Age-based screening of elderly drivers

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Please note: The studies included in this synopsis were selected from those identified by a systematic literature search of specific databases (see supporting document). The main criterion for inclusion of studies in this synopsis and the DSS was that each study provides a *quantitative effect estimate*, preferably on the number or severity of crashes or otherwise on road user behaviour that is known to be related to the occurrence or severity of a crash. Therefore, key studies providing qualitative information might not be included in this synopsis.

1 Summary

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1.1 COLOUR CODE: RED

Although studied by a number of good quality studies, age-based screening of all elderly drivers for fitness to drive has not been found to reduce fatalities. At the same time there are indications that it might increase fatalities among elderly pedestrians and the average risk per licensed (elderly) driver.

1.2 KEY WORDS

Fitness to drive assessment; elderly drivers; old drivers; senior; screening; motor vehicle; licensing policies; relicensing; licence renewal

1.3 ABSTRACT

Due to the increased numbers and mobility of elderly drivers in most industrialised countries, there has been a growing concern to assure the fitness of elderly drivers. Therefore many countries have introduced additional re-licensing requirements like vision tests, medical check-ups, or on-road driving tests for all drivers from a certain age on (most often 70 years). From a scientific point of view there is no indication that age-based screening of elderly drivers improves road safety. Although a good number of studies from Europe, Canada, and Australia have investigated this effect in the last decade, no effect of increased safety was found. On the contrary there are indications that the measure might have two unwanted side-effects: (1) increased accident risk per licensed driver, and (2) an increase of pedestrian fatality rate. However, studies from the United States indicate that obliging drivers to appear in person for licence renewal, rather than allowing re-licensing on-line or per mail has a beneficial effect on the number of fatal crashes involving elderly drivers.

1.4 BACKGROUND

The measure discussed is the *age-based* screening of elderly drivers. This means a fitness to drive assessment is scheduled by *chronological age* rather than concrete indications of reduced driving fitness.

- *Why do many countries screen elderly drivers at regular intervals?*

In an ageing society, the proportion of elderly drivers has been increasing and will do so for the next decades (OECD, 2001). The risk for severe crashes has been shown to increase for drivers from 75 years onwards (for an overview see DaCoTA, 2012). A number of functions important for driving show an age-related decline (e.g., vision, speed of perception and decision making). In addition to 'normal' age-related degeneration, many people of older age have one or more recorded illnesses, which can also compromise their fitness to drive.

- *What are the arguments against screening?*

Age-related decline of fitness to drive does not concern everyone at the same age, and it can mostly be compensated for by changes in driving behaviour: the elderly drive more carefully, at less busy times, and avoid darkness, as well as complex and/or unknown situations (Meng & Siren, 2012). The

greatest risk for elderly drivers is related to illness and impairments, which certainly become more frequent at higher age but can affect younger drivers as well.

If money and time would not be an issue and for each older driver a detailed diagnostic process could be offered, the results may be different . However in the interest of being (cost-) effective a fitness to drive assessment should be tailored to the reason for initiating the procedure – the referral diagnosis or the functional impairment felt by the driver or the passengers. A general standardised testing procedure must necessarily be superficial. For every candidate who is justly prohibited from driving, there are many who should give up, but go undetected, and many who have to give up driving but would never have had an accident. For undetected unfit drivers, the test results can act as a boost of confidence and therefore undermine above-mentioned compensation strategies. Physicians who doubt the fitness to drive of their patients will moreover be more hesitant to take action, if the candidate has been 'approved' by the official authorities (Mikkonen, 2014). For those drivers who lose their driving licence, driving cessation has severe consequences on the social, emotional and also physical well-being (CONSOL, 2012). Moreover, road users who have lost their driver's licence walk more and are consequently exposed to a higher injury and fatality risk than they were as a car-driver (Siren & Meng, 2012).

- *What are alternatives to age-based screening?*

Advising against age-based screening does not mean that it is not necessary to pay attention to the fitness of elderly drivers. A staged system of screening, that starts with a simple self test and /or a visit to the primary care physician is an alternative to mass screening. If the primary caretaker doubts the patient's fitness to drive, she can refer them to a specialist for a more thorough examination, which should be focused on maintaining mobility, e.g. by issuing a limiting licence (e.g. day-time only), adjusting medication, or possibly adjusting the vehicle (EC, 2017).

