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ANALYSIS OF WOOD DUST LEVELS, NASAL MUCOCILIARY TRANSPORT RATE (NMTR) AND WORKERS' RESPIRATORY COMPLAINTS IN FURNITURE HOME INDUSTRY, SURABAYA CITY, INDONESIA

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ABSTRACT--*Background:This research showed that wood dust in furniture workplace can potentially cause disruption to the nasal mucosa or slowing Nasal Mucociliary Transport Rate (NMTR). Research Objectives:Measuring wood dust levels in workplace, measuring the Nasal Mucociliary Transport Rate (NMTR) of the exposed and unexposed groups, and analyzing respiratory complaints and the use of PPE in the exposed group. Research Method:Cross sectional design, total sample size of the population amounted to 12 respondents containg 6 exposed and 6 unexposed respondents. Measurement of wood dust levels was done with EPAM 5000. Nasal Mucociliary Transport Rate (NMTR) test was done with Saccharin Test by ENT Specialists, using saccharin tablets and methylene blue tablets. Data analysis was obtained from cross tabulation results (crosstab). Research time was March to November 2019. Research Results:From the measurement of wood dust levels in areas was exposed 100% during operation and not exceeding the TLV of 5mg/m^3, but the results got higher during the operation. The exposed group was 33.34% and the unexposed group was 8.33% in the abnormal category. The average Nasal Mucociliary Transport Rate (NMTR) of the exposed group was 11 minutes 57 seconds, while the average Nasal Mucociliary Transport Rate (NMTR) of the unexposed group was 7 minutes 11 seconds which showed the Nasal Mucociliary Transport Rate (NMTR) of the exposed group is slower than the unexposed group. Based on the cross tabulation of respiratory complaints showed that there was a relation between respiratory complaints Nasal Mucociliary Transport Rate (NMTR) status with contingency coefficient value of 0,549. Conclusions andRecommendations:The wood dust levels in the work environment of the exposed area exceeded the threshold value. The exposed group of Nasal Mucociliary Transport Rate (NMTR) was not normal or slower than the unexposed group. The exposed group that did not use PPE mask 100% of the time the Nasal Mucociliary Transport Rate (NMTR) was slow and categorized as abnormal, because it was above the threshold limit value which was more than 10 minutes 55 seconds. Suggestions for furniture workers, further*

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increase of compliance to use PPE masks when working. Whereas for furniture owners pay more attention to workers in the use of PPE namely masks. Furniture owners can provide masks at work for their workers and socialize the importance of using masks when working.

***Keywords**: Wood Dust, Nasal Mucociliary Transport Rate (NMTR), Respiratory Complaints, Furniture Workers*

I. BACKGROUND

Work environment includes physical, chemical, biological and psychosocial environment which can cause various types of occupational diseases (1). According to the ILO (*International Labor Organization*), every 15 seconds, 160 workers experience accidents due to work. Every day, 6,300 people die from work accidents or illness related to working and it is estimated that more than 2.3 million deaths per year. More than 337 million per year accidents occur to a worker resulting in many workers being absent or not working. One area of work that needs attention is disease caused by working in the wood processing industry (7).

The wood processing industry has the potential to cause contamination in the workplace air in the form of wood dust. Because about 10 to 13% of the sawed wood will form wood dust. One negative impact of the wood processing industry is the emergence of air pollution by dust that arises in the processing or the results of the industry. This wood dust will pollute the industrial area and its environment so that workers and the community around the industry can be exposed to dust either because of raw materials, intermediate materials or final products. These pollutants can affect the environment and humans (Soeripto, 2008; Suma'mur, 2009) (8) (9).

Exposure to wood dust is associated with nasal problems, such as nasal congestion, dry nose, runny nose, nosebleeds and sinusitis. As the first and main gate for breath air entry, the nose is susceptible to ambient air conditions (Bratawidjaja, 2004) (17). Wood dust is an irritant in the nasal mucosa and is a cause of nasal symptoms in wood factory workers. Irritant exposure to industrial workers can increase the incidence of work-related rhinitis (RBD). Anggraini et al found that 27.8% of industrial workers exposed to irritants in the work environment were diagnosed with RBD. (18)

