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Incidence of Injuries in Motorcyclists Practitioners of Trails*

Incidência de lesões em motociclistas praticantes de trilhas

Davi Leal Sousa[1] Kelson Nonato Gomes da Silva[1] Eduardo Ferreira[1] Flávio Rogério de Sousa Morais[1]

[1] Centro de Ciências da Saúde, Universidade Estadual do Piauí (UESPI), Teresina, PI, Brazil

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Address for correspondence Davi Leal Sousa, Centro de Ciências da Saúde, Universidade Estadual do Piauí, Rua Olavo Bilac, 2335, Centro (Sul), Teresina, PI, Brazil CEP: 64001-280 (e-mail: davi_ipiranga@hotmail.com).

Abstract

Objective To investigate the incidence, mechanisms, types of injury, most affected anatomical regions, and factors leading to injuries in trail bikers.

Methods This was an observational, retrospective study analyzing 47 trail bikers. Data were collected through application of a referenced morbidity survey (RMS), which included information on injuries and their mechanisms.

Results The lesions with the highest incidence were abrasion and bruise. The most affected anatomical regions were the shoulders and knees. The most common injury mechanism was skidding or loss of traction.

Conclusion Trail bikers are exposed to risk factors and, consequently, to falls; it is important to develop more protective equipment, especially for the shoulders and knees.

Keywords

- sports
- off-road motor vehicles
- sports injuries
- motorcycles

Resumo

Objetivo Investigar a incidência, os mecanismos, os tipos de lesão, as regiões anatômicas mais acometidas, e os fatores que podem levar a lesões nos motociclistas praticantes de trilhas.

Métodos Trata-se de uma pesquisa observacional do tipo retrospectivo, na qual foi realizada uma análise com 47 motociclistas praticantes de trilhas. Os dados foram coletados através da aplicação de um inquérito de morbidade referida (IMR), que incluiu informações sobre as lesões e seus mecanismos.

Resultados Ao analisar a amostra, verificou-se que os tipos de lesões com maior incidência foram abrasão e contusão. As regiões anatômicas mais acometidas foram o ombro e o joelho, e o mecanismo de lesão mais comum foi a derrapagem ou perda da tração.

Conclusão Os trilheiros estão expostos a fatores de risco e, consequentemente, às quedas, sendo importante desenvolver mais equipamentos de proteção, em especial para o ombro e para o joelho.

Palavras-chave

- esportes
- veículos *off-road*
- lesões esportivas
- motocicletas

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Introduction

Off-road motorcycling emerged in Brazil in the 1970s, when enthusiasts from all over the country placed their motorcycles on trails to have fun during the weekend.[1]

Today, off-road motorcycling is increasingly diversified and widespread in Brazil; in addition to competitive modalities (including rally, endurance, trial, and motocross), there are natural trails, which are not for competition. Motorcycle trail is a sport aiming to overcome access difficulties and natural obstacles, such as stones, erosions, mud and steep descents or climbs.[2]

Since its inception, in the early 1920s, off-road motorcycling have gained popularity, with millions of participants worldwide.[3,4] This sport provides several positive factors for its practitioners, including benefic health and fitness changes that contribute to an improved quality of life and, as such, fewer risk factors for future diseases.[5–7] On the other hand, the increase in the number of trail bikers resulted in an increased injury risk and incidence.[3,8]

Injury in trail bikers is quite frequent.[8,9] Sprains,[10,11] fractures,[12–15] dislocations,[12,15] contusions,[16] ligament injuries,[12–15] and wounds[14,15] have been described in the literature as the most common injuries associated to this sport. Hence, the development of injury prevention strategies must include an investigation of potential risk factors, such as physical and mental fitness, protective equipment, specific off-road motorcycle laws and lesion mechanisms.[13,14,17,18] Those who are responsible for the rehabilitation of injured individuals or for their training, in the case of athletes, must absolutely master these factors.[19]

Off-road injuries, especially on motorcycle trails, require further research, since there are few reports in the literature addressing this sport specifically. As such, this study aimed to investigate the incidence, mechanisms, types of injury, most affected anatomical regions, and the factors that lead to injuries in trail bikers.