- *How is the effect of age-based screening measured?*

For the evaluation of individual assessment tools see SafetyCube Synopsis *Medical Referrals* (Boets, 2017). To evaluate the procedural aspects (age-based vs. medical referrals) the most common designs are between country / state comparisons (e.g., Langford et al., 2004; 2008; McGwin, 2008); before-after comparisons (e.g., Siren & Meng, 2012), and panel analyses across several states and several years (e.g., Tefft, 2013; Sharp & Johnson, 2005; Tay, 2012; Grabowski, et al., 2004). The dependent variable is often the fatal-crash involvement rate. For most studies the fatality rates are calculated with respect to the population of the age-segment in question. This is suboptimal, because age-based screening could reduce the number of licensed drivers. Only the Australian studies have based their rates on different baselines: population, licensed drivers, km driven, time spent in traffic (Langford et al., 2004a; 2004b; 2008).

1.5 OVERVIEW OF RESULTS

Generally, studies from Europe, Australia, and Canada do not find an effect, while studies from the US tend to do so. Seven studies from Europe, Australia, and Canada have found no change in the fatality rate due to stricter requirements for licence renewal for elderly drivers. On the contrary, those (Australian) studies that calculated risk-rates *per licensed driver* (rather than per population) even found an *increased* risk per elderly driver for the states with age-based screening. Two studies also found a negative effect of age-based screening on pedestrian fatality rates.

Studies from the US tend to find a reduced fatality rate associated with vision tests upon licence renewal for elderly drivers. However, according to two more recent studies, (Tefft, 2013; Grabowski, 2004) the aspect that affects fatality-rates is to oblige candidates to come for licence renewal *in person* as opposed to giving them the opportunity to do so by (e-)mail or online. There is also an

effect of a vision test, but only for those states where renewal by mail is possible. These results suggest that the most important aspect of the whole procedure is to ask people to come and *personally* see someone for the renewal – be that the officer at the licensing authority or their local optician.

2 Scientific overview

2.1 THEORETICAL BACKGROUND

Objective of age-based screening for elderly drivers

Due to the ageing of societies and increased mobility in elderly people, a growing number of drivers is part of this demographic group: the elderly. More than two decades ago researchers started to worry about the accident rate in elderly drivers. Due to an age-related decline in perceptual, cognitive, and physical functions and an increase in chronic diseases, there is a general decline in fitness to drive in the elderly population. And indeed, it was found that although the absolute number of accidents is declining with age, this is due to a reduction in population and in mileage while the risk for accidents per kilometre driven is increasing from an age of 75 on (OECD, 2001; Vaa, 2003; DaCoTA, 2012).

There are two reasons for the increased risk per kilometre in elderly drivers that have nothing to do with a possible regression of their fitness to drive. The most important reason for the increased risk is probably the frailty of elderly drivers due to which they become severely injured or even die of the consequences in an accident that would be much less harmful for a younger person (Li, Braver, & Chen, 2003; DaCoTA, 2012). Moreover elderly drivers typically have a lower mileage than younger ones, and the risk per kilometer is higher for all drivers who drive shorter routes, mainly attributed to the type of road that short routes are driven on (Langford, 2006). Nevertheless, accident causation data suggest that not only does the risk of getting injured or killed increase with age but also the risk of causing accidents (Statistisches Bundesamt, 2012).

Although it is clear that there are great differences in how people age and at what moment their fitness is too compromised to keep driving a car, the need for monitoring the fitness of elderly drivers has been perceived, especially as not all drivers are aware to what extent their functioning is compromised. As a consequence, 12 European countries have a mandatory screening procedure for elderly drivers who want to renew their licence (CONSOL, 2013).

Contra-indications to age-based screening

Age-based screening is, however, far from being undisputed. In general it has been concluded that no positive effect of a screening procedure can be demonstrated (Haustein & Siren, 2015, Vlakveld & Davidse, 2011). Elderly people are generally careful drivers and mostly take measures themselves to compensate for a regressing fitness to drive by either adapting their driving patterns (not driving in darkness, during rush-hour, or on routes unknown to them) or by stopping driving altogether (Meng & Siren, 2012). It is also argued that even with scientifically validated tests, many drivers who would never have an accident are prohibited from driving (Martin, Marottoli, & O'Neill, 2013). Forced driving cessation is associated with an increased chance of depression and with being unable to continue living independently (Windsor, Anstey, Butterworth, Luszcz, & Andrews, 2007; Ragland, Santariano, & MacLeod, 2005). Additionally a substantial proportion of older people relies on driving a car for mobility, and they are left with unfulfilled mobility needs when they stop driving (CONSOL, 2013; GOAL, 2013). Moreover, drivers who lose their licence will (hopefully) tend to increase the number of trips made walking. In this unprotected transportation mode, elderly road users have an even higher risk.

