

Driver Licensing Legislation

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Preface

This is the first report of Work Package 5 of the EU project CONSOL, “CONcerns and SOLutions – Road Safety in the Ageing Societies” (contract period: 2011-2013). WP 5 is entitled “Case analyses of practices aimed at managing the safety of older road users” and consists of two parts: WP 5.1 “Driving Licensing Legislation” and 5.2. “Urban infrastructure”. This report covers WP 5.1, which describes and assesses the different practices of driver legislation policies in the 27 EU countries and draws conclusions and recommendations based on studies that evaluated the different policies and practices.

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Executive Summary

Against the background of the aging population, the question of the fitness and safety of older drivers has been widely discussed. Research from various countries has indicated that licensing policies are not evidence based and tests that are commonly used to assess the fitness to drive show at best very low correlations with accident rates. Chronological age *per se* seems to be, in the case of mature drivers, at best only a weak predictor of safe driving performance. Yet, licensing policies based on chronological age are widely used and many countries have chosen to invest in age-based testing of driving fitness. More evidence based policies have been called for, both out of ethical and economic reasons.

In the present report, the different driver licensing policies in the 27 EU countries are described and their effects are assessed based on evaluation studies. The mapping of licensing policies in Europe (Chapter 2) indicates considerable heterogeneity of existing policies. Six out of 27 countries, most of them in Central Europe, issue unlimited licences, and the licences issued by the remaining 21 countries vary greatly. In some countries licenses have to be renewed every 10 years, while in other countries the license has to be renewed for the first time at a specific age. In most cases the intervals become shorter with increasing age. Most of the countries that issue licenses require medical examinations (with limited validity) to renew the license. The methods used to assess the fitness to drive vary with regard to the testing procedures and the medical professionals involved, but general practitioners have a dominating role. There is also a considerable heterogeneity regarding the direct costs paid by the licensee in connection with license renewal.

In Chapter 3 the effects of older driver screening and licence renewal policies are evaluated through a literature review. There is no evidence supporting the assumption that general age-based assessments have any safety benefits. However, the review of evaluation studies identified possible safety benefits of more specific measures, namely in-person renewal (as opposed to renewal by mail) and restricted driving. These effects were, however, all found in American studies and it is not clear whether all of them can simply be transferred to the European context. The few existing European evaluation studies all conclude that aged-based licence renewal is associated with negative safety effects for older people, because it triggers a shift from the car to unprotected modes of transport. In addition, driving cessation is associated with negative mobility and health related effects. Older drivers are a safe group of drivers and a general screening of the whole population of older drivers does also not appear as a reasonable societal investment. In sum, age-based screening implies large societal and private costs and decreases transport safety on a system level.

To take away the licence would only appear justified if it was possible to reliably identify unsafe drivers. Existing measures, however, fail in that respect. Apart from the negative consequences for the older person who has to cease driving, the relatives, who have to take care for the older persons' future

transport needs are also concerned. Finally, the GPs, when in charge of this decision, often find themselves in an ethical dilemma.

In the future, more older people will hold a license and keep driving until an advanced age. Based on the results it is recommended to shift the focus from restricting their mobility to prolonging older persons' safe driving careers (Chapter 4). This should be supported by soft policy measures as well as technological advances up to autonomous cars. In addition, different kinds of mobility services have to be provided to ensure a high level of mobility after driving cessation. Taking into account the increasing heterogeneity of older road users, the various measures should be designed for and addressed to different target groups of older road users.

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1 Introduction

As the size of the older population is increasing, managing older road users' safe mobility has become a topic of interest in most Western industrialised countries. Providing satisfactory opportunities for independent travel and mobility helps the older population to maintain an independent lifestyle and their own well-being. As the safest and most convenient mode of transportation for older persons, private cars are often seen as the best option for independent mobility (OECD, 2001). The question of the fitness and safety of older drivers has, however, also been widely discussed, resulting in a debate about the meaningfulness of screening and of various measures which aim to identify those older drivers who are no longer fit to drive (e.g. Fain, 2003; Fitten, 2003; White & O'Neill, 2000).

In 2002, Hakamies-Blomqvist, Raitanen and O'Neill demonstrated in their seminal paper that an increase in age does not cause higher crash rates per exposure. Since then, this finding has been repeatedly confirmed by independent studies (Fontaine, 2003; Keall & Frith, 2004a; Langford, Koppel et al., 2008), thus challenging the traditional concept of a direct association between age-related deterioration of safety-relevant driving skills and driving performance. Chronological age *per se* seems to be, in the case of mature drivers, at best only a weak predictor of safe driving performance. However, screening policies based on chronological age are widely used in most European countries and many US and Australian states (e.g. Insurance Institute for Highway Safety, 2012; Langford et al., 2004b; Meuser, 2008; Mitchell, 2008; White & O'Neill, 2000).

As noted by O'Neill (2012a), ageism, vested interests, and biased conceptions about the ageing process can be traced in the eagerness of regulating older drivers' right to drive through various screening policies. Lately, however, more evidence-based policies have been called for (Desapriya et al., 2012; O'Neill, 2012b; Siren & Meng, 2012).

Especially in times of economic crisis like these, it is also in the interest of society to assess whether the costs associated with age-related controls are associated with a distinct road safety benefit.

In the present report, the driver licensing policies in Europe, especially as regards older drivers, are described (Chapter 2). The report provides an overview of policies in all 27 EU-member countries and a more detailed description of policies in the CONSOL partner countries (Austria, Czech Republic, Denmark, France, Spain, Sweden, and the UK).

In addition, the effects of older driver screening and licence renewal policies are evaluated through a literature review (Chapter 3).

Finally, conclusions and recommendations are drawn based on Chapters 2 and 3 (Chapter 4).

2 Mapping Driving Licensing Policies in Europe

In this chapter we present an overall picture of the driving licence policies for non-professional drivers in the 27 EU countries. We describe the variety in licensing policies with regard to the criteria: validity of the license, age of first assessment, methods of assessment and costs. Subsequently, we provide a more detailed description of the policies in the CONSOL partner countries, representing examples of different existing policies.

2.1 Overview of Licensing Policies in Europe

As Table 1 indicates, there is considerable variety in the driving licence policies of the 27 EU countries with regard to the validity of the licence and the procedure to renew the licence, if required.

Basically, we can distinguish between 4 types of licenses (see Figure 1):

- 1) Licenses of unlimited validity - that means they are valid for the whole life. Unlimited licenses are issued by *Austria*, Belgium, Bulgaria, France, Germany, and Poland.
- 2) Licenses that generally do not require a medical examination to be renewed but only an administrative procedure (*Sweden*) and a self report of medical conditions (*UK*).
- 3) Licenses that require a medical check by (at least) a physician to be renewed with the age of first assessment at 50 (Italy, Portugal), 60 (*Czech Republic*, Luxembourg), 65 (Greece, Slovakia) or 70 years (Cyprus, *Denmark*, Finland, Ireland, Malta, The Netherlands, Slovenia).
- 4) Licenses that have to be renewed every ten years including a medical examination for all age groups (Romania), with increasing frequency with increasing age starting at 40 (Hungary), 55 (Lithuania), 60 (Latvia), 65 (Estonia, *Spain*).

The CONSOL partner countries (*indicated by italic letters*) are represented in all four categories and detailed descriptions of their policies will give more insight into the different kinds of procedures (see Chapter 2.2.)

Figure 1 provides a quick glance over the distribution of countries with the four types of driving licences. The figure shows that unlimited licences are more typical in Central Europe. It should however be noted, that the EU directive 2006/126/EC now requires the member states to issue

licenses with limited validity and thus unlimited licenses will disappear and at a minimum, a administrative renewal process will be implemented.

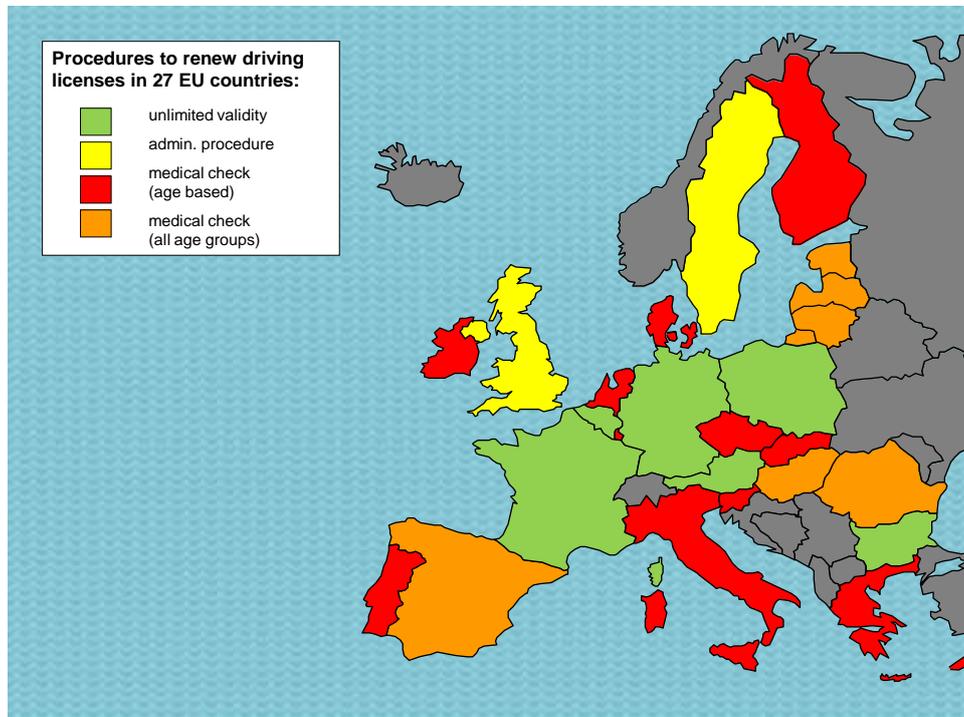


Figure 1: Types of driving licences in Europe

Table 1: Licence renewal procedures in 27 EU countries (in alphabetic order)

Country	Validity ¹	Age of first assessment	Periodicity	Physician requirement	Methods used	Costs paid by licensee in EUR
Austria	unlimited					
Belgium	unlimited					
Bulgaria	unlimited					
Cyprus	limited	70		yes	To be decided by the physician	No fee
Czech Republic	limited	60	65, 68; then every 2 years	yes	GP examination	Ca. 20 €
Denmark	limited	70	70, 74, 76, 78, 80, then every year	yes	Physical check, Mini-mental test (m-MMSE), clock drawing test	4 €; GP statement separately, ca. 40-80 € (costs not fixed); ca. 117 € in case a practical driving exam is necessary
Estonia	limited	Every 10 years	When exchanging expired license or restoration (if it has been >2 years since last assessment) Before 65: every 10 years After 65: every 5 years	yes	GP examination	ca. 25 €
Finland	limited	70 Before that, driver license needs to be administratively renewed every 15 years (new picture - no assessment)	Before 70: every 15 years (administrative renewal) After 70: every 5 years (with medical check)	yes	GP examination	53 € for the new license (2012 price). GP statement separately, ca. 50 € and up.

¹ The EU Directive 2006/126/EC has not been implemented in all EU countries at the time of the data collection, and thus there are some changes to be expected especially for the countries that issue unlimited licenses. The directive requires the EU member states to issue drivers licences with a validity period between only 10 and 15 years and accordingly, at least an administrative procedure has to be implemented.

