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Risiko Paparan Gas Hidrogen Sulfida terhadap Kapasitas Vital Paru Penduduk di Sekitar Tempat Pembuangan Akhir

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Abstract

Waste is one of factors causing air pollution in Palembang City. Volume of waste that should be processed increases every day, while condition of waste management service is still 70% of the total volume. The waste processing is managed by using open dumping system, which affects on the increase of air pollution. One of gases that exist as effect of the process of organic compound decomposition of anaerobic bacteria from garbage is sulfide hydrogen (H_2S) pollutant which can promote health disorders, especially respiratory system. This study aimed to analyze correlation between characteristics (age, sex, nutritional status, smoking, and living distance) and the risk quotient of sulfide hydrogen concentration in air ambient to the lung capacity of people around landfill area. This study used cross-sectional design with the sample of 78 people around landfill area. Data analysis used double logistic regression. Results showed that nutritional status (p value = 0.022, OR = 12.085) and RQ (p value = 0.016; OR = 7.547) significantly related to lung vital capacity of people around landfill area. People around landfill area having worse nutrition and lower RQ than the median were potential to have lung vital capacity disorder. The dominant variable significantly influencing to lung vital capacity of people living around Sukawinatan Landfill is nutritional status.

Keywords: Air pollution, lung vital capacity, nutritional status

Abstrak

Sampah merupakan salah satu penyebab terjadinya polusi udara di Kota Palembang. Setiap hari terjadi peningkatan volume sampah yang harus diolah, sedangkan kondisi pelayanan pengelolaan sampah baru mencapai sekitar 70% dari total sampah secara keseluruhan. Pengolahan sampah yang dilakukan menggunakan sistem *open dumping* berdampak terhadap peningkatan terjadinya polusi udara. Gas hidrogen sulfida (H_2S) yang diperoleh dari proses penguraian senyawa organik oleh bakteri anaerob pada tumpukan sampah dapat mengganggu kesehatan, terutama sistem pernapasan. Penelitian ini bertujuan untuk menganalisis hubungan antara karakteristik (usia, jenis kelamin, status gizi, merokok, dan jarak tempat tinggal) dan besaran risiko konsentrasi H_2S udara ambien terhadap kapasitas vital paru penduduk di sekitar tempat pembuangan akhir (TPA) sampah. Penelitian ini menggunakan desain potong lintang dengan sampel 78 orang penduduk yang berada di sekitar TPA. Analisis data menggunakan uji regresi logistik ganda. Hasil menunjukkan nilai status gizi (nilai p = 0,022, OR = 12,085) dan RQ (nilai p = 0,016; OR = 7,547) berhubungan secara signifikan terhadap kapasitas vital paru penduduk yang berada di sekitar TPA. Penduduk yang berada di sekitar TPA dengan nilai status gizi buruk dan nilai RQ lebih rendah dari median berpotensi mengalami gangguan kapasitas vital paru. Variabel dominan yang secara signifikan memengaruhi kapasitas vital paru penduduk yang berada di sekitar TPA sampah Sukawintan adalah status gizi.

Kata kunci: Polusi udara, kapasitas vital paru, status gizi

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Introduction

Air pollution can promote several dangerous diseases, especially those which attack the lung. The pollutants, such as dust, dirt, and other poisonous substances can threaten the lung tissue and weaken the body immunity.[1] Air pollution can be caused by the industrial waste, household waste, and the large volume of the waste in the landfill area.[2]

In Palembang City, waste problem should be well managed. The volume of the waste increases everyday due to the growth of the number of people. To solve that problem, the waste control management was done in Sukawinatan Landfill as the center. However, the service of this waste management has just been 70% of the total volume of the waste in Palembang.[3]

The volume of the waste production in Palembang could be 1000 ton a day, but only 500 ton were taken to Sukawinatan Landfill. The system that is used to manage this waste is landfill control system. By having this system, the volume of the waste that had been burried for such a duration of time are closed by the land.[4]

Beside using landfill control system, the waste is also managed by using open dumping system. Open dumping is a technique of which the a large volume of waste were dumped and piled up without being layered by the geotextile and leachate layers. In open dumping system, the waste was just dumped in the landfill without any treatment. This open dumping system affects the increase of air pollution.[5]

