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PhD SEMINAR SESSIONS

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Unveiling the Key Factors Behind Injury Severity in Single-Vehicle Motorcycle Crashes

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About Ph.D. project

- Investigating the factors that influence motorcyclist safety with a focus on rural roads
  - Human factors and infrastructure influence
    - Studying rider behavior
    - Past crash data
    - Perception of road infrastructure elements

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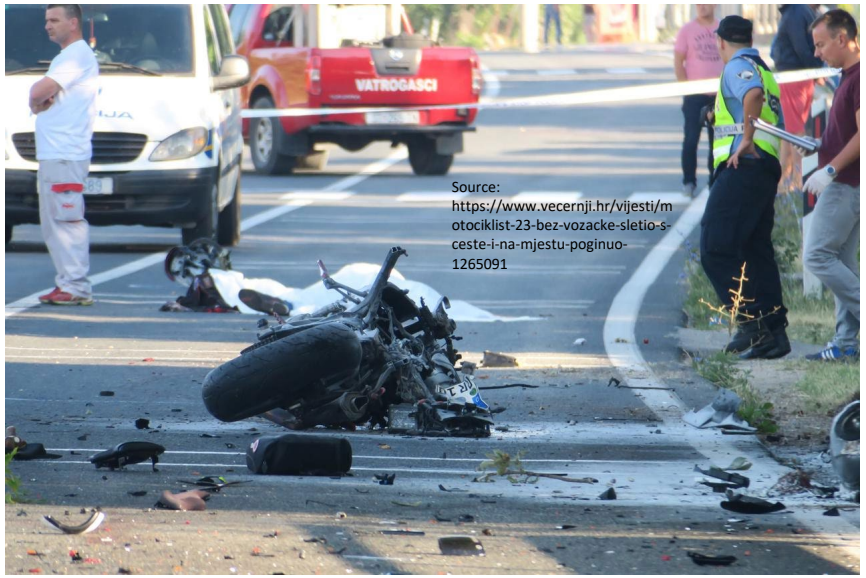
Introduction

- Vulnerable road users
- Need for targeted research on motorcycle safety


Source: https://www.vecernji.hr/vijesti/motorist-poginuo-kod-bjelovara-1748190


Source: https://www.vecernji.hr/zagreb/policija-trazi-svjedoke-jucerasnje-nesrece-na-slavonskoj-1779661



Source: https://www.vecernji.hr/vijesti/motociklist-23-bez-vozacke-sletio-s-ceste-i-na-mjestu-poginuo-1265091


Source: https://www.zagorje.com/clanak/vijesti/detalji-tragedije-u-zagorju-smrtno-stradao-motociklist-47

