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EASTERN KENTUCKY UNIVERSITY

Improving Safety Regulations to Decrease Respiratory Health Issues in
Construction Workers

Honors Thesis
Submitted
In Partial Fulfillment
Of the
Requirements of HON 420
Spring 2020

By
Kendall Stiens

Mentor
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Department of Applied Engineering and Technology

Abstract

Improving Safety Regulations to Decrease Respiratory Health Issues of
Construction Workers

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Among the construction industry is many harmful substances that affect the health of workers exposed to harmful agents. A systematic review was constructed from several case studies that examined and evaluated the respiratory health of construction workers, as well as the factors that affect the respiratory health of workers. It was concluded that construction workers presented with symptoms such as, productive cough, asthma, and lung infections that had worsened within 3 years of being in the construction industry.

Additionally, construction divisions that were exposed to harmful substances or safety hazards had a higher percentage of cigarette smokers; concluding that the safety hazards indirectly affect the workers as well due to smoking habits. The risk of lung cancer also greatly increased for individuals exposed to specific chemical agents.

Accompanying the systematic review, research was conducted to identify the common company practices in comparison to the OSHA regulations. In conclusion, companies were found to not have adequate supply of respiratory

protection on site and did not conduct respirator usage training for new hire employees. As a whole, this research has shown that lack of access and lack of enforcement, in addition to the general exposures have led to respiratory health issues in workers. Companies should be more diligent in incorporating respiratory protection training and usage into their protection plan to help decrease the negative effects of exposures on respiratory health.

Key Terms:

Respirator

PPE (personal protective equipment)

Respiratory Health

Lung infections

Lung Cancer

Abstract	1
Figures	4
Introduction	6
Discussion	6
Case Studies	6
Study A	7
Study B	9
Study C	11
Case Study Conclusion	13
Current Safety Management Practices	15
OSHA Respiratory Protection Program	15
Current Common Practices	20
Conclusion and Recommendation	25
References	28

