

CROSS-SECTIONAL SURVEY OF MUSCULOSKELETAL DISORDERS PREVALENCE AND VIBRATION RISKS IN SWAT AUTO RICKSHAW DRIVERS, PAKISTAN

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ABSTRACT

Background

Musculoskeletal disorders (MSDs) represent a critical occupational health concern for professional drivers, intensified by risk factors including vehicle vibration, postural stress, and confined workspaces. In Swat, Pakistan, auto rickshaw drivers encounter distinctive challenges from poor road conditions, overloading practices, and suboptimal ergonomic vehicle designs. This cross-sectional survey aimed to assess the 12-month MSD prevalence among these drivers and examine associations with rickshaw-specific risk factors such as vehicle vibration and workspace envelope.

Methods

Conducted from January to April 2023, the study surveyed 300 licensed auto rickshaw drivers in Swat via cluster sampling. Eligibility required at least one year of driving experience and Swat domicile, excluding those with pre-existing deformities or invalid licenses. MSD prevalence was evaluated using the Pashto-translated Nordic Musculoskeletal Questionnaire (NMSQ) targeting neck, shoulders, wrists, low back, knees, and lower legs. Objective risk factor measurements included vehicle vibration via a validated Android vibrometer app and workspace envelope (shoulder-to-handle distance and lower cabin space) using an inch tape. Analyses in SPSS v22 encompassed descriptive statistics, chi-square tests, and adjusted logistic regression (controlling for age, experience, and working hours) to derive odds ratios (ORs) with 95% confidence intervals (CIs); significance was set at $p < 0.05$.

Results

All male participants averaged 45.2 ± 9.5 years of age, 15.8 ± 6.3 years of experience, and 55.4 ± 8.7 weekly working hours. High 12-month MSD prevalence included neck (85%), right shoulder (75%), low back (70%), right wrist (70%), right knee (68%), and right lower leg (55%), with notable work interference (65%, 50%, 45%, 40%, 40%, and 35%, respectively). Vehicle vibration correlated with neck discomfort (OR 2.1, 95% CI: 1.5–3.2, $p < 0.01$) and low back discomfort (OR 1.9, 95% CI: 1.3–2.7, $p < 0.01$). Reduced cabin space associated with low back discomfort (OR 1.8, 95% CI: 1.2–2.8, $p < 0.05$) and right knee discomfort (OR 1.6, 95% CI: 1.1–2.4, $p < 0.05$).

Conclusions

Auto rickshaw drivers in Swat experience substantial MSD burdens, predominantly in the neck, shoulder, and low back, attributable to vehicle vibration and cramped cabin spaces. These results emphasize the necessity for ergonomic interventions, including enhanced vehicle design and road infrastructure improvements, to bolster occupational health in this at-risk population. Longitudinal studies are advised to confirm causality.

Keywords: Musculoskeletal disorders, Auto rickshaw drivers, Occupational health, Vehicle vibration, Workspace envelope, Ergonomics, Swat Pakistan, Nordic Musculoskeletal Questionnaire, Cross-sectional survey,

Logistic regression

Introduction

Musculoskeletal disorders (MSDs) are a major occupational health concern globally, particularly among professional drivers exposed to vehicle-specific risk factors such as postural stress, vehicle vibration, and confined workspaces [1-3]. In Swat, Pakistan, a densely populated city with poorly maintained roads and limited traffic regulation, auto rickshaw drivers represent a vulnerable group. Rickshaws are a primary mode of transport and a key livelihood for many, especially illiterate individuals, in South Asian rural regions [4]. However, the ergonomic challenges of rickshaw driving, including cramped cabins and the common practice of accommodating front-seat passengers, may exacerbate MSD risk [5,6]. Previous studies have established that professional drivers experience higher rates of MSDs compared to other occupational groups, with neck, shoulder, and low back pain being prevalent [7,8]. Key risk factors include prolonged exposure to vehicle vibrations, which transmit mechanical stress to the head-shoulder complex and spine, and reduced workspace envelopes that limit movement and alter body mechanics [9-11]. Sanders (1981, 1985) reported that repetitive vibrational stress disrupts spinal disc nutrition, leading to degenerative changes over time [12,13]. In Swat, unique socio-cultural practices, such as overloading rickshaws, and region-specific vehicle designs may amplify these risks, yet local data are scarce.