Air pollution is the effect of decomposition process of organic substances in an aerobic and anaerobic waste that promotes the bad smell. The bad smell happens as the waste decomposition process that produce carbodioxyde (CO_2), nitrogen (N_2), hydrogren (H_2), oxygen (O_2), metana (CH_4), amoniac (NH_3) and sulfide hydrogen (H_2S) gasses.[6]

H_2S can cause the respiratory system disorder, such as the shortness of breath, or even the disability of central nervous system depending on the level and the duration of thoses gases exposure. According to Agency for Toxic Subtances and Disease Registry, the low level exposure of H2S can cause the irritation on nose, throat, and eyes. The highest level exposure of H_2S (>500 ppm) can cause the loss of consciousness or the worst case is that it can cause the death.[7]

Then, it is concluded that the bad smell is the result of the waste dumping. The smell of the waste will get worse when the officers release the waste using the excavator. The people living around Sukawinatan landfill complain about the smell causing the respiratory system disorder. Moreover, many people also suffered upper repiratory tract infection (URI).

According to the data from Palembang City Health Office (2015), URI is the second most infectious disease suffered by people living nearby Sukarami Primary Health Care (24%) and Social Primary Helath Care (26%). Those Community Health Centres are around Sukawinatan Landfill.[8]

Therefore, this study was conducted to find out the correlation between the characteristics (age, sex, nutritional status, smoking and the living distance) dan the ambient air sulfide hydrogen (H_2S) concentration risk quotient (RQ) to the lung capacity of people living around Sukawinatan Landfill.

Method

This study was an analytic survey using cross sectional approach done in April-June 2016. The population of this study was the people living around the landfill with the distance ± 600 meter. The analysis object population was the ambient air around the landfill which was plot into the Google Earth to decide and divide the points to get the ambient air in the distance ± 600 meter.

The samples of this study were 78 people living around Sukawinatan Landfill with the age of 18-30 years old and have been living there for at least three years. This study used propotional sampling technique. In the distance of 30-315 meters, 53 samples were taken, and 25 samples were taken in the distance of 316-600 meters.

H_2S was measured by using Aircheck Sampler based on the air ambient around the landfill on the distance of 30-315 meter (2 points for taking the sample of the air containing of H_2S) dan 316-600 meter (2 points for taking the sample of the air containing of H_2S).

Lung vital capacity was checked and measured by using digital spirometry. When being checked and measured by this spirometry, the respondents must be in a good condition, not wearing tight outfit, not after eating within two hours, not smoking within one hour, and not consuming alcohol within four hours. There were three times manuvers done in this checking activity. The checking includes whether or not there was lung vital capacity disorder (obstruction and restriction) by checking the presentation score as the comparison of (Forced Vital Capacity (FVC)/Vital Capacity VC) and (Forced Exhale Vital (FEV)/Forced Vital Capacity).[9]

Results

People's characteristics in this study were the age, sex, smoking activity, nutritional status, and the distance of the house. The characteristic data is explained in Table 1.

Table 1 shows that samples of this study were 51.3% in the age group of ≥ 24 years old. The samples of this study were mostly females at 59% and passive smokers (passive smokers and non-smokers) at 71.8%. Nutritional status of the samples was good (57.7%), and they live mostly in the distance of 0-315 meter (67.9%).

The RQ is the risk ratio that includes H_2S concentra-

Table 1. Frequency Distribution Based on Characteristics

Variable	Category	n	%
Age	≥ 24 years	40	51.3
	< 24 years	38	48.7
Sex	Male	32	41.0
	Female	46	59.0
Smoking status	Active smoker	22	28.2
	Passive smoker (passive smoker and non-smoker)	56	71.8
Nutritional status	Bad (skinny and fat)	33	42.3
	Good	45	57.7
House distance	0 - 315 meter	53	67.9
	316 - 600 meter	25	32.1

Notes:
n = The Number of Sample; % = Percentage

tion, intake rate, exposure time, exposure frequency, exposure duration, and weight. Each variable was analyzed descriptively to determine the mean, deviation standard, minimum and maximum scores. The result of risk agent components is shown in Table 2.

