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Components of driving competency measurement in the elderly: A scoping review

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Abstract

Background: Iran will face the "aging Tsunami" phenomenon by the 2040s. Therefore, paying attention to the elderly's driving to maintain and promote their independence and quality of life on the one hand and paying attention to the dangers of driving by the elderly for road safety will be important. The purpose of this research was to determine the components of driving competency in the elderly.

Methods: The research has employed a scoping review. To this end, searches of scientific databases were conducted using keywords between 1990 and 2019. The process of selecting the documentation was-based on the PRISMA chart.

Results: In the first phase, 2769 records were found, and finally, 37 records met the inclusion criteria set for this study. The results indicated that 18 components were extracted that were classified into seven main categories including cognitive, sensory, motor, mental functions, and medications, diseases, and driving history.

Conclusion: Sensory, motor, and cognitive abilities are the most important components of elderly safe driving. Therefore, as age increases, chronic disease, multiple drug use, and subsequent problems increase. This can affect the ability to drive safely and can cause traffic injuries. Therefore, it is recommended to use the results of this research to design a suitable tool and model for assessing driving competency in the elderly.

Keywords: Automobile driver examinations, Aged, Automobile driving, Licensure, Traffic crashes, Geriatric assessment, Driving competency, Safe driving, Elderly

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Introduction

Increasing life expectancy and health promotion has led to an increase in the population of people over 60 years old, the so-called "Aging Tsunami" (1). A quick look at the growing trend of the elderly population in Iran and comparing it with the selected countries in Figure 1 indicates that the trend in Iran is growing faster.

In the meantime, maintaining the independence of the elderly to enhance social participation and quality of life is crucial (3). In fact, driving is a symbol of self-esteem and the freedom of the elderly (4).

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↑What is "already known" in this topic:
Decrease in natural abilities and diseases of old age affect driving performance. Since different components affect driving, identifying them can help to accurately assess the driving skills of the elderly. Appropriate assessment of the driving license of the elderly at the time of renewal of the license can improve the safety of road users by reducing driving errors and accidents.

→What this article adds:
This study identified and classified the main effective components for the driving license of the elderly. The findings of the study have provided the necessary context for the preparation of native tools for use by the police NAJA when renewing the driver's license for the elderly.

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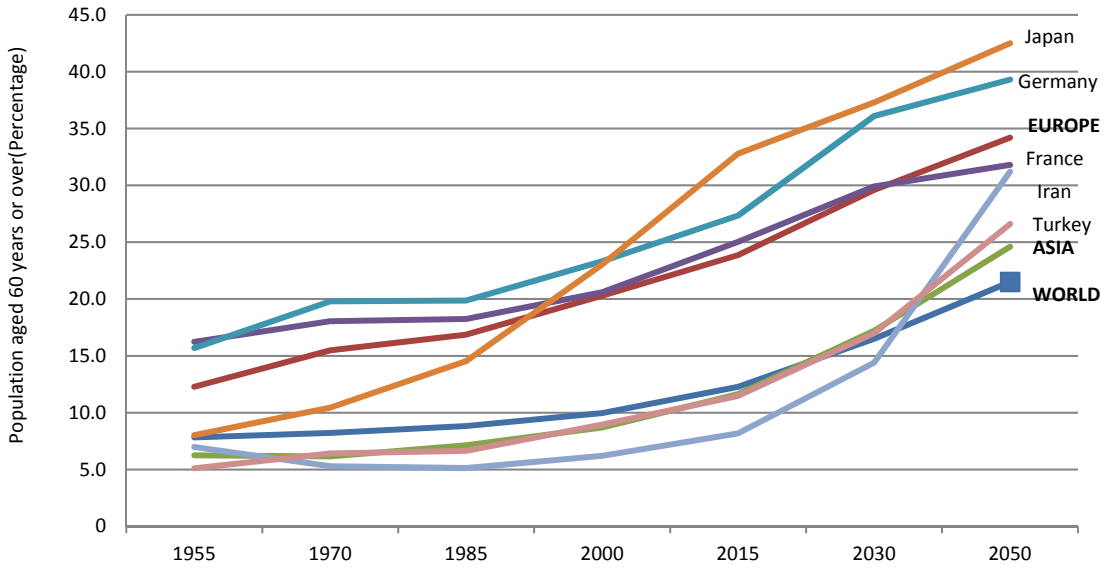

Fig. 1. The trend of elderly population growth in Iran and the world (2)

Driving is a complex activity that requires multiple tasks at the same time (3). Driving requires seeing and hearing clearly, paying attention to other cars, signs and alarms, and pedestrians, and responding quickly and appropriately react to events that drivers typically perform regularly using their perceptual, cognitive, and motor abilities (3).