Figures

Figure 1.0

Health Conditions of Workers

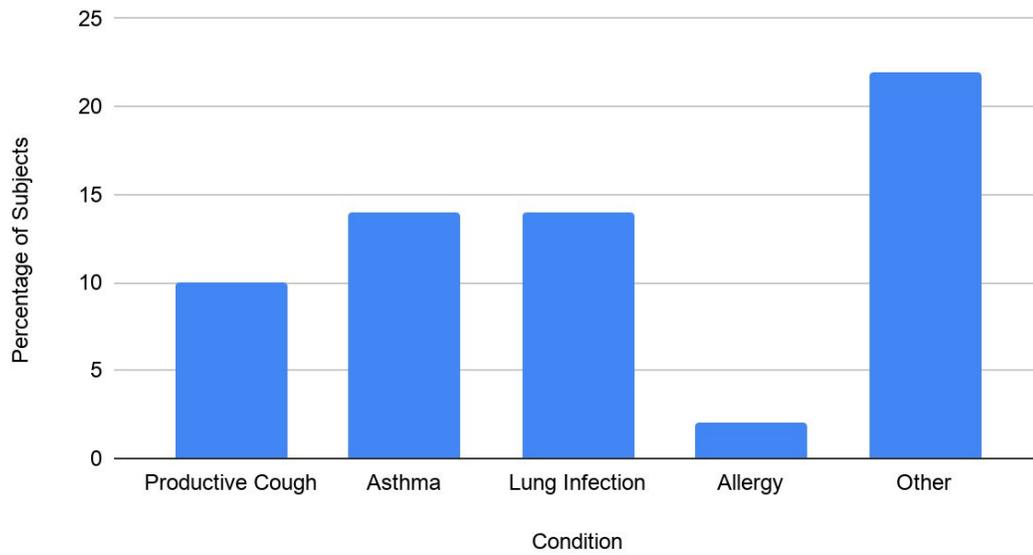


Figure 1.1

Tobacco Habits

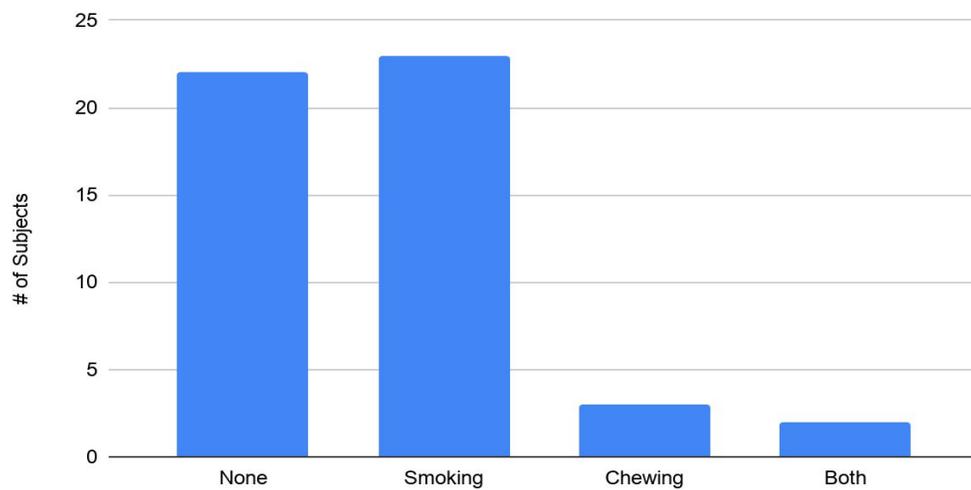


Figure 2.0

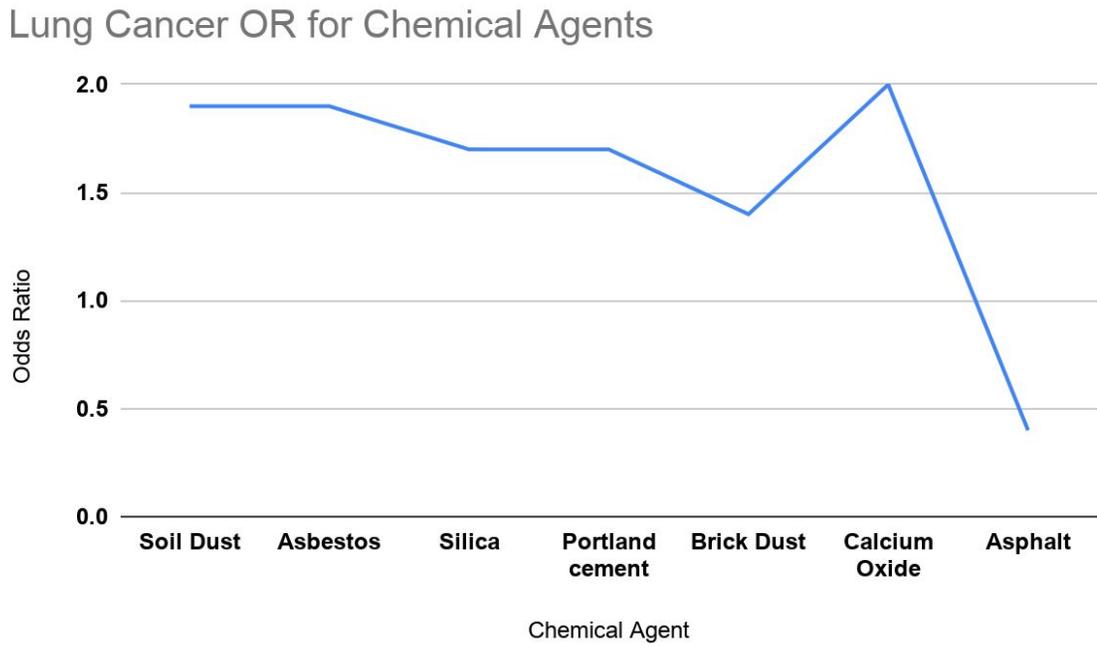
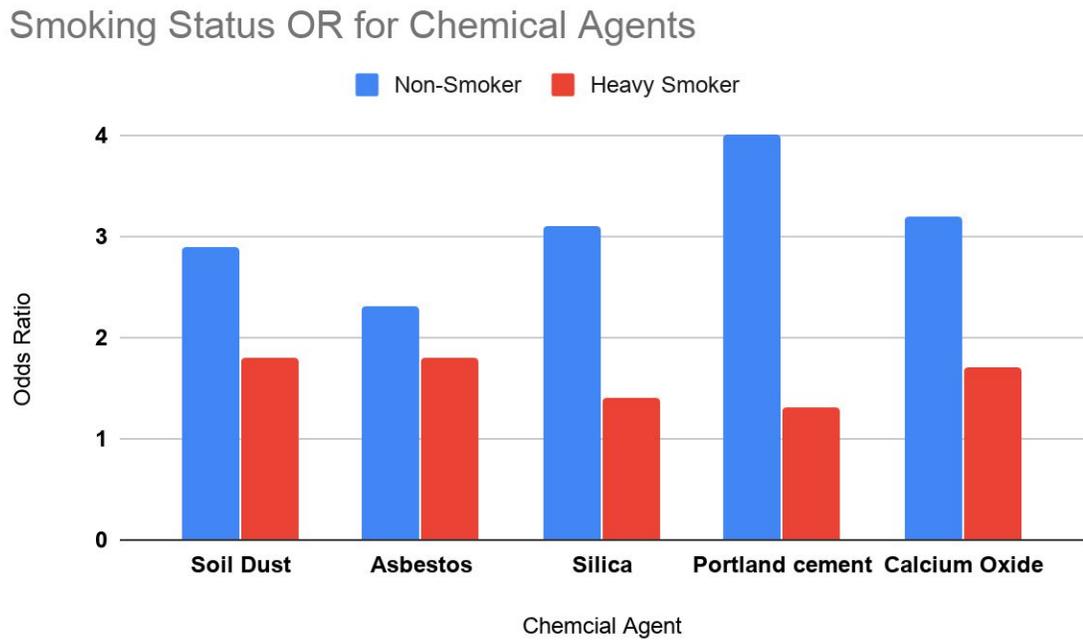


