GIS-based Identification and Evaluation of Significant Factors for Aging-Involved Crashes

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Motivation
Traffic crashes are one of the leading causes of death, substantial economic loss, and severe injuries for the drivers. This problem becomes even more challenging and complex when aging populations are considered due to their cognitive, behavioral, and health limitations. Since the growth among aging Floridians is expected to continue, it becomes crucial to identify and investigate the major factors contributing to the crashes involving aging populations, along with prevalence of occurrence locations of these crashes on the roadway networks. Unlike previous accident-focused traffic safety studies mostly focusing on the general population, this study attempts to understand the unique nature of aging-involved crashes by differentiating the crash contributing factors from other age group-involved crashes. This differentiation can assist state and local agencies in strategic planning efforts for developing appropriate intervention and prevention programs to improve safety and enhance mobility for aging road users. The knowledge gained from the results of this research will not only help identifying the critical factors contributing to aging-involved crashes, but also contribute to the development of more reliable aging-focused safety plans and models. This poster provides an overview on an ongoing project sponsored by the Center for Accessibility and Safety for an Aging Population (ASAP).

Demographics & Available Data
- The population of the age group 65 and older is increasing both in U.S. and Florida (with a higher rate in Florida). At 2030, it is expected that the number of 65+ population will increase approximately 60-65%.

Case Study Applications for Tallahassee, Leon County, Florida

Objectives
- Hot-Spot Analysis:
  To identify the crash clusters on a roadway network and to discover geo-spatial differences by comparing crash concentration points between aging people and other age groups.

- Factor Analysis:
  To identify the statistically significant factors (including population density) affecting the aging-involved crashes using a multiple logistic regression-based approach.

Methodology
- Crash Density Evaluation Methodology
  The Kernel Density tool in ArcGIS software calculates a magnitude per unit area from point features using a kernel function in order to fit a smoothly tapered surface to each point. Resultant is a raster map where each pixel has a density value.

- Crash Density Comparison Methodology
  Crash densities were compared with each other in order to detect age group specific hot spots. Comparisons were made based on maxima-normalized crash densities, since comparing based on the crash numbers or non-normalized densities would disguise age group specific hot spots due to uneven number of crashes. Comparisons were also made by a 'Raster Algebra' operation of ArcGIS software, which allow for pixel by pixel operation.

- Crash Density – Population Relationship
  Kernel Density maps for population groups were created using Census Block data for 2010. A specific parameter, namely population factor (PF), was developed to evaluate population density based on maximizing-crash normalized crash densities. Population factor by logistic regression method.

\[ PF = \frac{D_i}{A_i} \times \frac{\max(D) - D_i}{\max(D)} \]

Where
- \( D_i \) is Density Values in between compared maps (e.g. crash density in 65+ population map vs. crash density in general map).
- \( A_i \) is area density values of surrounding points of compared map.
- \( max(D) \) is maximum pixel density values of compared map.

\[ DR = D_i - \frac{A_i}{A_0} \times \frac{\max(D) - D_i}{\max(D)} \]

- Factor Analysis: Population Density Factor (estimated by Kernel Density)

Logistic Regression Analysis for Population Density Relationship
- Response Variable: 1 - 65+ Crash, 0 - Else
- Predictor Variable: Population Density Factor (estimated by Kernel Density)
- Results of the analysis show that there is a strong correlation between the spatial allocations of aging-involved crashes and population density.

Conclusions
- The aging-involved crashes differ from other age group crashes due to the nature of aging driving behaviors. This is supported by the behavioral research which shows that the natural changes brought about by aging such as slower reflexes, deteriorated vision, weaker cognitive skills affect the type, frequency and severity of crashes.
- Factor analysis results show that some factors such as speed limit, are more significant than others, and therefore increase the risk of crash for aging drivers. On the other hand, aging drivers are less prone to have a crash due to alcohol and drug impaired driving.
- Results of the analysis show that there is a strong correlation between the spatial allocations of aging populations and aging-involved crashes.

GIS for Geospatial Analysis
Visualization of Data by Maps
Investigation of Intensity & Clusters of Crashes
Statistical Model for Significant Factors
Evaluation & Interpretation of Results

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