Open Access Library Journal
2025, Volume 12, e13107
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Describing Injury Patterns and Risk Factors of Regular Bicycle Related Accidents of Patients Admitted to the Emergency Treatment Centre of Karapitiya Teaching Hospital, Galle

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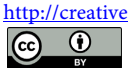
How to cite this paper: Peiris, J.S.D., Perera, U.C.P. and Jayasinghe, M. (2025) Describing Injury Patterns and Risk Factors of Regular Bicycle Related Accidents of Patients Admitted to the Emergency Treatment Centre of Karapitiya Teaching Hospital, Galle. *Open Access Library Journal*, **12**: e13107.
https://doi.org/10.4236/oalib.1113107

Received: February 18, 2025
Accepted: March 11, 2025
Published: March 14, 2025



Abstract

Background: Bicycle riding is a widely used mode of transportation in rural Sri Lanka, particularly in the Galle District. This study aims to examine the patterns of injuries and identify the risk factors associated with regular bicycle-related accidents. **Methods:** A descriptive population study was conducted at the Emergency Treatment Centre of Karapitiya Teaching Hospital, Galle, Sri Lanka, to evaluate injury patterns and risk factors associated with regular bicycle-related accidents. The study included regular bicycle riders of all ages and genders, with a specific focus on those who use standard bicycles. Off-road, electric, and race bicycles were excluded from the study. **Results:** Data was collected from 348 patients who sustained bicycle-related injuries. Among them, 233 (66.95%) were adults aged over 18 years, while 115 (33.04%) were minors under 18 years. Of the total participants, 281 (80.74%) were male. The injuries identified were 228 abrasions, 61 contusions, 46 lacerations, 35 fractures, 8 dislocations and 5 concussions. The regions injured were 193 upper limb injuries, 105 lower limb injures, 10 chest injuries, 13 abdominal injuries, 7 pelvic injuries and 4 spinal injuries. Environmental risk factors included 47 rainy weather incidents and 108 nighttime riding. Road-related risk factors consisted of 96 narrow roads, 43 bendy roads, 19 roads under construction, 21 roads with intersections and 19 dusty roads. Bicycle-related factors included the absence of lights in 44 and absence of bells in 20. Human-related risk factors included 27 with poor vision, 18 with hearing impairment, and 66 with alcohol consumption. No participants wore helmets or safety appliances. **Conclusion:** Injuries resulting from blunt force trauma, such as abrasions, contusions, lacerations,

and fractures, were most commonly observed in regular bicycle riders. Other significant injuries included those affecting the chest, abdomen, pelvis, and spine. Various risk factors contributing to these injuries were identified, including environmental conditions (e.g., rain and nighttime riding), road conditions (e.g., narrow, bendy, or under-construction roads, as well as intersections and dusty paths), bicycle-related factors (e.g., lack of lights and bells) and human factors (e.g., poor vision, hearing impairments, and alcohol consumption). While limb injuries were the most frequent, head injuries were also prevalent across all age groups and had the potential to result in serious morbidity and mortality. The use of helmets is a critical preventative measure for reducing head injuries. Additionally, the risk of limb injuries, particularly in children, can be minimized through the use of appropriate safety gear. To further reduce the occurrence of accidents and injuries, the implementation and enforcement of road safety rules for bicycle riders is essential.

