J-Kesmas: Jurnal Fakultas Kesehatan Masyarakat p-ISSN: 2355-0643, e-ISSN: 2355-0988
(The Indonesian Journal of Public Health) Vol. 8, No. 1, April, 2021
Available at http://jurnal.utu.ac.id/jkesmas Open Access RESEARCH ARTICLE

Description of Acute Respiratory Infections (ARI) Trends in The High Risk Area Zone of Exposure To Coal Smoke of The Electric Steam Power Plant (ESPP)/PLTU Nagan Raya

[1]Enda Silvia Putri, [2]Susy Sriwahyuni

[1]Departement of Nutrition Faculty of Public Health Universitas Teuku Umar, Meulaboh
[2]Departement of Public Health Faculty of Public Health Universitas Teuku Umar, Meulaboh
Coresponding author: Enda Silvia Putri, e-mail: endasilviaputri@utu.ac.id
Co-author : SS: e-mail: susysriwahyuni@utu.ac.id
Submitted:02/02/2021 **Revised:** 02/03/2021 **Accepted:** 19/04/2021 **Published online**: 19/04/2021

doi: https://doi.org/10.35308/j-kesmas.v7i2.1646. **How to cite this article**: Putri, ES., & Sriwahyuni, S (2021). Description of Trends Acute Respiratory Infections (ARI) in High-risk Area Zone Exposure To Coal Smoke Of The Electric Steam Power Plant (ESPP)/Pltu Nagan Raya. *J-Kesmas: Jurnal Fakultas Kesehatan Masyarakat (The Indonesian Journal of Public Health)*.8(1). 45-50.

Abstract

The cases of ARI increase every year after the active operation of the industry. This research aims to explore a description of ARI trends in the high risk zone of exposure to coal smoke of the electric steam power plant (ESPP)/PLTU Nagan Raya. The research method was a combination of cross sectional and phenomology designs. The sample research was 50 people with the criteria for residence 0-50 km from ESPP Nagan Raya with high risk area zone exposure, whilst the technical sample was purposive sampling. The results of this research found an increasing trend for ARI as many as 10% / month during 2019-2020. Chi square test showed P value = 0,000 in which the intrepretation was relationship suspected smoke exposure with symptoms of ARI. Based on in-depth interviews with the community, they experienced respiratory complaints due to the smoke from the ESPP during the establishment of the company, they also complained that their polluted soil and plants were not grown well. To conclude, there was an increasing trend of ARI in the high risk zone of exposure to ESPP smoke and there was relationship between suspected smoke exposure and complaints of ARI, and people were experiencing respiratory complaints.

Keywords: ESPP; Coal; Smoke; ARI

Introduction

After the tsunami, reconstruction and development of Nagan Raya Regency can be said to be fast including in the industrial sector, for instance, Nagan Raya District. It can be seen that its active activity is more or less post-tsunami with the establishment of PLTU Nagan Raya as well as PT. PLN (Persero) Nagan Raya sector power plant or PLTU Nagan Raya originated from the forerunner to the construction of the 10,000 MW project assigned by the government to PT. PLN (Persero) in 2006 according to Presidential Decree No. 17 of 2006 dated 05 July 2006, the project was located in the Suak Puntong village, Kematan Kuala Pesisir, Nagan Raya Regency(PLTU Nagan Raya, 2014).

The growth of these industries could be a positive impact in terms of employment opportunities, in which many local people can work in these two companies (news from local newspaper: serambi news).The positive impact given certainly does not close our eyes to the negative impacts that could be caused by the two industries, as seen from several news published in local newspapers (read: serambinews) related to the waste and smoke produced by those company, even though there was no research in the areas where these two companies were established, which shows the negative impact of the waste and smoke products of these companies (Sa'dul Bahri, 2019; Serambi, 2013, 2019).

