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Associations Between Non-Ergonomic Working Posture, Work-Related Stress, Smoking Habits, and Physical Activity with Low Back Pain among Police Personnel in the Special Region of Yogyakarta

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ABSTRACT

Background: Low back pain is one of the most common musculoskeletal complaints among police personnel. Several factors, including working posture, work-related stress, smoking habits, and physical activity, are presumed to be associated with the occurrence of low back pain. This study aimed to analyze factors associated with low back pain among police personnel.

Subjects and Method: This analytic observational study with a cross-sectional design involved 226 male and female police personnel aged 20–40 years in the Special Region of Yogyakarta, selected using total sampling. The dependent variable was the occurrence of low back pain, while the independent variables included working posture, work-related stress, smoking habits, physical activity, age, and years of service. Data were collected using the Rapid Upper Limb Assessment (RULA) to assess working posture, the Police Stress Questionnaire–Operational (PSQ-Op) to measure work-related stress, and the Numeric Rating Scale (NRS) to assess low back pain intensity. Data were analyzed using the Chi-square test and path analysis.

Results: Path analysis showed significant direct effects of non-ergonomic working posture (b = 0.19; 95% CI = 0.09 to 0.29; p < 0.001), work-related stress (b = 0.35; 95% CI = 0.23 to 0.46; p < 0.001), smoking habits (b = 0.17; 95% CI = 0.05 to 0.29; p = 0.007), physical activity (b = −0.16; 95% CI = −0.27 to −0.05; p = 0.006), and age (b = 0.11; 95% CI = 0.01 to 0.22; p = 0.034) on the occurrence of low back pain. Years of service had an indirect effect on low back pain through age (b = 0.99; 95% CI= 0.98 to 0.99; p < 0.001).

Conclusion: Non-ergonomic working posture, work-related stress, smoking habits, physical activity, and age have direct effects on the occurrence of low back pain.

Keywords: Low back pain, working posture, work-related stress, smoking, physical activity

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BACKGROUND

Low back pain is defined as pain occurring in the lower back region, specifically between the lower margin of the 12th rib and the gluteal fold. This condition can limit an individual's work activities and social interactions (WHO, 2023). Low back pain is one of the most prevalent musculoskeletal disorders worldwide, with an estimated lifetime prevalence ranging from 49% to 70% among the adult population (Potaczek and Jasiewicz, 2023).

Data from the Global Health Data Exchange indicate that approximately 70% of years lived with disability are attributed to low back pain (Laurensyah et al., 2024). Despite its high prevalence, low back pain is often underestimated compared to life-threatening diseases such as cancer and infectious diseases.

However, it imposes a substantial economic burden on governments, particularly in terms of healthcare costs, reduced productivity, absenteeism, and disability (Chowdhury et al., 2023). Low back pain may result from various factors, including occupational physical exposures such as prolonged standing, walking, or sitting, repetitive lifting, and awkward working postures (Sormunen et al., 2022).

Police personnel typically work 7–8 hours per day and often remain seated or standing for extended periods, increasing the risk of musculoskeletal disorders, including low back pain. Non-ergonomic working postures may lead to continuous muscle contraction, resulting in muscle tension and shortening (Crisanty et al., 2024).

Working posture refers to an ideal body position that ensures proper alignment of body segments, thereby minimizing the energy required to maintain a given position (Khairani et al., 2023). Ergonomic posture enables individuals to achieve optimal balance between body mass distribution and skeletal structure within their physical limitations. Proper posture enhances respiratory function and improves blood and fluid circulation, thereby reducing muscle fatigue and minimizing pain (Khairani et al., 2023).

Work-related stress is another factor associated with low back pain, as stress may mediate the occurrence of disorders or behaviors linked to low back pain (Laurensyah et al., 2024). Among police personnel, low back pain is not primarily caused by heavy lifting, as commonly observed in manual laborers, but rather by static and repetitive work demands.