Subject Areas

Clinical Medicine

Keywords

Injury Patterns, Risk Factors, Regular Bicycles

1. Introduction

Riding bicycles is a popular mode of transport in many European countries, particularly the Netherlands [1]. It has also been a common mode of transport in Asian countries since the early 20th century [2]. A 2018 study on bicycle use in Galle, Sri Lanka, calculated a maximum speed of 44 km/h for regular bicycles, which highlights their widespread use and relevance for transportation and leisure activities [3]. However, injury patterns and risk factors among regular bicycle riders remain under researched, especially in Sri Lanka, with most studies focusing on motor bike and motor vehicle related injuries. According to accident statistics done in year 2006 by University of Ruhuna, bicycle related fatalities in Sri Lanka are found to be 326 in year 2005 and bicycle related casualties are found to be 2773 in year 2001. During the COVID-19 pandemic, there was a notable decline in public transport usage in Sri Lanka, leading to an increase in the use of private modes of transport, including bicycles [4]. This shift emphasizes the need for improved safety measures for both rural and urban cyclists. Cycling is not only an eco-friendly and health-conscious activity but has also raised concerns about road safety due to the increasing number of accidents. While several studies have examined motor vehicle-related injuries and their risk factors, research on bicycle-related injuries, particularly in Sri Lanka, remains scarce. This gap is critical, as cycling is gaining popularity, especially in urban areas, with various types of bicycles in use, including regular bicycles, race bicycles, off-road bicycles, and electric bicycles [5]. In the

Galle district, regular bicycles are most commonly used, though electric bicycles are more prevalent in urban areas.

Safety measures, such as wearing helmets, can significantly reduce the risk of head and neck injuries in case of accidents [6]. Helmets are commonly worn by riders of race bicycles, off-road bicycles, and electric bicycles, but their use is less frequent among regular bicycle riders. A study conducted in the Netherlands found that head injury was the most common type of injury among cyclists, highlighting the importance of helmet use for protection. Similarly, in China, one-third of electric bicycle riders involved in accidents sustained serious injuries, underscoring the growing risk as electric bicycles become more popular in urban areas of Sri Lanka.

Furthermore, studies conducted in the United States and the United Kingdom have identified several risk factors associated with bicycle-related injuries. In the United States, the lack of helmet use was linked to a higher fatality rate in accidents, particularly those involving head injuries. In the United Kingdom, cyclists were found to be twice as likely to suffer fatal injuries per mile compared to car occupants, with environmental factors contributing to the increased risk [7]. Additionally, cyclists traveling against traffic flow were found to have a significantly higher risk of accidents [8]. Age was also identified as a risk factor, with youth and adolescents being more prone to severe injuries in bicycle collisions [9].

Given the growing popularity of bicycles in both rural and urban areas of Sri Lanka, and the risk of severe injury such as head trauma, it is crucial to investigate the injury patterns and risk factors associated with bicycle accidents. This study aims to identify and describe injury patterns and risk factors among patients admitted to the emergency treatment centre of Karapitiya Teaching Hospital, Galle, and to recommend safety measures and legal strategies to prevent serious injuries and fatalities.

2. Materials and Methods

This study was a descriptive population study conducted at the Emergency Treatment Centre of Karapitiya Teaching Hospital, Galle, Sri Lanka. The study aimed to investigate injury patterns and risk factors in regular bicycle-related accidents.

The study population consisted of regular bicycle riders of all ages and genders who were admitted to the Emergency Treatment Centre due to road traffic accidents. Both major and minor injuries were included, provided they met the inclusion criteria. The study exclusively focused on regular bicycle riders, excluding those using off-road, electric, or race bicycles.

Inclusion Criteria were; regular bicycle riders admitted to the Emergency Treatment Centre due to road traffic accidents, patients of all ages, sexes, and injury severities, informed written consent obtained from the patients. Exclusion Criteria were; cyclists who refused to give informed consent, cyclists unable to provide consent due to serious or fatal injuries, cyclists in severe pain preventing participation, riders of off-road, electric, or race bicycles.

The sample size consisted of 348 cases. Consecutive sampling was used, where data were collected from all eligible patients meeting the inclusion criteria during the study period.

Data was collected using a structured data collection sheet, which included the age/sex of participant, history of the accident, wearing of helmet, environmental risk factors, road related risk factors, bicycle related risk factors, human related risk factors, type of injury, a diagram to locate and describe the injuries. Data collection was conducted by trained specialist judicial medical officers who perform daily ward rounds. Informed written consent was obtained from each participant. In cases where the patient could not provide consent due to serious or fatal injuries, consent was sought from the next of kin. Participants were informed that they could withdraw from the study at any time without any consequences.

