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*Original Article*

# Comparison of Neck Pain and Disability With and Without Helmet in Commercial Bikers

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## ABSTRACT

Background: Neck pain is a common musculoskeletal complaint among commercial bike riders because of prolonged riding duration, sustained cervical posture, repetitive road vibration, occupational workload, and possible helmet-related biomechanical loading. Although helmets are essential for head-injury prevention, their relationship with neck pain and neck-related disability remains clinically debated. Objective: To compare the prevalence and severity of neck pain and neck-related disability among commercial bike riders with and without helmet use. Methods: This observational cross-sectional study was conducted among 231 male commercial bike riders in Lahore, Pakistan. Participants were selected through non-probability convenience sampling and categorized into helmet users (n = 115) and non-helmet users (n = 116). Data were collected using a self-structured questionnaire, Numeric Pain Rating Scale, and Neck Disability Index. Descriptive statistics and chi-square tests were applied using IBM SPSS Statistics version 25, with $p < 0.05$ considered statistically significant. Results: Neck pain was reported by 67 helmet users (58.3%) and 85 non-helmet users (73.3%). Non-helmet users had higher crude odds of neck pain than helmet users (OR = 1.96; 95% CI: 1.13–3.42; p = 0.016). Severe-to-complete disability was more frequent among non-helmet users than helmet users (15.5% vs 6.1%), whereas moderate disability was higher among helmet users (24.3% vs 16.4%). Neck pain was significantly associated with Neck Disability Index category within both helmet users and non-helmet users ($p < 0.001$). Conclusion: Neck pain and disability were common among commercial bike riders, with greater neck-pain prevalence and severe-disability burden among non-helmet users. These findings suggest that cervical symptoms in commercial riders are multifactorial and should be addressed through helmet safety, ergonomic correction, posture education, and preventive neck-care strategies. Keywords: Neck Pain; Neck Disability Index; Helmet Use; Commercial Bike Riders; Numeric Pain Rating Scale; Occupational Health.

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## INTRODUCTION

Motorcycles are widely used as an economical and flexible mode of transportation, particularly in densely populated urban settings where commercial riders depend on motorcycles for daily income-generating activities. Although motorcycles offer advantages such as low fuel consumption, easier maneuverability, and accessibility in congested areas, riders remain exposed to substantial biomechanical and safety-related risks. Motorcycle-related injuries commonly involve the head, cervical spine, and musculoskeletal system, and cervical injuries may lead to long-term pain, functional limitation, disability, or reduced occupational productivity (1). Helmet use is therefore considered an essential preventive measure because it reduces the risk of head and brain injuries during road traffic incidents; however, prolonged helmet use may also alter head–neck loading, cervical muscle activity, and perceived discomfort during sustained riding (2).

Neck pain is a common musculoskeletal complaint that may arise from mechanical, postural, traumatic, or degenerative factors. In occupational riders, prolonged static posture, repetitive road vibration, poor ergonomic positioning, long riding duration, and sustained activation of cervical postural muscles may

contribute to neck discomfort and disability. Commercial bike riders are particularly vulnerable because they often ride for several hours daily, frequently carry work-related loads, and are exposed to uneven road surfaces and traffic-related physical stressors. Previous literature suggests that motorcyclists and other drivers may experience neck pain due to prolonged sitting posture, forward head position, reduced cervical mobility, and repetitive strain during driving-related tasks (3). These factors may impair daily activities such as driving, lifting, sleeping, reading, concentration, work performance, and recreation, all of which are domains represented in the Neck Disability Index.

Helmet use presents a complex clinical and public-health issue. On one hand, helmets are indispensable for preventing fatal and non-fatal head injuries; on the other hand, the additional weight of a helmet may increase the mechanical demand on the cervical spine, especially when worn for extended periods. Some studies have reported associations between helmet use, helmet weight, forward head posture, neck pain, and cervical disability among motorcycle riders (4). Other evidence, however, indicates that neck injuries are not consistently increased among helmet users and that the protective benefits of helmets remain substantial (5). This mixed evidence suggests that helmet use should not be examined in isolation; rather, neck pain among riders should be understood as a multifactorial outcome influenced by helmet characteristics, riding duration, posture, occupational exposure, road conditions, physical conditioning, and individual health factors.

