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Wood Dust Exposure as a Risk Factor for Respiratory Disorders in Furniture Workers: A Systematic Review

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ABSTRACT

Wood dust is generated when machines are used to cut, shape, or smooth wood materials. One industry that has a high risk of exposure to wood is the furniture industry. Wood dust particles can enter the lungs and affect respiratory health when inhaled. The study aims to determine wood dust exposure and explain the risk factors for respiratory disorders in furniture workers. The method used was systematic review. This review process includes several stages, starting from identification using keywords, screening titles and abstracts, determining article eligibility, selection based on inclusion criteria, to data extraction. The articles analyzed in this review came from the period 2019 to 2024, with a total of seven articles reviewed. The results of the review demonstrated that workers with high exposure to wood dust exhibited a higher prevalence of respiratory diseases compared to those with lower exposure. These findings underscore the necessity for heightened awareness and adherence to the utilization of respiratory protection equipment (RPE) among workers.

Keywords : *Wood dust; Respiratory disorders; Furniture industry*

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INTRODUCTION

Occupational diseases are typically the result of work environment factors and work relationships. According to the International Labour Organization (ILO), approximately three million workers lose their lives each year due to work-related accidents and illnesses. The majority of these fatalities, amounting to 2.6 million, are caused by occupational diseases with one of the most prevalent cases being respiratory diseases (1). This means that occupational disease cause a higher moratality rate than work-related accidents.

In 2020, the number of respiratory disease cases increased to 235,254,961 cases, with workers in the industrial sector ranking first, covering 85% of the total cases, followed by the agricultural sector at 10%, and the pharmaceutical sector at 5% (2). Research conducted by Ro'In, Raharjo, & Setiani demonstrated that workers in the wood furniture industry, particularly those in the wood cutting section, are susceptible to respiratory disorders (3).

The furniture industry is responsible for the processing of basic wood materials into various ready-to-use furniture products (4). These products encompass a wide range of household items, including tables, chairs, and cabinets, which are collectively referred to as home furnishings.In Indonesia, the primary raw material utilized in furniture production is wood (5). According to data from the Indonesian Furniture and Handicraft Association (AMKRI), the furniture industry in Indonesia has the capacity to provide direct employment for approximately 500,000 individuals and indirect employment for 2.5 million individuals (6). The growth of this industry, which relies on wood raw materials and employs a significant number of workers, has the potential to generate economic benefits through increased employment opportunities and enhanced community welfare.However, it should be noted that production activities also generate emissions of air pollutants, including wood dust, which workers may be exposed to.

Wood dust is produced during the cutting, sanding and shaving of wood and can contaminate the air in the working environment. When levels exceed safe limits, this dust

has the potential to cause respiratory problems, including acute respiratory infection (ARI). Even when within acceptable limits, long-term exposure can lead to various health problems, including decreased vital lung capacity (VEP1/KVP), coughing, wheezing, chronic bronchitis, chest tightness and asthma(7).

According to the International Labour Organization (ILO), approximately three million workers lose their lives each year due to work-related accidents and illnesses. The majority of these fatalities, amounting to 2.6 million, are caused by occupational diseases (1). This means that occupational disease cause a higher moratality rate than work-related accidents. Based on the results of research conducted by Ambiya, et al in 2022 in Banda Aceh City, it proves that there is a significant relationship between the length of exposure to wood dust and respiratory complaints (8).

Furniture work carries a high risk of occupational diseases. There are several things that can make occupational diseases occur, namely age, exposure to wood dust, age, smoking habits, lazy use of PPE, and working period (length of exposure to wood dust). Wood furniture industry workers have a very high risk of experiencing wood dust accumulation in their respiratory tract (9). Dust particles that are inhaled and retained in the lung tissue can increase with regular exposure to wood dust.

A dust-filled work environment can affect worker productivity. Therefore, special attention is needed both in terms of sawmill work ability, safety, and occupational health. This study aims to determine the risk factors associated with the onset of respiratory disorders in furniture workers, especially due to wood dust exposure.

METHODS

This study uses the PRISMA (Preferred Reporting Items for Systematic Review and Meta Analysis) systematic review method obtained from scientific articles. This method promotes a critical and systematic mindset in the face of rapid technological developments in order to stay focused and not lose direction in research. In addition, a systematic review

plays a role in mapping areas of uncertainty and determining the level of relevance of a study. PRISMA improves the reliability of systematic reviews with comprehensive reporting guidelines. PRISMA provides checklists and flowcharts to ensure clear documentation. It minimizes bias and improves the reproducibility and transparency of results.

