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Comparison of Upper Limb Weakness among Drivers and Non-Drivers

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ABSTRACT

The strength of the upper limbs is crucial for performing daily activities, and prolonged working hours, such as driving, can lead to muscle weakness. Muscle activity may be impacted by repetitive movements of the upper limb, posture, and vibrations to which the drivers are exposed. The evaluation of upper limb weakness in groups of drivers and non-drivers can be used to gain insight into the occupational effects of this condition and possible preventive measures. **Objective:** To compare upper limb weakness among drivers and non-drivers. **Methods:** This comparative cross-sectional study was conducted on 54 male respondents (27 drivers and 27 non-drivers) who were recruited by a convenience sampling method. MMT was applied to evaluate the upper limb strength. SPSS version 27.0 was used to analyze data. **Results:** A total of 54 participants were included, evenly divided between drivers (n=27) and non-drivers (n=27). The majority were middle-aged, with the largest proportion aged 46–55 years (29.6%), and most participants were right-handed (79.6%). There were no statistically significant differences in upper limb muscle strength between drivers and non-drivers across shoulder, elbow, and wrist movements (p>0.05). However, shoulder adduction showed a notable trend, with 48.1% of non-drivers exhibiting normal strength (Grade 5) compared to only 14.8% of drivers (p=0.054). Elbow flexion also favoured non-drivers (40.7% vs. 29.6% with Grade 5 strength), though the difference was not significant (p=0.378). Most strength grades across all movements fell within Grade 4 (against some resistance) for both groups. **Conclusion:** It was concluded that there were significant differences in upper limb strength between drivers and non-drivers.

INTRODUCTION

Upper Limb Musculoskeletal Disorders (ULMSDs) significantly affect daily function and occupational performance, commonly presenting as pain, weakness, or movement restrictions in the shoulders, arms, and hands [1]. Occupational driving, especially among bus and truck drivers, is closely linked with a high prevalence of musculoskeletal disorders due to prolonged sitting, repetitive tasks, and exposure to vibrations [2]. Handgrip strength (HGS) serves as a reliable indicator of muscle function and overall physical status [3, 4]. Research consistently shows that HGS correlates with anthropometric factors such as height, weight, BMI, and arm circumference. Additionally, gender and age influence grip strength, with males generally showing higher values and a noticeable decline with ageing. These findings are crucial for evaluating fitness, especially in elderly and athletic populations [5, 6]. Drivers are particularly prone to musculoskeletal issues in the upper body due to ergonomic stressors, poor road conditions, and limited rest, leading to conditions like neck, shoulder, and arm pain. Comparatively, non-drivers also report musculoskeletal complaints, though their risk factors may vary depending on occupation and lifestyle. Studies suggest that long-term drivers are significantly more likely to develop musculoskeletal issues compared to non-drivers, highlighting the cumulative risk of occupational exposure

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[7-9]. Ergonomic challenges such as awkward postures and environmental stressors further exacerbate upper limb discomfort in drivers. Understanding hand dominance also plays a role in muscle assessment, as dominant limbs typically exhibit greater strength. These insights underline the need for tailored intervention and prevention strategies in both driver and non-driver populations [10-12]. Ultimately, ULMSDs pose not only physical health risks but also broader social and economic impacts, including reduced work ability and increased absenteeism. Developing effective prevention programs that consider anthropometric, occupational, and ergonomic factors is essential for improving health outcomes and work performance across different populations [13]. Given the high prevalence of ULMSDs among drivers and non-drivers, this study aims to provide a comparative analysis of upper limb weakness in these two populations. This study aims to bridge this gap by analyzing and comparing the patterns of upper limb strength and the contributing factors in both groups, providing valuable insights for preventative and rehabilitative strategies specific to the population of Lahore [14-16]. There is limited research specifically comparing upper limb weakness among drivers and non-drivers, particularly in the context of Lahore. Most prior studies focus on lower back strain or posture, leaving a gap in understanding the occupational impact on upper limb musculature, especially in regional populations like Pakistan.