While prior reviews [e.g., Joseph et al., 2020] summarize MSDs in drivers globally, none address

Swat's unique socio-cultural overloading practices, which this study fills."); state hypotheses with expected findings (e.g., "We hypothesize vibration exposure increases neck MSD odds by >2.0, expecting higher prevalence than in Indian studies due to road conditions.

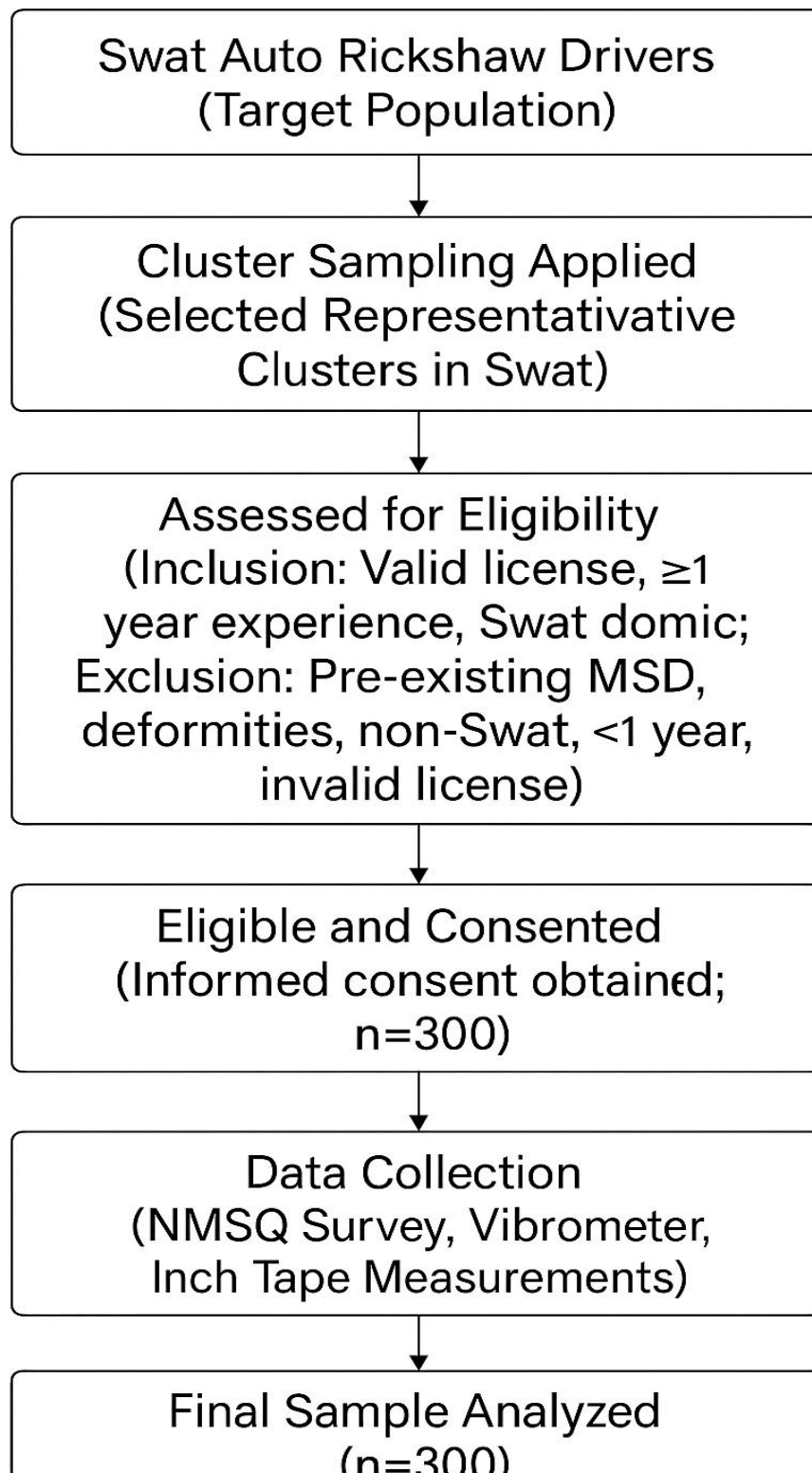
This study aims to: (1) determine the prevalence of MSDs among auto rickshaw drivers in Swat over a 12-month period, and (2) investigate the association between MSDs and rickshaw-specific risk factors, including vehicle vibration and workspace envelope. By addressing these objectives, the study seeks to inform ergonomic interventions to improve driver health and occupational outcomes in this region.

