



Risks and Countermeasures for Road Traffic of the Elderly in Europe



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Edmonton, 10 July 2018

Outline



- NTUA Dpt of Transportation
- Older driver characteristics
- Road safety of elderly in Europe
- Methodological challenges
- Countermeasures
- Safety vs Mobility
- Conclusions





NTUA - Dpt of Transportation Planning & Engineering



NTUA History



- NTUA and the **School of Civil Engineering** have contributed unceasingly to the country's scientific, technical and economic development since their foundation in **1837**
- In 2018, the School of Civil Engineering of NTUA was ranked 11th in Europe among all Civil Engineering Schools and 31st worldwide









- is composed by three Laboratories: , Traffic Engineering, Transport and Railways, Highways and Pavement Engineering
- comprises more than 70 highly qualified personnel (8 Faculty members)
- offers **17 undergraduate courses** at the School of Civil Engineering
- contributes to 6 postgraduate courses at NTUA Engineering Schools
- has produced highly innovative research through more than 60 PhD theses and within more than 300 National, European and International Research Projects, which led to more than 1.200 publications





20+ members Scientific Team:

- Internationally recognized Professors
- 8 Senior Transportation Engineers (4 PostDoc)
- 6 Transportation Engineers PhD Candidates
- 2 Information Systems Engineers
- With experience in Greece and Internationally (since early 90s):
- 75 road safety research projects (Greek 30, International 45), mostly through highly competitive procedures and several international cooperations
- More than 500 scientific **publications** (> 150 in Journals), widely cited worldwide
- More than 60 scientific **committees**
- International collaborations: European Commission, UN/ECE, OECD/ITF, WHO, World Bank, EIB, CEDR, ERF, UITP, ETSC, WCTR, TRB, decades of Universities and road safety research centers





NTUA Road Safety Observatory





An international reference road safety information system, with most updated data and knowledge, with:

- more than 3.000 visits per month,
- tens of items and social media posts/tweets annually



NRSO Basic Tools

- Databases and knowledge:
 - Greek Road Accident Database with disaggregated data
 - SANTRA (1985 2015, 1,2 million records)
 - European Road Accident Database with disaggregated data
 - **CARE** (1991 2016, 35 million records)
 - International Road Accident Database with aggregated data
 - **IRTAD** (1991 2016)
 - Databases of International Organisations
 - WHO, IRF, ERF κ.λπ.
 - Databases with Aggregated Data
 - Vehicle fleet, vehicle-kilometers, driver behavior, etc.
 - Online Road Safety Library > 5.000 reports
 - International **Bibliography** database (access to the overwhelming majority of scientific journals)
- Large number of statistical analysis **tools** (software, standards)
- Driving Simulator

Older driver characteristics

Demographic characteristics (1/2)

- In the coming years, Europe is facing a significant shift in the age distributions of populations
- A **gradual increase** in the proportion of older people is expected by 2050, approximately 28% of the European population will be 65 years or older
- The expected increase in the number of elderly people is different for the younger (65-74 years) and the older elderly (≥ 75 years).

Demographic characteristics (2/2)

- Currently, 16% of the European population is aged 65 years or above, and 4% is aged 80 years and above. These percentages will increase up to 25% and 8% respectively in 2040
- In Europe, the percentage of licenced drivers in the group of drivers between the age of 65 and 74 years used to vary from 71 to 93% for men and from 7 to 46% for women
- Tomorrow's older driver will continue to drive **longer** and for **larger distances** than earlier cohorts, partly because they have better access to cars

Demographic change

Predicted percentage of older people (\geq 65 years) in the population

This demographic change can be attributed to three main factors:

- Declining fertility
- Increasing longevity

• Migration

Driving Behaviour and Road Safety

- **Driving in traffic** is more than just knowing how to operate the mechanisms which control the vehicle
- Road accidents constitute a major social problem in modern societies (eighth leading cause of fatalities globally and the leading cause of fatalities for young people aged 15-29 years):
 - 1.2 million fatalities worldwide
 - 25.300 in the European Union

Older drivers have a relatively high fatality rate due to:

- functional limitations
- physical vulnerability
- low annual mileage

Particular Older Driver Behaviour characteristics

- driving habits
- social behaviour
- risk compensation
- changing behaviour over time

- **Cognition** is "the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses."
- It encompasses processes such as knowledge, attention, memory and working memory, judgment and evaluation, reasoning and "computation", problem solving and decision making, comprehension and production of language, etc.