Methodology

This is an observational retrospective research to gather information on injuries reported by trail bikers. This study was conducted during the 2nd *Trilhão da Juventude*, a major off-road event held on July 2018 in Ipiranga, PI, Brazil. All participants were informed and invited to participate in the survey (70). However, since 20 of them were not present or did not respond to the survey, 50 individuals were included in the study. This research was reviewed and approved by the Research Ethics Committee under opinion number 2.932.053.

The inclusion criteria were off-road motorcyclists of both genders who practice trails in any age group and were properly enrolled in the 2nd *Trilhão da Juventude*. Of the 50 participants who agreed to participate in the study, 3 did not answer the questionnaire properly, leaving a sample with 47 trail bikers. All participants were informed of the objectives of this study, which comply with the research standards involving human beings (resolution 466/2012) from the Brazilian National Health Council; in addition, the participants authorized the use of any information provided.

Data collection was conducted before the event and obtained through the referred morbidity survey (RMS), deemed an appropriate procedure to investigate the health status of specific populational groups.[20] The questionnaire (appendix 1) was prepared according the model described by Gabriela[19] and modified according to the reality of the modality addressed in this research; the requested information included the type of injury, affected anatomical region, mechanism of injury, factors that may have contributed to the injury, time of sport practice, and personal information (gender, age, height, and weight). The entire process of questionnaire application was conducted by the researcher together with two properly trained assistants. Sports injury was considered any musculoskeletal disorder resulting from the practice of motorbike trail.

After data collection through RMS, the information was entered and tabulated in a specific database for statistical analysis. The database, as well as tables and graphs, were built in Microsoft Excel 2010 (Microsoft Corp., Redmond, WA, USA). Data analysis was performed with the R software, version 3.4.3 (The R Foundation for Statistical Computing, Vienna, Austria), using the Chi-squared test for statistical significance analysis and considering 0.05 (5%) as the alpha level of significance.

Results

A total of 47 male trail bikers, aged 18 to 50 years old, participated in this study. Of these, 20 reported never having suffered any type of injury, while 27 stated that they had already suffered one or more injuries during non-competitive trail rides.

►**Table 1** shows the characteristics of injured and non-injured trail bikers ($n = 47$) who participated in the study. The non-injured group presented an average age of 24.95 years, average height of 1.76 m, average weight of 76.55 kg, and average body mass index (BMI) of 24.18, indicating adequate weight, and average time of trail practice of 2.49 years. In the injured group, the average age was 32.11 years, average height was 1.73 m, average weight was 83.20 kg, average BMI was 27.84, indicating overweight, and average time of trail practice was 6.14 years.

Fifty-six injuries were identified, since some bikers were injured more than once. The most common lesions were abrasion and contusion, both with 23.21% (►**Figure 1**). The most affected anatomical regions were the shoulders, with 23.53%, followed by the knees, with 13.73% (►**Figure 2**).

Other injuries were also reported, such as calf and thigh cramps, clavicle and rib fractures, and traumatic thumb amputation.

The shoulders were the most frequent injury site in the upper limbs, affecting 38.71% of the subjects; the most frequent types of shoulder injuries were abrasion (12.90%), contusion (9.68%), fracture (9.68%) and dislocation (6.45%). Next, the arm, elbow, and fingers were the most affected sites, with 12.90% each. The most common type of arm injury

Table 1 Sociodemographic profile from trail bikers ($n = 47$) included in the study

