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REVIEW ARTICLE

Major research trends in respiratory diseases in construction sites; a scientometrics study considering the COVID-19 pandemic

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ABSTRACT

Most construction workers, including operators and engineers, suffer respiratory injuries due to exposure to hazardous materials and particulate matter (PM). This review article presents a brief overview of previous research on respiratory diseases in construction sites and links it to the COVID-19 epidemic, trying to explain other possible routes of coronavirus spread. The purpose of this review study is to find other methods of coronavirus transmission in construction sites. To achieve this goal, on the one hand, the literature on the spread of COVID-19 disease was reviewed. On the other hand, by reviewing the literature related to the health of construction department workers, we find that people who work in this occupational class suffer from respiratory diseases after a while. Therefore, they are at high risk for coronavirus. The next step is to review the literature on the effects of COVID-19 on the bodies of people with a history of respiratory disease. It is found that these people are at risk of death. It seems that transmission is not limited to known methods such as sneezing and coughing. In addition, the virus can be spread by dust and airborne particles. Due to the special conditions at the construction site, there is a higher probability that the coronavirus will be transmitted between individuals and employees. Obviously, the infection of individuals can cause irreparable harm and economically affect the construction industry. Analytical methods are based on scientometrics and research methods, in line with the PRISMA methodology. Articles from the WOS port were based on keyword searches.

KEYWORDS: *construction sites, COVID-19, respiratory diseases, SARS-COV-2, scientometrics review*

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INTRODUCTION

Spreading the diseases in construction sites through dust and construction activities

According to the Health and Safety Executive (HSE) handbook, construction dust is not only a nuisance, but also troublesome. It can be downright damaging to an individual's wellbeing and even end in death for some types. Therefore, regular inhalation of the dust over a long period of time can lead to life-threatening lung infections. There are three main types of construction dust:

- Silica dust – respirable crystalline silica (RCS) found in concrete, clay, and sand;
- Wood dust – produced when working with machinery such as power saws to cut or shape wood;
- Other 'general' dusts (or nuisance dusts) – the best known include gypsum, marble, dolomite, and limestone.

Based on HSE data sheets, various activities such as cutting kerbs and precast concrete blocks, tunneling, scappling, producing a smooth finish on flat surfaces (surface grinding), crushing, screening destruction material, removing debris, chiseling out mortar before repointing, laying epoxy flooring, and carpentry work can produce hazardous dust. It can damage the lungs if ingested and cause lung infection if not adequately controlled (1). Also, at the forefront of dust-generating activities is the demolition of buildings, which releases large amounts of dust and silica into the atmosphere, and this could cause lung cancer in demolition workers and even their death (2). Regardless of the activities carried out in the construction industry, the weather conditions, humidity, temperature, and wind speed Also might cause the emission of PM and dust into the air (3). Due to the fact that construction activities are always faced with the production of dust, a number of articles have addressed the issue of the spread of diseases through construction activities. A review of the recent articles indicates that there is a possibility of spreading the diseases through construction activities. For example, the article by Liang et al. pointed out that construction activities have a potential role in spreading the dengue virus (4). After the physical injuries, the spread of infectious diseases such as the respiratory diseases is the reason for the absence of construction workers (5). Due to the poor hygiene, migrant workers spread infectious diseases like hepatitis and malaria, as well as respiratory diseases such as the flu and arboviral infections like Zika and dengue (6). Tamburro et al. stated that, the knowledge of construction workers about infectious diseases at work are very low. Only 24% of them believe that there are emerging and re-emerging infectious diseases, which could be spread through construction activities (7). Also, the research of Tüchsen et al. shows that the spread of respiratory and intestinal infectious diseases is common among the tunnel and bridge construction workers (8). So the disease can be transmitted in other ways than direct contact. Biologically, the disease can be transmitted through infectious aerosols (9). The virus can be transmitted through various means, such as droplets, aerosols, and contact with infected surfaces (10). Workplaces, and shared rooms can propagate infectious diseases (11).