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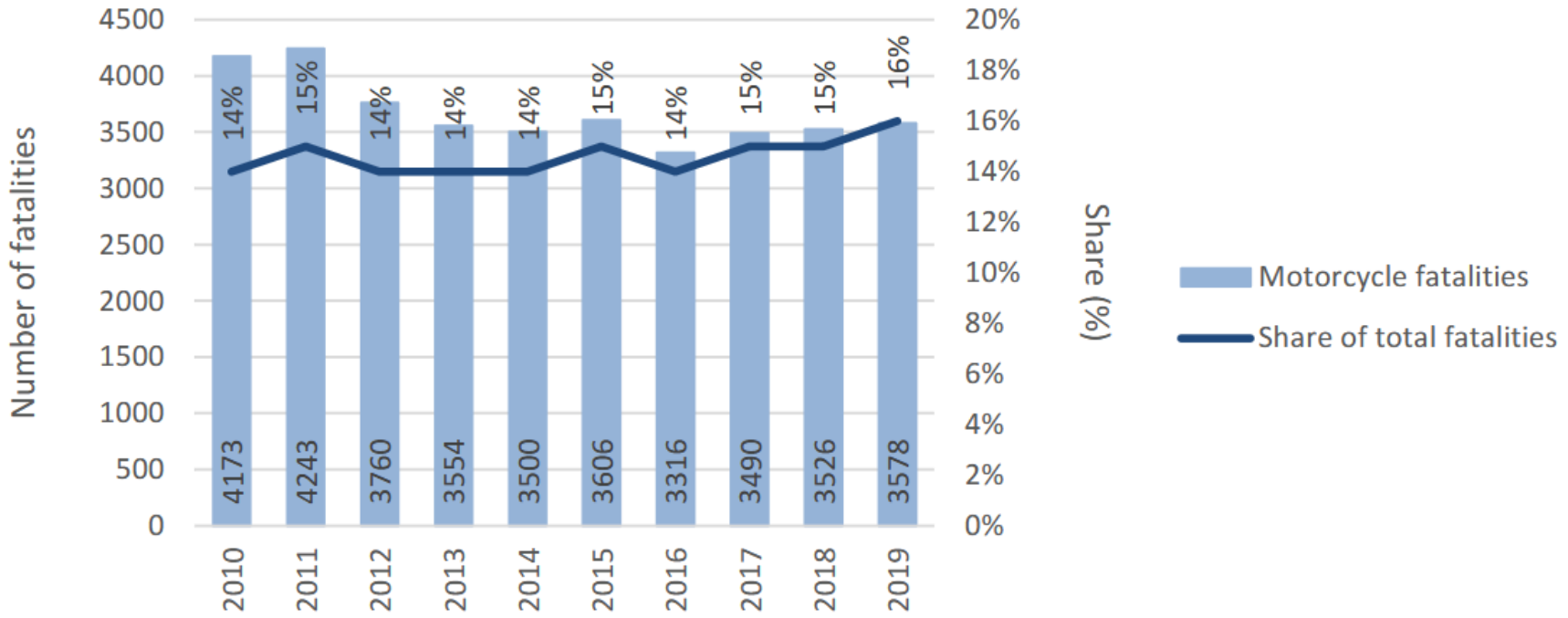
Introduction

Annual number of motorcycle fatalities, and their share in the total number of fatalities in the EU27 (2010-2019)



Data source: Road Safety Thematic Report – Motorcycles (January 2023), according to European Commission (2021)