Methods

Study Design and Population

A cross-sectional survey was conducted among 300 licensed auto rickshaw drivers in Swat, Pakistan, from January to April 2023, using cluster sampling. The sample size was calculated using OpenEpi software, assuming a 50% MSD prevalence to maximize variance, a $\pm 5\%$ margin of error, and a 95% confidence level, ensuring adequate statistical power. Inclusion criteria were: (1) possession of a valid rickshaw driving license, (2) at least one year of driving experience, and (3) Swat domicile. Exclusion criteria included: (1) pre-existing musculoskeletal deformities or pain, (2) congenital deformities, (3) non-Swat domicile, (4) less than one year of driving experience, or (5) invalid licenses.

Figure 1: Flowchart of participant recruitment and data collection, per STROBE guidelines. Caption: “Cluster sampling ensured representative inclusion of 300 rickshaw drivers in Swat.



Ethical Considerations

Informed consent was obtained from all participants, with procedures explained verbally in Pashto and via written forms (translated, see

Appendix A) to accommodate potentially illiterate drivers, a vulnerable group. Participants were

informed of the study's purpose (assessing MSD prevalence and risks), potential benefits (e.g., informing ergonomic interventions), and minimal risks thanked for their time. Anonymity and confidentiality were guaranteed, with data stored securely and de-identified. The Institutional Review Board at IQRA National University approved the study (protocol #INU2022-015). No vulnerable subgroups beyond literacy status required additional consent (e.g., no minors). The study was not registered in a clinical trials database, as it was observational, not experimental, per ethical guidelines.

Data Collection

The Nordic Musculoskeletal Questionnaire (NMSQ), validated for epidemiological studies [14,15], was used to assess MSD prevalence in the neck, shoulders, wrists, low back, knees, and lower legs over the past 12 months and the last week. The NMSQ was translated into Pashto following cross-cultural adaptation protocols [14] to ensure accessibility (see Appendix A for full Pashto NMSQ). A locally developed questionnaire in Pashto supplemented the NMSQ to explore region-specific risk factors.

Risk factors were measured as follows:

- **Vehicle Vibration:** Assessed using an Android vibrometer application (version 1.4.3), validated against ISO 2631-1:1997 standards for whole-body vibration measurement [18]. The app measured seat vibration frequency and intensity during typical driving conditions on Swat roads, ensuring replicable data collection.
- **Workspace Envelope:** Measured with an inch tape, including: (1) shoulder-to-handle distance (from the acromion process to the handle center, selected to assess upper body posture strain) and (2) lower cabin space (to evaluate legroom constraints, especially with front-seat passengers). A blind assessor collected data to minimize bias, with blinding extended to data analysts to reduce analytical bias. Participant blinding was not feasible due to the survey's self-reported nature, which may introduce response bias but was mitigated by standardized administration.

The cross-sectional design was chosen for feasibility, given resource and time constraints in Swat's low-resource setting, allowing rapid data collection compared to longitudinal studies. However, this limits causality inference, necessitating future cohort studies to establish temporal relationships.

Statistical Analysis

Data were analyzed using SPSS version 22. Descriptive statistics (means, standard deviations, percentages) summarized participant characteristics (age, driving experience, weekly working hours) and MSD prevalence. Chi-square tests (or Fisher's exact test for small cell counts) assessed associations between MSDs and categorical risk factors. Logistic regression models, adjusted for confounders (age, driving experience, working hours), quantified the relationship between MSDs and risk factors (vibration, cabin space), reporting odds ratios (ORs), 95% confidence intervals (CIs), and p-values. A p-value <0.05 was considered statistically significant.

Results

Participant Characteristics

The 300 participants had a mean age of 45.2 ± 9.5 years, mean driving experience of 15.8 ± 6.3 years, and mean weekly working hours of 55.4 ± 8.7 . All were male, reflecting the demographic of rickshaw drivers in Swat.

