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Factors Influencing Injury Severity Among Elderly Pedestrians - Insights from Urban Imagery and Explainable Machine Learning

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Elderly pedestrians, due to their frailty, are among the most vulnerable road users. Recognizing their heightened risk of crashes, researchers have begun to explore the factors influencing the severity of injuries they sustain in traffic crashes. International reports underscore the challenges posed by an aging global population, particularly in the transportation sector. This demographic shift has significant implications for elderly pedestrians, who often rely on walking as a primary means of exercise and mobility due to their diminished physical and cognitive capacities.

South Korea stands out as one of the most rapidly aging countries globally, with more than 21.8% of its population being elderly. The elderly in South Korea (aged 65 and over) experience disproportionately higher fatality rates in traffic incidents compared to their counterparts in most OECD nations.

This study examines key factors that affect injury severity in elderly pedestrians, focusing particularly on the roles of age and the human eye-level street environment. The study applied five years of pedestrian crash data from Seoul, South Korea, containing key crash-risk factors, supplemented by pedestrian eye-level street view imagery factors obtained through the application of semantic segmentation techniques built using deep learning approach. Subsequently, various machine learning models, including bagging and boosting models, were applied to analyse different injury severity level in the crash data. Additionally, Shapley Additive Explanations (SHAP) values were computed to interpret features and predict elderly pedestrian crash injury severity.

The findings reveal that factors such as pedestrian age, time of crash, pedestrian gender, roadway types, and eye-level street environment features significantly influence injury crash severity. Conversely, the month of year, day of week and driver age appear to have negligible impacts on crash severity. Specifically, attributes of the pedestrian eye-level street environment demonstrate notable non-linear and threshold effects on crash occurrences across all injury severity levels. For example, urban greenery can significantly reduce the risk of fatal injuries up until a certain density threshold.

Overall, the implications gleaned from this research are poised to provide safety experts with invaluable information and findings to refine or update current policies aimed at enhancing elderly pedestrian safety for improving pedestrian safety.

Keywords: Elderly pedestrian; Machine learning; Injury severity; Street environment