These include prolonged sitting during patrol or administrative duties, extended standing during traffic control, the use of heavy equipment such as vests and utility belts, and non-ergonomic postures during duty. Prolonged exposure to these conditions may increase biomechanical load on the lumbar spine and trigger low back pain. High workload can also induce work-related stress, impair concentration, and increase the risk of absenteeism (Khairunnisa et al., 2024). Uniformed personnel, such as police officers, are frequently exposed to both acute and chronic stressors in the workplace (Jankowski et al., 2021).

Smoking habits have also been associated with low back pain. Nicotine is known to impair blood flow to intervertebral disc tissues and accelerate spinal degeneration, thereby increasing susceptibility to low back pain. In certain occupational groups, including police personnel, smoking prevalence tends to be higher.

A study among traffic police officers at Jombor Traffic Post, Sleman Police Resort, Yogyakarta, reported that 57% of officers were active smokers (Anggareni et

al., 2024). Smokers are reported to have nearly twice the risk of experiencing low back pain compared to non-smokers (Dai et al., 2021).

Physical activity is another important factor related to low back pain, particularly among police personnel who may have low exercise frequency. Several mechanisms explain this association. Lack of physical activity may reduce core muscle strength, which plays a crucial role in supporting the spine, thereby increasing the risk of low back pain (Teichtahl et al., 2015).

Physical inactivity also contributes to weight gain, which increases mechanical load on the spine and elevates the likelihood of low back pain (Alzahrani et al., 2019). This correlation arises from excessive mechanical stress imposed on spinal structures due to overweight or obesity. Additionally, obesity is associated with postural and biomechanical changes that further increase spinal load and vulnerability to low back pain (Kato et al., 2021).

Police personnel often spend prolonged periods in static sitting or standing positions. Without adequate physical exercise, posture may deteriorate, increasing pressure on the lumbar region and leading to low back pain (Locatelli, 2021).

SUBJECTS AND METHOD

1. Study Design

This study employed an analytic observational design with a correlational approach and a cross-sectional method, in which all study variables were measured simultaneously. The study was conducted at five police offices in the Special Region of Yogyakarta from May to June 2025.

2. Population and Sample

The study population consisted of police personnel in the Special Region of Yogyakarta. The sample included 226 male and female police personnel aged 20–40 years. The sample size was determined based on the rule-of-thumb recommend-dation for moderate sample sizes ranging from 200 to 400 participants (Piriyakul, 2021).

3. Study Variables

The dependent variable was low back pain. The independent variables were working posture, work-related stress, smoking habits, and physical activity.

4. Operational Definitions

Low Back Pain: Defined as pain occurring in the lower back region, specifically between the lower margin of the ribs and the gluteal fold, with or without radiation to the lower extremities (WHO, 2021).

Non-ergonomic Working Posture: A body position that does not conform to ergonomic principles, thereby increasing biomechanical load on the musculoskeletal system, particularly in the lower back region (Edwards and Fortingo, 2024).

Work-related Stress:: A psychological and physiological condition resulting from an imbalance between job demands and an individual's capacity to cope with those demands (Ugwuoke et al., 2024).

Smoking Habits: The habitual use of tobacco products leading to exposure to harmful substances such as nicotine, carbon monoxide, and tar, which negatively affect health (WHO, 2021).

Physical Activity: Refers to structured and regular physical activities performed to improve physical fitness, health, and overall well-being (WHO, 2021). In this study, physical activity refers to voluntary activities performed by police personnel outside the routine physical training mandated by institutional standard operating procedures.

5. Research Instruments

Data were collected using structured questionnaires. Low back pain was assessed using an LBP screening questionnaire, and pain intensity was measured using the Numeric Rating Scale (NRS). Working posture was evaluated using the Rapid Upper Limb Assessment (RULA). Work-related stress was measured using the Operational Police Stress Questionnaire (PSQ-Op). Smoking habits were assessed using the WHO STEPS instrument (Tobacco Use), and physical activity was measured using the International Physical Activity Questionnaire (IPAQ).