Additionally, a screening procedure might boost the confidence of some drivers who have passed the test. A study by a Finnish insurance company found that elderly drivers had more crashes and fines directly after they had passed the screening test, as compared to right before it. Based on

anecdotal evidence, the authors also raised the concern that physicians who doubted their patients' fitness to drive might rather avoid the uncomfortable task of telling them so, if they assume that the problem will be taken care of in the licence renewal procedure (Mikkonen, 2014)

Age-based screening versus medical referral

The measure discussed here is age-based screening, which means that independent of their medical condition everybody is tested from a certain age on. Advising against age-based screening does not mean that it is not necessary to assess the fitness of elderly drivers. The question is rather whether it should be done routinely from a certain age on or whether it should be initiated by concrete indications either from the drivers and their family themselves or per referral from the physician.

For a population wide screening, the costs of this procedure must be kept relatively low. At the same time, the efficiency of fitness to drive assessment tools depends on the target group. Given a particular diagnosis (e.g., cognitive impairment, Parkinson's disease, Vascular diseases) testing should be focused on different functional aspects and thus different tools are needed, which is impossible for a routine check-up that has to be applied to everyone (see Synopsis on Medical Referrals, Boets et al., 2017). An important question is consequently what to do with the test results of more general screening tests. Using the test results directly to decide on driving prohibition is associated with a high error rate. This means there will be many drivers who are not fit to drive, but can continue, as well as many drivers who are actually fit to drive but will be forced to stop.

In practice, it is more important to focus the diagnostic effort on those drivers with reasonable doubt with respect to their fitness to drive. The decision does not necessarily have to be black and white. Restricting the licence to situations that the candidate can still handle (e.g. only day-time driving or a general limit of 80 km/h) has been shown to be respected by the drivers in question and to lead to a decrease in crashes (Nasvadi & Wister, 2009; Kulikov, 2011). However, to determine which situations a candidate can still handle, a detailed diagnostic process is needed. This process can be much better tailored to the candidate, if testing is initiated by the diagnosis of a physician or concrete problems noticed by the drivers or their social environment (e.g. relatives or friends).

Evaluating the effect of screening elderly drivers

To evaluate the effect of screening, typically three types of studies have been conducted:

(1) Beforeafter comparisons: upon introduction of a new (element in the) screening procedure, the crash-rate before the introduction is compared to the one after. A general trend in crash numbers is usually taken into account by conducting the same analysis on a group of younger drivers not subjected to the procedure. The papers reviewed here did not however account for other possible influences specifically affecting elderly fatalities.

(2) Comparisons between two countries/ states/ provinces that differ with respect to the licensing policies for elderly people. This approach can be combined with (1), to have pre-/post-comparisons in both countries. Seeing a change for elderly drivers only in the country with screening (but not for the younger ones and for neither age-group in the country without screening) increases the confidence that the observed pattern is actually due to the licensing policy.

(3) Comparing several states/ provinces/ countries with respect to different aspects of their licensing policies for elderly drivers and taking those into account in their crash rates. Statistically, these are the most advanced studies that enable researchers to distinguish different aspects of the screening procedure and at the same time correct for possible confounds with other variables.

2.2 INCLUDED STUDIES

Table 1: Information on sample and design of coded studies (sorted by recency)

Author(s), Year	Sample and study design	Method of analysis	Outcome	Confounds/ corrections	Main result	
Tefft, 2013 - USA	The effect of different aspects of licensing requirements on fatal crash involvement rates of elderly motorists is analysed in 46 US states.	Negative binomial regression analysis / panel analysis	Fatal-crash rate per population	Possible differences in elderly mobility as drivers are not taken into account.	States requiring licence renewal to be requested in-person had a lower crash involvement of drivers 85+ than those who did not. For those states where licence renewal can be requested on-line or per e-mail, a vision test was associated with lower fatality rates for drivers 85+	(–)
Tay, 2012 - Canada	The stringency of licensing requirements (rated by experts) in five Canadian provinces is related to the respective vehicle collision rates for ageing drivers.	Negative binomial regression analysis	Fatal-crash rate per population	Results are corrected for share of elderly drivers as well as a number of economic factors.	No significant effect was found, but states with stricter licensing policies towards elderly drivers tend to have even higher vehicle collision rates for elderly drivers.	–
Siren, 2012 - Denmark	Comparing fatal motor vehicle crashes before and after inclusion of cognitive testing into mandatory screening procedure in Denmark.	Chi-square	Fatal-crash rate per population: car drivers / pedestrians and cyclists	Possible differences in elderly mobility and other changes concurrent with measure are not taken into account.	No significant changes in crash-frequency were found for car drivers (neither for elderly nor for younger ones). For pedestrians and cyclists there was a significant increase for elderly but not for younger persons.	↘
McGwin, 2008 USA	Comparing fatal motor vehicle crashes before and after introduction of visual acuity standards in Florida.	Relative risk	Fatal-crash rate per population	The decrease in elderly fatalities started one year before the first drivers had been tested. This could be an indication that the decrease in elderly fatalities was caused by something other than the law.	For elderly drivers 80+, the risk on motor vehicle crashes was lower after the law as compared to before. For all drivers together (independent of age) the difference was non-significant but in tendency the other way around.	↗