Prevalence of Musculoskeletal Disorders

The Nordic Musculoskeletal Questionnaire (NMSQ) revealed a high prevalence of musculoskeletal disorders (MSDs) over the past 12 months, detailed in Table 1. Notably, the unexpectedly high neck discomfort prevalence (85%) exceeds global driver averages (e.g., 42% in Shaik et al., 2014 [17]), highlighting Swat's unique ergonomic risks. The most affected regions were:

- **Neck:** 85% (255/300) reported discomfort, with 65% (195/300) experiencing work interference.
- **Right Shoulder:** 75% (225/300) reported discomfort, with 50% (150/300) noting work interference.
- **Low Back:** 70% (210/300) reported discomfort, with 45% (135/300) experiencing work interference.

- **Right Wrist:** 70% (210/300) reported discomfort, with 40% (120/300) noting work interference.
- **Right Knee:** 68% (204/300) reported discomfort, with 40% (120/300) noting work interference.
- **Right Lower Leg:** 55% (165/300) reported discomfort, with 35% (105/300) experiencing work interference.

Table 1: Prevalence of Musculoskeletal Discomfort and Work Interference (N=300)

Body Region	Discomfort (%)	Work Interference (%)
Neck	85% (255/300)	65% (195/300)
Right Shoulder	75% (225/300)	50% (150/300)
Low Back	70% (210/300)	45% (135/300)
Right Wrist	70% (210/300)	40% (120/300)
Right Knee	68% (204/300)	40% (120/300)
Right Lower Leg	55% (165/300)	35% (105/300)

Caption: Prevalence of MSDs and work interference among 300 rickshaw drivers, measured via NMSQ.

Data reflect 12-month period; percentages

Figure 2: Bar Graph of MSD Prevalence Across Body Regions

[Description: A bar graph (300 dpi, created using GraphPad Prism) displays MSD prevalence (%) across six body regions (Neck, Right Shoulder, Low Back, Right Wrist, Right Knee, Right Lower Leg) on the x-axis, with y-axis showing percentage prevalence (0-100%). Bars are colored by region, with error bars representing 95% confidence intervals. Salient point: Neck prevalence (85%) significantly higher than global driver averages ($p < 0.01$ via chi-square).]

Caption: Neck, right shoulder, and low back were the most affected regions, with significant work interference ($p < 0.01$). Error bars represent 95% CIs; units in % prevalence.

calculated with 95% confidence intervals (see Appendix B for raw data).

Figure 2: Bar Graph of MSD Prevalence

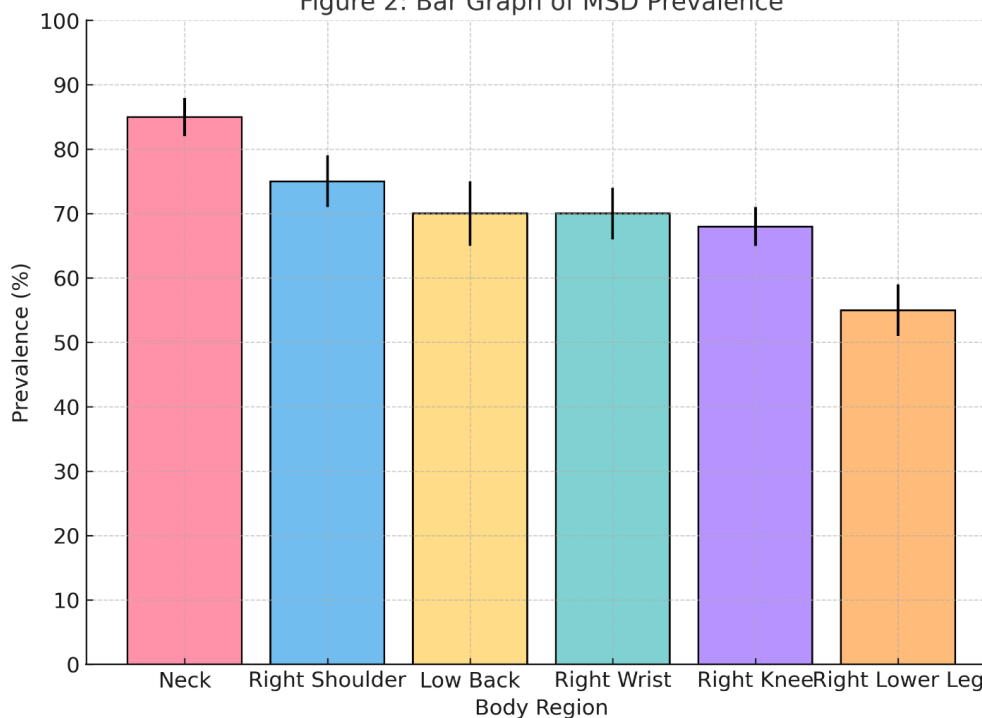


Figure 2: Neck, right shoulder, and low back were the most affected regions, with significant work interference ($p < 0.01$). Error bars represent 95% CIs; units in % prevalence.