The number of elder drivers has increased coincided with increasing the number of elderly; so that more than 40 million people in their 60s and over in the United States had a valid driver's license in 2015, according to CDC (Centers for Disease Control and Prevention). That number has increased as much as 50% since 1999 (5). Elderly driving is associated with an increased risk for drivers and other road users. Results from various statistics indicate that the death rate of older drivers (generally more than 70 years) is higher than drivers of other age groups (6, 7). According to the findings of the Evans study, the death rate of drivers at the age of 85 and older was 9 times higher than drivers at the age of 25 to 69 years old (7).

However, the primary cause of elderly car accidents is their age limitations rather than careless behavior and irresponsibility (8). Although the number of accidents at these ages is higher than other groups, it is important to note that the capabilities of all older drivers do not necessarily decrease in a certain proportion. On the other hand, higher rates of depression, isolation, reduced self-esteem, decreased physical and social performance, increased mortality, and decreased quality of life of elderly people without a renewed driver's license (9, 10). The results of a study in Japan showed that the death rate from traffic accidents in this age group decreased to less than one second in the same period with the use of appropriate measures given the 1.3 times increase in the number of drivers over 75 years from 2003 to 2013 (11).

Therefore, it is necessary to establish appropriate criteria for assessing the driving competence of this age group to ensure both the safety of road users and the preservation of independence and health of the elderly. Examination of the extension of driving license in different countries shows that the criteria for measuring eligibility for driving in the world do not follow the same pattern (12).

Since identifying factors affecting age-related driving is considered as a key strategy to reduce the risk of elderly driving (13), this study was designed and conducted to determine the main components that determine driving eligibility of the elderly.

Methods

The present study is a scoping review. The advanced search was conducted at PubMed, Scopus, ProQuest, Web of Science, google scholar databases using keywords like the battery, model, screening tool, guideline, Predictor factors, older / elder driver, and proper communication words including OR, AND (Table 1).

The inclusion criteria include English language, original and review studies and other documentation including tools and guidelines and exclusion criteria include studies specifically targeting elderly people with a particular illness or disability such as stroke web-based tools, do not access to the full articles, studies that used simulation as a screening tool or study outcome.

Searching for the records was conducted from 1990 to August 2019, and all studies with defined criteria were reviewed. The research team also searched for gray literature through library resources search and google search to

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Table 1. Search strategy

Database	Search strategy	N
PUBMED	((((((Battery[Title/Abstract]) OR Model[Title/Abstract]) OR Guideline[Title/Abstract]) OR Predictor factors[Title/Abstract]) OR Screening Tool[Title/Abstract]) OR Multivariate Analysis[Title/Abstract]) AND ((older driver*[Title/Abstract]) OR elder driver*[Title/Abstract])	159
Scopus	((TITLE-ABS-KEY ("older driver") OR TITLE-ABS-KEY ("elder driver"))) AND ((TITLE-ABS-KEY (battery) OR TITLE-ABS-KEY (model) OR TITLE-ABS-KEY (guideline) OR TITLE-ABS-KEY ("Predictor factor") OR TITLE-ABS-KEY ("Screening Tool") OR TITLE-ABS-KEY ("Multivariate Analysis")))	572
ProQuest	((ab(older driver) OR ab(elder driver)) AND (ab(multivariate analysis) OR ab(battery) OR ab(screening tool) OR ab(Predictor factor) OR ab(model) OR ab(guideline))) OR ((ti(multivariate analysis) OR ti(screening tool) OR ti(Predictor factor) OR ti(guideline) OR ti(model) OR ti(battery)) AND (ti(older driver) OR ti(elder driver)))	1779
Web of Science	(TI=(battery) OR TI=(model) OR TI=(guideline) OR TI=(Predictor factor) OR TI=(Screening Tool) OR TI=(Multivariate Analysis)) AND (TS=(older driver*) OR TS=(elder driver*))	237
Google scholar	battery, model, screening tool, guideline, Predictor factors, Multivariate Analysis, older driver, elder driver	22

increase the search sensitivity.

The process of selecting the documentation for this study, according to the PRISMA chart, is illustrated in Figure 2.

Two authors (S.B, A.E) independently did all steps such as search, title/abstract screening, and full-text assessment for eligibilities. Data extraction was done by self-made form, based on the aim of the research, that includes author, year, location of study, title, abstract, source, name and type of production, outcome measurement, components, and references. Two authors (S.B, A.E) independently charted the data and continuously updated the data charting form in an iterative process.