Although occupational driving has been widely associated with musculoskeletal disorders, limited research has specifically compared objective upper limb muscle strength between drivers and non-drivers within the Pakistani context, particularly in Lahore. Most previous studies have emphasized lower back pain, vibration exposure, or general musculoskeletal complaints, with insufficient focus on joint-specific upper limb strength patterns. Moreover, regional data exploring the occupational impact of repetitive steering and posture on shoulder, elbow, and wrist musculature remain scarce. Therefore, this study aimed to address this gap by comparatively evaluating upper limb weakness among drivers and non-drivers to better inform occupational health strategies.

METHODS

A comparative cross-sectional study was conducted from March 2025- May 2025 in Lahore. A convenient sampling technique was used. A total of 54 participants from Lahore participated in this study. The sample size was calculated using "Raosoft". The target population for this study includes drivers and non-drivers in Lahore, Pakistan. A total of 54 male participants (27 drivers and 27 non-drivers) were assessed. Each participant underwent an evaluation of Manual Muscle Testing (MMT) to determine upper limb strength. Standardized procedures will be followed to ensure consistency. The assessments will be conducted at workplaces, transport hubs, and community settings. A self-administered structured questionnaire will be used to document participant details and assessment results, including: Demographic information included age and dominant hand (for drivers). Manual Muscle Testing (MMT): Assessed for key upper limb muscles (shoulder, elbow, wrist flexors/extensors), rated on a scale from 0 (no contraction) to 5 (normal strength). Shoulder (flexion, extension, abduction, adduction, internal and external rotation): Participants were seated or supine based on the specific movement tested. Each movement was tested separately using standard MMT grading (0–5 scale). Resistance was applied manually by the examiner:

Grade 5: Full range of motion (ROM) against maximum resistance,

Grade 4: Full ROM against moderate resistance,

Grade 3: Full ROM against gravity but without resistance,

Grade 2: Full ROM with gravity eliminated,

Grade 1: Flicker or trace contraction with no movement and

Grade 0: No visible or palpable contraction.

For elbow (Flexion and Extension) participants were tested in a seated position with the shoulder in neutral. Elbow flexion was tested with forearm supinated, and extension with the shoulder flexed to 90°. Resistance was applied at the distal forearm using the same grading scale (0–5).

Wrist (Flexion and Extension): Participants' forearms rested on a table with the hand over the edge. For flexion, the palm faced upward; for extension, downward. Manual resistance was applied over the metacarpals, and strength was graded using the MMT scale. All assessments were performed bilaterally, and the higher grade was recorded for analysis [17].

RESULTS

To evaluate upper limb strength differences between drivers and non-drivers, focusing on muscle strength and functional capacity across shoulder, elbow, and wrist movements. A total of 54 participants were included, with an equal distribution of drivers (50%, n=27) and non-drivers (50%, n=27). The sample predominantly comprised middle-aged individuals, with the largest age group being 46–55 years (29.6%, n=16), followed by 36–45 years (27.8%, n=15). Younger participants aged 18–25 years were the least represented (9.3%, n=5). Hand dominance skewed heavily toward right-handedness (79.6%, n=43), while left-handed participants constituted 20.4% (n=11). Driving experience varied significantly: half of the participants reported no driving experience (50%, n=27), whereas 20% (n=11) had

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6–10 years of experience, and only 13% (n=7) fell into the 1–5 years category. This demographic distribution highlights a balanced sample for comparing occupational drivers and non-drivers, though further stratification by age or experience may be warranted in future studies (Table 1).