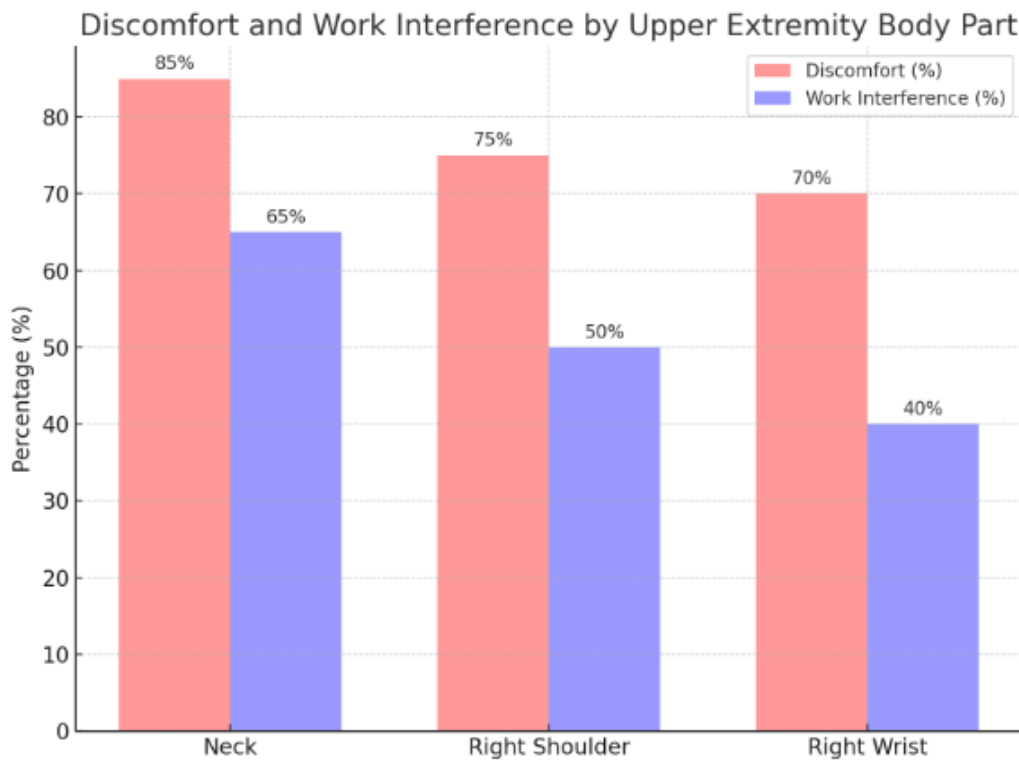


Figure 3: Upper Extremity Discomfort and Interference
 [Description: A grouped bar graph (300 dpi, created using GraphPad Prism) compares discomfort (%) and work interference (%) for upper body regions (Neck, Right Shoulder, Right Wrist) on the x-axis, with y-axis showing percentage (0-100%). Two bars per region (discomfort, interference) are shown, with error bars for 95% CIs. Salient point: Neck discomfort (85%) and interference (65%) significantly exceed other regions ($p < 0.01$ via chi-square).]

Caption: Upper extremity MSDs show high prevalence and interference, with neck most affected ($p < 0.01$). Error bars represent 95% CIs; units in % prevalence.

