Original Article

Animal-Vehicle Collisions in North of Iran: What's to Be Done?

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Abstract

Introduction: Animal-vehicle accidents are a growing concern in many parts of the world not only because of its environmental consequences but also because of its economic and social costs. The purpose of this study was to investigate the epidemiology of accidents involving animals in Northern Iran. **Materials and Methods:** In this retrospective cross-sectional study, the data of all animal-vehicle accidents which had occurred during 2014–2018 were obtained from the traffic police database. **Results:** According to the regression model, fatalities and injuries associated with animal-vehicle collisions on main roads were significantly lower than those on the secondary and rural roads ($P < 0.001$). The reports showed a significantly lower number of accidents on wet, slippery than the dry roads ($P < 0.001$). **Conclusion:** This study reports on the high number of accidents involving animals in Guilan which lead to injuries and fatalities of both humans and animals. Importantly, the pattern of such accidents was found to be different from that of motor vehicle collisions, suggesting a model for changing human behavior and reducing accidents that involve animals.

Keywords: Accident, animal, collision, epidemiology, Guilan, Iran, vehicle

Introduction

According to the Fatality Analysis Reporting System, an average of 165 people were killed each year in highway accidents involving animals from 1995 to 2004 which reached 210 by 2008. Besides, 26,647 road users underwent different medical treatments for nonfatal injuries due to these accidents.[1]

Roadside accidents involving large vertebrates are a huge burden not only because of their environmental consequences but also because of economic and social costs.[2] The Insurance Institute for Highway Safety has estimated that the costs of vehicle-deer crashes alone in the United States were around 1.1 billion dollars.[1] In a study by Bissonette *et al*., the total cost of 13,202 vehicle-deer crashes in Utah from 1996 to 2001 was approximately 45,175,454 dollars. Other costs included human death $24 million (53%), vehicle damages $18 million (39%), moose loss $2.7 million (6%), and psychological

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burden (grief) $1 million (2%).[2] Meanwhile, the number of reported animal-vehicle collisions is low and usually remains unreported.[3] This evidence suggests the need for further study on the increasing number of such costly accidents.[1]

A study in Australia (2008) revealed that in counties and remote areas, the number of fatalities following a direct collision with animals or indirect collisions due to swerving to avoid colliding with animals was considerably high. Moreover, motorcyclists played an important role in causing fatal accidents with animals more than other types of motor vehicles.[3]

In a study by Haikonen and Summala *et al*., the highest rates of vehicle collisions involving deer and moose were recorded at 1 h after the sunset. The relative risks of collisions with white-tailed deer and moose were respectively 30 and 60 times more in autumn and summer. Thus, this investigation mainly emphasized the animal behavior model, recognizing it dependent on the animals' internal cycle which inhibits them from wandering around during daytime noise.[4]

Examining the fatalities due to road accidents in Iran which had occurred from 2010 to 2011 showed that daylight had an inevitable impact on vehicle-animal collisions since 35% of people died in accidents in the daytime, 56% at night, and 9% at dawn or sunset.[5] Thus, the rate of accidents involving animals is very high, especially during the darkness[1,3,6] similar to other types of accidents.[7]

In different countries, vehicle accidents may involve different animals from squirrel (the most frequently road-killed animal),[8] deer and moose,[9] reptiles and mammals in the US,[10,11] to Kangaroo in Australia[3] and camel, dog, cow, and horse in Iran which were reported as the most involved animals in road accidents during 2010–2011.[5] It is important to mention that sometimes, collisions occur due to swerving to avoid hitting animals which may lead to a collision with objects and vehicle overturn; sometimes, these accidents are not recorded as crashes involving animals in official reports.[12]

In Iran, the Environmental Protection Agency of Yazd province is one of the few institutions that have documented the data on the road-related animal deaths which only includes certain animals. According to some experts, at least five animals are killed every day on the roads of Yazd, and in the first half of 2016, 100 animals were killed on Yazd's roads.[13] This, in turn, necessitates urgent attention to the fundamentals of road safety planning.

