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Risk Analysis of Exposure to Particulate Matter (PM10) for Quarry C Mining Workers at PT. X Palu

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Article Info	ABSTRACT
	One of the air pollutants that can cause health problems is particulate matter. Continuous exposure to PM10 can lead to various health issues, especially the ones related to the respiratory system. Workers at PT. X Palu have a higher risk of developing diseases caused by PM10 exposure. This is because they work and remain in an environment with PM10 exposure throughout their working hours. The purpose of this research is to analyze health risks due to PM10 exposure among C mining workers at PT. X Palu. This study used a quantitative descriptive method with an environmental health risk analysis (EHRA) approach. The study population consisted of 15 workers selected using a total sampling technique. PM10 samples were collected using an air sampler. Measurements were taken at 3 location points every hour during operational hours in the mining area, along with filling out observation sheets and interviewing respondents. The results showed that the PM10 concentration outdoor was 0.07777778 mg/m³. This value exceeds the quality standard set by the Ministry of Health Regulation No. 2 of 2023 for a 24-hour period, which is 75 μg/m³ or 0.075 mg/m³. The PM10 intake values ranged from a minimum of 0.0309 mg/kg/day to a maximum of 0.2534 mg/kg/day. The RQ values were ≤1, indicating that the workers were not at risk. Based on all the measurements conducted, it can be concluded that although the PM10 concentration at PT. X Palu exceeds the quality standard, the workers are not at risk. It is recommended that PT. X Palu implement health promotion programs for employees to help prevent the health impacts of PM10 exposure, monitor policies regarding the use of personal protective equipment (PPE), and conduct routine medical check-ups for workers.

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INTRODUCTION

One activity that has the potential to produce PM10 is C mining (stone mining). PM_{10} is air pollution consisting of several small particles consisting of a complex mixture of solid particles and liquid droplets of organic and inorganic materials in the air with an aerodynamic diameter of 10 microns or smaller and is easily inhaled into the respiratory tract through the nose or mouth. The efficiency of inhalation of particulate matter into the respiratory tract is very important to determine the magnitude of particulate concentration and the health effects that will be caused. Based on data from the Energy and Mineral Resources Office of Central Sulawesi Province in 2024, there were 70 active C mining companies, both in Palu City and Donggala Regency, of which 28 were located in the administrative area of Palu City. This study was conducted to analyze the health risks due to exposure to particulate matter (PM10) for C mining workers at PT. X Palu.

LITERATURE REVIEW

Based on the Regulation of the Minister of Environment and Forestry of Indonesia No. 11 of 2021, air pollution is the entry or introduction of substances, energy, and/or other components into the ambient air by human activities so that they exceed the established ambient air quality standards. One of the air pollutants is particulate matter (PM), which is a term for air pollution in the form of small particles that can settle in the lower respiratory tract and can cause continuous irritation of the respiratory tract accompanied by various tissue reactions. According to the Regulation of the Minister of Health (PERMENKES) No. 2 of 2023, the ambient air quality standard for PM10 in a 24-hour measurement is 75 µg/m³, and for an annual average, 40 µg/m³.

METHODOLOGY

This type of research uses a quantitative descriptive method with a cross-sectional research design and an observational approach and Environmental Health Risk Analysis (ARKL), the focus of the research location is outdoors (security post, road and crusher). The number of samples in this study is 15 respondents using total sampling. The process of collecting, processing and analyzing data is by interviewing respondents, weighing respondents, filling out observation sheets and measuring PM10 concentrations using an Air Sampler measuring tool, as well as conducting documentation.

