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Correlation Analysis Between Cardiovascular Load and Lung Function Disorders Based on FVC Values in Construction Workers

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ABSTRACT

Introduction: Construction work environments, often characterized by exposure to dust and chemicals, pose significant risks to workers' respiratory and cardiovascular health. While much research has focused on the impact of dust on lung function, the role of cardiovascular load in contributing to these health issues remains underexplored. This study aimed to analyze the correlation between cardiovascular load (%CVL) and pulmonary function impairment based on forced vital capacity (FVC) in construction workers. **Methods:** This observational cross-sectional study involved 37 construction workers in Central Jakarta, selected through purposive sampling. Data were collected via spirometry and heart rate measurements before, during, and after work. **Results:** The results showed that 79% of respondents had restrictive disorders, while 21% had obstructive disorders. Statistical analysis revealed a significant negative correlation between %CVL and FVC values ($p < 0.001$; $r = -0.550$). These findings indicate that increased cardiovascular load is associated with decreased lung function, particularly in workers with long-term exposure to dust and extended work durations. **Conclusion:** Managing physical workload and controlling workplace environments are crucial to preventing pulmonary function decline in construction workers.

Keywords: cardiovascular load, pulmonary impairment, FVC, construction workers

INTRODUCTION

The work environment is one of the factors that greatly affects the health of construction workers, especially the health of lung and respiratory function. Workers in the construction sector are often exposed to dusty work environments, which can increase the risk of inhaling fine particles that hurt the respiratory system (Momtazmanesh et al., 2023). This condition requires special attention because continuous exposure to dust can potentially cause serious health problems in workers.

In addition to respiratory risks, work accidents are a serious threat to construction workers. Work accidents include physical incidents at the work site and diseases triggered by the work environment, such as exposure to dust, chemicals, and other pollutants (Kemnaker, 2016). This shows that aspects of occupational health and safety need to be managed properly to protect workers from various risks in the workplace.

Exposure to chemical pollutants, such as heavy metals and gases, also has a significant impact on the cardiovascular system. Workers exposed to these substances have a higher risk of developing heart disorders, such as unstable angina, stable angina, and hypertension (Vinnikov et al., 2023). In addition, workers with sedentary activities are also susceptible to thrombophlebitis, further strengthening the importance of controlling health risks in the

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workplace.

Not only chemical pollutants, but long-term exposure to inhaled silica dust can also have serious impacts on lung function. According to research conducted by Syuhrabi (2022), workers exposed to silica dust in the long term experienced a significant decrease in forced vital capacity (FVC) and forced expiratory volume in one second (FEV1), which are the main indicators of lung function. The greatest decrease in lung function was found in workers exposed to more than five times the permissible exposure threshold, indicating that controlling dust exposure is very important in preventing more severe lung health disorders.

However, previous studies have mostly focused on the impact of dust exposure on lung function without considering cardiovascular load as an additional risk factor. Cardiovascular load (%CVL) is an important indicator reflecting physical stress due to heavy work activities, which can also contribute to lung function disorders. In addition, the lack of studies investigating the relationship between %CVL and FVC, especially in construction workers in Indonesia, is a research gap that needs to be filled. Construction workers in Indonesia have unique characteristics, such as long working hours and exposure to different working environments from developed countries, so specific data are needed to understand their health risk factors.

This study aims to analyze the correlation between % cardiovascular load and lung function disorders measured by FVC values in construction workers. With a significant relationship, this study can provide an important contribution to understanding the interaction between cardiovascular physical load and lung health in the heavy worker population.

METHOD

This study uses observational research with a cross-sectional research design conducted from July to August 2024. The test research has also complied with ethical approval number 376/IX/2024/KEP. The population of this study were workers on the construction of Tower X in Central Jakarta. The number of samples was 37 people with a sampling technique using purposive sampling with the following criteria. Inclusion criteria: Age <50 years, male gender, work experience >5 years, all work sub-units. Exclusion criteria: have a history of lung disorders/diseases and have a history of uncontrolled asthma.