In Denmark, the number of killed deer significantly correlated with the season and geographic area. The number of young and adult deer that were killed on roads was more than predictions.[14]

Another study (2015) has provided clear evidence on the distribution of these accidents, attributing them to the behavior of the animals rather than human behavior or error. In the spring and early summer or mating seasons (July and August), these animals are very active, which makes them more prone to road accidents, though this pattern varies during day and night. It is also believed that the increase in the population of deer present in certain areas explains the increased number of animal-related accidents, but there is a different story on weekends as human plays a more important role in causing these types of accidents on holidays.[15] However, in a qualitative study on accidents with camels, human behavior was considered as the main cause. The study concluded that prevention would always be challenging without the animal owner's accountability.[16]

Considering the major cause of the accident, William and Wells reported that animal accidents mostly occurred at speeds above 55 mph. It is important to note that most of the deaths resulted not from direct collisions with animals, but with other objects and vehicles when encountering animals on the roads.[17]

Collision with animals on roads has negative consequences including animal/pet injury and death, risks of injury and death to car occupants, extinction of endangered species, damage to vehicles and roads and related costs, and unfavorable scenes with a negative impact on public transit and tourist attractions. Therefore, the importance of death animals due to road accidents, especially in Iran with such a geographical extent and diversity which hosts different animal species, should be considered necessary by policy-makers in the Ministry of Health.[18]

In order to reduce the significant number of animal-vehicle crashes on the roads of Guilan (North of Iran), performing related investigations is the preliminary, vital step to pinpoint the detailed patterns of this particular type of accident.[15] Cost–benefit analysis has also shown that efforts that are prioritized according to real road data can finally lead to positive, financial benefits as well as improved driver safety.[2]

Reviewing the related literature demonstrated that no Iranian study has examined the collisions with animals in detail. Moreover, considering the different climatic, geographical, and cultural conditions in our country, studies performed abroad may not meet our needs to undertake comprehensive interventions and preventive measures compatible with varying conditions in Iran. Insufficient knowledge on this particular issue can bring about more human and animal injuries and fatalities and remarkable economic losses. Therefore, this study aimed at investigating the epidemiology of animal collisions in Guilan province located in the North of Iran.

Materials and Methods

This retrospective descriptive cross-sectional study was approved by the Ethics Committee of Guilan University of Medical Sciences, Rasht, Iran. After obtaining written permission from the university, the data were collected from the Iranian Traffic Police database. In this study, all of the accidents occurred from 2014 to 2018, involving all types of animals (e.g., sheep, camel, horse, and buffalo). The data of the accident were previously recorded and archived by the traffic police. It is important to mention that animal accident means any collision when one side of the accident is a domestic or a nondomestic animal and the other side is a motor vehicle such as a car, motorcycle, tiller, minibus, and autobus.

Inclusion criteria

All of the accidents involving animals that had occurred in Guilan during 2014–2018 were included. However, the accidents which were not reported to the police or had missing data were excluded.

Data analysis method

The data were first entered into Excel software. After sorting, to calculate the frequency and ratio of the factors, mean and standard deviation were used. The severity of the crashes varies so the number of related fatalities and injuries is not the same in different accidents. In this study, the number of fatalities and injuries due to animal-vehicle collisions was counted for each crash used as the indicator of the crash severity. The Poisson regression model was used to determine the relationship between road type, road condition, and lighting condition, cause of the accident and road geometrics, and number of vehicle occupants with the dependent variables of the number of injuries and fatalities in each crash. Finally, the findings were analyzed using Excel and (STATA software) STATA SE v13.1, STATA CORP, United States. The collected data and variables included the time of collision, the weather condition (rainy, snowy, foggy, and sunny), the geometric design of the road (road twist, intersection, residential area, turnaround, etc.), animal species, cause of the accident (inattention to road ahead, unauthorized speeding and overtaking, etc.), the condition of the vehicle and occupants (death, injury, and damage to the vehicle), and type of the road (rural, urban, highway, etc.). These variables were assigned as independent variables, and injuries and fatalities due to road traffic accidents were determined as the dependent variables.

Results

Findings showed that the highest (n = 100) and lowest (n = 7) number of the accidents with animals had occurred around 9 PM and 7 AM, respectively [Figure 1].

Most of the animal-related collisions were recorded in several cities; Rezvanshahr (77.49 of total 1000 accidents in Iran), Talesh (77.03 of total 1000 accidents), and Masal (51.24 of total 1000 accidents) [Table 1]. The highest and lowest number of crashes belonged to rural roads (n = 594) and highways (n = 5), respectively. Most of the vehicles involved in the crashes were trucks (37.27 of 1000 accidents) and cars (13.81 of 1000 accidents), respectively. Considering the geometric design of the roads, most of the accidents occurred on the straight roads (n = 877) and a less number at intersections (n = 1). Most of the collisions were recorded in foggy weather (27.61 in total 1000 accidents), followed by snowy condition (2.82/1000 accidents). Unfortunately, the police data were incomplete and the animal species explicitly mentioned in their report. Only in some cases, it was stated accident with animals or cow.

