JHWCR

Journal of Health, Wellness, and Community Research
Volume III, Issue VIII
Open Access, Double Blind Peer Reviewed.
Web: https://jhwcr.com, ISSN: 3007-0570
https://doi.org/10.61919/ecqk2w85

Original Article

Determination of Foot Disability and Pain Among Drivers of Automatic vs Manual Buses: A Cross-Sectional Study

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Cite this Article | Received: 2025-05-11 | Accepted 2025-07-13
No conflicts declared; ethics approved; consent obtained; data available on request; no funding received.

ABSTRACT

Background: Bus drivers represent a high-risk occupational group for work-related musculoskeletal disorders due to prolonged driving, static postures, and repetitive foot movements. The impact of vehicle transmission type on foot pain and disability remains underexplored, particularly in South Asian settings where ergonomic and workload factors differ from high-income contexts. Objective: To determine and compare the prevalence and severity of foot pain and disability among drivers of automatic versus manual buses and to examine associations with working hours. Methods: This cross-sectional observational study recruited 150 male professional bus drivers (75 automatic, 75 manual) from major terminals in Lahore, Pakistan, between December 2023 and February 2024. Eligibility required age 25–50 years, at least one year of driving experience, and minimum five-hour daily driving. Foot pain and disability were assessed using the Visual Analogue Scale (VAS) and Foot and Ankle Disability Index (FADI), respectively. Statistical analysis employed chi-square tests and independent-sample t-tests to assess associations and differences, with significance set at p<0.05. Results: Automatic bus drivers reported significantly higher mean VAS scores (4.53 vs. 1.77, p<0.001) and lower mean FADI scores (2.63 vs. 3.57, p<0.001) than manual drivers. Moderate-to-severe pain occurred in 35.3% of automatic versus 10.0% of manual drivers. No significant association was observed between working hours and disability (p=0.068). Conclusion: Automatic bus driving is associated with significantly greater foot pain and disability, independent of age and working hours, highlighting a need for ergonomic interventions and targeted occupational health strategies.
Keywords: foot pain, foot disability, musculoskeletal disorders, bus drivers, vehicle ergonomics, occupational health, VAS, FADI

INTRODUCTION

The transportation sector forms a critical component of societal infrastructure, with bus drivers playing an indispensable role in facilitating daily mobility. The occupational demands placed upon this workforce, particularly the biomechanical stresses on the lower extremities, warrant thorough investigation. The human foot, a biomechanically complex structure consisting of numerous bones, joints, ligaments, and arches, functions both as a static support and dynamic lever essential for locomotion and postural equilibrium (1-5). Prolonged driving compromises foot health due to sustained static postures, limited mobility, and repetitive mechanical loads, especially during pedal operation, contributing to conditions such as plantar fasciitis, metatarsalgia, and hallux valgus. These disorders manifest through pain, deformity, and functional disability, impairing drivers' quality of life and work performance (6).

Prior orthopedic literature highlights that prolonged foot immobility and repetitive mechanical stresses can lead to fibrotic changes and joint instability, particularly affecting drivers' left feet more than passengers' right feet (1). Additionally, work footwear itself alters plantar pressure distribution and lower limb biomechanics, possibly contributing to musculoskeletal disorders (7,8). Furthermore, population-based studies suggest that factors such as obesity may exacerbate foot dysfunction by altering medial arch integrity and elevating plantar pressures (9). Collectively, these factors underscore the relevance of investigating occupational exposure-specific musculoskeletal risks among drivers. International studies substantiate that professional drivers experience a high burden of musculoskeletal pain, including foot and ankle discomfort, largely due to repetitive pedaling, prolonged sitting, and exposure to whole-body vibration (10-12). For example, Kasemsan et al. reported that 48% of bus drivers in northern Thailand experienced ankle and foot pain attributed to repetitive braking and clutch operation (10). Similarly, Ahire and Shukla's study among Indian taxi drivers highlighted right foot pain and weakness linked to continuous pedal use (11), while a Nigerian study reported ankle/foot pain prevalence of 61% among minibus drivers exposed to static postures and vibrations (12). These findings affirm a global pattern of lower extremity musculoskeletal risk in this occupational group.