Studies in other areas are in which ESPP/PLTU is awarded and coal mining companies have proven that there is a relationship between smoke or dust from coal burning with cases of hoarseness (including ARI). The results of the study (Juniah, et al, 2013) stated that coal mining has an impact on public health, especially ARI, (Jie Y, etc, 2014) who found that there was a change in lung function due to exposure to coal dust (Sarver, E., etc, 2019). Exposure to coal dust causes the lungs to blacken. The research focuses on investigation about analyzing the trend of increasing cases of ARI in the high risk zone of ESPP Nagan Raya exposure to coal smoke. This case is interesting to study from the ARI data that the researcher got from the Padang Rubek Health Center, which is the health center whose working area is the area in which the company was founded. The cases of ARI at the

Padang Rubek Health Center tend to increase every year after the active industrial operation in this company (Jie et al., 2014; Juniah, Dalimi, Suparmoko, & Moersidik, 2013; Sarver, Keles, & Rezaee, 2019).

Data on ARI Cases in 2019: 803, 2020 / August: 507. The data in 2020 was lower than 2019 inasmuch as it was still a total of eight months, it can be predicted to increase when viewed from the 2019 data. Data on ARI cases can be more than the real and there is separation of ARI in children or cases of common cold. Common cold is mostly affected in high-risk groups, especially children. Case data were collected based on patients who were residents of the work area of the public health centre in which settlements were in the two industrial areas. This research is expected to be able to provide evaluation material for this company to control the industrial waste produced if it is suspected of having an effect on the ARI cases that occur. For the community, they could take precautions as early as possible against the impact of the industrial waste (Rubek, 2019).

Methods

The research method in this research was to combine qualitative and quantitative research methods. Qualitative method used a phenomenological approach design, while quantitative method used a cross sectional approach design. The phenomenological design used to capture problems through in-depth interviews uses interview guides to community groups (zone 0-20 Km from industry), and (zone area> 20-40 Km from industry) assuming a high risk of exposure to ESPP Nagan Raya smoke. The cross-sectional design was used to capture problems through interviews using a questionnaire to groups of people suspected of being a high-risk group for ARI cases in (zone 0-20 Km from industry), and (zone area> 20- 40 Km from industry) with high risk assumptions of exposure to smoke from ESPP Nagan Raya. The sample size (50 people) was taken by non-random sampling technique, such as purposive random sampling. Phenomological analysis was tested by problem triangulation and cross sectional analysis with univariate and bivariate analysis with Chi Square test (Sugiyono, 2016; Sulistyaningsih, 2011)

Results

The results of the research at the initial stage were looking at the description of ARI cases based on secondary data obtained from the Public Health Center Padang Rubek, Kuala Pesisir District, Nagan Raya Regency, which is the area of the ESPP establishment zone. The ESPP is in the Padang Rubek Health Center area.

Secondary Data

Case Data of ARI at Public Health Center Padang Rubek

The results of the secondary data obtained researchers from the ARI case data at the Public Health Center Padang Rubek, which is zone of the PLTU establishment, are explained in Figures 1 and 2..