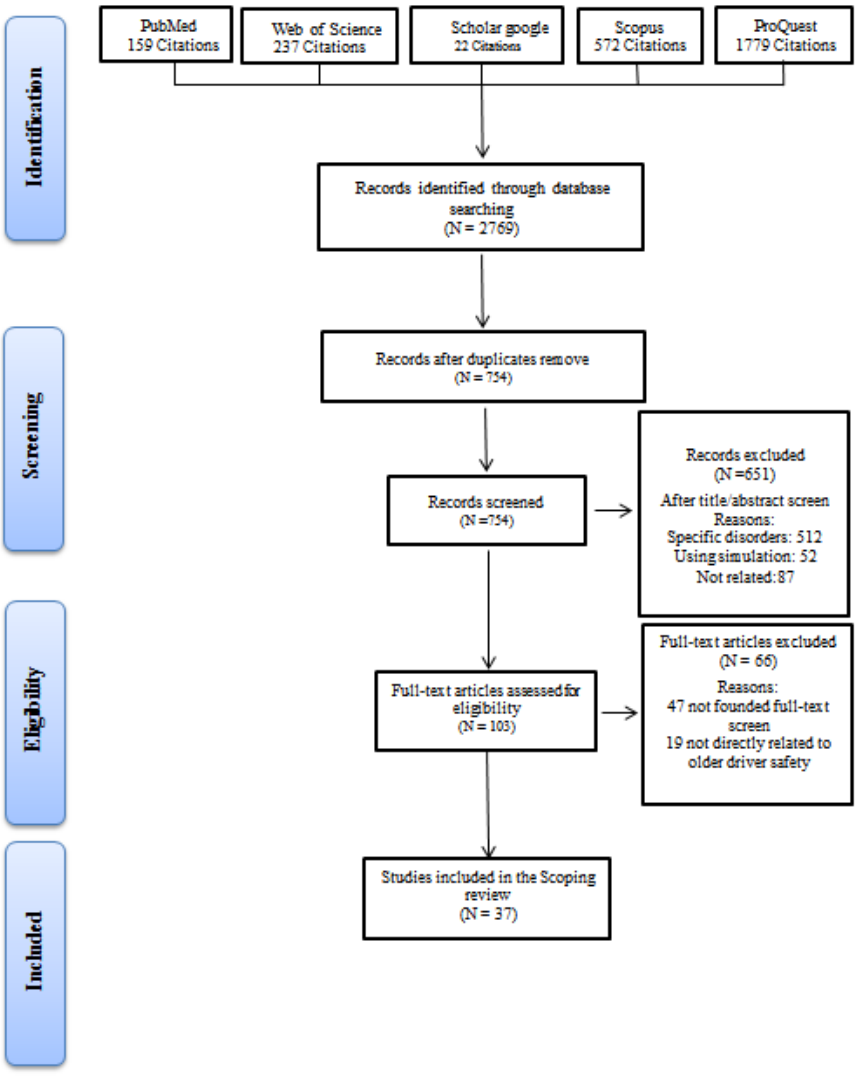

Fig. 2. Search and selection process

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Results

Descriptive findings on the type of output of the selected studies are presented in Table 2.

Appendix summarizes the findings of the selected studies.

Table 3 examines the types and frequencies of components in the selected documentation.

The main components and dimensions of each of the components extracted in this study are shown in Table 4.

Discussion

The findings of this study were classified into seven main groups, including cognitive, sensory, motor, Emotional/Mental and medications, diseases, and driving history.

Driving as a complex task requires efficient and appropriate use of various sensory, motor, and cognitive functions (21). The driver must be able to respond to unusual and unexpected events while driving. On average, each driver needs 20 decisions to travel each mile, and it takes approximately half a second for a proper response to avoid a potential accident (50). Since integration in the functions required to drive has naturally diminished with age, the consequences of driving-related abilities also occur in addition to diseases of old age and medications used to relieve and treat them.

In this study, the health-related abilities required for safe driving in the elderly were examined. The following are the main extracted concepts:

***Sensory Functions**:* Driving is a vision-driven task because vision provides about 90% of the information needed for safe driving (51). Visual perception refers to the brain's capacity to recognize and interpret visual stimuli, which constitute the visual function of individuals together with visual processing (which is part of cognitive ability) (52).

Typically, the visual condition deteriorates with age, and the speed of visual processing becomes slower (3, 53). Increasing age is associated with structural changes in eyes that can lead to decreased visual acuity, contrast sensitivity, visual field, and increased glare. However, problems such as visual acuity can be corrected by wearing glasses, but others are not correctable and increase the risk of driving, especially at night (53).

Elderly eyes need more light and time to adapt to luminous changes (3). Visual clarity decreases at sunrise, sunset, and at night. The sensitivity of the eyes to high lights, especially the headlights of front cars and street lights, increases the difficulty of seeing people, objects, and motions outside the straight line of vision (3).

However, most vision problems are a combination of eye building problems and cognitive problems, especially the speed of processing, visual processing, and attention shift (53).

