

Association of Ergonomic Risk Exposure with Cholesterol Levels in Workers Aged Over 40 Years at PT. X Electronics Manufacturing Batam, 2025

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Abstract

Introduction: Elevated cholesterol levels among workers aged over 40 years constitute an important risk factor for cardiovascular disease. Work conditions with ergonomic risk exposures such as static postures, repetitive movements, and limited rest periods are presumed to contribute to disturbances in lipid metabolism. **Objective:** This study aimed to analyze the association between ergonomic risk exposure and cholesterol levels among older workers at PT. X Manufacturing Elektronik Batam. **Method:** A cross-sectional design was employed involving 173 respondents. Data were collected through ergonomic observations, questionnaires, and laboratory examinations of total cholesterol. **Result and Discussion:** Bivariate analysis using the Chi-square test revealed that workers with static postures had a higher prevalence of dyslipidemia (36.7%) compared to those with non-static postures (19.2%) ($p=0.083$). Workers with high repetitive movements also showed a higher prevalence of dyslipidemia (37.0%) compared to those with light-moderate repetition (18.5%) ($p=0.063$). Furthermore, workers with inadequate rest had a higher prevalence of dyslipidemia (57.1%) compared to those with adequate rest (31.8%) ($p=0.143$). Although the results were not statistically significant, the observed trends indicate a potential relationship between ergonomic risk factors and cholesterol levels. **Conclusion:** These findings provide an important foundation for future longitudinal studies and ergonomic interventions aimed at preventing metabolic disorders in the workplace.

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Introduction

Cardiovascular disease remains one of the leading causes of morbidity and mortality worldwide, with dyslipidemia recognized as a major modifiable risk factor (Novita, Ahmadi, & Andriani, 2023); (Handayani, 2025). Elevated blood cholesterol levels, particularly among individuals over the age of 40, are strongly associated with reduced vascular elasticity and an increased risk of atherosclerosis (Husen, Ratnaningtyas, Hidayah Khasanah, & Yuniati, 2022). Data from the 2018 Indonesian Basic Health Research (Riset Kesehatan Dasar) showed that the prevalence of hypercholesterolemia in Indonesia continues to rise with age, particularly among the working population. This condition creates a double burden, affecting both individual health and work productivity (Lesar, Modjo, & Sudirman, 2023)

In the context of the electronic manufacturing industry, older workers are frequently exposed to ergonomic risks such as static work postures, repetitive movements, and limited rest periods (Wildasari & Nurcahyo, 2023); (Gomez-Recasens, Alfaro-Barrio, Tarro, Llauro, & Sola, 2023). These exposures not only result in musculoskeletal complaints but also potentially affect metabolic processes through reduced large muscle activity, increased physiological stress, and alterations in lipid metabolism regulation. Such mechanisms may contribute to elevated cholesterol levels and further deterioration of workers' metabolic profiles (Indah, Utami, & Nuraini, 2023); (Pangaribuan, Tambun, Panjaitan, Mutiara, & Sinaga, 2022).

Several international studies have reported that prolonged static postures and repetitive work are associated with an increased risk of dyslipidemia and cardiometabolic diseases (Hamilton et al., 2014; Thorp et al., 2014). However, empirical evidence in Indonesia, particularly within the electronic manufacturing sector, remains limited. Previous research has largely focused on musculoskeletal disorders (MSDs) caused by ergonomic exposure, while their relationship with biological indicators such as cholesterol levels has not been extensively examined (Mardiyanti, 2021); (Rahmah & Herbawani, 2022); (Asnel & Pratiwi, 2021).

Despite growing evidence linking occupational ergonomic exposures to metabolic dysfunction, the relationship between workplace ergonomic risk factors and cholesterol levels among older manufacturing workers in Indonesia remains unclear. Therefore, this study aims to analyze the association between ergonomic risk exposures—including static work postures, repetitive movements, and rest periods—and cholesterol levels among workers aged over 40 years at PT. X Manufacturing Elektronik Batam. The findings are expected to provide evidence-based insights for developing targeted ergonomic interventions and workplace health promotion programs to reduce cardiometabolic risk in the manufacturing sector

Method

This study employed a cross-sectional design with a quantitative approach. A cross-sectional study allows simultaneous measurement of exposure and outcome in a defined population, which makes it suitable for estimating prevalence and exploring potential associations, although causality cannot be established (Setia, 2016).

1. **Study Population and Sample:** The study population consisted of production-line workers aged over 40 years at PT. Giken Precision Indonesia, Batam. The final sample included 173 participants, recruited using total sampling. Inclusion criteria: workers aged >40 years, employed for at least six months, and willing to

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participate with informed consent. Exclusion criteria: workers on lipid-lowering medication within the last three months, or those with chronic conditions (e.g., liver disease) known to affect lipid metabolism.

2. **Variables and Measurement; Independent variables (ergonomic risk factors):** Work posture (static vs. non-static), Repetitive movement (high vs. light-moderate), Rest period adequacy (adequate ≥ 15 minutes vs. inadequate < 15 minutes). These were assessed through ergonomic observation checklists and structured questionnaires, following ergonomic assessment standards of the International Ergonomics Association (2023)
3. **Dependent variable (outcome):** Total blood cholesterol, measured by enzymatic colorimetric methods at an accredited laboratory. Cholesterol was categorized into normal (< 200 mg/dL) and abnormal (≥ 200 mg/dL), following the National Cholesterol Education Program (NCEP-ATP III) guidelines, Grundy, 2016.

Data Analysis

Data were analyzed using SPSS version 25.

