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Introducing practical tools for fit to drive assessment of the elderly: A step toward improving the health of the elderly

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Abstract:

Today, as age increases, the demand for independent living has increased. Since driving is one of the safest and preferred ways for the elderly to travel, paying close attention to the accurate assessment of the elderly's driving ability can prevent traffic accidents in this age group. The purpose of this study was to identify and introduce practical tools for drive assessment fitness of the elderly. This systematic review was conducted according to Cochrane methodology and reported findings according to PRISMA. The following databases were searched from PubMed, ISI web of knowledge, Scopus, ProQuest, Medlib, SID, Magiran, Iran doc, and Iran Medex based on the population intervention comparison outcome method. The total records involving 12 main tools were assessed from 26 selected records in the final evaluation. The research findings indicated the selection of seven tools in the psycho-cognitive function domain such as TMT-B, Clock Drawing Test, MAZE, Montreal Cognitive Assessment, GDS-15, MMSE, and ACE-R, three tools in the sensory function domain such as Snellen, Confrontation Visual field, and Whispered Voice Test, and also two tools in motor function domain such as Rapid pace walk, and Manual test of the range of motion. The findings led to selecting practical, accurate, and fast tools for widespread use for the assessment of driving competencies of the elderly. Therefore, it is recommended that the selected tools be used in practical batteries to assess the driving skills of the elderly.

Keywords:

Aged, competency, driver, driving, fit to drive, elder

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Introduction

According to the WHO, the population of over 60 in the world will almost double from 2015 to 2050 and will increase from 12% to 22%.[1] Prolonging life expectancy presents important opportunities for the elderly, family and even society as a whole,[2] which is expected to remain active as well as more. However, health is the determining factor in turning this stage of life into an opportunity or a threat.[3] Hence since 2015, the World Health Organization (WHO) has been using an approach called healthy aging in the functional domains of the elderly.[2] Healthy aging is defined as the process of optimizing opportunities for mental, physical, and social health to enable older people to engage in social activities without discrimination and to enjoy a good, independent life.[4] As noted in WHO's report, there is no such thing as normal aging, and differences in the abilities and health needs of older people are not accidental and depend on their lifestyle throughout their lives.[4] An active lifestyle and maintaining social activities of the elderly is directly related to the process of healthy aging. In fact, with age, the type

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of social activity of individuals changes.[5] In addition, globalization, technology development, urbanization, migration, and changing gender norms have also directly and indirectly affected the lives of the elderly.[1]

Driving is the most common, reliable and preferred mode of transportation for the elderly and provides them with freedom, safety, and access to other place and people.[6] This has led to a significant increase in the number of elderly drivers.[7] Driving is a continuous and simultaneous interaction between the driver and the environment, both of which can affect driving safety. Driving is done by performing coordinated tasks in the driver's sensory, cognitive, and musculoskeletal systems.[7] Aging reduces driving-related capabilities and coordination between the organs involved while driving, as well as driving skills. On the other hand, in the event of an accident, older drivers will suffer more damage.[8] It is also important to note that reducing age-related natural abilities, illness, medication, and other underlying factors can also affect the ability to drive in old age.[9-11] Therefore, the importance of assessment of driving competency of the elderly is not hidden from anyone. However, there is currently no single, agreed-upon instrument or tool in the world for measuring the driving skills of the elderly or predicting their driving outcomes;[12] Therefore, researchers in different parts of the world, according to self-goals and facilities, have combined different tools to be able to extract the most appropriate and accurate method for evaluating this capability.[13] Therefore, this study was conducted with the aim of introducing practical tools to assess the driving competencies in the elderly.

Materials and Methods

A systematic review (SR) was conducted to provide an overview of the best available evidence. We did the search strategy based on the population intervention comparison outcome method and included all relevant articles without time limitation. The procedure was, then, followed by the PRISMA methods [Figure 1]. Nine databases including the PubMed, ISI web of knowledge, Scopus, ProQuest, Medlib, SID, Magiran, Iran doc, and IranMedex were searched. All databases were searched using the following keywords: Old People, Elder, Aged, Aged +80, Geriatric, Senior, Ageing, Aging, Old Age, Driver, Automobile Driving, Scale, measure, battery, screening tool, tool, Screening, Validity, Reliability, Questionnaire. A researcher (S. B.) conducted literature search. After removing duplications by Endnote X7 software, the titles, abstract, and full texts identified by the database searches were independently reviewed for eligibility by two researchers (S. B. and A. E.). In case of any dispute for screening and selection process, those were solved by discussion between the two researchers.