Country	Validity ¹	Age of first assessment	Periodicity	Physician requirement	Methods used	Costs paid by licensee in EUR
France	unlimited					
Germany	unlimited					
Greece	limited	65	Every 3 years	yes	Assessment by two physicians. 1. A pathologist (and related disciplines) or cardiologist or pneumonologist 2. An ophthalmologist.	108 €
Hungary	limited	Every 10 years	Before 40: every 10 years After 40: every 5 years After 60: every 3 years, After 70: every 2 years		GP examination	no information available
Ireland	limited	70	Before 60: 1, 3 or 10 years (optional) Before 70: 3 years After 70: 1-3 years (determined by medical)	yes	Assessment by doctor (usually GP)	Generally fee associated with private GP consultation, but may be cost-free for those on a Medical Card (means-related free health care)
Italy	limited	50	Before 50: 10 years After 50: 5 years After 70: 3 years	yes	GP examination	24 € for administrative fees and from 20 to 50 € for GP examination
Latvia	limited	Every 10 years	Before 60: every 10 years After 60: every 3 years	yes	GP examination	20-40 €
Lithuania	limited	Every 10 years	Before 55: every 10 years Before 70: every 5 years Before 80: every 2 years After 80: every year	yes	GP examination (if necessary psychiatrist)	15 €

Country	Validity ¹	Age of first assessment	Periodicity	Physician requirement	Methods used	Costs paid by licensee in EUR
Luxembourg	limited	60	60: every 10 years After 70: every 3 years After 80: every year	yes	GP examination (including check for eyesight, hearing, cardiovascular disorders, endocrine disorders, diseases of the nervous system, mental disorders, alcoholism, drugs and medicines, blood disorders and diseases of the genitourinary system)	Stamp for application - €6, medical visit (not covered by healthcare)
Malta	limited	70	Every 5 years	yes	Not specified	29 €
The Netherlands	limited	70 (between 69 and 74 depending on the exact age at which the driver got the first driver's licence) ¹	Before 70: every 10 years After 70: every 5 years ²	yes	Examination of blood pressure, visual acuity with and without correction (glasses), the field of vision, hearing, limitations in the use of the neck, back, and limbs, and the general physical and mental condition	Application 45 € medical report form 23 €
Poland	unlimited					
Portugal	limited	50	50, 60, 65, 70 After 70: every 2 years	yes	GP examination (psychological assessment optional)	15 €
Romania	limited	Every 10 years	Every 10 years	yes	Psychological and medical examination. Assessment in private or state clinics	25 - 40 €
Slovakia	limited	65	Every two years	yes	Psychological and medical examination	30 €
Slovenia	limited	70	Every 10 years	yes	Medical certificate on physical and mental fitness to drive	
Spain	limited	At obtainment of each new license, or when one expires, with different periods depending on age/health status	Before 65: every 10 years After 65: every 5 years	yes	Medical and Psychological examination required	50-70 € (in specific clinical centres)

² Before the age of 60, the periodicity of licence renewal (for fit people) is 10 years. If the licence expires between the age of 60 and 65, the periodicity can vary from 5 to 10 years, as for those people it will expire at the age of 70. For those people (about half of all drivers) the age of first assessment is 69 (just before one turns 70). If the licence expires between the age of 65 and 70, the periodicity of the driver's licence is (maximally) 5 years. As a result, their age of first assessment varies from 70 to 74. After the age of 70, the periodicity is also (maximally) 5 years. Additional limitations of 1-3 years depending on health could be imposed.



Country	Validity ¹	Age of first assessment	Periodicity	Physician requirement	Methods used	Costs paid by licensee in EUR
Sweden	limited	Every 10 years (administrative renewal)	Every 10 years	no		18 €
United Kingdom	limited	70 Before that, driver license needs to be administratively renewed every 10 years (new picture - no assessment)	After 70: every 3 years	no	Confirmation required at age of 70 that no medical disability is present, thereafter every three years drivers must satisfactory complete a self-certification checklist on medical conditions to renew their licence. Drivers reporting a disability or medical conditions may be required to undergo a fitness to drive assessment in a mobility centre.	Administrative renewal is free. Detailed assessment at a mobility centre: costs vary between centres between approx. 70-120 €.

2.1.1 Validity

The majority of the 27 EU countries limit the validity of their driving licences in some form, while only six countries issue unlimited driving licences to non-professional car drivers.

Regarding the general validity of the driver's licences in the countries with limitations and obligatory renewal procedures three different concepts prevail. In Sweden and Romania renewal processes are not age based; Swedish and Romanian car drivers are obliged to renew their licences every ten years regardless of age (even if in a very different way). In the other 19 countries the renewal procedures vary with the age of the driver. In 11 countries the renewal procedure starts not before a certain age, in 8 countries the license has to be renewed every ten / fifteen years. In both cases time periods between renewal procedures decrease with rising age, but intervals vary considerably between countries.

2.1.2 Age of first assessment

The first assessment of age based driver screenings varies significantly between European countries. In most countries the time periods between obligatory assessments to renew the driver's licence decrease from a certain age onwards.

This initial age where time periods decrease range from 40 years up to 70 years:

- | **40:** Hungary
- | **50:** Italy, Portugal
- | **55:** Lithuania
- | **60:** Luxembourg, Czech Republic
- | **65:** Estonia, Greece, Spain, Slovakia
- | **70:** Denmark, Slovenia, Cyprus, Malta, Ireland, Netherlands, UK, Finland, Latvia

In most countries there are additional gradations of the periodicity with rising age: for example in Hungary assessments are obligatory every 10 years after issuance of the license; from 40 years on every 5 years; from 60 every 3 years and finally from age onwards 70 every 2 years.

2.1.3 Method of assessment

The renewal practices of driver licences range from purely administrative procedures (Sweden) to more comprehensive medical examinations including psychological, physical, cognitive and sensory test batteries.

While some countries only require all car drivers up to a certain age to renew their licences by updating needed information (e.g. identification picture), others rely on self-report questionnaires consisting of check lists of relevant medical conditions. Medical checks to screen licence holders for fitness to drive vary with regard to the testing procedures and the medical professionals involved, with some countries including tests on cognitive abilities and comprehensive visual acuity tests.

Depending on the required procedures and the experts involved in the screening, these can include general practitioners and special centres for traffic medicine and driving fitness assessment. In general, fitness to drive screenings consist of an examination by a general practitioner with further specific tests (visual acuity tests, psychological examination, etc.) only mandated if indicated to be necessary over the course of the basic assessment. The role of general practitioners seems to be dominating in the assessments although previous research has indicated that they do not necessarily possess the needed knowledge on ageing and driving fitness (e.g., Hakamies-Blomqvist et al. 2002) or feel confident in doing the driver assessments (e.g., Jang et al., 2007; Marshall et al., 2012; Sims et al., 2012). Previous research has stressed the importance of multidisciplinary assessments and need of specialized training in any fitness to drive evaluations (e.g., Larsson et al., 2007; Sommer et al., 2004; Marshall et al., 2012) but the recommendations do not seem to have transferred to the practices in place.

Some countries, for example, Ireland, do not specify the content of the medical assessment. Comparatively comprehensive assessments were found in Greece, Luxembourg, the Netherlands, Romania, Slovakia, Slovenia, Spain, Sweden and the UK, where they generally include sensory, psychological and cognitive examinations.

Reporting methodologies also vary between countries, with some relying on the drivers themselves and family members to report any illnesses or health related conditions that can have an impact on fitness to drive, or on the family physician to report if there is any concern over fitness to drive. A majority of the countries with age related fitness to drive assessments rely on fixed obligatory procedures at prescribed intervals. The different practices have different legal and moral implications regarding who bears the responsibility of driving fitness. In those countries where the renewal is based on self reports, it is the driver her/himself, while in countries where medical professionals are obliged to report unfit drivers, these professionals are in principle responsible for their patients' fitness (and safety).

2.1.4 Costs

The direct costs of the license renewal vary. The costs to the licence holders are mostly dependent on the practices required for licence renewal, the respective testing procedures and experts involved. The only country where these screenings are free of charge for older drivers is Cyprus. In the remaining countries costs vary greatly with especially high costs if practical driving exams are needed. The lower



fees range between 15 and 20 € but costs go up to 108 € in Greece for an assessment not even including a driving exam or up to approx. 120 € for in-depth fitness to drive assessments in the UK for those drivers whose fitness is in doubt.

The overt, direct costs have to be borne by the licensee in most countries, with generally no health care allowances being available. However, there are indirect costs of the procedure to be borne by the society. In most cases, the driver fitness examinations are subsidized so that the licensee only pays parts of the real costs. In addition, coordinating a screening system involving the licensing authorities, health professionals and the licensee bears some costs that the society is responsible for.

2.2 Country Examples

In the following the licence-renewal procedures of the CONSOL partner countries are described in more detail. The descriptions illustrate the wide spectrum of different procedures within Europe.

2.2.1 Austria

In Austria there is no legislative basis for a mandatory screening of certain age groups with regard to their fitness to drive. There are, however, legal means for assessing the fitness to drive among car drivers as prerequisite to obtaining and maintaining a driving licence, especially after certain health related incidents (including driving observation rides if a significant health condition is indicated, or psychological diagnostics). Mandatory assessments can be ordered by public health officers and are carried out by medical specialists and/or traffic psychologists depending on the assessment of the appointed expert; in addition there is also a legal obligation for all licence holders to communicate any impairment negatively affecting abilities to drive.

While there is recurring discussion about whether mandatory age-based assessments should be introduced, fitness to drive assessments are only offered on a voluntary basis: Older car drivers can voluntarily participate in traffic psychological driving behaviour observations and diagnostic screenings, the costs however have to be borne by clients themselves, with mobility checks for older drivers costing around 150€, depending on the respective institution. Another voluntary option specifically aimed at older drivers over 60 years is the “Mobil sein – mobil bleiben”³ (being mobile – staying mobile) initiative by the ÖAMTC, a 6 hour course costing 55€ (45€ for club members), which includes road safety training and reaction and concentration training lessons.

The „Kuratorium für Verkehrssicherheit“ (KfV) initiated the „bewusst.sicher.werkstatt – Verkehrskompetenz für SeniorInnen“⁴ (aware.safe.workshop – traffic competence for seniors) a platform where older drivers, usually above 65 years, can participate in discussions and workshops on how to drive safe, compensate for experienced problems and improve self-assessment and self-perception of driving skills and abilities.

Results of a qualitative study published in 2011 by the KfV showed that supporting constant mobility by providing opportunities to improve perception and reaction skills among older car drivers proves to be more effective than restraints and mandatory screening tests.

The ongoing discussion among Austrian traffic sociologists, psychologists and responsible public institutions is currently centred around the EU directive on driver licensing (classes A and B) in

³ Source: <http://www.oeamtc.at/?id=2500,1109099,> (07.09.2012)

⁴ Source: <http://www.bewusstssicher.at/senioren.html> (07.09.2012)

Europe⁵, as EU member states will issue drivers licences with a validity period between only 10 and 15 years from January 19th, 2013 on. In this context the introduction of mandatory health examinations to assess fitness to driver, or shorter validity periods for licences of drivers above 50 years, are debated intensely, although no specific plans have been presented yet.

