

# Relative Odds of Neck Pain to Helmet Use Among Motorcyclists: A Case-Control Study.

## Original Article

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## ABSTRACT

**Background:** Neck pain is a widespread problem among motorcyclists, which is often neglected. There is limited research on the motorcycle's ergonomics, particularly in the context of the interaction between the riders and motorcycle. Motorcycle helmets have proven to increase the weight on the neck, thus causing more burdens which can lead to neck pain.

**Methodology:** Case-Control study design was opted to measure the relative odds of neck pain in relation to the helmet use as an exposure. A total of 260 (mean age of  $22.58 \pm S.D. 1.95$  years) undergraduate students were selected using purposive sampling. The case to control ratio was 1:4 (54 Cases and 206 Controls) where cases were defined as the motorcyclists having neck pain with a riding experience of more than one year. The neck pain and disability scale were obtained using a self-administered questionnaire. Chi-square and binary logistic regression were used to calculate the significant relationship and odds of neck pain amongst motorcyclists with and without helmet use.

**Results:** The study results showed that out of 260 motorcyclists, 190 (73.1%) were helmet users, and 54 (20.8%) had neck pain, 70 (27.9%) helmet users had a neck pain prevalence of 11 (4.2%). The relative odd to have neck pain was 2.13 times more amongst the motorcyclists using the helmet as compared to that of non-helmet users. The logistic regression results showed significant results ( $P < 0.05$ ) with regards to the BMI, helmet weight and duration of helmet use but did not show a significant relation with average motorcycle use per day unless it exceeded 70 kilometres.

**Conclusion:** Use of helmet can be a potential cause of neck pain amongst motorcyclist users but the odds to have neck pain enhance with the increase in motorcycle use per day. The protective benefits are multi-fold for helmet use which outreaches the negative impact, including neck pain amongst motorcyclists.

**Keywords:** *Helmet use, neck pain, motorcyclists.*

## INTRODUCTION

Motorcycles are the most convenient source of transportation. Helmets have been shown to have a protective effect in the event of road traffic accident, saving head, brain and facial tissue from serious injury.<sup>[1]</sup> Most of the road fatalities in developing countries are because of motorcycle accidents. Although a cheap source of transportation, yet the motorcycles are not safe because, in most two-wheelers, the centre of gravity is not standardized. Another reason for accidents is the speed of the vehicle. The chance of fatal injury increases many folds at higher speeds.<sup>[2]</sup>

Though not often discussed, neck pain is one of the commonly encountered problems by motorcyclists who regularly use helmets while riding. There is limited literature available regarding the discomfort among motorcyclists and the occurrence of neck pain because of helmet use. Discomfort in motorcyclist's body parts during the ride can be due to the poor posture, poor suspension of the bike, high speed, seat height, the position of handlebars and footrests.<sup>[3]</sup> Cyclists and motorcyclists who travel for shorter distances may also experience neck and upper back pain.<sup>[4]</sup> It has been



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observed the helmets serve as an additional weight on the head, and this can contribute towards the head and neck discomfort as well as restrict the range of motions of the individual's neck.<sup>[5]</sup> One of the reasons identified by a large number of motorcyclists for not wearing a helmet during riding was neck pain as they contributed the neck pain to the helmet's weight which caused discomfort if worn for a long time.<sup>[6]</sup>

Motorcyclists reported a significant restriction in their head and neck range of motion after prolong use of a helmet.<sup>[7]</sup>

There is an excellent scope for researchers to research motorcyclists as there is very little evidence available on this subject. There is a need to satisfy the motorcyclists about their posture concerning their motorcycle use. The rate of helmet use in various countries is different, as, in Iran, it varied from 8.6% to 75%.<sup>[7]</sup> The helmet use rate is 56% in Pakistan, 19.7% in Spain, and 90% in Vietnam,<sup>[8,9]</sup> and these rates were determined among adults. Some researchers suggest that the neck pain experienced by the motorcyclists can be due to the seating posture during the riding process.<sup>[10]</sup> However, no research has been undertaken to evaluate the neck pain levels among the motorcyclists during their riding process while wearing a helmet. Our study will highlight the discomfort levels among motorcyclists who regularly wear helmets while riding. The objectives of this study were to identify the relationship between neck pain and helmet use among helmet and non-helmet user motorcyclists among undergraduate university students of Lahore, Pakistan, and the level of significance between neck pain and helmet use. The findings may be helpful for other researchers to conduct more studies as well as get a better understanding of neck pain with helmet use.