Figure 2.1



Introduction

A construction labor worker that is exposed to construction chemicals and dust will have a higher chance of presenting with respiratory health issues than an individual that is not exposed. I aim to find ways to improve respirator decisions and usage in the field to hopefully improve the respiratory risks due to exposure. Throughout the research process, I intend to examine the current issues with respirator usage and discover ways to decrease the effects of exposures on the workers pulmonary function.

Discussion

Case Studies

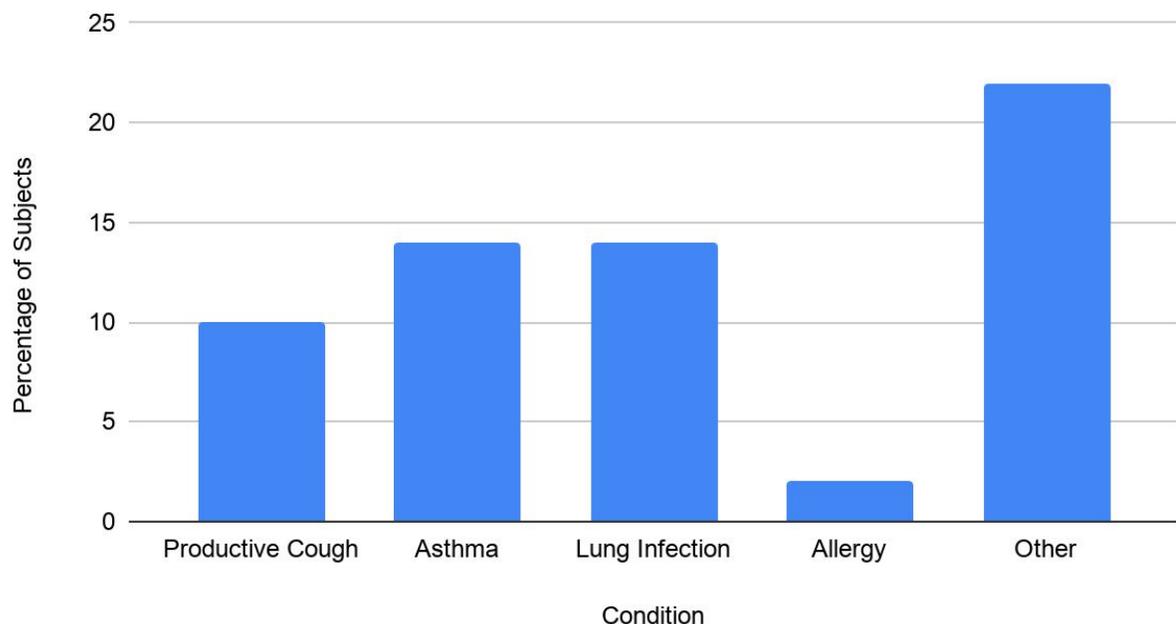
Several institutions and professionals have done extensive case studies and research regarding the respiratory health and function of construction workers. There was focus on specific substances and their effects on the health of workers to determine the exposures with the highest risk. Common factors that may compromise the studies were taken into consideration, such as smoking frequency in construction workers.

Study A

A group at the College of Applied Medical Sciences at Qassim University conducted a case study, “Effect of Exposure to Cement Dust among the Workers: An Evaluation of Health Related Complications”. Ahmad Almatroudi later wrote an article about the study. The study was conducted to determine the effect of exposure to cement dust by staining sputum samples of cement workers and found evidence of inflammation in the lungs of those workers exposed to cement dust. The authors also conducted a questionnaire inquiring the workers about productive cough, asthma, lung infections and other health-related issues after working in the cement industry for three or more years. Figure 1.0 presented below shows the percentage of the subjects that experienced each of the health conditions from the questionnaire. The other conditions the workers experienced

Figure 1.0

Health Conditions of Workers



were back pain, hypertension, etc. Each subject that presented at least one of the conditions claimed that the condition was non-existent or not as severe before working in the cement industry. From this conclusion, the hypothesis is supported that workers in the construction industry exhibit more severe symptoms than when not working in construction.

