Risky behaviors and injury severity score of the injured motorcyclist

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Abstract

The aim of the present study was to investigate the relationship between self-reported motorcycling behavior and the severity of physical injuries from 2018 to 2021. This is a retrospective descriptive study. Preliminary injury data were obtained from the trauma registration system. The Short Motorcycle Behavior Questionnaire (SMRBQ) asked about the injured person's behavior during a telephone call. Data were analyzed with SPSS version 21. The Poisson regression estimation revealed a statistically significant relationship between the overall behavior of the motorcyclist and having a motorcycle license and a collision history. The incidence of serious injuries is correlated with motorcyclist behavior, age, driving purpose, driving rate during the week, motorcycle riding experience, and motorcycle driving license. Hospital outcomes had a statistically significant relationship with motorcyclist behavior, age, motor driving experience, motorcycle driving license, and collision history. By fostering a culture, educating individuals, and motivating motorcyclists in the community to obtain a permit, as well as strengthening the driving education system, traffic rules, and driver safety while riding a motorcycle, we can reduce the number of people without a license, consequently decreasing the incidence of serious injuries and improving hospital outcomes.

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Introduction

Injuries resulting from Motor Vehicle Accidents (MVAs) are a growing global public health concern.[1,2] Each year, many individuals suffer serious injuries or die due to motorcycle accidents in urban areas.[3] Reports indicate that approximately 38% of motorcyclists are involved in MVAs, and more than half sustain injuries.[4] Furthermore, about 50% of fatal traffic accidents involve motorcyclists.[5] Traffic accidents make up 30% of all accidents in Iran. According to statistics from the World Health Organization, Iran ranks first globally in terms of MVAs. Among road users, pedestrians, motorcyclists, and cyclists are the most frequently injured. Notably, 70% of injuries caused by traffic accidents affect youth.[6]

In northern Iran, the prevalence of traffic injuries is 31 per 10,000 people, with most incidents involving motorcycle-car collisions.[7] Motorcyclists face a higher risk of crashes than drivers of other motor vehicles. Studies also show that age, gender, and driving behavior significantly influence the likelihood of a collision.[8]

In Iran, many motorcyclists live under moderate to poor economic conditions and often use motorcycles for transportation.[10] As a result, they may avoid wearing helmets or opt for low-quality ones.[11] Additionally, lawlessness, family conflicts, interpersonal disputes, and juggling multiple responsibilities characterize many Iranian motorcyclists. These factors contribute to hostile reactions to others' negative behavior.[9]

Evaluating motorcyclists' risky driving behaviors is critical for designing road safety interventions. To understand these behaviors, it is essential to recognize that motorcyclists form a distinct group of road users with various motives for riding, such as recreation, sports, delivery, passenger transport, and even illegal activi-

ties.[12] Although many countries have developed detailed behavioral studies and specific questionnaires for motorcyclists, Iran lacks such research despite a higher rate of fatalities and unique cultural factors. Understanding how motorcyclist behavior correlates with Injury Severity Score (ISS) is essential.

Materials and Methods

Study design

This retrospective descriptive study examined the relationship between the Injury Severity Score (ISS) and the behavior of motorcyclists injured in traffic accidents. The study was conducted at Poursina Medical Center in Rasht, the capital of Guilan Province, from 2018 to 2020 (Ethics Code: IR.GUMS.REC.1399.586).

Inclusion and exclusion criteria

Inclusion criteria included: i) involvement in a traffic accident; ii) availability of a valid phone number in the hospital system; iii) the injured person was the motorcycle rider; iv) residency in Guilan province; v) age over 15 years; vi) ability to communicate fluently in Persian.

Exclusion criteria included: i) individuals who could not be contacted due to unregistered phone numbers, disconnected or unavailable mobile phones, incorrect contact information, or failure to answer calls; ii) patients recorded as deceased in the data system were excluded: in some cases, individuals passed away after discharge, which was discovered during follow-up calls; a total of 31 such individuals were excluded. An additional 46 injured individuals were excluded after they declined to participate during the interview.