Respiratory diseases in the construction sites

According to National Cancer Institute (NCI) Dictionary, respiratory diseases can affect organs related to breathing, such as the lungs, throat, and chest muscles. These diseases can be caused by smoking and exposure to tobacco smoke; other causes include air pollution, asbestos, radon, and infections (12). The most common diseases in the construction industry are asthma, silicosis, asbestos-related diseases, chronic obstructive pulmonary disease (COPD), and lung cancer (13). Regardless of the activities carried out in the construction industry, smoking by a large number of employees in this industry has become the reason for the increase in respiratory diseases in the workplace (14).

COVID-19 as a respiratory disease

COVID-19 is a member of the coronavirus family that was diagnosed in acute respiratory infections in Wuhan, China, in December 2019. The main reason of spreading COVID-19 is by breathing in the air contaminated by viral aerosol droplets when the infected person coughs, sneezes, or talks (15). Another method of spreading the virus could be through contact with contaminated surfaces, but the risk is low (16). The spread of COVID-19 through contact with asymptomatic individuals is also a challenge (17). The common symptoms of COVID-19 and diseases such as the flu or the common cold lead people to think they have not contracted coronavirus and make others sick (18). Recovery can be lengthy and painful for some people. Persistent breathing problems, dizziness, ringing in the ears, and mental health problems have been reported by patients who recovered (19). Age is a key factor in COVID-19 patients, and with each 5-year increase in age, the probability of death increases by 15.5% (20).

Objectives

It has always been a common practice for construction workers to suffer from respiratory diseases due to dust, fine dust and particulate matter. COVID-19 disease is an infectious respiratory disease caused by a virus called coronavirus, but the virus can also be transmitted in various other ways, such as dust, fine particles, aerosols, vapors and PM. This review article attempts to assess the possibility of transmission SARS-COV-2 through construction activities. Considering the amount of risk that exists, we can address the concerns of employees and think of a solution for it. The importance of this article can be understood by examining the impact of the COVID-19 disease on people with a history of respiratory diseases. Often, the cost of treating the disease and compensation are high. Working conditions in construction sites are such that a range of activities and materials can be harmful to the health of the human respiratory system. This review article identifies the causative agents by examining the other published articles in this regard and examines respiratory diseases in the construction sites in a more general way. With the widespread prevalence of coronavirus, all aspects and means of virus transmission should be considered. The possibility of spreading this disease through construction activities is an issue that should be taken into account and this review article attempts to prove this by providing evidence in this regard. Background illnesses such as lung diseases can cause irreparable damage to this organ. Of course, it should be noted that this fact is not specific to the workers of this industry and can be generalized to all members of society. Based on the research and findings of scientists on different ways of spreading coronavirus and its generalization to construction activities, the possibility of spreading the virus through construction activities, dust, pollution, PM, aerosols, and vapors can be investigated. It can be said that the issue of the transmission of the coronavirus through construction activities has not been considered, only the different ways of spreading it have been studied. Therefore, based on this information, conclusions can be drawn in this regard. This review article can provide a way to do more research and more closely examine the spread of viruses and diseases through construction activities and pollution. Finally, after examining the possible routes of transmission, the concerns of the construction workers about COVID-19 disease will be discussed and possible solutions for managing this situation will be provided.

MATERIALS AND METHODS

Eligibility criteria

The population studied in this review article was construction workers, especially heavy machinery operators, who developed respiratory and lung diseases over time as a result of their work conditions. If a person with a history of respiratory disease becomes infected with COVID-19, a more severe course of illness or even death may occur. This study is innovative in that it identifies COVID-19 infectious respiratory disease as an occupational disease among construction workers. The research method used in this paper is qualitative. The conclusion is obtained by reviewing the information published in other researchers' articles, reputable websites, reports, and standards. The approach that was used in this review article is "Grounded theory", which was used to verify the spread of the COVID-19 pandemic hypothesis through construction activities. The data collection method is "Secondary data" since the previous information and statistics were used. The reason for using this method is its flexibility, as this idea can be generalized and different conclusions can be drawn from it in other fields. On the other hand, this is a new idea which could provide an opportunity for further research on this topic.

Survey

The main purpose of this article is to investigate the respiratory diseases of construction workers from the past to the present, which accompany today's COVID-19 pandemic. To achieve this objective, two intermediate objectives should be proven: 1) the presence of dust, harmful particles, and vapors that cause respiratory diseases, and 2) The spread of COVID-19 disease on construction sites and the possible reasons behind this problem. Next, the concerns of the construction staff about the COVID-19 disease will be discussed. Finally, possible solutions to this issue will be presented.