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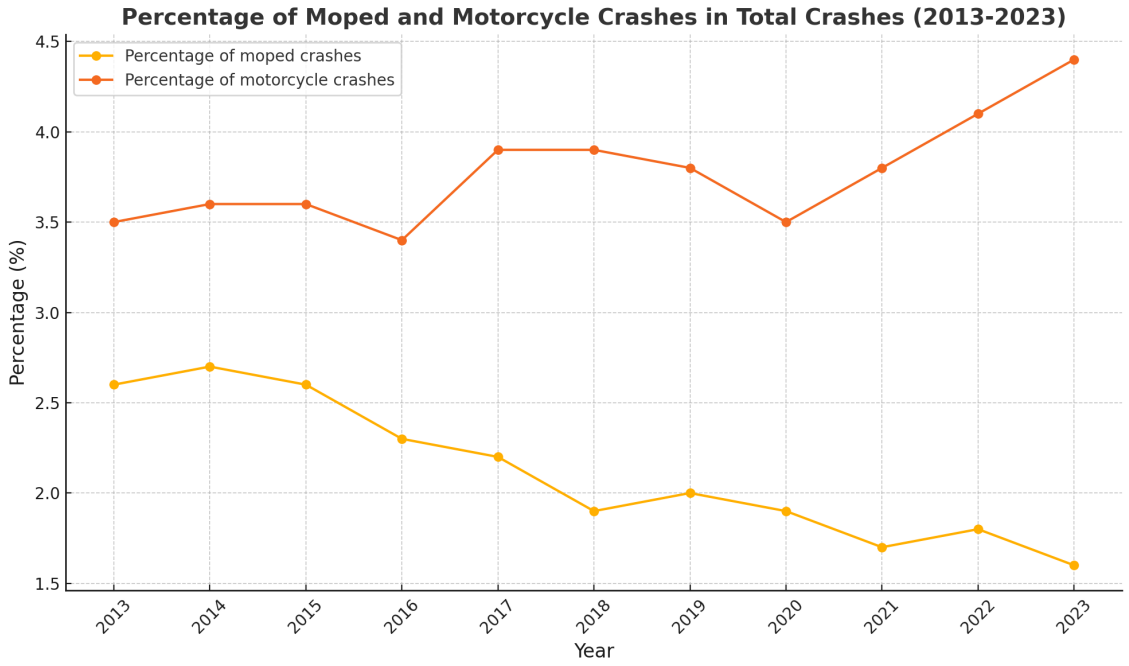
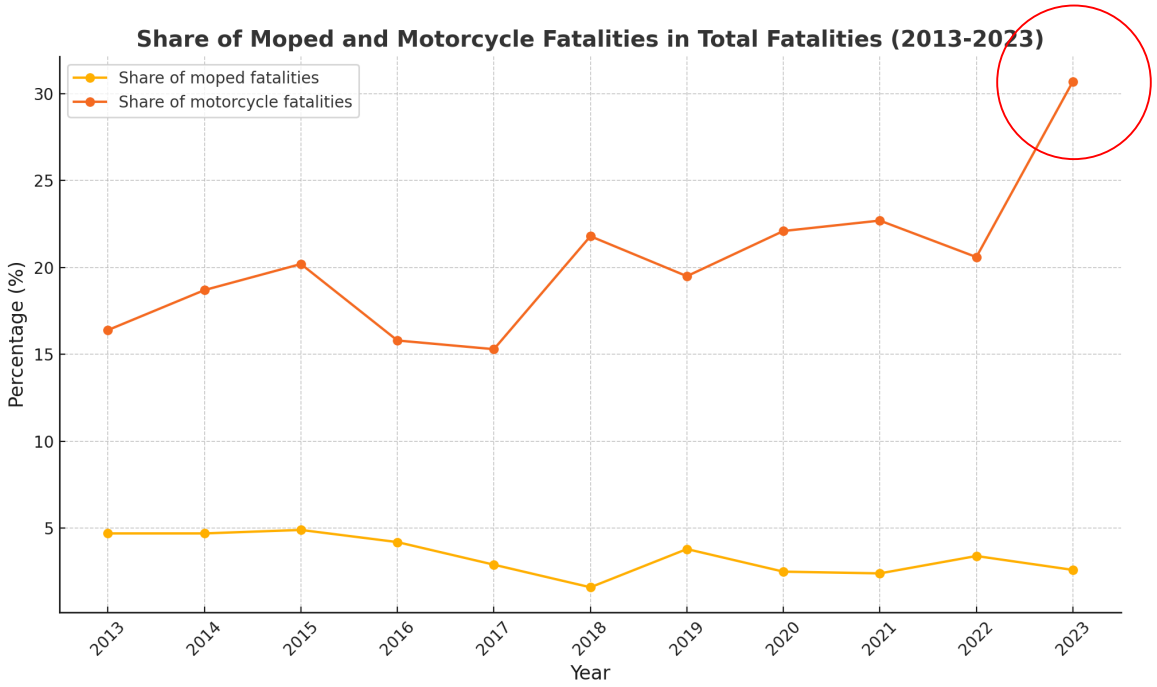
Introduction





Crash data from Croatia, 2013-2023

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Data source: Road safety bulletins 2013-2023, Ministry of the Interior, Republic of Croatia

Introduction

- Primary objectives
  - Identify key factors influencing injury severity in single-vehicle motorcycle crashes
  - Compare traditional (MLR) and machine learning (RF) methods
  - Use a real-world dataset (Croatia, 2017–2022)

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Data overview

- Official records of single-vehicle motorcycle crashes from 2017 to 2022 (except 2020)

