

ORIGINAL ARTICLE

Study of Lung Function Disorders of Headstone and Stone Mortar Crafters and Factors That Affect Them

Rizky Maharja¹, Helmy Gani², Riadnin Maharja³, Muhammad Azrul Syamsul², Ade Wira Lisrianti Latief², Arni Juliani², M.Anas², Sri Novianti Bahar²

¹ Faculty of Health Sciences, Universitas Sulawesi Barat, Majene, West Sulawesi, Indonesia, 91412

² Department of Industrial Hygiene, Occupational Health and Safety, Sekolah Tinggi Ilmu Kesehatan Makassar, Makassar, South Sulawesi, Indonesia, 90231

³ Youth Entrepreneurship and Employment Support Service Program, Makassar, Indonesia

ABSTRACT

Introduction: Dust is one of the chemical substances that cause occupational disease, especially among stone crafters. Its deposition for a long period can lead to various health problems, hence, there is a need for early detection. Therefore, this study aims to assess the occurrence of lung function disorder in headstone and stone mortar crafters. **Methods:** A cross-sectional design was used and the sample population consists of all headstone and stone mortar crafters in Allakuang Village, Sidrap Regency, Indonesia. They were selected using a purposive sampling method, and 33 out of 148 people met the criteria. Subsequently, their lung function was measured once using spirometry as well as FVC and FEV1 parameters. The data obtained were then analyzed using Chi-Square. **Results:** 18 of 33 respondents with lung function disorders. They had a long tenure, a normal working time, bad exercise habits, as well as a normal and overweight nutritional status based on their BMI category. The statistical test results showed that tenure, working time, and exercise habits had an effect on the disease condition with $p=0.000$. Meanwhile, other factors, such as age and nutritional status had no effect with p -values of 0.981 and 0.14, respectively. **Conclusion:** Based on the results, the majority of headstone and stone mortar crafters have lung function disorders, and the influential factors include tenure, working time, and exercise habits.

Malaysian Journal of Medicine and Health Sciences (2023) 19(6):208-214. doi:10.47836/mjmhs.19.6.28

Keywords: Chemical hazard, Dust, Lung function, Occupational disease, Occupational health

Corresponding Author:

Rizky Maharja, PhD

Email: rizkymaharja@unsulbar.ac.id

Tel: +62 82331895359

INTRODUCTION

Occupational diseases are conditions or disorders caused by work activities or exposure to the work environment (1). The International Labor Organization (ILO) (2) stated that these diseases have a mortality rate of approximately 2.4 million per year. These diseases are also caused by several chemical compounds in nature which are often produced during the work process, and are potentially inhaled by workers, such as dust (3). Furthermore, its inhalation causes a buildup of particles in the respiratory system, which affects the airways. This further leads to various conditions, such as irritation of the respiratory tract, increased production of mucus, narrowing of the airways, loss of mucus membranes and cell layers as well as difficulty in breathing.

Based on the report issued by The Institute for

Occupational Safety and Health (NIOSH) (4) published by the Center for Disease Control (CDC), approximately 92,000 workers died in the US due to respiratory tract diseases. Furthermore, the World Health Organization (WHO) (5) stated that obstructive pulmonary disease is the fifth leading cause of death and is expected to rise to the fourth position by 2030. Health and Safety Executive (6) stated that thousands of workers die from work-related lung diseases every year by breathing in certain dusts, gases, silicosis, fumes, and vapours. A previous study in home industry of produces cast aluminum also showed that 10 out of 36 workers experienced lung function disorders (7). This is in line with Pramesti et. al. (8) that 92.86% of employees had similar conditions, which were caused by dust.

Based on the results of The Surveillance of Work and Occupational Respiratory Disease (SWORD) in the UK, 3,300 cases of occupational pulmonary diseases were found among workers in large, small, and home industries. Employees in the home sectors, such as the stone industry are also susceptible to these conditions when proper work procedures are not followed (9,10).

This is consistent with Pratama and Ratna (11) that stonemasons are at risk of developing lung function disorders.