Existing studies have investigated helmet-related discomfort, neck pain, forward head posture, and disability among riders, but findings remain inconsistent across populations and settings. Some studies from Pakistan and neighboring regions have reported a high prevalence of neck pain among helmet-wearing occupational riders, while others suggest that non-helmet users may also experience considerable neck pain because of ergonomic, postural, and environmental exposures unrelated to helmet loading (6,7). In the present manuscript, commercial riders were categorized according to helmet-use status, with 115 riders reporting helmet use and 116 reporting no helmet use, allowing direct comparison of neck pain and disability patterns between the two groups. This comparative approach is important because commercial bikers represent a high-exposure occupational group, yet local evidence remains limited regarding whether neck pain and disability differ meaningfully between helmet users and non-helmet users.

The knowledge gap is therefore not whether helmets prevent head injury, which is well established, but whether commercial bikers who use helmets differ from non-helmet users in the frequency and severity of neck pain and neck-related disability. Clarifying this relationship is clinically relevant because inappropriate interpretation of helmet-related discomfort may discourage helmet use, whereas ignoring cervical ergonomic problems may leave occupational riders vulnerable to persistent pain and functional limitation. A balanced investigation can help guide safer helmet practices, ergonomic education, posture correction, riding-duration management, and preventive physiotherapy strategies without undermining the essential role of helmets in road safety.

Using the PICO framework, the population of interest was male commercial bike riders aged 19–35 years riding for prolonged occupational durations in Lahore, Pakistan; the exposure was helmet use during riding; the comparison group was commercial riders who did not use helmets; and the outcomes were neck pain and neck-related disability measured using the Numeric Pain Rating Scale and Neck Disability Index. Therefore, this study aimed to compare neck pain and disability among commercial bikers with and without helmet use. The research question was: among commercial bike riders, is helmet-use status associated with differences in the prevalence and severity of neck pain and neck-related disability?

## MATERIALS AND METHODS

This observational cross-sectional study was conducted to compare neck pain and neck-related disability among commercial bike riders with and without helmet use. The study was carried out in Lahore,

Pakistan, after approval from the relevant institutional ethics committee of the University of Management and Technology. Data collection was completed over a two-month period during 2023–2024. A cross-sectional design was selected because the objective was to assess the frequency and severity of neck pain and disability at a single point in time among occupational riders exposed to prolonged motorcycle riding.

The target population consisted of male commercial bike riders working through ride-hailing or delivery-related services, including riders affiliated with platforms such as InDrive, Foodpanda, and Yango. Participants were selected through non-probability convenience sampling from different localities of Lahore. Eligible participants were male riders aged 19–35 years who had been riding commercially for at least two years and who reported daily riding duration of approximately 4–8 hours. Riders were excluded if they had a history of neck surgery, severe neck injury, current intensive treatment for neck pain, use of neck-specific protective equipment other than helmets, or known musculoskeletal disorders involving cervical or shoulder pain.

A total sample of 231 commercial bike riders was included in the final analysis. Participants were categorized according to helmet-use status into two comparison groups: riders who reported wearing a helmet during bike riding and riders who reported not wearing a helmet during bike riding. The helmet-user group included 115 participants, whereas the non-helmet-user group included 116 participants (8). Written or online informed consent was obtained before data collection, and participants were informed that their responses would be kept confidential and used only for research purposes.

Data were collected using a self-structured questionnaire, the Numeric Pain Rating Scale, and the Neck Disability Index. The self-structured questionnaire recorded demographic and occupational information, including age group, socioeconomic status, helmet-use status, duration of bike riding, and history or frequency of neck pain. Neck pain was assessed using the Numeric Pain Rating Scale and categorized into no pain, mild pain, moderate pain, and severe pain. Neck-related disability was assessed using the Neck Disability Index, which evaluates the effect of neck symptoms on activities such as pain intensity, personal care, lifting, reading, headache, concentration, work, driving, sleeping, and recreation. Neck Disability Index scores were categorized as no disability, mild disability, moderate disability, severe disability, and complete disability (9,10).