## METHODOLOGY

It was a case-control study conducted through quantitative analysis directing to determine the relative odds of neck pain among motorcyclists and the significance of normal motorcycle use per day, helmet weight, durations of helmet use, BMI, motorcycle riding experience and neck pain among helmet users. Students enrolled in undergraduate universities of Lahore, Pakistan, were selected by purposive sampling technique. The cases were described as those motorcyclists who were using a motorcycle for more than one year, wearing a helmet for more than one month and having neck pain while controls were described as those motorcycle riders, who had regularly been riding for more than one year and used helmet regularly but did not have neck pain. The

sample size was calculated as 260 in which case to control ratio was 1:4 at a 95% confidence interval using online software (AUSVET).<sup>[11]</sup> Students were approached, and after the informed consent to participate in our study, they were given a demographic questionnaire and neck pain and disability scale questionnaire. The questionnaires were explained to all the participants and they were also informed about the aims and objectives of our study. Students were given the right to opt or withdraw from the study if they did not want to participate in our study. The demographic data collected was age, university, respective department, helmet use, per day average motorcycle use, helmet weight, duration of helmet use, the regularity of use of helmet, neck pain while wearing a helmet were asked and a previous diagnosis of any musculoskeletal problem. The neck pain and disability scale (NPAD) questionnaire were used as an objective measurement in those motorcyclists who experienced neck pain while wearing a helmet during their journey. The NPAD questionnaire has a reliability of 0.93 and the validity of 0.45.<sup>[11,12]</sup> Chi-square and regression analysis were applied to the following variables: age, helmet weight, duration of helmet use, average motorcycle use per day and neck pain) to determine the significance and relative odds. The data obtained was analyzed by categorizing each variable.

## RESULTS

Out of 260 motorcyclists, 190 (73.1%) were helmet users, and 70 (26.9%) were non-helmet users. There were 54 (20.8%) subjects who were using a helmet with associated neck pain. The participants who were helmet users without neck pain were 136 (52.3%). A total of 11 (4.2%) participants were non-helmet users but had neck pain. Fifty-nine (22.7%) participants were non-helmet users and without neck pain [Table 1].

The subjects were divided into three categories based on average motorcycle use per day. In the first category, which ranged from 10 to 40 kilometres, 21 subjects had neck pain and accounted for 8.1% of the entire group. In the second category, which ranged from 40 to 70 kilometres, there were 19 (7.3%) subjects, and in the third category, which ranged to greater than 70 km, 25 (9.6%) subjects were identified. Overall, 65 (25%) participants out of 260 participants reported the presence of neck pain. In our study, 192 (75%) subjects did not have neck pain with 74 (28.5%) in the first category, 67 (25%) in the second category and 54 (20.8%) in the third category. The regression analysis of neck pain with normal motorcycle use per day did not show a significant relation ( $p=0.266$ ). However, the Exp (B) value of third category (70 to 100 km) revealed a significant

|  | Do you experience neck pain? |             | Total       |
|--|------------------------------|-------------|-------------|
|  | yes                          | no          |             |
| Do you use a helmet while riding a motorcycle? yes | 54 (20.8%)                   | 136 (52.3%) | 190 (73.1%) |
| no   | 11(4.2%)                     | 59 (22.7%)  | 70 (26.9%)  |

Table 1: Helmet use or non-helmet use and occurrence of neck pain

| Average Motorcycle use per day<br>in kilometers |       | Do you experience<br>neck pain? |       | Total | Sig.<br>(0.266) | Exp<br>(B) |
|---|-------|---------------------------------|-------|-------|-----------------|------------|
|   |       | yes                             | no    |       |                 |            |
| 10-40 kilometers                                | Count | 21                              | 74    | 95    | 0.157           | 1.631      |
|   | %     | 8.1%                            | 28.5% | 36.5% |                 |            |
| 40-70 kilometers                                | Count | 19                              | 67    | 86    | 0.167           | 1.633      |
|   | %     | 7.3%                            | 25.8% | 33.1% |                 |            |
| 70-100 kilometers                               | Count | 25                              | 54    | 79    | 0.001           | 2.160      |
|   | %     | 9.6%                            | 20.8% | 30.4% |                 |            |