One of the most important stone crafts in South Sulawesi is the headstone and stone mortar (*cobek*), which are produced with a grinding machine by craftsmen in Allakuang Village, Sidrap Regency, South Sulawesi, Indonesia. The process often generates a large amount of dust that can potentially be inhaled through the nose and mouth (12), thereby causing a buildup in the lungs. Based on the preliminary observation, stone crafters often develop respiratory disorders, such as coughing, shortness of breath, and phlegm buildup.

Deposition of dust on the head or in the lungs has local or systemic effects on the body (13). Exposure for a long period can cause various diseases, hence, early detection is needed as a solution to this problem. It is also necessary to conduct a study on lung function disorders among stone crafters to develop a proper program to mitigate the severity as well as prevent the disease in the future. Therefore, this study aims to assess the occurrence of lung function disorders and factors that affect them in headstone and stone mortar crafters.

MATERIALS AND METHODS

This is a quantitative study with a cross-sectional design, which was conducted from March to November 2021. The sample population consist of all headstone and stone mortar crafters in Allakuang Village, Sidrap Regency, South Sulawesi, Indonesia. They were selected using the purposive sampling method based on the following criteria: primarily working as a headstone or stone mortar crafter, tenure of >1 year, not suffering or having a history of respiratory tract diseases, such as bronchitis, pneumonia, pulmonary tuberculosis (TB), asthma, or allergy, not smoking, and willing to be a study respondent. Based on the predetermined criteria, 33 out of 148 samples were selected. Some of the crafters met the criteria but refused to participate because of the COVID-19 pandemic. Although gender was not included as a criterion, all the participants were men. The age range of respondent was 17-65 years old. The age classification based on the Ministry of Health of Republic Indonesia on 2009 . The authors use the own created questionnaire to obtain background information, included the criteria of sample selecting.

Subsequently, lung function was measured once using spirometer (Brand Minota, Type AS-507), and the FVC and FEV1 parameters were assessed. Three pulmonary function parameters were recorded as forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and the ratio of FEV1/FVC. The values were taken as percentage predicted for FEV1 and FVC based on the American Thoracis Society (ATS) spirometry guidelines of 2005

The quality control for the spirometer performed by Occupational Safety and Health Laboratory of Universitas Islam Negeri Alauddin Makassar. First, authors sorted the respondents based on the criteria, then measured the respondents once. In this case, authors used the disposable mouth-pieces to avoid contamination. All workers were sitting in a comfortable position during the measurement. Nose clips were used to avoid any leakage from the nose. Self-demonstration was provided on how to exhale air forcefully during the procedure after taking a deep breath.

The data obtained were then analyzed using Statistical Package for Social Science (SPSS) version 25 (Chi-Square). This study has obtained an ethical clearance by the Ethical Committee of the Faculty of Health Science, Universitas Sulawesi Barat under the following registration number 002b/UN55.4/KOM.ETIK/2021.

RESULTS

Based on the measurement results on headstone and stone mortar crafters, the majority of them experienced lung function disorders, as shown in tables. Based on the Table I, most of the respondent are adults (26-45 years old), elementary school graduates, and not smoking, also all of the crafters are male. Furthermore, based on Table II, most of the respondents had lung function disorders (54.5%) with the mean of 71.542, median of 74.1, and standard deviation of 19.6913.

Most of the participants with a long exposure period experienced the disease, as shown in Table III. Based on the data, the samples were classified into 2 groups, namely long tenure of ≥5 years and short tenure of <5 years (14). Furthermore, 17 of 20 have long tenure experienced the lung function disorders. According to the statistic test, a p-value of 0.000 was obtained, indicating that tenure is an influential factor for lung function disorder among crafters.

Table I: Respondent Characteristics

Characteristics	n	%
Age		
Young 17-25 years old)	4	12.1
Mature (26-45 years old)	20	60.6
Old (46-65 years old)	9	27.3
Level of Education		
Elementary school	16	48.5
Junior High School	7	21.2
Senior High School	10	30.3
Smoking Status		
Yes	0	0
No	33	100
Gender		
Male	33	100

Table II: The value of FEV₁/FVC measurement on headstone and stone mortar crafters

Lung Function Disorders	n	%	Mean	Median	Standard Deviation	Interquartile Range (IQR)
Yes (FEV ₁ /FVC ≤75%)	18	54.5	71.542	74.1	19.6913	32.19
No (FEV ₁ /FVC >75%)	15	45.5				