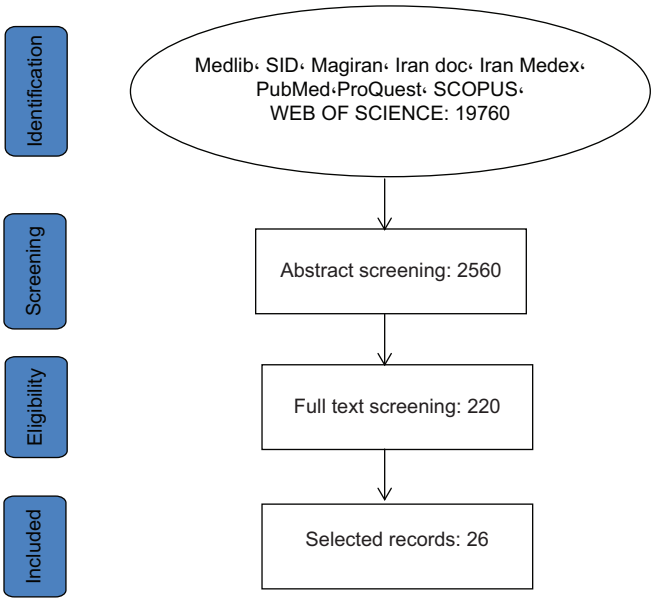

Figure 1: Research flow based on PRISMA methods

The review included all records linked with research objects, in English and Persian language, which (1) No need for specialized training; (2) Portability and easy portability; (3) No need for equipment or computer programs; (4) exist evidence of use in evaluating elderly drivers, and (6) psychometric criteria for the tool. Studies only published as an abstract were excluded due to the very high risk of bias in such designs.

The methodological quality of the included studies was critically assessed by the Downs and Black scale.[14] It is a checklist of 27 items to evaluate the risk of bias with each item scored "yes" (1 point), "no" (0 point) or "unable to determine" (0 point). The scale includes the aspects of reporting, external validity, internal validity, and power. The Downs and Black scale total, for the current review, was modified to 15 items, some items were not scored because of nonconformity in the items and included studies. Higher scores showed higher method quality.

Data were collected using data extraction form. If necessary, we contacted the authors for missing data, clarification, or both.

The study did not involve contact with humans, so the need for ethical approval was assess by university of Social Welfare and Rehabilitation Research Ethics Committee. This SR was not registered.

Results

In total, data of 26 studies were included for qualitative analyses. Summary of results is indicated in Table 1. Relevant results such as design, sample size, population, and all tools that used in the study were extracted from

Table 1: Summary of the reviewed studies

Authors/year	Name of article or battery	Tools domain			
		Cognition/Mental	Sensory	Motor	Other
Engum *et al*. 1988[53]	CBDI (Cognitive behavioral driver's inventory)	Visual reaction differential response visual reaction differential response reversed visual discrimination differential response II visual scanning	-	-	-
Wang *et al*. 2003/ AMA[54]	ADReS (Assessment of Driving-Related Skills)	TMT-B CDT	Snellen Confrontation test	ROM Muscle strength test RPW	-
Kantor *et al*. 2004[55]	Model for predicting on the-road performance	TMT-B RT MMSE	-	Grip strength (WFL, not WFL)	-
Ball *et al*. 2006[56]	Performance-Based Measures	Cued/delayed recall Scan test UFOV MFVP TMT-A TMT-B	-	RPW mobility questionnaire Foot-tap test ROM Arm reach	-
Langford *et al*. 2006 [57]	A re-assessment of older drivers as a road safety (GRIMPS and DriveABLE battery)	Test visual closure sub-test MFVP Cued recall, delayed recall scan test UFOV TMT-A TMT-B	Visual acuity (standard and low contrast)	RPW Arm reach Foot-tapping test Head neck rotation	-
Eby *et al*. 2007[58]	Comprehensive battery of assessment instruments for older drivers	Ruler drop test MVPT CDTMMSE TMT-A TMT-B	Pelli-robson test Snellen "E" test Amsler Grid test Randot Stereoacuity test	RPW Arm reach test Clock reading test Jamar dynamometer test Nine-hole peg test	Medical history Road test
Molnar *et al*. 2007[59]	Assessment Battery	MMSE Ottawa driving and dementia	-	Timed Toe Tap Test	Driving habits Medical
Stav *et al*. 2008[60]	Predictive model	UFOV MMSE	contrast sensitivity slide-B	RPW	-
Wood *et al*. 2008[61]	Multidomain tests	UFOV Color choice RT TMT-B	Dot motion threshold score	Knee extension strength score Sway path length	-
Keay *et al*. 2009[62]	Factors that predict stopping or restricting driving in older drivers	GDS TMT-A Beery-buktenica developmental test of VMI	Pelli-Robson Cs chart	-	Driving history

