numbers of different types of man-made fibers that are entering commerce to

substitute for asbestos as a result of the shift away from asbestos use. Concern about the safety of man-made materials has arisen. Detailed material characterization and biological testing of man-made fibers should precede their widespread distribution into the environment (Environmental Protection Agency). In conclusion, asbestos has a long and extensive history and has caused a wide range of health problems. The effects of low levels of exposure to asbestos are unknown and an area where more research is greatly needed.

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