The exposure variable was helmet-use status, defined as riding with or without helmet use during commercial motorcycle activity. The main outcome variables were presence of neck pain, pain severity according to the Numeric Pain Rating Scale, and disability severity according to the Neck Disability Index. Additional descriptive variables included age group, riding duration, and socioeconomic status (11). Neck pain was operationally defined as self-reported cervical discomfort or pain experienced by the rider, while neck-related disability was defined according to the categorical severity levels derived from Neck Disability Index scoring.

To reduce selection bias, the same eligibility criteria were applied to both helmet users and non-helmet users. To reduce information bias, all participants were assessed using the same questionnaire format and standardized outcome tools. Riders with previous severe neck injury, neck surgery, current intensive treatment for neck pain, or neck-specific protective gear use were excluded to minimize distortion of the relationship between helmet-use status and neck pain or disability. Potential confounding variables considered during data collection included age group, riding duration, and socioeconomic status.

The sample size was calculated using a single-proportion formula with a 95% confidence level, an estimated proportion of 0.184, and a 5% margin of error. The calculated minimum sample size was 231 participants. After accounting for an expected 2% attrition rate, the adjusted required sample size was 236; however, 231 complete participant responses were available and included in the final analysis.

Data were entered and analyzed using IBM SPSS Statistics version 25. Descriptive statistics were used to summarize demographic, occupational, pain-related, and disability-related variables. Frequencies and percentages were calculated for categorical variables, including helmet-use status, age group, socioeconomic status, neck pain presence, pain severity categories, and Neck Disability Index categories. Mean, standard deviation, minimum, and maximum values were calculated for riding duration. Group-wise comparisons were performed between helmet users and non-helmet users. Associations between neck pain and Neck Disability Index categories were assessed using the Pearson chi-square test. A p-value of less than 0.05 was considered statistically significant.

Data integrity was maintained by checking completed questionnaires for completeness before data entry. Responses were entered systematically into the statistical software, and categorical variables were coded consistently before analysis. Missing or incomplete responses were excluded from the final dataset. Participant confidentiality was maintained throughout data handling, analysis, and reporting, and no personally identifiable information was disclosed in the study findings.

## RESULTS

A total of 231 commercial bike riders were included in the analysis. Of these, 115 riders (49.8%) reported wearing a helmet while riding, whereas 116 riders (50.2%) reported not wearing a helmet. The age distribution was similar between groups: among helmet users, 43 participants (37.4%) were aged 19–26 years and 72 (62.6%) were aged 27–35 years; among non-helmet users, 45 (38.8%) were aged 19–26 years and 71 (61.2%) were aged 27–35 years. The difference in age-group distribution between helmet users and non-helmet users was not statistically significant (p = 0.826). Mean riding duration was slightly higher among helmet users than non-helmet users (6.18 ± 1.61 hours vs 5.74 ± 1.49 hours), with a statistically significant mean difference of 0.44 hours (95% CI: 0.04 to 0.84; p = 0.032). Socioeconomic status was also comparable between groups (p = 0.755) .

*Table 1. Baseline Characteristics of Commercial Bike Riders by Helmet-Use Status*

| Variable | Helmet Users, n = 115 | Non-Helmet Users, n = 116 | Total, N = 231 | Statistical Test | p-value |
|---|---|---|---|---|---|
| **Age group, n (%)** | | | | $\chi^2 = 0.048$ | 0.826 |
| **19–26 years** | 43 (37.4) | 45 (38.8) | 88 (38.1) | | |
| **27–35 years** | 72 (62.6) | 71 (61.2) | 143 (61.9) | | |
| **Duration of bike riding, hours/day** | | | | Welch t = 2.16 | 0.032 |
| **Mean ± SD** | 6.18 ± 1.61 | 5.74 ± 1.49 | — | Mean difference = 0.44 hours; 95% CI: 0.04–0.84 | |
| **Minimum–maximum** | 4–8 | 4–8 | — | | |
| **Socioeconomic status, n (%)** | | | | $\chi^2 = 0.562$ | 0.755 |
| **Lower income** | 44 (38.3) | 50 (43.1) | 94 (40.7) | | |
| **Middle income** | 55 (47.8) | 51 (44.0) | 106 (45.9) | | |
| **High income** | 16 (13.9) | 15 (12.9) | 31 (13.4) | | |

