



Factors related to work due to hypoxia in confined space workers of pt osaka buana konstruksi

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Abstract

Confined space workers are a job with high risk, but it cannot be avoided for several reasons related to the production process. One of the risks is hypoxia in workers. This study aims to determine the factors associated with the incidence of work-related hypoxia in confined space workers at PT Osaka Buana Construction. This research is an analytical observational study with a cross-sectional design. The population in this study was 33 confined space workers at PT Osaka Buana Construction. The research sample consisted of 33 people obtained using the total sampling method. Measurements were carried out using a questionnaire for age and length of service variables. The nutritional status variable is measured based on BMI, hypoxia is measured using a pulse oximeter. The data obtained were analyzed bivariate using Spearman Rho's correlation test because the data was not normally distributed. The results of the study showed that the variables age (pvalue=0.455), length of service (pvalue=0.813), and nutritional status (pvalue=0.598) were not related to the incidence of hypoxia in confined space workers at PT. Osaka Buana Construction. Based on the research results, age, length of service and nutritional status do not have a significant relationship with the incidence of hypoxia in PT confined space workers. Osaka Buana Construction.

Keywords: Hypoxia, Confined Space, Worker, Nutritional.

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1. Introduction

Working in a confined space is one job in the industrial world with a high risk. However, working in a confined space cannot be avoided for several essential reasons related to the continuity of the production process. Confined space means a room that is large enough and has a configuration in such a way that workers can enter and carry out work in it has limited access in and out, such as in tanks, ships, silos, storage areas, safes or other spaces that are may have limited access, not designed for continuous or, continuous work in it [1]. Hazards in Confined space can be grouped into two, namely atmospheric hazards and non-atmospheric hazards. Atmospheric hazard is a danger related to indoor air, such as oxygen levels, toxic chemical substances, flammable gas/vapor/mist, etc. Meanwhile, non-atmospheric hazards are hazards related to physical hazards, such as dangers from work equipment and environmental

conditions, both inside and outside Confined Space. There are several potential hazards in confined spaces, such as chemical hazards, biological hazards, and physical hazards, atmospheric gases [2]. Atmospheric hazards (hypoxia and toxic atmospheric conditions) are the hazards that contribute most to the occurrence of work accidents in confined spaces (3). Atmospheric hazards (hypoxia and toxic atmospheric conditions) are the hazards that most contribute to work accidents in confined spaces (4). Oxygen is the second most abundant gas in the air after nitrogen and is a basic need for living creatures. Oxygen is essential in metabolism, chemical transport, acid-base balance, and providing nutrition to cells. The body can experience a lack of oxygen called hypoxia [3]. The effects of hypoxia will affect critical organ systems in different ways. People in healthy conditions exposed to moderate hypoxic conditions will develop tolerance by responding to try to increase oxygen delivery. At the same

time, the central nervous system experiences dysfunction as a result of a lack of oxygen. This condition can damage the nerves, brain, liver, and other organs and can cause death in humans. This symptom can be characterized by an above-average heart rate, very low oxygen saturation, fast and short rhythm and volume [5]. Joint research by WHO and ILO estimates that around 1.9 million workers worldwide died due to accidents or work-related diseases in 2016. Among the 19 occupational risk factors studied, the main risk was exposure to long working hours, which caused the deaths of 750,000 workers. Workplace exposure to air pollution (particulate matter, gases, and smoke) causes 450,000 deaths [6]. According to data from OSHA (Occupational Safety and Health Administration), among confined space accidents reported from 1984 to 1986, suffocation and poisoning caused 146 deaths, asphyxiation caused 42 deaths, and about 12% of deaths in the process rescue [3]. In Indonesia, work accidents due to working in confined spaces occurred in Balikpapan, in which three oil and gas workers died due to inhaling poisonous gas while checking water storage tanks. IN Pangkalan Kerinci, there was also an accident that happened to an employee of PT. Riau Prima Energi (RPE), which caused the victim to die, and three associate employees had to be hospitalized due to respiratory problems. In this incident, the victim was declared dead due to inhaling the chemical Sulfamic Acid. A similar accident also occurred on November 21, 2016, which caused two workers to die while carrying out welding to repair an oil storage tank at the PT factory. Tawu Inti Bati [7]. The use of silos is generally used in agriculture, the flour mill industry, and the feed mill industry as a place to store agricultural products, products, or animal feed. A silo is a storage area that has a mechanical mechanism in it; from a security level, it is quite dangerous due to the high risk of accidents. Some of the gas content of the existing materials takes over the position of oxygen in the silo. Based on initial information obtained from K3 Experts from PT. Osaka Buana Construction that before starting work on Confined space, there are measurements of atmospheric gases, including Oxygen, Carbon Monoxide, and H₂S, and measurements of the lowest concentration of flammable gases in the air which will spread fire when exposed to an ignition source (LEL). Measurements are carried out to determine the security level of the Confined Space area before use. If one of the parameters exceeds the threshold value (NAB), there is a risk of causing problems to the health and safety of workers. Based on the background above, researchers are interested in conducting research related to factors related to work-related hypoxia in workers in confined spaces at PT. Osaka Buana Construction Makassar.