Samples that meet these criteria will then undergo lung function tests using spirometry before work and %cardiovascularload measurements by measuring the pulse rate before work, while working, and while resting.

The results of the study will be processed using univariate and bivariate data analysis. Univariate data analysis aims to determine the characteristics of respondents from: age, body Mass Index (BMI), duration of work in a day and length of work period.

The bivariate data analysis uses a normality test in the form of the Shapiro-Wilks Test because the number of respondents is less than 100 people and the correlation is tested using the Pearson Rank Test.

RESULTS

The research results were obtained as follows:

Univariate Data Analysis

Respondent Characteristics Based on Age, BMI, Duration of Work, Length of Work based on spirometry results, and % CVL

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Table 1. Respondent Characteristics

Characteristics	Category	Frequency	Percentage
Age	20 – 29	6	16%
	30 – 39	17	46^
	40 - 49	12	33%
	50 - 59	2	5%
IMT	BB Less	4	10%
	Normal	21	57%
	Overweight	7	19%
	Obesity	5	14%
Working Duration	5 -9 Hour	5	14%
	10 – 14 Hour	30	81%
	15 – 19 Hour	2	5%
Working Period	1 – 10 years	1	3%
	11 – 20 years	25	68%
	21 – 29 years	9	24%
	>29 years old	2	5%
Spirometry Results	Restriction	31	21%
	Obstruction	6	4%
%CVL	Repair Required	15	41%
	Allowed to work for short periods	19	51%
	Needs immediate corrective action	3	8%

Characteristic data based on age, it was found that the age range of the largest respondents was 30-39 years old, 17 people. The 30-39 year range is included in the productive age. While the age range of the fewest respondents was 50-59 years old, 2 people. Based on the BMI value, it was found that the BMI value range of the largest respondents was at the normal weight value, namely 57% or 21 people, and the fewest was the underweight category, 10% or 4 respondents. The range of work duration per day of the largest respondents was at a work duration of 10-14 hours per day, with as many as 30 people. While the range of work duration per day of the smallest respondents was at a work duration of 15-19 hours per day, as many as 2 people. The length of service of the largest respondents was at the age of 30-39 years, as many as 17 people. The age range of the smallest respondents was at the age of 50-59 years, with as many as 2 people. Spirometry results showed the most lung disorders, namely restriction. It can also be seen that more than 50% of workers showed a fairly high CVL%, namely being allowed to work for a short time. However, there are also quite a few things that need improvement (table 1.

Bivariate Data Analysis

Normality Test

Table 2. Normality Data

	Spirometry	Shapiro-Wilk Statistic	df	Sig.
CVL	Good	.860	24	.003
	Bad	.705	13	.001

Based on the results of the normality test using the Shapiro-Wilk Test, the sig. Value is 0.001. Thus, the data is normally distributed data (table 2).

Correlation Test

Table 3. Correlation Data

		CVL	Spirometry
CVL	Pearson Correlation	1	-.550
	Sig. (2-tailed)		.000
	N	37	37
Spirometry	Pearson Correlation	-.550	1
	Sig. (2-tailed)	.000	
	N	37	37

Based on the results of the correlation test using the Pearson Ranks Test, the sig. Value is 0.001 and the correlation coefficient shows a value of -0.550. Thus, the data includes a very

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significant correlation but is not in the same direction (table 3).

DISCUSSION

The hypothesis proposed in this study is that there is a significant negative relationship between increased cardiovascular load (%CVL) and Forced Vital Capacity (FVC) values in construction workers. Based on the results of statistical tests, this hypothesis is proven with a significant negative correlation ($p < 0.001$; $r = -0.550$). These results indicate that the higher the %CVL, the lower the worker's lung capacity, indicating that increased cardiovascular load can worsen lung function.

The interpretation of these results supports the understanding that cardiovascular load is an important indicator of cardiovascular workload, reflecting the level of physical stress due to prolonged heavy activity, such as lifting, and exposure to dust, and chemicals. In construction workers, heavy physical activity and exposure to hazardous environments accelerate the decline in FVC values, indicating restrictive disorders of lung function.