6. Data Analysis

Univariate analysis was conducted to describe the characteristics of study variables, including sex, education level, low back pain status, age, years of service, pain intensity, non-ergonomic working posture, work-related stress, smoking habits, and physical activity. Bivariate analysis was performed to examine the association between independent variables (working posture, work-related stress, smoking habits, and physical activity) and low back pain using the Chi-square test at a 95% confidence level (95% CI). Multivariate analysis was conducted using path analysis, a statistical technique used to assess both direct and indirect effects of independent variables on the dependent variable (Ayuningrum et al., 2019). The analysis followed several steps, including model specification, model identification, parameter estimation, and model re-specification (if necessary). All analyses were performed using Stata version 13.

7. Ethical Considerations

Ethical principles applied in this study included informed consent, anonymity, and confidentiality. Ethical approval was obtained from the Ethics Committee of Dr. Moewardi Regional General Hospital, Surakarta, on May 9, 2025 (Ref. No.: 892/V/HREC/2025).

RESULTS

1. Univariate Analysis

Table 1 presents the characteristics of 226 police personnel based on categorical data. The majority of respondents were male (218; 96.46%), while 8 (3.54%) were female. Regarding educational level, 152 respondents (67.26%) had completed high school/ vocational education, 68 (30.09%) held a bachelor's degree, and 6 (2.65%) had a master's degree. Based on low back pain (LBP) status, 124 respondents (54.87%) reported experiencing LBP, whereas 102 (45.13%) did not.

Table 1. Univariate Analysis of Categorical Variables (n = 226)

Variable	Frequency (n)	Percentage (%)
Sex		
Male	218	(96.46%)
Female	8	(3.54%)
Education Level		
High School/Vocational School	152	(67.26%)
Bachelor's Degree	68	(30.09%)
Master's Degree	6	(2.65%)
LBP		
No	102	(45.13%)
Yes	124	(54.87%)

Table 2 summarizes the characteristics of respondents based on continuous variables. The mean age was 32.23 years (SD=5.16), ranging from 20 to 40 years. The mean years of service was 12.31 years (SD=5.22), with a range of 0 to 21 years. The mean LBP pain intensity score was 1.16 (SD=1.22; range 0–3). The mean score for non-ergonomic working posture was 7.50 (SD=2.41; range 3–12). The mean work-related stress score was 4.54 (SD= 1.10; range 3–6). The mean smoking habit score was 2.09 (SD = 1.89; range 1–5). The mean physical activity level was 2339.90 MET-minutes/week (SD=1252.04; range 111–4957).

Table 2. Univariate Analysis of Continuous Variables (n = 226)

Variable	Mean	SD	Min.	Max.
Age (years)	32.23	5.16	20	40
Years of Service (years)	12.31	5.22	0	21
LBP Pain Intensity	1.16	1.22	0	3
Non-ergonomic Working Posture	7.5	2.41	3	12
Work-related Stress	4.54	1.10	3	6
Smoking Habits	2.09	1.89	1	5
Physical Activity (MET-min/week)	2339.9	1252.04	111	4957

2. Bivariate Analysis

Table 3 shows the bivariate analysis of age, years of service, pain intensity, non-ergonomic working posture, work-related stress, smoking habits, and physical activity based on LBP status. The mean age in the LBP group was significantly higher than in the non-LBP group (35.31 ± 3.18 vs. 28.49 ± 4.61; $p < 0.001$). Similarly, the LBP group had longer years of service compared to the non-LBP group (15.42 ± 3.24 vs. 8.54 ± 4.66; $p < 0.001$).

The mean pain intensity score was significantly higher in the LBP group (2.11 ± 0.82) compared to the non-LBP group (0.00 ± 0.00; $p < 0.001$). The mean score of non-ergonomic working posture was also higher in the LBP group (8.91 ± 1.97) than in the non-LBP group (5.79 ± 1.68; $p < 0.001$).

The mean work-related stress score was higher in the LBP group (5.34 ± 0.74) compared to the non-LBP group (3.57 ± 0.55; $p < 0.001$). Similarly, smoking habit scores were higher in the LBP group (3.43 ± 1.33) than in the non-LBP group (0.47 ± 0.99; $p < 0.001$).

In contrast, physical activity showed an inverse pattern. The non-LBP group had a significantly higher mean physical activity level (3329.78 ± 954.94 MET-minutes/week) compared to the LBP group (1525.64 ± 798.60 MET-minutes/week; $p < 0.001$).

