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Asbestos Exposure: Alternatives, Regulations, and Implications in New York City

New York City has had an extensive history of asbestos use, specifically in its construction industry, which originated from the early 20th century. However, asbestos is a classified carcinogen that poses severe health risks, including mesothelioma. This literary review will examine the historical prevalence of asbestos-containing materials (ACMs) in New York City, explore the regulations surrounding asbestos, and evaluate alternatives such as fiberglass and cellulose insulation. While both fiberglass and cellulose have advantages and disadvantages, they present much healthier alternatives to asbestos. Understanding the extent of asbestos presence and exploring alternative materials can help develop effective measures for mitigating the spread of mesothelioma and other diseases upon exposure- thus ensuring the well-being of New York City residents and other individuals.

New York City, a city well renowned for its historical buildings and landmarks has also been the epicenter for asbestos use. In the late 19th century, New York City experienced a significant surge in its population, thus igniting a construction boom that intended to accommodate the growing population. Architects and engineers were tasked with constructing structures that could endure the test of time, making asbestos a more desirable solution for reinforcing buildings. Asbestos, a naturally occurring silicate material (minerals which contain silicon and oxygen in SiO44- units, arranged in specific patterns) is best known for its durability and insulation. Now, asbestos is commonly used in fireproofing, flooring, roofing, and other forms of construction. These perceived benefits in construction along with the Industrial Revolution have provided an incentive for use in various industries or construction materials-making the material more widespread in the state of New York. However, asbestos-classified as “Class 1 Carcinogenic”- has consistently been shown to have severe health risks and can ultimately lead to death after long-term exposure (“Asbestos and Cancer Risk | American Cancer Society”). After asbestos fibers are released, they are often inhaled by those exposed and can get logged into the body-causing cold-like symptoms which are often ignored. In a case study conducted by researchers, it reviewed the correlation between Asbestos exposure and the cause of death of 188 subjects in Broni, Italy, statistical analysis was performed after the

subjects' death. Using the Kaplan-Meier estimator, the confidence interval of 95% helped to identify if there was a significant correlation. The results demonstrated there was a significant correlation between occupational exposure to asbestos and the development of lung cancer and asbestosis (Visonà et al.). Consequently, the rapid rise in asbestos-related diseases later pressured more government intervention and regulation. With the rich history of construction and industrialization in New York City comes the high presence of asbestos in buildings-which poses risks to the health of workers and residents of the city. This literary review aims to assess the history and uses of asbestos-containing materials (ACMs) across New York City and evaluate alternatives to asbestos including fiberglass and cellulose. By understanding the extent of asbestos presence and the potential pathways of exposure, effective measures for the mitigation of the disease by using alternatives can be developed.

The Historical Presence of Asbestos in New York City from Homes to Workplaces:

Throughout the history of New York City, asbestos (naturally occurring material) has played a significant role in various industries and construction projects. Asbestos became a desirable choice for construction from the late 19th century until it was banned in the late 20th century. This growth of asbestos in New York City can be credited to Henry Ward John's company (Johns-Manville Corporation), which started manufacturing asbestos to support construction projects in the city starting in the 1850s (Mauney). Commencing in the late 19th century, asbestos became useful for its exceptional insulative properties. These properties are mainly attributed to its ability to slow the transfer of heat, effectively reducing heating and cooling costs. Specifically, in residential homes and apartments, this insulation comes in various types that may potentially contain asbestos. The four most prominent types of insulation in homes are blanket insulation, block insulation, loose-fill insulation, and spray-on insulation. Blanket insulation assumes the shape of large rolls, similar to a cotton blanket, and is often used in attics and as blankets. Block insulation transforms into rigid panels and is typically made of foam; it can be found throughout the entire home. Loose-fill insulation is blown through machines and is quickly identified by its fluffy texture. Spray-on insulation is applied as a liquid and later solidifies to fill gaps, commonly found in walls and ceilings (Jones-Stohosky). Another form of insulation, zonolite insulation, although less frequently used, poses a higher risk of asbestos exposure because of its vermiculite presence. Vermiculite, composed of heat-treated mica flakes, also

exhibits favorable insulative properties. Similarly, both asbestos and mica flakes typically form under high pressures and temperatures, making asbestos more prevalent within this type of insulation (Jones-Stohosky). In various sectors, workplaces in New York City have been linked to a significant presence of asbestos. These industries include shipyards and power plants, with notable examples being Caddell Dry Dock & Repair Company and Todd's Shipyards. Caddell Dry Dock & Repair Company, which is still active in the state of New York, was established for commercial shipping and repair. Due to the widespread use of asbestos for insulation in ships, shipbuilders were consistently exposed to asbestos, and many employees developed mesothelioma or asbestosis. Similarly, Todd's Shipyard is infamous for its involvement in asbestos-related incidents. Several power plant stations in New York that have been linked to asbestos exposure include Arthur Kill Generating Station, Astoria Gas Generating Station on Staten Island, and Ravenswood Generating Station in Queens (Molinari).