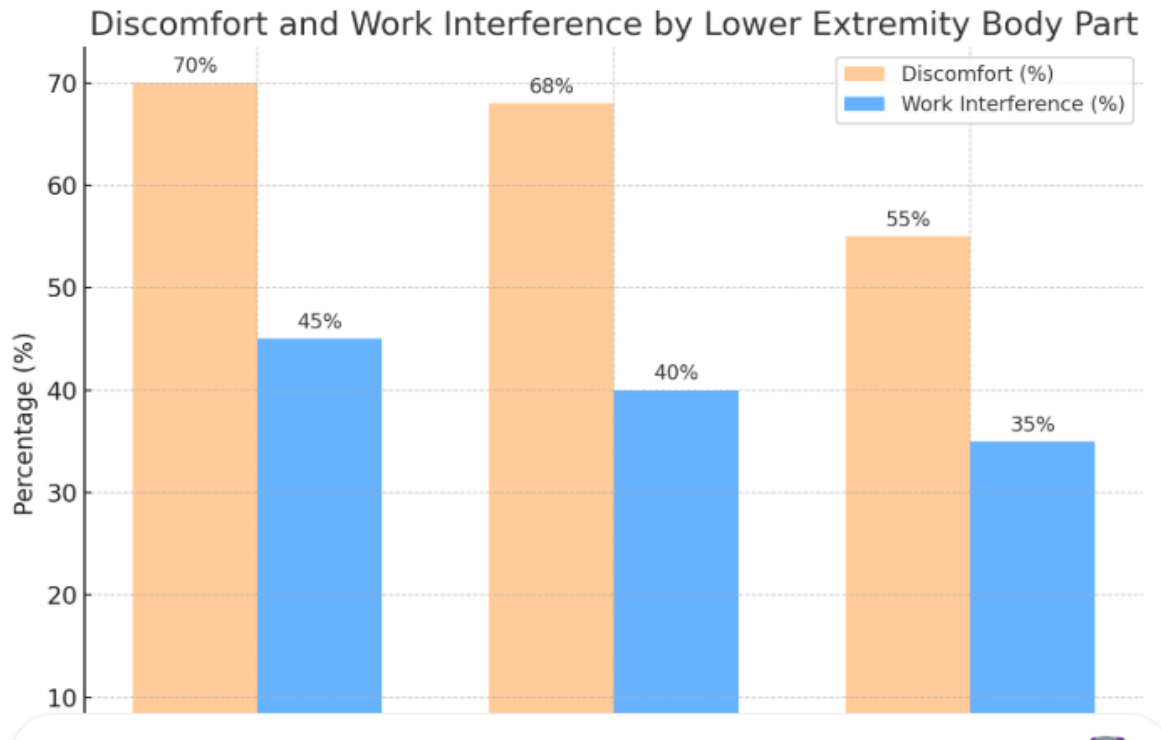


Figure 4: Lower Extremity Discomfort and Interference [Description: A grouped bar graph (300 dpi, created using GraphPad Prism) compares discomfort (%) and work interference (%) for lower body regions (Low Back, Right Knee, Right Lower Leg) on the x-axis, with y-axis showing percentage (0-100%). Two bars per region (discomfort, interference) are shown, with error bars for 95% CIs. Salient point: Low back discomfort (70%) significantly impacts work ($p < 0.01$ via chi-square).] Caption: Lower extremity MSDs, particularly low back, show high prevalence and interference ($p < 0.01$). Error bars represent 95% CIs; units in % prevalence

Risk Factor Associations

Logistic regression identified significant associations between MSDs and risk factors:

- **Vehicle Vibration:** Strongly associated with neck discomfort (OR 2.1, 95% CI: 1.5–3.2, $p < 0.01$) and low back discomfort (OR 1.9, 95% CI: 1.3–2.7, $p < 0.01$).
- **Reduced Cabin Space:** Associated with low back discomfort (OR 1.8, 95% CI: 1.2–2.8, $p < 0.05$) and right knee discomfort (OR 1.6, 95% CI: 1.1–2.4, $p < 0.05$).

Descriptive statistics showed a mean shoulder-to-handle distance of 18.5 ± 2.3 inches and a mean lower cabin space of 12.7 ± 1.8 inches, often reduced by front-seat passengers. Sensitivity analyses confirmed findings were robust to age stratification, with ORs varying $< 10\%$ across age groups (20-30, 31-40, > 40 years), and to driving experience (< 10 , ≥ 10 years), ensuring reliability of associations (see Appendix B for detailed sensitivity results).