The source of data for this study came from national and international journals obtained through online sites including PubMed, Science Direct, and Google Scholar databases. The search for national journals was carried out through the Garuda Indonesia Portal with keywords entered, namely 'wood dust exposure and respiratory disorders' and 'risk factors for respiratory disorders in furniture workers' for Indonesian-language journals, while for international journals using the keywords 'exposure to wood dust and impaired respiratory disorders in furniture workers'.

The inclusion criteria in this study were: 1) Articles published in 2019-2024 2) Articles with cross sectional research types 3) Articles according to the title and abstract, and content. Exclusion criteria in this study are articles that discuss health problems other than respiratory disorders in furniture workers and wood dust exposure outside the furniture industry.

RESULTS

Based on the results of searching articles using the database, in the 2019-2024 period with the keywords “Wood Dust”, “Respiratory Disorders”, or “Furniture Workers”, 1,148 international and national articles were obtained. The articles were screened based on the suitability of the title, abstract, content and selected those that met the inclusion criteria, resulting in 8 articles that did not match the research design so that there were 15 articles that were assessed for eligibility, resulting in 8 articles that were less relevant in terms of incomplete text, inappropriate samples, and not accredited. So there are 7 articles that can be analyzed and discuss wood dust exposure and explain the risk factors for respiratory disorders in furniture workers.

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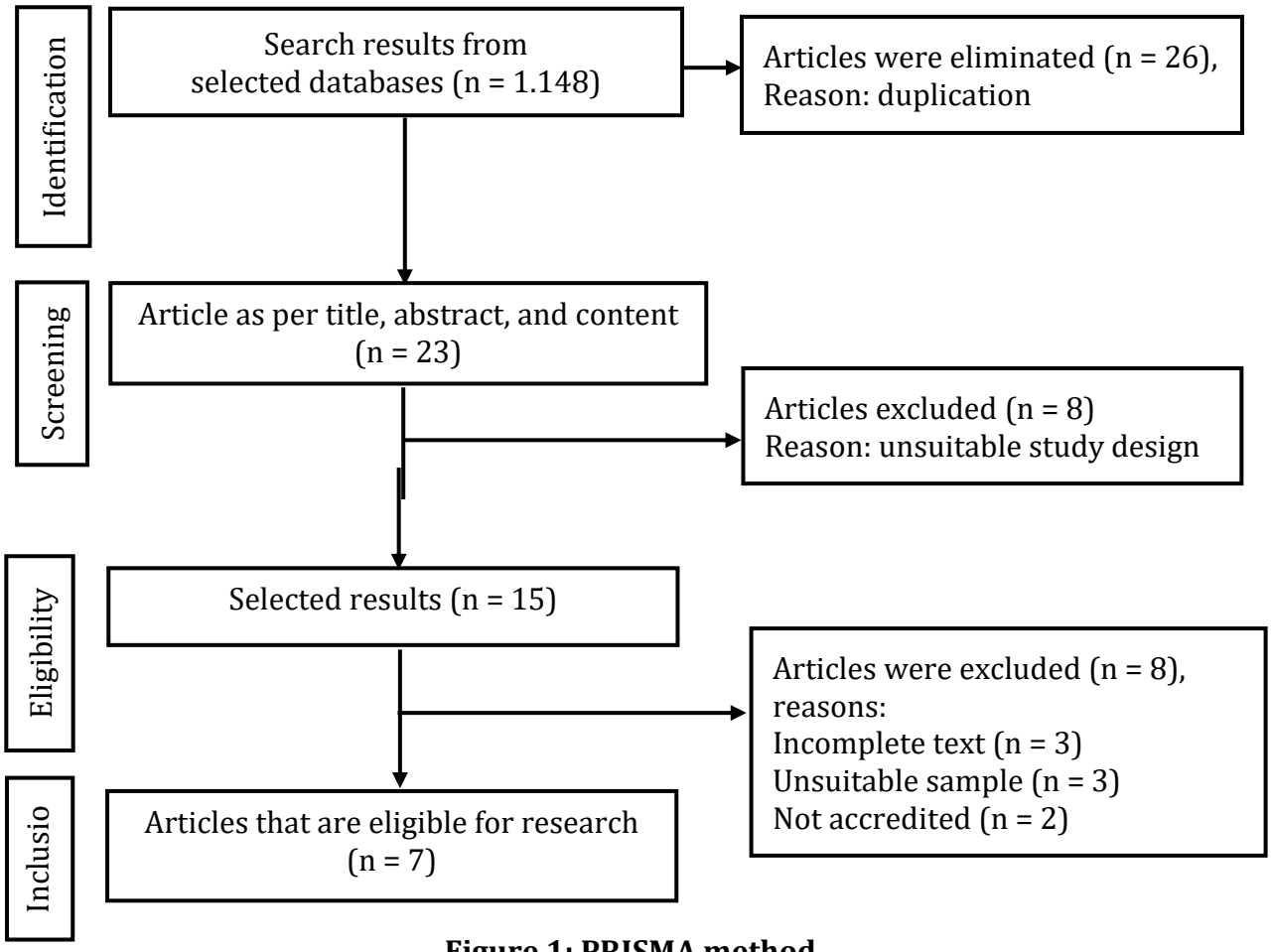

