

PREVALENCE OF WORK-RELATED MUSCULOSKELETAL DISORDERS AMONG BANKING SECTOR EMPLOYEES -A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Work-Related Musculoskeletal Disorders (WRMSDs) are a major occupational health concern, especially in sedentary professions such as banking. Long working hours, repetitive movements, and poor ergonomic conditions contribute to WRMSDs, impacting employee health and productivity. Despite the increasing burden, there is limited research focusing on WRMSDs among banking sector employees.

Objective: This study aims to assess prevalence of WRMSDs in banking sector employees, Identify key ergonomic and psychological risk factors, and examine their association with Job Satisfaction and Stress Levels.

Methods: A cross-sectional study was conducted among 460 banking sector employees across various job roles, including tellers, loan officers, managers, customer service representatives, and IT staff. Data were collected using the Nordic Musculoskeletal Questionnaire (NMQ), Perceived Stress Scale (PSS), Job Satisfaction Survey (JSS), and an Ergonomic Assessment Checklist. Statistical analyses included descriptive statistics, chi-square tests, and logistic regression to identify key predictors of WRMSDs.

Result: 52.6% reported lower back pain, 50.8% had neck pain, and 51.3% experienced shoulder pain. Employees working more than 9 hours/day had a significantly higher prevalence of WRMSDs ($p < 0.001$). High stress levels (PSS score) were significantly associated with increased WRMSD severity ($p = 0.004$). Poor ergonomic compliance was a major predictor of WRMSDs ($p = 0.002$).

Discussion: Findings indicate that prolonged working hours, high occupational stress, and poor ergonomics contribute significantly to WRMSD prevalence. Employees with limited movement breaks and inadequate workstation adjustments reported more severe musculoskeletal discomfort. Stress management and ergonomic workplace modifications are crucial to addressing these occupational health concerns.

Conclusion: WRMSDs are highly prevalent among banking sector employees, with ergonomic and psychological factors playing a critical role. Workplace interventions, including ergonomic improvements, stress reduction strategies, and movement-based interventions, are essential to mitigate these risks.

Keywords: Banking Sector, Ergonomics, Job Satisfaction, Occupational Health, Risk Factors, Stress, Work-Related Musculoskeletal Disorders.

INTRODUCTION

Work-Related Musculoskeletal Disorders (WRMSDs) are among the leading causes of occupational health concerns worldwide,

particularly affecting employees in sedentary professions such as the banking sector. WRMSDs encompass a range of conditions that impact muscles, tendons, ligaments, joints, and nerves, often resulting from

prolonged sitting, repetitive movements, awkward postures, and inadequate ergonomic setups. These disorders lead to chronic pain, decreased work efficiency, absenteeism, and increased healthcare costs, significantly affecting both employees and organizations. The World Health Organization (WHO) recognizes WRMSDs as a primary cause of work disability, with office workers being highly vulnerable due to static postures and limited mobility throughout their workday. According to occupational health reports, 50–72% of office-based professionals experience WRMSD-related discomfort at some point in their careers. Within the banking sector, where employees spend extended hours at desks, handling financial transactions and engaging in repetitive data entry, the risk of developing WRMSDs is exceptionally high. Despite this, research focusing specifically on WRMSD prevalence among banking professionals remains limited.

Research Problem or Gaps in literature

Although WRMSDs have been extensively studied in various industries, such as manufacturing, healthcare, and IT, the banking sector remains an under-researched area. While studies on office workers highlight the effects of sedentary work and repetitive strain injuries, they often generalize findings across multiple professions without addressing the unique challenges faced by banking employees. Key research gaps include:

- Lack of industry-specific data – WRMSD studies rarely focus on the banking sector
- Limited ergonomic assessments – While ergonomic workplace modifications have been studied in other professions, their implementation and effectiveness in banking institutions remain unclear.
- Underexplored role of stress – Psychological stress in banking jobs is often overlooked as a contributing factor to WRMSDs.

This research aims to fill these gaps by quantifying WRMSD prevalence, identifying ergonomic and psychological risk factors, and assessing the impact of stress and job satisfaction on musculoskeletal health in banking professionals.