The prevalence of eye diseases such as cataracts, retinopathy, glaucoma, and macular degeneration also increases with age. These diseases not only reduce vision but also reduce the depth of vision and visual field that are associated with reduced ability to estimate distance and speed (50). The most common age-related eye diseases are cataracts and glaucoma (53,54).

The hearing also decreases sharply with age, but it generally does not have a significant effect on driving quality (53). However, severe hearing problems can lead to disregard for important sounds and alarms while driving and increase the risk of traffic accidents (3).

Cognition Functions: Naturally, some cognitive abilities such as conceptual reasoning, memory, and processing speed decrease with age (55). The cognitive abilities of the driver are closely related to the driving situation, and many of its dimensions are essential for safe driving (3).

Age-related cognitive problems are the cause of various types of human errors while driving (56). Therefore, special attention has been paid to the assessment of different cognitive dimensions to assess the driving ability of the elderly.

Some of the important aspects to consider in the cognitive assessment of drivers include attention, reaction time, multitasking, visual processing, short-term and working memory, executive function, and visual search (33, 50). Reducing any of the cognitive areas needed can have a negative impact on driving abilities that require decision-making and rapid response based on instantaneous situations (33).

In general, executive functions have a wide range of cognitive processes and behavioral competencies, including verbal reasoning, planning, ability to sustain attention, problem-solving, resistance to interference, cognitive flexibility, use of feedback, sequencing, multitasking, the ability to deal with novelty, etc. (57). Another study examines the most important aspects of executive functions for driving are impulse control/inhibition, working memory, deci-

Table 2. Frequency of study outputs in selected records

No	Type of study's outputs	N	%
1	Battery	21	31.6
2	Model	9	23.7
3	Guideline	6	15.8
4	Screening Tool	6	15.8
5	Predictor factors	5	13.1
Total		37	100

Table 3. Extracted components of this review

No	Components	F	%
1	Cognitive Function	31	22.3
2	Sensory function	27	19.4
3	medical conditions & History	15	10.8
4	Motor	10	7.2
5	Physical functions	10	7.2
6	Driving Experience &Behaviors	9	6.5
7	Medication use	8	5.8
8	Mental & Emotional Functions	6	4.3
9	Review Of Systems & Initial Screen	6	4.3
10	Functional Status	3	2.2
11	Perceptual functions	3	2.2
12	Crash History	2	1.4
13	Family Concerns	2	1.4
14	On-Road Driving	2	1.4
15	Psychomotor functions	2	1.4
16	Demographics	1	0.7
17	Ethanol use	1	0.7
18	visual- cognitive ability	1	0.7
Total		139	100

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Table 4. Main dimensions of extracted components

Cognition Function	Sensory Function	Physical Function	Review Of Systems	Medication Status & Drug Abuse
• Attention	• Vision	• Balance	• Chronic Medical Conditions	• Benzodiazepines
○ Visual Attention	○ Vision acuity	• Range Of Motion	• Cardiovascular conditions	• Narcotics
○ Divided attention	○ Contrast sensitivity	• Functional range of motion	• Diabetes mellitus	• Antihistamines
○ Selective Attention	○ Peripheral vision	• Gross mobility and balance	• Eye disease	• Sedatives and hypnotics
• Memory	○ Visual fields	• Coordination	• Glaucoma	• Anticholinergic medications such as
○ Short term memory	○ Colour vision	• Flexibility and speed	• Diabetic retinopathy	○ Tricyclic antidepressants
○ Delayed short term memory	• Hearing loss	• Physical flexibility	• Age-related macular degeneration	○ Antipsychotics, oxybutynin
○ Visual memory	• Pain	• Upper body	• Neurological disease	○ Dimenhydrinate
○ Verbal memory	• Perception	• Shoulder	• Non-Alzheimers dementia	
○ Working Memory	• Depth perception	• Limb proprioception and kinesthesia	• Dementia	• Alzheimer's disease agents
• Visual perception		• Lower body stiffness	• Stroke	• Parkinson's disease agents
• Visuoconstruction		• Upper/Lower Body Muscle Strength/ tone	• Parkinson disease	• Ethanol use
• Visual Closure		• Upper Body Maximum Torque (left & right)	• Cervical arthritis	
• Visual neglect	**Mental Status**	• Upper Body Initial Reaction Time	• Spinal stenosis	Driving Status
• Visual search	• Mental Status	• Hand coordination and dexterity	• Musculoskeletal disease	• Recent Crashes
• Visualization of Missing Information	• Mental flexibility	• Endurance	• Arthritis	○ Driving incidents or changes in the past 5 years
• Visuospatial ability	• Physical and mental well-being	• Grip strength	• Bone and joint problems	○ MVCs in past year to which police were called
• Visual tracking	• Little interest or pleasure in things normally enjoyed	• Finger flexion	• Specified hip/knee disorders	• In-car experiences
• Field of View	• Mental Status	• Fatigue	• Effects of polio	○ A self-reported measure of driving exposure
• Motion perception		• Perceptual speed	• Mental disease	○ Driver self-assessment from safe driving
• Motion detection		• Motor function	• Recent decline in ability to manage medications	○ Limitation in driving or stop driving in past year
• Executive function		• Use of a locomotion appliance	• Decline in general daily decisions	• Knowledge of road signs
• Reaction time		• Receiving help in transportation	• Psychiatric conditions	• Speed of driving compared to the general flow of traffic
• Speed of processing		• Having an unsteady gait	• Delirium	• Driving behaviors
• Information processing			• Depression	• Drive in raining During the past 3 months
• Abstraction			• Other disorders	
• Orientation			• Sleep disorders	
• Insight			• Diarrhea	
• Concentration			• Syncope or presyncope	
• Sentence repetition			• Hypoglycemia	
• Block design			• Hyperglycemia	
• Comprehension			• Orthostatic systolic blood pressure	
• Digit span				