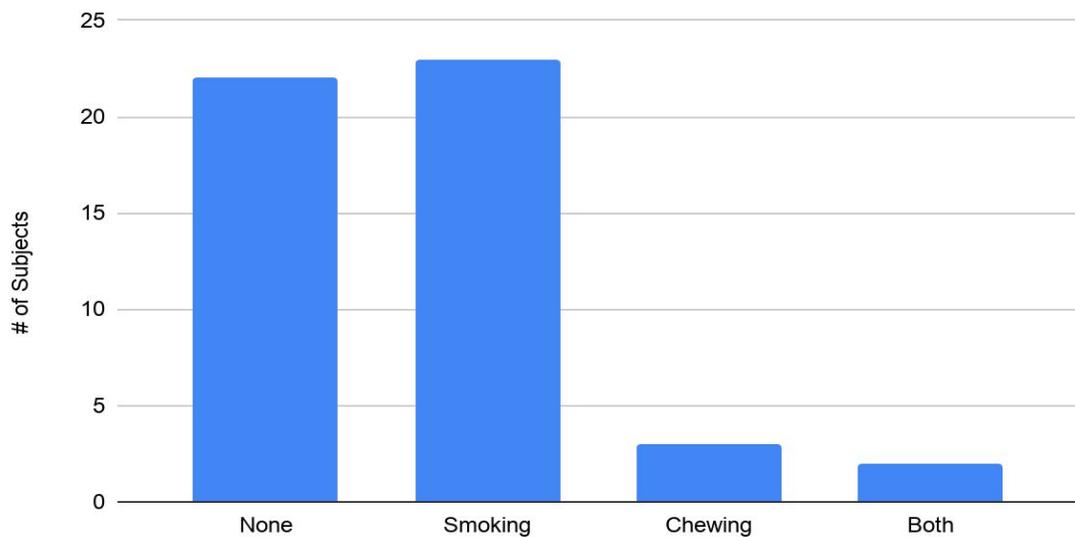
The evidence collected from the sputum samples in this study also showed results to support the hypothesis that people have worse health conditions when in the cement industry. The sputum collections were stained with Hematoxylin and Eosin to determine and analyze the presence of inflammation in the lungs. The sputum samples were from the same 50 subjects, then separate control samples were analyzed as well, in which there was a larger presence in the subjects working in the cement industry than the control group. Following the H&E staining, 35 subjects' samples (70%) presented with evidence of severe inflammation. The control group, however, showed no severe inflammation in the sputum sample staining. Furthermore, the cement workers had more severe lung inflammation than those who do not work in the cement industry.

In addition to the health conditions and sputum samples, the study also identified the frequency of tobacco use among the same 50 subjects in the cement industry. The distribution is shown Figure 1.1. While almost half of the subjects participated in neither smoking or chewing tobacco, the other half were participants. With this information, one may assume that the tobacco use contributed to the severe health conditions and inflammation. However, the

subjects still stated that the severe health conditions did worsen once in the cement industry; while most subjects also admitted that their tobacco usage was consistent with this questionnaire prior to working in the cement industry.

Figure 1.1

Tobacco Habits



Study B

In like manner, The *American Journal of Industrial Medicine* published a study conducted by Chin, Hong, Bates, et al. to examine the relationship between occupational factors, such as dust and chemical exposures, and cigarette smoking among trade workers. The purpose of the study was to find methods to hinder work environments from promoting smoking habits. The study used data from the MassBUILT study (2004-2007) to test an intervention method called randomized controlled trial (RCT) that promotes smoking cessation. The participants included in the study were diverse, but the majority were white males

in their late 20s, only 8% had completed 4 years of college and 43% of the subjects were classified as current smokers at the time of the study. In fact, of the 30% of blue-collar workers that smoke cigarettes, 38% were construction workers. The construction industry had the highest percentage of smokers over any other blue-collar industry. Current smokers were found to be significantly less concerned about occupational hazards and were regularly exposed to dust and chemicals; however, workers that were exposed to these occupational hazards had higher rates of smoking than workers that were not exposed to hazards. Trades that are typically more stressful, exhibited a higher number of current smokers than trades that are less stressful; this result is most likely because smoking is used as a coping method for the stress the workers encounter on the job. The study opened the idea that the trade industry can cause respiratory issues, not only by the exposures on site but also the correlation of cigarette smoking. The stress level of the industry workers is shown to cause an increase in the tendency to smoke cigarettes regularly. Additionally, the study found that the smoking prevalence amongst the trade workers is almost double the percentage of the general population in the United States. With this information, it adds another angle to consider for the possible cause of decreased pulmonary function in construction workers. Managers on site should be looking into the RCT method to help promote smoking cessation; in result this alone should be found to lower the respiratory risks of all workers on the site.