Table III: The factors that affect lung function disorders in headstone and stone mortar crafters

Variable	Category	Lung Function Disorders		p-value
		Yes n (%)	No n (%)	
Tenure	Long (≥5 years)	17 (51.5)	3 (9.1)	0.000
	Short (<5 years)	1 (3.0)	12 (36.4)	
Working Time	Normal (≤ 8 hours/day)	11 (33.3)	0 (0)	0.000
	Abnormal (> 8 hours/day)	7 (21.2)	15 (45.5)	
Age	Young (17-25 years old)	2 (6.1)	9 (33.3)	0.981
	Adult (26-45 years old)	11 (37.3)	9 (33.3)	
	Old (46-65 years old)	5 (15.2)	4 (12.1)	
Exercise Habit	Good (at least once exercise a week)	3 (9.1)	12 (36.4)	0.000
	Poor (no exercise in a week)	15 (45.5)	3 (9.1)	
Nutritional Status	Underweight (BMI <18.5)	1 (3.0)	2 (6.1)	0.140
	Normal (BMI 18.5-24.9)	5 (15.2)	11 (33.3)	
	Overweight (BMI 25-29.9)	11 (33.3)	2 (6.1)	
	Obese (BMI ≥30)	1 (3.0)	0 (0)	

Meanwhile, the majority of the participants with a normal working time had no lung function disorders. According to the Republic of Indonesia Government and United States Department of Labor, the regular working duration is 8 days per week as stated by (15,16). Among the 22 crafters with a normal working time, 7 experienced the condition, while the remaining 15 did not experience the condition. In addition, 11 of them with an abnormal duration had lung function disorders. From the statistical test, a p-value of 0.000 was obtained, which indicates that tenure is an influential factor in the disease.

The results showed that most of the adult (26-45 years old) participants had lung function disorders, where 2 out of 4 youngsters, 11 of 20 adults as well as 5 of 9 aged crafters were affected. In this case, the age classification is based on the Ministry of Health of the Republic of Indonesia on 2009(17). Based on the statistical test, a p-value of 0.981 was obtained, indicating that the nutritional status is not an influential factor among headstone and stone mortar crafters.

The results also revealed that the majority of crafters with bad exercise habits developed lung function disorders. Bull et.al. (18) stated that the minimum recommendation of physical activity for children and adolescents aged 5-17 years old is 60 minutes/day, while the recommendation for adults at the age range of 18-64 years old is 75-150 minutes/week. Furthermore, 3

of 15 participants with good habits as well as 15 of 18 others in the bad habits category were affected by the disease. From the statistic test, a p-value of 0.000 was obtained, indicating that exercise habits is an influential factor among crafters.

The majority of samples with normal and overweight nutritional status suffered from lung function disorders. According to WHO (19), BMI was categorized into four classes. In this case, 1 of 3 is underweight, 5 of 16 are normal, and 11 of 13 participants had overweight nutritional statuses, respectively, all experienced the disease along with one crafter with obesity. Based on the statistic test, a p-value of 0.14 was obtained, nutritional status had no effect on lung function disorder among the workers.

DISCUSSION

Based on the results of the examination using spirometry with FEV₁/FCV parameters, most of the headstone and stone mortar crafters had lung function disorders. Several respondents also experienced complaints, such as coughing, fever, shortness of breath, chest pain, and phlegm discharge in the morning. The results showed that crafters working in a dusty environment are prone to diseases related to respiratory or pulmonary disorders because granite is one of the raw materials they use for the production. A previous study on marble stone

workers in Myanmar revealed that these conditions have led to the occurrence of similar diseases (20). This study also found that workers in different workplace (cobblestone paving workers, kaolin, gold mine, quarry, stone cutting) were exposed to higher levels of dust (21,22)

Furthermore, most of the affected headstone and stone mortar crafters in Allakuang Village worked in an arid locality, where the soil is prone to lifting due to the dry condition (23). Based on the field observation, the intensity of dust in these areas was significantly higher than in others, hence, they must be supported with objective measurement. Airborne dust increases the risk of exposure and respiratory diseases, and this is in line with Abidin et al. (7) exposures below the NAB level can still cause lung function disorders.