Source of information

In order to achieve the intermediate objectives, in the first section, the keywords related to this section such as "dust," "construction workers" and "respiratory diseases" were searched in the WOS database. In the second part, the keywords "Coronavirus," "COVID-19" and "Spread" were selected to investigate other routes of coronavirus transmission. Through the conclusion of the two intermediate goals, the main purpose of this review can be extracted and solutions can be provided. Figure 1 summarizes how to achieve the objectives of this study in the form of a flowchart. Additionally, in Figure 1, all databases used are listed separately for each subject. The main study period was from 2010 to 2020. However, by examining the references of several articles that were related to the field of this study, some resources before 2010 (n = 8) were also selected to investigate the issue precisely.

Study selection and data collection process

First, the mentioned keywords in question were searched in the WOS database. Then, the abstract of these articles was surveyed and those that were more relevant to the topic were selected. These articles have been thoroughly reviewed, and new resources have been selected from the references of these articles for further examination of inquiries raised. Selected references are all in the English language. Since the point of contention was new, several well-known websites and reports provided by the authorities were used to verify the issue. Figure 1 shows the details of these sites and the number of reports, respectively.

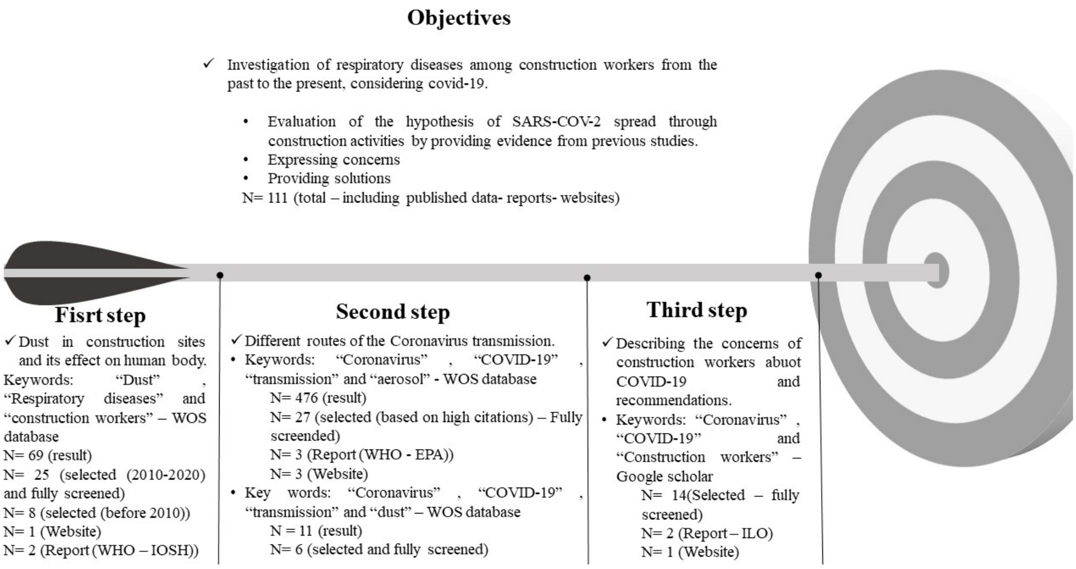

Figure 1. Explanation of the overall framework along with the number of references selected in each section (N refers to the number of references).

Data items

PICOS has been used to define the study criteria. The collection and preparation of the list of required information has been done according to the PRSIMA method.

Risk of bias

This study was performed to strengthen the hypothesis of the possibility of further injury to construction workers due to COVID-19 disease. It should be noted that the findings of this study were drawn by reviewing other studies and conclusions by other researchers. It is possible to prove this possibility through laboratory and virological studies, but the results of this study can provide the necessary knowledge about preventative measures to prevent the possible loss.

Additional analysis

The analytical method used is scientometric analysis. This method is used to objectively map a scientific area and related challenges based on the scientometric results of other researchers. This approach is suitable for inferring the desired outcomes of this study.