Variables	With lesion		Without lesion		*P*-value
	Absolute frequency	Relative frequency (%)	Absolute frequency	Relative frequency (%)	
Age					
18–30	11	39.29%	17	60.71%	$< 0.05^{**}$
31–50	16	84.21%	3	15.79%	
Height (m)					
1.62 - 1.75	18	66.67%	9	33.33%	> 0.05
1.76 - 1.89	9	45.00%	11	55.00%	
Weight (kg)					
60–80	13	54.17%	11	45.83%	> 0.05
81–109	14	60.87%	9	39.13%	
Body mass index					
Adequate weight	11	45.83%	13	54.17%	> 0.05
Overweight	9	69.23%	4	30.77%	
Obesity	7	77.77%	2	22.23%	
Low weight	0	0.00%	1	100.00%	
Time practicing trail					
2 months–5 Years	13	40.63%	19	59.37%	> 0.05
6 years–25 Years	14	93.33%	1	6.67%	

*Chi-square test (95% confidence).
**Statistical significance ($\alpha = 0.05$).

was abrasion (6.45%), followed by bruising and cuts (3.23%). In elbows, abrasion and bruising (6.45%) were the most frequently reported type of injury; tendon rupture, dislocation, sprain, and cuts appear with 3.23% each.

Knees were the most injured site in lower limbs (35%). The most common type of knee injury was contusion (15%), followed by abrasion (10%), fracture (5%) and ligament injury (5%). Next, there were ankle injuries, with 25% of all lower extremity lesions, in which sprains predominated (25%). Thigh injuries account for 20% of the total; abrasion (5%) and bruising (5%) were the most common type of thigh injury.

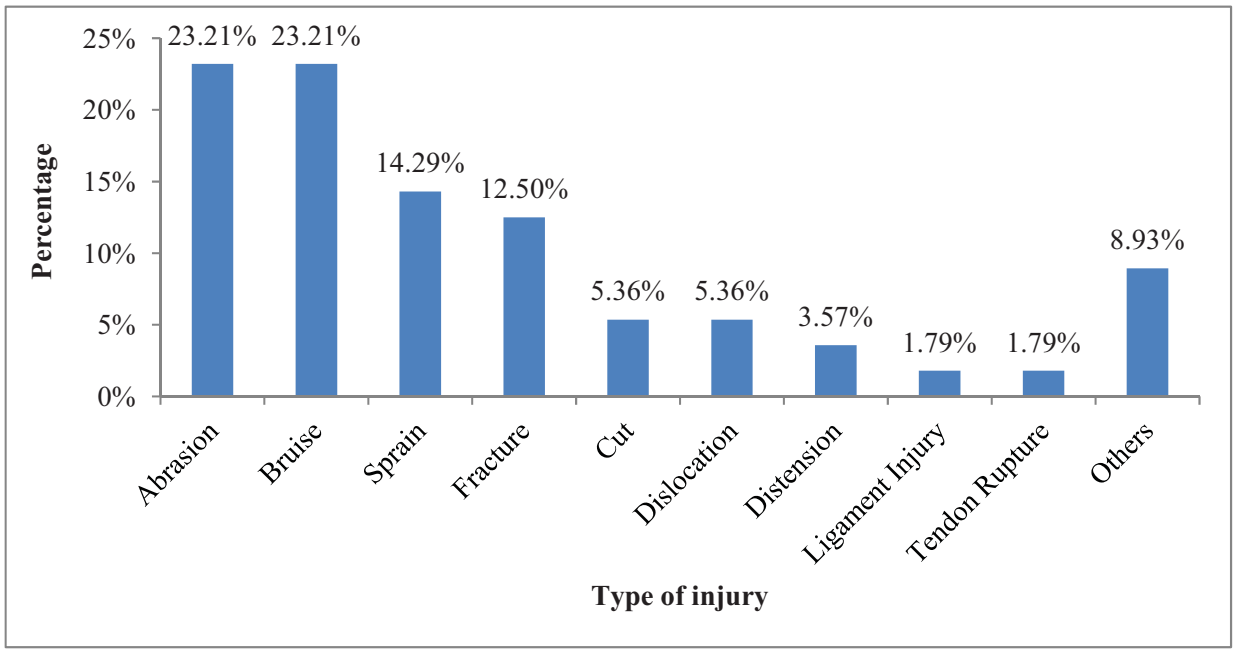

Fig. 1 Distribution of injuries reported by trail bikers.