2. Participants & methods

This type of research is observational analytic with a cross-sectional study design. This research is to study the dynamics of the relationship between risk factors and effects by using an observation approach or collecting data at one time (point time approach). The dependent variable is the incidence of work-related hypoxia. Meanwhile, the independent variables consist of worker factors, including age, nutritional status, and length of work. Work environmental factors include oxygen levels in the air, hydrogen sulfide levels, and carbon monoxide levels. The research population was all confined space workers at PT. Osaka Buana Construction has as many as 33 people. The

sample was obtained using the total sampling method so that the number of samples was the same as the population, namely 33 people. Measurements were conducted using a questionnaire to obtain data on individual characteristics, age variables, and length of service. Hypoxia is measured using a pulse oximeter. Nutritional status is obtained by measuring BMI based on body weight measured using a digital scale, and height is measured using a microtome. The data obtained was then analyzed univariately and bivariate to see the relationship between variables. Bivariate tests were carried out using Spearman's rho correlation test because the data was not normally distributed.

3. Result

The respondents in this study were 33 people who were confined space workers at PT. Osaka Buana Construction Makassar. All respondents were male.

3.1 Univariate Analysis

The individual characteristics of the 33 respondents in this study are presented in the table 1 below: Based on the data in the table above, it shows that of the 33 respondents who experienced mild hypoxia, 16 people (48.5%), 4 people experienced moderate hypoxia (12.1%) and 13 people (39.4%) experienced normal conditions. Based on age data, there were 25 young workers (75.8%) and 8 old workers (24.2%) Based on work period data, there are 20 new workers (60.6%) and 13 old workers (39.4%). Based on the nutritional status table data, it shows that 18 workers with normal nutritional status (54.5%), 7 people (21.2%) are obese and 8 people are thin (24.2%).

3.2 Bivariate Analysis

Bivariate analysis was carried out to examine the relationship between age, length of service, and nutritional status with the incidence of hypoxia in PT confined space workers. Osaka Buana Construction. Bivariate analysis was carried out using the Spearman-Rho correlation test. Based on the data in the table above, it shows that of the eight respondents belonging to the old age group, one person (12.5%) experienced moderate hypoxia, three people (37.5%) experienced mild hypoxia, and four people (50%) were in standard category. Then, of the 25 respondents belonging to the young age group, there were three people (12%) with moderate hypoxia, 13 people (52%) experienced mild hypoxia, while the other nine people (36%) were in the normal category. The results of bivariate analysis using the Spearman correlation test obtained a p-value = 0.455 > 0.05, so it can be concluded that there is no significant relationship between worker age and the incidence of hypoxia in PT confined space workers. Osaka Buana Construction Makassar. The data in the table shows that of respondents with obese nutritional status, two people (28.6%) experienced moderate hypoxia, one person (14.3%) experienced mild hypoxia, while the other four people were in the normal category. Then, of the eight respondents whose nutritional status was thin, five (62.5%) experienced mild hypoxia, and three (37.5%) were in the normal category. Of respondents with normal nutritional status, two people (11.1%) experienced moderate hypoxia, ten people (55.6%) experienced mild hypoxia, and six people (33.3%) were in the normal category. The results of the bivariate analysis obtained a p-value = 0.598 > 0.05, so it can be concluded that

there is no significant relationship between the nutritional status of workers and the incidence of hypoxia in PT confined space workers. Osaka Buana Construction Makassar. Based on the data in the table, it shows that of the 13 respondents with long working periods, there were three people (23.1%) experienced moderate hypoxia, three people (23.1%) experienced mild hypoxia, and seven people (53.8%) in the category regular. Then, of the 20 respondents with a new period of work, one person (5%) experienced moderate hypoxia, 13 people (65%) had mild hypoxia, and 6 people (30%) were in the normal category. The bivariate results show a $p\text{-value} = 0.813 > 0.05$, so it can be concluded that there is no significant relationship between worker length of service and the incidence of hypoxia in PT confined space workers. Osaka Buana Construction Makassar.