Langford, 2008 Australia	Comparing fatality rates for elderly drivers in Victoria (no screening) to those in New South Wales (NSW - screening).	Relative risk	Fatal-crash rate per population and per licensed driver for: (1) driver, (2) passenger, (3) person outside vehicle	Fatalities per population analysis gave similar results to fatalities per driver analysis	No significant differences between Victoria and NSW concerning fatality rates for the drivers themselves, for passengers, or for persons outside the vehicle.	–
Sharp, 2005 - USA	The effect of different aspects of licensing requirements on fatal crash involvement rates of elderly motorists is analysed in 46 US states.	Logistic regression (mixed effects)	Fatal-crash rate per population	States with vision tests and on-road driving tests have lower crash-rates	No comparison to younger age-groups. No differentiation between vision/driving test requirements and 'in-person" renewal.	↗
Grabowski; 2004 - USA	The effect of different aspects of licensing requirements on fatal crash involvement rates of elderly motorists is analysed in 46 US states.	Negative binomial regression.		Corrected for number licensed drivers and effects on younger drivers	For 85+ 'in-person' renewal reduces the fatality rate. No other significant effects.	–
Keall, 2004 - New Zealand	Analysed crash-records of individual elderly drivers (80+) tested in on road driving exams for licence renewal. Drivers who passed the test right away with drivers who needed more than one attempt.	Logistic regression	Crash history (yes/no)		Each time the test is failed the probability for crash involvement during two years after the test increases by 33%.	↗
Langford, 2004 - Australia	Comparing crash rates for elderly drivers in Melbourne (no screening) to those in Sydney (screening).	Poisson regression with different off-sets	Crashes per population, license, distance driven, time driven	Corrected for elderly mobility	Fatal crash rates per licence and per time spent driving were significantly higher in Sydney (screening) as compared to Melbourne (no screening)	↘
Langford, 2004 - Australia	Comparing fatality/serious injury rates for elderly drivers in Victoria (no screening) to those in other states (different licensing procedures).	Poisson regression with different off-sets	Fatal & serious crashes per population, license, time driven	Corrected for elderly mobility	Elderly driver crash rates (fatal & severe) per licence and per time spent driving in Victoria (no screening) were significantly lower than in other states.	↘

2.3 RESULTS

At the European level, the evaluation of including a test for cognitive impairment into the Danish screening program (Siren & Meng, 2012) suggests that stricter screening rules do not lead to lower crash-rates. It should be noted that two studies not coded for SafetyCube (Mitchel, et al., 2008 reporting only graphic results and Hakamies-Blomquist, 1996) confirmed this null-effect. This is also confirmed in studies from Australia (where Melbourne and Victoria, with no aged based screening were compared to other cities and states with screening). The Australian studies also investigated the risk *per licensed driver* (rather than per population). This risk is even higher in those states that have elderly screening procedures implemented. Only in the United States, the comparison of crash-rates before and after the introduction of a screening programme in Florida indicated decreasing crash-rates for elderly drivers. It must be noted however, that the largest decrease occurred in the year *before* the first driver was tested, which introduces reasonable doubt whether this effect has anything to do with the screening procedure.