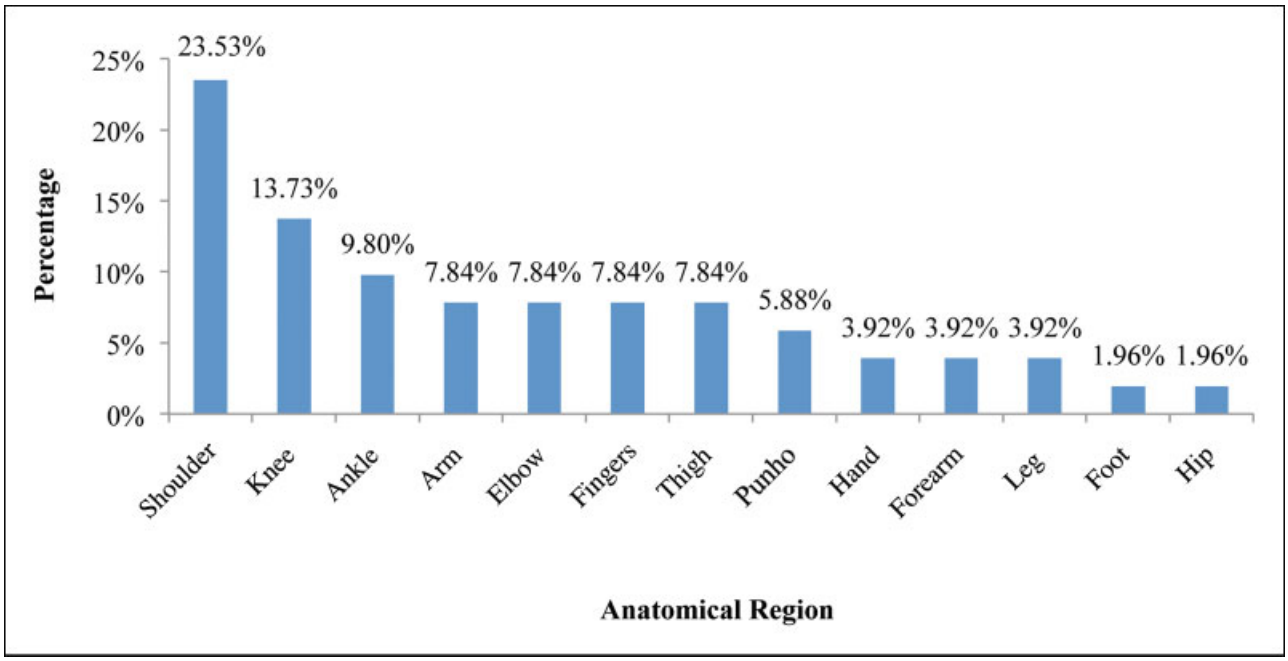

Fig. 2 Distribution of injured anatomical regions reported by trail bikers.

►**Table 2** shows the mechanisms of injury; skidding or loss of traction was the main cause of injuries (35.48%), and 25.81% of the bikers reported that they fell and suffered the injury in a curve segment, while 9.68% reported injury suffered in a straight segment. Another 32.26% were injured after collision with an immovable object, most commonly stones (22.58%) and trees (9.68%).

As for the direction of the fall, 40.74% of the bikers fell to the left side, 33.33% fell to the right side, 22.22% fell on the handlebars, and 3.70% suffered injuries without falling (►**Figure 3**).