Crash records

- 7676 crashes involving motorycles

Data cleaning

- Incomplete
- Year 2020
- Multi-vehicle

Final dataset

- 2170 single-vehicle motorcycle crashes

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Data overview

Variable	Description	Code	Sample (N)	Percentage (%)
Road type	Motorway	1	57	2.63%
	State road	2	859	39.59%
	County road	3	395	18.20%
	Local road	4	167	7.70%
	Uncategorized	5	504	23.23%
	Urban street	6	188	8.66%
Road characteristics	Curve	17	1102	50.78%
	Road stretch	18	668	30.78%
	Other	23	46	2.12%
	Intersection	41	275	12.67%
	Other intersection	42	20	0.92%
	Road object	43	18	0.83%
	Railway crossing	44	8	0.37%
	Pedestrian/bicycle-related	47	33	1.52%
Speed limit (km/h)	<= 30	1	155	7.14%
	40	2	303	13.96%
	50	3	1207	55.62%
	60	4	189	8.71%
	>= 70	5	316	14.56%

Table 1. Road related variables

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Data overview

Variable	Description	Code	Sample (N)	Percentage (%)
Citizen of Croatia	Yes	1	1744	80.37%
	No	2	425	19.59%
	Unknown	3	1	0.05%
Gender	Male	1	2082	95.94%
	Female	2	88	4.06%
Alcohol in blood	No	0	1671	77.00%
	Yes	1	499	23.00%

Table 2. Participant related variables

Variable	Description	Code	Sample (N)	Percentage (%)
Weather conditions	Clear	1	1265	58.29%
	Cloudy	2	312	14.38%
	Rain	3	84	3.87%
	Other conditions	4	509	23.46%
Part of the year	April - September	1	1694	78.06%
	October - March	2	476	21.94%
Part of the day	Day	1	1531	70.55%
	Night	2	573	26.41%
	Dusk	3	51	2.35%
	Dawn	4	15	0.69%

Table 3. Temporal related variables

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Data overview

Variable	Description	Code	Sample (N)	Percentage (%)
Crash type	Run-off-road	1	1293	59.59%
	Hitting an object on the road / a roadside object	2	279	12.86%
	Other crash types	3	598	27.56%
Crash circumstances	Inappropriate speed	1	1503	69.26%
	Late hazard detection / Sudden braking	2	119	5.48%
	Other circumstances	3	548	25.25%
Crash severity*	No injuries	0	330	15.21%
	Mild injuries	1	832	38.34%
	Death or severe injuries	2	1008	46.45%

** dependent variable*

Table 4. Crash related variables

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Methods

- Multinomial Logistic Regression (MLR)
  - Categorical dependent variables with more than two outcomes
  - Interpretability
- Random Forest (RF)
  - Enhances the decision tree approach by employing an ensemble method that generates multiple decision trees
  - Ability to handle non-linear relationships, and to detect complex interactions among variables