2.2.2 Czech Republic

In the Czech Republic, driver licence renewal for persons older than 60 is regulated by law, which requires licence holders to undergo medical fitness to drive examination at the ages of 60, 65 and 68 (at the earliest 6 months before, and no later than on the day they reach the respective age) and every two years thereafter. When driving a motor vehicle, drivers of these age groups must be able to present an original certificate of their medical fitness to drive.

The Ministry of Transport has issued a form for the certification of medical fitness of drivers aged 60 years and older. However, according to experts, it is not binding. It is sufficient if the driver carries a certificate of medical fitness that includes:

- Basic identifying information about the assessed person,
- Data on driving licence groups for which the medical fitness was assessed,
- Result of the assessment of medical fitness, i.e. an indication of whether a person is physically fit,
- If there is any medical condition (and which),
- Or if the driver is medically unfit,
- Date of issue of the report and its expiry date,
- Details on the doctor (or medical organisation) that issued the report, including stamp and signature.

A report of medical fitness to drive motor vehicles is issued by an examining physician after evaluating the licence holder's health. The report must also include a self-assessment of the driver's subjective condition. It is based on previous entries in medical records kept for the person under consideration, provided by the registering practitioner, and the results of other special examinations that the examining physician has required. In most cases, professional examination by an ophthalmologist is required. If the driver has chronic conditions and the physician is undecided about the ability to drive safely, examination by a neurologist or other specialist may be required. The price for the preparation

⁵ Directive 2006/126/EC of the European Parliament and of the Council of 20 December 2006 on driving licences.

of the medical fitness certificate varies in different medical facilities. It usually ranges from CZK 200 to 500 (approx. 8-20 €).

Until April 2011, general practitioners did not necessarily receive all information regarding the driver wishing to renew the licence from specialists, if they did not particularly ask for them. Currently, the general practitioner is informed of the patient's health condition, even if he/she only visits a specialist. In addition, any physician is required to notify the relevant licensing authority about any concern over a driver's medical fitness. This will cause a re-examination of medical fitness and can lead to subsequent withdrawal of a driving licence.

To date the Czech licence renewing procedure has not been evaluated.

2.2.3 Denmark⁶

In Denmark, the driver licence is valid until the age of 70. Thereafter, it needs to be renewed at the age of 70, 74, 76, 78, and 80. After the age of 80, the licence needs to be renewed every year.

In order to renew it, the driver needs to go through a physician's check for a medical certification. As of May 1st 2006, a short version of Mini-mental test (cf. Folstein, Folstein & McHugh, 1975) and the clock-drawing test (cf. Critchley, 1953; Shulman, Shedletsky, Silver, 1986) were added to the examination in order to identify drivers with cognitive deficits. The costs for getting the certification are not fixed and vary among physicians (approx. 40-80 EUR).

If the physician has no concerns, the licence can be renewed. The cost for a new licence is ca. 4 EUR (30 DKK). If the physician is undecided or has concerns, the process will be dealt with by the police, and usually the applicant needs to undergo a practical driving exam. The test costs ca. 117 EUR (870 DKK, at the time of writing). This and the hire of the test car are paid by the driver. The driving exam must include different traffic environments and comprises the same elements as the driving test for novice drivers. Police can also gather further information about the applicant, such as neuropsychological test results, in order to make a decision. After the police have made a decision, the applicant will be informed. He/she has the possibility to appeal to the police.

The renewal procedure and the age limits were reviewed by a working group about ten years ago (Sundhedsstyrelsen, 2003) and the age limit for licence expiration (70 years) was decided to be kept unchanged. The working group recommended adding cognitive tests to the medical screening, and this was implemented in 2006.

Aspects of the Danish screening system have been evaluated in two studies. First, Hansen and Hansen (2002) did a pilot study of the new screening system with Mini-mental test (m-MMSE) and

⁶ The country descriptions of Denmark and Sweden are slightly adapted versions of the descriptions provided by Anu Siren in the VTI report 749A (Levin et al., 2012).

clock drawing test before it was implemented in the whole country. In the study, two periods were compared: a period before (6 months) and after (10 months) implementation of the cognitive test. The study was carried out in Southern Jutland. During the two periods, a total of 6,091 people applied for a licence renewal (2,631 before and 3,460 after the implementation of the cognitive test). Before the test was introduced, 0.6 per cent of drivers (15 persons) did not get their licence renewed, while after the test was introduced, the share was significantly higher, namely 1.5 per cent (50 persons). There were also fewer older drivers than normally who applied for licence renewal after the test was introduced. The conclusion of the study was that the use of m-MMSE resulted in higher numbers of drivers who were sent to a driving test and higher numbers of drivers who did not renew their licence. This was seen as positive effect and it was concluded that the use of cognitive screening would enhance road safety.

Safety effects were, however, not evaluated in the Hansen and Hansen (2002) study, and thus their main conclusion is somewhat unfounded. A more recent study by Siren and Meng (2012) evaluated the safety effects of the renewal procedure with cognitive screening. In their study, they compared accident rates for older road users before and after nation-wide implementation of the m-MMSE and clock drawing test. Their results showed that while there was no change in accident rates before and after for older drivers, there was a significant increase in fatalities among older vulnerable road users (bicyclists and pedestrians). This increase was not found among the control group (18–69 year olds). The authors concluded that while cognitive screening had not succeeded in preventing accidents among older drivers it had caused a modal shift into less protected modes of transport, thus indirectly causing more pedestrian and bicyclist fatalities among older persons.

Recently the Regionale Færdselssikkerhedsudvalg (the Regional Road Safety Committee) in Denmark created a brochure that describes why and how to renew the licence. The leaflet was tested among all 69 year old drivers in East Jutland, and 41 per cent of them responded to an enclosed questionnaire. The project showed that nine out of ten were now planning to renew their licences in good time. The leaflet led more older people, especially older women, to think about their driving licence and their spouse to persuade them to continue to drive. Some respondents said they would now drive more often or take a refresher course (Regionale Færdselssikkerhedsudvalg, 2011).

2.2.4 France

In France, the driver licence is valid for the whole life.

The stipulations on whether a private car driver has to undergo a medical examination are given in article R226-1 of the Highway Code. The driving licence can be invalidated or adapted if the driver presents a medical condition incompatible with safe driving. The health criteria for driving a motor vehicle that form the basis for the medical examination are given in the ministerial order published in August 31 2010 (last version to be similar to the EU directive). These criteria are clustered in different

topics: cardiopulmonary, vision, otolaryngology, pneumology, addiction, neurology and psychiatry, physical. Age is not a topic *per se*; however, it could relate to various criteria. Drivers are supposed to report on their own initiative any health problems that could negatively impact their driving. General practitioners are not allowed to do that because it would be considered as a violation of the patient-doctor confidentiality. Family or care givers can report health concerns over drivers. Once the case of a driver is reported to the driving licence authorities, he/she will be convoked to a medical examination made by two accredited doctors. In France there are 2500 doctors accredited to do the medical check for the driving licence. These doctors get a 3-day training course on a regular basis, which always includes a 2-3 hour information session on car-adaptations and driving solutions for the disabled. Drivers that have to undergo a medical examination are assessed by the two doctors in the building of the local driving licence authorities. The normal fee for this medical check is about 33 €. For applicants with a disability the medical check is free of charge. If the medical situation requires specific knowledge, the accredited doctors can ask for external advice from a specialist; this is particularly the case for diseases like Parkinson or Alzheimer. It is also possible to request a practical trial.

There is no available data about this reporting system and the activity of this medical committee but unofficially, it is suggested that the system works only for drivers suffering from a major health problem which require them to go to the hospital. Otherwise the majority of older drivers will stop as a result of pressure from their family or caregivers or their general practitioner regarding the possible absence of risk insurance coverage.

The road safety administration in association with the health administration has then developed a new approach which targets general practitioners. An information leaflet has been produced to explain French regulations about fitness to drive and to give some guidelines that can help the GP to detect if the driver has difficulties with driving. The information is aimed at older drivers and their family; but again, no reporting to the local driving licence authorities is planned.

2.2.5 Spain

In Spain, the driver licence is valid for 10 years until the driver turns 65 years, and for 5 yearly intervals thereafter (shorter relicensing intervals are always possible). In order to obtain or renew a licence, the driver needs to undergo medical and psychological examination. The examination is carried out in specific medical centres by a general physician, an ophthalmologist and a psychologist.

The examination includes 13 dimensions (see Table 2). The cost of the examination depends on type of driving licence and if it is first issuance or renewal. Costs range between 50 to 70 € and are paid by the licence applicant.

Table 2: Dimensions and tests of the Spanish driver’s check-up (R.D. 818/2009 & Orden PRE 2356/2010)

1) Visual capacity	Visual acuity, visual field, aphasias & pseudoaphasias, luminous sense, palpebral motility, eyeball mobility, progressive deterioration.
2) Auditory capacity	Audio acuity (hypoacusia).
3) Locomotive system	Motility, progressive affections or abnormalities, height/stature.
4) Cardiovascular system	Cardiac insufficiency, tempo disorders, coronariopathies, hypertension, aneurysms, peripheral arteriopathy, venous diseases.
5) Hematologic disorders	Onco-hematologic processes, processes submitted to chemotherapy, polycythemia vera. Anaemia, leucopenia & thrombopenias, coagulation disorders, anticoagulative treatment.
6) Renal system	Nephropathies, renal transplant.
7) Respiratory system	Dyspnoea, sleeping disorders, others affections with influence on driving safety.
8) Metabolic & Endocrine diseases	Diabetes mellitus, hypoglycemia, thyroid & parathyroid diseases, adrenal diseases.
9) Nervous & Muscular systems	Encephalic, medullar & nervous peripheral system diseases, epilepsies & convulsive crisis, balance disorders, muscular disorders, transitory & recurrent ischemic accidents.
10) Mental & Behavioural disorders	<ul style="list-style-type: none"> – Delirium, dementia, amnesic & other cognitive disorders, – mental disorders due to medical disease not classified under others paragraphs that could suppose a risk for road safety, – schizophrenia and other psychotic disorders, – affective disorders, – dissociative disorders, – sleeping disorders of non respiratory origin, – impulse-control disorders, – personality disorders, – disorders of the intellectual development, – attention deficit disorder and disturbing behaviour, – other mental disorders not included in previous paragraphs that could suppose a risk for road safety.
11) Disorders related to substances	<ul style="list-style-type: none"> – Alcohol abuse, alcohol dependence, alcohol induced disorders, – habitual consumption of drugs and medicines, medicines or drugs abuse/dependence, medicines or drugs induced disorders.
12) Perceptive-Motor aptitudes	Movement estimation (speed perception), visual-motor coordination (both hands), multiple (and discriminative) reaction time, practical intelligence.
13) Other not specified causes which could suppose incapability to drive or could affect the traffic safety	

The general aim of the examination is to verify that no illness or deficiency exists which could affect the fitness to drive or could compromise road safety. If in doubt over some condition or deficiency during the examination, the related professional of the centre can send the applicant to an external specialist in the corresponding field in order to confirm the diagnosis, treat the problem (if it can be treated) or request a detailed report on the treatment that is being received. The overall result of the examination can be:

- *Apt for ordinary renewal/issuance* – When the corresponding criteria are fully accomplished.
- *Not-apt for ordinary renewal/issuance, but apt for extraordinary renewal/issuance* (with written observations and restrictions). Shortcomings or deficiencies which can be compensated for by

restrictive conditions covered by the criteria include: adaptations or limitations of people (e.g.: hearing-aid), of vehicles (e.g.: automatic gearing) or of driving conditions (e.g.: reduction of the speed limit, of the licence validity period, or driving only during daylight hours).