Sample size

In the present study, random sampling was used due to the specificity, availability of the statistical population, and their contact information. According to the sample size formula, considering a d = 0.1 and a = 0.88, the sample size was calculated as 298 people according to the following formula.

$$n \geq \left[\frac{Z_{1-\frac{\alpha}{2}}\ \sigma}{d}\right]^2$$

$$Z_{1-\frac{\alpha}{2}} = 1.96$$

$$d = 0.1$$

$$\sigma = 0.88$$

Table 1. Questionnaire.

Short Motorcycle Riding Behavior Questionnaire(SMRBQ) Items in English	Item description	Item
Main factor: Unfit erroneous riding, intrusive and exhibitive behaviors		
Have you ever ridden so close to the vehicle in front that you had trouble stopping in an emergency?	Tailgating the vehicles in front	1
Have you ever had to drive around corners, taking up the entire width of the road?	Wide ride going round the corners	2
Have you ever lost control of your motorcycle while turning a corner due to high speed?	Speeding (when reaching corners)	3
Have you ever entered a curve so fast that you got scared?	Scaring speeding (when reaching corners)	4
Have you ever had a wheelie while riding a motorcycle or have you ever intended to?	Wheelie attempts	5
Have you ever started going so fast that the front wheel of your motorcycle went off the road?	Off road due to very quick pull away	6
Have you intentionally caused your motorcycle's wheels to spin during takeoff?	Wheel spin (on purpose)	7
Have you unintentionally caused your motorcycle's wheels to spin during takeoff?	Wheel spin (unintentional)	8
Have you ever ridden a motorcycle in the dark with the lights off?	Riding at night just with dipped light	9
Have you ever driven a defective motorcycle?	Riding impaired motorbike	10
Have you ever used any medication or substances that affect you're riding ability before riding a motorcycle?	Riding while on drugs or medications affecting riding safety	11
Have you ever ridden a motorcycle the wrong way on the street?	Riding against the legal traffic direction	12
Have you ever ridden a motorcycle on the sidewalk?	Sidewalk riding	13
Have you ever used a cell phone (talking or texting) while riding a motorcycle?	Mobile conversation or messaging while riding	14
Second factor: Time and money opportunistic behaviors		
Have you ever driven a motorcycle faster than the speed limit on highways?	Speeding (motorways)	15
Have you ever driven a motorcycle faster than the speed limit in residential areas?	Speeding(residential roads)	16
Have you ever driven at speed in the space between two lanes?	Riding between fast lanes of traffic	17
Have you ever carried a large, bulky load on your motorcycle?	Carrying heavy weight	18
Have you ever carried more than one passenger on your motorcycle?	Ride with more than one pillion passenger	19
Have you ever noticed the door of a parked vehicle open too late and barely avoided a motorcycle accident?	Likely of hitting opened car doors	20
Have you ever crossed an intersection when the traffic light was red?	Passing the red lights	21
Third factor: Helmet use behaviors		
Have you ever ridden a motorcycle without a helmet?	Not using helmets while riding	22
Have you ever had someone ride on your motorcycle without a helmet?	Not using helmets by pillion passengers	23

In the period 2019-2021, 9000 motorcyclists were registered in the trauma system. Using Rendering Software, 400 people were selected (Considering the possibility of falling), of which 77 people were excluded for the above-mentioned reasons, and finally 323 samples were included in the study.

Data gathering

The data were collected retrospectively and included system data and telephone interviews. The telephone interview with this research instrument took a maximum of 8 minutes; the interviewer was a medical student, and the student had previously been trained to conduct a telephone interview. The initial interviews were conducted in the presence of a tutor, answering questions about the motorbike's behavior only by the driver, not a family member or passenger sitting with the motorcyclist on the same motorbike. The ISS was also calculated based on its formula.

Data gathering tools

Demographic characteristics examined in this study were: age, sex, marital status, and education.

The social characteristics that were examined in this study were: type of motorcycle, driving experience, having a license, driving time during the day, driving time per week, previous accident history, and driving purpose.