Once collected, the data were entered into a master sheet using only case numbers to ensure anonymity. Data analysis was performed using the Statistical Package for Social Sciences (SPSS). Variables analysed included: age, sex, type of injury, region of injury, environmental risk factors, road related risk factors, bicycle related risk factors and human related risk factors. The data regarding all variables were analysed as a percentage and probability. The injured regions were analysed with age.

All data were managed and analysed anonymously, with strict confidentiality maintained. The principal investigator held personal custody of the study data.

The study did not cause any harm or pain to participants. The research focused solely on analysing injury patterns and risk factors, which aimed to benefit all bicycle riders by improving safety measures. There were no legal risks or concerns related to participation in the study.

There was no external funding for the study, and no money was spent on study purposes. The results will be shared with legal and forensic communities via scientific forums to contribute to future safety recommendations.

The study was carried out over a period of 12 months, from October 2023 to September 2024 (Figure 1).

	2023/2024	**2024**
Activity	**October - January**	**January - September**
Literature survey		
Proposal writing		
Ethical clearance		
Data collection		
Data entry/analysis		

Figure 1. Study time table over 12 months.

3. Results

Data was collected from 348 patients who sustained bicycle-related injuries. Among them, 233 (66.95%) were adults aged over 18 years, while 115 (33.04%) were minors under 18 year (Figure 2 and Table 1). Of the total participants, 281 (80.74%) were male (Figure 3 and Table 2).

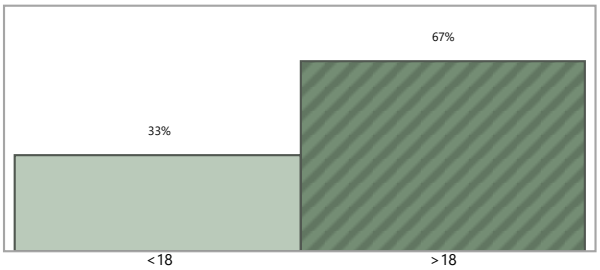


Figure 2. Percentage of distributions of age.

Table 1. Count and probabilities of age.

Level	Count	Prob
<18	115	0.33046
>18	233	0.66954
Total	348	1.00000

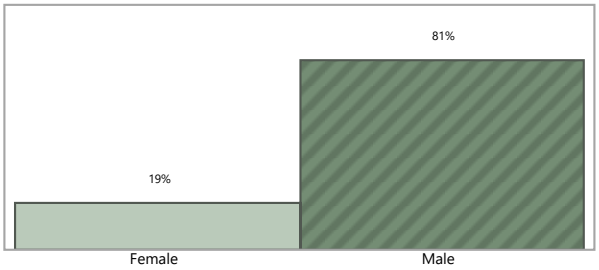


Figure 3. Percentage of distributions of sex.

Table 2. Count and probabilities of sex.

Level	Count	Prob
Female	67	0.19253
Male	281	0.80747
Total	348	1.00000

The injuries identified were 228 abrasions, 61 contusions, 46 lacerations, 35 fractures, 8 dislocations and 5 concussions (Figure 4 and Table 3).

The regions injured were 193 upper limb injuries, 105 lower limb injures, 10 chest injuries, 13 abdominal injuries, 7 pelvic injuries and 4 spinal injuries (Figure 5 and Table 4), (Figure 6 and Tables 5-7).