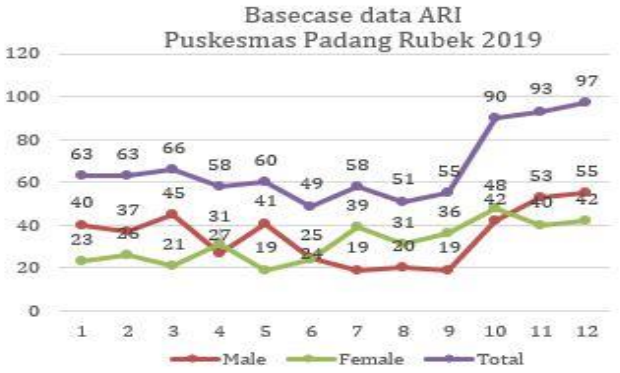

Figure 1. Graph Basecase Data ARI at Public Health Center Padang Rubek 2019

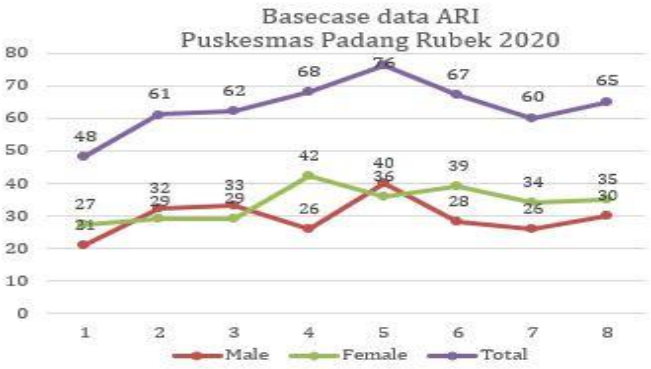

Figure 2. Graph Basecase Data ARI at Public Health Center Padang Rubek 2020

In Figures 1 and 2, it can be seen that the data on ARI cases in 2019 was as many as 803 cases and 507 cases in 2020. This data was very volatile as seen from the average case data in 2019 and 2020 with an average case value of 50 cases per month. Researchers only obtained case data for 2019 and 2020. The reason for the insufficient data obtained at the Public Health Center Padang Rubek was almost the same reason as the Meureubo Health Center. The case data that has been obtained are unable to actually describe the existing case data. In the ARI case data at Public Health Center Padang Rubek, the researcher was only able to see the distribution of case data by sex at two years and was unable to see other characteristics and their causes. Researchers cannot provide an overview

based on the case data whether ESPP smoke causes ARI.

Primary Data

The primary data in the initial plan was actually data on ARI cases in each public health center which then based on this data we conducted questionnaires, but because the complete data from the public health center, researchers did not get such as residence data so it was difficult for researchers to take samples from this data. The researchers took the research sample based on the distance of the house in the village which was nearest to the ESPP area and we interviewed the family head.

The results of primary data collection were obtained from 50 samples that were respondents (residents of the village of Suak Puntong: 25 people were the first village closest to the PLTU, residents of Kuala Baroe village: 25 were the second closest village to the PLTU which was also the village in the working area of the Public Health Center Padang Rubek).

Univariate Analysis

The results of the univariate analysis based on questionnaire questions interviewed by field officers are as follows om table 1.

Table 1 depicts that the percentage for the highest age was at 40 years old as many as 8%, the highest gender was in the female gender of 66%. The status has experienced the highest symptoms of ARI, namely 62% that did not use a mask by the community before experiencing the highest ARI symptoms of 100%. After experiencing symptoms of ARI, namely 94%, the public suspicion of the incidence of ARI symptoms that they suffered from the smoke of ESPP was the highest one as much as 62%, counseling by ESPP was also the highest at the point of not doing preventive counseling of 100%.

The given table 1 highlights the 50 people interviewed where 62% of them have symptoms of ARI. Researchers did not get the complete address from the public health center to get positive cases of ARI based on doctor's diagnosis and caused by PLTU smoke. But with no counseling from the PLTU, this is not good enough with many people experiencing symptoms that can be suspected due to inhalation of PLTU smoke because people rarely use masks while they are continuously exposed to dust and smoke. In addition, it needs to conduct further research by carrying out lung examinations using special equipment in high-risk communities so that they can confirm whether the ARI is due to smoke or not.

Bivariate Analysis and In-depth Interview Results

In the bivariate analysis, the researchers saw the relationship between ARI symptoms and the public's suspicion of exposure to coal dust and ESPP smoke that caused the symptoms of ARI they experienced.

Table 1. Relationship between ARI Symptoms and Suspected Exposure to Coal Dust and Smoke from the ESPP

Suspicion of ARI Due to Exposure to Smoke PLTU Nagan Raya	Symptoms ARI				Total		P-Value
	Yes		No				
	n	%	n	%	N	%	
Yes	31	100	0	0	31	100	
No	0	0	19	100	19	100	0.000
Total	31	100	19	100	50	100	

Table 1 shows that there was a relationship between exposure to PLTU smoke and symptoms of ARI by looking at the P value = 0.000 <α = 0.05. These results can make us a temporary suspicion that the smoke from the ESPP that someone inhales can indicate that someone is experiencing symptoms of ARI. This suspicion cannot be too strong as evidence before an examination of the lungs by looking at the coal dust residue and ESPP smoke.

