



Evaluation of Lung Function as a Result of Bad Air Quality from Forest and Peatland Fires Concerning Work Activities

(Evaluasi Fungsi Paru sebagai Dampak Kualitas Udara Buruk dari Kebakaran Hutan dan Lahan Gambut Terkait Aktivitas Kerja)

Tumpal Simatupang^{1,2*}, Yetrie Ludang¹, Aswin Usup¹, Nawan¹, Bambang S. Lutt¹, Liswara Nenang¹

¹Postgraduate Program, Palangka Raya University, Indonesia

²Doris Sylvanus Hospital, Palangka Raya, Indonesia

*Corresponding Author: simatupang_tumpal@yahoo.com

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ABSTRACT

Air quality continues to be a significant concern for the environment and human health on a global scale, especially in emerging nations. In 2015, Indonesia attracted worldwide attention as a result of extensive forest and peatland fires. The particle concentration indicator in Central Kalimantan exhibited an elevated level in 2023 as compared to 2022. Exposure to air contaminated with PM pollution presents substantial health hazards for persons participating in routine activities. Nevertheless, there is a scarcity of studies about the effects of forest fires on respiratory health in Central Kalimantan. The calibrated Chest Miyagi multipurpose HI-801 spirometer was used to do lung function measurements. Participants were assessed while standing indoors in a controlled environment with consistent air flow. A researcher recruited a total of 215 respondents who met the research criteria from 7 urban and rural locations. The locations were subjectively chosen by the researcher to achieve the desired sample size, with a focus on places near forest and peatland fire sources. Prior to the test, the subjects' height and weight were assessed and entered into the spirometer, which then automatically calculated predictions for lung function. Spirometry is a method used to evaluate lung function, which involves measuring several parameters including forced vital capacity (FVC), forced expiratory volume in one second (FEV1), the ratio of FEV1 to FVC, and Forced Expiratory Flow (FEF). This study aimed to assess the effects of recurrent forest fires, which result in poor air quality, on lung function in individuals based on their occupation in Palangka Raya City, Pulang Pisau Regency, and Kapuas Regency, located in Central Kalimantan Province. This assessment was conducted using spirometry tests. In 2023, it was noted that the quantity of PM 2.5 in the air in Palangka Raya City surpassed the level set by the World Health Organisation (WHO). However, there were no notable variations in lung function among the participants based on their gender.

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ABSTRAK

Kualitas udara terus menjadi perhatian penting bagi lingkungan dan kesehatan manusia dalam skala global, terutama di negara-negara berkembang. Pada tahun 2015, Indonesia menarik perhatian dunia akibat kebakaran hutan dan lahan gambut yang luas. Indikator konsentrasi partikel di Kalimantan Tengah menunjukkan tingkat yang lebih tinggi pada tahun 2023 dibandingkan dengan tahun 2022. Paparan udara yang terkontaminasi dengan polusi PM menimbulkan bahaya kesehatan yang substansial bagi orang-orang yang berpartisipasi dalam kegiatan rutin. Namun demikian, terdapat kelangkaan penelitian tentang dampak kebakaran hutan terhadap kesehatan pernapasan di Kalimantan Tengah. Spirometer multiguna Chest Miyagi HI-801 yang telah dikalibrasi digunakan untuk melakukan pengukuran fungsi paru. Para peserta dinilai sambil berdiri di dalam ruangan dalam lingkungan yang terkendali dengan aliran udara yang konsisten. Seorang peneliti merekrut total 215 responden yang memenuhi

Kata Kunci:

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kriteria penelitian dari 7 lokasi perkotaan dan pedesaan. Lokasi-lokasi tersebut dipilih secara subyektif oleh peneliti untuk mencapai jumlah sampel yang diinginkan, dengan fokus pada lokasi-lokasi yang dekat dengan sumber kebakaran hutan dan lahan gambut. Sebelum tes, tinggi dan berat badan subjek dinilai dan dimasukkan ke dalam spirometer, yang kemudian secara otomatis menghitung prediksi fungsi paru-paru. Spirometri adalah metode yang digunakan untuk mengevaluasi fungsi paru-paru, yang melibatkan pengukuran beberapa parameter termasuk kapasitas vital paksa (FVC), volume ekspirasi paksa dalam satu detik (FEV1), rasio FEV1 terhadap FVC, dan Arus Ekspirasi Paksa (FEF). Penelitian ini bertujuan untuk menilai dampak kebakaran hutan yang berulang, yang mengakibatkan kualitas udara yang buruk, terhadap fungsi paru pada individu berdasarkan pekerjaan mereka di Kota Palangka Raya, Kabupaten Pulang Pisau, dan Kabupaten Kapuas, yang terletak di Provinsi Kalimantan Tengah. Penilaian ini dilakukan dengan menggunakan tes spirometri. Pada tahun 2023, tercatat bahwa kuantitas PM 2.5 di udara di Kota Palangka Raya telah melampaui ambang batas yang ditetapkan oleh Organisasi Kesehatan Dunia (WHO). Namun, tidak ada variasi yang mencolok dalam fungsi paru-paru di antara para peserta berdasarkan jenis kelamin mereka.