Addressing Asbestos in New York City-Regulations, Risks, and Abatement Measures:

In New York City around the 20th century, asbestos reached its peak, and it was not until the late 20th century and 2000s that regulations were implemented to prevent asbestos exposure and usage. In 1992, The New York City Department of Environmental Protection (DEP) conducted a study that presented associated risks with asbestos exposure due to the presence of asbestos in ACMS in buildings. The study evaluated 886 buildings across 16 different categories in New York City. The results revealed that almost 70% of the buildings contained ACMs at a staggering 68%. However, the estimated total amount of ACM in the city was 323 million square feet, with a significant portion being linked to thermal insulation. Sequentially, a management bill was introduced to prevent further spread of asbestos (Lundy and Barer). Additionally, according to New York State statistics, about 2354 residents died from mesothelioma from 1999-2015 with about 23 asbestos deposits and mines known to exist in New York. The popularity of asbestos during this time was also met with backlash, leading to more government regulation in New York City. New York City building owners are now legally required to have a DEP-certified asbestos investigator to investigate if there is sensitive ACM activity within the building. In 2009, procedures were (are) implemented to address the spread of asbestos. Before asbestos abatement, a certified asbestos investigator from the (DEP) identifies Asbestos Containing Material (ACM) and determines the project's extent. Based on the report, the project is either

classified as "Not an Asbestos Project A" or an "Asbestos Project B." (A Guide to the New York City Asbestos Regulations). Following the investigation, ACP5 or ACP7 is utilized. The ACP5 form certifies that no ACMs will be disturbed or present. Once the DOB receives the ACP5 form, it can proceed. However, if disturbed ACM exceeds 10 square feet or 25 linear feet, it is categorized as an "Asbestos Project," stopping the proceeding of the project (5). After the process, abatement of ACMs continues in the following forms: physical removal and disposal of asbestos, encapsulation to prevent fiber release by coating it, or construction over asbestos to prevent potential fiber release. These procedures have ultimately worked to abate the effects and exposure of asbestos to residents of the city.

Fiberglass:

Fiberglass's Strength, Versatility, and Health Considerations

Fiberglass, a man-made composite material (made of two or more materials) consisting of glass fiber reinforcement and polyester resin, was first trademarked as "Fiberglass' ' in 1938. The composition of fiberglass involves using thermosetting polyester resin to bind fibers together, while the glass fibers simultaneously provide strength and flexibility (Connolly). Fiberglass is categorized into different categories of glasses, such as E class, which is known for its insulating properties commonly used in households, C glass, used for its chemical resistance, and S glass, a structural glass capable of withstanding high temperatures. Most fiberglass compositions are silica-based, with each type of glass containing over 50% SiO_2 (Chawla). Fiberglass has gained popularity as an alternative to asbestos, starting in the 1950s, and one of the reasons for its growing use is its desirable weight-to-strength ratio, which improves the quality and performance of the material while also maintaining a lower weight (Patel). Additionally, fiberglass serves as a great electric insulator and is incombustible with minimal temperature sensitivity. Often, fiberglass is used for insulation, mesh fabrics in homes, flooring, cladding, tape, and most notably, in mattresses-acting as a flame retardant, all while being more affordable. There are perceived benefits of fiberglass, when exposed to fiberglass there are negative health effects. Fiberglass is made of refined glass shards allowing it to be airborne. Short-term exposure to fiberglass can cause eye and skin irritation, and soreness in the throat and nose. If inhaled- it can exacerbate health conditions like bronchitis, asthma, or pulmonary fibrosis (Fiberglass). However, there is still controversy about whether fiberglass can be considered a carcinogen

because there has not been an official link between fiberglass inhalation and cancer such as mesothelioma.