Table 3. Bivariate analysis of age, years of service, pain intensity, working posture, work-related stress, smoking, physical activity, and low back pain

Independent Variables	LBP		Non-LBP		p
	Mean	SD	Mean	SD	
Age (years)	35.31	3.18	28.49	4.61	<0.001
Years of Service (years)	15.42	3.24	8.54	4.66	<0.001
LBP Pain Intensity	2.11	0.82	0	0	<0.001
Non-ergonomic Working Posture	8.91	1.97	5.79	1.68	<0.001
Work-related Stress	5.34	0.74	3.57	0.55	<0.001

Independent Variables	LBP		Non-LBP		p
	Mean	SD	Mean	SD	
Smoking Habits	3.43	1.33	0.47	0.99	<0.001
Physical Activity (MET-min/week)	1525.64	798.60	3329.78	954.94	<0.001

3. Analisis Multivariat

Multivariate analysis was conducted using path analysis to evaluate both direct and indirect effects of variables associated with low back pain among police personnel.

a. Structural Model

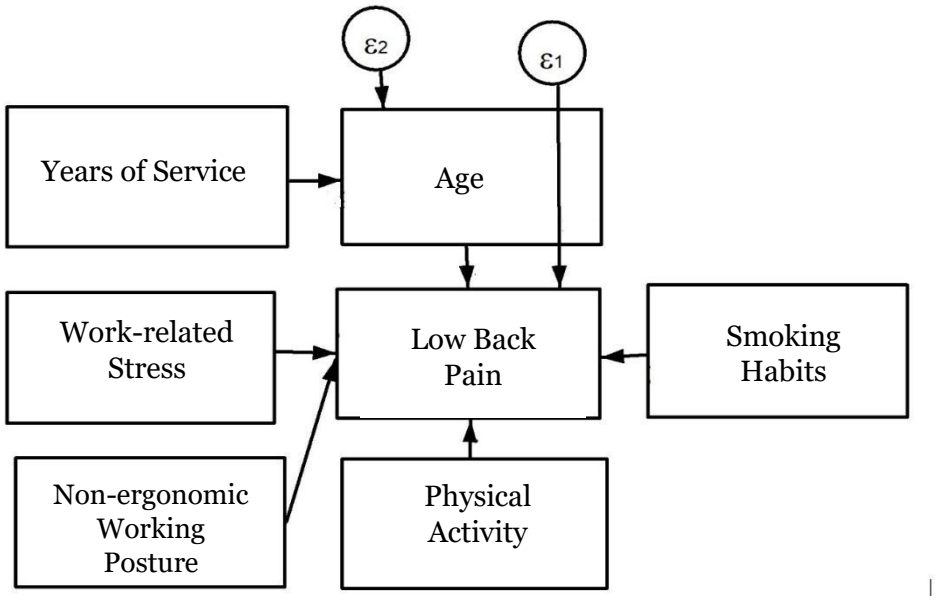

Figure 1. Structural Model of Path Analysis Examining the Associations between Working Posture, Work Stress, Smoking, Physical Activity, Age, and Tenure, and Low Back Pain

The structural model (Figure 1) demonstrates that low back pain is directly influenced by non-ergonomic working posture, work-related stress, smoking habits, physical activity, and age. Non-ergonomic working posture, work-related stress, smoking habits, and age showed positive effects on LBP, whereas physical activity showed a negative effect. Years of service had an indirect effect on LBP through age.

b. Model Fit and Parameter Estimation

Prior to parameter estimation, model fit was evaluated to ensure adequacy of the proposed path model. The goodness-of-fit indices indicated a well-fitting model, with $p = 0.244$ ($p > 0.05$), RMSEA = 0.045 (< 0.08), CFI = 0.98 (> 0.90), TLI = 0.95 (> 0.90), and SRMR = 0.032 (< 0.08). These results suggest that the model was appropriate for estimating the relationships among study variables.