Neck pain was reported by 67 of 115 helmet users (58.3%) and 85 of 116 non-helmet users (73.3%). The between-group difference was statistically significant ($\chi^2$ = 5.79; p = 0.016). Non-helmet users had approximately 1.96 times higher crude odds of reporting neck pain compared with helmet users (OR = 1.96; 95% CI: 1.13–3.42). Daily neck pain was reported by 25 helmet users (21.7%) and 33 non-helmet users (28.4%), while “never” experiencing neck pain was reported by 37 helmet users (32.2%) and 33 non-helmet users (28.4%). The overall distribution of neck-pain frequency did not differ significantly between groups (p = 0.408). NPRS severity distribution was also not significantly different (p = 0.403), with severe pain reported by 18 helmet users (15.7%) and 18 non-helmet users (15.5%).

Neck Disability Index categories showed that 50 helmet users (43.5%) and 49 non-helmet users (42.2%) had no disability. Mild disability was almost identical between groups, affecting 30 helmet users (26.1%) and 30 non-helmet users (25.9%). Moderate disability was more frequent among helmet users (28 participants; 24.3%) than non-helmet users (19 participants; 16.4%). In contrast, severe disability was more frequent among non-helmet users (13 participants; 11.2%) than helmet users (6 participants; 5.2%),

and complete disability was also higher among non-helmet users (5 participants; 4.3%) than helmet users (1 participant; 0.9%). The overall difference in NDI category distribution between helmet users and non-helmet users was not statistically significant ($\chi^2 = 6.97$; $p = 0.137$) .

*Table 2. Neck Pain, Pain Frequency, and Pain Severity by Helmet-Use Status*

| Variable | Helmet Users, n = 115 | Non-Helmet Users, n = 116 | Total, N = 231 | Statistical Test / Effect Size | p-value |
|---|---|---|---|---|---|
| **Experienced neck pain, n (%)** | | | | $\chi^2 = 5.79$; crude OR for non-helmet users = 1.96; 95% CI: 1.13–3.42 | 0.016 |
| **Yes** | 67 (58.3) | 85 (73.3) | 152 (65.8) | | |
| **No** | 48 (41.7) | 31 (26.7) | 79 (34.2) | | |
| **Frequency of neck pain, n (%)** | | | | $\chi^2 = 3.98$ | 0.408 |
| **Daily** | 25 (21.7) | 33 (28.4) | 58 (25.1) | | |
| **Weekly** | 28 (24.3) | 20 (17.2) | 48 (20.8) | | |
| **Monthly** | 11 (9.6) | 17 (14.7) | 28 (12.1) | | |
| **Occasionally** | 14 (12.2) | 13 (11.2) | 27 (11.7) | | |
| **Never** | 37 (32.2) | 33 (28.4) | 70 (30.3) | | |
| **Numeric Pain Rating Scale category, n (%)** | | | | $\chi^2 = 2.93$ | 0.403 |
| **No pain** | 37 (32.2) | 34 (29.3) | 71 (30.7) | | |
| **Mild pain** | 24 (20.9) | 35 (30.2) | 59 (25.5) | | |
| **Moderate pain** | 36 (31.3) | 29 (25.0) | 65 (28.1) | | |
| **Severe pain** | 18 (15.7) | 18 (15.5) | 36 (15.6) | | |
| **Pain intensity category, n (%)** | | | | $\chi^2 = 3.96$ | 0.412 |
| **No pain** | 43 (37.4) | 38 (32.8) | 81 (35.1) | | |
| **Very mild** | 28 (24.3) | 34 (29.3) | 62 (26.8) | | |
| **Moderate** | 28 (24.3) | 23 (19.8) | 51 (22.1) | | |
| **Fairly severe** | 7 (6.1) | 14 (12.1) | 21 (9.1) | | |
| **Very severe** | 9 (7.8) | 7 (6.0) | 16 (6.9) | | |

*Table 3. Neck Disability Index Severity by Helmet-Use Status*

| Neck Disability Index Category | Helmet Users, n = 115 | Non-Helmet Users, n = 116 | Total, N = 231 | Statistical Test | p-value |
|---|---|---|---|---|---|
| **0–8% No disability** | 50 (43.5) | 49 (42.2) | 99 (42.9) | $\chi^2 = 6.97$ | 0.137 |
| **10–28% Mild disability** | 30 (26.1) | 30 (25.9) | 60 (26.0) | | |
| **30–48% Moderate disability** | 28 (24.3) | 19 (16.4) | 47 (20.3) | | |
| **50–64% Severe disability** | 6 (5.2) | 13 (11.2) | 19 (8.2) | | |
| **70–100% Complete disability** | 1 (0.9) | 5 (4.3) | 6 (2.6) | | |

