Background:

The elderly population is rapidly increasing on a global scale, and aging societies require proactive attention. With the rapid development of technology and economics, the number of elderly drivers is also on the rise, with an increasing willingness to drive in their daily lives and even for employment purposes. Therefore, the roles and significance of elderly individuals within urban transportation systems have grown substantially.

However, it is widely recognized that elderly individuals may not possess the same level of mental acuity as their younger counterparts, potentially leading to cognitive disadvantages when handling complex traffic situations. This raises the question of whether the increasing presence of elderly drivers brings greater safety concerns for urban transportation systems. Furthermore, due to age-related declines in physical abilities, elderly drivers often find themselves in vulnerable positions during accidents, with a higher probability of severe injuries. As urban planners, the challenge lies in determining how to enhance the safety of elderly drivers' mobility from the perspective of the built environment.

Review:

2.1 Aging driving

Personal mobility plays a vital role in daily life and social functioning, irrespective of age or social interactions. Road traffic accidents constitute a significant global health concern, resulting in more than 1.3 million fatalities annually worldwide, along with a higher incidence of severe injuries (World Health Organization, 2022). As individuals age, physiological functions, such as vision and reaction time, experience a decline, accompanied by potential cognitive impairments. Consequently, the safety performance of elderly drivers has emerged as a public concern, as indicated by Marottoli et al., who identified several clinical measures contributing to accident risk among older drivers (Marottoli et al., 1994). Lyman et al. further investigated the relationship between chronic diseases and functional abilities, cognitive impairments, visual impairments, mobility limitations, and driving difficulties among elderly drivers (Lyman et al., 2001). In order to gain a better understanding of the potential risks associated with elderly driving, it is imperative to make meaningful comparisons of accident risks across different age groups of drivers while considering differences in travel exposure.

2.2 Age correlation

Numerous studies have delved into the link between traffic accidents and drivers' characteristics, with age emerging as a pivotal factor in these inquiries.

Several investigations, including those by Massie et al. (1995) and Ma & Yan (2014), have highlighted a greater likelihood of traffic accidents involving both young and elderly drivers, who are also more susceptible to severe injuries or fatalities. However, Anne et al. (2015) presented opposing findings, suggesting that older drivers had the lowest rate of vehicle crash involvement in 2008. Shirley et al. (2018) added to this discourse by revealing that crash rates were highest among the youngest age group and notably declined until the 60-69 age group. Additionally, Lam's research showed an increase in injury and total crash rates in the oldest age group (70 or above), while a decline was observed from the 20-24 to the 50-69 age groups in motor-vehicle accidents.

These contrasting conclusions may be attributed to two primary factors: 1) variations in driving habits among different countries and 2) discrepancies in the measurement of traffic accident rates. Accurately estimating accident exposure is often challenging or impossible due to privacy concerns and the limited availability of personal driving data, as underscored by Stamatiadis (1997). Consequently, diverse alternative methods for measuring exposure have been devised. Induced exposure analysis, originally introduced by Thorpe in 1967, has undergone algorithmic enhancements over time (Shirley et al., 2018). An advantageous feature of this approach is its capability to categorize all samples into specific groups for analysis. In recent years, the utilization of big data and proxy variables, such as travel trip data, has gained prominence as a means of estimating exposure, as demonstrated by Ding (2021) and Li (2018). This approach offers the advantage of accurately estimating total exposure using real-world data. Collectively, these exposure measurement methods provide accessible and effective means

2.3 built environment

As the built environment and accident statistics need to have spatial boundaries, the adoption of research scales distinct from different studies. On the macro level, Quddus et al. (2008) explored factors influencing traffic fatalities from the census tract scale. Asadi et al.(2022) discussed how built environment relates to traffic safety from an area-level of 100x100m2 grid cells. In order to get more specific characteristic of the environment, Kwon and Cho (2020) approached the scene labeling technique for identifying the street properties from a more microscopic perspective.

The association between built environment and traffic accidents are usually analyzed by constructing a regression model. Kaygisiz(2017) found that traffic accidents are usually appeared with the complex land uses by utilizing binery logit models and data regression models. Tanja Congiu(2019) conducted an retrospective study to explore the influences on pedestrian accidents caused by built environment. Zhong(2022) further analyzed the relation between accidents and built environment from the spatio-temporal view with GWR models, demonstrating that accidents happens frequently near schools and hospital and the probability downs during weekends.

A large number of studies have explored the various environmental factors affecting the incidence of car accidents, such as the property of traffic lane, traffic flow, road pattern, landform, land use characteristics etc(Ewing, 2009; Wier, 2009; Marks,1957; Kaygisiz, 2017). However, different researchers may draw opposite conclusions about whether a factor is positive or negative. Several studies suggested that the narrow lanes leading to higher crash frequencies(Xie et al.,2007; Potts et al., 2007), while some others proposed that relatively narrower widths keep safer as drivers’ risk perception raised(Noland, 2003; Schramm and Rakotonirainy, 2009; Abdel-Aty et al., 2014; Wu and Lin, 2022). The four-armed intersection type relates to high risk of accidents according to Marks(1957). To the contrary, as Lee et al.(2023) indicated, stopping or slowing down at 4-way intersections decreases the chances of accidents. Those inconclusive results also bring significance for us to explore the association between built environment and accidents in the ageing background.

Data

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| Data | Purpose | Source |
| Road collision data | Traffic accident information.  Location, time, age etc. | Transport For London |
| Built Environment | POI, Land use, road network  For analyse the influential factors | Open street map  Office for National statistics(UK) |
| Others | Weather, census... | Multi-source |

Methodology:

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| --- | --- |
| Methodology | aim |
| Quasi-induced exposure | Measuring the exposure of total trips in each age group, for exploring the relationship between age and accident propensity. |
| Negative binomial regression  (to be discussed) | Examine the determinant factors for traffic accidents in different age groups |