Table 4 shows that all analyzed variables were statistically significantly associated with low back pain ($p < 0.001$). Age was positively associated with LBP, with the LBP group being older by 6.82 years on average (b = 6.82; 95% CI = 5.35 to 8.29; $p < 0.001$). A similar pattern was observed for years of service, where each additional year was associated with an

increased risk of LBP (b = 6.88; 95% CI = 5.32 to 8.45; p < 0.001).

Pain intensity differed significantly between groups, with the LBP group reporting higher scores (b=2.11; 95% CI= 1.97 to 2.25; p<0.001). Non-ergonomic working posture also showed a significant difference, with higher mean scores in the LBP group (b=3.12; 95% CI = 2.52 to 3.72; p < 0.001).

Work-related stress scores were significantly higher in the LBP group, with a mean difference of 1.77 points (b=1.77; 95%CI=1.55 to 1.99; p<0.001). Smoking habits were also higher in the LBP group, with a mean difference of 2.96 points (b= 2.96; 95% CI=2.53 to 3.39; p<0.001).

In contrast, physical activity was negatively associated with LBP. The non-LBP group had a higher average physical activity level, with a mean difference of 1804.14 MET-minutes/ week (b=−1804.14; 95%CI= −2043.76 to −1564.52; p<0.001). This finding indicates that higher levels of physical activity are associated with a lower risk of low back pain.

Table 4. Path Analysis of Factors Associated with Low Back Pain

Dependent Variable		Independent Variable	b	95% CI		p
				Lower limit	Upper limit	
Direct Effects						
LBP	←	Non-ergonomic Working Posture	0.19	0.09	0.29	<0.001
	←	Work-related Stress	0.35	0.23	0.46	<0.001
	←	Smoking Habits	0.17	0.05	0.29	0.007
	←	Physical Activity	-0.16	-0.27	0.05	0.006
	←	Age (years)	0.11	0.01	0.22	0.034
Indirect Effects						
Age (years)	←	Years of Service (year)	0.99	0.98	0.99	<0.001
n = 226						
p = 0.244						
RMSEA = 0.045						
CFI = 0.98						
TLI = 0.95						
SRMR = 0.032						

DISCUSSION

1. Association between Non-ergonomic Working Posture and Low Back Pain

The findings of this study are consistent with those of Prihantini et al. (2024), which demonstrated a significant association between sitting posture and low back pain among office employees at the Directorate General of New, Renewable Energy and Energy Conservation. This suggests that poor sitting posture is a major ergonomic factor contributing to low back pain in office workers. Although the study population differs from police personnel, similarities in job characteristics such as prolonged sitting and limited postural variation may lead to comparable risk mechanisms.

Among police personnel, these risks may be exacerbated by fieldwork demands, the use of duty equipment, and prolonged sitting during patrol or administrative tasks, thereby increasing the likelihood of musculoskeletal disorders. An experimental study by Hasan and Ma'Rufa (2024) further

supports this finding, reporting that barbers in Surabaya often worked in uncomfortable postures for extended periods, with 53% experiencing low back pain, highlighting insufficient ergonomic awareness and the need for ergonomic education.

Similarly, Suryadi and Rachmawati (2020) reported a significant association between working posture and low back pain among packaging workers in the tobacco industry, where individuals with moderate to high-risk postures experienced severe functional impairment. In addition, Prianggi et al. (2021) found that workers who sat for ≥8 hours per day had a 1.31 times higher risk of low back pain compared to those who sat for <8 hours (aOR = 1.31; 95% CI = 0.64 to 2.54; p = 0.43).

2. Association between Work-related Stress and Low Back Pain

This study is in line with Rabbing et al. (2022), who reported that high levels of occupational stress among police investigators were associated with increased musculoskeletal complaints, particularly in the lower back. Similarly, Range et al. (2023) highlighted that police personnel are at high risk of low back pain due to chronic occupational stress, compounded by heavy workloads and prolonged static postures in patrol vehicles.

Furthermore, Demissie et al. (2024) identified prolonged computer use, non-ergonomic sitting positions, lack of ergonomic training, and insufficient physical activity as significant contributors to musculoskeletal disorders, particularly affecting the lower back, neck, and shoulders. These findings suggest that prolonged work-related stress, in the absence of adequate organizational support and stress management strategies, is a key determinant of low back pain, especially in occupations involving repetitive or static tasks.