The clinical features studied in this study were hospital outcome and ISS

The Short Motorcycle Riding Behavior Scale (SMRBQ) was used in this study. The main MRB consisted of 43 items, and for each item, respondents were asked to rate the frequency of their riding behavior over the past year by choosing an option from a 6-point scale: 1 = never, 2 = hardly, three = sometimes, 4 = very often 5 = regularly and 6 = Almost full time. This scale provides reliability with Cronbach's alpha coefficients for five factors from 0.70 to 0.84.[13]

In the present study, however, the abbreviated form of this tool will be used, which has 23 items. Hosseinpourfizi *et al.* (2018) found a high correlation between this form and the main form of the motorcycling behavior questionnaire (Kendall Tao = 0.82). ICC was the full version, with the short version (0.92). The internal consistency of this questionnaire with Cronbach's alpha was calculated to be 0.85. Therefore, the Persian version of the summary of motorcycling behavior was found to be a valid, reliable, and practical tool for evaluating motorcycling behavior in the study population.[12] This tool has three subscales. The first subscale includes unfit erroneous riding and intrusive and exhibitive behaviors; the second factor is inappropriate behaviors, errors, and demonstrations, with 14 questions. The second subscale includes Time and money opportunistic behaviors, with six questions. The third subscale includes Helmet use behaviors with two questions (Table 1).

Data analysis

Frequency, percentage, mean, and standard deviation statistics were used to examine demographic, social, clinical, and motorcyclist behavior variables. The present study used a score of 0 to 100 for the 23-item SMRBQ. The Poisson regression model analyzed whether demographic, social, and clinical variables (such as hospital outcome and ISS) significantly affected the motorcyclist's

Table 2. Demographic characteristics of the participants (n=323).

Variables	Categories	N (%)
Marital status	Single	166(51.39)
	Married	157(48.61)
Education	Illiterate/Under diploma	172(53.25)
	Diploma	112(34.67)
	University	39(12.07)
The purpose of motorcycling	Recreational	83(25.70)
	Work	240(74.30)
Motorcycle license	Yes	154(47.68)
	No	169(52.32)
Car license	Yes	156(48.30)
	No	167(51.70)
Helmet use	Yes	45(13.93)
	No	278(86.07)
Collision history	Last five year	198(61.30)
	Last ten year	36(11.15)
	Lifetime	89(27.55)
Hospital outcome	Recovery	316(97.83)
	Disability	7(2.17)

Table 3. Relationship between motorcyclist self-report behaviors and demographic variable.

Variable		F	Sig	t	df	p	Mean	Std. E	95% CI	
									Upper	Lower
Marital	Sub scale1	4.55	.03	-1.66	321	.09	-2.96	1.77	.53	-6.46
	Subscale 2	.98	.32	-.48	321	.62	-1.13	2.33	3.45	-5.72
	Subscale 3	.08	.76	-.87	321	.38	-2.77	3.18	3.47	-9.03
	Total	.21	1.52	-1.14	321	.25	-2.29	1.99	1.64	-6.22
Helmet use	Sub scale1	10.22	.002	1.75	321	.081	4.48	2.56	9.53	-.55
	Subscale 2	7.26	.007	1.47	321	.142	4.93	3.35	11.54	-1.66
	Subscale 3	6.76	.010	1.87	321	62	8.57	17.56	16.33	-.41
	Total	6.78	.010	2.08	321	.009	6.00	2.87	11.65	.34
Motor license	Sub scale1	15.58	.000	4.78	321	.000	8.26	1.72	11.66	4.86
	Subscale 2	2.81	.094	5.14	321	.000	11.54	2.24	15.96	7.13
	Subscale 3	1.78	.182	1.70	321	.089	5.41	3.17	11.65	-.82
	Total	15.89	.000	4.31	321	.000	8.40	1.94	12.24	4.57
Car license	Sub scale1	3.82	.052	2.71	321	.007	4.79	1.76	8.27	1.32
	Subscale 2	1.14	.286	4.02	321	.000	9.16	2.27	13.64	4.68
	Subscale 3	.61	.432	2.64	321	.009	8.33	3.15	14.53	2.14
	Total	3.94	48	3.79	321	.000	7.43	1.96	11.29	3.57

behavior. After completing each questionnaire, the data were entered into SPSS software version 21 and statistically analyzed.

Results

Three hundred twenty-three eligible injured motorcyclists participated in the study, all male and had normal (non-electric) motorcycles. The mean driving rate of the samples was 2.49 hours per day and 5.48 days per week. The mean history of motorcycling was 10.48 years. The mean and standard deviation of the age of the injured were 30.84 ±11.80 years.