- *Not-apt* (without observations or restrictions) - When the person is not able to drive that class of vehicle (however he/she may be suitable for other licences).
- *Decision interrupted* (delay of decision on renewal/issuance) – When a report from a specialist is outstanding or when the person is in treatment or recuperating.

The result of the examination is sent to the traffic authority by the examination centre, together with the rest of personal information needed to apply for the *issuance* or the *renewal* of the driving licence. A copy of the results is given to the applicant. In case that the applicant does not agree with the result, he/she can contest the decision and request a second assessment from the Traffic or the Health authority, or he/she can go directly to another centre. There is an established procedure for solving such cases.

In order to improve and develop this model, four goals have been established by experts and practitioners linked to the DGT (Traffic General Directorate) for the immediate future of this system:

- To progress the specialization of the facultative professionals.
- To complete this model with secondary prevention activities, like rehabilitation of recidivist drivers and medical advice
- To advance the assessment of specific populations, such as drivers with special needs, reduced mobility,...; in order to facilitate these people's access to the driving.
- And finally, as requirement for achieving the above goals, to develop the computerized database system which enables cross checks of outcome data with other databases (accidents, fines, illness background,...) and to improve data exploitation.

This last measure, which is currently being implemented in a pilot, will facilitate the evaluation of the system, to reveal the examination patterns followed by physicians and psychologists in charge of fitness to drive assessments, and the relations among the assessed dimensions and driving records.

2.2.6 Sweden

In Sweden, an issued driver licence is valid for 10 years and thus needs to be renewed every 10 years, regardless of driver's age. The renewal is administrative and does not require medical examination or other proof of fitness to drive. The drivers are automatically sent renewal forms by mail when the expiry date is nearing. The cost for renewal is at the moment 18 EUR (150 SEK).

Physicians are required to report to authorities if they have patients whose driving ability they have concerns over. Such concerns need to be based on a medical examination, but since 2010, physicians had the possibility (but are not required) to report drivers, who do not want to be examined. If the physician reports a patient, he/she has to be examined further. The responsibility for this lies at The Swedish Transport Agency (Transportstyrelsen), which has a dedicated section for traffic medicine. The actual examinations for fitness to drive are carried out in the centre for traffic medicine.

In Sweden, traffic medicine is a well-established and well-regulated field. Medical issues and procedures related to driver licence have been evaluated, reviewed and redefined several times by different actors and stakeholders (physicians, other traffic medicine professionals, the Association for traffic medicine, researchers, road authorities, and politicians). Especially the roles and responsibilities of physicians have been reviewed several times (e.g. Englund, 2010; Svensk trafikmedicinsk förening, 2009; Vägverket, 2005). The safety effects of the lack of age-based population screening in Sweden have been examined by one study (Hakamies-Blomqvist, et al., 1996), and one study has compared the physicians' competence and attitudes in relation to older driver evaluations in Sweden and Finland (where the system is similar to the Danish one) (Hakamies-Blomqvist et al., 2002).

The first study by Hakamies-Blomqvist et al. (1996) compared accident rates in Sweden (no age-related screening), and Finland, where all drivers from the age of 70 onwards have to go through a medical check in order to renew their licence. The results did not show any safety benefits resulting from the Finnish system, and, on the contrary, showed that Finland had a higher pedestrian fatality rate after the age of 70. The authors argued that by triggering a modal shift from being a car driver to a unprotected road user (pedestrian, cyclist, moped rider), the screening indirectly caused an increase in the number of unprotected road users who were killed, and concluded that the age-based mandatory screening thus produced an overall negative safety effect.

In the second study by Hakamies-Blomqvist et al. (2002) that compared the general practitioners' competence and attitudes in relation to older driver evaluations in Sweden and Finland, it was found that the strict screening policy did not mean that the Finnish general practitioners were better informed about ageing and fitness to drive than their Swedish counterparts, but had more restrictive attitudes towards ageing and driving.

2.2.7 United Kingdom

In the UK driving licences for non-professional drivers are valid up to the age of 70. To maintain the licence after this point, drivers must complete and submit a self-declaration of medical fitness to the Driver and Vehicle Licensing Agency (DVLA) at three yearly intervals. The renewal of the licence is free of charge for drivers aged 70 or older.

Irrespective of age drivers are legally required to notify the Drivers Medical Branch at the DVLA of any disability (either physical or medical condition) which is, or may become, likely to affect their fitness as a driver. Medical standards for both non-professional and professional drivers are summarized in a guidance document for medical practitioners (available at <http://www.dft.gov.uk/dvla/medical/aag.aspx>). The DVLA will request a report from the driver's doctor or other specialist and can subsequently (completely or temporarily) revoke the licence or refer the driver to one of 17 accredited Mobility Centres in the UK to undergo a comprehensive fitness to drive assessment.

The Mobility Centres in the UK were initially established to support disabled drivers. Today they provide information, advice and assessment to people wishing to begin, or continue, using personal transport following injury, illness or disability. This includes fitness to drive assessments for older drivers. The range of assessment services provided by the Centres varies and can comprise cognitive and perceptual tests, physical ability tests, vision tests, rig assessments and an in-vehicle assessment. At a minimum, they include a functional examination of fitness to drive and advice on vehicle and control adaptations, where necessary. The average length of an assessment is three hours, and driving performance assessments are usually carried out in the patient's own vehicle. Staff employed at Mobility Centres typically are occupational therapists and approved driving instructors, but can also include clinical psychologists, GPs, psychotherapists, nurses and social workers.

Following the assessment, Mobility Centres provide a recommendation to the DVLA of whether the examinee is considered fit to drive, unfit to drive or whether further monitoring and examination is required to make a decision. It is for the DVLA to make the final decision on the extension or curtailment of the driving licence.

Older drivers can also consult with their General Practitioner (GP) if in doubt over their fitness to drive, can be referred to a specialist, or a Mobility Centre by their GP for an assessment or can self-refer there. GPs may also report a driver to the DVLA if in doubt over their fitness to drive and when there is a concern that the driver may pose a risk to other road users. However, to protect doctor-patient confidentiality and avoid the potential damage to the doctor-patient relationship that may arise from the notification of the licensing agency without the older driver's consent, GPs are not legally required to notify the DVLA if they have concerns over a patient's fitness to drive.

There have been no systematic evaluation studies carried out in the UK to date to ascertain the impact of current age-based controls on road safety.

2.3 Summary

While there is a predominance of fitness to drive screenings in Europe, there is a high variance regarding the details of these assessments. Not all of the countries with limited validity of issued licences require age based screenings, but rather require renewal procedures at constant time intervals (in most cases every 10 years).

The testing procedures as well as the responsibility of reporting medical conditions eventually impairing fitness to drive also vary between countries and range between self report questionnaires to processes in which several medical specialists are involved.

The required procedures are tied to varying ages for the first assessment and different time periods between screenings, with some countries reducing time periods between examinations from 40 years on and countries with first assessments at age 70.

The heterogeneity of fitness to drive screenings also persists with regard to the costs associated with the assessment procedures. In only one of the countries fitness to drive screenings is free for the seniors applying for license renewal, in all other countries these procedures are associated with costs that usually depend on the required procedures and can be as high as 117€ (Denmark) if a practical driving exam is required.

Evidence of the effects on traffic safety of these procedures is scarce. Considering the CONSOL partner countries, evaluation studies were only available for Sweden and Denmark. These led to the joint conclusion that there are no positive effects of age-based checks on traffic safety, on the contrary: increased numbers of older road users not renewing their licences and others not passing the examination, led to a subsequent increase in numbers of older road user injuries due to changing to less protected modes of transportation.

3 Effects of age-based assessments of older drivers – a literature review

3.1 *Evaluation studies from three continents*

The safety effects of screening older drivers for fitness to drive have been studied in many different contexts and with different study designs. Basically we can distinguish between:

- studies that evaluate the effects of newly introduced or changed assessment procedures by comparing accident rates (or other safety/mobility related variables) before and after the implementation;
- studies that compare safety and/or mobility related variables between regions that differ in their licence renewal policies.

In the first type of studies it has to be considered if any other societal or political changes have happened within in the period of examination, which could have influenced the results. The problem of the second type of study is that regions differ in aspects other than their licence renewal policies, which may also have an impact on accident rates. These factors (e.g. infrastructural aspects, road traffic law and its enforcement, socio-demographic structure) have to be controlled for in order to obtain reliable results.

The evaluation studies, described in the following, cover research from the last 20 years and three continents (North America, Australia/Oceania, Europe) and are summarized in Table 3.

Rock (1998) compared the accident rates in the State of Illinois before and after the licence renewal rules were revised. For the younger age group (69–74 years old), the rules were eased by removing the earlier mandatory driving test from the licence renewal procedure. For the older age group (81+ years old), the rules were tightened and the licence renewal was set to every second year (every year for drivers aged 87+), where it had previously been every 4 years. The conclusion was that no safety effect could be observed; the new rules did not lead to an increase in the number of accidents caused by the younger of the older drivers, nor did it contribute to a decrease in the number of accidents involving the older of the older drivers. McGwin et al. (2008) compared the motor vehicle collision fatality rates before and after a new visual acuity licensing standard for 80+ drivers was implemented in Florida in 2004 and found a significant reduction in their fatality rates, while overall fatality rates in Florida increased. A similar decrease in older drivers' fatality rates was not found in bordering states and was thus ascribed to the implementation of the vision test.

At least six other American studies (Grabowski et al., 2004; Lange and McKnight, 1996; Levy et al., 1995; Nelson et al., 1992; Sharp & Johnson, 2005, Tay, 2012) compared accident rates in different states with different age-based licence renewal policies. Levy et al. (1995) compared 50 US states analysing Fatality Analysis Reporting System (FARS) accident statistics, and found only testing for visual acuity to be related to lower accident rates, while adding knowledge tests to the renewal procedure had no significant effect. In a study by Lange and McKnight (1996), accident rates in states with age-based road testing were compared with neighbouring states without such skill tests. In states requiring age-based skill testing, tested drivers showed significantly lower relative involvement in injury accidents than drivers in the comparison states. However, if this result was due to the removal of unsafe older drivers, and not just due to an overall reduction of older drivers, one would expect that a greater proportion of the accidents by older drivers in the states without testing were single vehicle accidents, for which the elderly drivers were more clearly responsible. However, the opposite was the case, which questions the safety benefits of age-based renewal testing. In line with this, a Canadian study (Tay, 2005) examining the licensing requirements in five provinces and their related vehicle collision rates, found a positive correlation between the stringency of the requirements and mean crash rates.