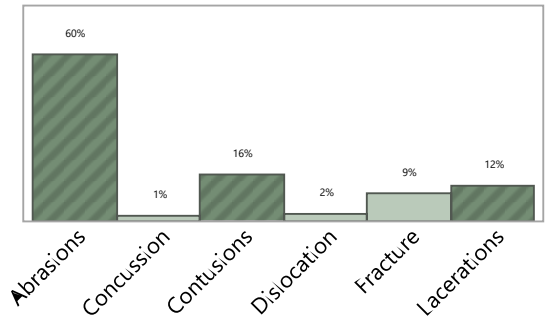


Figure 4. Percentage of distributions of injuries.

Table 3. Count and probabilities of injuries.

Level	Count	Prob
Abrasions	228	0.59530
Concussion	5	0.01305
Contusions	61	0.15927
Dislocation	8	0.02089
Fracture	35	0.09138
Lacerations	46	0.12010
Total	383	1.00000

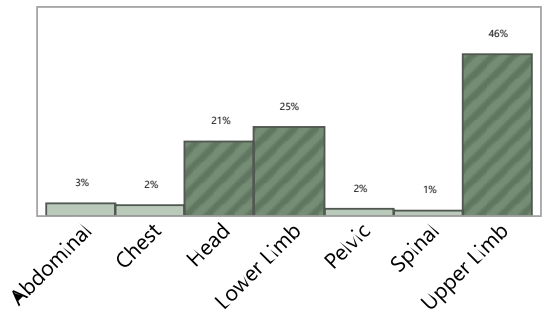


Figure 5. Percentage of distributions of regions regions distributions of injuries.

Table 4. Count and probabilities of regions.

Level	Count	Prob
Abdominal	13	0.03103
Chest	10	0.02387
Head	87	0.20764
Lower limb	105	0.25060
Pelvic	7	0.01671
Spinal	4	0.00955
Upper limb	193	0.46062
Total	419	1.00000

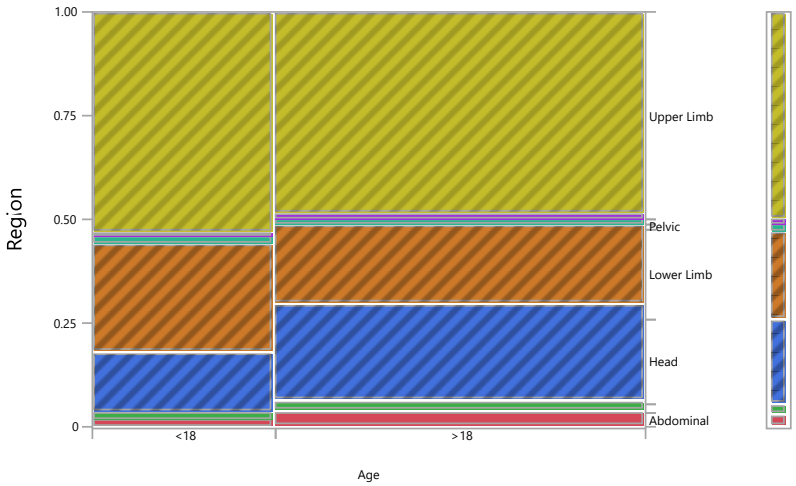


Figure 6. Contingency analysis of region by age (mosaic plot).

Table 5. Contingency table (age by region).

Count Total % Col % Row %	Abdominal	Chest	Head	Lower limb	Pelvic	Spinal	Upper limb	Total
<18	2	2	17	30	2	1	61	115
	0.57	0.57	4.89	8.62	0.57	0.29	17.53	33.05
	18.18	25.00	23.94	40.00	40.00	25.00	35.06	
	1.74	1.74	14.78	26.09	1.74	0.87	53.04	
>18	9	6	54	45	3	3	113	233
	2.59	1.72	15.52	12.93	0.86	0.86	32.47	66.95
	81.82	75.00	76.06	60.00	60.00	75.00	64.94	
	3.86	2.58	23.18	19.31	1.29	1.29	48.50	
Total	11	8	71	75	5	4	174	348
	3.16	2.30	20.40	21.55	1.44	1.15	50.00	

Table 6. Contingency table (age by region) Rsquare.