4. Discussion

Oxygen is one of the gas components humans need to maintain the survival of all human body cells. Oxygen from the air inhaled by living creatures enters the lungs and is circulated throughout the body by being bound by red blood cells. Due to the importance of oxygen supply in the human body, information about oxygen levels in the blood is essential to determine the body's health condition. If humans lack oxygen, it can result in hypoxemia or hypoxia [8]. Age plays a vital role in tolerance to hypoxia. Research conducted [9] showed that respiratory function and blood circulation will improve from childhood and become optimal at 20-30 years. After that, there will be a decline. After reaching a maximum point in young adulthood, diffusion, ventilation, oxygen uptake, and all lung function parameters will decrease with increasing age. Based on the results of statistical tests, it was found that age was not significantly related to the incidence of hypoxia in PT confined space workers. Osaka Buana Construction. This can happen because most respondents are young, so the probability of experiencing hypoxia is relatively low. Young workers who experience hypoxia can be caused by other factors outside the worker's

age, such as smoking habits or physical fitness. This study's results align with the research results of Fadlilah et al. [10], who found no significant relationship between age and oxygen saturation (SpO₂) in Nursing Students at a university in Yogyakarta. Body Mass Index (BMI) is a simple way to monitor nutritional status, exceptionally underweight and overweight [11]. If BMI increases, fat tissue will affect cardiorespiratory function because excessive body fat can burden oxygen uptake by working muscles. Fat accumulation can inhibit oxygen supply from the blood in the muscles [12]. The high amount of fat in the body of obese sufferers will become an obstacle and increase the burden on cardiovascular and respiratory function. Based on the research results, workers' nutritional status did not have a statistically significant relationship with the incidence of hypoxia in PT confined space workers. Osaka Buana Construction. This can happen because workers are generally in the thin and regular nutritional status categories. So, the risk of experiencing disorders related to respiratory system disorders is generally low. This research is in line with Bimantara and Hardiansyah [13], who found no significant relationship between nutritional status and the quality of VO₂ max in students at the Sport Agar Sehat Semarang football school. Work period is the time or length of time the workforce works in a place. The working period can have a positive or negative effect. Suma'mur stated that the longer a person works, the more he is exposed to the dangers of the work environment. The longer a worker in a confined space works, the greater the potential for experiencing hypoxia. The study results showed no significant relationship between the work period and the incidence of hypoxia in confined space workers at PT Osaka Buana Construction. These results do not align with research conducted by Ginting, Santosa, and Trigunarso [14], who found a significant relationship between length of service and oxygen levels in the blood of gas station operator officers in Bandar Lampung City.

Table 1: Characteristics of Respondents

Variable	N	%
Hypoxia		
Normal	13	39.4
Mild Hypoxia	16	48.5
Moderate Hypoxia	4	12.1
Age		
Young	25	75.8
Old	8	24.2
Years of service		
New Workforce	20	60.6
Old Workforce	13	39.4
Nutritional status		
Thin	8	24.2
Normal	18	54.5
Fat	7	21.2

Table 2: Bivariate Analysis Results

Variable	Hypoxia Events						Total	P-value	
	Currently		Light		Normal				
	n	%	n	%	n	%			
Age									
Old	1	12.5	3	37.5	4	50.0	8	100	0.455
Young	3	12.0	1	52.0	9	36.0	25	100	
			3						
Nutritiona									
I status	2	28.6	1	14.3	4	57.1	8	100	0.598
Fat	0	0	5	62.5	3	37.5	18	100	
Thin	2	11.1	1	55.6	6	33.3	7	100	
Normal			0						
Years of service	3	23.1	3	23.1	7	53.8	13	100	0.813
Long	1	5.0	1	65.0	6	30.0	20	100	
New			3						

5. Conclusion

Based on the research results, the age of workers is not significantly related to the incidence of hypoxia, the nutritional status of workers is not significantly related to the incidence of hypoxia, and the length of service is not significantly related to the incidence of hypoxia in confined spaces worker at PT. Osaka Buana Construction. The following are recommendations for controlling the risk of hypoxia in young workers in confine space areas, namely by maintaining fitness and for companies to prepare personal protective equipment that meets standards and check the work environment periodically.