Figure 1: PRISMA method

Table 1
Extraction of Research Data

No	Publication Identity	Method	Research Objectives	Results
1	a. Title: *Prevalence of chronic respiratory symptoms and associated factors among wood workers in Bahir Dar City, Ethiopia; a comparative cross-sectional study* b. Authors: Abateneh., et al	A comparative cross-sectional study was conducted in Bahir Dar in March-April 2021 on 229 exposed and.	Assessing the prevalence of respiratory symptoms and associated factors among timber workers.	The prevalence of respiratory symptoms was higher among the exposed group than the unexposed group.

No	Publication Identity	Method	Research Objectives	Results
	c. Journal Name: BMC Pulmonary Medicine d. Year: 2024	228 unexposed workers.	.	
2	a. Title: *Occupational Exposure to Wood Dust and Prevalence of Respiratory Health Issues Among Sawmill Workers in Abeokuta Metropolis, Ogun State, Nigeria* b. Authors: Olujimi., et al c. Journal Name: Journal of Natural Science, Engineering and Technology d. Year: 2023	This study was conducted in Abeokuta, Ogun State, involving 315 sawmill workers from 11 sites and 100 non-sawmill workers as a control group.	Assessment of lung function and respiratory system among sawmill workers.	Sawmill workers in Abeokuta are more vulnerable to environmental pollution and hazards associated with wood dust; have a higher prevalence of
3	*a.* Title: *Association Between PM2,5 Wood Dust Exposure and Acute Respiratory Infection on Plywood Industry Workers in PT. Muara Kayu Sengon, Jatilawang District, Banyumas Regency* b. Authors: Ro'In, Raharjo & Setiani c. Journal Name: ICENIS d. Year: 2023	This study involved 142 female workers in 17 sites of the plywood industry PT Muara Kayu Sengon, Jatilawang, Banyumas.	Know and analyze the relationship between exposure to PM2.5 wood dust with the incidence of acute respiratory (ARI) in plywood industry workers.	There is an association between PM2.5 exposure, wood dust, length of service, use of personal protective
4	a. Title: Relationship between duration of exposure to wood dust and respiratory complaints in woodworkers in Banda Aceh City b. Author: Ambiya, et al	This study was carried out by randomly sampling 40 people working in the logging industry in Banda Aceh.	This study is to determine the relationship between the length of exposure to wood dust and respiratory	There is a significant relationship between the length of exposure to wood dust and respiratory complaints

No	Publication Identity	Method	Research Objectives	Results
	c. Journal Name: Syiah Kuala Medical Journal d. Year: 2022		complaints in wood workers.	($p<0.05$). Respondents who worked more than 5 years 88.9% had severe respiratory complaints.
5	a. Title: *The association between wood dust exposure and respiratory disorders and oxidative stress among furniture worker* b. Authors: Kargar-Shouroki., et al c. Journal Name: The Central European Journal of Medicine d. Year: 2022	This study was conducted in Yazd province, Iran, on 45 furniture workers exposed to wood dust.	Determine whether or not there is an association between respiratory parameters and oxidative stress	There was a significant positive relationship between FVC and FEV1 with SOD and TAC. The results of this study indicate that wood dust exposure significantly increases respiratory distress and confirms the relationship between lung
6	*a.* Title: *Occupational Exposure to Inhalable and Respirable Wood Dust of Pedunculate Oak (Quercus robur L.) in a Furniture Factory* b. Authors: Čavlović., et al c. Journal Name: BioResources d. Year: 2022	Methods include air sampling with personal sampling pumps, respirable and inhalable dust measurements, and data analysis to assess the risk and effectiveness of extraction systems in reducing exposure.	The determination of respirable oak dust mass levels and respiratory tract entry from ambient air was carried out by utilizing a personal sampling pump as well as two types of containment filters.	The risk of lower respiratory tract disease increases with higher exposure to respirable particles, and the OEL is an indirect measure of protection against exposure to respirable particles.
7	a. Title: *Respiratory Health Disorders among Workers in Joinery Workshops*	The study was conducted between February 1, 2019, and	Studied respiratory health disorders in workers in several	Respirable wood dust concentrations averaged 3.61±2.00 mg/m^3, causing

No	Publication Identity	Method	Research Objectives	Results
	b. Authors: Rasoul., et al c. Journal Name: Egyptian Journal of Occupational Medicine d. Year: 2021	August 31, 2020, and involved 100 woodworkers selected from 11 woodworking shops.	assessed their workplace environment	respiratory disorders. This exposure also decreased lung function.