sion making/judgment, cognitive flexibility, expresses self-awareness /insight and planning (58).

Information processing and reaction time slow down with age, and attention span may be shorter (3). It gets difficult to do two things at once. As a result, the elderly may experience a feeling of overwhelming pressure, especially by signs, warnings, pedestrians, or other vehicles at intersections (3). Attention and multitasking decrease with age (approximately in the fifth decade of life) in healthy individuals (50).

Dementia and mild cognitive impairment (MCI) are the most common diseases that cause cognitive impairment in older drivers. Drivers with dementia experience traffic accidents 2.5 to 5 times more than those without dementia (59). It is worth noting that every elderly person with mild cognitive impairment or early stages of dementia does not necessarily have a high risk of driving, and any elderly without dementia definitely do not have the necessary driving competencies (50).

Motor Functions: Motor functions play an important role in safe driving. Age-related changes in the motor system can affect a person's ability to drive and move. Motor skills such as muscle strength, endurance, and flexibility are essential for vehicle control (19). Muscle strength decreases with age by about 3% each year after the age of 70 years old (50).

Motor problems affect gait and balance, motor sequencing, sensorimotor adaptation, and motor control by aging (50). Any medical problem that affects the hands, feet, neck, and waist can affect the fitness needed to drive and can result in the urgency of maneuvering to rotate the head, steering wheel, or extend braking time (3).

Postural balance, muscle strength, and cognition are also associated with braking time while driving (53). Elderly joints may be deflected or may have difficulty walking, and movement also decreases with age and sometimes due to pain from age-related diseases such as osteoarthritis (50, 60). Motor coordination and dexterity, Complex and fine-grained movements also decrease with age (53, 61).

In addition, Morgan et al. (2018) introduced important

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driving dimensions for examining older drivers as a history of falls and gait impairment and functional impairment in ADLs or IADLs (50).

***Emotional/Mental Functions**:* The personalities and attitudes of older drivers have a significant impact on risky driving reporting and traffic accidents (59). Many psychological factors can affect a person's ability to drive, one of which is the loss of self-esteem in driving as a result of changes in vision, physical strength, and cognition (62).

Emotional factors, such as passive experiences like anxiety or fear of losing function, can also affect driving competence (33). Taylor's study illustrates that 17-30% of drivers experience driving anxiety (63). Although emotions and emotional distress factors do not directly affect driving function, they can affect the cognitive abilities required for safe driving and decision-making and may pose a risk to driving (64).

One of the biggest concerns in this area is a decrease in consciousness or arousal. The driver's level of arousal is related to his or her level of alertness on the road, which can be reduced by the lack of sleep, fatigue, and ethanol or drug abuse (65). Anxiety and irritation can manifest as aggressive driving, while depression and mental disorders can lead to distraction and inattention while driving. The results of previous studies show that 10-35% of drivers were either emotionally upset or stressed during an accident (66).

***Diseases**:* Some chronic age-related medical problems such as arthritis, eye disease, heart disease, arterial hypertension, diabetes, and dementia can affect the ability to drive (9, 67).

The effects of functional problems while driving may be due to the use of medications needed to treat one, more concomitant diseases or problems caused by pain and functional limitations associated with the disease.

Some age-related diseases such as osteoarthritis, deconditioning, extrapyramidal disorders, and brain injury (such as stroke) can decrease motor abilities. Time and distance judgments can be impaired by fatigue, neurological disorders (such as Alzheimer's disease), and visual impairments (65).