Based on the Poisson regression model, there was a significant negative relationship between the risk of the accident with animals on secondary and rural roads compared with the main roads where more severe collisions occur ($P < 0.001$). Furthermore, the condition of roads had a significant positive association with fatalities and injuries due to animal-vehicle accidents ($P < 0.001$) which are usually reported less on wet and slippery roads than accidents in normal weather. Daylight had a direct and significant statistical relationship (at 90% confidence interval) with fatalities and injuries ($P = 0.076$); whenever it was night or the road's lighting condition was poor, the accident was more deadly [Table 2].

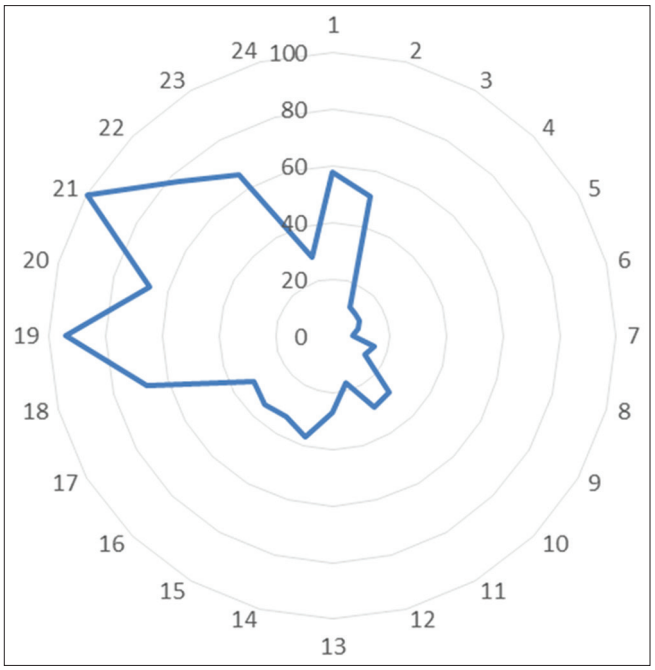

Figure 1: The frequency of animal accidents based on time of accident with animals during 2014–2018 in Guilan, Iran

The findings of the study on the Geographic Information System of accidents involving animals in Guilan are depicted. The cloudy area indicates the areas where the number of vehicle-animal accidents was higher than others. The red lines show the roads of the province and the black lines represent the boundaries of the cities/towns. The highest rate of animals-accident belonged to Rezvanshahr, southern Talesh, and North of Rasht [Figure 2].

Discussion

According to the results of this study, most of the animals' accidents occurred around 9 PM and the least at about 7 AM [Figure 1]. The results of some studies were consistent with the findings of the current study. All in all, it can be concluded that most of the animals-vehicle accidents occur at night time in Guilan since during the day, the animals are released for grazing, and as darkness falls when returning home, they may not be easily visible to the drivers because of their dark color. Moreover, it was discovered that most of the animal accidents belonged to Rezvanshahr and the least to Rudsar city. Since no previous research has been conducted in Guilan, it was not easy to specify the accident-prone cities

of the province, but previous evidence suggests that animals usually pass forest and farm roads where no other route is available.

Table 1: Characteristics of crash with animals during 2014–2018 in Guilan, Iran

Variable	Dimension	Animal accidents	Total accidents	Animal accidents per 1000 accidents
Cities	Rezvanshahr	127	1639	77.49
	Talesh	159	2064	77.03
	Masal	31	605	51.24
	Siahkal	20	533	37.52
	Fooman	56	2186	25.62
	Somesara	112	4574	24.49
	Astaneh	26	1306	19.91
	Shaft	29	1553	18.67
	Astara	8	485	16.49
	Anzali	43	2904	14.81
	Langrood	16	1239	12.91
	Rudbar	24	2533	9.47
	Rasht	257	35,693	7.2
	Lahijan	9	1377	6.54
	Amlash	2	383	5.22
	Rudsar	7	2067	3.39
Type of vehicle	Car	634	45,921	13.81
	Motorcycle	192	9568	20.07
	Heavy/bus	44	2170	20.28
	Truck	54	1449	37.27
	Others	0	1419	0
Geometric design of road	Bridge	6	No data	
	Twist	42	No data	
	Intersection	1	No data	
	Straight	877	No data	
Weather condition	Cloudy	164	7936	20.67
	Rainy	124	8033	15.44
	Snowy	1	355	2.82
	Sunny	622	44,024	14.13
	Foggy	9	326	27.61