Study C

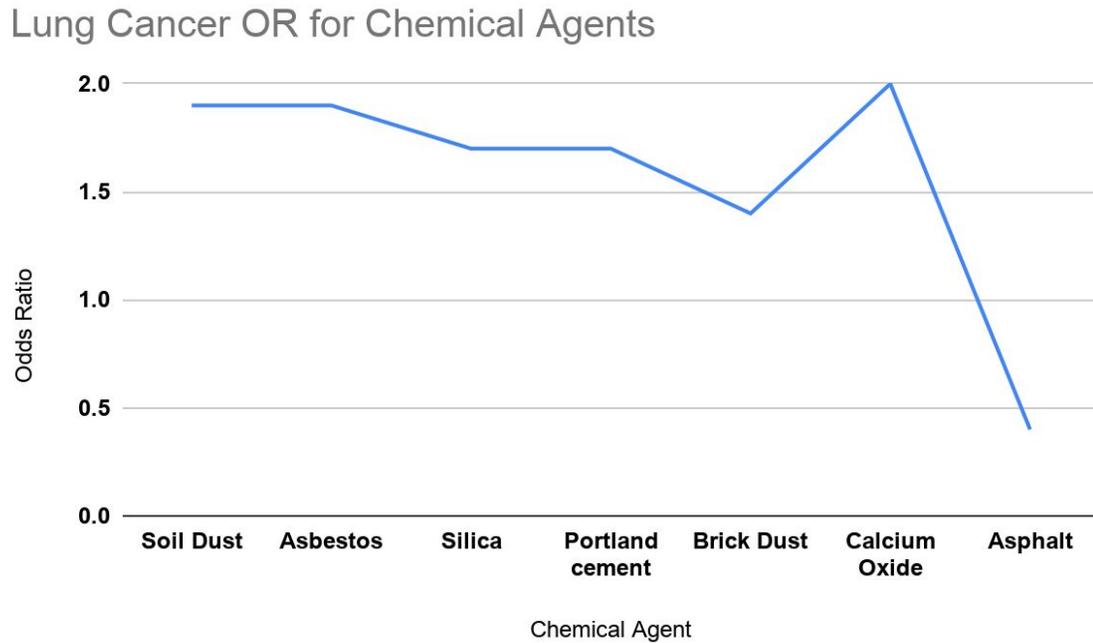
A case study in *BMC Public Health* conducted by Lacourt et al. considered a different effect on workers in the construction industry. Lacourt et al. assessed the lung cancer risk of construction workers and whether exposure to selected construction industry chemicals, dust, etc. carries excess risks. Two studies were performed; one examining the odds ratio of lung cancer for construction workers compared with other blue-collar workers and another examining the odds ratio for construction workers exposed to 20 agents typically found in the construction industry compared to the construction workers unexposed to the agents. In both studies, there was a study group and a control group.

The results of the first study showed that there was a low-significant odds ratio (OR) of 1.15 when comparing construction workers and all other workers outside the construction industry and the OR was 1.11 when comparing construction workers and other blue-collar workers. The OR for industrial and heavy construction workers was 1.26, while the OR for trades contracting workers was 1.02. This evidence proves that there is a risk of lung cancer in construction workers and that precautions should be taken.

The second study results showed that multiple of the exposure agents had a high significance of those substantially exposed. The agents with the highest OR, as seen in Figure 2.0, were asbestos, silica, Portland cement, soil dust and calcium oxide; therefore, substantial exposure to those agents will put workers at

a higher risk of lung cancer. However, asphalt exposure has a very low odds ratio

Figure 2.0



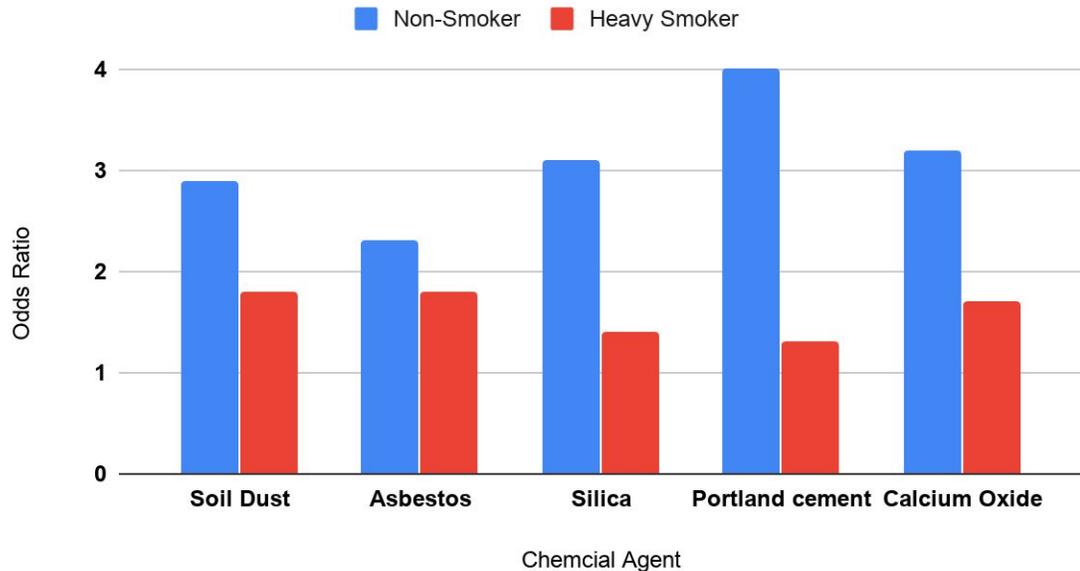
for lung cancer. Safety measures should be increased when workers are exposed to the agents with a higher chance of lung cancer due to exposure. Relating this back to the significance of smoking among construction workers, the chemical agents with the highest odd ratios were analyzed for smokers and non-smokers.