The production and diffusion of dust in the woodwork industry is a function of the work organization, the presence and efficiency of ventilation systems, the skills of the individual workers and the kind of wood products that are manufactured. Wood dust is an accumulation of any wood particulate that is generated during processing or handling of wood. When this dust becomes airborne it may be inhaled by workers, leading to mucosal irritation, allergies and respiratory system cancer (Mandryk 2000; Pellegrini 2002) (30) (31). The process of sawing and sanding at a wood furniture company produces a considerable amount of dust or wood particles in the air, so the air in the environment is no longer clean. This is very influential on the nose health of people in the environment, especially the workers, considering that these workers are in the environment about 8 hours per day and at least 6 days per week, plus they generally do not wear masks. If the deposition of dust or particles is excessive and last long or continuously, it can cause interference with the nasal mucosa, ranging from mild disturbances (disruption of ciliary function) to more severe forms of damage or structural changes (mucous gland hyperplation, increased trophy cells) and truly pathological disorders (squamous cell metaplasia to carcinomas *in situ*) (Watelet *et al.*, 200 ; Irawan, 2004). (2) (3)

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In general, the first impairment that appears on the nasal mucosa due to excessive exposure to particles or dust is disruption of the cilia function or cilia due to "overwork". In here, the movement of the nasal mucosal cilia or commonly called Nasal Mucociliary Transport Rate (NMTR) will slow down, so the time needed to evacuate particles or dust from the rice limen to the koana becomes longer. If all transportation systems are stuck, the particles or dust trapped by mucous palms will penetrate the mucosa and can cause disease. In general, people who have a slow mucociliary transport are less sensitive to disease than the faster mucociliary transport (Munkholm and Mortensen, 2014; Balenger JJ, 1994) (4) (5). Research on the time of NMTR has been done a lot, especially abroad, both for people who are categorized as normal (unexposed) or exposed to particles or dust in their daily lives. The figures obtained by these researchers turned out to be different, both in normal people especially in people who are exposed. In Indonesia, research concerning the timing of NMTR on wood furniture company workers is rarely conducted. Therefore, it is necessary to know whether exposure to wood particles or dust contained in inspirational air affects the function of the cilia, especially on the speed of movement of the nose cilia of employees at wood furniture companies.

Previous research has been carried out on the NMTR , some of which are the furniture company workers exposed to wood dust obtained the results of the NMTR time in the wood furniture worker group of 17 minutes 24 seconds, compared to the NMTR time for non wood furniture workers of 10 minutes 55 seconds (Soemadi R, et al , 2009) (11). In limestone processing workers, there is a significant difference between the mean time of NMTR for limestone workers, 568.05 seconds compared to non-workers 435.2 seconds (Darmawan, et al, 2008) (6). Syahrizal (2008) in his research on the time of NMTR stated that substances attached to the surface of the wood and leather industry can slow down the time of NMTR (12). Research on the correlation between exposure to silver dust with Nasal Mulociliary Transport (NMTR) was carried out in Gede City in Yogyakarta with the results of a significant positive correlation and a very strong working time with Nasal Mucociliary Transport Rate (NMTR) on silver craft workers. (Suherman, 2013) (15). The difference in nasal mucosiliary transport (NMTR) also shows significant between smokers and nonsmokers in Medan. (Generous, 2010) (16)

II. METHODS

The variables in this research consisted of the dependent and independent variables. The dependent variable was variable that attached, which was Nasal Mucociliary Transport Rate (NMTR) of wood furniture in Surabaya City. The independent variable was variable that can affect the dependent variable, namely the wood dust levels in the work environment and the use of PPE in the exposed group.

Measurement of wood dust levels was carried out at the location of the furniture making process. The measurement of dust levels was carried out by officers using EPAM 5000. Measurement of total dust levels was done at 2 points, namely at UD. Jati Indah and UD. Rizky Resources. Measurement of Mucociliary Nose Transport (NMTR) was done with Saccharin Test by ENT Specialists, using saccharin tablets and methylene blue tablets.

Data collection techniques used questionnaire sheets for respiratory complaints and observation sheets for the use of PPE (masks), as well as the measurement of dust levels in work environment exposed to wood dust.

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This type of research was observational descriptive because researchers only observed directly and did not give specific treatment to the object under research and researchers only describe the condition of the researched objects. The design of this research was *cross sectional*, because independent variables and dependent variables were assessed simultaneously at the same time. Data analysis used cross tabulation (Crosstab) to determine the relationship of wood dust levels in the air, the use of workers' PPE with the Nasal Mucosiliary Transport Rate (NMTR) and respiratory complaints.