Across individual NDI activity domains, most comparisons between helmet users and non-helmet users were not statistically significant. For personal care, 53 helmet users (46.1%) and 59 non-helmet users (50.9%) reported no pain during washing or dressing ($p = 0.670$). For lifting, 56 helmet users (48.7%) and 55 non-helmet users (47.4%) reported lifting without extra pain ($p = 0.670$). Reading without pain was reported by 60 helmet users (52.2%) and 51 non-helmet users (44.0%) ($p = 0.298$). Driving without neck pain was reported by 55 helmet users (47.8%) and 49 non-helmet users (42.2%), while severe driving-related neck pain was reported by 3 helmet users (2.6%) and 10 non-helmet users (8.6%); however, the overall driving-domain distribution did not reach statistical significance ($p = 0.129$). Sleeping without disturbance was reported by 61 helmet users (53.0%) and 66 non-helmet users (56.9%), with greater sleep disturbance of 3–4 hours reported by 6 helmet users (5.2%) and 13 non-helmet users (11.2%) ($p = 0.124$).

*Table 4. Functional Neck Disability Domains by Helmet-Use Status*

| NDI Domain | Main Category Distribution in Helmet Users | Main Category Distribution in Non-Helmet Users | Statistical Test | p-value |
|---|---|---|---|---|
| **Personal care** | Without pain: 53 (46.1%); extra pain: 27 (23.5%); painful: 21 (18.3%) | Without pain: 59 (50.9%); extra pain: 23 (19.8%); painful: 15 (12.9%) | $\chi^2 = 3.19$ | 0.670 |
| **Lifting** | Without extra pain: 56 (48.7%); extra pain: 20 (17.4%); pain prevents lifting weight: 22 (19.1%) | Without extra pain: 55 (47.4%); extra pain: 24 (20.7%); pain prevents lifting weight: 18 (15.5%) | $\chi^2 = 3.20$ | 0.670 |
| **Reading** | No pain: 60 (52.2%); slight pain: 29 (25.2%); moderate pain: 13 (11.3%) | No pain: 51 (44.0%); slight pain: 24 (20.7%); moderate pain: 20 (17.2%) | $\chi^2 = 4.89$ | 0.298 |

| NDI Domain | Main Category Distribution in Helmet Users | Main Category Distribution in Non-Helmet Users | Statistical Test | p-value |
|---|---|---|---|---|
| **Headaches** | No headache: 51 (44.3%); infrequent slight headache: 36 (31.3%); frequent slight headache: 17 (14.8%) | No headache: 53 (45.7%); infrequent slight headache: 26 (22.4%); frequent slight headache: 18 (15.5%) | $\chi^2 = 4.08$ | 0.396 |
| **Concentration** | No difficulty: 55 (47.8%); slight difficulty: 26 (22.6%); fair difficulty: 20 (17.4%) | No difficulty: 52 (44.8%); slight difficulty: 21 (18.1%); fair difficulty: 19 (16.4%) | $\chi^2 = 5.74$ | 0.332 |
| **Work** | Much work: 58 (50.4%); usual work: 19 (16.5%); most usual work: 23 (20.0%) | Much work: 56 (48.3%); usual work: 21 (18.1%); most usual work: 19 (16.4%) | $\chi^2 = 4.00$ | 0.550 |
| **Driving** | Without neck pain: 55 (47.8%); slight pain: 24 (20.9%); moderate pain: 19 (16.5%) | Without neck pain: 49 (42.2%); slight pain: 27 (23.3%); moderate pain: 11 (9.5%) | $\chi^2 = 8.55$ | 0.129 |
| **Sleeping** | No trouble sleeping: 61 (53.0%); slightly disturbed: 21 (18.3%); 1–2 hours sleepless: 21 (18.3%) | No trouble sleeping: 66 (56.9%); slightly disturbed: 12 (10.3%); 1–2 hours sleepless: 15 (12.9%) | $\chi^2 = 7.23$ | 0.124 |
| **Recreation** | No pain: 60 (52.2%); some neck pain: 35 (30.4%); not all usual recreation: 16 (13.9%) | No pain: 56 (48.3%); some neck pain: 28 (24.1%); not all usual recreation: 16 (13.8%) | $\chi^2 = 8.91$ | 0.113 |