DISCUSSION

Research on the relationship between wood dust exposure and respiratory problems provides a comprehensive picture of the health impacts of this exposure in the furniture industry. Abateneh et al. (2024) in Ethiopia, for example, conducted a comparative study to identify the prevalence of chronic respiratory symptoms among wood workers (10). The study highlighted key risk factors such as prolonged exposure to wood dust and poor working environmental conditions, which significantly affected workers' respiratory health.

Workers with long-term exposure tend to experience more frequent and more severe respiratory symptoms than those exposed for shorter periods of time (10). This study provides important insights into how uncontrolled work environments can exacerbate the risk of respiratory disorders. In addition to respiratory complaints, the present study also took into consideration other potential risk factors, including smoking habits, the use of personal protective equipment (PPE), and the characteristics of the subject's job. Meanwhile, a study by Ambiya et al. (2022) in Banda Aceh specifically evaluated the relationship between the duration of wood dust exposure and workers' respiratory complaints. The study showed that workers exposed for more than five years had a significantly higher risk of experiencing complaints such as shortness of breath, chronic cough, and fatigue than those exposed for shorter periods of time (8).

This condition is caused by exposure of the lungs to fibrotic organic dust, which can reduce the elasticity and expandability of the lungs. As a result, the alveoli face a heavy

respiratory workload, so the body has to compensate with rapid and shallow breathing. This breathing pattern can trigger alveolar hypoventilation and reduce the lungs' ability to maintain gas levels within normal limits. This decrease in lung development ability leads to a decrease in the vital capacity of the lungs, which in turn leads to respiratory complaints.

Olujimi et al. (2023) in Nigeria advanced the regional perspective through an evaluation of the prevalence of respiratory health disorders among sawmill workers, utilizing clinical examination to assess the health impact of wood dust exposure. The study showed that workers who had worked in sawmills for more than 10 years had a higher tendency to experience respiratory disorders compared to those who had worked for less than 4 years (11).

The study showed variations in the most commonly experienced respiratory symptoms, namely sneezing and runny nose, caused by exposure to wood irritants or chemicals used in the preservation of new wood. These chemicals are typically used to protect wood from pests, insects, fungi and worms. Continued exposure to these irritants has the potential to adversely affect the health of sawmill workers (12). Another study by Čavlović et al. in 2022 focused more on technical aspects, measuring inhalable and respirable wood dust exposure in a furniture factory using oak. Inhalable dust concentrations were higher than respirable dust, influenced by wood species, cutting tool speed, temperature, and environmental humidity. Hardwoods such as Quercus robur L. tend to produce finer dust particles during the machining process, particularly with high-speed tools, increasing the risk of dust inhalation into workers' respiratory tracts.

The length of exposure of workers to wood dust is also closely related to the severity of respiratory symptoms, such as shortness of breath and decreased lung vital capacity (13). Although the average dust concentration is below the OSHA-established exposure limit, negative effects on the respiratory system are reported even at lower concentrations (14). This study emphasizes that the type of wood being processed, as well as specific activities such as cutting and sanding, result in varying levels of dust exposure, indicating the

importance of the type of work and wood raw materials as major risk factors in wood dust exposure.

Shouroki et al (2022) added another dimension by finding an association between wood dust exposure and oxidative stress in furniture workers. This oxidative stress contributes to cell damage and exacerbates chronic respiratory disorders, suggesting that the impact of wood dust is not only limited to the respiratory tract but also affects the body's systemic balance (15). In this study, the average concentration of respirable dust (1.51 mg/m^3) was higher than that of nonrespirable dust (1.23 mg/m^3). This difference can be explained by the influence of machine rotation speed, temperature, environmental humidity and the type of wood used (hardwood or softwood) on dust particle size. Higher tool speeds during the machining process generate more heat, which in turn increases the amount of respirable dust compared to non-inhalable dust (15).