III. RESULTS AND DISCUSSION

Measurement of Dust Levels in Exposed Group Work Environments

The results of measurements of wood dust levels in exposed areas can be seen in the following table:

Table 1: Measurement Results of Wood Dust Levels in Exposed Areas

No.	Measurement Time	O'clock (WIB)	Dust Levels (mg / m³)	Dust TLV (mg / m³)
1	When work is in progress (Morning)	08.29	13,206	5
		09.07	12,190	5
2	When work is not in progress (Afternoon)	16.54	11,871	5
		17.32	7,141	5

Standards: *Regulation of Manpower Minister Number 05 Year 2018 concerning Occupational Safety and Health at Work Environment

Based on Table 1, it explained that the dust levels in the exposed area is quite high. According to Regulation of Manpower Minister Number 05 Year 2018 concerning Occupational Safety and Health at Work Environment, the threshold value for wood dust in work environment is 5mg/m³. The results showed the wood dust levels that were measured at work in the morning and evening exceeded the predetermined TLV. The first measurement of dust when the work took place was 13,206 mg/m³ and the second measurement was 12,190 mg/m³. While the measurement of dust when the work does not take place was 11.871 mg/m³ and the second measurement was 7.141 mg/m³.

Based on observations in areas exposed to wood dust, high wood dust due to high work intensity and cleanliness in the area exposed. The amount of wood processing waste that was not cleaned after the work is completed causes a buildup of wood waste on the floor of the exposed area and a lot of dust on the walls, a machine that when blown by the wind can scatter in the air. Wood dustgenerated from processing or handling of wood, such as cutting, sanding, or shaving. Although not all can harm health (depending on the species of wood used), wood dust can still be a threat to workers who are exposed to toxic wood dust every day (Bohadana, 2015) (20).

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Many researchs on workers in furniture manufacturing sector are evidenced that upper and lower respiratory system symptoms are increased in people exposed to wood dust. (28) Also, these symptoms are related to the exposure levels and seen frequently in cases of exposures higher than 5 mg/m³ (29).

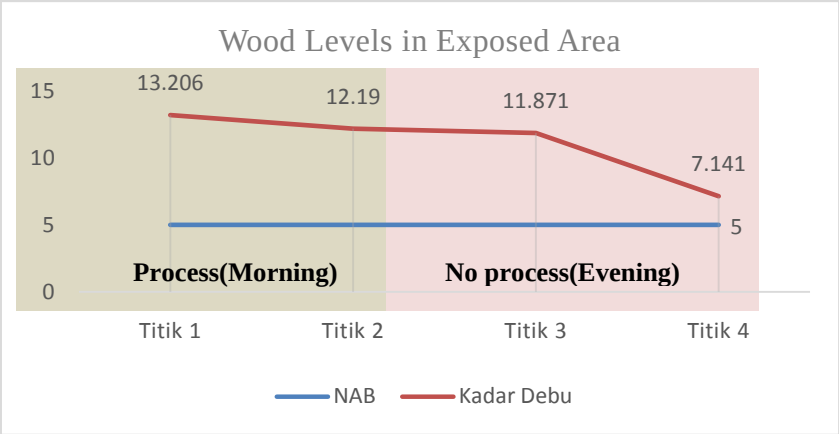

Figure 1: Wood dust levels in exposed areas

Based on the picture above, it can be seen that the dust levels during the work process takes place (morning) was greater than the wood dust levels when the work did not take place (evening).

The results of dust measurements in the morning and evening showed figures above the threshold limit value as set in the Regulation of Manpower MinisterNumber 05 Year 2018 concerning Occupational Safety and Health at Work Environment. Thus, persistent and high levels of wood dust exposure can cause nasal complaints, disruption of Nasal Mucociliary Transport Rate (NMTR) and inflammatory reactions in the nasal mucosa (19). Nasal problems, cough, phlegm, chronic bronchitis, frequent headache, eye and throat irritations were the most common symptoms reported by woodworkers. The high personal airborne dust exposure levels observed, as well as workers not wearing respirators might have contributed to the high prevalence of nasal symptoms. (Alwis, Kuruppuge U, 1998) (27).

The use of Personal Protective Equipment (PPE) in the form of a mask

Use of Personal Protective Equipment (PPE) in the form of masks based on the results of interviews with questionnaires and observations on the area of exposure. These results are presented in table 2.