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1. Introduction

Global air quality continues to be a prominent concern for both the environment and public health, especially in less developed nations. Common sources of pollution commonly arise from transportation infrastructure, industrial facilities, garbage incineration, wildfires, and particle matter (Hime NJ. et al., 2018). The contaminants found in forest fire smoke include particulate matter (PM), carbon monoxide (CO), carbon dioxide (CO₂), nitrogen dioxide (NO₂), methane (CH₄), volatile organic compounds (VOCs), and ozone (O₃) (Schneider SR and Jonathan P.D. Abbatt, 2022; Hassan S.K and Mamdouh I.K, 2017). Air pollution has both immediate and long-lasting impacts on human health (Khaniabadi et al., 2018; Liu Jun et al., 2021). Outdoor air pollution exposure in developing nations indirectly leads to around 4.3 million fatalities per year, according to the World Health Organisation (WHO, 2015). In Indonesia, the total number of deaths caused by air pollution from particulate matter and ozone (O₃) was 71,372 in 2010. This estimate rose to 80,650 in 2016 (Ritchie, 2021). In the Republic of Indonesia, Government Regulation No. 22 of 2021 classifies particulate matter into two categories based on size: PM_{2.5} and PM₁₀. Particulate matter (PM) is a composite blend of tiny particles including dust, filth, smoke, and liquids that are present in the air. PM_{2.5}, which

refers to particulate matter with a size less than 2.5µm, is currently the subject of much research because of its capacity to deeply penetrate the lungs and circulate in the bloodstream (Azizah, 2019; Indiana Department of Environmental Management, 2014). The data from Palangka Raya, Pulang Pisau District, and Kapuas District indicate a significant number of cases of upper respiratory tract infections (URTIs) in 2014 and 2015, coinciding with peatland forest fire and haze episodes, as reported by the Governor of Central Kalimantan in 2015. This study aims to assess the influence of repeated forest fires, which lead to air pollution, on lung function among individuals in different occupations in Palangka Raya City, Pulang Pisau District, and Kapuas District, located in Central Kalimantan Province. This will be done through the use of spirometry tests. The locations were chosen using purposive sampling, taking into account that these three areas are regularly exposed to and impacted by forest and peatland fires.

2. Methods

The study was carried out in Palangka Raya city, Pulang Pisau Regency, and Kapuas Regency. The selection of places was conducted via purposive sampling, taking into account that these three areas are susceptible to and impacted by frequent forest and peatland fires. A grand total of 215 participants that

satisfied the research criteria were effectively enlisted. The researcher conducted examinations at 7 places, both in urban and rural regions. These locations were chosen subjectively to meet the required sample size, with consideration given to areas near the sources of forest and peatland fires. This study utilised a cross-sectional methodology, gathering data from samples of the population affected in Palangka Raya City, Pulang Pisau Regency, and Kapuas Regency. The study sample comprised individuals who were 20 years of age or older. The participants were chosen by non-probability purposive sampling, a method in which the researcher selects respondents based on defined criteria or for specific objectives. Data collecting took place between September and December 2023.

3. Result and Discussion

3.1. Result

The most common occupation among the respondents was found to be unemployment (43.3%), followed by farmers (37.2%) and private employees (14.9%), ranking second and third, respectively.