The results of the in-depth interviews conducted found that the community began to experience complaints about the symptoms of ARI since the company was established in their village. They rarely experienced such complaints before. They stated that when they experienced complaints that were difficult to handle they would go to the public health center. The doctor's diagnosis was unable to state that the cause was due to the smoke from the ESPP because they did not have adequate tools to test this. The environmental conditions are very apprehensive such as the soil. The plants are not as fertile as it owing to the effect of the company waste based on complaints from residents in the area. Residents stated that it was very rare for the company

to provide direction and preventive efforts towards the impact of the waste they generated, even though many residents had experienced complaints when they were often exposed to the waste, plus a lack of understanding of the use of masks as a preventive measure. Masks are now often used because of the incessant promotion of COVID19 prevention, not owing to preventing the effects of company's waste.

Discussion

Based on the results of our research, we see that This research found an increasing trend of ARI cases by 1% every year from 2012 to 2020 in the working area of the public health center which is close to the area where the two companies were established. Based on the univariate results of 100 residents who are their villages located 0-50 km from company, 63% have symptoms of ARI. The bivariate results stated that there was a significant relationship (P value = 0.000) between exposure and symptoms of ARI although this statement should be strengthened by examining the residual respiratory exposure, but this result could be a strong presumption for us to do this test. The residents stated that they often experienced complaints about the symptoms of ARI after the establishment of the company in their village. The residents also said that the environmental conditions around their village were getting worse, such as air pollution due to the company's activities.

The aforementioned statement was also supported based on several research results showing that the activities of PLTU and coal entry plants have a negative impact on the environment and the health conditions of the surrounding community. Bahri's (2018) research results related to the health and environmental impacts of dust emissions from the activities of the PLTU Karangkandri Cilacap stated that from the results of the impact assessment, it was known that the loading and unloading route through Tanjung Intan Port were more dominant (both for health and environmental impacts) when compared to the loading and unloading route. Load through the PLTU Pier, with the difference between the two impacts as follows: (1) Non-carcinogenic impact of 2.28.10-05 DALY, (2) carcinogenic impact of 2.13.10-06 DALY, (3) impact on respiratory disorders of 3,67.10-03 DALY, (4) impact on aquatic ecotoxicity of 4,1.10-01 PDF * m2 * year, (5) impact on terrestrial ecotoxicity of 123.5 PDF * m2 * year (Saipul Bahri, 2018).

Although this study has not been able to confirm the relationship between smoke exposure from coal combustion in ESPP Nagan Raya with the incidence of ARI, many studies have stated that it is closely related to exposure to inhaled coal smoke with lung function failure and the cause of ARI. Simanjuntak's research, 2013, Wahyuni, 2019, Hafsari 2015, Sholihah, 2015, the results of their research found that there was a relationship between coal dust / smoke exposure and the incidence of ARI in a person (Hafsari, Ramadhian, & Saftarina, 2015; Rahayu Simanjuntak, Suwondo, & Wahyuni, 2013; Sholihah, Hanafi, Wanti, Bachri, & Hadi, 2015; Wahyuni et al., 2019).

Based on research from various countries, it found that it was extremely related to exposure to coal smoke, especially those who are often exposed, so a person will be susceptible to ARI as studies conducted by Noemi, 2019 in the US, Laney 2012 in the US, Report on the causes of ARI in the US 2013, Suarthana, 2019 in the US, Cohen, 2008, in US, Perret in UK, 2017, Robert 2018 Virgina, Grove 2014 in Africa, Abraham in Australia 2016, Cui 2015 in China, Graber 2018 in China, Linus 2011 in USA, Pang 2019 in China. Dean 2013 in China even revealed that exposure to smoke from continuous burning of coal can cause lung cancer, similar to the research conducted by Jinhui 2019 in China, Rahul 2012 in India, Joseph 2010 in Mexico, Ruoding 2019 in Virginia, Prakash 2012, Prabjit 2019(Barn et al., 2019; Bunnell et al., 2010; Cohen, Patel, & Green, 2008; Cui et al., 2015; Graber, 2018; Grové, Van Dyk, Franken, & Du Plessis, 2014; Hall, Blackley, Halldin, & Laney, 2019; Iii et al., 2013; Jl, Churg, & Fh, n.d.; Kodgule & Salvi, 2012; Kurmi, Arya, Lam, Sorahan, & Ayres, 2012; Laney, Petsonk, Hale, Wolfe, & Attfield, 2012; Li et al., 2019; Pang et al., 2019; Perret et al., 2017; Santo Tomas, 2011; Shi et al., 2019; Stansbury, 2018; Suarthana, Laney, Storey, Hale, & Attfield, 2011).

