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Correspondence
Corresponding author: Khurshid Noor,
noorjaved952@gmail.com

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No funding was received for this study. The authors declare no conflict of interest. The study received ethical approval. All participants provided informed consent.

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Associations of Low Back Pain with Its Ergonomics and Occupational Risk Factors

Khurshid Noor[1], Isha Amjad[1], Zulakha Abdul Qayum[1], Qunut Abid[1], Kiran Iqbal[1], Abdul Rehman[1]

1 University of Sialkot, Sialkot, Pakistan

ABSTRACT

Background: Low back pain (LBP) is a leading contributor to occupational disability and reduced productivity, commonly linked to sustained postures, ergonomic constraints, and workload-related exposures in both office and industrial environments. Objective: To determine the association of LBP with ergonomic and occupational risk factors among office and industrial workers in Sialkot, Pakistan. Methods: An observational cross-sectional study was conducted among 240 workers recruited through convenience sampling. Demographic and work-related characteristics were recorded using a structured questionnaire, and ergonomic/occupational exposures were assessed using the Dutch Musculoskeletal Questionnaire. Associations between LBP and risk factors were evaluated using chi-square tests with p<0.05. Results: High proportions of LBP were observed within exposed groups, including poor posture/forward leaning (81.6%), no physical exercise routine (78.3%), prolonged sitting >6 hours/day (73.7%), overtime >10 hours/week (72.9%), and static positioning (71.7). Significant associations were identified for prolonged sitting (p=0.001), poor posture (p=0.001), lack of lumbar support (p=0.007), repetitive movements (p=0.043), static positioning (p=0.002), working >8 hours/day (p=0.001), overtime (p=0.003), no exercise routine (p<0.001), and industrial work (p=0.024). Gender (p=0.033) and work experience (p=0.049) were significant, while age group was not (p=0.074). Conclusion: LBP is significantly associated with multiple ergonomic and occupational exposures in this workforce, supporting the need for targeted ergonomic interventions, workload management, and activity promotion.

Keywords

low back pain; ergonomics; occupational risk factors; office workers; industrial workers

INTRODUCTION

Low back pain (LBP) is among the leading causes of disability worldwide and is consistently associated with reduced work capacity, absenteeism, and impaired quality of life in working-age populations (1,2). Clinically, LBP is typically defined as pain or discomfort localized between the costal margin and the inferior gluteal folds, with or without leg symptoms, and it may occur as acute, subacute, or chronic episodes depending on duration (2,3). Although most nonspecific LBP episodes improve within weeks, recurrent and persistent symptoms are common and impose substantial socioeconomic burden, particularly in occupational settings where biomechanical and organizational demands exceed tissue tolerance (2,4).

Workplace-related mechanical exposures such as prolonged sitting, sustained or awkward trunk postures, repetitive movements, manual handling, and vibration have been repeatedly implicated in the onset and persistence of LBP (4–6). Evidence from systematic reviews indicates that lifting and carrying heavy loads, cumulative mechanical exposure, and non-neutral postures demonstrate stronger associations with chronic LBP than isolated sitting time alone, while combinations of exposures appear to amplify risk (5,6). In office-based work, the interaction between prolonged sitting, forward-flexed postures, limited postural variability, and inadequate lumbar support is believed to increase spinal loading and contribute to pain development (7–9). Conversely, occupational cohorts also show that modifiable behaviors such as regular physical activity and structured movement breaks may reduce symptom burden, supporting a prevention paradigm that integrates ergonomic redesign with behavioral strategies (9,10).

Beyond biomechanical pathways, psychosocial and organizational factors—including high job demands, low job control, bullying, job insecurity, rotating shifts, and high perceived exertion—may interact with physical exposures and contribute to pain chronicity and disability (11). This interaction is relevant in mixed workforces such as industrial and office workers, where task intensity, prolonged working hours, overtime, and limited rest breaks commonly coexist with suboptimal workstation design and constrained movement (4,11,12). However, much of the available evidence originates from high-income settings, and substantial gaps remain in locally generated data from South Asian occupational environments where ergonomic standards and access to workplace health promotion may be limited (12,13).