The results shown in the table prove that the heavy smokers still have an odds ratio over 1.0 for each chemical, meaning that heavy smokers are still at a significant risk of lung cancer from the chemicals. The non-smokers have a larger odds ratio for these chemicals than the heavy smokers, because the odds of a

non-smoker that are not exposed to these chemicals is much lower than a heavy smoker that is not exposed to chemicals.

Figure 2.1

Smoking Status OR for Chemical Agents



Therefore, the risk will greatly increase for the non-smokers and be directly correlated to the harmful construction substances; while the heavy smokers' risk of lung cancer will still have an increase due to exposure to harmful chemicals, just not as significant of an increase.

Case Study Conclusion

Overall, workers exposed to harmful construction substances are likely to have negative effects on their lung function. With half the subjects in one study presenting symptoms such as a productive cough, asthma, lung infection and other various health conditions. The most dangerous chemicals/substances in

the industry have been shown to include asbestos, soil dust, Portland cement, silica and calcium oxide. One study discussed the prevalence of smoking and tobacco use within construction workers. The stressful environment proved to be connected with an increase in tobacco use among workers and almost 50% of the subjects in the study were considered smokers, while the other half did not smoke at all. Even though the construction industry has a high presence of tobacco use, Study C shows that the exposure to the harmful substances still has an odds ratio of above 1.0 for heavy smokers; concluding that the risk of lung cancer for heavy smokers does in fact increase when exposed to hazardous construction substances.

A cohesive conclusion can be determined from the case studies discussed. Individuals that work in the construction industry have a greater risk of lung cancer, lung infection, productive cough, and asthma. While it has been proven that construction workers have a higher percentage of smokers than any other blue-collar industry and the stress of the industry has been proven to cause an increase in smoking habits among workers, the exposure to chemicals will still put the workers at risk for lower pulmonary function and various lung diseases.

Current Safety Management Practices

OSHA Respiratory Protection Program

A construction company should instill a respiratory protection program for their employees to optimize protection from exposure to harmful substances that may be inhaled. When implementing respiratory protection, there must be a written program that follows OSHA requirements and respirator standards. The written respiratory protection program should include several sections that will be discussed, such as:

- respirator selection
- medical evaluations
- use of respirators
- maintenance and care
- assuring adequate air quality
- training and fit testing
- program evaluation

The first step is to identify the exposure risks on a specific site, to do so employers must do an exposure assessment. This assessment will help evaluate the workplace hazards and determine what hazards are present, exposure levels, and whether or not those levels are acceptable (Larson 2016).

Understanding the exposure levels of any airborne contaminants and whether the levels are within OSHA limits will allow the safety management team to

determine if any measures, such as ventilation, elimination or substitution can be used to decrease the exposure. Other measures such as relief workers, rotation of workers, and work breaks can also be used to lower the exposure of contaminants to workers. If the control measures can not be used or do not get the exposure levels to an acceptable limit, then respiratory protection must be provided to workers.

Once the exposure assessment is complete and it is determined that respiratory protection is required, the next step is to go through respirator selection. Respirators must be approved by the National Institute for Occupational Safety and Health (NIOSH); these respirators have an assigned protection factor (APF) given to allow the safety team to determine which APF is appropriate for the level of exposure identified in the exposure assessment (Larson 2016). In addition to the APF evaluation, consideration of the other protective equipment that may be required is necessary. If workers are going to need glasses, then it may interfere with the respiratory protection. If it interferes with the other protection, it may cause the worker to be uncomfortable. When workers are uncomfortable in their PPE, it can cause the workers to not wear any of the equipment or wear it inappropriately (Larson, 2016). Improper use or lack of use of the respiratory protection can lead to high exposures to harmful chemicals and substances leading to respiratory health issues. Each of these aspects are important in selecting the appropriate respirators. There are a variety

of sources online that employers can use to help select respirators for their workers (Larson, 2016).

After selecting the appropriate respirators, workers will need to be approved by a licensed healthcare professional to wear a respirator. OSHA first requires each worker to complete a questionnaire about their current medical conditions (Larson, 2016). It can be determined from the questionnaire whether a worker has a condition that may prevent them from being able to use a respirator. There is no duration established before a re-evaluation is required. However, if the worker presents with signs or symptoms of a medical condition that may impair his use of protective equipment then they need to be re-evaluated by a medical professional (Larson, 2016). Overall, the medical evaluation is to ensure that workers are able to use the respiratory equipment appropriately and effectively.