N	DF	-LogLike	RSquare (U)
348	6	3.2048222	0.0070

Table 7. Contingency table (age by region) Chisquare.

Test	ChiSquare	Prob > ChiSq
Likelihood ratio	6.410	0.3789
Pearson	6.175	0.4039

Environmental risk factors included 47 rainy weather incidents and 108 nighttime riding (Figure 7 and Table 8). Road-related risk factors consisted of 96 narrow

roads, 43 bendy roads, 19 roads under construction, 21 roads with intersections and 19 dusty roads (Figure 8 and Table 9). Bicycle-related factors included the absence of lights in 44 and absence of bells in 20 (Figure 9 and Table 10). Human-related risk factors included 27 with poor vision, 18 with hearing impairment, and 66 with alcohol consumption (Figure 10 and Table 11). No participants wore helmets or safety appliances.

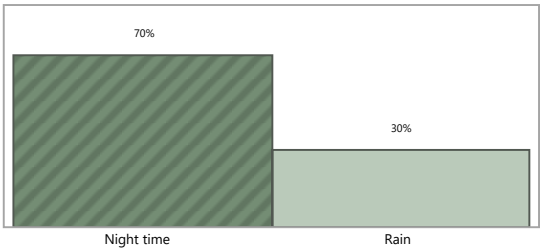


Figure 7. Percentage of distributions of environmental risk factors.

Table 8. Count and probabilities of environmental risk factors.

Level	Count	Prob
Night time	108	0.69677
Rain	47	0.30323
Total	155	1.00000

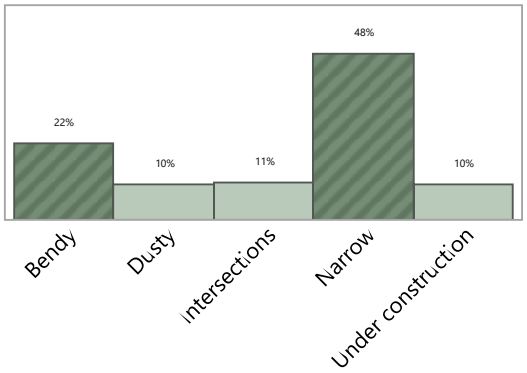


Figure 8. Percentage of distributions of road risk factors.

Table 9. Count and probabilities of road risk factors.

Level	Count	Prob
Bendy	43	0.21717
Dusty	19	0.09596
Intersections	21	0.10606
Narrow	96	0.48485
Under construction	19	0.09596
Total	198	1.00000

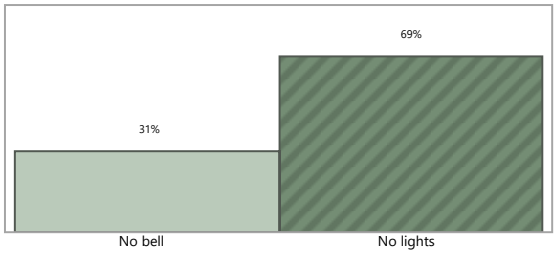


Figure 9. Percentage of distributions of bicycle related risk factors.

Table 10. Count and probabilities of bicycle related risk factors.

Level	Count	Prob
No bell	20	0.31250
No lights	44	0.68750
Total	64	1.00000

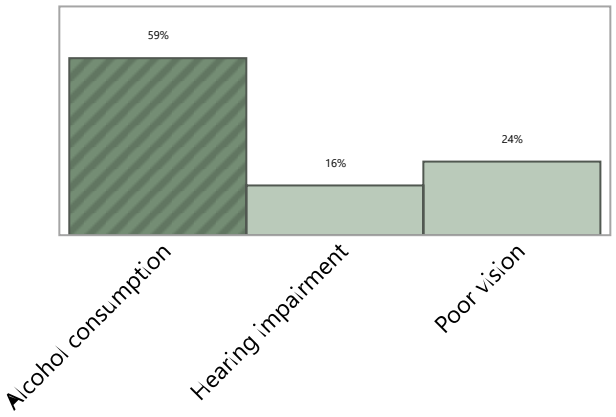


Figure 10. Percentage of distributions of human related risk factors.