In contrast, a study by Sharp and Johnson (2005), who tested the effect of different state policies (renewal cycle, vision & written test, road test, combined tests) for driver's licence renewal in regression analyses, came to the conclusion that stricter examination of driving, such as both eye tests, paper-pencil test and practical test, leads to better road safety. The study, however, shows some methodological weaknesses. The applied level of significance, for example, differs from what is commonly accepted, and the study did not control for other possibly interfering factors on state-level. Nelson et al. (1992) compared the involvement in a fatal crash of older licensed drivers in 20 US states, which differed with regards to their vision testing requirements for relicensing. According to their results mandatory vision testing is associated with a lower risk of older driver's crash involvement. The results were, however, not statistically significant for all considered age groups. A more recent study by Grabowski et al. (2004) investigated a number of factors including in-person renewal, vision tests, road tests and the frequency of licence renewal (which vary in different states) as predictors of older driver's safety. The study showed that the only predictor of lower accident rates was in-person renewal (as opposed to renewal by post), and that this effect was only observed for those aged 85 years and older. Additional tests, regardless of whether they were medical or tests of practical driving skills, had no effects on safety.

Grabowski et al. (2004) explained the fact that earlier studies (Levy et al., 1995; Nelson et al., 1992; Shipp, 1998) by contrast had found a positive effect of vision-testing, by one or more out of four limitations of these studies: (1) the effects of in-person licence renewal and vision test laws were not examined separately; (2) the data were older; (3) state traffic laws unrelated to licensure (e.g. seatbelt

laws, speed limit laws) were not controlled for; (4) the heterogeneity in the response to licensure laws in the younger old and the older old was not recognized. The first limitation also holds for the more recent study by McGwin et al. (2008), who themselves point out that the exact mechanism responsible for the association between lower accident rates and the introduction of vision tests for 80+ drivers remains unclear because of lacking evidence for an association between visual acuity and accident involvement.

Kulikov (2011) examined the impact of five different state relicensing policies on the reduction of driving and driving cessation of older drivers in the United States. She found that older people's driving mobility was not only influenced by their health and socioeconomic backgrounds, but also by state relicensing policies. According to the results "in person renewal at age 70+", "restricted licensing" (e.g. driving allowed only during daylight hours, additional vehicle equipment required) and "peripheral vision testing" significantly reduced the likelihood of driving reduction and/or cessation, while "mental testing" and "accelerated renewal" (i.e. requirement for older people to renew their drivers' licences more often than younger people) significantly increased driving reduction and cessation. The author recommends restricted licensing as "a potential mechanism for extending the years of independent mobility for older people" (p. 15). Support for restricted driving also comes from a Canadian study (Nasvadi & Wister, 2009). Comparing crash records of restricted and unrestricted older drivers over a 7-year-period (1999- 2006), it was found that the risk of causing a crash was 87% lower for restricted drivers compared with unrestricted drivers after controlling for age and gender. In addition, restricted drivers kept their licence longer than unrestricted drivers and continued to drive crash free longer.

The results of the different American studies comparing the safety effects of different licensing procedures are not consistent. There is, however, no evidence that a general age-based assessment has any safety effects. The only aspects that have been found to be related to safety or mobility in more than one study are vision testing (with methodological weaknesses), in-person renewal and restricted driving.

An Australian study (Langford et al., 2004a) compared older (80+ years old) drivers' crash rates in Melbourne, where no age-based screening is used, and Sydney, where drivers have to undergo a medical check and a driving test at the age of 80. No safety benefit could be observed for the seniors in Sydney in this study; on the contrary, crash rates calculated on a per-licence-issued basis and time-spent-driving basis were even higher. Another Australian study (Langford et al., 2004b) compared older driver accident statistics in six Australian states with different licensing policies. The results showed that the older driver accident rates were lowest in Victoria, the only state without age-based mandatory screening. Furthermore, Langford, Bohensky et al. (2008) studied the effects that screening policies for older drivers had on other road users' risk of being killed by an older driver. They found that age-based mandatory assessment programmes did not have demonstrable safety benefits, in terms of either the total number of fatalities or the number of deaths of other road users. Ross et al.

(2011) investigated the effect of age-based testing among older Australians, comparing data from states with different mandatory age-based licence testing practices. They found that after accounting for demographic, health and functional factors older adults required to undergo an age-based testing were between 2.2 and 1.5 times more likely to report not driving. Moreover, the percentage of drivers with probable cognitive or visual impairments was similar in the groups with and without age-based testing.

This indicates that older people's mobility was restricted by age-based testing without any safety related effects. In a study from New Zealand (Keall & Frith, 2004b) a newly introduced system for licensing older drivers was evaluated. The new system included a practical on-road driving test that had to be completed every two years from the time the driver turned 80. The study examined all drivers who finally passed the test (after one or more attempts) within the first three years of operation. The results indicated that each driving test failure prior to passing the driving test was correlated with an increased accident risk of 33%, when other driver characteristics, such as age and gender, were controlled for. The authors concluded that the results indicated that the driving test had the ability to identify accident involvement. An important question, that naturally could not be answered by the study, is how the crash involvement of people who failed the test and gave up trying (5%) would perform and in how far their accident risk increased being involved in traffic as an unprotected road user after having lost the licence.

The studies from Australia and Oceania that compared regions with different licensing policies found no safety benefits of age-based screening programmes.

In the European context, Mitchell (2008) compared seven EU-member states with different older driver licensing policies. He found that the ratio of fatality rates for older car drivers relative to the rates for middle aged car drivers were lowest in countries that had fewer requirements for licence renewal and thus a higher level of licence holding for older car drivers. Hakamies-Blomqvist et al. (1996) compared accident rates in Sweden, where there is no age-related screening, and Finland, where all drivers aged 70 or more have to go through a medical check in order to renew their licence. The results did not show any safety benefits resulting from the Finnish system, and, on the contrary, showed that Finland had a higher pedestrian fatality rate for people aged 70 and older. The authors argued that by triggering a modal shift from being a car driver to being an unprotected road user (pedestrian, cyclist, moped rider), the screening indirectly caused an increase in the number of unprotected road users who were killed, and concluded that the age-based mandatory screening thus produced an overall negative safety effect. They also suggested that the screening may have an effect on the wrong sub-groups, i.e. on people who were more sensitive to social pressure and had a high feeling of subjective risk, but were safe drivers. This possibility is also consistent with the results of Langford et al. (2004a,b) and Siren and Meng (2012). The latter compared the number of fatal accidents before and after a screening for cognitive impairment was included in the existing screening procedure in

Denmark in 2006. The authors did not find any safety benefits of the addition of the cognitive screening to the screening procedure, but observed an increase of the number of fatalities in unprotected road-users, possibly due to a modal shift from car driving to walking and cycling.

Finally, the road safety institute SWOV conducted a literature study to estimate the road safety effects of raising the minimum age from 70 to 75 for the medical examination for driving licences in the Netherlands (Vlakveld & Davidse, 2011). It came to the conclusion that instead of raising the minimum age, the age-related medical examination should be completely abolished.

Summarising the results from Europe, the few existing studies conclude that aged-based licence renewal is rather associated with negative safety effects for older people. Taking into account the studies from all three continents, there is no evidence that a general age-based screening has any safety benefits. There are some positive effects found for single measures, namely vision testing, in-person renewal and restricted driving (all in the American context).

The conclusions that can be drawn based on the reviewed studies will be discussed in more detail in the following.

Table 3: Studies examining the relation between accident involvement and different licence renewal procedures for older road users

Authors, year of publication	Setting	Methods/Design	Main outcome	Conclusions, comments	Safety effect [specific measure]
Grabowski, Campbell, Morrisey, 2004	all US states (1990-2000)	Retrospective, longitudinal study conducted 1990-2000 of all fatal crashes in the US, which involved older drivers of three age groups (65-74; 75-84; 85+) or middle-aged (25-64) drivers. In two regression approaches the effect of state laws mandating in-person renewal, vision tests, road tests, and frequency of licence renewal on driver fatalities were studied.	among individuals aged 85+ states with in-person licence renewal were associated with a lower driver fatality rate vision tests, road tests, more frequent licence renewal, and in-person renewal for individuals aged 65-74 and 75-84 years were not independently associated with the fatality rate among older drivers	state-level factors (e.g. number of licenced elderly drivers, traffic laws, per capita income) were controlled for limitations and differences to the results of other studies (esp. w.r.t. vision testing) are discussed thoroughly	+ [in-person renewal] 0 [other measures]
Hakamies-Blomqvist, Johansson, Lundberg, 1996	Finland (age-based medical screening); Sweden (no age-based screening) (1990)	Comparing injury accidents, fatality rates of car drivers and passengers, and fatality rates of unprotected road-users between Sweden and Finland.	similar age-related variation in injury accidents and car fatality rates among Finland and Sweden higher age-related increase in fatality rates of unprotected road users in Finland	no safety benefits of ages-bases screening but possibly shift of older drivers to unprotected modes with higher accident risk authors discuss possibility that older driver screening makes relatively safe drivers cease driving and keeps unsafe drivers on the road	0/-
Lange, McKnight, 1996	Illinois, Indiana (age-bases testing); Michigan, Ohio (no age-bases testing) (1991–1992)	Per-driver accident rates of US states with age-based licence renewal testing (road tests) were compared with those of neighbouring states without such testing.	in US states requiring age-based skill testing, tested drivers had significantly <i>lower</i> relative involvement in injury accidents than their counterparts in the comparison states in single-vehicle accidents (for which the elderly drivers were more clearly responsible) older drivers in the states with age-based testing had <i>higher</i> accident rates	the ability of age-based renewal testing to achieve significant reductions in unsafe older drivers is questioned by the results as differences could be due to reducing the number of older drivers per se, not older unsafe drivers limitation: differences among states, other than their renewal policies, were not controlled for (but were partly controlled by choosing neighbouring states)	0
Langford, Fitzharris, Koppel, Newstead, 2004	Melbourne (no age-based testing); Sydney (age-based testing) (1996–1999)	Crash rates per population, per licenced driver, per distance driven, and per time spent driving were compared between Melbourne and Sydney based Poisson regression method.	drivers aged 80+ years in the Sydney region had higher rates of casualty crash involvement than their Melbourne counterparts, statistically significant on a per licence issued basis and time spent driving basis	no safety benefits found authors discuss possibility that older driver assessment makes relatively safe drivers cease driving and keeps unsafe drivers on the road	0/-