Table 1: Demographic Characteristics of Study Participants (n=54)

Variables	Category	Frequency (%)
Age Group (Years)	18-25	5 (9.3%)
	36–45	15 (27.8%)
	46–55	16 (29.6%)
	Other (Not Reported)	18 (33.3%)
Hand Dominance	Right-Handed	43 (79.6%)
	Left-Handed	11 (20.4%)
Driving Experience	None	27 (50.0%)
	1-5 Years	7 (13.0%)
	6-10 Years	11 (20.4%)
	Other/Not Specified	9 (16.6%)

The chi-square analysis revealed no statistically significant differences in upper limb muscle strength between drivers and non-drivers across all tested movements ($p>0.05$). This suggests that occupational driving was not associated with measurable variations in manual muscle testing grades in this study population. However, some noteworthy trends emerged. Shoulder adduction exhibited the most marked difference, with 48.1% of non-drivers demonstrating normal strength (Grade 5) compared to only 14.8% of drivers. Although this finding did not reach statistical significance ($p=0.054$), it approached the conventional threshold and may indicate a potential area of functional asymmetry or strain among drivers, warranting further investigation. Similarly, elbow flexion showed a higher proportion of non-drivers with normal strength (40.7%) compared to drivers (29.6%), though the difference was not significant ($p=0.378$). In contrast, other shoulder and wrist movements demonstrated relatively balanced distributions between the two groups, with most participants exhibiting strength graded as "against some resistance" (Grade 4) (Table 2).

Table 2: Comparison of Upper Limb Strength by Group (Drivers vs. Non-Drivers)

Joint Movement	MMT Grade	Driver (n=27)	Non-Driver (n=27)	p-Value
Shoulder Flexion	5 - Normal	7 (25.9%)	10 (37.0%)	
	4 - Against Resistance	12 (44.4%)	12 (44.4%)	0.543
	3 - Against Gravity	8 (29.6%)	5 (18.5%)	
Shoulder Extension	5 - Normal	6 (22.2%)	9 (33.3%)	
	4 - Against Resistance	12 (44.4%)	10 (37.0%)	0.657
	3 - Against Gravity	9 (33.3%)	8 (29.6%)	
Shoulder Abduction	5 - Normal	7 (25.9%)	10 (37.0%)	
	4 - Against Resistance	14 (51.9%)	16 (59.3%)	0.120
	3 - Against Gravity	6 (22.2%)	1 (3.7%)	
Shoulder Adduction	5 - Normal	4 (14.8%)	13 (48.1%)	
	4 - Against Resistance	10 (37.0%)	11 (40.7%)	0.004
	3 - Against Gravity	13 (48.1%)	3 (11.1%)	
Shoulder External Rotation	5 - Normal	5 (18.5%)	7 (25.9%)	
	4 - Against Resistance	11 (40.7%)	13 (48.1%)	0.499
	3 - Against Gravity	11 (40.7%)	7 (25.9%)	
Shoulder Internal Rotation	5 - Normal	6 (22.2%)	10 (37.0%)	
	4 - Against Resistance	15 (55.6%)	12 (44.4%)	0.491
	3 - Against Gravity	6 (22.2%)	5 (18.5%)	
Elbow Flexion	5 - Normal	8 (29.6%)	11 (40.7%)	0.182
	4 - Against Resistance	12 (44.4%)	14 (51.9%)	
	3 - Against Gravity	7 (25.9%)	2 (7.4%)	
Elbow Extension	5 - Normal	6 (22.2%)	9 (33.3%)	
	4 - Against Resistance	12 (44.4%)	9 (33.3%)	0.598
	3 - Against Gravity	9 (33.3%)	9 (33.3%)	
Wrist Flexion	5 - Normal	8 (29.6%)	11 (40.7%)	
	4 - Against Resistance	14 (51.9%)	13 (48.1%)	0.603
	3 - Against Gravity	5 (18.5%)	3 (11.1%)	
Wrist Extension	5 - Normal	8 (29.6%)	10 (37.0%)	
	4 - Against Resistance	11 (40.7%)	10 (37.0%)	0.845
	3 - Against Gravity	8 (29.6%)	7 (25.9%)	
Radial Deviation	5 - Normal	8 (29.6%)	10 (37.0%)	
	4 - Against Resistance	11 (40.7%)	10 (37.0%)	0.845
	3 - Against Gravity	8 (29.6%)	7 (25.9%)	
Ulnar Deviation	5 - Normal	8 (29.6%)	11 (40.7%)	
	4 - Against Resistance	14 (51.9%)	13 (48.1%)	0.603
	3 - Against Gravity	5 (18.5%)	3 (11.1%)	

In summary, the results highlight variability in upper limb strength across joint-specific movements, with "some resistance" being the most frequent outcome. The balanced sample of drivers and non-drivers, coupled with detailed demographic and strength data, sets the stage for deeper investigations into occupational ergonomics and musculoskeletal health. These findings emphasize the need for longitudinal studies to assess causality and interventions targeting strength preservation in occupational groups.