Table 2: Distribution of Exposed Respondents Based on the Use of Personal Protective Equipment (PPE)

PPE usage (mask)	**Exposed Group**	**Percentage (%)**
Using	4	66.7
Not using	2	33.3
Total	6	100

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Based on Table 2, the exposed group who used Personal Protective Equipment (PPE) in the form of masks were 4 people with a percentage of 66.7% while those who did not use Personal Protective Equipment (PPE) in the form of masks were 2 people with a percentage of 33.3%. From the results of questionnaires and interviews about the use of masks in the exposed group, it was found that the exposed group that used the PPE mask did not wear masks every day when working. The reason of the exposed group to rarely wearing masks or not wearing masks was because they felt uncomfortable and had difficulty breathing when wearing masks. The type of mask used when working was a cloth mask. In the use of PPE masks when working furniture, owners do not oblige and remind the workers to wear PPE when working.

Masks usage by industrial workers in which the air in the workplace contains a lot of dust is an effort to reduce the entry of dust particles into the respiratory tract. By wearing a mask, it is hoped that workers will be protected from the possibility of respiratory problems caused by exposure to air with high dust concentrations. The habit of using a good mask and the right type of mask is a "safe" way for workers who are in a dusty work environment to protect health (Khumaidah, 2009) (13).

When workers are working with dust, they should wear protective masks to prevent respected particles to be inhaled. However, there is usually a lack of protection against inhalable dust particles in the workrooms at industrial estates in Elazıg and Diyarbakır ˇ Province, Turkey. Researchs on particle size have shown that the highest large proportion of airborne wood dust can be trapped in the nasal passage (32) (33).

Results of Nasal Mucociliary Transport Rate(NMTR) in Exposed and Unexposed Areas

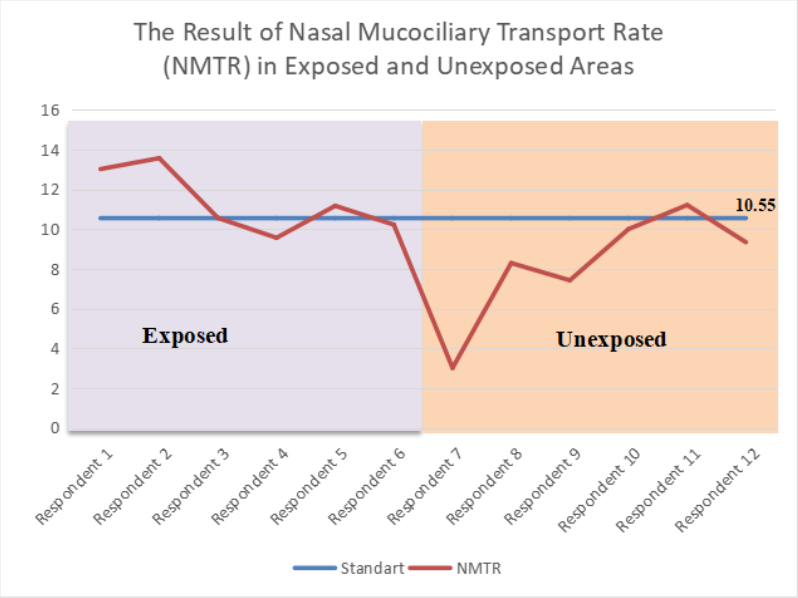

Figure 3: Test Results of Nasal Mucociliary Transport Rate(NMTR) in Exposed and Unexposed Areas

Based on Figure. 2, test results of the Nasal Mucociliary Transport Rate (NMTR) were divided into 2 groups, namely areas exposed to wood dust and areas unexposed. Each had 6 respondents in each group. Respondents who had a Nasal Mucociliary Transport Rate (NMTR) above the normal limit which more than 10

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minutes 55 seconds were classified as abnormal Nasal Mucociliary Transport Rate (NMTR), while those who were below the normal limit were classified as normal Nasal Mucociliary Transport Rate (NMTR).

Distribution of Respondents Based on Respiratory Complaints

Table 3: Distribution of Respondents Characteristics of Exposed Group and Unexposed Group Based on Respiratory Complaints

Categories of Respondents	Respiratory Impairment Complaints				Total	%
	Yes	%	No	%		
Exposed Group	5	83,33	1	16,67	6	100
Unexposed Group	0	0	6	100	6	100

Based on table 3, the results showed that the exposed group of respondents who had respiratory complaints as many as 5 people with a percentage of 83.33% and who did not have respiratory complaints as many as 1 person with a percentage of 16.67%. While the unexposed group all respondents did not have respiratory complaints with a percentage of 100%.