Authors, year of publication	Setting	Methods/Design	Main outcome	Conclusions, comments	Safety effect [specific measure]
Langford, Fitzharris, Newstead, Koppel, 2004	Queensland, Tasmania, Western Australia, New South Wales, Victoria, South Australia (1994–1998)	Older driver fatal and serious injury crash involvement rates were compared between Victoria (no age-based screening) and states with different licensing procedures.	on a per-licensing basis, drivers aged 80+ in all states had higher serious injury crash involvement than drivers from Victoria on a per-population basis, Victorian older drivers were at least as well performed as those from other states	various mandatory assessment procedures were not associated with road safety benefits limitations are discussed, esp. that the comparisons may be influenced by other differences between the states	0/-
Langford, Bohensky, Koppel, Newstead, 2008	Victoria (no age-based testing); New South Wales (age-based testing), Australia (1988-2001)	Fatality rates associated with older drivers in both states were calculated for the main categories of road users per number of target drivers and per number of licenced drivers.	no significant differences between the states in terms of the total number of fatalities or the number of deaths of other road users	age-based mandatory assessment programs showed no demonstrable safety benefits	0
Levy, Vernick, Howard, 1995	all US states (1985-1989)	Effect of different state policies for driver's licence renewal (vision tests, knowledge tests, road tests) on fatal crashes involving senior drivers were estimated by regression methods.	mandatory testing for visual acuity, adjusted for licence renewal period, was associated with lower fatal crash risk for older drivers	differences among states, other than their renewal policies, were controlled for	+ [vision test]
McGwin, Sarrels, Griffin, Owsley, Rue, 2008	Florida (visual test introduced for drivers aged 80+), Georgia, Alabama (2001-2006)	Motor vehicle collision (MVC) fatality rates for all Florida residents and for drivers aged 80+ were compared before and after the implementation of the “visual acuity licensing standard”. Bordering states (Georgia, Alabama) were used as control measures.	the fatality rate, among all age-groups increased comparing the pre-post period by 6% while fatalities among drivers aged 80+ decreased significantly by 17%; in Georgia and Alabama no changes in older drivers fatalities was found	limitations of the study and alternative reasons for the decline in older road users decrease in fatality rates are discussed	+ [vision test]
Mitchell, 2008	Denmark Finland, France, The Netherlands, Norway, Sweden, UK	Association between driver licensing procedures in 7 European countries and older driver safety is looked into.	countries with the highest level of licence holding for older car drivers have the lowest ratio of fatality rates for older drivers relative to middle aged car drivers two of the three countries with the most relaxed licensing procedures, have the lowest fatality rate for car drivers aged 65+	concludes that there is no evidence that any licence renewal procedure has an effect on the overall road safety of drivers aged 65+ no inferential statistics to confirm the statistical significance of the purely descriptive results	0
Nasvadi, Wister, 2009	British Columbia, Canada (1999-2006)	Crash records of restricted and unrestricted drivers aged 66+ were compared in a cohort study design.	risk of causing a crash was 87% lower for restricted drivers compared with unrestricted drivers after controlling for age and gender	authors conclude that driving restrictions may be effective for prolonging the crash-free driving of some ageing drivers	+ [restricted driving]

Authors, year of publication	Setting	Methods/Design	Main outcome	Conclusions, comments	Safety effect [specific measure]
Nelson, Sacks, Chorba, 1992	20 US states with/without required vision testing for relicensing (1986-1988)	Fatal accident rates in states that conduct periodic vision testing with that in states not requiring such testing were compared, examining the ratios of fatality rates for different groups of 65+ drivers against those of drivers aged 45-64.	significantly higher ratios in the states without vision testing for 65-74 and 85+ aged drivers vs. 45-64 year-olds ($p < .05$); but not for 75-84 year-olds ($p = .05$)	other potential reasons for the differences between the states were not considered	+/0 [vision test]
Rock, 1998	Illinois (US) (1987-1989; 1995)	Examination of crashes, fatal crashes, crash rates, and licensure rates of senior drivers before and after a revision of the length of licence term and renewal requirements (road test) for older drivers	eliminating of a road test for age group 69-74 had no negative safety impact more frequent renewal period for those aged 81+ showed no benefit compared to control group (=75-80 y., no change)	methodological and data limitations are discussed thoroughly a policy of 4-year renewal is suggested as being more efficient in an overall cost-benefit sense	0
Sharp, Johnson, 2006	15 US states (1990-1999)	Effect of different state policies for driver's licence renewal (renewal cycle, vision & written test, road test, combined tests) on older driver crash involvement estimated by regression methods.	crash rates are positively related to the length of the renewal cycle for older drivers and negatively related to the stringency of testing at renewal	methodological problems the reported effects are not significant on a commonly accepted level existing research in this field is ignored	(+)
Shipp, 1998	US states (1989-1991)	Effect of state vision-screening relicensing policy on vehicle occupant fatality rate for 60+ aged drivers estimated by regression methods.	vision-related relicensing policies were significantly associated with lower vehicle occupant fatality rates of older drivers	other potential reasons for the differences between the states were controlled for	+
Siren, Meng, 2012	Denmark (2003-2008)	Number of fatal accidents before and after the addition of screening for cognitive impairment to the existing screening procedure are compared.	no significant difference in the number of older drivers involved in fatal accidents before and after the implementation of the cognitive screening significant increase in the number of unprotected older road users who were killed between the two periods	screening had no effect on the safety of older drivers screening process may have produced a modal shift among older persons from driving to unprotected modes of transportation	0/-
Tay, 2012	5 Canadian provinces (1998-2004)	Effect of stringency of the licensing in 5 provinces on number of crashes involving ageing drivers by regression methods.	stringency of licensing for ageing drivers is associated with increase in crashed involving ageing drivers	other potential reasons for the differences between the provinces were controlled for	-

+ = positive effect on safety; - = negative effect on safety; 0 = no safety effect; 0/- = no overall safety effects, partly negative effects; () = study has limitations that restrict the validity of results

3.2 Implications of evaluation studies

In this section the effects of mandatory age-based screenings are assessed based on different criteria: safety, mobility, cost-benefit, adequacy of methods, and ethical aspects based on the respective literature.

3.2.1 Safety-related aspects

As shown in Chapter 3.1, previous research indicates that mandatory age based screening in general has no positive safety effects (e.g. Hakamies-Blomqvist et al., 1996; Heikkinen et al, 2010; Langford et al., 2004a,b; Mitchell, 2008; Siren & Meng, 2012). Research rather suggests that stopping older people from driving may have negative safety effects, as they tend to shift from driving a car to unprotected modes of transport (cf. Hakamies-Blomqvist et al., 1996; Heikkinen et al, 2010; Siren & Meng, 2012). At present, the unprotected modes of transport, that is, primarily walking and cycling, are significantly less safe for older persons. Because of their higher fragility this is especially problematic for women and the oldest old (e.g. Hakamies-Blomqvist et al., 2004; Kirk et al., 2003; Li et al, 2012; Meuleners et al, 2006; Stevens & Sogolow, 2005).

3.2.2 Mobility-related aspects

Previous research has shown that mobility and the ability to leave the home are essential aspects of the quality of life of older persons (Farquhar, 1995), and often connected to psychological well-being, independence, and the sense of being empowered in old age (e.g., Bonnel, 1999; Fonda, Wallace & Herzog, 2001; Gabriel & Bowling, 2004; Marottoli et al., 1997; Ragland, Satariano & McLeod, 2005). Any measures that restrict older people's mobility should thus be avoided, especially when they fail to demonstrate the intended safety effect. The requirement for older people to renew their drivers' licences more often than younger people has been found to be significantly related to increased driving reduction and cessation (Kulikov, 2011). Driving cessation is associated with a decrease in activities outside the home (Harrison & Ragland, 2003; Marottoli et al., 2000; Rosenbloom, 2001) as well as a decrease in mobility options (Peel, Westmoreland, & Steinberg, 2002; Taylor & Tripodes, 2001). In addition, previous studies have found driving cessation related to negative health outcomes, such as increased depressive symptoms (Fonda, Wallace, & Herzog, 2001; Marottoli et al., 1997; Ragland, Satariano, & McLeod, 2005), decreased life satisfaction (Harrison & Ragland, 2003) and declines in physical and social functioning (Edwards, Lunsman, Perkins, Rebok, & Roth, 2009; Mezuk & Rebok, 2008). Consequences of giving up driving vary with socio-demographic variables, such as age, gender, income and place of living, with rural residents and low-income groups being particularly affected (Haustein et al., 2013).

Previous research has shown that coercive renewal policies make especially women to stop driving prematurely (Hakamies-Blomqvist & Wahlström, 1998; Rimmö & Hakamies-Blomqvist, 2002; Siren, Hakamies-Blomqvist & Lindeman, 2004; Wilkins et al., 1999). While men more often give up their license due to health problems and later in life, women tend to give up driving at younger age and for less pressing reasons. In addition, older women more often than men tend to suffer from non-fatal, long term conditions that do not hamper the ability to drive a car but affect the physical mobility and thus make daily transport by alternative modes difficult (Arber & Cooper, 1999; Leveille et al., 2000), which makes the mobility disadvantage due to premature cessation even worse.

3.2.3 Cost-benefit aspects

It is important to assess the costs and benefits of different measures for society. Age-based assessment programmes for older drivers are an example of a political investment that seems to make sense at first glance, but fails to produce the desired benefits (e.g., Siren & Meng, 2012). Research evidence has indicated that on a traffic systems level, this measure even decreases overall safety and mobility and is associated with various direct and indirect costs for the older drivers themselves and for society as a whole. The focus on managing older road users' safe mobility in a cost effective way should therefore shift from identifying and removing at-risk drivers to prolonging older persons' safe driving careers by better accompanying the process of continuing to drive and by enhancing the safety of older unprotected road users.

A possible obstacle to this might however be the fact that designing and selling "tests" that are supposed to measure individual driver safety is a large business and there are therefore enormous vested interests and heavy lobbying towards the governments to have extensive older driver testing programmes.

If population-based screenings at certain age are considered as necessary investments by the policy makers, the cost efficiency of these should be enhanced. In other words, the massive investments should produce some benefits for the society. One possibility is to develop the health visits into having more meaningful and general scope, e.g. by evaluating the general health status from public health and disease prevention perspective.

3.2.4 Adequacy of methods used in driver evaluation

Most policies to assess older people's ability to drive are not evidence-based (cf. Salmi et al., 2011). Research so far has failed to demonstrate that age-based screening procedures decrease the number of crashes. Possible reasons for this are diverse. First, screening aims to assess "individual risk", which has been criticised conceptually (Hakamies-Blomqvist, 2006). It is indeed questionable whether individual risk can be conceptualised and evaluated in a reliable way. On an individual basis, it is not possible to predict who will be involved in an accident if he/she is allowed to drive. Most at-risk drivers

never have accidents, as accidents on an individual level are rare and multi-determined. Second, all screening methods carry a considerable level of uncertainty (Hakamies-Blomqvist, 2006; Langford et al., 2008). Depending on the chosen balance between sensitivity and specificity, either some cases are missed or a number of older drivers lose their automotive mobility. Third, previous research has shown that mandatory age-related screening measures may have an effect on subgroups other than the one which was originally targeted. There is evidence that many older persons, especially older women, choose to give up driving prematurely if the license renewal procedures require them to be screened (Hakamies-Blomqvist & Wahlström, 1998; Siren et al., 2004). Their mobility thereafter is likely to be maintained through less safe modes of transportation. Finally, the lack of the desired safety effects of screening may reflect the fact that older drivers with cognitive or other medical impediments do not pose a notable safety hazard in the traffic system. Cognitive impairments have been found to be associated with reduced levels of driving and voluntary driving cessation (Donorfio et al., 2008; Kostyniuk and Molnar, 2008; Lyman et al., 2001; Rimmö & Hakamies-Blomqvist, 2002). The reduced presence in traffic directly contributes to a lower absolute risk of crashes. Consequently, removing these drivers from the driver population will, at best, prevent a very small number of accidents.

While no significant correlation with accident rates has been found for general mental or medical testing (e.g. Levy et al., 1995; Grabowski et al., 2004; Siren & Meng, 2012), some positive outcomes have been found for in-person renewal (as opposed to renewal by mail/online) (Grabowski et al., 2004; Kulikov, 2011) and restricted licensing (Kulikov, 2011; Nasvadi & Wister, 2009). These effects were all found in American studies and it needs to be investigated if the results can be transferred to the European context.