The findings of Turrado's study of GAZEL cohort data (2020) indicate that diseases such as angina, coronary disease, myocardial infarction, stroke, nephritic colic, urinary stones, and Glaucoma were associated with an increased risk of traffic accidents (68). Morgan considers peripheral neuropathy, recurrent hypoglycemia, seizure, delirium, syncope or pre-syncope, vertigo, orthostatic hypotension, stroke or TIA, visual impairment despite the correction, and neurodegenerative diseases as the most important driving disorders of the elderly (50).

The results of Sargent-Cox (2011) showed that the elderly and having more than one medical problem increases the likelihood of self-control in driving (69). Findings from another study suggest that cognitive problems accepted by drivers are associated with worry and avoidance of specific driving situations (70).

Medications: Medications can affect visual, cognitive, or motor abilities while driving (71). Findings from previous studies have shown that taking certain medications, polypharmacy, and even discontinuing some medications can increase the chance of crash in the elderly (3, 2).

Medications for treating depression, anxiety, sleep disorders, heart disease, muscle spasms, and medications that affect the CNS can cause problems with safe driving (3, 73). Both prescription and non-prescription drugs can affect the ability to drive (3).

The association between the use of certain drugs such as benzodiazepines, antidepressants, nonsteroidal anti-inflammatory, hypnotics, angiotensin-converting enzyme inhibitors, anticoagulants, and lithium drugs, as well as ethanol and drug abuse, has been shown in various studies (9, 72, 74).

Visual impairments can be caused by taking drugs such as antimalarial, antiarrhythmic, antitubercular agents, antidepressants, anticonvulsants, antianxiety agents, psychotropic, bone disorder agents, musculoskeletal agents, and acne and AIDS-related agents (75, 65).

Ethanol and drug abuse, as well as taking drugs with or without prescription, can affect the CNS, affecting attention, Time and distance judgments, searching, and scanning behaviors (65).

Morgan's study concludes that long-term use of high-risk drugs and ethanol and drug abuse are some of the issues to be considered to assess driver competence. He has introduced high-risk drugs for drivers such as Hypnotics, Anticholinergics, Antipsychotics, Benzodiazepines, Opiates, Parkinson medications, Muscle relaxants, Stimulants, Anticonvulsants, Antidepressants (50).

Driving experience: Experience driving and practicing through increased knowledge and driver skill affect driving competence. Having anticipatory abilities helps the driver avoid the dangers (33).

Family concerns about elderly driving or recent driving problems can help identify elderly drivers at risk (76). On the other hand, checking driving records and accidents or errors registered by the police can also be used to predict the driving situation of the elderly.

The elderly can use their experiences to cover deficits created in a particular dimension of their health by taking advantage of other dimensions. For example, people who are not cognitively impaired can drive at a safe speed by understanding their vision problems, adjusting their driving time, driving conditions, environmental conditions, or equipment in their car for safe driving.

Study limitations

Considering the complexities and problems of acquiring the nature of driving abilities, and in particular examining these abilities in the elderly (with a natural decline in abilities, chronic illnesses, the use of various drugs, and compensating for some disabilities using empirical skills) was one of the limitations of this study. The necessity of using studies whose result is practically usable in our country (e.g., programs that use simulation and web-based applications were excluded) is also one of the most important limitations of this study. The lack of access to some important tools and guidelines in our country due to the lack of access to desired websites.

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Conclusion

Generally, three key components are needed for safe driving in the elderly, including vision, cognition, and motor function. These factors enable the elderly driver to perform the stages of perception, decision-making, and response correctly. Disorders in any of these abilities, whether caused by the aging process, medical problems, drug use and abuse, fatigue, inattention or distraction, or emotional states, can increase the risk of a crash. However, no single feature or disability can predict the risks associated with elderly driving. The findings of this study can be used by researchers to conduct further studies and police to apply when renewing a driver's license to accurately identify the problems and permanent illnesses caused by the driver's age.

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Conflict of Interests

The authors declare that they have no competing interests.

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Appendix. Summary of the selected studies