Conclusion

The results of this research can be concluded that: there was an increase in the trend of ARI cases every month by 10% based on data from the public health center located in the area where the ESPP (PLTU) Nagan Raya was established. There was a connection between the suspected smoke exposure of ESPP (PLTU) Nagan Raya and the symptoms of ARI with a P value = 0.000.

Based on the results of in-depth interviews, the community claimed to have experienced health complaints (such as respiratory problems and eye irritation) or complaints about poor environmental conditions (air, soil) due to the smoke from ESPP (PLTU) Nagan Raya, lack of preventive counseling from the company, people do not dare to submit complaints to the company, health workers, and local leaders.

Acknowledgement

Researchers are very grateful to all parties who have helped researchers so that this research is carried out, such as research members, students involved in the research, the Faculty of Public Health, Universitas Teuku Umar, the Institute for Research and Community Service and Education Quality Assurance at Universitas Teuku Umar/LPPM-PMP Universitas Teuku Umar, Public Health Center Padang Rubek, respondents, and the DRPM of Ministry of Research, Technology and Higher Education of the Republic of Indonesia/DRPM KEMENRISTEKDIKTI Republik Indonesia who have funded this research..

Author Contribution and Competing Interest

Enda Silvia Putri as the main researcher who designs, compiles, analyzes, compiles the results of research analysis, and writes manuscript. Susy Sriwahyuni as the second researcher provided input in drafting the manuscript and submitting it.

The author declares that there is no competing interest of any kind, such as: financial, professional, or significant personal which might affect the performance or presentation of the work described in this manuscript.

References

Bahri, S. (2018). Dampak Kesehatan dan Lingkungan Emisi Debu Dari Aktivitas PLTU Karangkandri Cilacap. *Jurnal Rekayasa Teknologi Industri Hijau (RATIH)*, *3*(1), 1–9. Retrieved from https://ejournal.unugha.ac.id/index.php/ratih/article/view/91/71

Bahri, S. (2019). Limbah PLTU Diduga Cemari Saluran Air. *Serambinews.Com.* Retrieved from https://aceh.tribunnews.com/2019/04/08/limbah-pltu-diduga-cemari-saluran.

Barn, P., Gombojav, E., Ochir, C., Boldbaatar, B., Beejin, B., Naidan, G., … Allen, R. W. (2019). Coal smoke, gestational cadmium exposure, and fetal growth. *Environmental Research*, *179*(May), 108830. https://doi.org/10.1016/j.envres.2019.108830

Bunnell, J. E., Garcia, L. V., Furst, J. M., Lerch, H., Olea, R. A., Suitt, S. E., & Kolker, A. (2010). Navajo coal combustion and respiratory health near shiprock, New Mexico. *Journal of Environmental and Public Health*, *2010*. https://doi.org/10.1155/2010/260525

Cohen, R., Patel, A., & Green, F. (2008). Lung Disease Caused by Exposure to Coal Mine and Silica Dust. *Seminars in Respiratory and Critical Care Medicine*, *29*(06), 651–661. https://doi.org/10.1055/s-0028-1101275

Cui, K., Shen, F., Han, B., Yuan, J., Suo, X., Qin, T., … Chen, J. (2015). Comparison of the Cumulative Incidence Rates of Coal Workers' Pneumoconiosis between 1970 and 2013 among Four State-Owned Colliery Groups in China. *International Journal of Environmental Research and Public Health*, *12*(7), 7444–7456. https://doi.org/10.3390/ijerph120707444