RESULTS AND DISCUSSION

Dust in construction sites and its effect on human body

According to Cheriyan and Choi, the construction industry contributes significantly to the generation of fine dust pollution (21). Also, recent studies have shown that the construction industry produces the highest amount of PM in the atmosphere (70%) (22). Khamraev et al. suggested that construction projects produce a large amount of PM, accounting for 70-80% of total PM. Therefore, PM is one of the main pollutants in the environment. They can be harmful to human health because their constituents may contain toxic substances (23). Doney et al. studied respirable crystalline silica (RCS). As mentioned before, inhalation of silica can cause lung cancer and silicosis. According to their research, about 79% of workers who may suffer from silica exposure work in the construction industry. A large group of workers (30,200) are in the residential building sector. This is followed by 11,400 contractors, some of whom were employed for the foundation concrete placement. Finally, the lowest number belongs to commercial and institutional building construction (8400) and masonry contractors (7700) (24). Flynn and Susi conducted a table summarizing which type of machine releases the greatest amount of dust is inhaled from people during its operation. Drill, concrete mixer, chip gun, and grinder generate a large amount of dust, respectively (25).

This type of dust is known to be harmful to the health of different workers such as heavy machinery operators, employees, visitors, and all people nearby. PM_{10} found in dust and smoke can be inhaled through the nose and throat, damaging the respiratory tract and eyes. $PM_{2.5}$ characterizes fine, inhalable particles. Khan and Strand studied road dust particles, focusing on $PM_{2.5}$, which can cause chronic health effects. $PM_{2.5}$ in road dust can cause cardiovascular and respiratory complications. In worse cases, inhalation can lead to cancer or even death (26). Markowitz and Dickens identified occupational lung cancer as a rare disease in their study. They believe that lung cancer, despite being the cause of widespread occupational mortality, is still unknown in the medical centers and workers' compensation system (27). Compared to the general population, construction workers are 2.3 to 12 times more likely to develop lung cancer. They also face additional risks due to poor economic conditions and lack of access to medical services (28).

According to Zhang et al., too many particles are released into the air during the life cycle of a building. A large proportion of the particles are PM. Dust generation is unavoidable during the construction process (29). The use of heavy construction machinery (such as bulldozers, tractors, grinders, road rollers, etc.) can generate a large amount of dust in the surrounding environment. This dust can enter the human lungs and cause damage (30). Young et al. examined three different construction sites and measured total dust, PM_{10}, and $PM_{2.5}$. Concentrations of PM and dust were higher indoor, even when minimal activity was occurring. They concluded that total dust exceeded United States National Ambient Air Quality Standard (NAAQS) limits (31). Many construction activities, such as drilling, generate particles, and inhaling the particles can damage the lungs during the exposure period (32). According to Münzel et al., the aspects of air pollutant exposure are (1) Chronic effects, which are much larger than acute effects; (2) Elderly and those with pre-existing heart conditions or obesity who are at higher risk (33). In the UK, more than 500 construction workers die of lung cancer each year because they inhale silica dust at work (34). According to Narayanan, there are two types of lung diseases: asthma and progressive silicosis, which rapidly affect the human body. On the contrary, due to long-term exposure to harmful substances, certain types develop gradually (35). Dement et al. studied lung cancer mortality in construction workers. They developed a model to predict worker mortality based on age and smoking history, two key factors that increase lung cancer in construction workers (36). Tammemägi et al. demonstrated that lung cancer risk extends well beyond 15 years after smoking cessation (37). Consistent with other studies, workers with chronic obstructive pulmonary disease were found to have an increased risk of lung cancer (38, 39). Lacourt et al. suggested that people who worked in the construction industry have a slightly increased risk of lung cancer. Workers who were exposed to soil dust, asbestos, Portland cement, calcium oxide, crystalline silica, and calcium sulfate have an increased risk. In addition, the study also found that workers in the heavy construction sector have higher risk signs, but there is no evidence that long-term workers have higher risk signs (40). Bovio et al. studied lung cancer mortality across occupations and businesses in Switzerland. Among operators of heavy machinery, male workers of rubber and plastic machinery are at a higher risk. In addition, working in mines leads to an unhealthy condition of the workers due to the high dust concentration (41). Järvholm argued that exposure to silica dust and asphalt fumes can cause cancer. Also, he stated that inhalation of radon and diesel exhaust from heavy machinery used in tunnel projects can cause lung cancer (42). Stocks et al. researched on the reported work-related illnesses in the UK construction industry (43). Respiratory diseases accounted for the largest number of reported illnesses, followed by skin and musculoskeletal disorders. In another study, they also found that there is an increased risk of long-latency respiratory diseases (mesothelioma, pneumoconiosis, lung cancer, and nonmalignant pleural disease) for pipefitters, plumbing and heating engineers, electricians, joiners and carpenters, scaffolders, and workers in the construction and woodworking trades (44). Jung et al. examined lung cancer risks across different industries and occupations in Ontario. They observed excess risks in occupations such as drilling/blasting, other mining/quarrying, mineral ore processing, excavation/leveling/paving, truck driving, bus driving, painting, and construction (45). Donato et al. studied lung and stomach cancer in cement production workers. They concluded that there is a risk of lung cancer in cement production workers, but no increased risk was observed (46). Finally, deteriorated lung function predicts deaths (47).