Table 2 Distribution of lesion mechanisms reported by the trail bikers included in the study

Lesion mechanism	Absolute frequency		Relative frequency (%)	
Skidding or loss of traction	11		35.48	
Curve segment		8		25.81
Straight segment		3		9.68
Collision with immovable object	10		32.26	
Rock		7		22.58
Tree		3		9.68
Collision with movable object	4		12.90	
Motorcycle		4		12.90
Rollover	4	4	12.90	12.90
After jump	2	3	6.45	6.45
Total	**31**	**31**	**100**	**100**

The most common risk factors contributing to injury were high speed, reported by 25.81% bikers, followed by lack of protective equipment (12.90%), alcohol intake (9.68%) and recklessness (9.68%) (►**Figure 4**).

Discussion

This study showed that, on average, injured trail bikers are 32.11 years-old, weight 83.20 kg, are about 1.73 m tall, have a BMI of 27.84, and practice trails for 6.14 years. These socio-demographic profile variables provide relevant information regarding the risk of injury. Mary et al.[10] conducted a study with off-road riders in Victoria, Australia, and found that inexperienced, underweight, young people of short stature may be more prone to injury.

Tomida et al.[21] studied elite motorcyclists in Japan to determine whether age and experience of motocross and trial bikers correlated with injury. These authors concluded that there is no relationship between age and experience with injury occurrence. This statement partially matches our results, in which the Chi-squared test showed that age was the only statistically significant variable, meaning that athletes react to injuries differently depending on their age group.

Jason et al.[22] conducted a longitudinal analysis with young people, under 20 years-old, who received emergency medical care in Ontario, Canada, due to an off-road vehicle accident between April 1, 2002 and March 31, 2014. They found that these young people are associated with an increased emergency medical care due to off-road vehicle accidents. In addition, these authors point out that such injuries are partly caused by inadequate supervision and impulsive behavior. Our findings revealed that age is related to injury, but it was not possible to analyze whether people