Contd...

Table 1: Contd...

Authors/year	Name of article or battery	Tools domain			
		Cognition/Mental	Sensory	Motor	Other
Mathias *et al*. 2009[63]	Cognitive predictors of unsafe driving	UFOV Ergovision Complex RT task Paper folding task Dot counting WMS visual reproduction Computerized Visual Attention Task	-	-	-
Barrash *et al*. 2010[64]	Neuropsychological Tests	CFT TMT-A BD (Wechsler Adult Intelligence Scale-III BD test)	-	-	-
Dobbs *et al*. 2010[65]	SIMARD-MD	Number conversion part a score Supermarket task score Repeat of word list score	-	-	-
AMA-2010[66]	PODS (Plan For Older Drivers' Safety)	MoCA CDT Maze TMT-B	-	IADL ROM Get up and go Proprioception RPW	Driving history Medical history
Munro *et al*. 2010[67]	Model Predicting Rate of Lane-Change Failure	Brief test of attention score Beery-Buktenicka test of visual-motor integration score	-	-	-
Dawson *et al*. 2010[68]	Off-road neuropsychological battery	CFT-Copy CFT-Recall BD subtest of the Wechsler adult intelligence scale	Snellen chart	GP	-
Unsworth *et al*. 2012[45]	OT-DORA battery	Road law and road craft test OT drive home Maze Test MMSE	Snellen chart Visual confrontation test Motor sequences screen - Selected test of Proprioception Short form McGill pain questionnaire and visual analogue scale and pain Diagram whispered voice test	Simulated accelerator-brake test Berg balance scale The motricity index right heel pivot test ROM - goniometry Tardieu scale of muscle tone Muscle strength scale	Medical drug
Anstey *et al*. 2012[69]	Multifactorial Model of Driving Safety	Card rotation Paper folding Gestalt completion Snowy pictures Concealed words TMT-A TMT-B Number comparison task Digit symbol matching Letter cancellation tasks CRT	Bailey-lovie (logMAR) chart UFOV (Subtest 2)	-	Hazard perception test Hazard change detection task

Contd...

Table 1: Contd...

Authors/year	Name of article or battery	Tools domain			
		Cognition/Mental	Sensory	Motor	Other
		Digit-span backwards (adapted from WAISIII)			
Anderson *et al*. 2012[70]	Neuropsychological Assessment of Driving Safety Risk in Older Adults With and Without Neurologic Disease	UFOV GP CFT-copy BD BVRT-E CFT-recall	Snellen chart Pelli-Robson chart	-	Road test
Dickerson *et al*. 2013[71]	Assessment Tools Used by Driver Rehabilitation Specialists	Brake reaction UFOV MMSE TMT-A TMT-B MVPT CDT Letter-number cancellation SBT	Road signs (Optec) b	ROM Muscle tone	Road test
Chaudhary *et al*. 2013 (NHTSA)[72]	Evaluating older drivers' skills	EFT RO-CFT BDT LCT MNT MVPT Paper folding test MDRS TMT-A TMT-B BVRT Cognitive flexibility test SBT Rey auditory verbal learning test MMSE CDR CDT TSRT Nordic SDSA DST of the NAB Depression Scale CogStat	-	FRS	-
Bowers *et al*. 2013[73]	Clinical prediction of at-risk older drivers	MMSE UFOV	ETDRS chart MARS chart	-	-
Ferreira *et al*. 2013[74]	Cognitive and psychomotor tests as predictors of on-road driving ability in older primary care patients	ACE-R SDSA UFOV	-	SDB	-
Ghasemi *et al*. 2015[75]	Visual status	-	Snellen chart Confrontation test D15 test Pelli-Robson letter chart	-	-

Contd...