Cognitive functions related to safe driving

- Driving sufficient cognitive, visual and motor skills
- **Cognitive functions** related to driving may be categorized into the following six neuropsychological domains (Reger et al. 2004):
 - mental status-general cognition
 - attention-concentration
 - executive functions
 - language-verbal functioning
 - visuospatial skills
 - memory

Attention quick perception of the environment

Executive functions

- process multiple simultaneous environmental cues
- rapid, accurate and safe decisions

Visuospatial skills

- position the car accurately on the road
- manoeuvre the vehicle correctly
- judging distances and predicting the development of traffic situations

Memory

- journey planning
- adapting behaviour

Panagiotis Papantoniou, Risks and Countermeasures for Road Traffic of the Elderly in Europe

Cognitive functions critical for safe driving

Road Safety of Elderly in Europe

Methodological framework

- Macroscopic analysis of basic road safety parameters related to elderly people, using data from the EU CARE database with disaggregate data on road accidents, together with data from other international data files
- **Comparative analysis** among countries will allow for drawing an overall picture of the safety level of elderly people in Europe
- Provide useful support to all **decision makers** working for the improvement of safety in the European road network

Proportion of fatalities

- In 2016, more than **6.900** elderly people died in road accidents in the EU
- The number of elderly people killed in road accidents in 2016 decreased by 15%, while the total number of fatalities fell by 41% in the EU countries

Number of elderly fatalities and share of fatality total

- The **number of elderly fatalities** was **decreasing** up to 2013, while it increased during the last two years
- The **share** of elderly fatalities on total fatalities is **increasing** steadily

Elderly vs Middle aged

• The **risk** of being killed in an accident is clearly **higher** for the elderly than for the middle-aged

Relative elderly fatality rates

 The risk of being killed in a road accident for the elderly in the EU is about 1,4 times higher compared to the average member of the population across the EU as a whole

Elderly fatalities by age group

• The over 85 age group has the highest fatality rate (95) on average in the EU

Elderly fatalities by age group and gender

- Almost two thirds of elderly fatalities were men
- Women make up a **higher proportion** of fatalities among the elderly (35%) than within the whole population (24%).

Elderly fatalities by road user

VISION

• 37% of elderly fatalities were **pedestrians** in the EU countries

Elderly fatalities by road type

- There are fewer elderly fatalities on **motorways** and on **rural** roads, but more on urban roads
- The national distributions vary greatly between the EU countries

Elderly fatalities by Day of the week and Time of the day

- The weekday distributions (Monday-Thursday) are similar
- The elderly distributions had **peaks** slightly earlier in the afternoon, with additional peaks before noon

Elderly fatalities by seasonality

• The number of elderly and middle-aged fatalities have a **similar trend** from **June to August**, while from August and up to December trends are opposite

Distribution of specific critical events

• Specific critical events under the general category of **no action**, **premature action** and **incorrect direction**, are important for both the elderly and middle-aged groups

Distribution of specific critical events

Links between causes	Frequency
Faulty diagnosis - Information failure (between driver and traffic environment or driver and vehicle)	20
Observation missed - Permanent obstruction to view	17
Observation missed - Temporary obstruction to view	14
Observation missed - Faulty diagnosis	13
Observation missed - Distraction	7
Observation missed - Inattention	7
Observation missed - Inadequate plan	6
Faulty diagnosis - Communication failure	6
Faulty diagnosis - False observation	5
Faulty diagnosis - Cognitive bias	5
Others	66
Total	166

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Road accident health indicators (1/2)

Distribution of non-fatal road accident casualties attending hospital by mode of transport

Percentage of non-fatal road accident casualties who were admitted t hospital by age group and mode of transport

- Thirteen member states routinely collected data in a **sample of hospitals** and contributed them to the EU injury Database (EU IDB)
- According to estimates based on the EU IDB more than **four million people** are injured annually in road traffic accidents, one million of whom have to be admitted to hospital

Road accident health indicators (2/2)

Distribution of non-fatal road accident elderly casualties mode of transport and body part injured

bxverage length of stay (hospital bed days) of non-fatal road accident casualties by age group and mode of transport

• More than 40% of older casualties who attended a hospital were admitted to the hospital; their average stay in hospital was twelve days.