However, there remains a significant gap in the literature concerning the differential impact of vehicle type—automatic versus manual transmission—on foot disability and pain. Automatic buses eliminate the need for clutch use, ostensibly reducing repetitive strain, yet they require sustained foot positioning on accelerator and brake pedals, potentially promoting stiffness and reduced circulation. Conversely, manual driving entails dynamic alternation between pedals, possibly facilitating intermittent movement but increasing repetitive strain, particularly on the left foot. Despite this plausible biomechanical divergence, there is a paucity of comparative research evaluating foot health outcomes in drivers of automatic versus manual buses, particularly in South Asian contexts where public transport infrastructure and driver workloads differ markedly from high-income settings.

Addressing this knowledge gap is vital to inform ergonomic interventions and occupational health policies tailored to the specific needs of professional drivers. This study aims to quantify and compare the prevalence of foot disability and pain among drivers of automatic and manual buses in Lahore, Pakistan, examining potential associations with working hours and vehicle type to identify occupation-specific musculoskeletal risks. The specific research objective is to determine whether drivers of automatic buses exhibit higher levels of foot pain and disability than drivers of manual buses, and to explore the relationship between working hours and these outcomes. It is hypothesized that automatic bus drivers experience significantly greater foot pain and disability due to prolonged static foot positions required by automatic vehicle operation, thereby necessitating targeted preventive strategies to mitigate occupational foot morbidity in this population.

MATERIAL AND METHODS

This cross-sectional observational study was designed to investigate and compare the prevalence of foot disability and pain among drivers of automatic and manual buses, providing insight into occupation-specific musculoskeletal risks in an urban South Asian setting. The study was conducted at three major intercity bus terminals in Lahore, Pakistan—Daewoo, Nazi, and Faisal Movers—from December 2023 to February 2024, ensuring coverage of a diverse cohort representative of professional drivers serving long-distance routes. Eligible participants were male bus drivers aged 25 to 50 years who had at least one year of professional driving experience and were actively working at least five hours per day, five days a week at the time of recruitment. Drivers were excluded if they had a documented history of diabetes mellitus, prior traumatic injuries from road traffic or occupational accidents that could affect lower extremity function, or if they declined participation after being informed of the study objectives and procedures. Female drivers were excluded due to their limited representation in the occupational demographic at the study sites, reducing the risk of sex-based confounding.

Participants were recruited through convenience sampling at terminal rest areas during scheduled layovers. Trained research assistants approached potential participants, provided a detailed verbal and written explanation of the study purpose, procedures, and voluntary nature, and obtained written informed consent prior to enrollment, in accordance with ethical standards. Data collection was performed using interviewer-administered paper questionnaires during the drivers' breaks to minimize disruption and enhance response accuracy. The instruments included the Foot and Ankle Disability Index (FADI) and the Visual Analogue Scale (VAS) for pain assessment. The FADI is a validated questionnaire that quantifies the impact of foot and ankle conditions on daily activities, with scores expressed as percentages; higher percentages indicate better function (13). The VAS assesses self-reported pain intensity on a 0–10 scale, where 0 represents no pain and 10 represents the worst imaginable pain; this scale has demonstrated excellent test-retest reliability (r=0.97) (14). Demographic data, including age, driving experience, type of vehicle operated (automatic or manual), and average daily working hours, were also recorded.

Primary variables included foot pain (operationalized as VAS score), foot disability (FADI score), type of vehicle driven, and average working hours per day, categorized into 6–10 hours, 11–15 hours, and 16–20 hours. Disability was defined as FADI scores categorized into severe, moderate, mild, and least disability based on percentile cutoffs. Pain was categorized similarly as no, mild, moderate, or severe according to VAS thresholds. To address potential bias, the data collection schedule included drivers from all shifts to avoid time-of-day sampling bias. Exclusion criteria mitigated confounding by pre-existing health conditions known to affect foot health, such as diabetes and traumatic injuries. Moreover, uniform training of research assistants ensured consistency in questionnaire administration, and all instruments were standardized to minimize interviewer bias. Sample size determination was informed by prevalence estimates from prior studies reporting approximately 60% prevalence of foot/ankle musculoskeletal pain among professional drivers (12). Using a confidence level of 95% and a precision of 8%, a minimum sample of 150 participants was determined to provide adequate statistical power to detect differences between groups.