Table 1: Contd...

Authors/year	Name of article or battery	Tools domain			
		Cognition/Mental	Sensory	Motor	Other
NHTSA-2016[17]	Clinician's guide to assessing and counseling older drivers	CDT TMT-B MoCA maze test	Visual acuity Visual field	RPW ROM	-
Urlings *et al*. 2018[12]	Predictive battery of tests for fitness to drive screenings	Knowledge of road signs	Snellen chart	Functional reach test	-

SMAST=short michigan alcoholism screening test, MVA=Motor vehicle administration, SIMARD-MD=Screen for the identification of cognitively impaired medically at-risk drivers, PODS=Plan for older drivers safety, MVPT=Motor-free visual perception test, TMT-A=Trail making test-A, TMT-B=Trail making test-B, MMSE=Mini mental state exam, VMI=Visualisation of missing information, MFVP=Motor free visual perception, MVPT=Motor free visual perceptual test, GDS=Geriatric depression score, HVLT=Hopkins verbal-learning test, IVA=Integrated visual and auditory, CFT=Complex figure test, BD=Block design, MoCA=Montreal cognitive assessment, GP=Grooved pegboard, SBT=Short blessed test, EFT=Embedded figures test, RO-CFT=Rey-Osterrieth CFT, BDT=Block design test, LCT=Letter cancellation test, MNT=Maze navigation test, BVRT=Benton visual retention test, CDR=Clinical dementia rating, CDT=Clock drawing test, TSRT=Traffic sign recognition test, SDSA=Stroke driver screening assessment, DST=Driving scenes test, NAB=Neuropsychological assessment battery, ACE-R=Addenbrooke's cognitive examination revised, FRS=Functional Rating Scale, SDB=Senior drivers battery, VMI=Visual motor integration, ROM=Range of motion, RT=Reaction time, MDRS=Mattis Dementia Rating Scale, WFL=within functional limits., ETDRS=Early Treatment of Diabetic Retinopathy, MOMSSE=Mattis Organic Mental Status Syndrome Examination, ADL=activities of daily living, IADL=Instrumental activities of daily living, POMA=Performance Oriented Mobility Assessment, UFOV=useful field of view, WMS=Wechlser Memory Scale, OT-DORA=Occupational Therapy Driver Off-Road Assessment, CRT=choice reaction time, WAISIII=Wechsler Adult Intelligence Scale-Third Edition, BVRT-E=Benton Visual Retention Test

the selected records based on our research inclusion criteria. Selected studies led us to 12 main tools in three areas: sensory, psycho-cognitive, and motor. The list of tools of this study is shown in Table 2.

Discussion and Conclusion

The findings of this study led to the introduction of 12 practical tools in the sensory, motor, and cognitive domains to assess the ability of the elderly to drive safely. We continue this section based on three main domains of study.

Psycho-cognitive domain

The TMT-B has been widely used since 1944 for neuropsychological studies in clinical and research settings in Iran and the world. The validity has been evaluated and confirmed in various studies.[15,16] This test is used to assess driving competency and is a good predictor of driving accidents.[12,17,18] It is a pen and paper test. The participant is asked to connect a series of numbers and letters scattered on the page to each other alternately by a line. The time required to complete the test is recorded.[17]

The maze test is a pen and paper test and has different types. In this study, Dr. Snellger's maze test was selected. This test has been introduced in previous studies as a good predictor of driving accidents in the elderly living in the community.[19,20] In Iran, the mental maze test has been used to assess students' perceptual-motor skills.[21] To perform this test, the client must first complete a simple guide maze to familiarize themselves with the test. The main maze is then given to him. The test completion time is recorded in seconds.[17]

The MMSE was designed in 1975 by Folstein *et al*.[22] Since then, it has been used many times in various clinical and research settings.[23] This test consists of 5 areas and 11 questions that examine the various dimensions of the subject's psychological and cognitive areas. Seyedian *et al*.[24] have reported its validity in Iran. The use of this tool to predict the driving status of the elderly has been recommended in previous studies.[25] This test takes about 5-10 min. The total score of this test is 30 points.