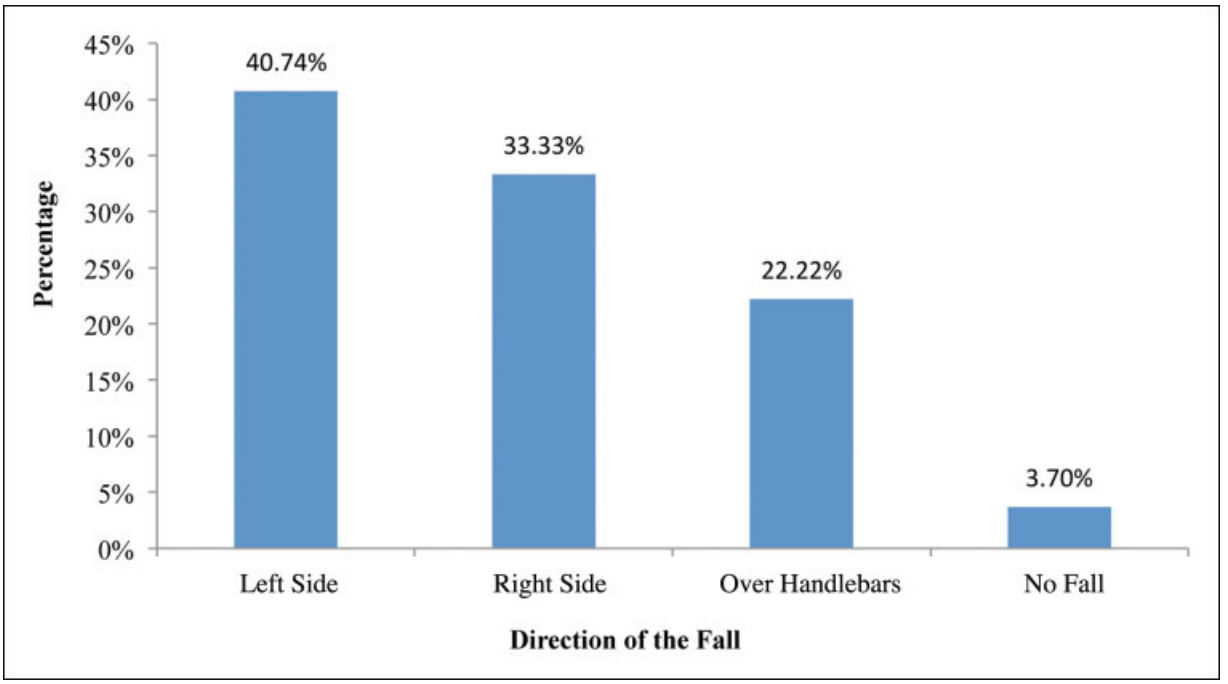

Fig. 3 Direction of trail biker fall.

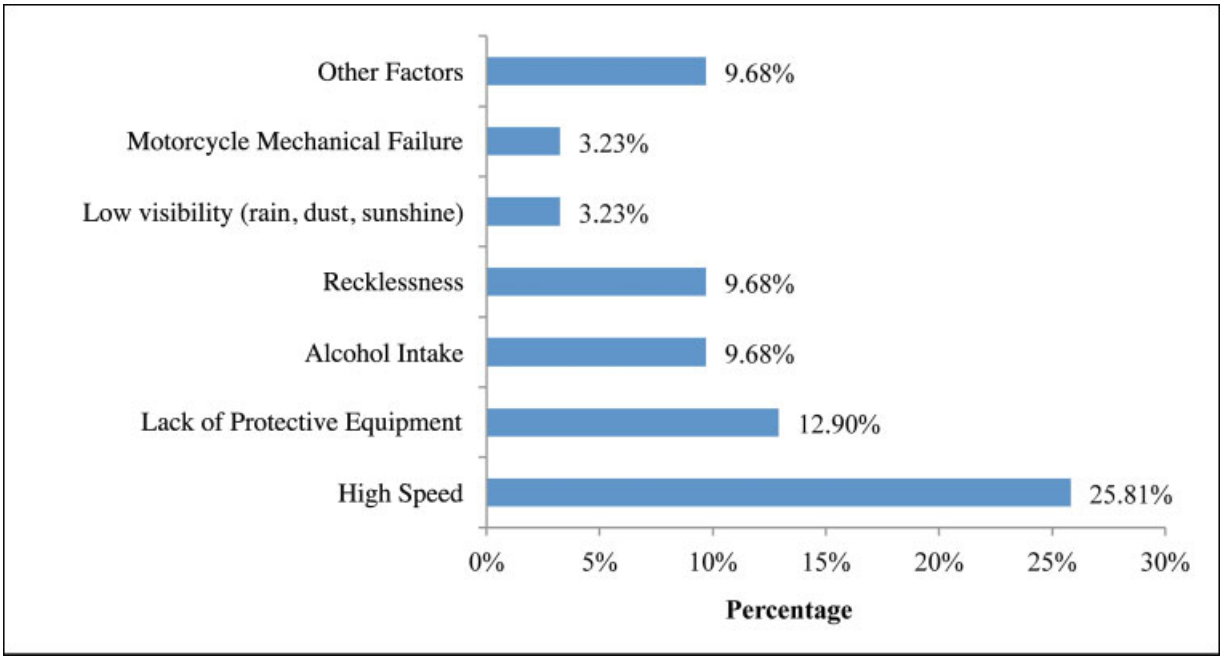

Fig. 4 Reported risk factors contributing to injury.

younger than 20 years-old are more susceptible due to their small participation in the study.

The mean BMI value (27.84) of trail bikers indicates overweight, corroborating the findings from Gobbi et al.,[17] who analyzed the physiological characteristics of motocross, rally and endurance riders, and identified that rally pilots are usually overweight. A literature review by Khanna et al.[23] points out that endurance riders are within normal weight limits. Although, in this study, the Chi-squared test showed no statistical significance regarding weight, some research indicates that overweight individuals are susceptible to injury in off-road sports, as the extra weight makes driving difficult, especially when going up or down hills and crossing mud.[17,23]

In the present study, most injuries occurred in upper limbs, consistent with the findings of Day et al.[11] who conducted a study in 2016 with 0- to 17-year-old children who were injured while riding an off-road motorcycle for recreational purposes. Benjamin et al.,[12] in 2015, found similar results, showing that upper extremity fractures

were the most prevalent ones among bikers participating in the Dakar rally in 2013 and 2014.