Table 2 shows that H_2S concentration mean was 0.48± 0.14 mg/m^3 (48 x 10^{-5}ppm) with the lowest was 0.300 mg/m^3 and the highest was 0.675 mg/m^3. The exposure time mean was 18.54±4.05 hour/day with the shortest was 6 hours/day and longest was 24 hours/day. Exposure duration mean was 12.31 ± 7.25 years with the shortest was 3 years and the longest was 30 years. The weight mean was 54.56 ± 10.33 kg with the lightest was 40 kg and the heaviest was 84 kg. The intake rate was 0.83 m^3/day and exposure frequency was 365 days/year.

After each Risk Agent intake was measured, the RQ was measured then. RQ in this study was the risk level of the non-carcinogenic (H_2S exposure). RQ explained the risk possibility that had potential to happen. If RQ > 1, it means that the people have high risk to be exposed to H_2S. Meanwhile, if RQ ≤ 1, the risk to be exposed to H_2S will be lower. RQ is scored by dividing the risk agent non-carcinogenic (I) by Reference Concentration (RfC).

RQ was measured by dividing risk agent non-carcinogenic intake (I) by Reference Concentration (RfC), the study obtained the score of RQ > 1. Thus, after RQ was divided by median score, the study obtained the median score 45.50. The people living around Sukawinatan Landfill having RQ more than or same as the median (≥ 45.50) were 50%. It was similar to RQ less than median (<45.50), with the minimum score was 147,30.

Lung vital capacity was obtained by measuring Forced Vital Capacity, Prediction Forced Vital Capacity, and Forced Expiratory Volume in one second (Forced Exhale Vital 1). Based on those scores, the lung vital capacity score was divided into two groups, which were in trouble (restriction and obstruction) and not in trouble. The result of lung vital capacity is presented in Table 3.

Table 3 shows that most of people (83.3%) had the

Table 2. The Mean of Risk Agent Intake Components

Risk Agent Component	Mean ± SD	Min – Max
H_2S concentration	0.48 ± 0.14 mg/m^3	0.300 – 0.675
Exposure time	18.54 ± 4.05 hours/day	6 – 24
Exposure duration	12.31 ± 7.25 years	3 – 30
Weight	54.56 ± 10.33 kg	40 – 84

Intake Rate (Constants= 0.83 m^3/day)
Exposure Frequency (Constants= 365 day/year)

Table 3. Frequency Distribution of Lung Vital Capacity Frequency

Lung Vital Capacity	n	%
Disorders	65	83.3
Normal	13	16.7

n = The Number of Sample; % = Percentage

problem with the lung vital capacity. To determine whether or not there was a significant correlation between the characteristics (age, sex, smoking status, nutrional status, and house distance) and the lung vital capacity of people living around Sukawinatan Landfill, the study used chi-square test. The results are shown in Table 4.

Table 4 shows that there was no significant correlation (p value >0.05) among the age, sex, smoking status, and house distance to the lung vital capacity of people living around Sukawinatan Landfill. The p value of each of them was 0.839; 0.680; 0.368; and 0.158. Meanwhile, there was a significant correlation (p value < 0.05) between the nutritional status and the lung vital capacity of people living around Sukawinatan Landfill with p value 0.006.

To determine whether or not there was any significant correlation between RQ and the lung vital capacity of people living around Sukawinatan Landfill, the analysis of study used chi-square test. The results of correlation is shown in Table 5.