Higher Risk for operators

Wu et al. divided dust sources into two groups. Some activities in which dust production is inherent are called direct sources. In addition, some activities indirectly play a role in dust production. The underlying sources of dust were reported by the workers. This study argued that soil-related activities are the main sources of construction dust. Activities such as excavation and backfilling, leveling and soil transportation generate the highest amount of dust compared to other construction activities (48). It seems that the operators of heavy equipment are more at risk than other groups of workers. A study reported that the risk of lung cancer for heavy equipment operators is much higher than previously observed (49).
In Järvholm and Silverman's study, several main types of equipment and their operators were examined, and the incidence of lung cancer was investigated. Table 1 shows the machines that were in operation during the first health check. A total of 8,436 men underwent more than one health examination. At the first and last examinations, about 80% of them took the same machine, indicating a low turnover among the construction workers. Sixty-one

Table 1: Major type of equipment used by operators in construction sites and the occurrence of lung cancer (extracted from Javarholm and Silverman study)

Type of equipment	No. of subjects	Observed/ expected
Paving machine	1125	6/6.9
Earth movers	1017	3/8.6
Dumper	881	0/2.2
Excavator	4754	15/24.6
Tractor	2185	12/12.8
Road grader	939	7/11.8
Sweeper	12	0/0.1
Roller		4/4.8
Loading machine	1727	7/6.2
Others (e.g. dredger) or operation of more than one machine	572	7/2.8

cases of lung cancer were observed among operators of heavy construction equipment. With the exception of dumper and sweeper machines, almost all heavy construction machines play a major role in causing lung cancer in operators. Comprehensive information is available in the in Table 1 (50). Rhomberg et al. stated that asphalt paver operators are at increased risk for lung and skin cancer from both dermal and inhalation exposure to asphalt emissions (51).

Bernstein et al. studied the respiratory problems caused by inhalation of liquefied gases and aerosols from metalworking machines. They found hypersensitivity pneumonitis in the workers' lungs, causing fever, cough, and fatigue in the workers (52). Xu et al. studied more than 2000 vehicles and the density of harmful particles. They concluded that the use of special equipment to clean the air in the cabin, use of air filters in the ventilation system, and prefabrication of materials before installation in the vehicle help to reduce the risk of lung cancer (53).

Asphalt workers are exposed to harmful dusts and fumes. About 467,000 and 455,000 particles/cm^3 are inhaled during paving and milling, respectively, and sometimes the number of the particles exceeds 100,000. Paver and milling operators and screed operators are exposed to more harmful dust than other workers (54). For tunnel operators, prolonged exposure to nitrogen dioxide appears to impair lung function. Blasting and diesel exhaust fumes pollute the area the most (55).

Discussion

Harmful dust, particles, and toxic vapors from construction activities are the major causes of respiratory disease among construction workers, even this risk is greater for heavy machinery operators. Based on WHO reports, the vast majority of victims of COVID-19 disease are people with a history of respiratory disease (56). Although the COVID-19 disease originated from a virus, there is sufficient evidence that this virus can be spread through dust, aerosols, and particles like $PM_{2.5}$ and PM_{10}. The construction environment and its employees are potentially hazardous areas for further emissions and deaths. Other ways of spreading the coronavirus are discussed below.

