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RESEARCH ARTICLE

# Risk factors and musculoskeletal disorder complaints among desk workers at PDAM Tirtanadi, Medan City

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**ABSTRACT**

**Background:** Musculoskeletal disorders (MSDs) represent a major occupational health concern, especially among computer-based workers. This study examined individual and occupational risk factors associated with MSD complaint levels among workers at PDAM Tirtanadi in Medan City.
**Method:** Using an analytical cross-sectional survey design, we recruited 150 respondents through purposive sampling. Data collection involved the Nordic Musculoskeletal Questionnaire to assess MSD complaints and the Rapid Office Strain Assessment (ROSA) to evaluate work postures. Analysis employed the chi-square test.
**Results:** Most workers (64.0%) reported high MSD complaint levels. Bivariate analysis showed significant associations with work posture, age, and work tenure. High-risk work posture emerged as the dominant factor: 83.8% of workers in this category reported high MSD complaint levels. Older age (69.3%) and longer work tenure (69.4%) also associated with high MSD complaint levels. No significant associations appeared with gender (p=0.146) or body mass index (p=0.718).
**Conclusion:** Non-ergonomic work postures, older age, and longer work tenure were the primary predictors of MSD complaints in this population. Management should implement an ergonomics program that addresses workstation design, posture training, and work scheduling to promote worker health.

**Keywords:** musculoskeletal disorders, work posture, risk factors

## Introduction

Occupational health is a fundamental right for every worker, which employers must guarantee. Workers have the right to choose work that provides prosperous, fair, safe, and decent conditions, including a comfortable environment.[1] Work-related diseases stem from risks in the work environment.[2] Ergonomic hazards represent a key occupational health issue, threatening worker health and causing losses for both workers and employers.[3,4] These impacts on workers include fatigue, which reduces productivity and leads to lost workdays and financial losses for employers. Musculoskeletal disorders are a primary health problem arising from ergonomic risks.[5,6]

Musculoskeletal disorders (MSDs) disrupt the function of joints, ligaments, muscles, nerves, tendons, and the spine. These degenerative conditions damage body tissues, causing pain that limits movement and impairs daily activities.[7,8] Recent study estimates indicate about 2.9 million annual work-related deaths in 2019, with diseases like circulatory issues and neoplasms predominant, though MSDs account for a substantial share of disability-adjusted life years (DALYs).[9] In Indonesia, the 2018 Basic Health Research (Riskesdas) reported an MSD prevalence of 7.3%, higher in older age groups and women.[10]

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MSDs risk is high among office workers, particularly those using computers for prolonged periods. Extended static sitting contributes to MSD symptoms, including neck, shoulder, and back pain, which reduce employee productivity.[11,12] Employees at PDAM Tirtanadi in Medan City spend most of their workday at computers managing customer data, monitoring water distribution systems, and performing administrative tasks. Initial surveys and interviews revealed frequent employee reports of MSD symptoms in the neck, shoulders, lower back, and wrists. These symptoms reduce individual comfort and quality of life, lower work productivity, increase absenteeism, and elevate company healthcare costs. Observations confirmed non-ergonomic workstations, including uncomfortable chairs and desks that were too high or too low, which promote poor posture and physical fatigue. Long working hours, inadequate equipment, and poor posture together increase MSD risk and severity among these workers.

Although research on musculoskeletal disorders (MSDs) among office workers is extensive, most studies use general ergonomic assessment tools such as RULA or REBA, which suit manufacturing tasks better.[13,14] This study applies the Rapid Office Strain Assessment (ROSA), an instrument designed specifically for computer-based workstations.[15,16] It also examines workers in the public service sector (PDAM Tirtanadi), whose workloads involve prolonged static computer use, often exceeding 8 hours daily due to water distribution system demands. The findings contribute theoretically by demonstrating that, in this homogeneous static office environment, physical factors such as body mass index (BMI) and gender do not predict MSD complaints. This contrasts with ergonomic studies in other sectors and indicates that workplace risks, particularly work posture, outweigh individual physiological characteristics in public service administration.[13,14] Based on this background, the study aims to analyze individual and occupational risk factors associated with MSD complaint levels among PDAM Tirtanadi workers in Medan City.

## Method

This study employed an analytic cross-sectional survey design with an explanatory approach. This design was selected to test the hypothesis regarding the relationship between independent variables (work posture, age, sex, body mass index, and tenure) and the dependent variable (level of musculoskeletal complaints) at a single point in time. The study was conducted at the PDAM Tirtanadi Head Office in Medan City in November 2025. This site was chosen because the work characteristics were homogeneous and dominated by prolonged static activities at computers, making it relevant to the ergonomics study objectives.

The population comprised all 240 workers at the PDAM Tirtanadi Head Office. Purposive sampling was used to select respondents who met inclusion criteria relevant to office ergonomics risks. Inclusion criteria included active use of computers as the primary work tool for at least 4 hours per day and willingness to participate. Sample size calculation yielded 150 respondents, deemed sufficient for statistical power in testing variable relationships. This sampling method minimized bias from field workers not exposed to the same office workstation ergonomics risks as the primary subjects.