3. Association between Smoking Habits and Low Back Pain

The present findings are consistent with Hilmi et al. (2024), who identified smoking as a lifestyle factor associated with physical health problems, including low back pain. Similar results were reported by Hassan et al. (2024), indicating that 52.7% of traffic police officers in Duhok were smokers, with 45.3% experiencing musculoskeletal complaints, including low back pain.

Ekinci and Şevgin (2023) further demonstrated that smoking may induce degenerative changes in the spine and contribute to neuropathic pain. Additionally, Locatelli (2021) reported that among military police, the use of equipment such as belt holsters which increase lumbar load was associated with a low back pain prevalence of 74.2% and chronicity of 70.1%. The study also emphasized that uneven load distribution, compounded by lifestyle factors such as smoking and physical inactivity, may increase the risk of chronic low back pain.

These findings support the conclusion that smoking is a significant risk factor for low back pain, particularly in occupations with high physical demands such as policing.

4. Association between Physical Activity and Low Back Pain

This study is consistent with Wilhelm et al. (2025), who demonstrated that physical activity particularly leisure-time physical activity is an effective preventive strategy for low back pain. Regular engagement in moderate to vigorous physical activity helps maintain posture, reduce muscle stiffness, and improve overall spinal health.

Similarly, Marins et al. (2025), in a randomized controlled trial among public safety workers, reported that an 8-week

smartphone-based exercise program focusing on core stability and health education significantly reduced pain intensity (MD=−1.54; 95%CI= −2.95 to −0.13) and disability (MD= −3.23; 95%CI=−5.51 to −0.95) compared to controls. These benefits persisted up to 16 weeks for disability, quality of life, and anxiety outcomes.

Rabbing et al. (2022) also emphasized the importance of physical activity in maintaining both physical and mental well-being among police personnel, who are at high risk of stress and musculoskeletal disorders. Although not all studies demonstrate a direct relationship between exercise and pain reduction, physical activity contributes to improved physical and psychological resilience. Thus, regular physical activity serves as a protective factor against low back pain, particularly among workers with high physical demands and static work postures.

5. Association between Age and Low Back Pain

The findings of this study are consistent with Locatelli (2021), who reported that low back pain prevalence was higher among both younger and older age groups among military police in Brazil, with chronicity increasing with age. This may be attributed to declining physical condition, cumulative workload, and reduced elasticity of musculoskeletal structures.

Ekinci and Şevgin (2024) also found that individuals aged 40–56 and 57–79 years experienced significantly higher pain intensity compared to younger individuals aged 18–39 years ($p < 0.05$). Additionally, psychological and organic pain beliefs increased with age, indicating that age influences both pain perception and severity.

Douma et al. (2018) further reported that older age (as reflected by seniority) was significantly associated with an increased prevalence of chronic low back pain (aOR = 1.061; 95% CI = 1.007 to 1.118). These findings highlight that age contributes not only to biological susceptibility but also to cumulative exposure to occupational ergonomic risks.

6. Association between Years of Service and Age

The association between years of service and age is inherently logical, as age increases alongside accumulated work experience. Locatelli et al. (2021) stated that older police personnel with longer service duration had a higher prevalence of low back pain, reinforcing the close relationship between age and years of service as risk factors for musculoskeletal disorders.

Similarly, Douma et al. (2018), in a study of 2,208 patrol officers in Canada, reported a mean age of 35.8 years (SD = 8.1) and mean years of service of 12.1 years (SD=7.6), indicating that increasing age is closely aligned with longer service duration and may elevate the risk of musculoskeletal disorders, including low back pain.

Ekinci and Şevgin (2024) also found that age was significantly associated with the severity of chronic low back pain, with older individuals reporting higher pain intensity and stronger pain-related beliefs. These findings suggest that increasing age is not only related to longer work exposure but also to greater symptom severity and perception.

AUTHOR CONTRIBUTIONS

VWM conceptualized the research question, developed the proposal, collected data, and performed data analysis.

S and BM provided input on the research methodology.

S, BM, RGHN, and AD contributed to manuscript review and refinement.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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