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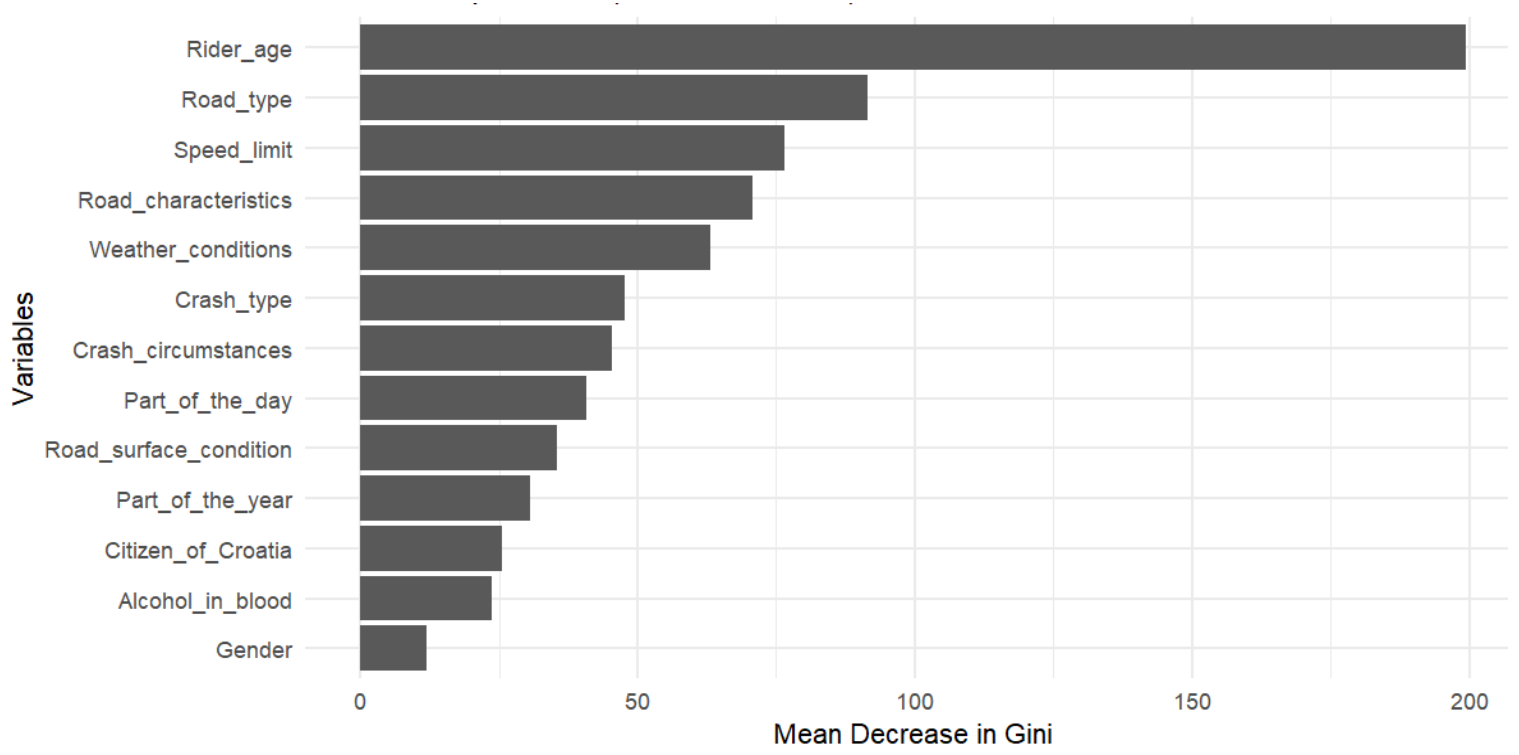
Results – RF



Variable importance according to the RF model

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Results - MLR

Variable	Chi-Square	df	Sig.
Road type	36.726	10	<0.001
Part of the day	4.743	6	0.577
Alcohol in blood	7.183	2	0.028
Gender	11.174	2	0.004
Rider age	14.612	2	<0.001
Citizen of Croatia	21.632	4	<0.001
Road characteristics	23.608	14	0.051
Road surface condition	16.239	6	0.013
Weather conditions	5.543	6	0.476
Crash circumstances	35.054	4	<0.001
Crash type	25.640	4	<0.001
Part of the year	3.158	2	0.206
Speed limit	7.095	8	0.526