Table 5 presents that 94.9% of 39 respondents having RQ greater than median (> 45.50) suffered from lung vi-

Table 4. The Correlation between the Characteristics and Lung Vital Capacity

Variable	Category	Lung Vital Capacity				N	p Value
		Disorder		Normal			
		n	%	n	%		
Age	> 24 years	33	82.5	7	17.5	40	0.839
	< 24 years	32	84.2	6	15.8	38	
Sex	Male	26	81.3	6	18.8	32	0.680
	Female	39	84.8	7	15.2	46	
Smoking status	Active smoker	17	77.3	5	22.7	22	0.368
	Passive smoker	48	85.7	8	14.3	56	
Nutritional status	Bad	32	97	1	3	33	0.006
	Good	33	73.3	12	26.7	45	
House distance	0- 315 meter	42	79.2	11	20.8	53	0.158
	316- 600 meter	23	92.0	2	8.0	25	

Notes:
n = Number of Sample; N = Total of Sample

Table 5. The Correlation between Risk Quotient and Lung Vital Capacity

Risk Quotient	Lung Vital Capacity				p Value
	Disorder		Normal		
	n	%	n	%	
RQ more than median (> 45.50)	37	94.9	2	5.1	0.006
RQ less than median (< 45.50)	28	71.8	11	28.2	

Notes:
n = Number of Sample

Table 6. Final Model of Lung Vital Capacity

Variable	Coefficient	p Value	OR (95% CI)
Nutritional status	2.492	0.022	12.09 (1.43-102.43)
RQ	2.021	0.016	7.55 (1.47-38.79)

Notes:
OR = Odds Ratio; CI = Convidence Interval

tal capacity disorder, while the respondents having RQ less than median (< 45.50) that suffered from lung vital capacity were 71.8%. According to the chi-square test results, p value was 0.006 (p value < α). From the results, it can be concluded that there was a significant correlation between RQ and the lung vital capacity of people living around Sukawinatan Landfill.

The results of final analysis indicated that there were only two predictor variables with p value < 0.05 that were nutritional status and RQ. Thus, both variables were selected as final model to the existence of lung vital capacity disorder. The complete final model is described in Table 6.

Table 6 shows that p value of nutritional status category was 0.002 (p value < 0.05) with OR 12.09. It means that people living around Sukawinatan Landfill with bad nutritional status had 12.09 times higher risk to have lung vital capacity disorder than people having good nutritional status. For RQ category, the p value was 0.016 (p value < 0.05) with OR 7.55. It can be concluded that people living around Sukawinatan Landfill with RQ more than median (≥ 45.50) had the risk 7.55 times more to have lung vital capacity disorder.

The results of logistic regression analysis showed that nutritional status and RQ were the most influential variables to lung vital capacity. To determine the probability of both variables, the probability test was done. The result of probability test was 99.18%. It means that the people living around Sukawinatan Landfill that had RQ more than median (≥ 45.50) were 99.18% and those people would have lung vital capacity disorder. Based on the results, people with bad nutritional status (skinny or fat) were 97%. People having OR = 12.09 were 95% CI = 1.43-102.43. From those results, it can be concluded that people with bad nutritional status had probability 12.085 times more to have lung vital capacity than people with good nutritional status. The probability of people with bad nutrition status was 92%.

Discussion

The result of this study show that that nutritional status and RQ were most influential variables to lung vital capacity. The people living around Sukawinatan Landfill that had RQ greater than median (≥ 45.50) were 99.18% and those people would have lung vital capacity disorder.

The people with bad nutritional status had probability 12.085 times more to have lung vital capacity than people with good nutritional status.

Bad nutritional status will decrease the body immunity, people will be easily infected by microba. Related to respiratory infection, if it happens continuously followed by wet cough, the people will suffer from chronic brochitis. One of the effects of nutritional deficiency is the decrease of immunity and antibody that people will be easily infected by several infectious diseases like cough, fever and lacking body ability to do the detoxification to strange items. Study by Sartika,[11] concludes that nutrition status is one of the factors that affect upper respiratory track infection occurrence in infant.

RQ results show that of 39 people living around Sukawinatan Landfill, the percentage of people that had RQ greater than median (> 45.50) and suffered long vital capacity disorder was 94.9%. It was more than people having RQ less than median (< 45.50) with the percentage at 71.8%. Based on chi-square test results, there was p value = 0.006 (p value < 0.05), which means that there was a significant correlation between RQ and the lung vital capacity of people living around Sukawinatan Landfill.

RQ in this study was the risk level for non-carcinogenic effects (H_2S exposure). RQ decribed possibility to the risks to happen. If RQ > 1, people living around Sukawinatan Landfill had risks to get exposed to H_2S. Meanwhile, if RQ ≤ 1, people had less possibility to get exposed to H2S.