Graber, J. M. (2018). Application of the Delphi method to reduce disability and mortality from coal mine dust lung disease in China; a new approach to an old problem. *Occupational and Environmental Medicine*, *75*(9), 615–616. https://doi.org/10.1136/oemed-2018-105075

Grové, T., Van Dyk, T., Franken, A., & Du Plessis, J. (2014). The Evaluation and Quantification of Respirable Coal and Silica Dust Concentrations: A Task-based Approach. *Journal of Occupational and Environmental Hygiene*, *11*(6), 406–414. https://doi.org/10.1080/15459624.2013.877140

Hafsari, D., Ramadhian, M. R., & Saftarina, F. (2015). Debu Batu Bara Dan Kejadian Infeksi Saluran Pernafasan Akut Pada Pekerja Pertambangan Batu Bara. *Majority*, *4*(9), 35–41. Retrieved from https://juke.kedokteran.unila.ac.id/index.php/majority/article/view/1405/1247

Hall, N. B., Blackley, D. J., Halldin, C. N., & Laney, A. S. (2019). Continued increase in prevalence of r-type opacities among underground coal miners in the USA. *Occupational and Environmental Medicine*, *76*(7), 479–481. https://doi.org/10.1136/oemed-2019-105691

Iii, H. D. H., Chapman, R. S., Wei, H., He, X., Tian, L., Larry, Z., … Lan, Q. (2013). *NIH Public Access*. *55*(1), 5–10. https://doi.org/10.1002/ajim.21014.Coal

Jie, Y., Houjin, H., Xun, M., Kebin, L., Xuesong, Y., & Jie, X. (2014). Relationship between pulmonary function and indoor air pollution from coal combustion among adult residents in an inner-city area of southwest China. *Brazilian Journal of Medical and Biological Research*, *47*(11), 982–989. https://doi.org/10.1590/1414-431X20144084

Jl, A., Churg, A., & Fh, G. (n.d.). *Table 1. Thoracic Society of Australia and New Zealand Recommendations for Control of Coal Workers ' Pneumoconiosis Goal: Eliminate CWP in Australia 1. Exposure limits and monitoring protocols*. 773–774.

Juniah, R., Dalimi, R., Suparmoko, M., & Moersidik, S. S. (2013). Public health impact of coal mining among community living in coal mining area (review on environmental benefits to absorb carbon). *Jurnal Ekologi Kesehatan*, *12*(01), 252–258.

Kodgule, R., & Salvi, S. (2012). Exposure to biomass smoke as a cause for airway disease in women and children. *Current Opinion in Allergy and Clinical Immunology*, *12*(1), 82–90. https://doi.org/10.1097/ACI.0b013e32834ecb65

Kurmi, O. P., Arya, P. H., Lam, K. B. H., Sorahan, T., & Ayres, J. G. (2012). Lung cancer risk and solid fuel smoke exposure: A systematic review and meta-analysis. *European Respiratory Journal*, *40*(5), 1228–1237. https://doi.org/10.1183/09031936.00099511

Laney, A. S., Petsonk, E. L., Hale, J. M., Wolfe, A. L., & Attfield, M. D. (2012). Potential determinants of coal workers' pneumoconiosis, advanced pneumoconiosis, and progressive massive fibrosis among underground coal miners in the United States, 2005-2009. *American Journal of Public Health*, *102 Suppl*(S2), S279-83. https://doi.org/10.2105/AJPH.2011.300427

Li, J., Ran, J., Chen, L. chi, Costa, M., Huang, Y., Chen, X., & Tian, L. (2019). Bituminous coal combustion and Xuan Wei Lung cancer: a review of the epidemiology, intervention, carcinogens, and carcinogenesis. *Archives of Toxicology*, *93*(3), 573–583. https://doi.org/10.1007/s00204-019-02392-y

Pang, Y., Zhang, B., Xing, D., Shang, J., Chen, F., Kang, H., … Niu, Y. (2019). Increased risk of carotid atherosclerosis for long-term exposure to indoor coal-burning pollution in rural area, Hebei Province, China. *Environmental Pollution*, *255*, 113320. https://doi.org/10.1016/j.envpol.2019.113320

Perret, J. L., Plush, B., Lachapelle, P., Hinks, T. S. C., Walter, C., Clarke, P., … Stewart, A. (2017). Coal mine dust lung disease in the modern era. *Respirology (Carlton, Vic.)*, *22*(4), 662–670. https://doi.org/10.1111/resp.13034

PLTU Nagan Raya. (2014). *Sejarah PLTU Nagan Raya*.