3.2.5 Ethical aspects

Losing a driving licence has been shown to have a number of negative outcomes for older drivers with regard to safety, mobility and health. Any measures that may lead to premature driving cessation should thus be justified by clear evidence which shows that the benefits for society outweigh the disadvantages for older people. Even if there were positive outcomes for society as a whole it would be a difficult task to balance the pros for society and cons for older people in an ethical way. However, most policies to assess older people's ability to drive are not evidence-based, and mandatory age based screening has failed to demonstrate any safety effects. Therefore, there is no ethical basis for restricting older people's licence. But the renewal procedure itself produces even further ethical problems - not only for the person to be screened, but also for those who are in charge of the decision to either renew or not to renew a person's licence, especially if it is the older driver's doctor (Somerville et al., 2010).

Two Australian surveys among general practitioners (GPs) describe the problem that this group faces (Sims et al., 2012; Wilson & Kirby, 2008). Only about half of the surveyed GPs felt confident in their



ability to assess fitness to drive; only about one fifth felt that GPs should have the primary responsibility for declaring patients' fitness to drive; about 80% felt that reporting a patient would impact on the doctor-patient relationship negatively; three quarters expressed concern about legal liability, and three quarters favoured further education (Sims et al., 2012). Most GPs believed that there was a need for more transport and support services for older drivers when they ceased driving (Wilson & Kirby, 2008). In cases where there were no adequate transport services available, GPs sometimes allowed people they considered not really medically fit to drive to continue with a restricted licence. This reveals the dilemma GPs find themselves in when assessing the fitness to drive of their older patients. Many GP's would prefer the final decision to take away the licence or not would come from an independent authority (Wilson & Kirby, 2008).

4 Conclusions and Recommendations

The mapping of licensing policies in Europe (cf. Chapter 2) indicates considerable heterogeneity of existing policies. Six out of 27 countries, most of them in Central Europe, issue unlimited licences, and the licences issued by the remaining 21 countries vary greatly with regard to age of first assessment, periodicity of renewal, methods used in the assessment and costs incurred by the person seeking to extend the licence.

In general, policies in place regarding the assessment of older people's ability to drive are not evidence-based (cf. Chapter 3). An opportunity to revise driver licence legislation covering the validity and renewal periods in Europe was recently presented with the introduction of EU-directive 2006/126/EC (EU, 2006). Yet, many countries did not take this opportunity to revise their policies towards more evidence-based procedures, but rather left them unchanged, although there is no evidence that general age-based controls have any safety benefits. The review of evaluation studies on the effects of screening procedures identified possible safety benefits of few more specific measures, namely in-person renewal and restricted driving. These effects were, however, all found in American studies and it is not clear whether they can simply be transferred to the European context. The few existing European evaluation studies conclude that aged-based licence renewal is associated with negative safety effects for older people because it triggers a shift from the car to unprotected modes of transport when ceasing to drive.

Previous research has demonstrated that older drivers per se are a safe group of drivers, and that they do not pose a threat to other road users' safety (e.g. Dellinger et al., 2004; Evans, 2000; Hakamies-Blomqvist et al., 2002; Haustein et al., 2013; Lafont et al., 2010). Against this background a general screening of the whole population of older drivers does not appear reasonable from a cost-benefit perspective. In addition, losing a driving licence has a number of negative outcomes for older drivers themselves with regard to safety, mobility and health. To take away the licence would only appear justified if it was possible to reliably identify unsafe drivers. The existing measures, however, fail in that respect. Apart from the negative consequences for the older person who has to cease driving, also the relatives, who have to take care for the older persons' future transport needs are concerned. Finally, the GPs, when in charge of this decision, often find themselves in a dilemma of not wanting to restrict their patient's mobility on the one hand and having concerns over the person's driving ability on the other hand.

It is recommended to shift the focus of managing older road users' safe mobility to prolonging older persons' safe driving careers, instead of restricting their mobility and exposing them to the higher risk of unprotected transport modes. Women especially often give up their licence when they are still fit to

drive (Siren et al., 2004) and could be even more encouraged to do so by an extensive renewal procedure. If the population based health visits at certain ages are seen as a necessary investment, it is recommended these visits to have more meaningful scope than that of traffic safety only. Providing a general health assessment for seniors at certain age milestones, for example, would not only be less ageist but also serve a purpose in public health promotion and disease prevention.

In addition to political measures, technological advances in the development of driver assistance systems and autonomous cars are an option to support longer driving careers. The acceptance of new technologies, however, highly differs between different segments of older people, which should be taken into account (Haustein, 2012). Moreover, advanced driver assist systems have often been criticised for not being user-friendly with regard to an older target group, especially the human-machine interface (Gstalter & Fastenmeier, 2013).

Restricted driving should be considered as a means to keep older people with driving related deficits auto-mobile under specified conditions (e.g. for specified ways), instead of taking the license completely away. This concerns especially drivers in rural areas, where alternatives to the car are not available or affordable.

Finally, voluntary driver trainings for older people have been suggested as a means to prolong older peoples' driving career (Gstalter & Fastenmeier, 2013). In a study with control-group design such trainings could be shown to be effective in improving the ability to master difficult traffic situations at an advanced age (Poschadel et al., 2012). In Austria there are initiatives organized by the Austrian Ministry of Transport and Innovation in collaboration with the national board of traffic safety such as the "Risk competence training for elderly motorists" project aiming at raising awareness and risk mitigation through developing individual compensation strategies regarding both mode choice and driving behaviour. These activities are based on voluntariness and practicability while avoiding medical or performance tests.

In the future, the number of the oldest-olds will increase significantly as life expectancy increases. At the same time, the ageing new cohorts are likely to differ from the preceding cohorts regarding their health, functionality, and mobility patterns. With respect to the new cohorts, it is very likely that we will experience a significant increase in the number of older drivers as they are usually more experienced and more active drivers than their parents, and will probably continue to drive into old age (Haustein et al., 2013; Siren & Haustein, 2013).

Yet, the majority of older drivers choose to cease driving at some point of their lives. Recent research suggests that training and pre-planning giving up driving may mitigate the negative consequences post driving cessation (Musselwhite, 2010; Musselwhite & Shergold, 2013). As the risk of getting injured or killed is higher for older people as pedestrians, cyclists and passengers of public transport, it is also important to support older persons early enough in the safe use of alternative modes of

transport to mitigate the end of their driving career and related feelings of dependence and restricted mobility. Some public transport providers offer respective courses, e.g. the Essener Verkehrs-AG (EVAG)⁷ offers bus trainings for the generation 50+, which combine information and exercises, such as boarding and alighting a bus in a safe way.

It is further recommended that people with no access to public transport, or no ability to use it, should be provided with compensatory services, such as door to door service or taxi vouchers. The adequacy of car-sharing or more informal transport services for different segments of older people should also be considered. For details on good practises we refer to the CONSOL WP 5.2 report.

⁷ <http://www.evag.de/service/bustraining-50.html>

5 References

- Arber, S. & Cooper, H. (1999). Inequalities in health in later life: The new paradox? *Social Science and Medicine*, 48, 61-76.
- Critchley, M. (1953). *The parietal lobes*. New York, NY: Hafner Publishing Company.
- Dellinger, A. M., Kresnow, M. J., White, D. D., & Sehgal, M. (2004). Risk to self versus risk to others: how do older drivers compare to others on the road? *American Journal of Preventive Medicine*, 26(3), 217-221.
- Desapriya, E., Ranatunga, Y., & Pike, I. (2012). We need evidence based tools to identify medically at risk drivers. *BMJ* 2012;345:e7087.
- Donorfio, L. K. M., Mohyde, M., Coughlin, J., & D'Ambrosio, L., (2008). A qualitative exploration of self-regulation behaviors among older drivers. *Journal of Aging and Social Policy*, 20, 323–339.
- Englund, L. (2010). Nya föreskrifter om medicinska krav för körkort från den 1 september 2010. *Trafikmedicinska rådets Nyhetsblad* (20, Nov 2010).
- EU (2006). DIRECTIVE 2006/126/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 December 2006 on driving licences (Recast) (Text with EEA relevance). Retrieved from: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:403:0018:0060:EN:PDF>
- Evans, L. (2000). Risks older drivers face themselves and threats they pose to other road users. *International Journal of Epidemiology*, 29(2), 315-322.
- Fain (2003). Should older drivers have to prove that they are able to drive? *Archives of Internal Medicine*, 163(18), 2126–2128.
- Fitten, L. J. (2003). Driver screening for older adults. *Archives of Internal Medicine*. 163(18), 2129-2131.
- Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, 12, 189-198.
- Fontaine, H. (2003). Age des conducteurs de voiture et accidents de la route: Quel risque pour les seniors. *Recherche-Transports-Securite*, 79–80, 107–120.
- Grabowski, D. C., Campbell, C. M., & Morrissey, M. A. (2004). Elderly licensure laws and motor vehicle fatalities. *JAMA*, 291, 2840–2846.

- Gstalter, H., & Fastenmeier, W. (2013). Äldre Fahrer und Verkehrssicherheit – Bestandsaufnahme und mögliche Massnahmen. *Zeitschrift für Verkehrssicherheit*, 59(1), 5-13.
- Hakamies-Blomqvist, L. (2006). Are there safe and unsafe drivers? *Transportation Research Part F: Traffic Psychology and Behaviour* 5, 347–351.
- Hakamies-Blomqvist, L., Henriksson, P., Falkmer, T., Lundberg, C., & Braekhus, A. (2002). Attitudes of primary care physicians toward older drivers: A Finnish-Swedish comparison. *The Journal of Applied Gerontology*, 21(1), 58-69.
- Hakamies-Blomqvist, L., Johansson, K., & Lundberg, C. (1996). Medical screening of older drivers as a traffic safety measure. A comparative Finnish-Swedish evaluation study. *Journal of the American Geriatrics Society*, 44, 650–653.
- Hakamies-Blomqvist, L., Raitanen, T., & O'Neill, D. (2002). Driver ageing does not cause higher accident rates per km. *Transportation Research Part F: Traffic Psychology and Behaviour*, 5(4), 271–274.
- Hakamies-Blomqvist, L., Sirén, A., & Davidse, R. (2004). Older drivers – a review. VTI report 497A. Linköping: VTI.
- Hakamies-Blomqvist, L., & Wahlström, B. (1998). Why do older drivers give up driving? *Accident Analysis and Prevention*, 30, 305–312.
- Hansen, E. A., & Hansen, B. L. (2002). Kognitive funktioner og kørefærdighed hos ældre bilister. *Ugeskrift for Læger*, 164, 337.
- Haustein, S. (2012). Mobility behavior of the elderly: an attitude-based segmentation approach for a heterogeneous target group. *Transportation*, 39, 1079–1103.
- Haustein, S., Siren, A., Framke, E., Bell, D., Pokriefke, E., Alauzet, A., Marin-Lamellet, C., Armoogum, J., & O'Neill, D. (2013). Demographic Change and Transport. Final report of Work Package 1 of the EU project CONSOL. Retrieved from: <http://consolproject.eu>
- Heikkinen, S., Dukic, T., Henriksson, P., Høye, A., Peters, B., & Sagberg, F. (2010). Åtgärder för äldre bilförare – effekter på trafiksäkerhet och mobilitet. VTI report 682. Linköping: VTI.
- Insurance Institute for Highway Safety, 2012, Older drivers: licensing renewal provisions, Nov 2012. Retrieved from: <http://www.iihs.org/laws/OlderDrivers.aspx>
- Jang, R. W., Man-Son-Hing, M., Molnar, F. J., Hogan, D. B., Marshall, S., Auger, J., Graham, I. D., Korner-Bitensky, N., Tomlinson, G., Kowgier, M. E., & Naglie, G. (2007). Family Physicians' Attitudes and Practices Regarding Assessments of Medical Fitness to Drive in Older Persons. *Journal of General Internal Medicine*, 22(4), 531-543.
- Keall, M. D., & Frith, W. J. (2004a). Older driver crash rates in relation to type and quantity of travel. *Traffic Injury Prevention*, 5(1), 26–36.