No	Author, Year and Location of Study	Title of Record	Product Name & Type	Outcome measurement	Components
1	Owsley-1991 (USA)(14)	Visual/Cognitive Correlates Of Vehicle Accidents In Older Drivers	Modeling Visual/Cognitive Correlates Of Accident Frequency(Model)	Accidents	− Cognitive − Mental Status
2	Marottoli-1998 (USA) (15)	Development Of A Test Battery To Identify Older Drivers At Risk For Self-Reported Adverse Driving Events	Test Battery To Identify Older Drivers At Risk (Battery)	Self-Report Of A Crash, Moving Violation, Being Stopped By Police	− Visual − Cognitive − Physical
3	Mcknight-1999 (USA) (16)	Multivariate analysis of age-related driver ability and performance deficits	Automated Psychophysical Test (APT) (Predictor Factors)	Accidents	− Sensory − Cognitive − Psychomotor − Perceptual
4	De Raedt-2001 (Belgium) (17)	Short Cognitive/ Neuropsychological Test Battery For First-Tier Fitness-To-Drive Assessment Of Older Adults	Short Cognitive/ Neuropsychological Test Battery	On-The-Road Driving Test	− Sensory − Cognitive − Neuropsychological Test
5	Wang 2003/ AMA(USA) (18)	Physician's Guide To Assessing And Counseling Older Drivers	Assessment Of Driving-Related Skills (ADRes) (Screening Tool)	-	− Motor − Cognition − Vision
6	Staplin-2003 NHTSA (USA) (19)	Model Driver Screening And Evaluation Program	Driver Screening And Evaluation Program (Model)	-	− Vision − Mental Functions − Physical Ability
7	Kantor-2004 (USA) (20)	An Analysis Of An Older Driver Evaluation Program	Model For Predicting On The-Road Performance(Model)	On-The-Road Driving Test	− Cognitive − Functional Status
8	Anstey-2005 (AUS) (21)	Cognitive, Sensory And Physical Factors Enabling Driving Safety In Older Adults	Model Of Factors Enabling Safe Driving Behavior(Model)	On-The-Road Driving Test & Accidents	− Cognition − Sensory Function − Physical /Medical Function
9	Classen-2006 (USA) (22)	Mixed Methods Approach Explaining Process Of An Older Driver Safety Systematic Literature Review	Structural Model For Older Driver Safety (Model)	-	− Body Function & Structure − Medication Use − Demographics − Activities − Exposure Rate
10	Langford-2006 (Australia) (23)	A Re-Assessment Of Older Drivers As A Road Safety Risk	Re-Assessment Of Older Drivers As A Road Safety (Battery)	On-The-Road Driving Test	− Vision − Cognition − Motor
11	Molnar- 2007 (Canada) (24)	Acceptability And Concurrent Validity Of Measures To Predict Older Driver Involvement In Motor Vehicle Crashes	Predicting Measures For Older Driver Involvement In Motor Vehicle Crashes (Battery)	Accidents	− Cognitive − Physical Examination Tests − Diabetes Mellitus − Driving Habits Questionnaire − MMSE

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No	Author, Year and Location of Study	Title of Record	Product Name & Type	Outcome measurement	Components
12	Eby-2007 (USA) (25)	Development And Pilot Testing Of An Assessment Battery For Older Drivers	Comprehensive Battery Of Assessment Instruments For Older Drivers (Battery)	Driving Performance Or Crash Risk	− Vision − Motor − Cognition − Driving Behaviors − Health Questionnaire − Driving Questionnaire
13	Wood-2008 (AUS) (26)	A Multi domain Approach for Predicting Older Driver Safety Under In-Traffic Road Conditions	Multi domain Tests (Battery)	On-The-Road Driving Test	− Vision − Motor − Cognition
14	Stav-2008 (USA) (27)	Predictability Of Clinical Assessments For Driving Performance	Predictive Model (Model)	On-The-Road Driving Test	− Vision − Cognition − Motor Performance
15	Edwards-2008 (USA) (28)	Acceptability And Validity Of Older Driver Screening WithThe Driving health® Inventory	Driver Health Inventory(DHI) (Battery)	Accidents	− Sensory − Physical − Cognitive
16	Classen-2008 (USA) (29)	Clinical Predictors Of Older Driver Performance On A Standardized Road Test	Clinical Predictors Of Older Driver Performance (Predictor Factors)	On-The-Road Driving Test	− Musculoskeletal Disorder − Neurological Drug Treatment Agents − Cognition
17	Zook Et Al-2009 (USA) (30)	Identifying At-Risk Older Adult Community-Dwelling Drivers Through Neuropsychological Evaluation	Neuropsychological Tests For Identifying At-Risk Older Drivers (Battery)	On-The-Road Driving Test	− Cognitive
18	Dobbs -2010 (Canada)(31)	The Introduction of a New Screening Tool for the Identification of Cognitively Impaired Medically At-Risk Drivers: The SIMARD A Modification of the DemTect	DriveAble (Battery)	-	− Cognitive − Standardized On-Road Driving Assessment − Medical Conditions − Medications
19	AMA-2010 (USA) (32)	Physician's Guide To Assessing And Counseling Older Drivers	Physician's Guide To Assessing And Counseling Older Drivers (Guideline)	-	− Initial Screen − Assess Driving Related Skills (ADRES) − Medical History − Review Of Systems − Medications
20	Lindstrom-2010 (Canada) (33)	Driving As An Everyday Competence: A Model Of Driving Competence And Behavior	Driving As An Everyday Competence (Dec) Model (Model)	-	− Physical Factors − Cognitive Factors − Emotional Factors − Sensory Factors − Driving Experience And Training
21	O'Connor-2010 (USA) (34)	The 4Cs (Crash History, Family Concerns, Clinical Condition, And Cognitive Functions): A Screening Tool For The Evaluation Of The At-Risk Driver	4Cs Scores (Screening Tool)	On-The-Road Driving Test	− Crash History − Family Concerns − Medical History − Cognitive Function