A number of older US-American studies (and one that coded for this review, Sharp & Johnson, 2015) have found a positive effect of mandatory vision tests at licence renewal. Two more recent studies give an interesting insight how this apparent contradiction with the rest of the world might come about (Tefft, 2013; Grabowski, 2004). In these two studies, different aspects of a screening procedure were investigating: simply obliging candidates to come in-person for renewal, having their vision tested, having their knowledge tested, and undergoing a practical driving test. The general design of both studies is very similar, with some improvements of statistical modelling and more recent data in the second one. Both studies lead to the same conclusion: for the oldest age-group (85+), the aspect that seems to have an effect on fatality-rates is to oblige candidates to come for licence renewal in person as opposed to giving them the opportunity to do so by (e-)mail or online. There is also an effect of a vision test, but *only* for those states where renewal by mail is possible. It seems that the most important aspect of the whole procedure is to ask people to come and *personally* see someone for the renewal – be that the officer at the licensing authority or their local optician.

Another interesting case is New Zealand. From 1999 to the end of 2006, older drivers aged 80 plus were subject to an on-road driving test every two years. The test had some validity in terms of safety: each test failure was associated with a 33% increase in the odds of subsequent crash involvement (Keall & Frith, 2004). But the test was criticised because it was experienced as stressful and often exceeded the driving demands that older drivers normally faced; the regime was also very costly to maintain. So in 2007, the requirement of an on-road driving test for licence renewal among 80+ was removed. Nevertheless, the numbers of casualties arising from crashes involving drivers aged 80 plus compared to drivers aged 70-79 showed no evidence of change (Keall, 2013).

2.4 CONCLUSION

Seven studies of satisfactory quality have failed to show a positive effect of screening the fitness of elderly drivers purely on the base of their age. On the contrary, two studies have shown an increased risk per licensed driver and one study has shown a negative effect, in the sense that screening has led to an increased number of pedestrian fatalities among the elderly. Three US-American studies suggest, however, that a requirement to come in-person for the renewal of their driver's licence might have a beneficial effect on the crash rate among elderly drivers.

The results thus emphasise the need for rising awareness among elderly drivers of the need to consider their fitness to drive, but at the same time indicate that routine-testing from a certain age on is not an adequate measure to achieve this.

Supporting document

2.5 LITERATURE SEARCH STRATEGY

The literature research for this synopsis was based on the literature review by Siren and Haustein (2015). Study selection for coding up to 2012 was based on the studies reviewed by Siren and Haustein. 10 studies were removed from Siren & Haustein's list (2015).

- Criterion: 2004 and later
  - 6 excluded
- Criterion: effect estimate in statistical analysis
  - 2 excluded
- Criterion: studies that evaluated the effect on administrative units (country, state, province) rather than on individual driver
  - 2 excluded

This left 9 studies to code for review. Additionally a search from 2013 on was conducted using the same search terms and database (Google Scholar) as Siren and Haustein.

2.5.1 Research terms and hits

Database: Google Scholar **Date:** 21st and 22nd April, 2017

Limitations/ Exclusions:

- Published: 2013 to current
- Document Type: Published articles

	search terms / operators / combined queries	hits
Search results sorted by relevance	('old' OR 'elderly' OR 'senior' OR 'age') AND ('license' OR 'license') AND ('assessment' OR 'testing' OR 'screening' OR 'renewal') AND ('driving' OR 'driver').	115,000
Screened results	Google sorts hits by relevance. All 9 titles relevant for the present search were found within the first 16 hits. The next 54 hits were screened, but no more relevant titels were found. Clearly relatedness to the topic was declining quickly, implying that hits were related to (successively smaller) subsets of the entered search terms only .	70
Selected for abstract review	Titles irrelevant for topic were discarded.	9
Selected for coding	Based on principles below.	1

2.6 PRIORITISATION

The following principles were applied for study selection among the 9 relevant abstracts. These – except for the publication year --were also respected in the studies selected from Haustein and Siren (2015).

Principles

- 2013 and later

- Studies that evaluated the effect on administrative unit (country, state, province) rather than on individual drivers

Excluded

- Effects of driving cessation
- Prevalence of functional impairments (e.g. reduced acuity)
- Risk of functional impairments
- Evaluation of individual tools (-> Synopsis Medical Referrals)
- Practical issues of test-applications

2.7 REFERENCES

List of coded studies

Grabowski, D. C., Campbell, C. M., & Morrisey, M. A. (2004). Elderly Licensure Laws and Motor Vehicle Fatalities. JAMA, 291(23), 2840-2846.

Keall, M. D., & Frith, W. J. (2010). Association Between Older Driver Characteristics, On-Road Driving Test Performance, and Crash Liability. Traffic Injury Prevention, 5:2, 112-116.