The association between neck pain and Neck Disability Index category was statistically significant within both helmet-use groups. Among helmet users, the Pearson chi-square value for the association between neck pain and NDI category was 50.530, with $p < 0.001$. Among non-helmet users, the Pearson chi-square value was 49.904, also with $p < 0.001$. These findings indicate that, regardless of helmet-use status, riders who reported neck pain were distributed differently across disability categories than riders who did not report neck pain.

*Table 5. Association Between Neck Pain and Neck Disability Index Category Within Helmet-Use Groups*

| Group | Variables Tested | Pearson Chi-Square Value | p-value |
|---|---|---|---|
| **Helmet users** | Neck pain × Neck Disability Index category | 50.530 | <0.001 |
| **Non-helmet users** | Neck pain × Neck Disability Index category | 49.904 | <0.001 |

Overall, neck pain was more frequently reported among non-helmet users than helmet users (73.3% vs 58.3%), and non-helmet users had nearly twice the crude odds of reporting neck pain. Although overall NPRS severity and NDI category distributions did not show statistically significant differences between helmet-use groups, severe and complete disability categories were numerically higher among non-helmet users, while moderate disability was numerically higher among helmet users. Neck pain was strongly associated with disability severity within both helmet-use groups.

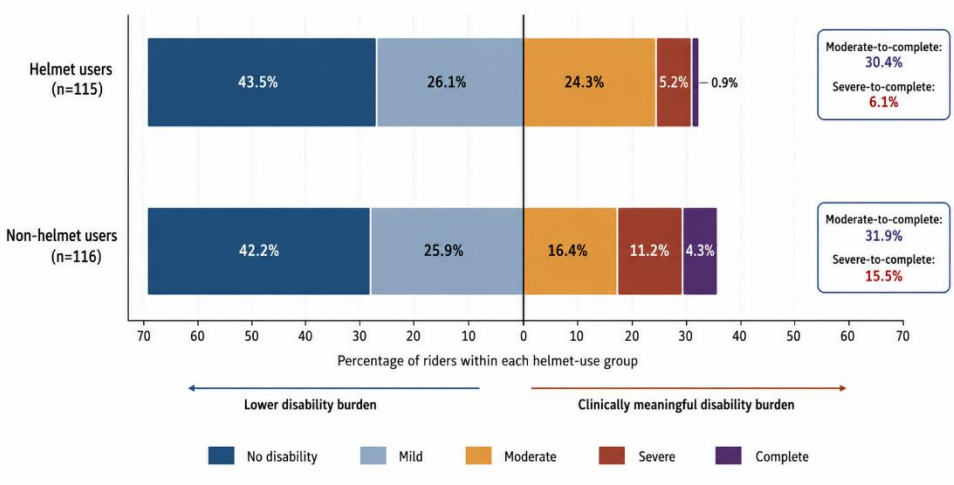


*Figure 1. Neck Disability Severity Burden by Helmet-Use Status Among Commercial Bikers*

The figure demonstrates a clinically meaningful redistribution of neck-disability severity across helmet-use groups. Moderate-to-complete disability affected 30.4% of helmet users and 31.9% of non-helmet users, showing a broadly comparable overall disability burden. However, the severity profile differed between groups: helmet users showed a higher proportion of moderate disability (24.3% vs 16.4%), whereas non-helmet users showed a greater concentration of advanced disability, with severe-to-

complete disability affecting 15.5% compared with 6.1% among helmet users. No disability was nearly equivalent between groups (43.5% vs 42.2%), and mild disability was also similar (26.1% vs 25.9%). This pattern suggests that while total clinically meaningful disability was similar, non-helmet users carried a heavier severe-disability burden, whereas helmet users clustered more strongly in the moderate-disability range.