Examining the Health Effects of Fiberglass Using a Study in Comparison to Asbestos

In a historical cohort study published in the "Iranian Red Crescent Medical Journal," the researchers aimed to investigate the potential health effects of fiberglass exposure, particularly in comparison to asbestos. The study focused on 49 workers who were regularly exposed to fiberglass within a local fiberglass industry, while also including 42 unexposed employees as a control group, with both groups not having prior exposure to fiberglass. To assess the respiratory health of the participants, the researchers utilized a standardized respiratory questionnaire to gather relevant data. In addition, the subjects underwent chest X-rays and received thorough examinations by physicians to identify any possible respiratory abnormalities. Just before the start of their work shifts, pulmonary function tests were conducted to evaluate their respiratory capabilities. To determine the extent of fiberglass dust exposure experienced by the participants, the researchers measured dust concentrations at different dusty work sites using established methods. Through a chi-square evaluation, the experiment did not find a significant difference or statistical significance in the prevalence of respiratory symptoms and abnormalities between the exposed and unexposed subjects (Neghab and Alipour 146). These findings contribute to the understanding that, at present, the potential adverse health effects associated with fiberglass exposure are less severe compared to those of asbestos.

Preventive Measures

While fiberglass may not have as severe health effects, it is still crucial to be aware of potential measures to prevent exposure. Firstly, when dealing with a fiberglass mattress, ensure that there is a mattress cover, keep the mattress sealed, and use a Hepa-filtered vacuum (an air filter that can remove any airborne particles with a size of 0.3 microns μm). It is also important to avoid contacting insulation material in homes. When working with fiberglass, wear loose clothing with a protective N95 mask and goggles. Most preferably, avoid directly touching the fiberglass (Frothingham). In terms of safety, when asbestos is airborne, it poses significant health risks as it is a carcinogen, which can potentially lead to the development of Mesothelioma (A type of cancer that affects the lining of the lungs or abdomen and has severe effects on the heart, lungs, and abdomen). On the other hand, fiberglass is not classified as a carcinogen and poses fewer

long-term health risks. However, both materials require adequate handling to prevent exposure. While there may be some risks associated with fiberglass exposure, taking precautionary measures has proven that fiberglass is a safer alternative to asbestos, and is often the most cost-effective option for many individuals.

Cellulose:

Structural Benefits

In terms of anatomical structure, cellulose is a carbohydrate and polysaccharide that forms the foundation of the cell walls in plants. Cellulose forms a complex network within the cell walls, which provides structural support and rigidity to plant cells-playing a vital role in maintaining the shape and foundation of plant tissue. The arrangement of cellulose microfibrils in the cell wall contributes to the overall strength and durability of plants, and its beta-1,4-glycosidic bond gives it its distinct properties (The Editors of Encyclopaedia Britannica). Cellulose, however, has integral properties making it desirable as an alternative to asbestos or fiberglass insulation. Cellulose fiber insulation (CFI) requires using paper-based materials, making the insulation viable and non-carcinogenic-unlike asbestos (and possibly fiberglass). Its thermal effectiveness scores better than most materials such as fiberglass- meaning CFI is an environmentally sustainable option (Hurtado et al.). It outperforms other materials like fiberglass in terms of thermal effectiveness, as indicated by its higher R-value. This characteristic allows CFI to efficiently reduce heat transfer, maintaining a comfortable temperature and resulting in energy savings and decreased heating and cooling expenses. Additionally, It provides a sustainable option as “The Cellulose Insulation Manufacturers Association” (CIMA) emphasizes that CFI yields one of the highest levels of recycled content among insulation materials, typically reaching around 85%. This high recycled (around 300k tons of recycled newspaper) content contributes to reduced greenhouse gas emissions, and carbon footprint, as well as remaining soundproof and inhospitable to pests.

Potential disadvantages

Cellulose insulation can be more expensive compared to fiberglass insulation with the price ranging from $0.70 to $0.80 per square foot for 6 inches of insulation. Fiberglass insulation is less expensive, costing around $0.30 to $0.40 a square foot for 6 inches of insulation. CFI may

also reap potential risks, raising some concerns due to the ink residues and potential toxicity of fire retardants like boric acid, sodium borate, and ammonium sulfate. However, many colored toxic inks have been banned in newspapers for over a decade- relieving concerns about their toxicity. A study by J. M. G. Davis published in the British Journal of Industrial Medicine in February 1993 further examines the risks associated with the retardants in CFI, “ingesting as little as 1/8 ounce of these chemicals can be fatal to infants.” Later, Davis explains that cellulose fiber manufacturing or production does not pose a threat because most CFI does not liberate respirable fibers in large quantities for inhalation (BuildingGreen). It is still crucial to properly handle CFI. Such as wearing respiratory protection during installation, and maintaining an airtight barrier between the insulation and living areas.

