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Modeling and Predicting Geospatial Teen Crash Frequency

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Introduction

Road traffic crashes have emerged as a significant public health concern in this century. According to the National Highway Traffic Safety Administration (NHTSA), in 2018, 2,476 teens aged 13-19 were killed in motor vehicle crashes. Per the Insurance Institute for Highway Safety (IIHS), crash rates per mile driven for teen drivers are nearly four times those of drivers 20 years and older. Despite the pandemic, North Carolina has seen a 12% increase in deadly teen car crashes in 2020. Such trends emphasize that it is important to assess the environment and identify the risk factors influencing teen crashes for planning strategies and improving their safety. This research, therefore, focuses on exploring the effect of road network, demographic, and land use characteristics to compute teen crash frequency.

Influence of location-specific indicators (e.g. rural/urban, in school vicinity, etc.) on teen crash frequency is difficult to capture from typical safety performance functions. Also, the global regression estimates (all data are used to develop a single model) may not give accurate estimates at certain locations. Geographic Information System (GIS)-based methods like geographically weighted regression (GWR) can help generate localized SPFs (develop a model specific to the location) by capturing the spatial variations in explanatory variables and accurately computing teen crash frequency. The emphasis is on incorporating the locally varying spatial aspects of road network, demographic, and land use characteristics on teen crash frequency using geographically weighted negative binomial regression models.

Study Methods

Team considered data for 201 spatially distributed road segments in Mecklenburg County, North Carolina, USA for the evaluation and obtained data related to teen crashes from the Highway Safety Information System (HSIS). They extracted demographic and land use characteristics around each selected road segment using two different buffer widths: 0.25 miles and 0.50 miles and used teen crash frequency of each road segment as the dependent variable. The team developed and compared generalized linear models with the negative binomial distribution and geographically weighted negative binomial regression models.

Findings

Some of the key findings are:

- Overdispersion in teen crash data and spatial nonstationarity are important factors for consideration.
- 0.25 mile buffer is appropriate to capture land use and demographic data and compute teen crash frequency.
- AADT, light commercial, and light industrial land uses have an increasing effect on teen crash frequency.
- Population, employment, # of households, and public or private high school enrollments have an increasing effect on teen crash frequency.
- Geographically weighted negative binomial regression model works better compared to the global GLM-based negative binomial regression model. The geographically weighted negative binomial regression model allows the conditional relationship between teen crash frequency and different explanatory variables at each spatial location of interest.

Policy/Practice Recommendations

Geographically weighted negative binomial regression model is a promising method for crash frequency modeling, and is recommended for use. The findings from this research improve the understanding of the relative contributions of the various explanatory variables on teen crash frequency, assist with effective countermeasure selection, and, thereby, reduce the teen crash frequency. Spatially varying teen driver education schemes and enforcement can also be designed based on the findings.

About the Authors

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To Learn More

For more details about the study, download the full report at

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