Clock Drawing Test is a very short and simple test for diagnosing cognitive disorders.[26] The validity and reliability of the test has been reviewed and confirmed in different countries.[27,28] In Iran, the validity and reliability of the test were reported by Sadeghipour Roodsari *et al*. (Reliability between evaluators 0.964 and kappa coefficient of 0.554 and concurrent validity of 0.782 with MMSE test).[29] This test is one of the most widely used tests to assess the driving status of the elderly, which has been used in many clinical and research settings.[17,30] However, so far 30 scoring methods have been reported for this test.[31] In order to perform this test, the subject is asked to draw a wall clock with all the numbers while the hands of the clock show 10 min past 11.[17]

The Montreal Cognitive Assessment Test (MOCA) is a cognitive screening questionnaire that measures cognitive skills over 10 min. Nasreddine *et al*. was designed it to diagnose mild cognitive impairment.[32] MOCA is one of the common tests used for cognitive assessment of the elderly in Iran and the world.[33,34] Its validity and reliability have been studied in the study of Chehrehnegar *et al*. in 2011.[35] It is also one of the most widely used tests to assess the condition of elderly drivers and predict their driving status.[17,36,37]

The Elderly Depression score (GDS-15), assesses depressive symptoms in the elderly. It is also one of the most widely used tests to study depression in Iran and the

Table 2: List of selected tools

Motor function domain	Sensory function domain	Psycho-cognitive function domain
RPW	Snellen	TMT-B
Manual test of range of motion	Confrontation visual field	Maze test
	Whispered voice test	CDT
		MoCA
		MMSE
		GDS-15
		ACE-R

RPW=Rapid pace walk, TMT-B=Trail making test-B, CDT=Clock drawing test, MoCA=Montreal cognitive assessment, MMSE=Mini-mental status exam, GDS=Geriatric depression score, ACE-R=Addenbrooke's Cognitive Examination-Revised

world.[38,39] Malakouti *et al*. reviewed the standardization of this questionnaire. In Iranian elderly and Cronbach's alpha coefficients of 0.9 and correlation coefficient of 0.58 were reported for the test-retest method.[39] The use of this test to evaluate the symptoms of depression in elderly drivers has also been reported.[40] In this test, the subject is asked to answer a questionnaire of 15 questions with two yes/no options. Counting the number of questions with a negative answer determines the test score. Addenbrooke's Cognitive Examination-Revised is a developed form of the MMSE which memory, language, and visuospatial subtests were extended, and fluency subtest was added. This summary version has the appropriate sensitivity and specificity for cognitive screening. psychometric properties of this test evaluted by Pouretemad *et al*. in Iran ($r = 0.5$, $a = 0.84$).[41]

In this study, some psycho-cognitive tools were removed due to overlap with the measured components by selected tools. For example, the TMT-B test measures all components of the TMT-A test and in addition, assesses other components such as working memory, divided attention, and selective attention. Therefore, only the TMT-B test was retained as selected tools. In addition, the practicality and familiarity of the selected tools are other issues that are covered by the findings of this section.

Sensory domain

Measuring visual acuity is the most basic and important method of measurement in visual examinations. The Snellen chart is considered as the most important clinical criterion indicating the quality of vision.[42] Dr. Hermann Snellen of the Netherlands in 1862 was developed first visual acuity chart. A special type of Snellen vision chart is the "rotational E" chart. All the symbols on the chart are capital letters E, located at 90° angles in different spatial directions. This test is the current standard in measuring visual acuity in Iran due to its availability, speed, and convenience.[43] The use of this test in assessing driving competence is common in Iran and the world and is currently used as a standard test for assessing visual acuity in examining assessment centers of police.[17,44]

The Confrontation Visual field is the simplest test to assess the field of view. This test has been used in various studies to evaluate the field of vision of various age groups and work, especially drivers in Iran and the world.[17,45,46] According to the executive instructions, the criteria for medical qualification of applicants for various types of driving licenses in Iran, has been proposed as the only criterion for assessing the field of vision.[43] To perform this test, the examiner sits at a distance of 3 feet or 90 cm from the subject and at a level equal to him. Each eye is examined separately. The subject is asked to close his or her right eye. The examiner closes his left eye at the same time. Each (subject and examiner) must keep their gaze fixed on the other party's open eye. The examiner moves his hand in the subject's field of vision and points to the number 1, 2, or 5 with his fingers. It does this for every right, left, up, and down quadrilateral. Ask the subject to say the number shown.[47] The examiner shows any visual field defects by shading the area with a visual field defect.[17]