## DISCUSSION

The present study compared neck pain and neck-related disability among commercial bike riders with and without helmet use and found that neck pain was more frequently reported by non-helmet users than helmet users. Among 231 riders, 58.3% of helmet users and 73.3% of non-helmet users reported neck pain, and non-helmet users had nearly twice the crude odds of neck pain compared with helmet users. This finding suggests that helmet use alone may not explain the occurrence of neck pain among commercial riders; instead, neck pain appears to be influenced by a broader combination of occupational, postural, ergonomic, and environmental exposures. Commercial riders are exposed to prolonged sitting, repetitive vibration, uneven roads, sustained cervical muscle activity, and work-related physical stress, all of which can contribute to cervical discomfort regardless of helmet status. Therefore, the observed higher neck-pain prevalence among non-helmet users should be interpreted as an association rather than evidence that absence of helmet use directly causes neck pain.

The results partly contrast with studies that reported higher neck pain among helmet users. A study reported a significant association between helmet use and neck pain among motorcyclists, suggesting that helmet wearers may have increased odds of neck pain because of additional load on the cervical region (12). Similarly, another study observed neck pain among a considerable proportion of occupational bike riders who wore helmets, indicating that prolonged helmet use may be associated with cervical discomfort in high-exposure riders (13). These findings support the biomechanical explanation that helmet weight, helmet fit, and prolonged wear may increase demand on cervical postural muscles. However, the present study showed greater neck-pain prevalence among non-helmet users, which indicates that helmet-related loading is unlikely to be the only determinant of symptoms in this population. Differences in rider selection, riding duration, road exposure, posture, delivery workload, socioeconomic characteristics, and helmet-use consistency may explain why findings vary across studies.

The disability findings provide a more nuanced interpretation than neck-pain prevalence alone. Overall, Neck Disability Index distribution did not show a statistically significant difference between helmet users and non-helmet users, but the pattern of disability severity differed clinically. Moderate disability was more common among helmet users, whereas severe and complete disability were more common among non-helmet users. Specifically, 24.3% of helmet users had moderate disability compared with 16.4% of non-helmet users, while severe-to-complete disability affected 6.1% of helmet users and 15.5% of non-helmet users. This suggests that the total burden of clinically meaningful disability was broadly similar between groups, but non-helmet users had a heavier concentration of advanced disability. One possible explanation is that non-helmet users may represent a subgroup with greater cumulative ergonomic exposure, poorer riding conditions, reduced safety practices, or delayed care-seeking behavior. Another possibility is that helmet users may experience discomfort that remains within moderate functional limitation, whereas non-helmet users may have disability driven by non-helmet-related factors such as posture, occupational load, stress, previous minor trauma, or prolonged riding without adequate recovery.

The significant association between neck pain and Neck Disability Index category within both helmet-use groups further supports the clinical relevance of pain severity in functional limitation. In helmet users, neck pain was significantly associated with disability category, and the same relationship was observed among non-helmet users, with both analyses showing $p < 0.001$. This indicates that once neck pain is present, disability burden increases regardless of helmet-use status. This finding is consistent with

previous work showing positive associations between cervical pain and disability among two-wheeler riders, where pain intensity and functional limitation were closely related (14). It also aligns with studies reporting that neck pain affects activities such as work performance, driving tolerance, concentration, sleep, and recreation, which are core components of disability assessment in occupational riders (15).

The relationship between helmet use and cervical symptoms remains clinically complex because helmets provide essential protection against head injury while potentially contributing to discomfort in some riders. Evidence from helmet safety literature consistently shows that helmets reduce the risk of head injury, severe head injury, facial injury, and fatal head injury among riders involved in crashes or falls (16). At the same time, some biomechanical studies suggest that helmet weight, prolonged riding, forward head posture, and additional carried load may influence cervical posture and neck pain (17). The present findings support a balanced interpretation: helmet use should not be discouraged, but rider comfort, helmet fit, helmet weight, cervical posture, and riding ergonomics should be addressed to reduce musculoskeletal symptoms. A public-health message that focuses only on helmet-related discomfort may unintentionally reduce helmet compliance, whereas a broader ergonomic approach can preserve helmet safety benefits while targeting modifiable causes of neck pain.