WHO (13) data showed that dust with a size of 0.1-5 or 10 microns are very hazardous to the respiratory tract. Furthermore, particles of 5-10 microns are obstructed by the upper respiratory tract, 3-5 microns are kept in the middle of the airway, while 1-3 microns can freely enter the lung tissue (24). However, in this study, authors did not measure the size of dust due to existing dust mobilization equipment.

The occurrence of lung function disorder is influenced by various factors, such as individual proneness as well as the amount of exposure to the body. Ardam (25) revealed that there is a strong positive relationship between the intensity of inhalation and pulmonary diseases, and this is consistent with the results of several studies, such as Armaeni dan Widajati (26), and Wahyuni et al. (27). However, Wulansari (28) obtained a different result, where there was no association.

Several factors affect the occurrence of lung function disorders among headstone and stone mortar crafters, such as tenure, working time, and exercise habits, as shown in Table 3. People with a tenure of >5 years as well as longer working hours are more exposed to chemicals substances, which can lead to disorders and dust buildup in the lung tissue (29). Suma'mur (14) revealed that the longer a worker stays in a dusty environment, the more severe the deposition that occurs. Continuous exposure to chemicals, such as dust in the workplace, even at a low dose is still detrimental to the body (30).

This study's results are in line with Amerta and Wirawan (31) that there is a significant relationship between tenure and lung function disorders. Similar results were also obtained by Juno (32), where workers with a working duration of >4 years experienced the condition. However, the results are inconsistent with Sinaga (33), which reported the absence of an association. This was assumed to be caused by the difference in tenure categorization, where Sinaga used >7 years and ≤7 years.

In terms of duration, the majority of the crafters work for <8 hours a day, which is normal. However, it can still cause daily dust accumulation, which increases the risk of lung function disorders. Sari et al. (34) revealed that working time had an effect on lung function disorders in ceramic workers in Medan. Similar results were also obtained by Kabir et al. (35) among stone workers in Bangladesh where they experienced the condition due to stone dust particulates.

The particles can mix with grinding dust from other sources within the same location as several crafters work in the same location. Headstone and stone mortar crafters with lung function disorders have a long working time, which increases the accumulation as well as the risk of clogging. Abidin et al. (7), stated the longer the duration of exposure, the higher the damage to the respiratory tract. This condition is exacerbated by the workplace condition. Although crafters are exposed to dust from their working place daily, the rate of Personal Protective Equipment (PPE) non-compliance is still very high. Most of the workers often put off their masks due to breathing difficulty, which inevitably leads to inhalation of harmful particles.

However, several crafters make efforts to mitigate the risk of lung function disorders by using running water during work as well as wearing moistened PPE. Moisturized dust has a heavier overall mass or weight, which causes clumping, and quick deposition on the ground, thereby preventing airborne particles. Farhadloo et al. (36) revealed that the oldest method for controlling dust is the application of water, which increases its weight and limits the movement in air. This method can be used to reduce the amount of particles inhaled by the crafters.

This study's results are in line with Apsari et al. (37) that working time has an effect on lung function disorder, where crafters with a longer duration are at higher risk of experiencing the condition. Similar results were obtained by Amerta and Wirawan (9), where the risk was higher for workers with a duration of ≤8 hours, Nabuasa et al. (38) stated that the possibility of decreased lung function is greater can be seen by the longer a worker spends working in the dusty area, the more exposure to dust they receive .

In terms of exercise habits, the majority of the crafters were in the poor category. This indirectly increases their susceptibility due to the effect of the factor on lung capacity. Several studies revealed that there is a positive correlation between the level of exercise and lung function (39). Bagus et al. (40), revealed that the human body, especially the muscles, requires a regular and stable supply of energy and fuel during physical activities. Therefore, oxygen is needed as a fuel for energy production, and to meet this need, the body must respond with a compensatory mechanism, namely increasing the frequency of respiration. This also

increases the efficiency of ventilation, which raises the vital capacity of the lung.