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Ethical permission

This research has been declared free from ethical problems based on the Decree of the Ethics Institute of the Faculty of Public Health, Hasanuddin University with the number 4511/UN4.14.1/TP.01.02/2023.

References

- [1] Minister of Manpower and Transmigration Decree. (2011). Decree of the Minister of Manpower and Transmigration of the Republic of Indonesia Number Kep. 326 /Men/ Xii /2011 Concerning Determination of Draft National Work Competency Standards for Indonesia in the Employment Sector in the Sector of Occupational Safety and Health, Sub-sector of Working in Confined Spaces.
- [2] C.-C. Chiu, Y.-M. Chang, T.-J. Wan. (2020). Characteristic analysis of occupational confined space accidents in Taiwan and its prevention strategy. *International Journal of Environmental Research and Public Health*. 17(5): 1752.. Available at: <https://doi.org/10.3390/ijerph17051752>.
- [3] J. Xia, Y. Liu, D. Zhao, Y. Tian, J. Li, Y. Zhong, N. Roy. (2021). Human factors analysis of China's confined space operation accidents from 2008 to 2018. *Journal of loss prevention in the process industries*. 71: 104480.. Available at: <https://doi.org/10.1016/j.jlp.2021.104480>.
- [4] Ferdian, D. Limanan, F. Ferdinal, E. Yulianti. (2020). The effect of chronic systemic hypoxia on the specific activity of the catalase enzyme in the blood and lungs of Sprague Dawley rats after being given fig leaves, *Tarumanegara Medical Journal*, 2(2), pp. 259–266.
- [5] L.A. Zain, R. Maulana, F. Utaminigrum. (2021). Hypoxia Detection Based on Heart Rate, Oxygen Saturation, Respiratory Volume and Rhythm Using the K-Nearest Neighbor Method. *Journal of Information Technology and Computer Science Development*. 5(1), pp. 146–153.
- [6] W.H. Organization. (2021). WHO/ILO joint estimates of the work-related burden of disease and injury, 2000–2016: global monitoring report.
- [7] N.I. Mardlotillah. (2020). Occupational Safety and Health Risk Management in Confined Space Areas. *Higeia Journal of Public Health Research and Development*. 4(Special 1), pp. 315–327.
- [8] D.B.S. Budi, R. Maulana, H. Fitriyah. (2019). Hypoxia Symptom Detection System Based on Oxygen Saturation with Heartbeat Using Arduino-Based Fuzzy Method. *Journal of Information Technology and Computer Science Development*. 3(2), pp. 1925–1933.
- [9] W.T. Sudaryanto. (2017). The Relationship Between Degree of Active, Light, Medium and Heavy Smoking and Blood Oxygen Saturation Levels (SpO2)', *Interest: Journal of Health Sciences*.
- [10] S. Fadlilah, N. H. Rahil, F. Lanni. (2020) 'Analysis of Factors Affecting Blood Pressure and Peripheral

- Oxygen Saturation (SPO₂)', *Kusuma Husada Health Journal*. 11(1), pp. 21–30.
- [11] R. Wulandari. (2023) 'The relationship between age and body mass index with VO₂max in basketball players at Mataram Basketball School and Bima Perkasa Academy'. *Scientific Journal of Physiotherapy*. 6(1), pp. 1–5. Available at: <https://doi.org/10.36341/jif.v6i01.3158>.
- [12] N. Gantarialdha. (2021) 'The relationship between body mass index and cardiorespiratory endurance expressed in VO₂max'. *Jurnal Medika Hutama*. 02(04), pp. 1162–1168.
- [13] G. Bimantara, A. Hardiansyah. (2023). 'The Relationship between Nutritional Status, Body Fat Percent, and Hemoglobin Levels on the Quality of VO₂ Max for Healthy Sports Football School Students Semarang'. 2023, 12(1), pp. 20–26.
- [14] D.B. Ginting, I. Santosa, S.I. Trigunarso. (2022). Blood Oxygen Levels of Bandar Lampung City Gas Station Operators in 2022. *Health Analyst Journal*. 11(2), pp. 104–109. Available at: <https://doi.org/10.26630/jak.v11i2.3553>.