Data were collected using two internationally recognized instruments in ergonomics and occupational health. The first was the Nordic Musculoskeletal Questionnaire (NMQ) Body Map, which measured the intensity and location of musculoskeletal complaints across 28 body regions. Complaint scores were classified into three levels: low (28-49), moderate (50-70), and high (71-112). The second was the Rapid Office Strain Assessment (ROSA) method, which assessed work posture risks at computer-based workstations. ROSA evaluation included section A (chair), section B (monitor and telephone), and section C (keyboard and mouse). Final ROSA scores greater than 5 indicated high risk requiring immediate corrective action. Both instruments are standard measures with established validity and reliability, eliminating the need for pilot testing in this population.

Procedures followed a chronological sequence, beginning with preparation (obtaining management permission from PDAM Tirtanadi and explaining procedures to potential respondents). After obtaining written informed consent, researchers conducted direct observations of workers' postures at their workstations using the ROSA guide. Respondents then completed individual data and NMQ Body Map questionnaires to record perceived pain or discomfort during daily tasks. All collected data were checked for completeness before digital processing.

Data analysis used statistical software in two main stages. Univariate analysis described frequency distributions and percentages for individual characteristics and ergonomics variables. Bivariate analysis tested relationships between independent and dependent variables using the chi-square test. Statistical

significance was set at $p < 0.05$ with 95% confidence intervals. Significant $p$-values indicated statistically meaningful associations between risk factors and musculoskeletal complaint levels.

Ethical approval was obtained from the Health Research Ethics Committee of Universitas Prima Indonesia (registration no. 002/KEPK/UNPRI/VII/2025). This study formed part of an undergraduate thesis conducted for academic purposes. The institution approved it, and PDAM Tirtanadi Medan granted permission. All participants received information about the study purpose and provided verbal consent before participating. As the study involved only noninvasive questionnaire administration and observation of work postures, with no biological samples or patient data, the institution deemed formal ethical review unnecessary. The study adhered to all relevant principles of the Declaration of Helsinki on anonymity and confidentiality.

## Results

Analysis of 150 office workers at PDAM Tirtanadi Medan revealed a high prevalence of musculoskeletal issues in the administrative environment. As shown in Table 1, 64.0% of participants reported high levels of musculoskeletal complaints, 14.0% reported moderate levels, and 22.0% reported low levels. Ergonomic risk assessment using the Rapid Office Strain Assessment (ROSA) categorized 64.0% of workers at high risk and the remaining 36.0% at moderate risk. Demographically, the workforce was predominantly experienced, with 76.0% of respondents aged 35 years or older and 74.0% having at least 5 years of tenure.

Table 1. Frequency distribution of respondent characteristics and ergonomic risk

| Characteristic | n = 150 | % |
|---|---|---|
| Level of musculoskeletal complaints | | |
| High | 96 | 64,00 |
| Moderate | 21 | 14,00 |
| Low | 33 | 22,00 |
| Work Posture | | |
| High Risk (Score >5) | 96 | 64,00 |
| Moderate Risk (Score 3-5) | 54 | 36,00 |
| Age | | |
| Older (≥35 Years) | 114 | 76,00 |
| Younger (<35 Years) | 36 | 24,00 |
| Work Tenure | | |
| Long (≥5 Years) | 111 | 74,00 |
| Short (<5 Years) | 39 | 24,00 |
| Gender | | |
| Female | 94 | 62,70 |
| Male | 56 | 37,30 |

Source: Primary Data, 2026

Bivariate analysis with the chi-square test showed a significant association between work posture and musculoskeletal complaint severity ($p < 0.001$). As shown in Table 2, 82.3% of workers in the high-risk posture category reported high complaint levels, compared with 31.5% in the moderate-risk category.

Table 2. Association of Work Posture, Age, and Tenure with Musculoskeletal Complaints

| Variable | High Level n (%) | Moderate Level n (%) | p-value |
|---|---|---|---|
| Work Posture | | | |
| High Risk | 79 (82.3%) | 10 (10.4%) | <0.001 |
| Moderate Risk | 17 (31.5%) | 11 (20.4%) | |
| Age | | | |
| Older (≥35 Years) | 79 (69.3%) | 15 (13.2%) | 0.037 |
| Younger (<35 Years) | 17 (47.2%) | 6 (16.7%) | |
| Work Tenure | | | |
| Long (≥5 Years) | 77 (69.4%) | 15 (13.5%) | 0.036 |
| Short (<5 Years) | 19 (48.7%) | 6 (15.4%) | |

Source: Primary Data, 2025

Individual demographic factors also correlated significantly with complaint levels. Workers aged 35 years or older had a higher prevalence of high complaint levels (69.3%) than younger workers (47,20%; $p = 0.037$). Similarly, work tenure predicted complaint severity: workers employed for 5 years or longer reported high levels at 69.4%, compared with 48.7% for those with shorter tenures ($p = 0.036$).