The results showed that several crafters had good exercise habits, such as playing badminton, football, takraw, volleyball, and jogging during their free time after work or during an off-day, namely Fridays. Physical activities, such as jogging, also help to improve the respiration system. Running during a futsal or other sports leads to the contraction of the diaphragm, which is the main muscle of respiration below the base of the lungs (41). The result also showed that lung vital capacity is closely associated with exercise because a good condition reduces the rate of tiredness. However, when the organ is contaminated with toxic substances, this causes a decrease in its function and capacity (42). This finding is in line with Fithri's (43) study that exercise habits have a positive effect on lung function disorders.

CONCLUSION

Based on the results, the majority of headstone and stone mortar crafters have lung function disorders, and the influential factors include tenure, working time, and exercise habits. According to the Hierarchy of Control, the situation can be managed with engineering control, such as the use of a guard on the grinding machine to prevent dust as well as the continuous addition of water. However, the workers must pay attention to the condition of the machine while using this method. Crafters can carry out administrative control, such as reducing the duration of exposure, improving exercise habits, and having a routine health check at least once a year. They are also expected to use PPE according to standards.

ACKNOWLEDGEMENTS

The authors are grateful to the headstone and stone mortar crafters in Allakuang Village, Sidrap Regency, Indonesia for their contribution. The authors are also grateful to the Ministry of Education and Culture as well as the National Agency for Research and Innovation, Republic of Indonesia for the study grant funds (070/E4.1/AK.04.PT/2021).

REFERENCES

1. Kementerian Sekretariat Negara Republik Indonesia KSNRI. Perpres RI No 7 Tahun 2019 tentang Penyakit Akibat Kerja. Indonesia; 2019.
2. Hämäläinen P, Takala J, Boon K. Perkiraan Global Kecelakaan Kerja dan Penyakit Yang Berhubungan Dengan Kerja 2017. In: Kongres Dunia XII tentang Keselamatan dan Kesehatan di Tempat Kerja. Singapura: Lembaga Keselamatan dan Kesehatan Kerja; 2017.
3. Kementerian Kesehatan Republik Indonesia KKRI. Peraturan Menteri Kesehatan Republik Indonesia No. 56 Tahun 2016. Indonesia; 2016.
4. The National Institute for Occupational Safety and Health TNI for OS and H. National Occupational Research Agenda (Disease and Injury) April 1996. USA; 1996.
5. World Health Organization. Preventing Disease Through A Healthier And Safer Workplace. Switzerland; 2018.
6. Health and Safety Executive. Lung Disease [Internet]. Work related lung diseases. Available from: <https://www.hse.gov.uk/lung-disease/about.htm>
7. Abidin AU, Henita N, Rahmawati S, Maziya FB. Analisis Risiko Kesehatan Paparan Debu Terhadap Fungsi Paru pada Pekerja di Home Industry C-Max. *J Sains dan Teknol Lingkung*. 2021;13(1):34–9. doi: 10.20885/jstl.vol13.iss1.art3
8. Pramesti IGA AV, Sutiari NK. Determinan Gangguan Kapasitas Fungsi Paru-Paru pada Perajin Batu Bata Merah di Kabupaten Bandung. *Arch Community Heal*. 2021;8(1):16–28. doi: 10.24843/ACH.2021.v08.i01.p02
9. Amerta PWP, Wirawan IMA. Hubungan Paparan Debu dengan Kapasitas Fungsi Paru Pengrajin Paras di Desa Ketewel, Sukawati, Gianyar. *Arch Community Heal*. 2020;7(1):87–95. doi: 10.24843/ACH.2020.v07.i01.p09
10. Wenas CAP, Kawatu PA, Joseps WB. Gambaran Kadar Debu, Status Merokok, dan Fungsi Paru Pada Pekerja Tambang Batu Di Desa Warembungan. Available from: <https://fkm.unsrat.ac.id/wp-content/uploads/2015/05/JURNAL-CHRISTINE-WENAS.pdf>
11. Pratama A, Ratna SLP. Prevalensi Gangguan Fungsi Paru Pada Pekerja Batu Padas Di Silakarang Gianyar Bali. *E-Jurnal Media*. 2017;6(5):1–5.
12. Parmar J, Patel C, Shukla AKN. Health risks associated with the grinding process. In: International Research Conference on Innovation, Startup and Investment (ICOSTART-2019). 2020.
13. Organization WH. Deteksi Penyakit Akibat Kerja. Jakarta: Penerbit Buku Kedokteran; 1993.
14. Suma'mur. Higiene Perusahaan dan Kesehatan Kerja (Hiperkes). 2nd ed. Jakarta: CV Sagung Seto; 2014.
15. Pemerintah Republik Indonesia. Undang-undang Republik Indonesia Nomor 13 tahun 2003. Indonesia; 2003.
16. United State Department Labor. The Fair Labor Standards Act. 1940.
17. Windri TM, Kinasih An, Sanubari TPE. Pengaruh Aktivitas Fisik dengan Kualitas Hidup Lansia Hipertensi di Panti Wredha Maria Sudarsih Ambarawa. *J Mitra Pendidik (KMP Online)*. 2019;3(11):1444–51.
18. Bull FC, Al- SS, Biddle S, Borodulin K, Buman MP, Cardon G, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *Br J Sport Med*. 2020;54(24):1451–62.