This study was in line with the study by Sulastri,[12] stating that there was a significant correlation between H_2S concentration and lung vital capacity (FVC dan FEV1) of people living around Tamangapa Antang Landfill (p value = 0.000). The study by Eduard, Pearce, & Douwes,[12] explained that H_2S level could influence the lung function (FEV1) for farmer. Then, the experiment done with the animal by Drimal *et al.*, [13], explained that the rats exposed to H_2S on high concentration could cause the respiratory system disorder.

From those results, it can be concluded that RQ was the calculation of how high the risk for people to get exposed to H_2S. The higher RQ, the higher risk for people to get exposed to H_2S. From the calculation of RQ, it was known that all RQ> 1. The percentage of RQ greater than median (> 45.50) that had lung vital capacity disorder was 94.9 %. OR score was 7.26 with 95% CI = 1.49-35.44. It means that people with RQ greater than median (> 45.50) had the probability 7.26 times more to have lung vital capacity disorder than those with RQ less than median (< 45.50). Probability of people with RQ more than median (> 45.50) having lung vital capacity was 87%.

The results of this study shows that dominant variables on binary logistic that potential to decrease lung vital capacity were RQ and nutritional status. Nutritional status influenced significantly to the lung vital capacity disorder. Nutritional status had OR 12.085, meaning that people with bad nutrition had 12 times more chances to have lung vital capacity than those with good nutritional status.

The decrease of lung vital capacity percentage on the individual having normal weight could be caused by the decrease of elasticity and wall chest stretching ability. The elastic wall chest will stretch more freely, so the intra thoracal pressure would be negative and inspirative air would be breathed more. Besides, the decrease of lung vital capacity could also be caused by the lack of diafragma ability to decrease the level of each individual who are over weight and with central obesity, so the intra throcal pressure would be less negative than the normal ones. Individual with thick chest wall due to the fat creases would distract the respiratory activity.[14]

Based on the bivariate analysis results, the percentage of people with bad nutritional status (fat or skinny) was 97 % having OR score 11.63 with 95% CI= 1.42-94.75. This means that people with bad nutritional status had 11.63 times more chances to have lung vital capacity disorder than those with good nutritional status. The probability percentage of people with bad nutritional status to have lung vital capacity disorder was 92%. That was in line with multivariate analysis in which nutritional status category had p value = 0.002 (p value < 0.05 with OR 12085. It means that people living around Sukawinatan Landfill with bad nutritional status had risks to have lung vital capacity disorder 12.085 times more than those with good nutitional status.

This study was in line with the study by Mandal & Majumdar,[15] who found out that there was correlation between the nutritional status and the lung vital capacity of stone grinders and brick field workers from west Bengal, India.[15] Chattopadhyay *et al.*,[16] , also did an experiment and found out that there was a significant correlation between the nutritional status and the lung vital capacity of Beedi workers in unorganized sectors. Then, the study by Mungreiphy,[17] showed that both low and high body mass index (BMI) were associated with the poor lung functions, and showed inverse relation. Subjects with normal BMI had better respiratory efficiency as compared to underweight, overweight/obese subjects.

People's nutritional status can influence the lung vital capacity. A skinny and tall person usually has more lung vital capacity than the fat and short one. The lack and over nutritional problem of adults (aged older than 18 years old) is an important problem because not only it is related to the risk of having certain diseases, it also can influence the work productivity, thus it needs more con-

tinuous control. One of the ways is by controlling the ideal or normal weight. The health condition can influence the lung vital capacity of person. If a person is healthy, that person will have strong and good respiratory muscles. In contrast, if a person is unhealthy, the strength of the respiratory muscles will decrease as well. Health disorder that is caused by the infection on respiratory system can decrease the lung function.[18]

Conclusion

Based on the results of this study, it can be concluded that there is a significant correlation of nutritional status and the lung vital capacity of people living around Sukawinatan Landfill (p value = 0.006). The dominant variable that influences significantly to lung vital capacity of people living around Sukawinatan Landfill was nutritional status (OR= 12.09).

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