Sabeti-Aschraf et al.[13] studied motorcyclists participating in the Erzberg Rodeo, an Austrian endurance race, between 2005 and 2007; these authors showed that the most frequent injuries were bruises and abrasions. Sandler et al.[24] also found out that bruises and abrasions were the most common lesions in children injured while driving off-road vehicles. This type of injury usually occurs when the front tire slips, resulting in a fall.[13] Williams et al.,[25] in 2017, studied children from motocross competitions, revealing that the most common lesions were fractures. For Padegimas et al.,[26] in 2016, sprains were more frequent; these findings are similar to ours, since sprains and fractures were, respectively, the third and fourth most common injuries.

Mary et al.[10] identified that the most injured anatomical regions in off-road riders were the shoulders, knees, wrists, and ankles, consistent with our findings, in which the most affected areas were the shoulders, knees, ankles, arms, elbows, fingers, and thighs. A systematic review by Khanna et al.,[23] from 2015, identified that hands, arms, and shoulders were the most common impact points after falls in endurance bikers. These authors also point out that the effort generated in the lower limbs is greater compared to the one generated in the upper limbs, which may explain lower-limb injuries.

Other injuries were reported by study participants, such as calf and thigh cramps, clavicle and rib fractures, and traumatic thumb amputation. The literature also reports such lesions; Winkes et al.[27] and Sabeti-Aschraf et al.[28] reported forearm cramps in motocross and endurance bikers. Clavicle and rib fractures have been reported by Nona and Richard,[15] who analyzed endurance bikers for 4 years during the 6- Day Enduro in four countries (Australia, Holland, United States, and Poland), and Benjamin et al.,[12] who studied rally drivers. Amputations were reported by Mary et al.[10] and Sawyer et al.[29] These authors further stated that amputations occur when the limb becomes trapped in the transmission chain, and that it is a feature of quadricycle-associated injury.

According to Sabeti-Aschraf et al.,[13] traction loss (skidding) was the most frequent injury mechanism, thus corroborating our findings. For Nona and Richard,[15] the most frequent injury mechanisms were collision with an immovable object, loss of traction (slippage) and collision with a moving object, respectively. Schönle and Fachklinik,[30] in a study conducted during the World Enduro Championship with drivers from 24 countries, identified that 7.1% of injuries were due to rollover. Falling after a jump is more common in motocross.[18] These results are similar to our findings.

In a study by Larson and McIntosh[31] involving off-road riders from the United States, most bikers fell to the left side. In the present study, falls to the left side were also most common. These same authors revealed that falls to the left side are more frequent, perhaps due to the location of the gear pedal, on left side of the motorcycle. Other authors described fall direction, including Khanna et al.,[23] who reported that falls on handlebars were the most common, followed by falls to the right and left side. Their data is similar to ours, since these were the three sides with most falls.

A number of studies have pointed out several risk factors as contributing factors to injuries, including high speed[3,13] lack of protective equipment,[10] alcohol intake,[9,10] recklessness,[22] low visibility,[13,15] and mechanical failures.[13,32] Roxanne et al.[8] investigated injuries to American motocross and recreational off-road riders and reported that the chance of injury increases when the individual is under the alcohol influence, riding at high speeds and not using protective equipment. These findings are consistent with the present study.

Conclusion

Trail bikers are exposed to risk factors resulting in falls. Injuries described here occur due to lack of experience, high speed, and the characteristics of the sport itself. The development of protective equipment, especially for the shoulders and the knees, is critical. Further studies are required to contribute with more information to physical therapists, other health professionals, and the general population.

