Weathering the Impact: Examining the Role of Weather Conditions on Car Accident Severity

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Introduction:

Road accidents are a serious and significant problem in the United States. Many Americans would say that the weather conditions while driving highly affect them. In fact, there are almost 6 million accidents per year, and 21% of them are weather related (Federal Highway Administration, (n.d.). Drivers must pay close attention to the road and others around them for the safety of themselves and others. With driving comes the unpredictability of the weather. Weather conditions such as rain, snow, and overcast can impair vision while driving. This can cause dangerous accidents on the road as a result. We want to examine how different road conditions affect the severity of car accidents.

Data:

The data was sourced from kaggle.com, from a study by Moosavi et al. (2019) on several factors related to road conditions and car accident severity. The data was collected from 49 U.S. states, from February 2016 to March 2023. While this dataset includes 7.7 million entries, we selected the first 10,000 entries for the sake of computational speed. The variables we extracted from this dataset were weather condition (e.g., cloudy, clear), inches of precipitation, miles of visibility, and accident severity (ranked from 1 to 4, with 4 being the most severe.
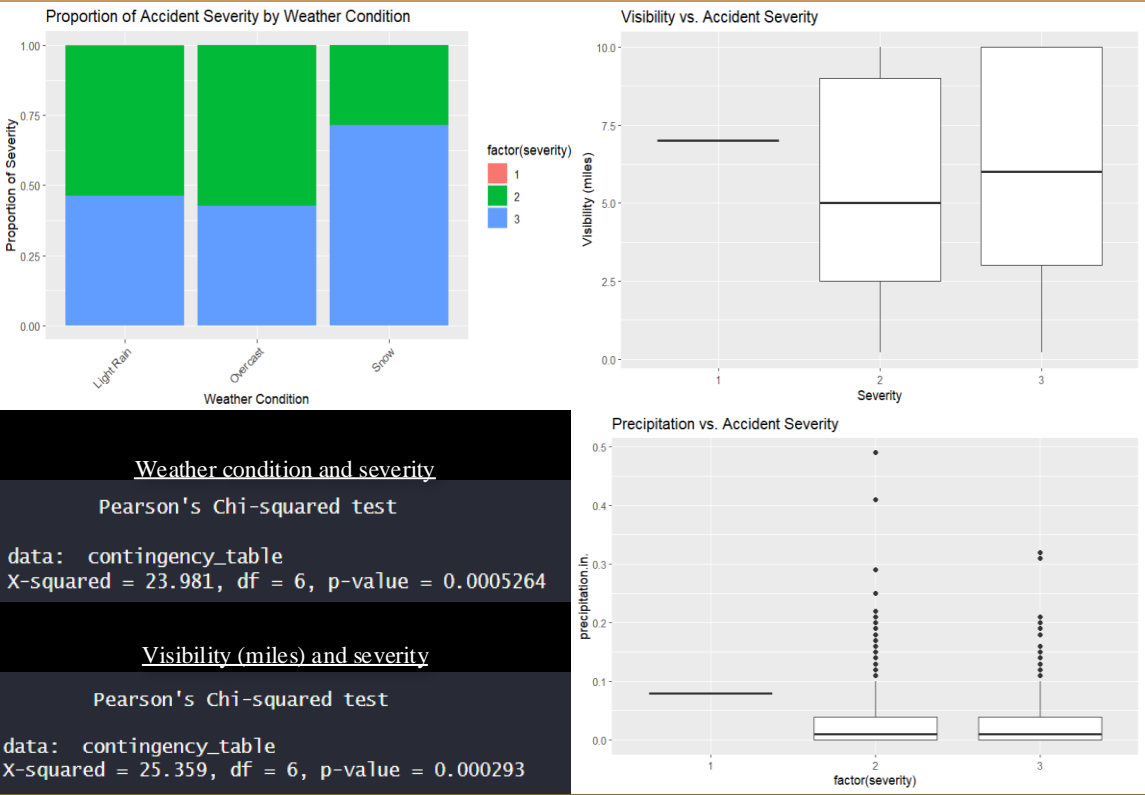
Variable	Mean	Std. Deviation
Precipitation (in.)	0.028	0.046
Visibility (miles)	8.914	2.57
Severity (1 to 4)	2.395	0.491

Research Question:

How do different weather conditions (like rain, snow, and overcast), precipitation (inches), and visibility (miles) affect the severity of car accidents?

Hypothesis:

The severity of car accidents will increase with worsening road conditions, more precipitation (inches), and less visibility (miles).

Proportion of Accident Severity by Weather Condition

Visibility vs. Accident Severity

Weather condition and severity

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Pearson's Chi-squared test

data: contingency_table
X-squared = 23.981, df = 6, p-value = 0.0005264
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Visibility (miles) and severity

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Pearson's Chi-squared test

data: contingency_table
X-squared = 25.359, df = 6, p-value = 0.000293
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Precipitation vs. Accident Severity

Analysis:

When analyzing the feature selection of possible predictors variables of severity, we found that the best were weather conditions, precipitation, and visibility. We performed a graph analysis to determine the proportion of Accident Severity by Weather Condition. Snow conditions showed that there is a higher likelihood of a 3-severity accident. Light Rain had more level 1 severe accidents. Overcast had a higher count of level 2 severe accidents. We can assume that snow causes more severe accidents of the three. The distribution does not vary significantly among the three conditions. Next, we did a chi square on Weather Condition and Severity. There was a <.05 p-value and concluded that the relationship between weather condition and accident severity is significant. We also did a Chi Square on visibility and severity. There was a p-value of <.05 and we can assume there is a significant relationship between the two. We performed a Chi Square on precipitation and accident severity, but there was no suggestion of statistical significance (>.05 p-value). Then, we did a boxplot on visibility and accident severity to confirm that their relationship was significant. The medians of level 2 and 3 severe accidents suggest they occur when there is low visibility in the road. The median of level 1 severe accidents also suggest that they occur with higher visibility in the road. The boxplot medians of precipitation vs. Accident severity suggest that there is little to no meaningful relationship between the two.

Conclusion:

From the analyses we ran from the extracted data, we found that weather condition does have a significant relationship with accident severity, and visibility also has a significant relationship with accident severity. As weather deteriorates, visibility tends to worsen as well, explaining why these variables are correlated in tandem with accident severity. Despite increasing precipitation having a profound effect on visibility, surprisingly, we did not find a significant relationship between inches of precipitation and accident severity. The data indicates that overall, drivers should be cautious of the weather conditions and visibility affecting their journey. This study was not void of limitations. With dataset only including entries from the U.S., the results cannot be generalized to the rest of the world. Differing driving styles and weather patterns across the world may affect these relationships in a variety of ways.

References:

Federal Highway Administration. (n.d.). *How do weather events impact roads?* U.S. Department of Transportation. https://ops.fhwa.dot.gov/weather/q1_roadimpact.htm
Moosavi, Sobhan, Mohammad Hossein Samavatian, Srinivasan Parthasarathy, and Rajiv Ramnath. "A Countrywide Traffic Accident Dataset.", 2019.