- doi: 10.1136/bjsports-2020-102955
19. The World Health Organization. Body mass index - BMI [Internet]. 1970. Available from: https://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi?source=post_page-----&msclkid=46b9b4d7d10b11ec854559fd2bab0e2b
 20. Htun ZZ, Win IY, Myat A, Naing SM. Lung Function Impairment and Workplace Control Measures among Marble Stone Carvers in Sa-Kyin Village, Madayar Township, Myanmar. *Int J Occup Saf Heal* [Internet]. 2021;11(1):25–30. doi: 10.3126/ijosh.v11i1.34972
 21. Hassen KA, Ibrahim MS. Exposure to occupational dust and changes in pulmonary function among cobblestone paving workers of Jimma , Ethiopia Expositro a poeira e alteraxxes na funzro pulmonar entre trabalhadores de pavimentazro com pedregulhos em Jimma , Etiyppia. *An Interdisiplinary J Appl Sci*. 2014;9(1). doi: 10.4136/ambi-agua.1227
 22. Gholami A, Sajedifar J, Dehaghi BF, Gavamabadi LI, Boghsani GT, Tazeroudi A, et al. Lung function and respiratory symptoms among mine workers in the Eastern part of Iran. *Russ Open Med J*. 2018;7(3):8–11. doi: 10.15275/rusomj.2018.0306
 23. The Pennsylvania State University. Soil Quality. Publication Distribution Center, The Pennsylvania State University. 2012.
 24. Suma'mur. Higiene Perusahaan dan Kesehatan Kerja (HIPERKES). Jakarta: Sagung Seto; 2014.
 25. Ardam KAY. Hubungan Paparan Debu dan Lama Paparan dengan Gangguan Faal Paru Pekerja Overhaul Power Plant. *Indones J Occup Saf Heal*. 2015;4(2):155–66. doi: 10.20473/ijosh.v4i2.2015.155-166
 26. Dewi E, Widajati N. Hubungan Paparan Debu Kapur dengan Status Faal Paru. *Indones J Occupational Saf Heal*. 2016;5(1):61–70. doi: 10.20473/ijosh.v5i1.2016.61-70
 27. Wahyuni A, Rahim MR, Sulasning, Awaluddin, Asyad DS, Selomo M. Hubungan Pajanan Debu dengan Kapasitas Paru pada Pekerja di Area Boiler PT Makassar Te'ne. *J Kesehat Masy Marit*. 2019;2(1):18–24.
 28. Wulansari DT. Analisis Hubungan Karakteristik Pekerja dan Paparan Debu Kayu dengan Status Faal Paru Pekerja BAgian Jumping Saw Industri Kayu di Banyuwangi. *J Kesehat Lingkung*. 2019;11(2):99–107. doi: 10.20473/jkl.v11i2.2019.99-107
 29. Jamil PAS, Karuppiyah K, Rasdi I, How V, Tamrin SBM, Mani KKC, et al. Associations of Occupational , Socio-Demographic and Lifestyle Factors with Lung Functions in Malaysian Traffic Policemen. *Ann Glocal Heal*. 2020;86(1):1–9. doi: 10.5334/aogh.2895.
 30. Pradana VA. Gambaran Gangguan Fungsi Paru Pada Pemulung Yang Bekerja Di Tempat Pemrosesan Akhir (TPA) Pakusari Kabupaten Jember. Universitas Jember; 2018.
 31. Amerta PWuP, Wirawan IMA. Hubungan Paparan Debu dengan Kapasitas Fungsi Paru Pengrajin Batu Paras di Desa Ketewel, Sukawati, Gianyar. *Achieve Community Heal*. 2020;7(1). doi: 10.24843/ACH.2020.v07.i01.p09