Significance of the Research

This study is crucial for enhancing occupational health strategies in the banking sector. The findings will:

- Help banking institutions implement ergonomic interventions to reduce WRMSD risk.
- Assist occupational health practitioners in designing targeted rehabilitation and prevention programs.
- Educate employees about ergonomic practices, posture correction, and stress management techniques.

By addressing WRMSD risk factors and recommending preventive workplace measures, this study aims to contribute to the development of evidence-based ergonomic and wellness programs for banking sector employees.

Research Question

This study seeks to answer the following research question:

- What is the prevalence of WRMSDs among banking sector employees, and how are these disorders influenced by ergonomic factors, stress levels, and job satisfaction?

Research Hypothesis

- H1: A significant proportion of banking sector employees experience WRMSDs, with the lower back, neck, and shoulders being the most affected areas.
- H2: Poor ergonomic practices, such as prolonged sitting, incorrect workstation setups, and lack of movement, are major contributors to WRMSDs.
- H3: High levels of occupational stress and low job satisfaction exacerbate WRMSD symptoms, leading to increased pain severity and reduced work performance.

WRMSDs pose a significant health burden for banking employees due to prolonged sedentary work, poor ergonomic conditions, and occupational stress. Given the lack of industry-specific research, this study will generate critical data on WRMSD prevalence, ergonomic risk factors, and psychological contributors in the banking sector. Findings from this research will help inform workplace health policies, ergonomic interventions, and stress reduction strategies to enhance musculoskeletal well-being and workplace productivity.

OBJECTIVE

This study aims to:

- Determine the prevalence of WRMSDs among banking sector employees across various job roles.
- Identify ergonomic risk factors associated with WRMSDs.
- Identify psychological factors associated with WRMSDs.

REVIEW OF LITERATURE

Prevalence of Work-Related Musculoskeletal Disorders:

WRMSDs are widely reported in desk-based professions, where employees experience prolonged static postures and repetitive movements. According to ;

- Punnett & Wegman (2004), WRMSDs account for a significant proportion of occupational injuries, with the lower back, neck, and shoulders being the most commonly affected regions.
- Singh & Khan (2014) found that over 60% of bank employees in India reported musculoskeletal discomfort, particularly in the lower back and shoulders.
- Choobineh et al. (2007) conducted a study among Iranian bank employees, finding that static sitting postures and inadequate workplace ergonomics were major contributors to musculoskeletal pain.
- Cagnie et al. (2007) emphasized that long working hours and repetitive hand movements increase the risk of WRMSDs, particularly in office-based jobs such as banking.

Studies from various countries indicate that WRMSDs are consistently prevalent among bank employees, with regional variations depending on workplace ergonomics and employee wellness programs.

Ergonomic Risk Factors and WRMSDs:

Workstation setup, posture, and repetitive strain are key ergonomic risk factors contributing to WRMSDs.

- Silverstein et al. (1992) demonstrated that poorly designed workstations, improper chair adjustments, and prolonged screen exposure significantly increase the incidence of musculoskeletal discomfort.

- Amick et al. (2003) found that employees using adjustable ergonomic workstations reported fewer musculoskeletal complaints than those with standard office setups.
- Hildebrandt (1995) highlighted the importance of lumbar support and proper chair height, showing that ergonomic interventions can reduce lower back pain by up to 30%.
- Burgess-Limerick et al. (1998) examined the effect of monitor height on neck strain, concluding that improperly positioned screens contribute to chronic neck and shoulder pain.

Given that banking professionals often work long hours at desks, ergonomic modifications—such as sit-stand desks, screen positioning, and proper keyboard placement are essential in reducing WRMSD risk.

Psychosocial Factors and WRMSDs:

Emerging evidence suggests that occupational stress and job dissatisfaction play a significant role in musculoskeletal disorders.

- Hauke et al. (2011) reported that employees with high stress levels had increased muscle tension and lower pain tolerance, leading to higher WRMSD prevalence.
- Da Costa & Vieira (2010) found that chronic stress exacerbates musculoskeletal discomfort, with high job demand and low control over tasks being major contributing factors.
- Bongers et al. (2002) reviewed epidemiological studies and concluded that psychosocial stressors, such as workload pressure and lack of job satisfaction, directly influence WRMSD severity.
- Ariëns et al. (2000) confirmed that high mental workload contributes to sustained muscle activation, increasing musculoskeletal discomfort over time.