RESULT

PM_{10} concentration values were measured for 3 days on Friday-Tuesday, October 11-14, 2025. These measurements were conducted at PT. X Palu by taking 3 outdoor points with a distance of 100 meters each between the points. The research points were point 1 at the security post, point 2 on the road passed by material transport trucks, and point 3 at the crusher. The time for measuring PM_{10} concentration values was carried out in the morning, afternoon, and evening, with morning starting at 08.00-10.00 WITA, afternoon starting at 11.00-14.00 WITA, and evening at 15.00-17.00 WITA. Measurements were carried out at these times because they are operational hours at PT. X Palu, which produces air pollution. Outdoor measurements with the highest average value were on day 1, namely 114.037 µg/m³ or 0.1144037 mg/m³, while measurements with the lowest value were on day 3, namely 77.77778 µg/m³ or 0.07777778 mg/m³.

Table 1. **Results of outdoor PM_{10} concentration measurements at PT. X Palu**

Measurement Results (µg/m3)				
Day/Date	Time	Point 1	Point 2	Point 3
Saturday, 11/10/2025	08.00-09.00	46	68	80
	09.00-10.00	54	67	108
	10.00-11.00	88	122	103
	11.00-12.00	95	174	165
	12.00-13.00	20	150	60
	13.00-14.00	60	225	189
	14.00-15.00	44	243	205
	15.00-16.00	43	127	149
	16.00-17.00	20	205	169
Average 114,037 µg/m³ = 0,114037 mg/m³				
Monday 13/10/2025	08.00-09.00	25	54	189
	09.00-10.00	32	103	108
	10.00-11.00	20	243	255
	11.00-12.00	55	309	301
	12.00-13.00	27	37	73
	13.00-14.00	43	32	90
	14.00-15.00	67	125	172
	15.00-16.00	87	119	108
	16.00-17.00	56	111	94
Average 108, 7037 µg/m³ = 0,1087037 mg/m³				
Tuesday 14/10/2025	r08.00-09.00	30	54	80
	09.00-10.00	45	45	86
	10.00-11.00	47	90	116
	11.00-12.00	68	96	141
	12.00-13.00	40	31	67
	13.00-14.00	53	73	131
	14.00-15.00	80	64	174
	15.00-16.00	55	90	149
	16.00-17.00	40	33	122
Average 77,77778 µg/m³ = 0,07777778 mg/m³				

DISCUSSION

This study focused on analyzing the health risks of particulate matter (PM10) exposure to workers in the C-type mining area. This study must take into account several factors. In addition to the PM10 concentration values, we also need to identify several other factors, such as the C value, exposure frequency, intake, exposure

duration, and concentration, to determine the RQ value for each respondent. All 15 respondents in this study had an RQ value ≤1. However, the PM10 concentration values obtained during the 3-day study period exceeded the standard. Several respondents also experienced respiratory problems such as coughing, sneezing, runny noses, shortness of breath, sore throats, headaches, eye irritation, and skin irritation during their work in the C-type mining area. This aligns with research by Regina et al. (2021), which also reported numerous respiratory complaints among industrial workers. Although the RQ values obtained for all workers in this study were not risky, the result does not mean that risks will not arise during prolonged work for miners.

CONCLUSIONS

The conclusion of this study is the daily exposure time value (tE) is 8 hours/day, the frequency value (ƒE) is 365 days/year, the lowest intake value obtained is 0.000309063 mg/kg/day, and the highest intake value is 0.2550343301 mg/kg/day, so that the measurement has an RQ≤1 value, meaning it is still safe or not yet risky. According to the Director General of P2-PL in 2012, the exposure duration value (Dt) is 1-8 years, and the particulate matter concentration (C) value obtained is 0.1001728 mg/m³, or equivalent to 100.1728 μg/m³, which means it exceeds the quality standard of 75 μg/m³ for 24-hour measurements according to Permenkes No. 2 of 2023, and the risk characteristics (RQ) of particulate matter (PM$_{10}$) in this study are 15 respondents who have an RQ≤1 value. This means it does not pose a health risk. A limitation of this study is that PM10 concentration measurements were only conducted during operational hours, i.e., 8 hours. The result does not adequately reflect the air quality at PT. X Palu over a 24-hour period. Ideally, measurements should be conducted over a 24-hour period or 1 year.

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