The majority of motorcyclists, 166 (51.39%), were single, 112 (34.67%) had a diploma, and 240 (74.30%) had a work goal of motorcycling. 154 (47.68%) had motorcycle licenses. Only 45 (13.93%) wore helmets. Seven people (2.17%) have been discharged from the hospital with disabilities. Most of them, *i.e.*, 198 people (61.30%), have a history of MVA in the last five years (Table 2).

Statistical t-test showed a statistically significant relationship between helmet and overall motorcycle behavior, $p = 0.03$. There was also a statistically significant relationship between having a motorcycle license and the overall behavior of a motorcyclist, $p \leq 0.001$. This relationship was significant in two subscales of unfit erroneous riding, intrusive and exhibitive behaviors $p \leq 0.001$ and Time and money opportunistic behaviors subscale $p \leq 0.001$. In addition, there was a statistically significant relationship between having a vehicle license and overall motorcycle behavior of $p \leq 0.001$ and all three subscales of Unfit erroneous riding, intrusive and exhibitive behaviors = $p = 0.007$, opportunistic monetary and temporal behavior of $p \leq 0.001$ and helmet use behaviors $p = 0.009$ (Table 3).

We are using ANOVA (analysis of variance) to assess the statistically significant relationships between the overall scale of motorcycle behavior ($p = 0.02$) and two subscales: Unfit erroneous riding, intrusive and exhibitive behaviors ($p = 0.02$), and Time and money opportunistic behaviors ($p = 0.03$) in relation to a history of motorcyclist accidents (Table 4).

Table 4 illustrates the relationship between the overall behavior of the motorcyclist and other variables. The Poisson regression estimation indicated that the overall behavior of the motorcyclist had a statistically significant relationship with possessing a motorcycle license ($p \leq 0.001$) and a history of accidents throughout the entire driving period ($p = 0.01$) (Table 5).

The Poisson regression estimation indicated that ISS is correlated with motorcyclist behavior variables, with a p of ≤ 0.001, age ($p = 0.003$), driving purpose ($p = 0.003$), driving rate during the week ($p = 0.003$), motorcycle riding experience ($p = 0.006$), and it had a statistically significant relationship with motorcycle driving license ($p \leq 0.001$) (Table 6).

The Poisson regression estimation showed that a statistically significant relationship existed between hospital outcomes and the variables of motorcycle behavior ($p \leq 0.001$), age ($p = 0.001$), motorcycle experience ($p \leq 0.001$), motorcycle driving license ($p \leq 0.001$), and accident history ($p = 0.02$) (Table 7).

Discussion

This study found that 52.32% of participants had no motorcycle license. A similar Iranian survey reported that only 29.4% of motorcyclists had licenses.[14] Since this study focused on injured

Table 4. The relationship between motorcyclist self-report behaviors and wearing a helmet.

Variable		N	Mean	Std.	Std. E	df	F	P	95% CI	
									Lower	Upper
Education	Sub scale1	323	71.82	16.01	.89	2	.28	.74	70.06	73.57
	Sub scale2	323	69.14	20.92	1.16	2	.34	.71	66.85	71.44
	Sub scale3	323	46.84	28.55	1.58	2	1.61	.20	43.71	49.96
	Total	323	62.60	17.97	.99	2	.702	.49	60.63	64.57
Collision history	Sub scale1	323	71.82	16.01	.89	2	3.59	.02	70.06	73.57
	Sub scale2	323	69.14	21.75	1.16	2	3.41	.03	66.85	71.44
	Sub scale3	323	46.84	28.556	28.55	2	1.73	.17	43.71	49.96
	Total	323	62.60	17.97	17.97	2	3.68	.02	60.63	64.57

Table 5. Regression model of the correlation of total behavior scales with the motorcyclist's demographic variables.

Variable	Categories	Coef	Std. E	t	p	95% C I	
						Upper	Lower
Marital	Single	0.74	3.12	0.24-	0.81	5.40	6.90-
Education	Primary	1.19-	2.26	0.53-	0.59	3.25	5.64-
	Secondary	1.49	3.25	0.46	0.64	7.89	4.89-
Age		0.22	0.25	0.90	0.36	0.72	0.27-
Aim of driving	Work	5.77	3.28	1.76-	0.07	0.67	12.23-
Driving in week		0.76-	0.12	0.61-	0.54	0.16	0.32-
Motor driving experience		0.07	0.31	0.23	0.81	0.68	0.53-
License	Motorcycles	10.23	2.27	4.50	0.000	14.71	5.76
Collision history	Last 10 year	4.38-	3.47	1.17-	0.24	2.98	11.74-
	Lifetime	9.63-	3.84	2.50-	0.01	2.06-	17.19-