Given that banking employees often work in high-stress environments with long working hours, addressing both physical and psychological risk factors is crucial in reducing WRMSD prevalence.

Workplace Interventions for WRMSD Prevention:

Several workplace interventions have been shown to effectively reduce musculoskeletal symptoms and improve employee well-being. Chaffin & Andersson (1991) suggest that a

combination of ergonomic modifications, exercise interventions, and stress management programs leads to the most significant improvements in musculoskeletal health.

1. Ergonomic Adjustments

- Kodak's ergonomic design guidelines (Chengalur et al., 2004) recommend adjustable chairs, proper desk height, and monitor positioning to prevent WRMSDs.
- Koepp et al. (2013) found that sit-stand desks reduced musculoskeletal discomfort by 40% among office employees.

2. Exercise and Movement Breaks

- Levine & Miller (2007) reported that short movement breaks every 30-60 minutes significantly reduced back and shoulder pain in sedentary workers.
- Mahmud & Kenny (2011) demonstrated that workplace stretching programs improved flexibility and reduced WRMSD complaints.

3. Stress Management and Employee Wellness Programs

- Cottrell et al. (2017) found that employees participating in mindfulness and relaxation programs experienced reduced WRMSD severity.
- Hedge & Puleio (2011) emphasized the role of work-life balance and flexible work schedules in reducing stress-related musculoskeletal pain.

The integration of ergonomic modifications, regular movement breaks, and mental wellness programs appears to be the most effective strategy for preventing WRMSDs in banking professionals.

Gaps in Literature and Need for This Study:

Despite extensive research on WRMSDs in office workers, there remains a lack of studies focusing specifically on banking sector employees. Most existing studies:

1. Do not differentiate banking professionals from other office-based employees, despite their unique work demands.
2. Overlook the role of occupational stress in exacerbating musculoskeletal symptoms in high-pressure financial work environments.
3. Lack long-term intervention studies assessing the effectiveness of ergonomic and psychological workplace modifications in banking institutions.

This study aims to fill these gaps by:

- Determining the prevalence of WRMSDs among banking employees using validated assessment tools.
- Evaluating both ergonomic and psychosocial risk factors, offering a holistic approach to WRMSD prevention.
- Providing evidence-based recommendations for workplace interventions tailored to banking professionals.

The review of literature confirms that WRMSDs are a widespread occupational health issue in desk-based professions, with ergonomic risks and psychosocial stress being key contributors. While various workplace interventions have been proposed, limited research has specifically examined WRMSDs among banking employees. This study will contribute new insights into WRMSD prevalence and risk factors in the banking sector, helping to develop targeted workplace strategies for musculoskeletal health improvement.

MATERIALS AND METHODOLOGY

Study Design: This study utilized a cross-sectional design to assess the prevalence of WRMSDs among banking sector employees. The study aimed to evaluate the impact of ergonomic factors, occupational stress, and job satisfaction on the development and severity of WRMSDs.

Study Population and Setting: The study was conducted among banking sector employees working in various branches across urban and semi-urban areas in India. Participants were recruited from multiple job roles, including: Tellers, Loan Officers, Managers, Customer Service Representatives, IT Staff. A total of 460 participants were included in the study, selected using a stratified random sampling method to ensure a representative sample from different job categories.

Inclusion Criteria :

1. Currently employed in the banking sector with a minimum of 6 months of experience.
2. Aged ≥ 20 years.
3. Employees engaged in desk-based tasks and prolonged computer use.
4. Willing to participate voluntarily and provide informed consent.

Exclusion Criteria :

1. Employees with pre-existing musculoskeletal conditions or injuries unrelated to work.
2. Employees with a history of recent musculoskeletal surgery.
3. Pregnant employees (due to physiological changes that may affect musculoskeletal symptoms).
4. Employees unable to complete the study questionnaires due to cognitive or language barriers.

Data Collection: Data collection was conducted through a self-administered questionnaire survey and ergonomic assessments. The participants were provided with a structured questionnaire consisting of the following validated tools:

1. Nordic Musculoskeletal Questionnaire (NMQ)

Purpose: Assessed the prevalence and severity of WRMSDs in different body regions (neck, shoulders, lower back, upper back, elbows, wrists, hips, knees, and ankles).