Table 2: Relationship of average motorcycle use per day with neck pain

| BMI Categories   |       | Do you experience<br>neck pain? |       | Total | Sig.<br>(0.033) | Exp(B) |
|------------------|-------|---------------------------------|-------|-------|-----------------|--------|
|                  |       | yes                             | no    |       |                 |        |
| Underweight      | Count | 6                               | 5     | 11    | 0.094           | 0.313  |
|                  | %     | 2.3%                            | 1.9%  | 4.2%  |                 |        |
| Normal<br>Weight | Count | 31                              | 78    | 109   | 0.884           | 0.944  |
|                  | %     | 11.9%                           | 30.0% | 41.9% |                 |        |
| Overweight       | Count | 16                              | 80    | 96    | 0.149           | 1.875  |
|                  | %     | 6.2%                            | 30.8% | 36.9% |                 |        |
| Obese            | Count | 12                              | 32    | 44    | 0.004           | 2.667  |
|                  | %     | 4.6%                            | 12.3% | 16.9% |                 |        |

Table 3: Relation of BMI with neck pain

| Relation of Neck Pain with Duration of Helmet Use |            |                   |       |       |                 |        |
|---|------------|-------------------|-------|-------|-----------------|--------|
| Duration of Helmet use                            |            | Do you experience |       | Total | Sig.<br>(0.035) | Exp(B) |
|   |            | neck pain?        |       |       |                 |        |
|   |            | yes               | no    |       |                 |        |
| non helmet user                                   | Count      | 11                | 59    | 70    | 0.992           | 1.006  |
|   | % of Total | 4.2%              | 22.7% | 26.9% |                 |        |
| 0.10-1.00 years                                   | Count      | 24                | 46    | 70    | 0.045           | 0.359  |
|   | % of Total | 9.2%              | 17.7% | 26.9% |                 |        |
| 1.00-4.00 years                                   | Count      | 24                | 58    | 82    | 0.118           | 0.453  |
|   | % of Total | 9.2%              | 22.3% | 31.5% |                 |        |
| 4.00-8.00 years                                   | Count      | 6                 | 32    | 38    | 0.000           | 5.333  |
|   | % of Total | 2.3%              | 12.3% | 14.6% |                 |        |

**Table 4:** Relation of Neck Pain with Duration of Helmet Use.

| Helmet Weight in Kilograms |            | Do you experience |       | Total | Sig.<br>0.000 | Exp(B) |
|----------------------------|------------|-------------------|-------|-------|---------------|--------|
|                            |            | neck pain?        |       |       |               |        |
|                            |            | yes               | no    |       |               |        |
| non helmet user            | Count      | 11                | 59    | 70    | 0.808         | 0.858  |
|                            | % of Total | 4.2%              | 22.7% | 26.9% |               |        |
| 0.25-1.25                  | Count      | 31                | 36    | 67    | 0.004         | 0.186  |
|                            | % of Total | 11.9%             | 13.8% | 25.8% |               |        |
| 1.30-1.90                  | Count      | 19                | 75    | 94    | 0.441         | 0.632  |
|                            | % of Total | 7.3%              | 28.8% | 36.2% |               |        |
| 2.00-3.00                  | Count      | 4                 | 25    | 29    | 0.001         | 6.250  |
|                            | % of Total | 1.5%              | 9.6%  | 11.2% |               |        |

**Table 5:** Relation of Neck Pain with Helmet Weight In Kilograms

relationship and average use of more than 70 kilometres increased the odds of neck pain by two times[Table 2].

The obtained basal metabolic index values were

categorized as follows:

1. underweight,
2. normal weight,
3. overweight and

#### 4. obese

The underweight category had 6 (2.3%), participants, with neck pain while the normal weight, overweight and obese categories had 31 (11.9%), 16 (6.2%), and 12 (4.6%) participants with neck pain, respectively. The subjects with no neck pain were 5 (1.9%), 78 (30%), 80 (30.8%), and 32 (12.3%) based on the BMI categories: underweight, normal weight, overweight, and obese categories, respectively. Table 3 shows a significant relationship between BMI and neck pain ( $p=0.033$ ). Keeping the obese category as a constant, the odds of neck pain are not much higher in all other BMI categories but are comparatively higher in the overweight category. The Exp (B) values in the underweight, normal weight, overweight and obese categories are 0.313, 0.944, 1.875, and 2.667 [Table 3]. The duration of helmet use in years categorized as follows:

1. no helmet use,
2. 0.1-1 years of use,
3. 1-4 years of use and
4. 4-8 years of use.