Langford, J., Bohensky, M., Koppel, S. & Newstead, S. (2008). Do age-based mandatory assessment reduce older drivers' risk to other road users? Accident Analysis and Prevention 40, 1913-1918

Langford, J., Fitzharris, M., Koppel, S., & Newstead, S. (2004). Effectiveness of Mandatory License Testing for Older Drivers in Reducing Crash Risk Among Urban Older Australian Drivers. Traffic Injury Prevention, 5:4, 326-335.

McGwin, G., Sarrels, S. A., Griffin, R., Owsley, C. & Rue, L.W. (2008). The Impact of a Vision Screening Law on Older Driver Fatality Rates. Archives of Ophthalmology, 126, 1544-1547.

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, 49, 474-484.

Sharp, E.B., & Johnson, P.E. (2005). Taking the Keys from Grandpa. Review of Policy Research, 22, 187-204.

Siren, A., & Meng, A. (2012). Cognitive screening of older drivers does not produce safety benefits.

Tay, R. (2012). Ageing driver licensing requirements and traffic safety. Ageing & Society, 32, 655-672.

Tefft, B. C. (2014). Driver license renewal policies and fatal crash involvement rates of older drivers, United States, 1986-2011. Injury Epidemiology 2014, 1:25, Accident Analysis and Prevention 45, 634-638.

References on further background information (sorted by authors)

EC (2017) Study on driver training, testing and medical fitness. European Commission, Directorate-General for Mobility and Transport, Brussels.

CONSOL. (2013). Driving Licensing Legislation Deliverable 5.1. Prague: Zuzana Strnadova, Transport Research Centre (CDV).

DaCoTA. (2012). Older Drivers, Deliverable 4.8 of the EC FP7 project DaCoTA. European Road Safety Observatory.

GOAL. (2013). Transport needs for an ageing society - Action Plan. Aachen: Institut für Kraftfahrzeuge (ika).

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., Siren, A., & Davidse, R. (2004). Older drivers – a review. VTI rapport 497A. Linkoeping: Swedish National Road and Transport Research Institute.

Holte, H., & Albrecht, M. (2004). Verkerhsteilnahme und -erleben im Strassenverkehr bei Krankheit und Medikamenteneinnahme. Berichte der Bundesanstalt fuer Strassenwesen, Reihe Mensch und Sicherheit, Heft M 162.

Langford, J. M.-B. (2006). Older drivers do not have a high crash risk—A replication of low mileage bias. Accident Analysis and Prevention 38, 574-578.

Langford, J., Mehorst, R., & Hakamies-Blomqvist, L. (2006). Older drivers do not have a high crash risk—A. Accident Analysis and Prevention 38, 574–578.

Kulikov, E. (2011). The social and policy predictors of driving mobility among older adults. Journal of Aging & Social Policy, 23, 1-18.

Li, G., Braver, E., & Chen, L. (2003). Fragility versus excessive crash involvement as determinants of high death rates per vehicle-mile of travel among older drivers. Accident Analysis and Prevention 35, 227–235.

Martin, A., Marottoli, R., & O'Neill, D. (2013). Driving assessment for maintaining mobility and safety in drivers with dementia. Dublin: The Cochrane database of systematic reviews.

Meng, A., & Siren, A. (2012). Cognitive problems, self-rated changes in driving skills, driving-related discomfort and self-regulation of driving in old drivers. Accident Analysis and Prevention 49, 322– 329.

Nasvadi, G., & 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, 621-633.

OECD. (2001). Ageing and transport - mobility needs and safety issues. OECD.

Ragland, D., Santariano, W., & MacLeod, K. (2005). Driving cessation and increased depressive symptoms. Journals of Gerontology: Medical Sciences, 60A, 399-403.

Siren, A., & Haustein, S. (2015). Driving licences and medical screening in old age: review of literature and European licensing policies. *Journal of Transport & Health,2*, 68-78.

Statistisches Bundesamt. (2012). Unfälle von Senioren im Straßenverkehr. Wiesbaden: www.destatis.de.

Vaa, T. (2003). Impairment, diseases, age and their relative risk of accident involvement. Oslo: TOI.

Vlakveld, W., & Davidse, R. (2011). Effect van verhoging van de keuringsleeftijd op de verkeersveiligheid. Leidschendam: Stichting Wetenschappelijk Onderzoek Verkeersveiligheid.

Windsor, T., Anstey, K., Butterworth, P., Luszcz, P., & Andrews, G. (2007). The role of perceived control in explaining depressive symptoms associated with driving cessation in a longitudinal study. The Gerontologist, 47, 215-223.