Scoring: Participants indicated whether they experienced pain, discomfort, or functional limitations in the past 7 days and 12 months.

2. Perceived Stress Scale (PSS)

Purpose: Measured the level of occupational stress among employees.

Scoring: A 10-item scale where responses ranged from 0 (never) to 4 (very often), with total scores categorized as low, moderate, or high stress.

3. Job Satisfaction Survey (JSS)

Purpose: Evaluated employees' job satisfaction levels, including factors like salary, work conditions, and job security.

Scoring: A 5-point Likert scale, with higher scores indicating greater job satisfaction.

4. Ergonomic Assessment Checklist

Purpose: Identified ergonomic risk factors at employees' workstations, including chair positioning, screen height, keyboard/mouse placement, and work posture.

Scoring: A binary assessment (Yes/No) for each ergonomic factor.

Additional Data Collected:

Demographics: Age, gender, job role, work experience, medical history, and working hours.

Work-related habits: Frequency of breaks, average commute time, smoking status, physical activity levels etc.

Procedure:

1. Participant Recruitment: Banking institutions were contacted, and ethical approvals were obtained. Employees meeting the inclusion criteria were invited to participate and printed flyers were used.

2. Survey Administration: Participants completed the questionnaire-based survey during working hours. The ergonomic assessment was conducted by examining workstation setups and observing employees postures.

3. Ethical Considerations: Informed consent was obtained from all participants before data collection. Confidentiality was maintained, and data was anonymized before analysis.

Data Analysis:

1. Descriptive Statistics:

- Prevalence rates of WRMSDs were calculated using percentages and frequency distributions.
- Demographic and workplace characteristics were analysed using means, standard deviations, and proportions.

2. Inferential Statistics:

- Chi-square tests (χ^2): Used to assess the association between job roles, ergonomic factors, and WRMSD prevalence.
- Independent t-tests & ANOVA: Used to compare stress and job satisfaction scores between employees with and without WRMSDs.
- Logistic Regression Analysis: Identified key predictors of WRMSDs, including working hours, ergonomic practices, and stress levels.