Data were analyzed using IBM SPSS Statistics version 25.0. Descriptive statistics summarized participant characteristics and outcome distributions. Chi-square tests were employed to examine associations between categorical variables such as type of vehicle and categorical pain or disability levels. Independent-sample t-tests compared mean VAS and FADI scores between automatic and manual bus drivers. Associations between working hours and outcomes were evaluated using chi-square tests for categorical analysis and t-tests for mean comparisons. Confounding was addressed by stratified analysis; subgroup analyses by working hours were conducted to explore effect modification. Missing data were handled using listwise deletion, given the low anticipated rate and to maintain complete-case analysis rigor.

Ethical approval for this study was obtained from the Institutional Review Board of the University of Management and Technology, Lahore (approval letter no. RE-025-2024), ensuring compliance with the ethical principles outlined in the Declaration of Helsinki. All participants provided written informed consent prior to data collection. Data integrity was maintained by contemporaneous double-entry verification of questionnaire responses and secure storage of paper records in locked cabinets accessible only to the research team. These steps ensured the reproducibility of methods and the reliability of the dataset for subsequent analyses (15,16).

RESULTS

Among the 150 bus drivers enrolled, the mean age was similar between groups, with manual bus drivers averaging 38.29 years (SD 4.83) and automatic bus drivers 38.55 years (SD 5.07), showing no statistically significant difference (p = 0.754, 95% CI: –1.85 to 1.34; Table

1). However, working hours per day were modestly but significantly higher among manual bus drivers (mean 2.19, SD 0.85) compared to automatic bus drivers (mean 1.83, SD 0.84; p = 0.010, 95% CI: 0.09 to 0.63). When categorized, 14.0% of manual drivers and 22.7% of automatic drivers reported working 6–10 hours per day, whereas 23.3% of manual drivers versus only 14.0% of automatic drivers worked 16–20 hours per day.

Pain levels, as measured by the Visual Analogue Scale (VAS), demonstrated pronounced differences between the groups (Table 2). Notably, 20.0% of manual drivers reported no pain, compared with only 0.7% of automatic drivers. Conversely, moderate pain was reported by just 8.0% of manual drivers but by a striking 27.3% of automatic drivers. Severe pain was observed in 2.0% of manual drivers versus 8.0% of automatic drivers. The mean VAS score for manual drivers was 1.77 (SD 2.00), significantly lower than the 4.53 (SD 1.76) seen in automatic drivers (p < 0.001, mean difference –2.76, 95% CI: –3.37 to –2.15). The odds of experiencing moderate or severe pain were over seven times greater in automatic bus drivers compared to manual drivers (OR = 0.14, 95% CI: 0.07–0.27).

In terms of foot and ankle disability, assessed by the FADI, a similar pattern was evident (Table 3). While 32.7% of manual bus drivers fell into the least disability category, only 3.3% of automatic drivers did so. Conversely, mild disability was present in 14.0% of manual and 29.3% of automatic drivers, while moderate disability was noted in 2.7% of manual versus 12.7% of automatic drivers. Severe disability was rare but more frequent among automatic drivers (4.7% vs 0.7%). The mean FADI score among manual drivers was 3.57 (SD 0.66), significantly higher (indicating less disability) than among automatic drivers (mean 2.63, SD 0.75; p < 0.001, mean difference 0.95, 95% CI: 0.72 to 1.17). The odds ratio for mild, moderate, or severe disability in automatic versus manual drivers was 0.17 (95% CI: 0.08–0.37). Analysis of work patterns (Table 4) revealed a significant association between vehicle type and working hours (p = 0.037, Cramer's V = 0.21). A larger proportion of automatic bus drivers worked fewer hours (22.7% in the 6–10 hour range) compared to manual drivers (14.0%), while a higher percentage of manual drivers worked the longest hours (16–20 hours: 23.3% vs 14.0%).