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No	Author, Year and Location of Study	Title of Record	Product Name & Type	Outcome measurement	Components
22	Munro-2010 (USA) (35)	Predictors Of Lane-Change Errors In Older Drivers	Predictors Of Lane-Change Errors (Predictor Factors)	Lane-Change Errors	− Cognitive Variables
23	Dawson-2010 (USA) (13)	Neuropsychological Predictors Of Driving Errors In Older Adults	Off-Road Neuropsychological Battery (Predictor Factors)	Driving Error	− Cognitive Abilities − Vision − Motor Skills
24	Betz-2012 (USA) (36)	A Pilot Study To Develop A Brief Question-Based Screening Tool To Identify Higher-Risk Older Drivers	CRASH (Screening Tool)	Crashes Or Police Stops	− Feel Confused Or Disoriented While Driving − Driver Avoid Driving Alone − Difficulty Seeing − Hand Over The Keys
25	Antin-2012 (USA) (37)	Comparing the impairment profiles of older drivers and non-drivers: Toward the development of a fitness-to-drive model	a fitness-to-drive model (Model)	-	− Perception − Physical Ability − Visual − Cognitive Ability
26	Anstey-2012 (AUS) (38)	The Role Of Cognitive And Visual Abilities As Predictors In The Multifactorial Model Of Driving Safety	Multifactorial Model Of Driving Safety (Model)	Capacity To Drive Safely, Hazard Change Detection Task	− Visual − Cognitive − Capacity To Drive Safely
27	Anderson-2012 (USA) (39)	Neuropsychological Assessment Of Driving Safety Risk In Older Adults With And Without Neurologic Disease	(Battery)	On-The-Road Driving Test	− Visual Sensory Functioning − Neuropsychological Tests − Road Test
28	Unsworth-2012 (AUS) (40)	Development of a Standardised Occupational Therapy – Driver Off-Road Assessment Battery To Assess Older and/ or Functionally Impaired Drivers	OT-DORA (Battery)	Cart Model	− Initial Interview − Sensory Assessment − Cognitive Assessment − Physical Assessment − Medical History − Medication Screen
29	Chaudhary-NHTSA 2013 (USA) (41)	Evaluating Older Drivers' Skills	Evaluating Older Drivers' Skills (Guideline)	-	− Cognitive − Motor − Vision
30	Bowers-2013 (USA) (42)	Can We Improve Clinical Prediction Of At-Risk Older Drivers?	Clinical Prediction Of At-Risk Older Drivers (Predictor Factors)	On-The-Road Driving Test	− Cognitive − Vision
31	Thomas-2013 (USA) (43)	Licensing Procedures For Older Drivers	(Guideline)	-	− Cognitive − Visual Perceptual − Psychomotor And Mobility

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No	Author, Year and Location of Study	Title of Record	Product Name & Type	Outcome measurement	Components
32	Eramudugolla - 2013 (AUS) (44)	The Multi-D Driver Screening Battery	Multi-D (Battery)	On-Road Errors	− Cognitive − Motor − Sensory
33	Morris-2014 (USA) (45)	Using The Community Health Assessment To Screen For Continued Driving	Driving Review Index (DRI) (Screening Tool)	Driving Behavior	− Cognitive Measures − Functional Measures − Clinical/Health Frailty
34	NHTSA-2016 (USA) (46)	Clinician's Guide To Assessing And Counseling Older Drivers	Clinical Assessment Of Driving Related Skills (CADRES) (Screening Tool)	-	− General − Vision − Cognition − Motor/Sensory
35	Austroads-2016 (AUS) (47)	Assessing Fitness To Drive	Assessing Fitness To Drive (Guideline)	-	− Sensory − Cognitive − Motor − Drugs − Conditions Likely To Affect Driving − Medical Conditions
36	CMA Driver's Guide- 2017 (Canada) (48)	Determining Medical Fitness To Operate Motor Vehicles	(Guideline)	-	− Red Flags − Hidden Disease − Cognition − Drugs − Record − In-Car Experiences − Vision − Ethanol Use − Multiple Comorbidities
37	Urlings-2018 (Belgium) (49)	Aiding Medical Professionals In Fitness-To-Drive Screenings For Elderly Drivers: Development Of An Office-Based Screening Tool	Predictive Battery Of Tests For Fitness To Drive Screenings (Screening Tool)	On-The-Road Driving Test	− Vision − Physical − Cognitive

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