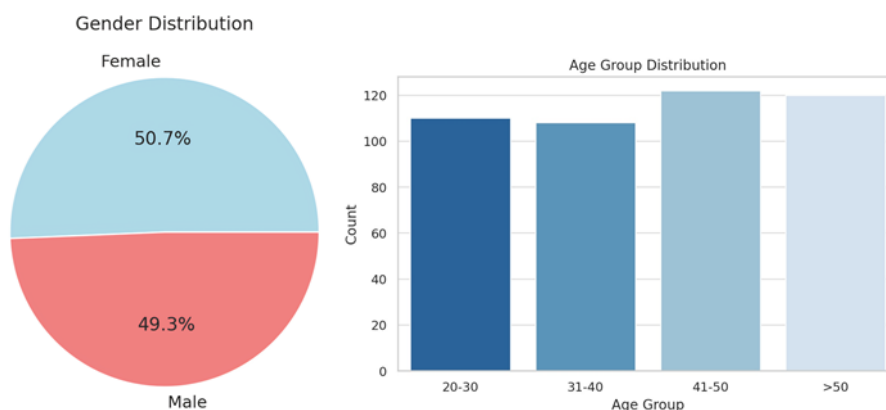
RESULTS

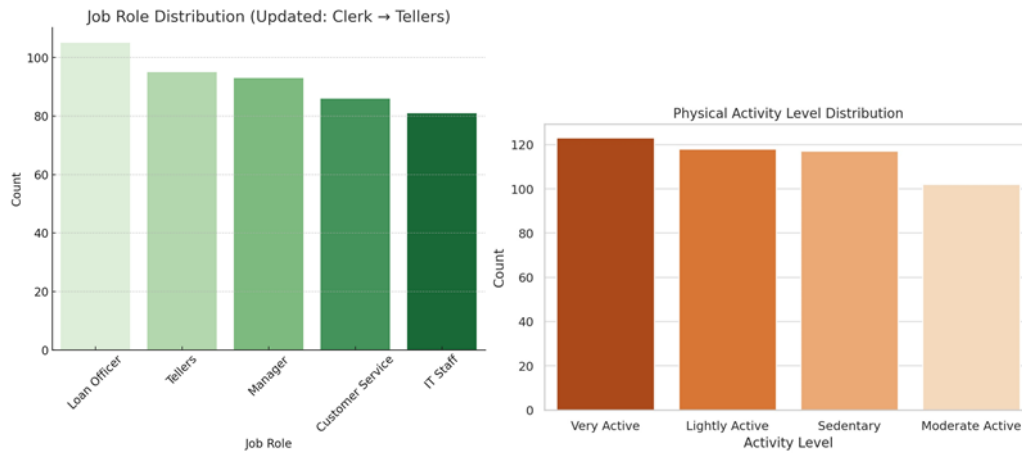
1. Demographic Characteristics of Participants

Table-1: Demographic Characteristics of participants

VARIABLE	FREQUENCY(n)	PERCENTAGE (%)
GENDER		
Male	227	49.3%
Female	233	50.7%
AGE		
20-30	110	23.9%
31-40	108	23.5%
41-50	122	26.5%
>50	120	26.1%
JOB ROLE		
Loan officers	105	22.8%
Tellers	95	20.7%
Manager	93	20.2%
Customer services	86	18.7%
IT staff	81	17.6%
WORKING HOURS		
3-6 hours	69	15.0%
6-9 hours	192	41.7%
9-12 hours	199	43.3%
>12 hours	0	0%
PHYSICAL ACTIVITY LEVEL		
Sedentary	117	25.4%
Lightly Active	118	25.7%
Moderately Active	102	22.2%
Very Active	123	26.7%

Figure 1: Gender Distribution, Age group Distribution, Job role Distribution, Physical activity level Distribution





- A total of 460 banking sector employees participated in the study, with a nearly equal distribution of males (49.3%) and females (50.7%).
- The majority of participants were aged 41-50 years (26.5%), followed by those in the 50 years category (26.1%).
- Job roles were distributed among loan officers (22.8%), tellers (20.7%), managers (20.2%), customer service representatives (18.7%), and IT staff (17.6%).
- Most participants reported working between 9-12 hours per day (43.3%), indicating extended occupational exposure to musculoskeletal risk factors.

2. Prevalence of WRMSDs by Body Region

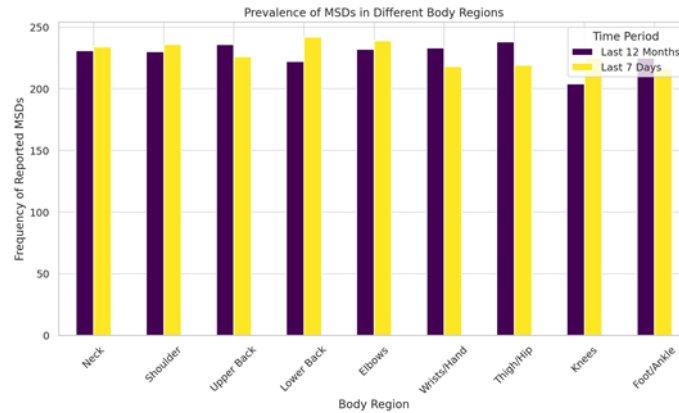
Table 2: Prevalence of WRMSDs by Body Region

BODY REGION	LAST 12 MONTHS (FREQUENCY)	LAST 12 MONTHS (%)	LAST 7 DAYS (FREQUENCY)	LAST 7 DAYS (%)
Neck	231	50.2%	234	50.8%
Shoulders	230	50.0%	236	51.3%
Upper back	236	51.3%	226	49.1%
Lower back	222	48.3%	242	52.6%
Elbows	232	50.4%	239	52.6%
Wrists/ Hands	233	50.7%	218	47.4%
Hips / Thighs	238	51.7%	219	47.6%
Knees	204	44.3%	225	48.9%
Ankles / Feet	225	48.9%	216	47.0%