 32. Juno K. Faktor yang Mempengaruhi Gangguan Fungsi Paru pada Pengrajin Batu Nisan dan Batu Cobek di Desa Allakuang Kabupaten Sidrap Sulawesi Selatan. *Akademi Hiperkes dan Keselamatan Kerja*; 2020.
 33. Sinaga RN. Analisis Faktor yang Memengaruhi Fungsi Paru pada Pekerja Bagian Produksi PT Mabar Feed Indonesia Tahun 2020. Universitas Sumatera Utara; 2021.
 34. Sari MP, Tarigan AmP, Nainggolan N, Eyanoe, Putri C, Susanti AD, Samoedro E, et al. The Association of Working Duration with Lung Function and Chest X-Ray Results in Ceramic Industry Workers of Company X, Mabar Medan. *J Respirologi Indones*. 2021;41(1):33–9. doi: 10.36497/jri.v41i1.158
 35. Kabir E, Islam A, Taufikuzzaman M. An investigation into respiratory health problems of workers at stone crushing industries in Bangladesh. *J Heal Researcj*. 2018;32(2):172–8. doi: 10.1108/JHR-01-2018-017
 36. Farhadloo MP, Akbari I, Shabestari SS, Shabestari DS. Reduce Dust Pollution Using Water Suppression. In: *The 8th National Conference & Exhibition on Environmental Engineering* At: Tehran University, Tehran, Iran [Internet]. 2016. Available from: https://www.researchgate.net/publication/309374596_Reduce_Dust_Pollution_Using_Water_Suppression
 37. Apsari L, Budiyo, Setiani O. Hubungan Paparan Debu Terhirup dengan Gangguan Fungsi Paru pada Pekerja Pertambangan Pasir dan Batu Perusahaan X Rowosari Kota Semarang. *J Kesehat Masy*. 2018;6(4):463–75. doi: 10.14710/jkm.v6i4.21455
 38. Nabuasa DJ, Berek NC, Setyobudi A. Factors Related to Lung Function In Wood Furniture Workers In Oesapa Village, Kelapa Lima Sub District Kupang City. *Timorese J Public Heal*. 2020;2(2):64–72. doi: 10.35508/tjph.v2i2.2785
 39. Dugral E, Balkanci D. Effects of smoking and physical exercise on respiratory function test results in students of university: A cross-sectional study. *Medicine (Baltimore)*. 2019;98(32):e16596. doi: 10.1097/MD.00000000000016596.
 40. Bagus MPN, Inten IDA, Dinata IMK. Hubungan antara rutinitas olahraga dengan fungsi paru pada perokok usia dewasa muda di Denpasar. *J Med Udayana*. 2020;9(7):45–9. doi: 10.24843/MU.2020.V09.i7.P09
 41. Susanti M, Yuliawati R. Correlation Between Physical Activity And Length Of Work With Lung Function Disturbance On Crusher Section Workers In Coal Mining In Pt. X Kutai Kartanegara. Universitas Muhammadiyah Kalimantan Timur;

- 2018.
42. Yuwono. Survei Hubungan Kebiasaan Merokok Dengan Kapasitas Vital Paru Pada Mahasiswa Pendidikan Jaminan kesehatan dan Rekreasi. Surabaya; 2005.
43. Fithri NK. Analisis Faktor yang Mempengaruhi Gangguan Fungsi PAru pada Pekerja Penjaga Pintu Tol Tangerang Karawaci. J INOHIM. 2017;5(1). doi: 10.47007/inohim.v5i2.129