Methodological challenges

Driving Behaviour Experiments of older drivers

- Driving **Simulator** Experiments
- Naturalistic Driving Experiments
- On road experiments
- In Depth Accident Investigations
- Surveys on Opinion and Stated Behaviour

Driving simulator experiments

Examination of a range of driving performance measures in a controlled, relatively realistic and safe driving environment

Advantages

- Collection of data which would be very difficult to collect under real traffic conditions
- Exploration of any possible driving scenario
- Driving conditions are identical for all drivers

Disadvantages

- Non totally realistic simulated road environment
- Possibility of adopting a different driving behaviour
- Feeling of safety
- Simulator sickness

Naturalistic driving experiments

A research method for the observation of everyday driving behaviour of road users

Advantages

- Large degree of control over the variables that affect driving behaviour
- Researchers study issues that cannot be investigated in a lab
- Help support the external validity of research

Disadvantages

- Difficult to determine the exact cause of a behaviour
- The experimenter cannot control outside factors
- Traffic incidents are very rare

On-road experiments

Studies using instrumented test vehicles to gain greater insights into the factors that contribute to road user accident risk and the associated crash factors at specific conditions.

Advantages

- Large degree of control over the variables that affect driving behaviour
- Study of actual observed behaviour

Disadvantages

• Data not collected over a longer time period and in response to selected interventions

In depth accident investigation

In-depth accident data describe the causes of accidents and injuries and aim to reveal detailed and factual information from an independent perspective on what happens in an accident

Advantages

- Describe the accident process and determine appropriate countermeasures
- Provide a major contribution to the development of new safety policies

Disadvantages

Insufficient reconstruction evidence

Surveys on opinion and stated behaviour

In stated behaviour surveys, a reference questionnaire is built, based on a list of selected topics and a representative sample of population is interviewed

Advantages

- Survey design may control for external factors
- Allow to investigate new situations, outside the current set of experiences

Disadvantages

- Often hypothetical nature of questions
- Actual behaviour is not observed
- Over- or under-representation of actual

behaviour

Reliability

- Increased variability Older people may perform very well on one occasion and much worse on another
- Aged related health conditions change from day to day

Validity

- Differential exposure
- Difficulties in distinguishing the effects of normal age-related changes from those from age-related disorders
- Older adults may take one or more prescription drugs which may impair driving

Methodological overview

- Every **experiment type** has benefits and deficiencies. Combination and meta-analysis of experiments results may bring more reliable conclusions.
- Sample size should correspond to the number of variables to analyse.
- Internal structure of experiments has a direct impact to the results **reliability**.
- Valid data analysis requires multi-annual effort to address the high complexity.

Measures

To ensure the **older adult's safety**, a package of measures should be composed that includes all of the elements listed below:

- Infrastructural measures
- Advanced Driver Assistance Systems (ADAS)
- Vehicle design and vehicle safety
- Education and training
- Arguably assessing the fitness to drive

Intersection design

- providing a good and early view on the intersection
- assistance in making a left turn
- assistance in roundabouts

Road signs and markings

- Street name signing
- Lane-use control signs
- "One-way" and "Yield" signs
- Road markings

Infrastructural measures (2/2)

Traffic lights and fixed lighting

- traffic signals
- fixed lighting

Exits and entries of motorways

- exit signing
- design of acceleration and deceleration lanes
- fixed lighting at interchanges
- prevention of wrong-way manoeuvres

Advanced Driver Assistance Systems (1/2)

Advanced Driver Assistance Systems (ADAS) provide personal assistance in a road environment that does not always take into account the possibilities and limitations of the older driver

- judge whether fellow road users are approaching the same intersection and at what speed
- notice other road users while merging and changing lanes
- notice traffic signs and signals
- react quickly in a complex traffic situation

Advanced Driver Assistance Systems (2/2)

ADAS for crash avoidance

- ADAS for enhanced mobility and lower injury severity
- night-vision enhancement systems
- navigation systems
- mayday systems

User acceptance

Pre-conditions for safe use of ADAS by older drivers

- Design principles for the human machine interface
- ADAS should work together
- Behavioural adaptation

Functionality	ADAS
Draw attention to approaching traffic	 Collision warning systems aimed at intersections Automated lane changing and merging systems
Signal road users located in the driver's blind spot	 Automated lane changing and merging systems Blind spot and obstacle detection systems
Assist the driver in directing his attention to relevant information	 In-vehicle signing systems Special intelligent cruise control
Provide prior knowledge on the next traffic situation	 Systems that give information on the characteristics of complex intersections the driver is about to cross

Vehicle design and vehicle safety

Measures which relate to the vehicle aim at:

- improving the **physical access** to the car
- making it easier to **operate** the vehicle
- improving the **safety** of the occupants

Vehicle design

 To facilitate older people's entry and exit of a car specific dimensions should be followed

Vehicle safety

- Intelligent restraint systems, capable of adjusting for lighter, older occupants
- Dual-stage **airbags** to minimise aggressive airbag contacts in moderate crashes
- Active **head restraints** to minimise injuries to the neck
- Side airbags to protect the head and chest in side collisions