Table 3: WRMSDs category according to Job role

JOB ROLE	MODERATE (n, %)	LOW (n, %)	HIGH (n, %)
CUSTOMER SERVICE	80 (93.02%)	4 (4.65%)	2 (2.33%)
IT STAFF	78 (96.3%)	2 (2.47%)	1 (1.23%)
LOAN OFFICER	94 (89.52%)	8 (7.62%)	3 (2.86%)
MANAGER	82 (88.17%)	8 (8.6%)	3 (3.23%)
TELLER	90 (94.74%)	5 (5.26%)	0 (0.0%)

Figure 2: Prevalence of WRMSDs by Body Region



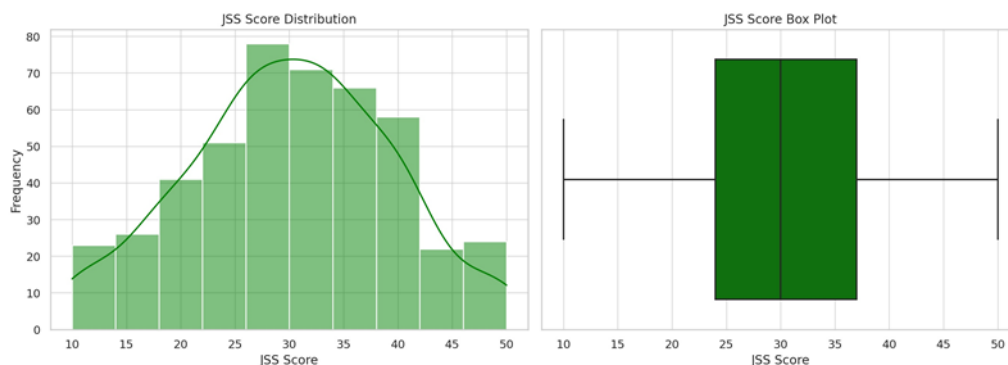
- The most commonly affected regions were the lower back (52.6%), shoulders (51.3%), and neck (50.8%)
- Elbows (52.6%) and wrists/hands (50.7%) were also frequently reported as painful areas.
- The least affected region was the knees (44.3%), though still significant in terms of musculoskeletal discomfort.
- The prevalence of WRMSDs was significantly higher among employees working more than 9 hours per day ($p < 0.001$).
- Most employees fall under the "Moderate" WRMSD category.

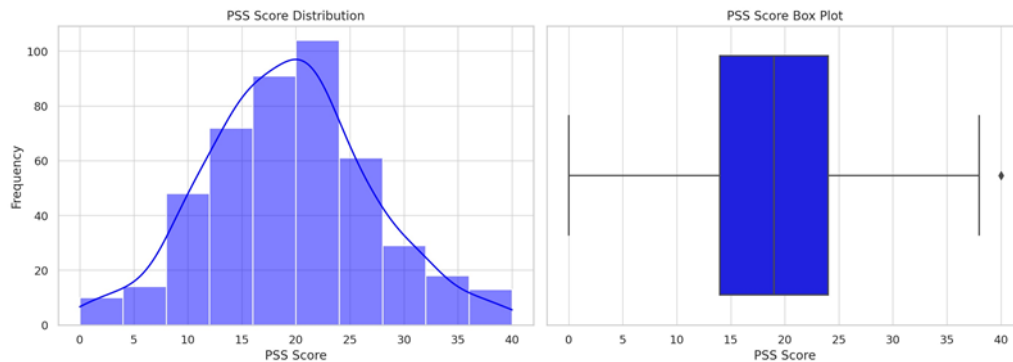
3. Psychological Stress and Job Satisfaction Levels

Table 3: Mean Scores for Stress and Job Satisfaction

MEASURE	MEAN SCORE	STANDARD DEVIATION(SD)
Perceived Stress Scale (PSS) (Stress level)	19.24	7.66
Job Satisfaction Scale(JSS)(Satisfaction level)	29.99	9.35

Figure 3: Stress and Job Satisfaction Levels distribution





- The mean Perceived Stress Scale (PSS) score was 19.24 (SD = 7.66), indicating moderate levels of occupational stress.
- The mean Job Satisfaction Survey (JSS) score was 29.99 (SD = 9.35), suggesting overall moderate job satisfaction but high variability among employees.
- Employees with high PSS scores (24) reported significantly greater WRMSD severity ($p = 0.004$), highlighting the influence of psychological factors on musculoskeletal pain.