The measurement of wood dust exposure in a person uses a pump connected to a cassette through a plastic tube. Total dust is measured using 37 or 25 mm cellulose filters, while respirable dust is sampled using devices such as the Institute of Occupational Medicine (IOM) sampler, GSP sampler, or button sampler. Dust collected on the filter is weighed under standardized conditions, with results expressed as mg/m^3 (16).

Although the average respirable dust concentration in this study was below the occupational exposure limit set by OSHA, health effects such as upper and lower respiratory tract disorders and genotoxicity have been reported to occur even at lower wood dust concentrations of less than 0.5 mg/m^3 and 0.3 mg/m^3, respectively.

Furthermore, a study by Rasoul et al. (2021) in Egypt focusing on workers in a wood workshop, showed that exposure to wood dust can significantly reduce lung function. This is likely due to the occupational hazards recorded in the woodshop environment, such as high levels of respirable wood dust, coupled with poor ventilation and inadequate use of personal protective equipment (17). It is known that dust concentration is associated with impaired respiratory function, so studying the combined effect of dust concentration and

work duration is considered more valuable than studying the effect of each factor separately. This is due to the fact that exposure to low dust concentrations over a long period of time can have similar effects to exposure to high concentrations over a short period of time (18). Therefore, it is important to calculate the time intensity factor (TIF), which is obtained by multiplying the duration of exposure in years by the concentration of the hazardous substance. This study provides strong evidence that inadequate working conditions in woodshops directly affect workers' respiratory health.

Ro'In, Raharjo, & Setiani, (2023) added another dimension by highlighting the impact of finer PM2.5 wood dust, which was found to increase the risk of acute respiratory infections in plywood industry workers. High or low concentrations of PM2.5 wood dust in the workplace are related to the physical environmental conditions in which workers carry out their activities. If the dust concentration in the work environment is high, it is likely that the dust exposure received by workers will also increase during the production process. This emphasizes the importance of strict air quality management in the workplace (3).

In addition, workers also inhale dust from the work environment. In the cutting and sanding process, the distance between tools and workers tends to be close, coupled with the non-use of personal protective equipment (PPE) in the form of masks. Dust that is inhaled and enters the respiratory tract can accumulate in the lungs, increasing the risk of workers developing acute respiratory infections (ARI) (19).

Therefore, socialization is needed from the management of the furniture industry as well as health workers from puskesmas, hospitals, and health offices to provide education about respiratory disorders and protective procedures, such as lung protection programs for workers in dry areas with potential wind, namely by using masks that cover the nose and mouth, as well as periodic health checks in the industrial environment.

Overall, this series of studies underscores the importance of controlling wood dust exposure to protect workers' health. Some of the suggested preventive measures include setting up adequate ventilation, using personal protective equipment (PPE), regular

monitoring and training workers on wood dust hazards. With an integrated approach, the adverse effects of wood dust exposure on respiratory health can be significantly minimized, creating a safer and healthier work environment.

SIGNIFICANCE OF LONG-TERM EXPOSURE

Ambiya et al. showed that long-term exposure to wood dust was also significantly correlated with respiratory complaints. Long-term exposure to wood dust in the furniture industry has been shown to be significantly correlated with respiratory complaints. The health impacts of wood dust exposure have been classified as carcinogens for humans, meaning that long-term exposure can increase the risk of developing serious diseases, including lung cancer and chronic respiratory disorders (20).

The study by Fatah, Marchianti, & Susanto in 2023 highlighted the importance of risk control through elimination, engineering, and effective use of PPE. This study showed that the implementation of good risk control can significantly reduce the incidence of respiratory symptoms (21).

This emphasizes the importance of continuous monitoring and implementation of effective control measures to protect workers' respiratory health in the long term. In addition, regular health surveillance for workers exposed to wood dust is also important to detect and treat health problems early.

CONCLUSIONS AND RECOMMENDATIONS

Wood dust exposure has been shown to be a significant risk factor for respiratory disorders in furniture workers, such as rhinitis, cough, shortness of breath and asthma. Wood dust concentrations that exceed safe limits can reduce lung function, as shown in various studies. However, the results of these studies are influenced by limitations in methodology, population, and measurement tools. Stakeholders in the furniture industry must ensure the use of effective dust extraction systems at each stage of production,

especially during high dust activities such as sanding, assembly and cleaning, by requiring the use of respiratory protective equipment (RPE). Work areas should be cleaned using wet methods or industrial vacuum cleaners to prevent the spread of dust. In addition, ventilation and exhaust systems should be regularly checked to ensure optimum performance. A routine health surveillance program should also be implemented to detect respiratory problems early and to evaluate the effectiveness of control measures.

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