Other routes of spread

Airborne fluids, called aerosols, can contain the coronavirus, further spreading the disease. The aerosols can be released into the air when people talk, cough, and sneeze (57). Coughing causes the particles to move at 60 miles per hour. Between 900 and 300,000 particles come out of the mouth when people talk, sneeze, and cough (58). The point of concern is that the particles can stay in the air for up to 8 hours, which is the main reason for the famous air pollution in Los Angeles (59). Heavier particles fall on the surface, which is another way for the coronavirus transmission (60). The size of the new coronavirus, SARS-CoV-2, is about 0.1 micrometer – about four-millionths of an inch in diameter. The aerosols that people produce when they breathe, talk, and cough are usually between 0.7 micrometer and 10 micrometers and can easily become airborne. Therefore, it can be concluded that aerosols can be an important route of transmission (61).

A nationwide study was conducted by Harvard University T.H. Chan School of Public Health. This study demonstrated a statistical association between COVID-19 deaths and other respiratory diseases caused by long-term exposure to dust and PM. They analyzed 3,080 counties in the United States and concluded that if Manhattan had reduced its average exposure to PM by just one unit, or one microgram per cubic meter, over the last several years, we would have 248 fewer deaths from the coronavirus (62, 63). As a confirmation of the research of Harvard University, Cui et al. found that the risk of death for SARS patients was twice as high in polluted areas in China (64).

According to Wang's theory, when a person infected with the virus breathes, talks, sneezes, or coughs, the viruses leaving the body combine with aerosols in the air. Bioaerosols are about 1 to 5 micrometers in size and are usually retained in the air, while heavier particles fall to the ground (65). Another route of transmission can be via airborne dust. Microorganisms in particulate matter or dust can be a route for transmission of infectious diseases (66). Inhalation of fine dust particles infected with the virus and suspended in the air can carry the virus into the throat and then into the respiratory tract. When a person's immune system is weakened, the likelihood of the infection spreading through the body increases (67). In a study on a mink farm, Oreshkova et al. found viral Ribonucleic acid (RNA) in dust around the farm, which in turn spread the virus among the mink and increased the risk of infection to farm workers (68). Professor William Ristenpart from the Department of Chemical Engineering at the University of California believes that people can become infected with influenza viruses through dust, fibers, and other microscopic particles in the air. He also found that this idea may be correct for the spread of coronavirus. He also concluded that this can be true for the transmission of the coronavirus (69, 70). Recent studies have shown that more densely populated and polluted areas are more susceptible to coronavirus infection (71). It should be noted that mines, farms, roads leading to rural and suburban areas, and any unpaved roads can be the routes of virus spread. According to the United States Environmental Protection Agency (EPA) report, fugitive dust from other regions accounts for 50% of the total PM_{10} sources and 20% of the total $PM_{2.5}$ sources in the US. (72). Therefore, if pollution contributes to the coronavirus, dust particles from unpaved roads will also affect its spread and impact. A study conducted in China associated high PM rates with measles outbreaks (73). This study examines the relationship between short-term exposure to environmental particles with an aerodynamic diameter ≤2.5µm ($PM_{2.5}$) and measles incidence in China.

In a study, Godri Pollitt et al. demonstrated the possibility of aerosol transmission of coronavirus using evidence from other articles and testimony from physicians. SARS COV-2 RNA is also present in the respiratory air of patients and can be spread by airborne particles (74). Domingo et al. suggested that the coronavirus is airborne. As air pollution increases, the number of COVID-19 patients also increased. Besides, increasing concentrations of air pollutants may make the disease more severe and deadly (75). Suman et al. noted that the coronavirus can be airborne for up to 3 hours and transmitted by contact with metal surfaces for up to 48 hours (76). Also, Stephens et al. discussed the transmission of viruses and infectious diseases through various routes such as short- and long-range aerosols, direct contact, and fomites in their study (77).