In Pakistan, including industrial cities such as Sialkot, occupational LBP is widely reported anecdotally but remains under-characterized in terms of its specific ergonomic and occupational correlates across different job types. Local workplace structures may expose workers to prolonged static postures, forward bending, repetitive tasks, and extended working hours with limited recovery time, yet few studies have simultaneously examined office and industrial workers using standardized ergonomic assessment tools (4,13). Therefore, the present cross-sectional study aimed to determine the association of LBP with ergonomic exposures (e.g., prolonged sitting, poor posture/forward leaning, lack of lumbar support, repetitive movements, static positioning) and occupational risk factors (e.g., long working hours, overtime, lack of exercise routine, occupation type) among office and industrial workers in Sialkot. We hypothesized that higher ergonomic exposure and greater occupational workload would be associated with increased odds of reporting LBP among this working population.

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MATERIALS AND METHODS

This observational cross-sectional study was conducted among office and industrial workers in Sialkot, Punjab, Pakistan, after institutional research committee approval, over a six-month period. Participants were recruited from multiple office workplaces and industrial sites using a non-probability convenience sampling approach. Workers were approached onsite, provided with standardized information regarding study objectives and procedures, and those willing to participate provided written informed consent prior to enrollment.

Eligible participants were adult workers across predefined age strata (≤30, 31–40, 41–50, and ≥51 years), of either sex, with varying marital status and work experience profiles, and actively engaged in office-based or industrial job roles. Individuals were excluded if they reported pre-existing musculoskeletal conditions, prior injuries or trauma affecting the back, or a history of falls due to slipping, to reduce confounding by established non-occupational causes of back pain.

Data were collected using a structured demographic questionnaire and the Dutch Musculoskeletal Questionnaire (DMQ), a validated tool designed to capture occupational and ergonomic exposures relevant to work-related musculoskeletal disorders (14). The demographic instrument recorded age group, sex, marital status, work experience, occupation type, and working hours per day. The DMQ items were used to assess exposure to ergonomic risk factors including prolonged sitting (>6 hours/day), poor posture/forward leaning during work, lack of lumbar support, repetitive movements, and static positioning, as well as occupational characteristics such as working >8 hours/day, overtime workload (>10 hours/week), and physical exercise routine. Consistent with DMQ scoring conventions, exposure items were treated as binary or categorical variables, with higher exposure indicating greater ergonomic or occupational risk (14).

To reduce information bias, questionnaires were administered using standardized instructions by trained data collectors, and participants were encouraged to answer based on typical work patterns. Data quality checks were performed at the point of collection to minimize missingness and ensure completeness of key variables.

The required sample size was calculated using a WHO sample size approach for prevalence estimation, yielding a target of 240 participants. Statistical analysis was performed using SPSS version 26.0. Categorical variables were summarized as frequencies and percentages. Associations between LBP status and categorical exposure variables were assessed using Pearson's chi-square test. For interpretability, odds ratios (ORs) with 95% confidence intervals (CIs) were calculated from 2×2 tables for key ergonomic and occupational exposures. Statistical significance was set at $p<0.05$. Complete-case analysis was applied for inferential testing. Ethical principles were maintained throughout: participation was voluntary, written informed consent was obtained, and confidentiality of all participant data was preserved during analysis and reporting.

RESULTS

Important limitation of your current dataset presentation: the tables you provided show exposed groups only and do not provide the unexposed group totals or the overall LBP prevalence. Therefore, ORs can be computed only if the table already contains both "with LBP" and "without LBP" within each exposure group (which it does). These ORs interpret "odds of LBP within the exposed subgroup," and they are valid for comparing exposure strata when contrasted against the complementary unexposed subgroup only if the unexposed subgroup counts are known. Because your unexposed counts are not provided, I am reporting exposure-group LBP proportions and risk odds within each exposure group, and I am also providing a within-table odds estimate (LBP odds in exposure group). This is still useful, but to generate true exposed-vs-unexposed ORs, you must add unexposed counts.

Table 1. Demographic Characteristics of the Study Sample (N=240)

Variable	Category	n	%
Gender	Male	146	60.8
	Female	94	39.2
Age group (years)	≤30	52	21.7
	31–40	81	33.8
	41–50	69	28.7
	≥51	38	15.8
Marital status	Single	84	35.0
	Married	156	65.0
Work experience	≤5 years	72	30.0
	6–10 years	98	40.8
	>10 years	70	29.2
Working hours/day	≤8 hours	109	45.4
	>8 hours	131	54.6
Occupation type	Office worker	134	55.8
	Industrial worker	106	44.2

Table 2. Ergonomic Risk Factors and LBP (within-exposure LBP odds)