Conflict of Interests
The authors declare that have no conflict of interests.

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Appendix 1 - Lesions associated with motorcycle trails

Volunteer: 01

Gender:_____ Age:_____ Height:_____ Weight:_____

Time practicing trails_____

1. WERE YOU EVER INJURED AT A NON-COMPETITIVE TRAIL RIDE? ( )Yes ( ) No

2. REGARDING INJURIES, MATCH THE FIRST COLUMNTO THE SECOND.

INJURY TYPE AFFECTED REGION

(**A**) CUT(any dimension)

(**B**) ABRASION(scraping, skinning, abrasions, exfoliation)

(**C**) CONTUSION(hard blow, impact on a body part)

(**D**) DISTENSION(stretching or disruption of muscle fibers)

(**E**) LIGAMENT LESION(stretching orrupture)

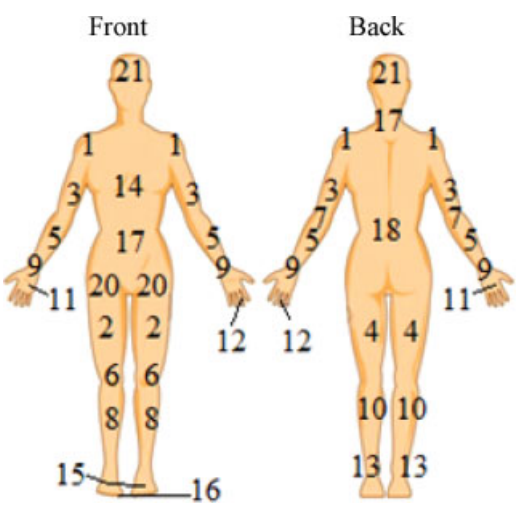
(**F**) TENDON RUPTURE(partial or total rupture)

(**G**) DISLOCATION (dislocation of the normal position of a joint)

(**H**) SPRAIN (sudden twisting of a joint surface)

(**I**) FRACTURE(complete or partial bone fracture)

Other_____



1. Shoulder( ) ( ) ( )
2. Anterior thigh ( ) ( ) ( )
3. Arm( ) ( ) ( )
4. Posterior thigh ( ) ( ) ( )
5. Forearm( ) ( ) ( )
6. Knee( ) ( ) ( )
7. Elbow( ) ( ) ( )
8. Leg( ) ( ) ( )
9. Wrist( ) ( ) ( )
10. Calf( ) ( ) ( )
11. Hand( ) ( ) ( )
12. Fingers( ) ( ) ( )
13. Ankle ( ) ( ) ( )
14. Thorax( ) ( ) ( )
15. Foot( ) ( ) ( )
16. Toes( ) ( ) ( )
17. Abdomen( ) ( ) ( )
18. Lumbar spine ( ) ( ) ( )
19. Cervical spine ( ) ( ) ( )
20. Hip ( ) ( ) ( )
21. Head ( ) ( ) ( )

Other_____

3. INJURY MECHANISM – HOW WERE YOU INJURED?

- Collison with an immovable object: ( )Tree ( ) Rock ( ) Fence
- Collison with a movable object: ( ) Car ( ) Animal ( ) Pedestrian ( ) Motorcycle
- Skidding or loss of traction: ( )In a curve segment ( ) In a straight segment
- Rollover( )
- After a jump( )

Other_____

3.1 WHAT WAS THE DIRECTION OF THE FALL?

- Forward fall, over handlebars( )
- Lateral fall: Right side( ) Left side ( )
- There was no fall( )

4. FACTORS THAT MAY HAVE CONTRIBUTED TO INJURY

( )Lack of protective equipment: Which_____

( )Motorcycle mechanical failure

( )High speed

( )Alcohol intake

( )Lack of concentration or attention

( )Lack of fitness

( )Recklessness

( )Low visibility (rain, dust, sunshine)

( )None of these factors

( ) Other:_____