From the results of questionnaires and interviews of respiratory complaints that often occured in the exposed group were slimy nose and sneezing after exposed to wood dust. Milanowski J, et al (2002) showed problems in the nose, such as nasal congestion, dry nose, colds, nosebleeds and sinusitis. Wood dust is an irritant in the nasal mucosa and cause of nasal symptoms in wood factory workers. (21) A South Australian study reported that the prevalence of regular blocked nose was 51%, sneezing 41%, regular colds and excess nasal secretion 45% and eye irritation 35% among furniture workers. Hardwood users reported more nasal symptoms than users of reconstituted wood. (Pisaniello et al., 1991)(26)

Table 5:Distribution of Respondents Based on Nasal Mucociliary Transport Rate(NMTR)

Categories of Respondents	NMCT				Total	%
	Normal	%	Abnormal	%		
Exposed Group	2	33,33	4	66,67	6	100
Unexposed Group	5	83,33	1	16,67	6	100

Normal Nasal Mucociliary Transport Rate(NMTR) was ≤10 minutes 55 seconds. From the test results obtained in the exposed group who had normal Nasal Mucociliary Transport Rate(NMTR) as many as 2 people with a percentage of 33.33% while those who had abnormal Nasal Mucociliary Transport Rate(NMTR) in the

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exposed group as many as 4 people with a percentage of 66.67%. In the unexposed group who had normal Nasal Mucociliary Transport Rate(NMTR) as many as 5 people with a percentage of 83.33% while those who had abnormal Nasal Mucociliary Transport Rate(NMTR) as many as 1 person with a percentage of 16.67%. In the exposed group who had abnormal NMTR were workers who did not wear PPE masks while working and who did not routinely wear masks but also in the sawmill process. However there were 2 of the exposed group had normal NMTR who routinely wore PPE masks in sanding section. In the unexposed group 1 had abnormal NMTR which was affected by other factors, not from dust exposure.

Waguespack (1995) wrote that the conditions affecting the Nasal Mucociliary Transport Rate(NMTR) are physiological / physical factors, air pollution, smoking, the environment, congenital abnormalities, allergic rhinitis, infections, viruses / bacteria, tropical medicines, systemic medicines, preservatives and surgical procedures. (23)

Average Differences of Nasal Mucociliary Transport Rate(NMTR) of Exposed Group and Unexposed Group

Table 6: Average Nasal Mucociliary Transport Rate(NMTR) of Exposed Group and Unexposed Group

NMCT	N	Minimum	Maksimum	Mean
Exposed Group	6	09.56 (596 seconds)	13.57 (837 seconds)	11.57 (717 seconds)
Unexposed Group	6	03.01 (181 seconds)	11.21 (681 seconds)	7.11 (431 seconds)

Table 6. showed that the average of the Nasal Mucociliary Transport Rate(NMTR) of the exposed group was 11 minutes 57 seconds (717 seconds). The minimum value of Nasal Mucociliary Transport Rate(NMTR) of the exposed group was 9 minutes 56 seconds (596 seconds) and the maximum value was 13 minutes 57 seconds (837 seconds). Whereas the average Nasal Mucociliary Transport Rate(NMTR) of the unexposed group was 7 minutes 11 seconds (431 seconds). The minimum value of Nasal Mucociliary Transport Rate(NMTR) of the unexposed group was 3 minutes 1 second (181 seconds) and the maximum value was 11 minutes 21 seconds (681 seconds). The Nasal Mucociliary Transport Rate(NMTR) of exposed group was slower than the unexposed group. Syahrizal (2008) in his research on the time of NMTR stated that substances attached to the surface of the wood and leather industry can slow down the Nasal Mucociliary Transport Rate(NMTR). (12)

There are several variables that affect the speed of the Nasal Mucociliary Transport Rate(NMTR), one of them is the wood dust levels in the environment of exposed group. The environment affects the speed of the Nasal Mucociliary Transport Rate(NMTR) such as dust or irritants in the air that can be inhaled and disrupt the respiratory tract. Previous research has been carried out on the NMCT time, some of them are on the furniture company workers exposed to wood dust obtained the results of the NMTR on the wood furniture workers group of 17 minutes 24 seconds compared to the NMTR on non wood furniture workers of 10 minutes 55 seconds (Soemadi R, Samihardja Y , Haryati R, 2009). (11)