Another section within the protection program is respirator training and maintenance. Employers are required to train workers annually to help ensure the workers' understanding of the importance of respiratory protection, and how to effectively select and use a respirator (Larson, 2016). There are several topics that must be covered in the training, starting with why workers need to use a respirator and how it can protect them. This is a very important topic in the training to help employees understand why they are being required to wear certain protection and what exactly the protection is preventing. Other topics regard the use and maintenance of a respirator. The training should cover how to properly put on and take off a respirator, and also how to inspect the respirator

before usage. Employees will need to know how to perform a “user seal check”, what to do if the respirator is not working properly, and maintenance and storage procedures (Larson, 2016). Additionally, employers need to include how an improper fit or improper use can increase the chance of exposure and decrease the effectiveness of the respirator. The final big topic to cover in training is how workers can evaluate their health themselves to identify health conditions that may hinder the use of a respirator. If employees know how to do this, then they will know when a medical re-evaluation will be necessary to ensure their own safety from exposure to harmful chemicals. Proper and regular training can help ensure that employees know how and when to use respiratory protection, as well as knowing how to inspect the equipment.

The final step as an employer is to evaluate the respiratory protection plan often. Employers need to communicate with workers about respirator usage and whether workers feel comfortable using respiratory protection. If the employer finds that the employees do not know how to use or feel comfortable using respiratory equipment, then their training may need to be adjusted or even increased. Also, it is important to keep track of inspection dates and make sure all equipment is up to date (Larson, 2016). If the equipment is out of date, there may need to be changes in the program to ensure that the protective equipment will receive inspections regularly. All of this information from evaluating the program will allow employers to better their protection plan and help better protect the employees.

The Occupational Safety and Health Administration has lots of available information about respiratory protection plans for employers and employees. Employers should be comfortable and familiar with instilling a respiratory protection program following the OSHA regulations and recommendations. These steps and sections for the protection plan are critical to ensuring the respiratory safety of workers. Throughout several studies, as discussed, the exposure to several construction air-borne substances can lead to workers having new or worsening respiratory health conditions. Conditions such as lung disease, lung cancer, asthma, and productive cough are common results of exposure to harmful substances. Employers that do not make sure workers understand how and when to use respiratory protection, and do not have a well managed protection plan/program, are more likely to have workers with respiratory health issues due to the lack of use or understanding. While the employee would be directly affected and harmed; it would cause issues for the employer as well. This protection plan can ensure the safety of employees and in turn save employers from possible workers compensation, loss of workers, OSHA investigations or even lawsuits.

Current Common Practices

Through research into how construction companies implement programs or follow OSHA recommendations and regulations, it was determined that many employers could greatly improve their current respiratory protection plan. To ensure confidentiality, companies will not be named directly; focus will be on company A and company B. Company A is a mid-sized construction general contractor, while Company B is a small construction company. In conclusion, each company had parts of how they handle respiratory protection that is not in the best interest of the employee.

One of the first factors evaluated was training. According to OSHA regulations and recommendations, training is one of the most important parts of ensuring respiratory protection. The more the workers are educated on the importance and usage of respirators, the more likely workers are to use the equipment correctly. Company A did follow the mandated annual respiratory protection training; however, it was not as thorough as OSHA requires. While they went over the importance of respiratory protection and the types of respirators, the usage training was not hands-on making it difficult for employees to get a good idea on how to properly use the respirators. Also, the employer does not include inspection or maintenance of respiratory protection in their annual training. On the other hand, company B agreed that they participate in no annual training for employees that is specific to respiratory protection. Neither of these companies

are protecting their employees appropriately by not providing employees with important information about respiratory protection. Not only is annual training important, each new employee should be trained how to use respiratory protection equipment before usage to ensure they are aware of proper usage. Without training new employees on how to use a respirator properly, the employer is putting the worker at risk of exposure. Company A and company B, both presented that they did not have a training program specific to new hired employees for respiratory protection. As mentioned previously, this is harmful to the employee due to the higher possibility of exposure. The employer is also at risk of several liability claims of negligence if employees were to show evidence of worsen health conditions.

Another determination found within research, is that availability of respiratory protection is a large issue. According to OSHA regulations, employers must supply respiratory protection equipment to all employees when the exposure assessment previously mentioned requires protection based on the level of exposure. However, research discovered that Company A does not follow that regulation very closely. While company A does have different respiratory equipment that employees would need, they do not always have them easily accessible to the workers. Majority of the projects company A is working only has the lowest level respiratory protection for employees; the higher levels are left at the home office. Although the employer owns the protection equipment, if the worker is on site, they may not have access to the equipment in a situation that

results in a higher level of exposure. Many workers that encounter a situation that requires respiratory protection were asked to go purchase the equipment with the company account or asked to go back to the home office to retrieve the equipment from there. Once workers found out that the respiratory protection was often not on site, they knew they would have to go out of their way to get the equipment. With this, workers were less likely to even wear the correct protection equipment and would just use the lowest level face masks that were available to them. Therefore, due to the lack of accessibility to the correct protection, the workers are put at a higher risk of exposure.