Likelihood ratio tests for predictors in MLR

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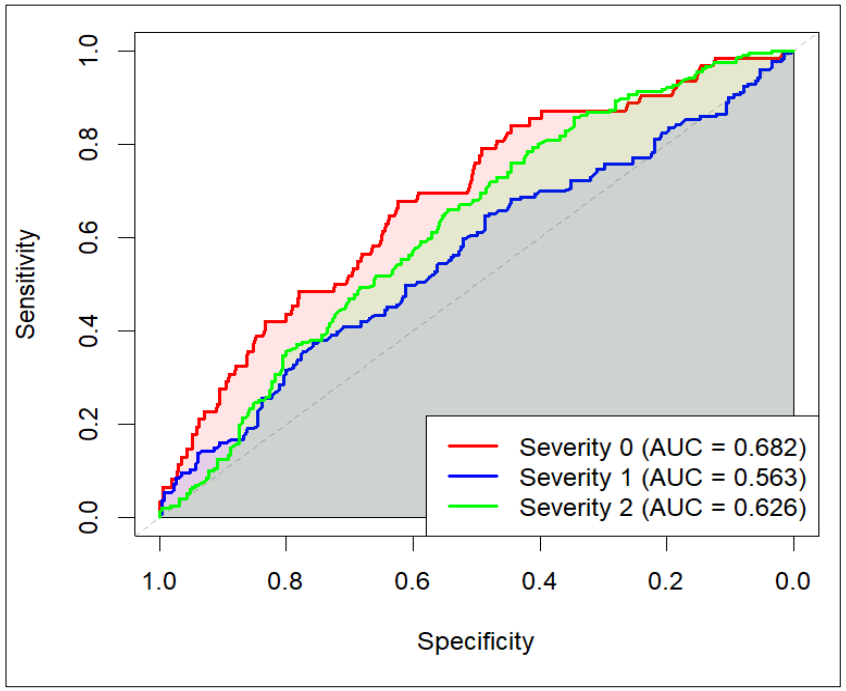
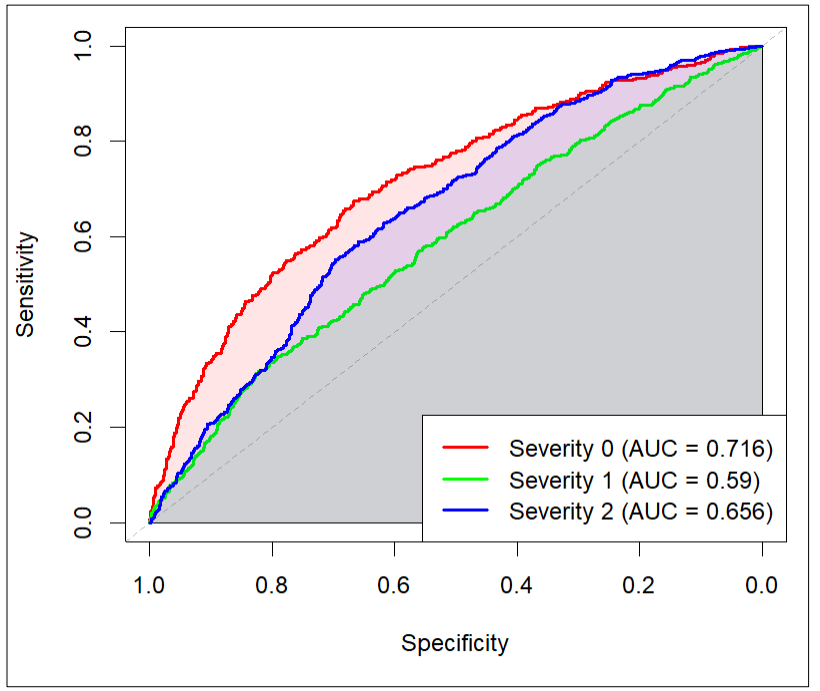
Results – comparison



ROC curve for RF model



ROC curve for MLR model

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Limitations

- Moderate prediction capacity
- Relying on police data
- Not so extensive dataset

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Future research

- Including more potential predictors
- Expanding the dataset
- Conducting the analysis of multi-vehicle crashes to compare

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Conclusions

- Suggestions for improving motorcyclist safety
  - Improving road infrastructure
  - Focus on rider education and training
  - Promote safe riding behaviors
  - Policy and enforcement improvements

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Thank you for your attention!

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