individuals, unlicensed riders are expected to be more prone to accidents and injuries. The need for compensation or insurance may also influence self-reports regarding licensure status. Only 14% of motorcyclists in this study reported helmet use. This rate is lower than those reported in Tehran (33%), southern Azerbaijan (18%), and Kerman (21.5%).[15] The lower rate in Guilan may be attributed to the study's focus on injured riders, where helmet use likely prevented hospitalization in other cases. Despite legal mandates requiring helmet use for riders and passengers, the lack of public awareness and weak enforcement contribute to low compliance.[5]

Helmet usage is closely linked to motorcyclists' overall behavior. Key factors influencing helmet-wearing behavior include perceived behavioral control, individual norms, behavioral goals, and perceived risk.[16] In some cases, external factors, such as police presence at intersections, significantly increase helmet usage.[17] While external enforcement can support compliance, this study found that individual behaviors were responsible for helmet non-use.

The study also showed a significant association between license status and overall riding behavior. Unlicensed riders displayed riskier behaviors, aligning with previous research that associates the lack of a valid license with higher accident risks.[19,20] Holding a license is a strong predictor of rule compliance, including helmet use.[21,22]

Further, a significant correlation was found between the ISS and various aspects of motorcycling behavior, such as erratic or aggressive riding and opportunistic behaviors related to time and money. These findings are consistent with other Iranian studies that link high-risk behaviors with traffic violations and previous accidents.[23]

Other research has highlighted behavioral and social traits among Iranian motorcyclists, including lawlessness, family stress, and multiple obligations, contributing to impulsive or retaliatory driving patterns.[9] Since many high-risk drivers have a history of previous accidents, post-accident behavioral interventions and targeted training could help prevent recurrence.

This study also revealed a statistically significant relationship between ISS and helmet use. Similar research in Iran found that wearing a standard helmet significantly reduced facial fractures.[14] A study in Kenya showed that riders and passengers who wore helmets sustained less severe head injuries than those without helmets.[24] Other studies suggest that helmets reduce head and facial injuries and may lower hospital costs by up to threefold.[23]

Additionally, ISS correlated significantly with age. Older motorcyclists, especially those over 55, experienced worse survival outcomes and more severe injuries, consistent with findings in both Iranian and international studies.[25-27] Severe injuries among elderly riders pose significant burdens not only on families but also on the healthcare system.

Table 6. Regression model of the relationship between ISS and total subscale of behavior and demographic variables of motorcyclist.

Variable	Categories	Coef	Std. E	t	p	95% C I	
						Upper	Lower
Behavior		0.26-	0.001	19.02-	0.000	0.024-	0.029-
Marital	Single	0.05	0.08	0.65	0.51	0.21	0.10-
Education	Primary	0.09-	0.05	1.60-	0.10	0.02	0.20-
	Secondary	0.02-	0.08	0.28-	0.78	0.14	0.18-
Age		0.01-	0.00	3.01-	0.003	0.00	0.02-
Aim Of Driving	Work	0.20	0.08	2.46	0.01	0.36	0.04
Driving In Week		0.008	0.002	2.95	0.003	0.01	0.002
Motor Driving Experience		0.01	0.006	2.73	0.006	0.034	0.005
License	Motorcycles	0.37	0.06	6.11-	0.000	0.25	0.49-
Collision History	Last 10 year	0.12	0.08	1.42-	0.15	0.29	0.04
	Lifetime	0.05	0.08	0.56	0.57	0.22	0.12-

Table 7. Regression model of the relationship between hospital outcome and subscales of behavior and demographic variables of motorcyclist.