The largest found issue was the overall usage of respiratory protection equipment. As mentioned, the lack of availability of the equipment to the workers plays a large role in the lack of usage. Even with the lack of usage, when workers do use respiratory protection, it is unlikely that it is the correct equipment for the level of exposure. The most common respirator on site was the filtering facepiece; a respirator that is the lowest level of protection and may not completely protect workers from harmful exposure. The filtering facepiece is the cheapest and easiest to buy, typically leading to it being the common respirator that the employers were supplying to workers. However, the level of exposure may require a higher level of protection than the filtering facepiece provides to the employees.

Another usage issue found during research, was that workers often did not use respiratory protection at all. The lack of accessibility contributed to this issue;

but also, the lack of enforcement. Respirators can be uncomfortable due to fitting and also for heavy breathing during manual labor on the construction site. Employees often choose to not wear any protection due to the low comfort level. Without proper and consistent enforcement on site, workers will continue to choose not to wear the correct or any respiratory protection. Employees that were no protective equipment, are at the highest risk of exposure to harmful substances leading to worsening health conditions. Many of the sites evaluated did not have a safety manager on site to enforce the regulations. Majority of the time, the superintendent was left to that responsibility. While the superintendent has the knowledge and authority to help enforce safety rules, that is not the sole task for that position. The individual may be occupied with other responsibilities that do not allow them to appropriately be able to designate their attention to safety hazards. This lack of personnel to enforce the usage of respiratory protection leads to employees being at risk of exposure and risk of negative health effects.

Overall, the current practices found on site are not adequate or effective in terms of respiratory protection for the workers. When employers allow a higher risk of exposure to their employees, it puts their workers at risk of several negative health effects. Not only are these employers allowing employees to be at risk, but they are taking a risk themselves. When their employees present with lung disease due to exposure, employers may have to pay for workers' compensation or even can be sued by the employee. Neither of these effects are

good for the employer. It will greatly affect not only finances, but their reputation as well. A worsened reputation by negating the responsibility of their employees' health, could lead to loss of business or loss of employees also leading to loss of business.

Conclusion and Recommendation

In conclusion, several case studies have been shown to prove that the exposure to several airborne substances in construction have negative health effects. Workers that were substantially exposed to substances such as silica, Portland cement, soil dust, calcium oxide and others, presented with productive cough, lung disease, inflammation of the lungs, and even lung cancer. Not only is exposure to these substances harmful, but the presence of cigarette smoking in construction contributes to the respiratory health issues in the industry.

After the evaluation of many construction sites and companies, it was discovered that the typical construction site presents with the lack of accessibility to respiratory protection and lack of personnel for enforcement. Many of the discussed OSHA guidelines were not consistently followed. The mandated annual training was not followed correctly at either Company A or Company B and neither had methods for respirator selection or medical evaluations of employees before respirator usage. It was found that the actions or negligence of employers have allowed employees to be substantially exposed to harmful substances that can lead to respiratory health issues.

Throughout this research process, many recommendations for employers can be made. After noticing that the actions of the employers have been less than acceptable and the worsening health conditions of employees due to exposure, it can be concluded that the effects of exposure have a higher chance of occurring

due to the decisions of the employers. While employers can only do so much to protect their employees, the companies analyzed are not practicing the best possible ways to protect workers from airborne substances. There are many ways that companies can improve their practices and programs to help better protect their employees and in turn protect themselves from financial losses.

One recommendation is to have more safety personnel on site to help enforce after regulations. This will keep workers from completely disregarding respiratory protection and will make sure that employees are using respiratory equipment properly. Each of these will help decrease the chances of exposure and help better prevent respiratory health problems. Another recommendation is to increase training. Companies should be supplying hands-on respirator training to new employees when they are hired and current employees annually, per OSHA regulations. The more education employees have on the importance of respiratory protection, and the proper selection and usage of respirators will also help provide adequate protection to workers from exposure. A final and important recommendation is to have respirators of all levels that may be required based on the exposure assessment on site at all times. If respirators are not available to the employees than there is a 0% chance of them being able to use respiratory protection. Lack of access to respiratory equipment will lead to employees being directly exposed to harmful airborne substances that will negatively affect the respiratory health of employees.

Following research done by others through case studies and the evaluation of construction sites to determine common safety practices, companies should highly consider implementing these recommendations. By implementing these recommendations, employees will be properly protected and the risk of employees being ill will decrease. Not only will this help the workers directly impacted from exposure, but the employers will benefit from a decreased risk of financial loss.

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