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Cross Tabulation of Respiratory Complaints and Nasal Mucociliary Transport Rate(NMTR)

Table 7: Cross Tabulation of Differences of Nasal Mucociliary Transport Rate(NMTR) of Exposed and Unexposed Groups Based on Respiratory Complaints

Variables	NMTR			
	Normal		Abnormal	
	N	%	N	%
Respiratory Complaints				
Have	1	20%	4	80%
Do Not Have	6	85,7%	1	14,3%

Table 7 showed that respondent who experienced respiratory complaints and had normal NMTR was 1 respondent with a percentage of 20% while those who had normal NMTR were 80%. Respondents who did not experience respiratory complaints who had normal NMTR were 6 respondents with a percentage of 85.7% while that who had abnormal NMTR was 1 respondent with a percentage of 14.3%. Respondents who had respiratory complaints and had normal NMTR were from the exposed group who routinely wore masks and had colds that were not necessarily affected by wood dust. There were 4 people in the exposed group who had respiratory complaints and abnormal NMTR due to the use of PPE masks that was not appropriate and routine. There were 6 respondents who did not have respiratory complaints and had a normal NMTR consisting of 1 person in exposed group and 5 people in unexposed group. 1 person in the unexposed group did not experience respiratory complaints but had an abnormal NMTR because of other factors that were affected by the nasal structure and anatomy.

Waguespack (1995) wrote that the conditions affecting the Nasal Mucociliary Transport Rate(NMTR) are physiological / physical factors, air pollution, smoking, the environment, congenital abnormalities, allergic rhinitis, infections, viruses / bacteria, tropical medicines, systemic medicines, preservatives and surgical procedures. (23) Nasal structural and anatomic abnormalities result in ciliary activity being disturbed and even stopped when the facing mucosal surfaces get closer or meet one another. Septal deviation, bullous konka or other nasal structural abnormalities can disrupt mucociliary transport (Openstax Collage, 2013). (24)

The relationship between respiratory complaints variable and the Nasal Mucociliary Transport Rate (NMTR) variable in the exposed and unexposed group with a coefficient contingency value of 0.549, which meant the

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strength level of the relationship between these variables was included in the strong category. A mucociliary transportation system is a system that works actively and simultaneously depending on the movement of cilia to push mucus lumps and foreign objects that are trapped in when breathing air through the transportation system in the respiratory tract. NMTR will slow down if there is a disruption in the respiratory tract. (Punagi and Ahmad, 2014) (25)

IV. CONCLUSION AND RECOMMENDATIONS

Wood dust levels in the work environment in the exposed area exceeded the TLV that has been stated in the regulation. Dust levels during work were higher than when the work did not take place. The exposed group that did not use PPE mask 100% of the Nasal Mucociliary Transport Rate(NMTR) was slow as categorized abnormal, because it was above the normal limit which more than 10 minutes 55 seconds. Group exposed to wood dust had more abnormal Nasal Mucociliary Transport Rate or slower than unexposed group. And there was difference NMTR on exposed and unexposed groups, NMTR of group exposed to wood dust was slower than NMTR of unexposed group. The use of PPE affected the Nasal Mucociliary Transport Rate(NMTR) of workers. Most exposed groups had respiratory complaints.

Recommendations for furniture workers, increase further compliance to use PPE masks when working. Whereas for furniture owners pay more attention to workers in the use of PPE namely masks. Furniture owners can provide masks at work for their workers and socialize the importance of using masks when working.