A review of recent studies shows that there is a link between the outbreak of measles in the United States and the dust storm of 1930. Alexander et al. and another study pointed to the likely role of dust as a carrier of Avian Flu in the 2015 outbreaks in Iowa (78). The study examined the possibility of influenza infection from airborne particles. The results showed that many people with the flu in Iowa became ill from inhaling infected particulate matter. These particles enter the city through air currents from farms and other areas (79). A team of Italian scientists led by SIMA (Societa Italiana Medicina Ambientale), in collaboration with world-renowned universities, published a "position paper" on the increasing spread of coronavirus with a simultaneous increase in particulate matter concentrations in the Po Valley (80). Viruses and bacteria are not usually dispersed in the air in the form of free particles, but are attached to soil dust or organic aggregates in the sea (81, 82). On January 23, 2020, a restaurant in Guangzhou, China, was under surveillance. Researchers believe that there is a person who is infected but asymptomatic. Since the air conditioning causes air circulation in the room, it is likely that the people sitting at the dining table and the other two tables are infected by aerosols. This may be confirmation that the virus is transmitted by aerosols (83). It is also claimed that the humidity and temperature of the air and the presence of dust will affect the development of the COVID-19 disease. Through this, we can predict the epidemic situation in different seasons of the year and provide management plans (84). Crawford et al. concluded in their review article that the increase in air pollution and PM (poor air quality) will propagate the spread of coronavirus. The occurrence of respiratory diseases due to poor air quality and COVID-19 may cause disasters (85).

Discussion

Whether the coronavirus can be spread through construction activities that are accompanied by the production of dust, particles, and aerosols is a matter that requires further laboratory studies, but this hypothesis can be strengthened by providing sufficient evidence. For example, 59% of the total transmission of COVID-19 disease comes from the asymptomatic transmission. So, we can conclude that the only way is not limited to transmission through sneezing or coughing (86). On the other hand, the rate of disease transmission in indoor places and poorly ventilated areas is higher than in outdoors, which suggests that the transmission is not only through direct contact with the infected person (56, 87, 88). Renninger et al.'s analysis confirmed the presence of SARS-COV-2 on bulk floor dust in rooms where infected patients were present. This is considerable for the asymptomatic transmission of COVID-19 (89).The results of research by Van Doremalen et al. show that SARS-COV-2 can be transmitted through fomites and aerosols. Also, the virus can remain viable for hours infectious (90). The results of Kähler and Hain 's experiments on the protective properties of masks against infection are interesting in terms of fluid physics. They showed that a pure fabric mask is not efficient, and the fine-grain filter of the vacuum cleaner bag is similar to or better than the KN95, N95, and FFP2 half-masks (91). Patent studies of suitable masks have shown that masks that have high efficient filtration to prevent dust ingress are useful in reducing the COVID-19 pandemic (92) .This is an emphasis on the nosocomial spread and super-spreading events. Also, Li et al. found that the use of an air curtain dust-collecting system in tobacco factories can reduce the spread of SARS-COV-2 through aerosols (93). As construction workers often suffer from respiratory diseases, according to the evidence provided, their working environment may increase the risk of transmission, and infection with the coronavirus puts them at risk of death. The findings of Zhong et al. demonstrate that construction personnel information about COVID-19 is acceptable, but most of them are unaware of the asymptomatic transmission of the disease (94).

What are the concerns?