In the construction sector, workers are often exposed to high physical risks due to continuous heavy activity, such as lifting, and exposure to dust, and chemicals. Based on the results of statistical tests, a very strong positive correlation was found between increased CVL and decreased FVC values, indicating that increased cardiovascular load is closely related to decreased lung capacity (Fishwick, Barber, and Darby, 2010; World Health Organization, 2019).

The decrease in FVC reflects the impairment of lung capacity, which can be caused by various factors, including prolonged physical fatigue and exposure to hazardous substances in the work environment. The strong correlation between CVL and FVC suggests that workers with high cardiovascular loads are more susceptible to decreased lung function. This is supported by previous studies showing that exposure to a work environment with pollutants and heavy physical activity increases the risk of respiratory disorders, especially in workers involved in intense physical work (Hnizdo, 2002; Fishwick, Barber, and Darby, 2010).

In addition, this analysis also supports the finding that construction workers who experience increased CVL tend to experience a more significant decline in lung function compared to workers with lower CVL. The relationship between CVL and FVC suggests that excessive physical activity can worsen lung function, especially in workers exposed to dust and air pollution. In other words, increased CVL resulting from heavy physical activity significantly affects the decline in lung capacity as measured by FVC, making it important to monitor cardiovascular load to maintain workers' lung health.(Vinnikov et al., 2023).

In addition to the correlation between CVL and FVC, factors such as work period and daily work duration also play an important role in influencing the lung health of construction workers. Long work periods increase the risk of cumulative lung function decline due to long-term exposure to pollution and heavy physical activity. Workers with more than 10 years of work experience tend to experience a more significant decline in FVC values, especially if they work without adequate protection from hazardous exposures. This shows that the longer a person works in a high-risk environment, the greater the chance of lung function decline, and daily work duration also plays an important role in accelerating lung function decline. Workers who work more than 8 hours per day experience a greater increase in CVL and a more significant decline in FVC. Prolonged physical load without sufficient rest causes accumulation of physical and cardiovascular fatigue, which ultimately hurts the respiratory system. This shows that the arrangement of working hours and rest times is an important factor that must be considered in preventing lung function disorders in workers (Cullinan et al., 2017; Tavakol et al., 2017)

The combination of long working hours and excessive daily work duration creates conditions that are particularly risky for construction workers' lung health. Long-term exposure to dust, pollutants, and heavy physical activity, coupled with long working hours, leads to a more rapid

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decline in lung function. Workers who have worked for more than a decade in an environment with long working hours are more susceptible to a more significant decline in lung function, reinforcing the importance of work planning that takes physical well-being into account (Albert and García-Serrano, 2010; Sohrabi et al., 2022)

Based on the data obtained, the majority of workers experience restrictions. Construction workers tend to experience more restrictive disorders than obstructive disorders in lung function, although both types of disorders can occur. Restrictive disorders are more dominant due to the nature of the exposure experienced, such as silica dust, asbestos, and microparticles from other construction materials. These particles, if inhaled in the long term, cause pulmonary fibrosis with the formation of scar tissue that reduces lung elasticity. The body's physiological response to this exposure is chronic inflammation of the lung interstitial tissue, resulting in reduced total lung capacity (TLC) and vital volume (VC) (Albert and García-Serrano, 2010; NEGAR, 2024). This condition is often permanent and progressive. On the other hand, obstructive disorders, such as chronic bronchitis or occupational asthma, can also occur in construction workers due to exposure to certain gases, chemical fumes, or dust that trigger inflammation of the respiratory tract. However, these disorders are usually acute and can subside if exposure is stopped (Fishwick, Barber, and Darby, 2010). The risk of obstruction is also increased in workers who have a smoking habit. Thus, restrictive disorders are more common due to the nature of exposure that causes permanent damage to lung tissue, while obstructive disorders are more influenced by acute environmental factors or individual habits (Hnizdo, 2002; De Matteis et al., 2017).