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Car part	Recommended dimension (cm)
Door frame height above ground	133-138
Width of door opening	80-100
Seat height above ground	50-60, 50 optimum
Doorsill height	36-40
Doorsill to car floor	4-9, 6 optimum
Seat front edge	35-45
Door opening angle	70, 90 when assistance needed

Formal **education** and **training** are important ways to

- inform older drivers of the physical and cognitive changes experienced as part of the ageing process
- on the implications of ceasing to drive
- on the choice of safer vehicles

The next two sections focus on **educational programmes** and **training programmes** for the older driver

Informing the older driver

Older drivers need information on the physical and cognitive changes that accompany ageing, and on the implications of ceasing to drive

- The potential for **declining sensory** and cognitive abilities
- Vehicle equipment and **ADAS**
- Increased vulnerability, and the importance of using protection devices
- Influence of **age-related illnesses**
- Information about the procedure to be followed to extend the driving licence
- Possible decision to no longer drive a car: making this debatable, and **discussing** the roles that relatives and family doctor can play
- How and where to seek and access **mobility** alternatives to the car

Training programmes provide a good opportunity for informing the older driver

- of the physical and cognitive changes that accompany ageing
- difficulties that may arise in traffic as a result of these changes
- how to modify **driving strategies** to avoid these difficulties

Assessing fitness to drive

The assessment of an older person's **fitness to drive** can take place both as part of renewal of the driving licence at a specified age and when a health problem has been identified

<u>Licensing procedures for older drivers</u> Practice in European countries on the licensing of older drivers **varies**. Some countries require renewal of the driving licence at a certain age, whereas others do not

Consultation of doctors

Psysicians represent an important first contact and information source and are in a position to make judgements and give advice to the patient about fitness to drive

Safety vs Mobility

- A licensing procedure that results in people losing their driving licence when they can still drive a car safely is undesirable
- Older people are **safer in a car** than pedestrian or cyclists
- Saying farewell to their car often is • also a farewell to part of their social lives

Stopping driving is likely to reduce mobility and **negatively affect the quality of life** as follows:

- reduce the number of out-of-home activities and be related to increased depression
- lead to a negative impact on an older person's identity, his feeling of independence, and his dignity

Alternative means of transport

The availability of **means of transport** other than the car is one of the most important ways to maintain older people's mobility

- Conventional **public transport services**, which are accessible to disabled people
- Bus service routes using small vehicles that pick up and discharge passengers close to origin and destination
- **Conventional taxis**, often with user-side subsidies in order to reduce the fare
- Dial-a-Ride service for **door-to-door trave**l for passengers who require assistance and/or who use a wheelchair that cannot be accommodated by a taxi or accessible bus
- Accessible pedestrian infrastructure to allow access to all transport services

Conclusions

Conclusions

- By 2050, **one in four people** will be aged 65 or over
- This increase in the older population coincides with an **increase in older road users** since far more elderly people will participate in traffic
- Older drivers have the second highest fatality rate of all age-groups
- The research attempted to identify the most promising current and future countermeasures aimed at increasing road safety focusing on older drivers

Key Countermeasures (1/2)

Infrastructural interventions

- Reducing the speed of other traffic, lower design speeds
- Use of protected-only operations at signalized intersections
- Self-explaining roads

Education, training & awareness raising

- about age-related illnesses and medication, effect of functional limitations
- self-evaluating and improving skills, <u>focus on</u> <u>speed</u>
- increased vulnerability and the importance of using protection devices

Key Countermeasures (2/2)

Licensing & enforcement

- License restrictions and renewal policies: in-person renewal, vision test
- Licensing screening and testing
- Law enforcement roles

Intelligent Transportation Systems

- Active safety: Intelligent Speed Assistance, Active pedestrian protection system, Lane change assistant, Intersection control system
- Passive safety: Safety belt & force limiter, Helmet, Frontal airbag, Seat belt reminder

Future challenges

- The **European and national policies** have a key role in guiding and regulating road design and vehicle standards, training and licensing for better protection of the elderly.
- Stimulate the development and deployment of elderlyadapted Advanced Driver Assistance Systems
 - Are the elderly ready for using new vehicle technologies?
 - Are automated vehicles ("the ultimate ADAS") the answer for safe mobility of the elderly?
- Until then ... many current challenges remain
 - Lack of data on elderly exposure and behaviour
 - Increase self-awareness and promote safe mobility
 - Promote modern concepts of forgiving roads, shared space
 - Slow down traffic

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