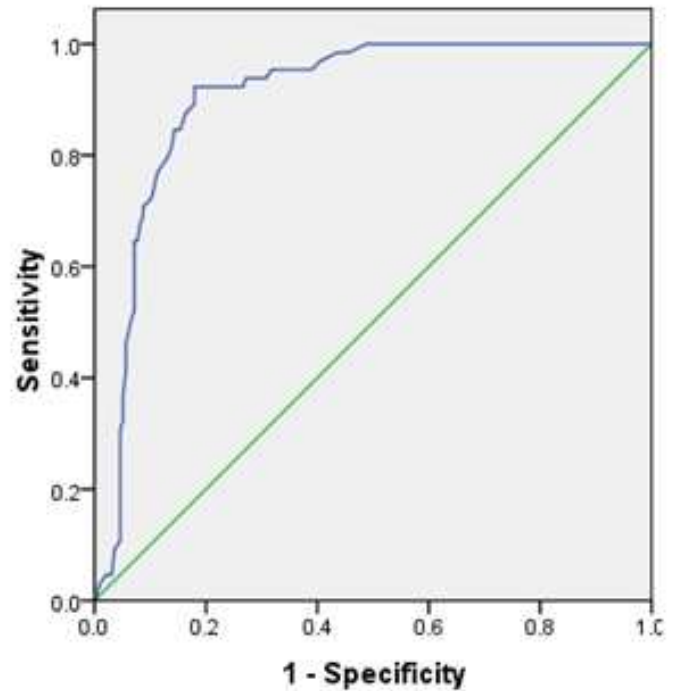
Twenty four subjects had neck pain (9.2%), and 46 reported no neck pain (17.7%) with 0.1-1 years of use. With 1-4 years of use, 24 (9.2%) subjects reported neck pain and 58 (22.3%) subjects had no neck pain. With 4-8 years of use, only 6 participants had neck pain (2.3%), and 32 had no neck pain (12.3%). There were also 11 non-helmet users who reported neck pain (4.2%) and 59 non-helmet users who did not have neck pain (22.7%). Binary logistic regression on helmet duration and neck pain was applied, and it indicated a significant relationship between neck pain and duration of helmet use ( $p=0.035$ ) and the Exp (B) value of the fourth category was 5.333. It reflects that the odds of neck pain are drastically higher in the fourth category than the rest of the categories [Table 4].

Helmet weight was measured with the help of a digital weighing scale and categorized into three different groups:

1. 0.25-1.25 kilograms
2. 1.30-1.90 kilograms and
3. 2.00-3.00 kilograms.

In the second category, which ranges from 0.25-1.25 kilograms, 31 subjects had neck pain (11.9%), and 36 subjects had no neck pain (13.8%). In the third category, which ranges from 1.30-1.90 kilograms, 19 subjects reported with neck pain (7.3%) and 75 subjects did not report neck pain (28.8%). In the fourth category, only 4 participants were having neck pain (1.5%), and 25 were having no pain (9.6%). We found

### ROC Curve



**Figure 1:** Correspondence between neck pain measurement and sensitivity of the NPADS questionnaire

out a significant relationship between helmet weight and neck pain ( $p<0.001$ ). The Exp (B) value of the fourth category is 6.250, and in relation to that, the Exp (B) of the second and third categories is 0.186 and 0.632, respectively. The odds of developing neck pain in the second and third category are less likely. The fourth category remains constant, and the chances of developing neck pain with helmet weight are higher in the third category as compared to the second category because Exp(B) is 0.583 and 1.733 for second and third category respectively. The fourth category has the highest relative risk of developing neck pain [Table 5].

The odds ratio was estimated by binary logistic regression, and it was 2.126 between neck pain and helmet use. An ROC curve was also established to evaluate the correspondence between subjective and objective measurement and to check the sensitivity of the NPADS questionnaire. The area under the ROC curve was 0.904, indicating a 90% correspondence between the subjective and objective neck pain measurement and denoted good sensitivity of the NPADS questionnaire [Figure 1].

## DISCUSSION

This research was proposed to determine any association or significant relationship between motorcyclists who uses helmets and the development of neck pain with helmet use. Overall, it was found that motorcyclists who use helmets had a two times higher risk or chance of developing neck pain in the long run as

as compared to the non-helmet user.