REFERENCES

1. Muryani S. 2000. Limestone Exposure and Visual Impairments of Workers on Limestone Burning Industry Sleman Regency. Master Thesis. Yogyakarta: Post Graduate Program Universitas Gadjah Mada; 65
2. Watelet, J.B., Bachert, C., Gevaert P., and Cauwenberge P.V. 2002.*Wound Healing of The Nasal and Paranasal Mucosa*; A Review, *Am J Rhinol*16: 77– 84.
3. Irawan P., 2004, Effects of Rhinosinusitis to Nasal Mucociliary Transport Rate Time, Science of Ear Nose Throat Diseases Faculty of Medicine Universitas Indonesia, Jakarta.
4. Ballenger JJ. 1994. Nasal dan Paranasal Sinuses, Clinical Application of Nasal and Paranasal Sinuses Anatomy and Physiology.In: Ear Nose Throat Diseases,Head and Neck 1st Edition: 18-25
5. Munkholm M, Mortensen J. 2014. *Mucociliary clearence: Pathophisiological aspects*. Department of Clinical Physiology, Nuclear Medicine and PET, Rigshospitalet, Copenhagen University Hospital, Copenhagen, Denmark. Clin Physiol Funct Imaging
6. Darmawan Anton Budhi, Aprilia Rizki, Santosa Qodri.2008. Speed Differences of Nasal Mucociliary Transport Rate Time of Limestone Processing Workers Compared to Non Workers [Online]. Cited 19Oktober 2018. Available from : http://www.perhati.org/wp-content/uploads/2011/11
7. ILO, (2005)*Deadly Dust*. China LabourBulletine.
8. Soeripto,. 2008. Industrial Hygiene. Faculty of Medicine Universitas Indonesia. Jakarta
9. Suma'mur,. 2009. Company HygieneandOccupational Health (Hiperkes). SagungSeto. Jakarta.
10. Regulation of Manpower and Transmigration Minister Number Per.13/Men/X/2011. Threshold Limit Value of Physical and Chemical Factors in Workplace. 2011. [Online]. Cited 19 Oktober 2018.Available at: betterwork.org/in-labourguide/wp-content/.../PERMENA.pdf.

DOI: 10.37200/IJPR/V24I4/PR201091
Received: 02 Oct 2019 | Revised: 30 Sep 2019 | Accepted: 15 Jan 2020