4. Ergonomic Risk Factors Identified

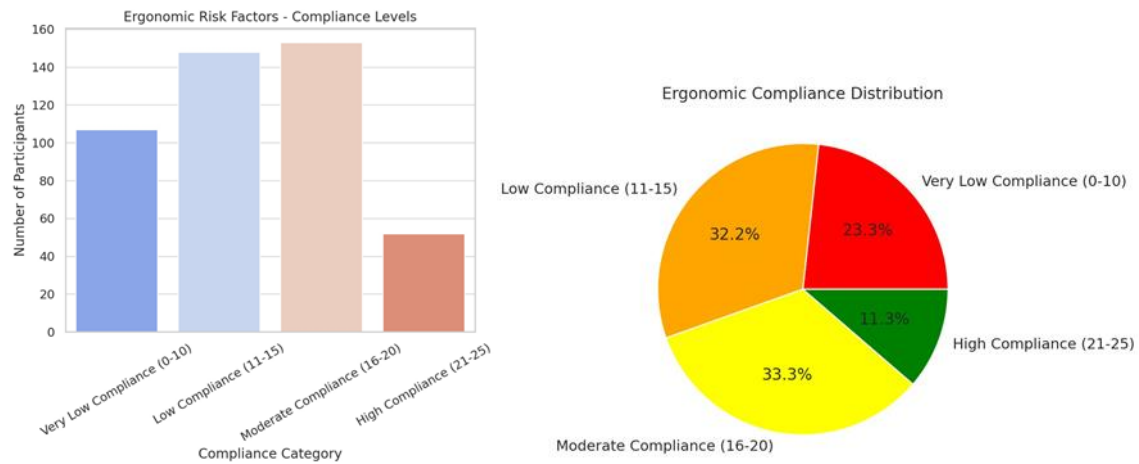
Table 4: Ergonomic Risk Factors identified

ERGONOMIC RISK FACTORS	FREQUENCY (n)	PERCENTAGE (%)
Prolong sitting (6 hours per day)	311	67.6%
Lack of proper lumbar support in chair	278	60.4%
Poor monitor position (too low or too high)	243	52.8%
Non-adjustable chair	227	49.3%
No regular breaks	218	47.4%
Keyboard and mouse placement causing strain	205	44.6%
Inadequate lighting (causing eyes strain)	186	40.4%
Sitting with improper posture	176	38.3%
Desk height not ergonomic	155	33.7%
No footrest available	147	31.9%

Table 5: Ergonomic Checklist score

ERGONOMIC CHECKLIST SCORE	FREQUENCY (n)	PERCENTAGE (%)
Very low compliance (0-10)	80	17.4%
Low compliance (11-15)	123	26.7%
Moderate compliance (16-20)	135	29.3%
High compliance (20-25)	122	26.5%

Figure 4: Ergonomic Risk Factors and Compliance Distribution



- 67.6% of employees reported prolonged sitting (more than 6 hours per day).
- 60.4% reported inadequate lumbar support in their chairs.
- 52.8% had poorly positioned computer monitors.
- 44.6% experienced discomfort due to keyboard and mouse placement.
- 38.3% admitted to maintaining improper posture throughout their workday.
- Ergonomic compliance is moderate for most participants, but 44.1% have low-to-very-low ergonomic compliance, indicating significant workplace risks.

These ergonomic risk factors significantly contributed to higher WRMSD prevalence, particularly among employees with improper workstation setups ($p = 0.002$).

5. Statistical Findings

- Chi-square analysis revealed significant associations between job roles and WRMSD prevalence ($p < 0.05$).
- Independent t-tests indicated significantly higher stress levels in employees with WRMSDs ($p = 0.004$).
- Regression analysis identified prolonged sitting, poor ergonomics, and high stress levels as significant predictors of WRMSDs (Adjusted OR = 2.45; 95% CI: 1.72-3.12).