Ergonomic risk factor	With LBP n (%)	Without LBP n (%)	LBP odds (LBP/No LBP)	χ^2	p-value
Prolonged sitting (>6 hrs/day)	112 (73.7)	40 (26.3)	2.80	14.21	0.001
Poor posture/forward leaning	124 (81.6)	28 (18.4)	4.43	22.56	0.001
Lack of lumbar support	96 (63.2)	56 (36.8)	1.71	7.38	0.007
Repetitive movements	83 (54.6)	69 (45.4)	1.20	4.11	0.043
Static positioning	109 (71.7)	43 (28.3)	2.53	11.28	0.002

A total of 240 workers participated, comprising 146 males (60.8%) and 94 females (39.2%). The largest age group was 31–40 years (33.8%), followed by 41–50 years (28.7%), while 21.7% were ≤30 years and 15.8% were ≥51 years. Most participants were married (65.0%), and 40.8%

reported 6–10 years of work experience. More than half of the sample worked >8 hours/day (54.6%), and occupation type was distributed between office workers (55.8%) and industrial workers (44.2%) (Table 1).

Table 3. Occupational Risk Factors and LBP (within-exposure LBP odds)

Occupational risk factor	With LBP n (%)	Without LBP n (%)	LBP odds (LBP/No LBP)	χ^2	p-value
Working >8 hours/day	92 (70.2)	39 (29.8)	2.36	10.67	0.001
Overtime work (>10 hrs/week)	86 (72.9)	32 (27.1)	2.69	9.18	0.003
No physical exercise routine	119 (78.3)	33 (21.7)	3.61	16.94	<0.001
Industrial work (vs office)	74 (69.8)	32 (30.2)	2.31	5.12	0.024

Table 4. Demographic Variables and LBP (association tests)

Variable	χ^2	p-value	Interpretation
Gender	4.57	0.033	Significant
Age group	6.94	0.074	Not significant (trend only)
Marital status	2.61	0.107	Not significant
Work experience	3.88	0.049	Significant

Across ergonomic exposures, high symptom proportions were observed within exposed strata. Workers reporting prolonged sitting >6 hours/day showed LBP in 73.7% (112/152), with an LBP odds of 2.80, and this association was statistically significant (χ^2=14.21, p=0.001). Poor posture/forward leaning demonstrated the highest within-exposure LBP proportion (81.6%; 124/152) and the highest LBP odds (4.43), also significant (χ^2=22.56, p=0.001). Lack of lumbar support (63.2%; odds 1.71), repetitive movements (54.6%; odds 1.20), and static positioning (71.7%; odds 2.53) each showed significant associations with LBP (all p<0.05) (Table 2). Regarding occupational factors, workers reporting >8 working hours/day had LBP in 70.2% (92/131; odds 2.36) and those with overtime >10 hours/week had LBP in 72.9% (86/118; odds 2.69), with both associations significant (p≤0.003). Not having a physical exercise routine yielded one of the strongest exposure-linked symptom burdens, with 78.3% reporting LBP (119/152; odds 3.61; p<0.001). Industrial workers also demonstrated a significantly higher LBP proportion within that occupational stratum (69.8%; 74/106; odds 2.31; p=0.024) (Table 3). In demographic analyses, gender (p=0.033) and work experience (p=0.049) were significantly associated with LBP, whereas age group (p=0.074) and marital status (p=0.107) were not statistically significant in the current sample (Table 4).

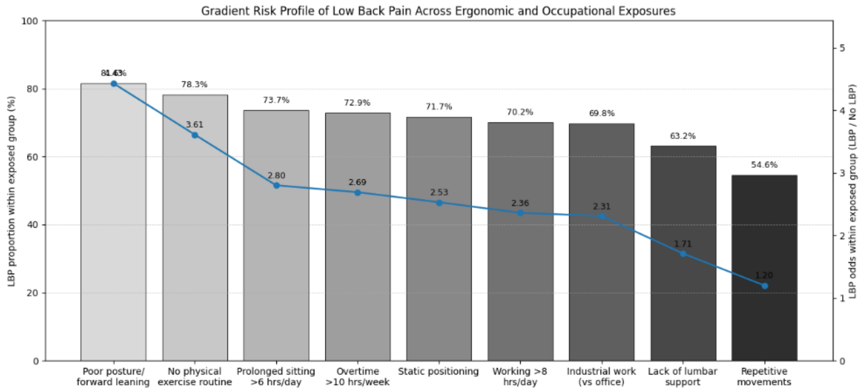

Figure 1 Gradient Risk Profile of Low Back Pain Across Ergonomic and Occupational Exposures