The findings also highlight the importance of occupational exposure among commercial riders. Unlike recreational motorcyclists, commercial riders often ride for several hours daily and may work under time pressure, carry delivery bags, navigate traffic congestion, and travel on uneven roads. In this study, riders were included if they had commercial riding exposure of 4–8 hours, and mean riding duration was slightly higher among helmet users than non-helmet users. Even this modest difference in daily exposure may contribute to cumulative cervical fatigue. Prolonged activation of cervical extensor and stabilizing muscles, repetitive road vibration, and sustained forward gaze during riding can increase mechanical loading across the cervical spine. These factors may explain why both helmet users and non-helmet users showed substantial pain and disability burdens.

Several individual Neck Disability Index domains also provide clinically useful insight. Although most domain-level comparisons were not statistically significant, non-helmet users showed numerically higher proportions of severe limitations in some functional areas, including driving-related pain and sleep disturbance. Driving without neck pain was reported by 47.8% of helmet users and 42.2% of non-helmet users, while severe driving-related neck pain was reported by 2.6% of helmet users and 8.6% of non-helmet users. Similarly, severe sleep disturbance of 3–4 hours was reported by 5.2% of helmet users and 11.2% of non-helmet users. These differences suggest that advanced functional consequences may cluster more strongly among non-helmet users, even when overall NDI category distribution does not reach statistical significance (18). Clinically, this supports screening not only for pain presence but also for sleep, driving tolerance, and work-related functional impairment.

The study has important strengths. It directly compared helmet users and non-helmet users in a clearly defined occupational group of commercial bikers, used established pain and disability tools, and included a balanced sample of helmet users and non-helmet users. The use of both NPRS and NDI allowed assessment of pain intensity as well as functional consequences. The study also provides locally relevant data from Lahore, where commercial motorcycle riding is common and road, traffic, and occupational conditions may differ from settings represented in much of the international literature.

However, several limitations should be considered when interpreting the findings. The cross-sectional design captures exposure and outcome at one point in time, so temporal direction and causality cannot be established. Helmet-use status was assessed categorically, but helmet weight, helmet fit, helmet type, duration of continuous helmet wear, and consistency of helmet use were not analyzed in detail. Important confounders such as body mass index, forward head posture, cervical range of motion, riding posture, delivery-bag weight, motorcycle type, road vibration exposure, psychosocial stress, sleep quality, and previous minor injuries were not adjusted for in multivariable analysis. The use of convenience sampling from one city may also limit generalizability to commercial riders in other regions. In addition,

although several group comparisons were performed, most inferential analyses were unadjusted, so observed differences should be interpreted as preliminary associations.

Overall, the study suggests that neck pain and neck-related disability are common among commercial bike riders, with a higher prevalence of neck pain among non-helmet users and a greater severe-disability burden in the non-helmet group. At the same time, helmet users also experienced substantial moderate disability, indicating that cervical symptoms among riders are multifactorial rather than attributable to helmet use alone. The findings support the need for preventive strategies that combine helmet safety with ergonomic intervention, including proper helmet selection, posture education, riding-break recommendations, cervical strengthening, stretching programs, and assessment of occupational risk factors. Future analytical work using adjusted regression models and more detailed biomechanical exposure assessment would help clarify whether helmet characteristics, riding posture, or occupational workload are the strongest predictors of neck pain and disability among commercial bikers.

## CONCLUSION

In this cross-sectional study of commercial bike riders in Lahore, neck pain and neck-related disability were common among both helmet users and non-helmet users, but neck pain was more frequently reported by riders who did not use helmets. Non-helmet users showed a higher prevalence of neck pain than helmet users, while the overall distribution of Neck Disability Index categories was broadly comparable between groups. However, the disability pattern differed clinically, with helmet users showing a greater proportion of moderate disability and non-helmet users showing a higher burden of severe-to-complete disability. Neck pain was significantly associated with neck-related disability within both helmet-use groups, indicating that functional limitation increases when cervical pain is present, regardless of helmet status. These findings suggest that neck pain among commercial bikers is multifactorial and may be influenced by riding posture, prolonged occupational riding duration, ergonomic stress, road vibration, physical workload, and individual musculoskeletal factors rather than helmet use alone. Helmet use should therefore continue to be promoted for head-injury prevention, while preventive strategies should also address helmet fit and weight, cervical posture, riding ergonomics, scheduled rest breaks, and neck-strengthening interventions to reduce pain and disability among occupational riders.

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