Study of Thermal Performance and Efficiency of Cellulose Fiber Insulation

In a study published in the “Indian Journal of Engineering & Materials Sciences,” researchers reviewed the properties of CFI by comparing an insulated model to an uninsulated model through the use of a simulation and experiment. The researchers found that in terms of thermal properties, the uninsulated test model began losing heat starting from 12 hours and continuing to 22 hours in the evening. On the other hand, the heat loss from the test model increased from 12 hours to 18 hours and decreased from 18 hours to 22 hours due to an initial rise in temperature difference following a decline. The model also determined that the insulated model displayed a lower thermal temperature because of its successful thermal resistance and heat flow. The disparity in the indoor temperature between the two models was a maximum of seven degrees Celsius. Additionally, the variation between the experimental and simulated results yielded less than 5%, validating the model's accuracy for further use and predictions. The findings also presented a reduction of around 150 kg/m2 of floor area in annual carbon dioxide emission (with an insulated roof, a 27% decrease in carbon dioxide emission was reported using optimum insulation thickness). Figure 10 illustrates the energy savings, cost savings, and carbon dioxide reduction from implementing cellulose fiber insulation and the white exterior color in the test model. The energy savings can be accredited to the reduced net heat flow into the indoor space of the test model as compared to the uninsulated test model-reducing the cooling load. The monthly energy amounted to 24 kWh (energy an electrical device or load used in kilowatts per hour), and the summer season's energy (from mid-April to mid-October) was 144 kWh (Ravinder

et al.). Ultimately, cellulose insulation presents as a much healthier alternative to fiberglass and asbestos because there are no confirmed dangers of fine fibers entering your respiratory system or causing long-term damage if inhaled. As compared to fiberglass and asbestos, CFI yields very low levels of VOC (volatile organic compounds). Overall, while CFI is more expensive, it presents as the most healthy option among the two.

Discussion:

First, the study conducted in Broni, Italy, establishes the strong correlation between exposure to asbestos and the development of lung cancer. The historical presence of asbestos in New York City, particularly in construction and workplaces like shipyards or power plants, underscores the exposure risks that residents and/or workers faced. This awareness of the health risks of exposure subsequently came with the introduction of regulations by the (DEP) to prevent the spread of asbestos-reflecting the importance of taking proactive measures such as using alternative insulation materials like fiberglass and cellulose. The research provides insights into the alternative's strengths, weaknesses, and health considerations. Fiberglass has been a widely popular substitute for asbestos since the 1950s, offering advantages from its strength and incombustibility. However, there are some health considerations from short-term exposure such as irritation and respiratory issues. Another alternative, cellulose, is a more expensive option and presents as a healthier alternative to both materials. It yields advantages like versatility, sustainability, and thermal conductivity. Unlike fiberglass, cellulose poses a potential minimal health risk from short-term exposure. There is also no conclusive evidence linking cellulose or fiberglass to mesothelioma (or other severe health conditions). It is still important to practice the necessary precautions when working with either material. In terms of results, the analysis demonstrates the need for more awareness, research, and promotion of using safer alternatives. However, it is also important to acknowledge the limitations of my literary review. The analysis is based in New York City, and the findings may not be directly applicable to other regions. Hopefully, there will be further studies that explore the possible carcinogenic link between fiberglass and mesothelioma, as well as future investments in research on other alternatives to asbestos that are cost-effective, sustainable, and pose minimal health risks

While the historical presence of asbestos in New York City's construction lingers, government regulations have been effectively implemented to combat the spread of asbestos-related diseases

in the city and mitigate its effects. These measures have played a crucial role in limiting asbestos exposure and ensuring the safety of residents. Following this, fiberglass and cellulose have been presented as alternatives to asbestos. Both alternatives share insulative properties-making them desirable for construction use. While short-term exposure to fiberglass can result in irritation, it has yet to be confirmed as a carcinogen or linked to causing mesothelioma. Cellulose, on the other hand, is naturally sustainable, and provides effective insulation, reducing heating and cooling costs. Both materials require proper handling and safety measures. New studies should further examine the long-term health effects of fiberglass insulation compared to asbestos and explore other viable alternatives.

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