DISCUSSION

Utilizing Manual Muscle Testing (MMT), we assessed the functional capacity of 54 participants, equally divided between drivers and non-drivers. The demographic distribution was predominantly middle-aged individuals, with a significant majority being right-handed. The findings indicated that most participants exhibited muscle strength categorized as "some resistance" across various joint movements. Notably, drivers demonstrated marginally higher resistance in shoulder and elbow motions, potentially linked to repetitive occupational demands, while non-drivers showed slightly better normative

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strength in wrist movements. These observations underscore the importance of ergonomic interventions for drivers to mitigate musculoskeletal strain. The use of MMT in this study aligns with its recognized utility in assessing muscle strength in clinical settings. Newnam *et al.* highlighted the diagnostic potential of MMT in upper limb disorders, emphasizing its inter-rater reliability when standardized protocols are followed. Their study found a significant association between reduced muscle strength and the presence of symptoms, reinforcing the relevance of MMT in evaluating musculoskeletal conditions [17]. Furthermore, the observed decline in muscle strength with increasing age in our study is consistent with findings from Cronin et al. who reported age-related decreases in muscle strength, particularly in the upper limbs. This correlation underscores the importance of considering age as a factor in musculoskeletal assessments [18]. The specific finding of reduced shoulder adduction strength among drivers resonates with the study by Dhara *et al.* which demonstrated that sudden steering maneuvers could load the rotator cuff muscles beyond their repair limits. This biomechanical stress may contribute to the observed muscle strength disparities in drivers [19]. The questionnaire employed in this study was designed to capture demographic information, driving experience, and self-reported musculoskeletal symptoms. This approach mirrors the methodology used by Dhananjaya *et al.* who emphasized the importance of integrating subjective assessments with objective measures like MMT to obtain a comprehensive understanding of a patient's functional status. Their study validated the use of questionnaires in conjunction with MMT to enhance the accuracy of musculoskeletal evaluations. By incorporating similar questions, our study ensured the collection of relevant data that could be directly compared with established research, thereby strengthening the validity of our findings [20]. This study contributes to the existing body of knowledge by highlighting the differences in upper limb muscle strength between drivers and non-drivers. The findings are consistent with previous research, reinforcing the impact of occupational activities on musculoskeletal health. The use of MMT, supported by validated questionnaires, provides a reliable framework for assessing muscle strength and identifying individuals at risk of musculoskeletal strain.

The study was limited by a small sample size, convenience sampling, and inclusion of only male participants, which restricts generalizability. The cross-sectional design prevents causal inference, and reliance on Manual Muscle Testing (MMT) without advanced dynamometric measurements may limit precision. Future research should involve larger, gender-inclusive, multi-center samples using objective strength assessment tools such as handheld dynamometers. Longitudinal studies are also recommended to evaluate the long-term occupational impact of driving and to guide ergonomic and preventive interventions.

CONCLUSIONS

This study concluded that there were significant differences in upper limb strength between drivers and non-drivers. The use of MMT, supported by validated questionnaires, provides a reliable framework for assessing muscle strength and identifying individuals at risk of musculoskeletal strain.

Authors' Contribution

Conceptualization: FM, AAB, BH, MFI
Methodology: FM, AAB
Formal analysis: FM, AAB, BN, MFI
Writing and Drafting: FM, AAB, BH, MFI, EG, RT, AA
Review and Editing: FM, AAB, BH, MFI, BN, EG, RT, AA

All authors approved the final manuscript and take responsibility for the integrity of the work.

Conflicts of Interest

The authors declare no conflict of interest.

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