Research by Alsharef et al. investigated the impact of COVID-19 on the construction industry through a questionnaire. They concluded that the spread of the coronavirus is more likely to occur on construction sites than other industries. The staff claimed that most of the transmission of COVID-19 was from asymptomatic individuals (evidence for the hypothesis of this article) (95). The process of testing and announcing results was very slow. Non-observance of social distancing (6 feet) and incorrect use of masks, especially in humid weather, are other issues of concern to on-site personnel. Things like the stress of getting COVID-19 and the feeling of anger caused by non-compliance with health protocols by colleagues and meeting the financial needs of their family in the pandemic are the concerns of construction workers (96). Jobs such as construction workers, contractors, and subcontractors fall into the high-risk category of the COVID-19 pandemic. But migrant and seasonal workers are in a very high-risk category. Because they may have moved from high-risk areas or spread the disease to their home country. Therefore, special decision should be considered in this regard (97). With the spread of COVID-19 disease and the increase in lockdowns, the cost and time of the project will be overrun. This problem will increase the unemployment rate and cause economic losses to the project (98). Shibani concluded in his research that with the expansion of COVID-19, projects have ceased, and people and banks are reluctant to invest in construction projects. This issue has caused great losses to construction companies and has led to a shortage of workforce (99). Jamaludin et al. emphasized that the COVID-19 outbreak may continue for many years. They put forward some suggestions and solutions to restore economic conditions and carry out daily work after the closure, while controlling the risk of infection (100). Alsharef et al. also studied economic and supply issues, as well as project delays caused by COVID-19 like other studies mentioned above (95). Zheng et al. concluded in their study that although health protocols are implemented to some extent at construction sites, enhanced strategies are needed to prevent the spread of the disease (101). Unfortunately, a study by Malecka et al. showed that the rules set by the authorities regarding the observance of health protocols in the workplace are not well implemented (102). According to the latest studies on delta variant, even with vaccination, there is a possibility of getting infected with delta variant (103). It is true that the possibility of hospitalization has been reduced, and the symptoms have not worsened, but the economic losses and loss of working hours, as well as the delay of construction projects, are undeniable.

What can be done?

Arrange a meeting to raise staff awareness about the importance of observing social distance at work, the use of masks, and minimizing the number of people who use lifts during a displacement (97). Food containers, water bottles, and staff utensils should not be shared between workers. Workers should not gather in toilets and bathrooms. In addition, compulsory laws should be considered, including fines for handwashing and the use of disinfectants (104). Educate people to recognize the first symptoms of COVID-19 and report their condition to employers. The government and stakeholders should provide the necessary support for the worker's treatment (105). As mentioned above, the coronavirus can be spread through dust and fomites, so measures need to be taken to disinfect reusable equipment and machinery. Avoid the use of old gloves and making eye or mouth contact when working with a shared toolbox (97). It is also recommended to use the temperature check portal to identify suspected workers before entering the construction site (95). Measures related to the use of technology, including the use of automated machines instead of manpower, artificial intelligence (AI) automation, air circulation equipment, and aerosol removal technologies developed by ASRAHE (The American Society of Heating, Refrigerating and Air-Conditioning Engineers) are examples of preventative measures. (106-108). The use of 4IR (fourth industrial revolution technologies) to compensate for the damage caused by COVID-19 to the construction sector is an interesting topic that can be explored and considered by stakeholders (109). The paper by Denny-Smith et al.

provides suggestions for improving infrastructure to assist recovery and the role of the construction industry in creating social value for the post-COVID-19 pandemic situation (110). Simpeh and Amoah found three steps to control COVID-19 at construction sites. These include screening, delivering control of materials entering the site, and observing social distancing (111).

CONCLUSION

Respiratory problems have long plagued construction workers, especially heavy machinery operators. Dust, metal fusion vapor, toxic substances, heavy vehicle exhaust fumes, $PM_{2.5}$, PM_{10}, and inhalable particles are some of these pollutants that are abundant at construction sites. These pollutants can cause respiratory diseases, cardiovascular problems, skin irritation, and in more serious cases, even lung cancer. COVID-19 with its viral origin is in the category of infectious respiratory diseases. Due to the worldwide pandemic of new SARS-COV-2 pneumonia, construction workers with a history of respiratory diseases are at high risk. The high number of workers on the site, migrant workers, low level of knowledge, and working conditions are things that can intensify this pandemic. On the other hand, reviewing recent articles on how the SARS-COV-2 virus is spread, it can be seen that more than half of people are infected with COVID-19 from asymptomatic individuals. So it is possible that dust, vapor, and particles from construction activities can carry SARS-COV-2. In this case, a big risk threatens the employees of the construction sector. Although this issue requires further investigation, at least in order to control the epidemic and prevent the trend of prevalence from getting worse, considering this hypothesis may be quite important for the managers and stakeholders. By considering the possibilities and envisaging preventative measures, the situation can be controlled to a certain extent. The spread of delta variant, even with vaccination, is an issue that does not pose a risk of death to the workers, but the issue of construction project delays and loss of working hours cannot be ruled out.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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