11. SoemadiRochmat, SamihardjaYuslam, HaryatiRiece. 2009.Relationship of Wood Dust Exposure to Nasal Mucociliary Transport Rate(NMTR) Time on Furniture Company Workers CV. Citra JeparaFurniture, Semarang. Medical Science, Vol. 1, No.1. [Online]. Cited 7 Oktober 2018. Available from: http://www.sainsmedika.fkunissula.ac.id/index.php/sainsmedika/article/viewFile/32/17
12. Syahrizal. 2008. Comparation of Nasal Mucociliary Transport Rate Time on Chronic Rhinosinusitis Patients Before and After Functional Endoscopy Sinus Surgery Conducted. Master Thesis. Medan: ENT Specialist Doctor Academic Program FK USU.
13. Khumaidah. 2009. Analysis of Factors Related to Pulmonary Function Impairments on Furniture Workers PT Kota JatiFurnindoSuwawal Village Milonggo District Jepara Regency. Master Thesis of Environmental Health Magister, Post Graduate Program, UniversitasDiponegoro Semarang.
14. Zein DF, Bahrudin M, Setiawan I. Differences of Nasal Mucociliary Transport Rate Time on Leather Tanning Industry Workers and Non Workers. Faculty of Medicine Universitas Muhammadiyah Malang; 2015. [Online]. Cited 19 Oktober 2018. Available at: http://ejournal.umm.ac.id/index.php/sainmed/article/download/4196/4559
15. Dermawan R. 2010. Perbedaan Waktu Mukosiliar Hidung pada Perokok dan Bukan Perokok. Program Pendidikan Dokter Spesialis Bidang Ilmu Kesehatan Telinga Hidung Tenggorok Bedah Kepala Leher Fakultas Kedokteran universitas Sumatra Utara. Medan
16. Suherman. 2013. Correlation between Work Period and Nasal Mucociliary Transport Rate Time on Silver Craft Workers in Production Section Kota Gede Yogyakarta. S2 Ked.Klinik/MS-PPDS UGM Yogyakarta Universitas Gadjah Mada
17. Bratawidjaja, Karnen. 2004. Allergy and Immunology on Occupational Diseases. Mirror of Medicine World, pp. 8-9.
18. Anggraini D, Wardani RS, Irawati N, Mansyur M, Dharmaningsih R, Wang D-Y.2014. *Diagnosis of occupational rhinitis to dust and gasses using peak nasal inspiratory flow*. Oto Rhino Laryngologica Indonesiana;44(2):104-10.
19. Zhao YA, Shusterman D. 2012. *Occupational rhinitis and other work-related upper respiratory tract conditions*. Clin Chest Med,33:637-47.
20. Bohadana, A.B, et al. 2015. *Symptoms Airway Responsiveness and Exposure to Dust in Beech and Oak Wood Workers.* Occup Environ Med Journal,57:268-273.
21. Milanowski J, Góra A, Skorska C, Krysińska TE, Mackiewicz B, Sitkowska J, et al. 2002.*Workrelated symptoms among furniture factory workers in Lublin region (Eastern Poland).* Ann Agric Environ Med;9(1):99-103.
22. Deborah S, Prathibha KM. 2014.*Measurement of Nasal Mucociliary Clearance*. Clinical Research in Pulmonology ;2(2)(1019):1-4
23. Wguespack R. 1995. *Mucociliary Clearance patterns following Endoscopic Sinus Surgery*. Laryngoscope (supplement) ;105:1-40
24. OpenStax College.2013. *The William and Flora Hewlett Foundation, Bill & Melinda Gates Foundation and The Maxfield Foundation Anatomy & Physiology*, Rice University, Texas.
25. Punagi AQ, Ahmad A. 2014. Local Immunity System on Sinonasal Mucus, Department of Health Sciences, Ear Nose Throat (ENT), Head and Neck Surgery. Faculty of Medicine UniversitasHasanuddin/RSUP Dr. Wahidin Sudirohusodo, Makassar. Review article. Wadi Husada Medical and Health Journal. Vol.1 No.3.
26. Pisaniello DL, Connell KE, Muriale L .1991. Wood dust exposure during furniture manufacture - results From an Australian survey and considerations for threshold limit value development. *Am. Ind. Hyg. Assoc. J.* 52(11): 485-492.
27. Alwis, Kuruppuge U.1998. Occupational Exposure Wood Dust. Department of Public health And Community Medicine Faculty of Medicine The University of Sydney New South Wales. Australia[Internet]. Available from::https://www.researchgate.net/publication/277245873
28. Schlünssen V, Schaumburg I, Andersen NT, Sigsgaard T, Pedersen OF.2002. *Nasal Patency is Related to Dust Exposure in Woodworkers*. Occup Environ Med ;59:23–9.
29. Hursthouse A, Allen F, Rowley L, Smith F. 2004. *A Pilot Study of Personnel Exposure to Respirable and Inhalable Dust During the Sanding and Sawing of Medium Density Fibreboard (MDF) and Soft Wood*. Int J Environ Health Res ;14(4):323–6.
30. Mandryk J., Alwis K.U., Hocking A.D.2000. Effects of personal exposures on pulmonary function and work-related symptoms among sawmill workers. Journal of Occupational Medicine - Elsevier Science Ltd., 44(4), 281-289.
31. Pellegrini A., 2002. Esposizioneprofessionale a polveri di legno duro: aspettitecnico-scientifici e normativi. GiornaledegliIgienistiIndustriali, 27(2), 123-133.
32. W. C. Hinds. 1998. “Basis for particle size-selective sampling for wood dust,” *Applied Industrial Hygiene*, vol. 3, no. 3, pp. 67– 72.

DOI: 10.37200/IJPR/V24I4/PR201091
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33. D. L. Pisaniello, K. E. Connell, and L. Muriale.1991. "Wood dust exposure during furniture manufacture—results from an Australian survey and considerations for threshold limit value development," *American Industrial Hygiene Association Journal*, vol. 52, no. 11, pp. 485–492.
34. Dostbilt Z,Cahit P,Ismail O,et al**.** 2011.Evaluation of Nasal Mucociliary Transport Rate Rate byTc-Macroaggregated Albumin Rhinoscintigraphy in Woodworkers Hindawi Publishing Corporation International Journal of Molecular Imaging Volume 2011, Article ID 620482, 4 pages[Internet]. Available from:https://www.researchgate.net/publication/51536190
35. K, m. S. K., alias, . M. & r., . S. K. (2018) a review on novel uses of vitamin e. Journal of Critical Reviews, 5 (2), 10-14. doi:10.22159/jcr.2018v5i2.24282
36. Lachiusa, I.C. The transformation of Ashtanga Yoga: Implicit memory, dreams, and consciousness for survivors of complex trauma (2016) NeuroQuantology, 14 (2), pp. 255-271.
37. Reddy, J.S.K. Could 'biophoton emission' be the reason for mechanical malfunctioning at the moment of death? (2016) NeuroQuantology, 14 (4), pp. 806-809.

DOI: 10.37200/IJPR/V24I4/PR201091
Received: 02 Oct 2019 | Revised: 30 Sep 2019 | Accepted: 15 Jan 2020