Therefore, to improve occupational health and safety in the construction sector, it is important to monitor not only cardiovascular load (%CVL) but also work duration and daily work duration. This study has the strength in integrating %CVL analysis as an indicator of cardiovascular load that has rarely been the focus of previous studies related to lung function disorders. By using this approach, this study provides strong evidence that managing cardiovascular workload can be an important strategy in maintaining lung health in construction workers. In addition, specific data from the construction worker population in Indonesia provide a new contribution that is relevant in the local context, which is often underrepresented in the global literature.

Efforts such as reducing daily work duration, providing adequate rest, and conducting regular health checks for workers with long working hours are highly recommended. These interventions, based on the findings of this study, may help reduce %CVL and slow the decline in lung function in workers, especially in work environments with high exposure risk.

CONCLUSION

The results of the %CVL calculation show that the majority of workers are allowed to work in a short time and the results of lung function based on the results of the spirometry examination can be seen that 6 respondents experienced obstruction and 31 respondents experienced restriction. Based on the results of the statistical test, it can be concluded that there is a relationship between cardiovascular load and lung function in construction workers. This study is expected to be an evaluation for HSE and workers to pay attention to their heart and lung health by evaluating the limits of working hours and overtime in a day.

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REFERENCES

Albert, C. and García-Serrano, C. (2010) ‘Cleaning the slate? School choice and educational outcomes in Spain’, *Higher Education*, 60(6), pp. 559–582. Available at: https://doi.org/10.1007/s10734-010-9315-9.

ISSN 2722 – 9610
E –ISSN 2722 - 9629

Cullinan, P. *et al.* (2017) 'Occupational lung diseases: from old and novel exposures to effective preventive strategies', *The Lancet Respiratory Medicine*, 5(5), pp. 445–455. Available at: https://doi.org/10.1016/S2213-2600(16)30424-6.

Fishwick, D., Barber, C.M. and Darby, A.C. (2010) 'Review series: Occupational and environmental lung disease: Chronic obstructive pulmonary disease and the workplace', *Chronic Respiratory Disease*, 7(2), pp. 113–122. Available at: https://doi.org/10.1177/1479972309354690.

Hnizdo, E. (2002) 'Association between Chronic Obstructive Pulmonary Disease and Employment by Industry and Occupation in the US Population: A Study of Data from the Third National Health and Nutrition Examination Survey', *American Journal of Epidemiology*, 156(8), pp. 738–746. Available at: https://doi.org/10.1093/aje/kwf105.

Kemnaker (2016) *Statistik Ketenagakerjaan Indonesia. Kementerian Tenaga Kerja Republik Indonesia*.

De Matteis, S. *et al.* (2017) 'Current and new challenges in occupational lung diseases', *European Respiratory Review*, 26(146), p. 170080. Available at: https://doi.org/10.1183/16000617.0080-2017.

Momtazmanesh, S. *et al.* (2023) 'Global burden of chronic respiratory diseases and risk factors, 1990–2019: an update from the Global Burden of Disease Study 2019', *eClinicalMedicine*, 59, p. 101936. Available at: https://doi.org/10.1016/j.eclinm.2023.101936.

NEGAR, A.S. (2024) 'Cardiovascular disorders and exposure to chemical pollutants', *J PREV MED HYG*, 65.

Sohrabi, Y. *et al.* (2022) 'Pulmonary function and respiratory symptoms in workers exposed to respirable silica dust: A historical cohort study', *Heliyon*, 8(11), p. e11642. Available at: https://doi.org/10.1016/j.heliyon.2022.e11642.

Tavakol, E. *et al.* (2017) 'Risk Evaluation of Construction Workers' Exposure to Silica Dust and the Possible Lung Function Impairments', *National Research Institute of Tuberculosis and Lung Disease*, 16(4).

Vinnikov, D. *et al.* (2023) 'Occupational exposure to fine particulate matter in the reinforced concrete production and its association with respiratory symptoms and lung function', *BMC Public Health*, 23(1), p. 1813. Available at: https://doi.org/10.1186/s12889-023-16753-x.

World Health Organization (2019) *Occupational Health: A manual for primary healthcare workers*.

ISSN 2722 – 9610
E –ISSN 2722 - 9629