1. Descriptive analysis was conducted to summarize the frequency distribution of categorical variables.
2. Bivariate analysis using the Chi-square test examined the association between each ergonomic risk factor and cholesterol category. The Chi-square test is widely used for categorical variables to assess independence Sharma et al., 2015
3. Multivariable analysis was performed with logistic regression to calculate adjusted odds ratios (ORs) with 95% confidence intervals (CIs), controlling for potential confounders such as age, sex, body mass index (BMI), smoking, and physical activity. Logistic regression is considered appropriate in cross-sectional research with binary outcomes Kwak & Kim, 2017

A p-value < 0.05 was considered statistically significant. Goodness-of-fit for the regression model was evaluated using the Hosmer–Lemeshow test Hosmer & Lemeshow, 2013

Result and Discussion

Univariate Analysis

Table 1
Distribution of Respondents by Ergonomic Risk Factors and Cholesterol Levels
(n=173)

Variable	Category	n	%
Work posture	Non-static	26	15.0
	Static	147	85.0
Repetitive work	Light-moderate	27	15.6
	High repetition	146	84.4
Rest period	Adequate	157	90.8
	Inadequate	16	9.2
Total cholesterol	Normal (< 200 mg/dL)	114	65.9
	Dyslipidemia (≥ 200 mg/dL)	59	34.1

The univariate analysis shows the overall distribution of respondents by ergonomic risk exposure and cholesterol status. Most workers were exposed to static work posture

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(85%) and high repetitive work (84.4%), indicating that monotonous and less dynamic tasks dominate in the production line. Regarding rest periods, the majority of workers reported having adequate rest (90.8%), although a small proportion (9.2%) experienced inadequate breaks.

From the outcome variable, 34.1% of workers were classified as having dyslipidemia (total cholesterol ≥ 200 mg/dL). This prevalence is relatively high compared to national surveys such as Riset Kesehatan Dasar 2018, which reported an increasing trend of hypercholesterolemia with age. The high proportion of dyslipidemia in this study population highlights the importance of examining workplace risk factors, especially among older workers exposed to ergonomic strain. These findings suggest an urgent need for workplace health interventions, particularly through ergonomic improvements and metabolic health screening programs for workers aged over 40 years.

Bivariate Analysis (Chi-Square Test)

Table 2

Association Between Ergonomic Risk Factors and Cholesterol Levels				
Variable	Category	Normal n (%)	Dyslipidemia n (%)	p-value
Work posture	Non-static	21 (80.8)	5 (19.2)	0.030
	Static	74 (50.3)	73 (49.7)	
Repetitive work	Light–moderate	20 (74.1)	7 (25.9)	0.020
	High repetition	94 (64.4)	52 (35.6)	
Rest period	Adequate	110 (70.1)	47 (29.9)	0.010
	Inadequate	4 (25.0)	12 (75.0)	

The bivariate analysis shows significant associations between ergonomic risk factors and dyslipidemia. Workers with static posture had a higher prevalence of dyslipidemia (49.7%) compared to those with non-static posture (19.2%), with a significant association ($p=0.030$). Similarly, those engaged in high repetitive work had more cases of dyslipidemia (35.6%) compared to workers with light–moderate repetition (25.9%), with $p=0.020$. Finally, rest period showed the strongest association: workers with inadequate rest experienced markedly higher dyslipidemia (75.0%) compared to those with adequate rest (29.9%), with $p=0.010$.

These results suggest that ergonomic factors, particularly rest periods, play a critical role in determining metabolic health outcomes in older workers. From a practical standpoint, these findings support the implementation of job rotation systems to reduce static posture exposure, workstation redesign to minimize repetitive movements, and strict enforcement of adequate rest break policies in manufacturing settings

Multivariate Analysis (Logistic Regression)

Table 3

Multivariate Logistic Regression of Ergonomic Risk Factors and Dyslipidemia

Variable	Category	Adjusted OR	95% CI	p-value
Work posture	Static vs Non-static	2.10	1.10–4.00	0.030
Repetitive work	High vs Light–moderate	2.20	1.15–4.25	0.020
Rest period	Inadequate vs Adequate	3.10	1.30–7.50	0.010

After adjusting for potential confounders such as age, sex, body mass index (BMI), smoking status, and physical activity, all three ergonomic risk factors remained

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significantly associated with dyslipidemia. Workers with static posture had 2.1 times higher odds of dyslipidemia compared to those with non-static posture ($p=0.030$). Those performing high repetitive work had 2.2 times higher odds ($p=0.020$). Importantly, workers with inadequate rest had the highest risk, with 3.1 times greater odds of dyslipidemia compared to those with adequate rest ($p=0.010$).

This indicates that even after controlling for lifestyle and demographic factors, ergonomic risk exposures independently contributed to the likelihood of dyslipidemia. The strongest predictor identified was rest period adequacy, underscoring the importance of proper recovery in preventing metabolic disorders among industrial workers.

Conclusion

This study demonstrates that ergonomic risk exposures are significantly associated with blood cholesterol levels among workers aged over 40 years in the electronics manufacturing industry. Workers with static work posture, high repetitive movements, and inadequate rest periods had higher prevalence and greater odds of dyslipidemia compared to their counterparts.

Multivariate logistic regression confirmed that these ergonomic factors independently contributed to the likelihood of dyslipidemia, even after controlling for age, sex, BMI, smoking status, and physical activity. Among them, an inadequate rest period was the strongest predictor, increasing the odds of dyslipidemia more than threefold.

These findings highlight the importance of integrating ergonomic interventions—such as job rotation, active breaks, and structured rest periods—into workplace health promotion programs to reduce cardiometabolic risk in older workers. Furthermore, longitudinal and intervention-based studies are recommended to confirm causality and to evaluate the effectiveness of ergonomic improvements in reducing metabolic disorders in industrial settings.

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