- Keall, M. D., & Frith, W. J. (2004b). Association between older driver characteristics on-road driving test performance, and crash liability. *Traffic Injury Prevention*, 5(2), 112–116.
- Kirk, A., Grant, R., & Bird, R. (2003). Passenger casualties in non-collision incidents on buses and coaches in Great Britain. *Proceedings of the 18th International Technical Conference on the Enhanced Safety of Vehicles*, 19-22 May, Nagoya.
- Kostyniuk, L. P., & Molnar, L. J. (2008). Self-regulatory driving practices among older adults: health, age and sex effects. *Accident Analysis and Prevention*, 40, 1576–1580.
- Kulikov, E. (2011). The social and policy predictors of driving mobility among older adults. *Journal of Aging & Social Policy*, 23, 1–18.
- Lafont, S., Gabaude, C., Paire-Ficout, L., & Fabrigoule, C. (2010). Des conducteurs âgés moins dangereux pour les autres: étude des accidents corporels en France entre 1996 et 2005. *Le Travail Humain*, 73(1), 75-92.
- Lange, J. E. & McKnight, A. J. (1996). Age-Based Road Test Policy Evaluation. *Transportation Research Record*, 1550, 81-87.
- Langford, J., Bohensky, M., Koppel, S., & Newstead, S. (2008). Do older drivers pose a risk to other road users? *Traffic Injury Prevention*, 9(3), 181-189.
- Langford, J., Fitzharris, M., Koppel, S., & Newstead, S. (2004a). Effectiveness of mandatory license testing for older drivers in reducing crash risk among urban older Australian drivers. *Traffic Injury Prevention*, 5, 326–335.
- Langford, J., Fitzharris, M., Newstead, S., & Koppel, S. (2004b). Some consequences of different older driver licensing procedures in Australia. *Accident Analysis and Prevention*, 36, 993–1001.
- Langford, J., Koppel, S., McCarthy, D., & Srinivasan, S. (2008). In defence of the 'low mileage bias'. *Accident Analysis and Prevention*, 40, 1996–1999.
- Larsson, H., Lundberg, C., Falkmer, T., & Johansson, K. (2007). A Swedish survey of occupational therapists' involvement and performance in driving assessments. *Scandinavian Journal of Occupational Therapy*, 14, 215-220.
- Leveille, S. G., Penninx, B. W. J. H., Melzer, D., Izmirlian, G., & Guralnik, J. M. (2000). Sex differences in the prevalence of mobility disability in old age: The dynamics of incidence, recovery, and mortality. *Journal of Gerontology: Series B: Psychological Sciences & Social Sciences*, 55B, S41-S50.
- Levin, L., Ulleberg, P., Siren, A., & Hjorthol, R. (2012). Measures to enhance mobility among older people in Scandinavia. A literature review of best practice. VTI report 749A. Linköping: VTI.

- Levy, D. T., Vernick, J. S., & Howard, K. A. (1995). Relationship between driver's license renewal policies and fatal crashes involving drivers 70 years or older. *JAMA*, 1995, 274, 1026–1030.
- Li, H., Raeside, R., Chen, T., & McQuaid R. W. (2012). Population ageing, gender and the transportation system. *Research in Transportation Economics*, 34, 39–47.
- Lyman, J. M., McGwin, G., & Sims, R. V. (2001). Factors related to driving difficulty and habits in older drivers. *Accident Analysis and Prevention*, 33, 413–421.
- Marshall, S., Demmings, E. M., Woolnough, A., Salim, D., & Man-Son-Hing, M. (2012). Determining Fitness to Drive in Older Persons: A Survey of Medical and Surgical Specialists. *Canadian Geriatrics Journal*, 15(4), 101-119.
- McGwin, G., & Sarrels, S. A, Griffin, R., Owsley, C., & Rue, I. W. (2008). The impact of a vision screening law on older driver fatality rates. *Archives of Ophthalmology*, 126, 1544–1547.
- Meuleners, L. B., Harding, A., Lee, A. H., & Legge, M. (2006). Fragility and crash over-representation among older drivers in Western Australia. *Accident Analysis & Prevention*, 38, 1006–1010.
- Meuser, T. M. (2008). License renewal policy & reporting medically unfit drivers: descriptive review & policy recommendations. In: *Proceedings from 2008 North American License Policies Workshop*, Washington DC: AAA Foundation for traffic safety, pp. 105–122.
- Mitchell, C. G. B. (KIT) (2008). The Licensing of Older Drivers in Europe—A Case Study. *Traffic Injury Prevention*, 9, 360–366.
- Musselwhite, C. (2010). The role of education and training in helping older people to travel after the cessation of driving. *International Journal of Education and Ageing*, 1(2), 197-212.
- Musselwhite, C. & Shergold, I. (2013). Examining the process of driving cessation in later life. *European Journal of Ageing*, 10, 89-100.
- Nasvadi, G. C., & Wister, A. (2009). Do restricted driver's licenses lower crash risk among older drivers? A survival analysis of insurance data from British Columbia. *The Gerontologist*, 42(5), 621–633.
- Nelson, D. E., Sacks, J. J., & Chorba, T. L. (1992). Required vision testing for older drivers. *The New England Journal of Medicine*, 326, 1784–1785.
- OECD (2001). *Ageing and Transport: Mobility needs and safety issues*. Paris: OECD
- O'Neill, D. (2012a). More mad and more wise. *Accident Analysis & Prevention*, 49, 263–265.
- O'Neill, D. (2012b). Medical screening of older drivers is not evidence based. *BMJ* 2012;345:e6371.
- Poschadel, S., Boenke, D., Blöbaum, A., & Rabczinski, S. (2012). *Ältere Autofahrer: Erhalt, Verbesserung und Verlängerung der Fahrkompetenz durch Training*. Schriftenreihe "Mobilität und Alter" der Eugen-Otto-Butz-Stiftung, Band 6. Cologne: TÜV Media GmbH.

- Regionale Færdselssikkerhedsudvalg. (2011). Når kørekortet skal fornyes. Retrieved November 3, 2011, from <http://www.vejsektoren.dk/wimpdoc.asp?page=document&objno=371974>
- Rimmö, P-A., & Hakamies-Blomqvist, L. (2002). Older drivers' aberrant driving behaviour, impaired activity, and health as reasons for self-imposed driving limitations. *Transportation Research Part F: Traffic Psychology and Behaviour* 5, 47–62.
- Rock, S. M. (1998). Impact from changes in Illinois renewal requirements for older drivers. *Accident Analysis and Prevention*, 30, 60–74.
- Ross, L. A., Browning, C., Luszcz, M. A., Mitchell, P., & Anstey, K. J. (2011). Age-based testing for driver's license renewal: potential implications for older Australians. *Journal of the American Geriatrics Society*, 59, 281–285.
- Salmi, L. R., Leproust, S., Helmer, C., & Lagarde, E. (2011). Systematic assessment of elderly persons' ability to drive evidence-based? Presentation at conference on Emerging Issues in Safe and Sustainable Mobility for Older People, Aug30–Sept 1, 2011, Washington, D.C
- Sharp, E. B., & Johnson, P. E. (2005). Taking the keys from grandpa. *Review of Policy Research*, 22, 187–204.
- Shipp, M. D. (1998). Potential human and economic cost savings attributable to vision testing policies for driver license renewal, 1989-1991. *Optometry & Vision Science*, 75, 103-118.
- Shulman, K. I., Shedletsky, R., & Silver, I. L. (1986). The challenge of time: clock-drawing and cognitive function in the elderly. *International Journal of Geriatric Psychiatry*, 1, 135-140.
- Sims, J., Rouse-Watson, S., Schattner, P., Beveridge, A., & Jones, K. M. (2012). To drive or not to drive: Assessment dilemmas for GPs. *International Journal of Family Medicine*, Article ID 417512.
- Siren, A., Hakamies-Blomqvist, L., & Lindeman, M. (2004). Driving cessation and health in older women. *Journal of Applied Gerontology*, 23, 58–69.
- Siren, A., & Haustein, S. (2013). Baby boomers' mobility patterns and preferences: What are the implications for future transport? *Transport Policy*, 29, 136–144.
- Siren, A. & Meng, A. (2012). Cognitive screening of older drivers does not produce safety benefits. *Accident Analysis & Prevention*, 45, 634–638.
- Somerville, E.R., Black, A. B., & Dunne, J. W. (2010). Driving to distraction—certification of fitness to drive with epilepsy. *Medical Journal of Australia*, 192, 342-344.
- Sommer, S. M., Falkmer, T., Bekiaris, E., & Panou, M. (2004). Toward a client-centred approach to fitness-to-drive assessment of elderly drivers. *Scandinavian Journal of Occupational Therapy*, 11, 62-69.

- Stevens, J. A., & Sogolow, E. D. (2005). Gender differences for non-fatal unintentional fall related injuries among older adults. *Injury Prevention*, 11, 115–119.
- Sundhedsstyrelsen (2003). Rapport fra arbejdsgruppen vedr. forslag til vurdering af kognitiv funktion ved lægeundersøgelse i forbindelse med kørekortfornyelse fra det 70 år (Januar 2003). København: Sundhedsstyrelsen.
- Svensk trafikmedicinsk förening (2009). Trafikmedicinska centrum och enheter. Ett förslag till förverkligandet av Vägverkets förslag. Stockholm-Solna Universitetsservice AB.
- Tay, R. (2012). Ageing driver licensing requirements and traffic safety. *Ageing and Society*, 32, 655-672.
- Vägverket (2005). Regeringsuppdrag om läkares skyldighet att anmäla olämpliga förare. Borlänge: Vägverket.
- Vlakveld, W. P., & Davidse, R. J. (2011). Effect van verhoging van de keuringsleeftijd op de verkeersveiligheid. SWOV report R-2011-6.
- White, S., & O'Neill, D., (2000). Health and relicensing policies for older drivers in the European Union. *Gerontology* 46 (3), 146–152.
- Wilkins, J. W., Stutts, J. C., & Schatz, S. J. (1999). Premature reduction and cessation of driving: Preliminary study of women who choose not to drive or to drive infrequently. *Transportation Research Record*, 1693, 86–90.
- Wilson, L. R., & Kirby, N. H. (2008). Individual differences in South Australian general practitioners' knowledge, procedures and opinions of the assessment of older drivers. *Australasian Journal on Ageing*, 27(3), 121–125.