The highest and lowest number of animal accidents dedicated to rural roads and highways, respectively. Most of the vehicles involved in accidents were cars, buses, and heavy vehicles, respectively. However, the incidence of animal accidents was higher in trucks. In a similar Iranian study, the largest number of animal accidents dedicated to cars, motorcycles, and trucks, and they were related to the number of vehicle types passed the roads of the country.[12]

In the present study, the type of animal involved in the crash was not specified in the police report. Most of the aboard studies focused on deer accidents.[17,19] In one study, Kangaroo was the most involved animal in this type of accident.[3] Most of these types of accidents in Guilan involved livestock or big wild animals which led to much damage to the vehicle, although drivers did not report collision with animals such as dogs and cats and other small animals.[16] Therefore, the pattern of these accidents in Iran is completely different from that of other countries and even different provinces of Iran in terms of the

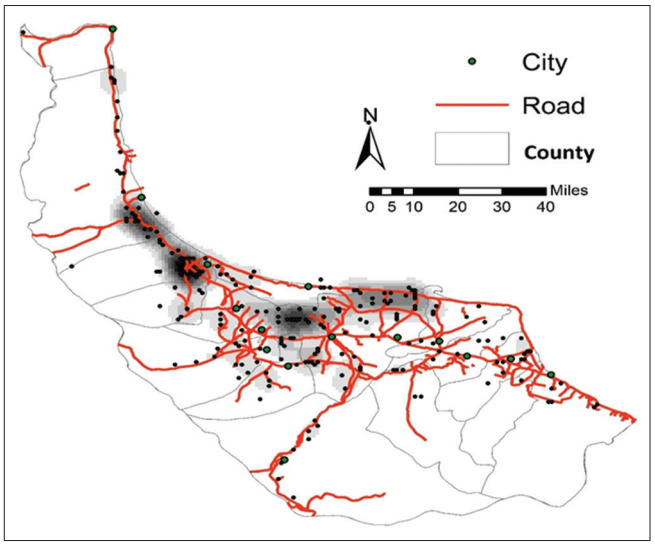

Figure 2: Findings of the study on the Geographic Information System of accidents involving animals in Guilan

Table 2: The Poisson regression model of causes of injuries and mortalities related to crash with animals during 2014–2018 in Guilan, Iran

Variable	Coefficient	SE	*P*	CI
Type of road, secondary and rural	−0.790	0.134	<0.001	−1.053–−0.528
Road condition, wet and slippery	−0.581	0.160	<0.001	−0.894–−0.268
Lighting condition, sunset, night	−0.201	0.113	0.076	−0.423–0.021
Main cause				
Sudden lane change	0.078	0.298	0.794	−0.507–0.662
Failure to control the vehicle	0.429	0.310	0.167	−0.179–1.037
Inattention to the road ahead	0.006	0.159	0.971	−0.306–0.318
Others	−0.346	0.138	0.012	−0.616–−0.077
Number of occupants	0.0157	0.1136	0.4449	0.0057–0.0256
Constant variable	0.936	0.262	<0.001	0.422–0.154

SE: Standard error, CI: Confidence interval

species of animals. In foreign studies, most wild animals are responsible for these accidents because domestic animals are rarely released and livestock are usually kept in livestock farms.

According to the regression model, human deaths and injuries due to animal-vehicle accidents were lower on the secondary roads than the main ones. However, it has been reported that due to the high traffic and speed limit on the main roads, the probability of such accidents is lower than that of rural areas.[19] Similarly, there are many reports on human-involved accidents in developing countries; two-thirds of all deaths due to road traffic accidents occur in rural roads, which emphasizes the need for safety on these roads.[20,21] Another study reported that nearly 98% of road accidents involving animals occurred on the roads where no signs of animal traffic were installed, and about 58% of crashes with animals were on highways, only 30% of which had animal warning signs. The parts with signs had fewer animal crashes.[21] In Iran, there is a lack of evidence of road accidents with animals, and perhaps, this is the first study considering this type of road accident in Iran. In a study by Monsef Kasmayi *et al*. in Guilan, only 4% of all accidents belonged to rural roads[22] with less mortality rate.[23] In the study by Davoudi *et al*. (2017), the number of fatalities in highways from 2009 to 2012 was 2344. Within the same period, 208 deaths were reported on the two-lane roads of the counties,[24] which derives from the difference between animal- and nonanimal-vehicle collisions, occurring on rural versus main roads and highways, respectively. This indicates the different patterns of these crashes and the necessity to devise a separate plan for reducing accidents involving animals.