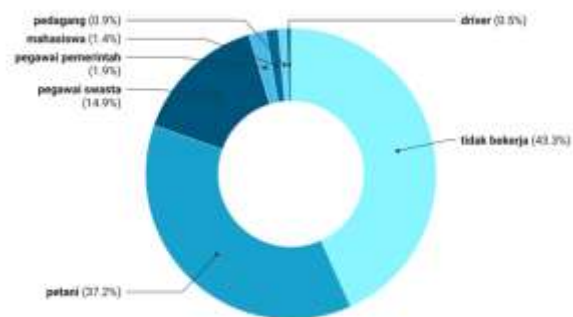


Figure 1. Respondents' Occupational Distribution

The lung function based on occupation can be observed in Table 1. The highest FVC value was found in students ($85.6\% \pm 16.9$),

while the lowest FVC value was found in farmers ($64.3\% \pm 25.8$). Traders and the unemployed showed similar FVC values ($65.5\% \pm 4.2$ and $65.7\% \pm 17.5$, respectively), which were also similar to those of farmers. Meanwhile, those with stable jobs such as government and private employees had FVC values that did not differ significantly ($69.9\% \pm 9.9$ and $69.1\% \pm 18.5$, respectively). The FEV1 values followed a similar pattern to the FVC values, with students having the highest FEV1 value ($78.3\% \pm 13.9$) and farmers having the lowest FEV1 value ($56.6\% \pm 25.3$). However, there was a difference in the pattern of FEV values compared to FVC. The FEV values of farmers and the unemployed did not differ significantly ($56.6\% \pm 25.3$ vs. $56.8\% \pm 19.5$). The FEV value of traders was slightly higher ($63.9\% \pm 5.6$) compared to the FEV values of government employees ($58.6\% \pm 11.1$) and private employees ($60.5\% \pm 25.7$).

The highest FEV/FVC ratio was observed in traders ($97.6\% \pm 12.9$) and the unemployed ($96.4\% \pm 108.5$), while government employees ($86.9\% \pm 24.5$) and private employees ($85.6\% \pm 20.6$) had the lowest FEV/FVC values. The lowest FEF value was found in respondents who were unemployed ($66.6\% \pm 31.6$), while the highest FEF value was found in government employees ($112.2\% \pm 110.1$). The most common occupation among the respondents was found to be unemployment (43.3%), followed by farmers (37.2%) and private employees (14.9%), ranking second and third, respectively.

3.2. Discussion

The researcher conducted sensitivity analysis to specifically examine lung function impairment based on occupation. This was done by excluding respondents who were students from the analysis. Students were

Table 1. Mean Values of Lung Function Parameters Based on Occupation (n=215)

Variable	Occupation (x ± SD)						P Value
	Government Employees	Private Employees	Farmer	Traders	Student	Unemployed	
FVC	69.9 ± 9.9	69.1 ± 18.5	64.3 ± 25.8	65.5 ± 4.2	85.6 ± 16.9	65.7 ± 17.5	0.481
FEV ₁	58.6 ± 11.1	60.5 ± 25.7	56.6 ± 25.3	63.9 ± 5.6	78.3 ± 13.9	56.8 ± 19.5	0.481
FEV ₁ /FVC	86.9 ± 24.5	85.6 ± 20.6	90.2 ± 18.2	97.6 ± 12.9	89.9 ± 2.8	96.4 ± 108.5	0.807
FEF	112.2 ± 110.1	71.2 ± 40.4	79.7 ± 99.4	70.5 ± 18.1	72.1 ± 16.6	66.6 ± 31.6	0.969

excluded because all of them (100%) did not have any lung function impairment (Table 14). Bivariate analysis between age, gender, occupation, and lung function impairment was conducted using chi-square analysis. Based on this study, it can be concluded that the lung function parameter values among farmers, traders, and the unemployed are similar. Similarly, the lung function parameter values among government and private employees also show similarity. However, the lung function parameter values among students differ. Indoor conditions can exacerbate due to ventilation in each house, allowing outdoor air to enter the house and potentially affect those indoors, especially for traders and the unemployed (Ardiyani et al., 2023). Lung function impairment among government and private employees shows moderate risk compared to farmers/traders/unemployed. This is because of the effect of buildings equipped with air conditioning which helps block the entry of outdoor air, where ventilation such as windows and doors are closed during forest fires (Ardiyani et al., 2023; Sharma, 2017). Air pollution is receiving attention in several major cities in Indonesia due to the trend of declining air quality in these cities (Santoso, M., 2020).

4. Conclusion

The conclusion of this research is that farmers, traders, and respondents who are unemployed tend to show poorer lung function compared to government employees and private workers.

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