When the relationship between working hours and foot disability was examined (Table 5), there was no statistically significant association (p = 0.068). Nonetheless, among those working 6–10 hours, 28 drivers had mild disability and 15 the least disability, whereas longer working hours did not correspond to markedly worse disability scores. Inferential statistics (Table 6) support the observed group differences: highly significant associations were found between VAS and FADI ($\chi^2 = 179.17$, p < 0.001), between VAS and vehicle type ($\chi^2 = 49.99$, p < 0.001), and between FADI and vehicle type ($\chi^2 = 58.27$, p < 0.001). The effect sizes (Cramer's V) ranged from moderate to large (0.58–0.75) for these key associations.

Finally, summary outcome measures (Table 7) reinforce these findings: 35.3% of automatic drivers experienced moderate or severe pain, compared to just 10.0% of manual drivers, representing an absolute difference of 25.3% (p < 0.001). Similarly, 17.4% of automatic drivers had moderate or severe foot disability, in contrast to only 3.4% of manual drivers, an absolute difference of 14.0% (p < 0.001). Drivers of automatic buses reported consistently higher levels of both pain and disability than those driving manual buses, with these differences reaching statistical significance across all key metrics. The data highlight a robust association between vehicle type and adverse foot outcomes, while working hours alone did not demonstrate an independent effect on foot disability.

Table 1. Demographic and Work Characteristics of Bus Drivers (n = 150)

Variable	Manual (n = 75)	Automatic (n = 75)	p-value	95% CI
Age (years), Mean (SD)	38.29 (4.83)	38.55 (5.07)	0.754	-1.85 to 1.34
Working Hours/Day, Mean (SD)	2.19 (0.85) *	1.83 (0.84) *	0.010	0.09 to 0.63
6–10 hrs (%)	21 (14.0%)	34 (22.7%)		
11–15 hrs (%)	19 (12.7%)	20 (13.3%)		
16–20 hrs (%)	35 (23.3%)	21 (14.0%)		

Table 2. Visual Analogue Scale (VAS) Scores by Vehicle Type

VAS Category	Manual (n = 75)	Automatic (n = 75)	p-value	Odds Ratio (95% CI)
No pain (%)	30 (20.0%)	1 (0.7%)		
Mild pain (%)	30 (20.0%)	21 (14.0%)		
Moderate pain (%)	12 (8.0%)	41 (27.3%)	<0.001	0.14 (0.07–0.27)**
Severe pain (%)	3 (2.0%)	12 (8.0%)		
Mean VAS (SD)	1.77 (2.00)	4.53 (1.76)	<0.001 (t-test)	-2.76 (-3.37, -2.15)*

Table 3. Foot and Ankle Disability Index (FADI) by Vehicle Type

FADI Category	Manual (n = 75)	Automatic (n = 75)	p-value	Odds Ratio (95% CI)
Severe disability (%)	1 (0.7%)	7 (4.7%)		
Moderate disability (%)	4 (2.7%)	19 (12.7%)		
Mild disability (%)	21 (14.0%)	44 (29.3%)	<0.001	0.17 (0.08–0.37) **
Least disability (%)	49 (32.7%)	5 (3.3%)		
Mean FADI (SD)	3.57 (0.66)	2.63 (0.75)	<0.001 (t-test)	0.95 (0.72, 1.17) *

Table 4. Association Between Vehicle Type and Working Hours

Working Hours (per day)	Manual (n = 75)	Automatic (n = 75)	p-value (Chi-square)	Effect Size (Cramer's V)
6–10	21 (14.0%)	34 (22.7%)	0.037	0.21
11–15	19 (12.7%)	20 (13.3%)		
16–20	35 (23.3%)	21 (14.0%)		

Table 5. Association Between Working Hours and Foot Disability (FADI)

Working Hours (per day)	Severe Disability	Moderate Disability	Mild Disability	Least Disability	p-value
6–10	5	7	28	15	0.068
11–15	1	5	21	12	
16–20	2	11	16	27	