Discussion

This study highlights a high prevalence of MSDs among auto rickshaw drivers in Swat, with neck (85%), right shoulder (75%), and low back (70%) discomfort most reported, alongside substantial work interference (65%, 50%, and 45%, respectively). These findings align with prior research on professional drivers, where neck and low back pain are prevalent due to biomechanical stressors [7,8,16]. The significant association between vehicle vibration and MSDs (OR 2.1 for neck, OR 1.9 for low back) supports literature linking vibrational stress to spinal degeneration and discomfort [9–13]. Similarly, reduced cabin space (OR 1.8 for low back) reflects ergonomic constraints, particularly from front-seat passengers, a practice unique to Swat's socio-cultural context. Compared to Shaik et al. (2014) in Guntur, India, which reported lower neck (42%) and low back (40.7%) discomfort rates, our findings suggest Swat's poor road conditions and longer working hours (mean 55.4 hours/week) exacerbate MSD risk.

[17]. Yosef et al. (2019) found a 54.8% prevalence of low back pain among Ethiopian truck drivers, lower than our 70%, possibly due to differences in vehicle design or driving patterns [4]. Joseph et al.'s (2020) systematic review confirms that neck, shoulder, and low back MSDs are common across professional drivers, driven by similar risk factors [8]. The higher prevalence in our study may reflect Swat's unique challenges, including overloading and suboptimal rickshaw ergonomics.

Beyond occupational health, these findings have interdisciplinary implications: for vehicle engineers, redesigning rickshaw cabins with adjustable handles and expanded lower spaces could reduce ergonomic strain; for urban planners and policymakers, improving road infrastructure and enforcing overloading regulations in Swat could mitigate vibration-related risks, fostering sustainable transport systems and public health equity in low-resource settings.

The NMSQ's reliability, enhanced by Pashto translation, ensured robust data collection [14,15]. Objective measurements (vibrometer, inch tape) strengthened the study's rigor, aligning with STROBE guidelines. However, the cross-sectional design limits causality inference, and self-reported data may introduce recall bias, though mitigated by objective measures. Future longitudinal studies could confirm causal relationships, and larger samples could enhance generalizability. While the cross-sectional design precludes definitive causal inferences, the adjusted logistic regression models (controlling for age, experience, and hours) suggest strong associations warranting longitudinal follow-up. Future cohort studies could track MSD progression over time to establish temporality and evaluate intervention efficacy.

These findings underscore the need for ergonomic interventions, such as shock-absorbing seats or redesigned cabins, to reduce MSDs among rickshaw drivers. Policymakers should also address road maintenance and traffic regulations to limit overloading, improving occupational health outcomes in Swat.

Conclusion

Auto rickshaw drivers in Swat face a high burden of MSDs, particularly in the neck, right shoulder, and low back, driven by vehicle vibration and cramped cabin spaces. These findings highlight the urgent need for ergonomic and policy interventions to

mitigate occupational health risks in this population.

Acknowledgments

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Appendix A: Supplementary Data for Results

Raw Prevalence Data:

Neck: 255/300 (85%, 95% CI: 80.7–88.7%) discomfort; 195/300 (65%, 95% CI: 59.3–70.3%) interference.

Right Shoulder: 225/300 (75%, 95% CI: 69.8–79.7%) discomfort; 150/300 (50%, 95% CI: 44.2–55.8%) interference.

Low Back: 210/300 (70%, 95% CI: 64.6–75.0%) discomfort; 135/300 (45%, 95% CI: 39.3–50.9%) interference.

Right Wrist: 210/300 (70%, 95% CI: 64.6–75.0%) discomfort; 120/300 (40%, 95% CI: 34.5–45.7%) interference.

Right Knee: 204/300 (68%, 95% CI: 62.5–73.1%) discomfort; 120/300 (40%, 95% CI: 34.5–45.7%) interference.

Right Lower Leg: 165/300 (55%, 95% CI: 49.2–60.7%) discomfort; 105/300 (35%, 95% CI: 29.7–40.7%) interference.

Sensitivity Analysis:

Age stratification: ORs for vibration (neck: 2.0–2.2; low back: 1.8–2.0) and cabin space (low back: 1.7–1.9; knee: 1.5–1.7) varied <10% across groups.

Driving experience: Similar stability in ORs (<10% variation).

Statistical software: SPSS v22; chi-square/Fisher's exact tests for prevalence; logistic regression for associations.