Neck pain in motorcyclists can be due to the helmet weight, distance travelled per day, duration of helmet use and motorcycle riding experience. It was also found in our study that individuals with more than five years experience of motorcycle riding had more chances of developing neck pain as compared to those who had less than five years of motorcycle riding experience.

There was a significant relationship with average motorcycle use per day. More use was associated with more odds of developing neck pain. Other variables including BMI, helmet weight and age did not have a significant relationship, but in logistic regression, these variables had an impact on neck pain in the long term.

It means that these variables will affect the incidence of neck pain. There is currently limited literature available which can exclusively identify the relationship between neck pain and helmet use. Very few studies have been conducted on motorcyclists' discomfort during the riding process. One of the studies conducted in Malaysia showed that 51.35% of male motorcyclists had musculoskeletal problems in their neck and head while riding a motorcycle.<sup>[13]</sup> The study supports the findings of our study as with the increase of average motorcycle use per day, the chances of neck pain also increase.

Research was also conducted in Karachi, Pakistan, estimating the prevalence of helmet use and to determine why non-helmet users do not wear helmets. In this study, 44% of the subjects reported physical discomfort, particularly in the neck and head as a reason for not wearing a helmet.<sup>[8]</sup> On the whole, helmets are very useful in preventing head injuries during fatal road accidents by protecting the head and neck. Contrary to that, increased helmet weight proved to be a contributor to the incidence of neck pain among motorcyclists. In Pakistan, the material used in the manufacturing of helmets does not meet the international standards thus leading to poor quality and non-standardized helmets in the market. However, it is not advised to avoid wearing helmet rather take measures to prevent neck pain during motorcycle riding and encounter those factors to reduce the incidence of neck pain among motorcyclists. This study provides a canvas for future researchers to evaluate those factors and contributors which had not been taken into account in this research paper, for example, the engine design and size of the motorcycle, comfortability of helmets, forward head posture of the rider, and the jerky movements of the motorcycle on the road could be

contributing towards the neck pain.

## CONCLUSION

The odds of having neck pain increases as the average motorcycle use per day increases. The BMI of the participants has a significant relationship ( $p=0.030$ ) with neck pain, and the odds are directly proportional to the BMI. The duration of helmet use also has a significant relation with neck pain ( $p=0.035$ ), and the odds of neck pain are increasing as the helmet weight increases. A significant relationship is found between helmet weight and neck pain ( $p=0.000$ ) and the odds of having neck pain with helmet weight rises as the helmet weight increases. The motorcycle user students who wear a helmet while riding motorcycle has two times higher odds of having neck pain as compared to those motorcycle user students who do not wear a helmet while riding a motorcycle.

## LIMITATIONS OF CURRENT STUDY

There were many confounding variables in our study including the biomechanical adaptations of the individual during riding, poor posture habits of the subjects, any undiagnosed musculoskeletal disorder, engine size and helmet size that can affect the outcome variable of neck pain. Our study encourages physiotherapists to consider these variables to find out any relationship of motorcyclists with neck pain. Our study showed a significant relationship and association of helmet use and neck pain, but the sample size was small, thereby limiting generalization.

## CONTRIBUTIONS TO SCIENTIFIC KNOWLEDGE

Helmets are useful and protective gadgets for bike riders. Undoubtedly, they contribute towards the prevention of head and neck injuries during road traffic accidents. There is no substitute for the unprecedented benefits of the helmets for motorcyclists. On the other hand, the non-standard helmets with less or no ergonomic adaptability are the leading cause of neck discomfort in the motorcyclists. This study highlighted the relationship of helmet weight and neck pain that would be helpful for helmet manufacturing companies to make ergonomically fit and standardized helmets with appropriate weight to lessen the burden of neck pain among motorcyclists. This research paper will open a new area of research as very little work has been done on the effects of machines on humans. This study is reflecting on how the interaction between a motorcycle (machine) and human can lead to some serious musculoskeletal problems or disorders. This study will benefit not only healthcare professionals to know more about the contributing factors of neck pain but

also to the manufacturing companies to focus not only on the style but also on the ergonomic adaptability and weight of the helmets. It is not a recommendation for motorcyclists to avoid helmet use during riding due to the fear of neck pain instead try to cope with the factors mentioned above, having the fact that they could be decremented.

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## CONFLICT OF INTEREST

The Authors declared no conflicts of interest.

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