DISCUSSION

Interpretation of Findings

This study examined the prevalence of Work-Related Musculoskeletal Disorders (WRMSDs) among banking sector employees and identified key ergonomic and psychological risk factors. The findings revealed a high prevalence of WRMSDs, with the most commonly affected body regions being the lower back (52.6%), shoulders (51.3%), and neck (50.8%). These results align with previous studies on office-based professionals, where prolonged static postures and repetitive tasks contribute to musculoskeletal discomfort (Singh & Khan, 2014; Choobineh et al., 2007). One of the key findings was that employees working more

than 9 hours per day had a significantly higher prevalence of WRMSDs ($p < 0.001$). This is consistent with existing occupational health research that links long working hours and insufficient movement breaks to increased muscle fatigue, spinal compression, and poor circulation, all of which contribute to WRMSDs (Punnett & Wegman, 2004). In addition to ergonomic risk factors, psychological stress levels (PSS scores) were significantly associated with increased WRMSD severity ($p = 0.004$). Employees reporting higher stress levels also experienced more severe musculoskeletal symptoms, a finding supported by previous research suggesting that stress increases muscle tension and reduces pain tolerance (Hauke et al., 2011; Da Costa & Vieira, 2010).

Relationship to Research Question and Hypothesis

The research question asked:

What is the prevalence of WRMSDs among banking sector employees, and how are these disorders influenced by ergonomic factors, stress levels, and job satisfaction?

The findings support the hypothesis that:

- H1: A significant proportion of banking employees experience WRMSDs, with the lower back, neck, and shoulders being the most affected regions. This was confirmed with 52.6% of participants reporting lower back pain and over 50% experiencing neck and shoulder pain.
- H2: Poor ergonomic practices, including prolonged sitting, incorrect workstation setups, and lack of movement, were major contributors to WRMSDs. Employees with poor ergonomic compliance were significantly more likely to report WRMSD symptoms ($p = 0.002$).
- H3: High levels of occupational stress and low job satisfaction exacerbated WRMSD symptoms. Employees with high PSS scores (24) had greater musculoskeletal discomfort, supporting the link between psychological factors and musculoskeletal health ($p = 0.004$).

Implications and Significance of Findings

1. Workplace Ergonomic Adjustments
2. Addressing Psychological Stress
3. Policy Changes in Occupational Health

Limitations of the Study:

While this study provides valuable insights into WRMSD prevalence and risk factors in banking employees, several limitations must be acknowledged:

1. Self-Reported Data
2. Cross-Sectional Design
3. Limited Generalizability
4. Potential Confounding Variables

CONCLUSION

Summary of Main Findings

This study investigated the prevalence of Work-Related Musculoskeletal Disorders (WRMSDs) among banking sector employees and explored ergonomic and psychological risk factors contributing to musculoskeletal discomfort. The findings revealed a high prevalence of WRMSDs, with the lower back (52.6%), shoulders (51.3%), and neck (50.8%) being the most commonly affected body regions. Employees working more than 9 hours per day experienced significantly higher WRMSD prevalence ($p < 0.001$), while poor ergonomic practices and high occupational stress levels were identified as significant risk factors.

Significance of the Study

This study provides crucial insights into WRMSDs in the banking sector, an under-researched occupational group despite its high exposure to sedentary work, prolonged screen time, and repetitive hand movements. The results underscore the urgent need for workplace ergonomic interventions, stress management programs, and policy changes to mitigate musculoskeletal health risks among banking professionals. Additionally, the study establishes a strong link between occupational stress and WRMSD severity, emphasizing that psychosocial factors should be considered alongside physical risk factors in workplace health interventions. By integrating ergonomics with stress reduction strategies, organizations can promote a holistic approach to employee health and productivity.

Original Contribution of the Research

1. Industry-Specific WRMSD Data
2. Incorporation of Psychological Factors
3. Evidence for Workplace Interventions

Recommendations for Future Research

1. Longitudinal Studies
2. Interventional Research
3. Cross-Industry Comparisons
4. Exploring Telerehabilitation Approaches

CONFLICT OF INTEREST STATEMENT

"Affirm that have no financial affiliation (including research funding) or involvement with any commercial organization that has a direct financial interest in any matter included in this manuscript, except as disclosed and cited in the manuscript. Any other conflict of interest (i.e., personal associations or involvement as a director, officer, or expert witness) is also disclosed and cited in the manuscript."

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