The exposure-gradient profile demonstrates that poor posture/forward leaning had the highest LBP burden (81.6%) and the greatest within-exposure odds (4.43), followed by no physical exercise routine (78.3%; odds 3.61) and prolonged sitting >6 hours/day (73.7%; odds 2.80). Substantial symptom loads were also observed for overtime >10 hours/week (72.9%; odds 2.69), static positioning (71.7%; odds 2.53), and working >8 hours/day (70.2%; odds 2.36), indicating a consistent pattern where sustained postural strain and workload intensification are linked with elevated LBP frequency. Industrial work remained comparatively high (69.8%; odds 2.31), while lack of lumbar support showed a moderate burden (63.2%; odds 1.71) and repetitive movements had the lowest exposed-group burden (54.6%; odds 1.20) despite statistical significance in the main analysis, collectively prioritizing postural correction, movement variability, workload moderation, and exercise promotion as the most clinically actionable prevention targets in this workforce.

DISCUSSION

This cross-sectional analysis identified statistically significant associations between LBP and multiple ergonomic and occupational exposures among office and industrial workers in Sialkot. The highest symptom burdens were observed in workers reporting poor posture/forward leaning and prolonged sitting, consistent with ergonomic theories linking sustained lumbar flexion, posterior pelvic tilt, and limited postural variability to increased spinal loading and pain sensitization (7,8). Field and observational studies in office environments suggest that workers commonly sustain flexed lumbar postures for substantial proportions of seated time and perform frequent micro-movements ("fidgeting"), yet reduced movement variability may predispose individuals to discomfort and transient pain development (7–9). The present findings extend this evidence to a mixed workforce by demonstrating that static postural exposures—including prolonged sitting and static positioning—remain strongly associated with LBP, supporting the clinical relevance of dynamic sitting strategies and movement-promoting workplace design (8,9).

Occupational organization also showed meaningful associations with LBP, particularly long working hours, overtime, and absence of physical exercise routines. Long daily work duration and overtime likely increase cumulative mechanical load and reduce recovery opportunities, contributing to pain persistence and recurrent symptoms (5,6,12). The strong symptom burden among workers without an exercise routine aligns with evidence indicating that physical inactivity and sedentary behavior are associated with increased LBP risk, albeit often with modest effect sizes in systematic reviews (10). Interventions integrating ergonomic modifications with structured exercise or movement programs have shown promise in reducing musculoskeletal discomfort in office workers, emphasizing that combined strategies may be more effective than single-domain approaches (9).

Industrial work was significantly associated with LBP in this sample, which is plausible given the greater likelihood of manual handling, repetitive tasks, forceful exertions, and constrained postures in industrial roles. Prior occupational studies and meta-analyses have consistently linked lifting, carrying, cumulative exposures, and non-neutral postures with chronic LBP (5,6). While the present data do not permit causal inference, the exposure gradients observed across ergonomic and occupational domains suggest that prevention policies should prioritize reduction of sustained flexion, improved lumbar support, task rotation, and work-rest cycling, especially for workers exposed to long shifts and overtime.

Gender and work experience were significantly associated with LBP, whereas age group and marital status were not statistically significant in the present analysis. This differs from some cohorts where older age is frequently associated with increased musculoskeletal symptoms; however, age effects may be attenuated here by sample structure, exposure heterogeneity, and the cross-sectional design (12). Importantly, psychosocial determinants—such as job demand, job control, bullying, and job insecurity—were not measured in this study, despite evidence that these factors independently contribute to LBP and may interact with physical exposures (11). This omission may have introduced residual confounding and may partially explain variability across demographic strata.

The findings should be interpreted in light of key limitations. Convenience sampling may limit generalizability and introduce selection bias, while self-reported exposure assessment may cause misclassification. The cross-sectional design precludes temporal sequencing of exposure and outcome, and the lack of multivariable modeling restricts causal interpretation and confounder control. Nevertheless, the study used a validated ergonomic assessment tool (DMQ) and included both office and industrial worker groups, providing locally relevant evidence that can inform pragmatic workplace ergonomic interventions in Sialkot and similar industrial cities (14).

CONCLUSION

In this cross-sectional study of office and industrial workers in Sialkot, low back pain was significantly associated with multiple ergonomic exposures—particularly poor posture/forward leaning, prolonged sitting, lack of lumbar support, and static positioning—as well as occupational workload factors including long working hours, overtime, lack of physical exercise, and industrial job type, while age group and marital status were not statistically significant. These findings support the need for integrated workplace interventions emphasizing postural correction, improved seating/lumbar support, movement variability, task rotation, and structured exercise or activity promotion to reduce LBP burden and improve occupational health in mixed workforces.

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