Since the introduction of Swan *et al*. in 1985, Whisper test has been used many times in clinical and research settings in different countries to assess the hearing status of drivers. Due to its ease of implementation and the lack of special tools and equipment, this test is one of the common tests for hearing assessment of drivers, especially elderly drivers.[48,49] In order to perform this test, the examiner stands at a distance of one hand (about 60 cm) from the right ear or the left ear from behind the patient. The nonexperimental ear canal is blocked by pressing a finger on the earlobe. The tester whispers the number-word and the combination of numbers and words in the exhaled state. The numbers are given in pairs to the test ear of the individual, and if there is more than 1 incorrect answer, the test result is considered positive (referral). In this case, 5 correct answers and more should be mentioned to be considered a negative screening result. The same process is repeated in the opposite ear.[50]

In this study, contrast sensitivity assessment, which is one of the important components for measuring driving ability, was omitted due to its specialization and the need for specialized equipment. However, examination of visual acuity and field can be associated with the diagnosis of primary vision problems and if necessary,

a specialized examination by an ophthalmologist can be used. Due to the fact that the selected tools in this study are used for screening, its ease of implementation and of course, the necessary accuracy should be considered. Since E-chart, Confrontation Visual field test and whispering tests are common and widely used tests in Iran and are also recommended to assess drivers' abilities, it seems that they can evaluate the components of this field well.

Motor domain

Rapid pace walk evaluates the components of the motor domain in <3 min. The results of various studies indicate the predictive power of this test to assess driving competence, especially in the elderly.[17,51] Due to its easy implementation and without the need for specialized equipment, this test is one of the tools for assessing the motor system in a number of tools for assessing the competence of elderly drivers.[17,52] Reliability among the evaluators of this test was reported to be 0.87, 0.605.[48] In order to perform this test, the subject is asked to walk a distance of 10 feet, equivalent to 3 meters, in the fastest possible time and return to the starting point. If the client uses a cane or walker, he/she is asked to use his/her mobility aids during the test; and is recorded in the test results sheet. Test duration is recorded in seconds.

Range of Motion (ROM) examines the ROM of driving-related joints, including the neck, shoulders, elbows, fingers, and ankles. There are several methods for measuring the ROM of joints. However, in this study, due to the importance of speed and ease of testing, a qualitative method of measuring ROM was used. This method has also been used in the Clinical Guide for the Review and Advice of Elderly Drivers developed by the American Aging Association.[17] In order to perform the test, the subject is asked to: (1) Neck rotation: such as when turning the head back to move backward or to park. The subject is asked to turn his head backward. Now do the same for the other party. (2) Shoulder and elbow flexion: Imagine you are in control of a car. Do a full turn to the right and a full turn to the left. (3) Bending a finger: Fist both hands. (4) Plantar flexion of the ankle: Pretend you are depressing the accelerator pedal. Now repeat the same for the other leg. (5) Ankle dorsiflexion: Pull your toes toward your body. In other words, the movement of the back (dorsal) part of the foot towards the front of the leg. Range scoring is done simply by two options, "normal" and "abnormal" for each side. ROM is considered abnormal when the ROM is limited or despite pain or good ROM is accompanied by pain or pause.[17]

Despite the various tools for assessing motor and functional status, there is no agreed test or method for assessing elderly driving competence among researchers and specialists in the fields of rehabilitation and transportation. The use of selected tests to assessment the balance and strength of the lower limbs as well as ROM are common in Iran and the world and are most widely used tests to assessment of the motor function in elder drivers. Ease of execution, accuracy and no need for special equipment or tools are the features that exist in these two tools.

Limitation and Strengths: We attempted to use comprehensive search strategy and search several databases as well as grey literature; however, the possibility that evidence included in this review is subject to publication and related bias cannot be ruled out. In addition, the most important limitation of this study was the lack of access to the full text of some documents.

Conclusion

Easy and accurate diagnosis of older drivers' disabilities with appropriate tools can be used to prevent traffic accidents and their consequences. Therefore, the use of practical tools in this field can help the health of elderly drivers, health system and the public. The findings of this study can be used to evaluate the driving abilities of the elderly in police clinical examination centers. It is also suggested that the present tools be used in order to conduct additional studies on the construction of a battery for elder driver assessment in Iran.

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Conflicts of interest

There are no conflicts of interest.

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