According to the regression model in the current study, the severity of the accident was lower when roads were slippery after rainfall. Contrary to these results, in the study by Solanki *et al*., the highest number of accidents involving animals occurred in wet seasons.[21] The reason for the difference between these findings is that according to our study, less often, the domestic animals are released out of barns when it rains. Some studies report that most of these accidents occur during mating seasons, i.e., spring and summer.[25,26] Compared with a nonanimal accident, the number of rainy and foggy days was associated with animal-vehicle accidents.[27] This may be due to the different habits of domestic and wild animals. Most of the animals in accidents reported in other countries were wild, therefore, which could not help us in explaining our results. Most of the reports have studied wildlife such as kangaroos, moose, and deer, which have a different living pattern from domestic animals. However, wild animals wander around on both rainy and sunny days, and the weather condition is not a contributing factor to their accident. Thus, the pattern of the accident is different in these animals and depends on their owner's behavior.

Finally, according to the regression model, the road light variable also had a statistically significant direct correlation with fatalities of animals, which means that at night and poor road lighting conditions, the number of fatalities and injuries was higher. One study reported that such accidents usually occur at night when the wildlife is more active.[4] In this regard, a systematic review showed that instruments used to reflect light do not reduce the fatalities of accidents involving animals. There was no significant difference between the number of such accidents in the daytime or at night with or without installing light reflectors. Because of the different behavior of animals at night, the pattern of collision is consistent with the activity of these animals.[21] It seems that the lightning condition of roads in developed countries is good enough that there is not much difference between day and night. It is evident that the behavior of domestic animals in the current study differs from that of studies in other countries in terms of the pattern of travel at night and day.

In our study, there was no significant relationship between the geometry of the roads and the cause of collision with reported fatalities and injuries. In similar studies, the major cause of the accident was high speed. Meanwhile, most of the dead had not used a helmet and seat belt.[17] Similarly, in an investigation, the difference between accidents involving animals outside the distance of recognizing the animal's warning signs was not significant in terms of accident severity, accident time, weather condition, driver's age, vehicle speed, and animal species.[27]

The results of this study highlight the importance of the behavior of the animal owner. This finding requires further investigation because of contradictory results reported in different studies. Several researchers report that in most of such accidents, people are to blame, as animals do not respond quickly enough to escape the accident even when one drives at a safe speed. Therefore, this is a human behavior that needs to be changed and the animal cannot be expected to change its behavior and be subject to traffic laws.[28] On the contrary, some argue that animals can change their behavior to become less prone to vehicle collisions with adaptive behavior.[29]

According to the results of the present study, most of the strategies that affect the behavior of humans and owners of animals appear to be effective, such as changing the driver's behavior by turning on the car's signal lights and making sound alarms to warn animals, changing farmers' behavior by altering the agricultural practices on high-risk roadsides,[27] and installing warning signs particularly on suburban/rural roads in mountainous areas by the traffic police. Installing signs of endangered species such as the deer crossing sign is more likely to attract the driver's attention than others, namely cow crossing.

The limitation of this study was that mild accidents without financial loss are not usually reported to the police, so there were no resources available to obtain related data. Meanwhile, in the police databank, the animal species was not mentioned explicitly, which suggests the need to improve the recording procedures of data for these types of accidents.

Conclusion

In the present study, a high number of animal-vehicle collisions with fatalities of humans and animals were reported in Guilan. The pattern of animal- and nonanimal-vehicle collisions was different so that fatalities and injuries with the same cause were lower on the main, wet roads than the secondary ones.

The results suggest a change model in human behavior, which urgently recommends that changing human behavior can predominantly reduce road accidents with animals. Solutions such as using car's turn signal lights, making sound alarms to warn animals, and installing warning signs of animal crossing, especially on rural, mountainous roads are of high importance. Last but not least, changing human behavior should not be taken for granted in two aspects; first, farming practices which may predispose animals to an accident on high-risk roadsides; second, avoiding animal release near roadside lands without watching them.

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Conflicts of interest

There are no conflicts of interest.

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