In contrast, certain individual characteristics showed no statistically significant associations with musculoskeletal complaint levels in this study population. Gender was not significant (p = 0.143), with high complaint levels in 67.0% of female workers and 58.9% of male workers. BMI also showed no significant association (p = 0.718); prevalence remained consistent across obese (65.9%), normal-weight (61.3%), and underweight (66.7%) categories (Table 3).

Table 3. Association of Gender and BMI with Musculoskeletal Complaints

| Variable | High Level n (%) | Moderate Level n (%) | p-value |
|---|---|---|---|
| Gender | | | |
| Female | 63 (67.0%) | 15 (16.0%) | 0.143 |
| Male | 33 (58.9%) | 6 (10.7%) | |
| Body Mass Index | | | |
| Obese/Overweight | 54 (65.9%) | 13 (15.9%) | 0.718 |
| Normal | 38 (61.3%) | 7 (11.3%) | |
| Underweight | 4 (66.7%) | 1 (16.7%) | |

Source: Primary Data, 2025

## Discussion

This study demonstrates a high prevalence of musculoskeletal complaints among administrative personnel in the public service sector, driven primarily by suboptimal workstation ergonomics and cumulative occupational exposure. The high proportion of workers with severe musculoskeletal discomfort highlights an occupational health challenge in environments with prolonged static computer work. These findings provide empirical support for the occupational biomechanics framework, which posits that sustained nonneutral postures lead to tissue fatigue and chronic pain. By focusing on administrative personnel, this research identifies the hierarchy of risk factors for occupational health deficits.

The significant association between work posture, as assessed by the Rapid Office Strain Assessment tool, and musculoskeletal complaint severity corroborates evidence linking poorly designed computer workstations to physical strain.[17,18] Office setups lacking neutral alignments lead to static postures that cause sustained muscle contractions, reducing blood flow and accelerating fatigue toward MSDs, as awkward postures strain soft tissues and limit circulation. This is echoed in office worker analyses where prolonged static sitting impairs muscle oxygenation and increases spinal pressure.[16,19] Ergonomic assessments like ROSA demonstrate sensitivity in predicting discomfort, with scores ≥5 signaling immediate workstation fixes tied to self-reported pain patterns via CMDQ. ROSA's validation for computer use risk, based on discomfort reports, supports targeted interventions for high-risk workers.[18] Research further shows that administrative workers with prolonged screen time and inadequate ergonomic interventions are vulnerable to cervical and lumbar strain.[20] The postural risk observed here indicates that standard office furniture often mismatches workforce anthropometry.[21,22]

Significant correlations between advancing age, longer work tenure, and elevated musculoskeletal complaints underscore the cumulative nature of ergonomic hazards. Older workers and those with longer service exhibit greater accumulation of microtrauma from repetitive administrative tasks. This aligns with the wear-and-tear theory of aging and occupational health, in which prolonged static loading reduces musculoskeletal tissue regeneration over time.[23–25] Studies in public administration report that chronic exposure predicts physical degradation more strongly than acute, infrequent ergonomic stressors.[26,27]

In contrast, the lack of significant associations between individual characteristics (gender and body mass index) and musculoskeletal complaints challenges established epidemiological assumptions. Some studies suggest females and individuals with higher body mass indices face greater risk due to differences in muscle mass and mechanical loading.[28,29] However, these findings indicate that environmental risk overrides individual morphology in constrained administrative roles. The uniform nonneutral static postures required by workstations render anatomical differences negligible in this cohort.[30–33]

These results advance the macroergonomics paradigm by showing that environmental and temporal factors explain outcomes in standardized tasks more than physiological traits.[34,35] Practically, the findings call for structural interventions in public utilities' occupational health management, such as adjustable seating and dynamic computer interfaces, rather than individual wellness programs alone. A review of public health policies advocated low-agentic structural changes like welfare and regulatory reforms for equitable occupational outcomes in high-need sectors.[36] Macroergonomic work system models from recent analyses also support redesigning equipment and environments for utility workers to boost productivity and comfort.[37]

Scheduled microbreaks and ergonomic training can also reduce sustained static loading and inform policy.[38,39]

Despite robust statistical associations, methodological limitations exist. The cross-sectional design limits causal inferences between ergonomic exposures and musculoskeletal disorder onset. Reliance on self-reported symptoms introduces recall and perception biases. The sample from one regional utility provider limits generalizability to dynamic or hybrid work environments with greater mobility. Future research should use longitudinal cohorts to track musculoskeletal disorder incidence. Objective measures, such as surface electromyography or kinematic analysis, can complement subjective assessments. Randomized controlled trials of workstation interventions will provide evidence to optimize public administration occupational health policies.

## Conclusion

Analysis of data from 150 respondents revealed significant associations between work posture, age, work duration, and musculoskeletal disorder (MSD) complaint levels. Work posture emerged as the dominant factor: workers with high-risk postures reported the highest MSD levels. In contrast, no significant associations appeared between gender, body mass index (BMI), or MSD complaints. PDAM Tirtanadi management should implement a comprehensive ergonomics program that incorporates workstation modifications, training on proper posture, and optimized work scheduling to address these risk factors and promote worker health. Future studies should use longitudinal designs to clarify causal pathways in MSD development within this occupational context.

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