Table 11. Count and probabilities of human related risk factors.

Level	Count	Prob
Alcohol consumption	66	0.59459
Hearing impairment	18	0.16216
Poor vision	27	0.24324
Total	111	1.00000

4. Discussion

In a study done in the United States in 1994, more injuries were detected in the children aged < 21 years more than adults ages > 21 years. In a study done in the United States in 1997, more injuries were detected in the adults than in children. In a study done in Hong Kong SAR in 2009 more injuries were detected in the adults than children. In a study done in Netherlands in 2020 more injuries were detected in the adults than children. Whereas in this study more injuries were

detected in the adults aged > 18 years than children ages < 18 years. In all the above studies, males were more commonly affected than females. Head injuries are common in adults in many studies, as shown in this study (Figure 6 and Tables 5-7). Limb injuries are common in children in many studies, as shown in this study (Figure 6 and Tables 5-7). Though some studies have identified head injury as the commonest type of injury of bicycle riders, many studies have identified limb injures as commonest injuries than head injuries as in this study (Figure 5 and Table 4).

Risk factors such as environmental factors, road factors, bicycle factors and human factors have been identified in many studies as in this study. Environmental and road related factors vary with regards to countries and locations within the country. Night time has a high percentage as an environmental risk factor in this study. Roads not having lights or adequate lighting in rural areas may have contributed to it. In this study, narrow and bendy roads have a high percentage as road related risk factors in this study. Unlike urban roads in Sri Lanka, rural roads have many narrow and bendy aspects. Bicycles not having lights have a high percentage as a bicycle related risk factor in this study. Night time riding may have contributed to it. Alcohol consumption is a significant human risk factor in this study. Helmets are worn by participants in some studies, but no participants wore helmets in this study.

Many injury patterns and risk factors that are preventable regarding bicycle riding are identified in this study, although limited studies are available in Sri Lanka in imposing safety measures and legal implementations.

5. Conclusion

Injuries resulting from blunt force trauma, such as abrasions, contusions, lacerations, and fractures, were most commonly observed in regular bicycle riders. Other significant injuries included those affecting the chest, abdomen, pelvis, and spine. Various risk factors contributing to these injuries were identified, including environmental conditions (e.g., rain and nighttime riding), road conditions (e.g., narrow, bendy, or under-construction roads, as well as intersections and dusty paths), bicycle-related factors (e.g., lack of lights and bells), and human factors (e.g., poor vision, hearing impairments, alcohol consumption). While limb injuries were the most frequent, head injuries were also prevalent across all age groups and had the potential to result in serious morbidity and mortality. The use of helmets is a critical preventative measure for reducing head injuries. Additionally, the risk of limb injuries, particularly in children, can be minimized through the use of appropriate safety gear. To further reduce the occurrence of accidents and injuries, the implementation and enforcement of road safety rules for bicycle riders is essential. Education of school children and employees of public and private sector should also be implemented via webinars and reading material. Bicycle riders should exercise extra caution, especially during holidays, when the risk of accidents may increase. The recent COVID-19 pandemic increased the use of bicycle riding even in the

urban regions of Sri Lanka which highlights the importance of this study.

Limitations of the study

Cyclists unable to provide consent due to serious or fatal injuries, cyclists in severe pain preventing participation, riders of off-road, electric, or race bicycles were excluded from the study.

Acknowledgements

To the director of Karapitiya Teaching Hospital for approval to conduct the study.

Ethical Approval

Ethical approval was given by the Ethical review committee of University of Ruhuna.

Conflicts of Interest

The authors declare no conflicts of interest.

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