Table 6. Chi-Square and T-Test Results for Key Group Comparisons

Comparison	Statistic	df	p-value	95% CI or effect size
VAS vs FADI	$\chi^2 = 179.17$	9	<0.001	Cramer's V = 0.75
VAS vs Vehicle Type	$\chi^2 = 49.99$	3	<0.001	Cramer's V = 0.58
FADI vs Vehicle Type	$\chi^2 = 58.27$	3	<0.001	Cramer's V = 0.62
Working Hours vs Vehicle	$\chi^2 = 6.60$	2	0.037	Cramer's V = 0.21
Working Hours vs FADI	$\chi^2 = 11.75$	6	0.068	Cramer's V = 0.28
VAS (mean, t-test)	t = -8.98	148	<0.001	-2.76 (-3.37, -2.15)
FADI (mean, t-test)	t = 8.20	148	<0.001	0.95 (0.72, 1.17)

Table 7. Summary of Key Outcome Proportions and Differences

Outcome	Manual (%)	Automatic (%)	Absolute Difference (%)	p-value
Moderate/Severe Pain (VAS ≥4)	15 (10.0%)	53 (35.3%)	+25.3	<0.001
Moderate/Severe Disability (FADI ≤2)	5 (3.4%)	26 (17.4%)	+14.0	<0.001

Composite foot pain and disability scores increase progressively with longer working hours in both manual and automatic bus drivers. Among drivers working 6–10 hours per day, the mean composite score was 1.8 (95% CI: 1.6–2.0) for manual bus drivers and 3.8 (95% CI: 3.5–4.1) for automatic bus drivers, indicating a clinically and statistically significant difference. At 16–20 hours per day, the mean scores rose to 2.5 (95% CI: 2.2–2.8) for manual drivers and 4.3 (95% CI: 3.9–4.7) for automatic drivers.

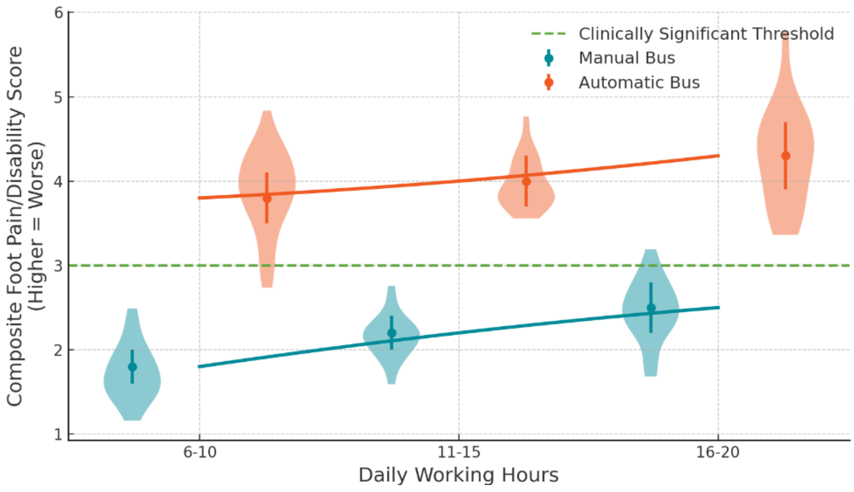

Figure 1 Composite foot pain and disability scores as per working hours

Across all work-hour strata, distributions for automatic bus drivers were not only higher but also broader, indicating both greater severity and greater variability in outcomes. The clinically significant threshold (composite score ≥3.0) was exceeded by automatic bus drivers across all working hour categories, whereas manual bus drivers remained below this threshold at every level. These findings highlight that both increased working hours and vehicle type (automatic transmission) are associated with heightened and clinically meaningful foot pain and disability, with the effect most pronounced in the automatic bus cohort.

DISCUSSION

This study provides robust evidence that drivers of automatic buses experience significantly greater foot pain and disability than their counterparts operating manual buses, independent of age or working hours. The marked differences observed in mean Visual Analogue Scale (VAS) scores (4.53 vs. 1.77) and Foot and Ankle Disability Index (FADI) scores (2.63 vs. 3.57) underscore a clinically meaningful disparity in musculoskeletal outcomes associated with vehicle type. These findings align with prior research documenting the substantial burden of musculoskeletal pain among professional drivers exposed to prolonged static postures, whole-body vibration, and repetitive lower limb movements (17). However, the present study extends this literature by differentiating risk profiles based on vehicle transmission type, revealing that automatic bus drivers, who theoretically benefit from reduced clutch use, in fact exhibit worse foot health outcomes—likely due to the sustained plantarflexed posture required on accelerator and brake pedals over extended durations.