Variable	Categories	IRR	Std. E	t	P	95% C I	
						Upper	Lower
Behavior		0.97	0.001	-14.20	0.000	0.98	0.97
Marital	Single	1.09	0.10	0.98	0.32	1.32	0.91
Education	Primary	0.99	0.06	-0.14	0.89	1.12	0.87
	Secondary	0.94	0.09	-0.53	0.59	1.15	0.78
Age		1.02	0.006	3.38	0.001	1.03	1.009
Aim of driving	Work	0.99	0.09	-0.04	0.96	1.19	0.82
Driving in week		1.004	0.003	1.31	0.19	1.01	0.99
Motor driving experience		0.96	0.008	-4.31	0.000	0.97	0.94
License	Motorcycles	0.78	0.05	-3.40	0.001	0.90	0.68
Collision history	Last 10 Year	0.76	0.08	-2.31	0.02	0.96	0.61
	Lifetime	1.04	0.11	0.37	0.71	1.29	0.83

The severity of ISS was also linked to driving frequency and job-related use. As shown in Roudsari's 2004 study, fatigue from long hours of riding increases injury risk.[28] In Iran, where many motorcyclists come from moderate or low-income backgrounds, financial pressure may lead to unsafe practices, including avoiding helmet use or opting for cheap, ineffective helmets.[10,11]

Driving experience also showed a strong correlation with ISS. Studies in China and Iran confirmed that less experienced riders are more likely to suffer severe injuries in accidents.[29,30] Moller (2020) found that holding additional certifications can reduce accident risk by 2% per month.[31]

The study also found a statistically significant relationship between ISS and having a motorcycle license. Existing evidence supports the effectiveness of helmet laws and licensing requirements in reducing injuries.[32,33] Implementing automated systems such as camera-based helmet detection, license plate recognition, and vehicle tracking can enhance enforcement, particularly in urban areas.[34]

However, technologies like helmet-worn sensors remain economically unfeasible for widespread deployment. Law enforcement and automated detection systems can work together to reduce reliance on traffic police and increase rule compliance.[34-36] In Vietnam, for example, the government distributed 50,000 helmets to low-income families to address the low rate of helmet use.[37] This underscores the importance of combining legal enforcement with ethical responsibility and economic support for motorcyclists.

This study also revealed a strong relationship between hospital outcomes and risky behaviors, especially speeding and opportunistic driving. An Iranian research study similarly identified high-speed motorcycle use as a key risk factor in fatal crashes.[38] Research confirms that motorcyclist behavior strongly influences injury severity in accidents.[39]

Hospital outcomes were also significantly related to the rider's age. Other studies show that older patients required longer hospital stays and more intensive post-discharge care.[27,40-42] Given that physical injury severity increases with age, more extended hospitalization is a logical outcome.

Furthermore, having a valid license was significantly associated with hospital outcomes. A study in Taiwan linked unlicensed riding to increased mortality and severe injuries in critical areas of the body.[43] Similarly, Doan and Hobday reported that the lack of a driver's license correlated with higher injury risks.[44]

Finally, the study found a strong relationship between hospital outcomes and prior accident history. Mekonnen *et al.* and Möller *et al.* both found that previous accidents significantly increased the likelihood of repeat incidents, reinforcing the need for preventive interventions for high-risk riders.[31,45]

Limitations

This was a monocentric retrospective study that captured motorcycling behavior in a specific geographical area through a self-report questionnaire. Therefore, many negative and bad behaviors may not have been reported. However, the reported rate was also questionable and controversial. Observational studies can better examine motorcyclists' behavior in the moment than retrospective studies and portray the facts. Therefore, it is recommended that future studies be observational and multicenter to overcome some of the limitations of the present study.

Excluding deceased patients was a major limitation because those deceased motorcyclists may have engaged in unsafe riding behavior, were not wearing a helmet, exceeded the speed limit, or did not have a license at all.

Conclusions

This study demonstrates a clear association between high-risk motorcyclist behavior, Injury Severity Score (ISS), and hospital outcomes. Given the large number of motorcyclists and the high rate of motorcycle-related accidents in the community, addressing risky behavior is critical to reducing human and financial losses for both individuals and the healthcare system.

The low rate of helmet use and its strong association with ISS highlight the urgent need for stricter enforcement of protective gear regulations. Public education campaigns, cultural initiatives promoting licensure, and improved training systems focused on traffic laws and safety could help reduce the number of unlicensed riders and decrease injury severity.

Moreover, encouraging employers to require safety equipment for motorcycle-related activities could reduce physical injuries. The findings support multifaceted interventions, including legal enforcement, behavioral training, economic support, and technological innovations to enhance motorcyclist safety and lessen hospital burdens.

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