Rahayu Simanjuntak, N. S., Suwondo, A., & Wahyuni, I. (2013). Hubungan antara kadar debu batubara total dan terhirup serta karakteristik individu dengan gangguan fungsi paru pada pekerja di lokasi coal yard pltu x jepara. *Jurnal Kesehatan Masyarakat Universitas Diponegoro*, *2*(2), 18705.

Rubek, P. P. (2019). *Data Kasus ISPA*. Nagan Raya.

Santo Tomas, L. H. (2011). Emphysema and chronic obstructive pulmonary disease in coal miners. *Current Opinion in Pulmonary Medicine*, *17*(2), 123–125. https://doi.org/10.1097/MCP.0b013e3283431674

Sarver, E., Keles, C., & Rezaee, M. (2019). Characteristics of respirable dust in eight appalachian coal mines: A dataset including particle size and mineralogy distributions, and metal and trace element mass concentrations. *Data in Brief*, *25*, 104032. https://doi.org/10.1016/j.dib.2019.104032

Serambi. (2013). PLTU Nagan Raya Pekerjakan 236 Putra Aceh. *Serambinews.Com.* Retrieved from PLTU Nagan Raya Pekerjakan 236 Putra Aceh

Serambi. (2019). Limbah PLTU Nagan Diduga Cemari Saluran Air Warga. *Serambinews.Com.* Retrieved from https://aceh.tribunnews.com/2019/04/06/limbah-pltu-nagan-diduga-cemari-saluran-air-warga-begini-kondisinya.

Shi, R., Meacham, S., Davis, G. C., You, W., Sun, Y., & Goessl, C. (2019). Factors influencing high respiratory mortality in coal-mining counties: A repeated cross-sectional study. *BMC Public Health*, *19*(1), 1–16. https://doi.org/10.1186/s12889-019-7858-y

Sholihah, Q., Hanafi, A. S., Wanti, W., Bachri, A. A., & Hadi, S. (2015). Analisis Sif Kerja, Masa Kerja, dan Budaya K3 dengan Fungsi Paru Pekerja Tambang Batu Bara. *Kesmas: National Public Health Journal*, *10*(1), 24. https://doi.org/10.21109/kesmas.v10i1.812

Stansbury, R. C. (2018). Progressive Massive Fibrosis and Coal Mine Dust Lung Disease: The Continued Resurgence of a Preventable Disease. *Annals of the American Thoracic Society*, *15*(12), 1394–1396. https://doi.org/10.1513/AnnalsATS.201809-598ED

Suarthana, E., Laney, A. S., Storey, E., Hale, J. M., & Attfield, M. D. (2011). Coal workers' pneumoconiosis in the United States: regional differences 40 years after implementation of the 1969 Federal Coal Mine Health and Safety Act. *Occupational and Environmental Medicine*, *68*(12), 908–913. https://doi.org/10.1136/oem.2010.063594

Sugiyono. (2016). Metodologi Penelitian Kuantitatif, Kualitatif, dan R&D. In *CV Alfabeta*. https://doi.org/https://doi.org/10.3929/ethz-b-000238666

Sulistyaningsih. (2011). Metodologi Penelitian Kebidanan:Kuantitatif-Kualitatif. In *Metodologi Penelitian Kebidanan:Kuantitif-Kualitatif*.

Wahyuni, A., Rahim, M. R., Arsyad, D. S., Selomo, M., Keselamatan, D., Kesehatan, F., … Unhas, M. (2019). *Hubungan pajanan debu dengan kapasitas paru pada pekerja di area boiler PT. Makassar Tene*. *2*(1), 18–24. https://doi.org/https://doi.org/10.30597/jkmm.v2i1.10702

****