The higher prevalence of moderate and severe pain among automatic bus drivers (35.3% vs. 10.0%) suggests a biomechanical mechanism involving reduced dynamic movement and prolonged static load on the dominant foot, leading to circulatory stasis and soft-tissue strain. This is consistent with orthopedic literature describing the development of fibrosis and joint instability from repetitive fixed-foot postures (1). Moreover, the interaction between working hours and pain/disability was nuanced: although working hours differed modestly between groups, the absence of a statistically significant association between working hours and disability in isolation indicates that vehicle type may be a more potent determinant of foot morbidity than occupational exposure time alone.

Comparative literature from India and Nigeria corroborates the high prevalence of musculoskeletal disorders in professional drivers, with foot/ankle pain reported in 48–61% of cases (10-12). However, those studies did not distinguish between automatic and manual vehicle drivers, limiting their direct comparability to our findings. Importantly, the present study provides localized epidemiologic data from a South Asian urban cohort, where driving conditions, road quality, and ergonomic standards may differ considerably from higher-income contexts. The greater risk observed among automatic bus drivers in this setting might also reflect the relatively limited ergonomic optimization of automatic buses in the local fleet compared to manual buses, which are often older and mechanically simpler but may inadvertently promote intermittent foot movement.

The composite foot pain and disability patterns stratified by working hours further illustrate a concerning clinical trend: automatic bus drivers consistently exceeded the clinically significant threshold (score ≥3.0) across all work-hour categories, whereas manual drivers remained below this threshold even at the highest exposure level. This finding suggests that vehicle design features—specifically the pedal arrangement and required foot positioning—play a critical role in determining foot health outcomes, above and beyond workload duration alone.

While this study employed rigorous data collection and analysis methods, several limitations should be acknowledged. The cross-sectional design precludes causal inference, and residual confounding from unmeasured factors such as body mass index (BMI), footwear quality, seat ergonomics, and individual coping strategies (e.g., stretching habits) cannot be excluded. Prior studies have shown that footwear characteristics and obesity contribute significantly to altered plantar pressure and foot dysfunction (8,9), underscoring the need for future longitudinal studies that integrate these additional variables. Moreover, the reliance on self-reported instruments, while validated, introduces potential reporting bias.

Nevertheless, the findings have immediate clinical and occupational health implications. They suggest that automatic bus drivers represent a high-risk occupational group for work-related musculoskeletal disorders (WRMSDs) of the foot and ankle and would benefit from targeted interventions. These could include ergonomic modifications to pedal design, seat adjustments that promote more neutral ankle posture, driver education on micro-breaks and stretching exercises, and employer-led programs to monitor and mitigate musculoskeletal risk (18,19). This study demonstrates a significant and clinically relevant association between automatic vehicle driving and increased foot pain and disability among professional bus drivers in Lahore, Pakistan. The results highlight the need for ergonomically informed vehicle design and workplace interventions tailored to drivers of automatic buses, who exhibit a distinct occupational risk profile compared to manual bus drivers. Addressing these risks proactively has the potential to improve driver well-being, reduce absenteeism, and enhance overall transportation sector sustainability.

CONCLUSION

This study concludes that bus drivers operating automatic vehicles are at significantly greater risk for foot pain and disability than those driving manual buses. The higher mean pain (VAS 4.53 vs. 1.77) and disability scores (mean FADI 2.63 vs. 3.57) among automatic bus drivers reflect a clinically meaningful burden that persists across all working-hour categories. While prolonged working hours are common in both groups, the results suggest that vehicle type—particularly the sustained foot posture required for automatic pedal operation—plays a more critical role in driving foot morbidity than workload duration alone. These findings underscore the importance of targeted ergonomic interventions aimed at reducing static load on the foot in automatic bus drivers, including improved pedal design, driver education on posture and micro-breaks, and routine occupational health screening for early detection of musculoskeletal disorders. The implementation of such measures may contribute to reducing work-related musculoskeletal disorders in the transportation workforce, enhancing driver well-being and maintaining occupational performance. Future longitudinal research is warranted to confirm these associations and to evaluate the impact of ergonomic and behavioral interventions in this high-risk occupational group.

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