A 10-YEAR SCOPING REVIEW OF SCREENING AND ASSESSMENT TOOLS USED FOR DRIVING REHABILITATION IN OLDER ADULTS

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Abstract

This scoping review aims to explore the screening and assessment tools used for driving rehabilitation in older adults and the domains that these tools evaluate. Web of Science, Scopus, and PubMed databases were used to search for potential studies published from 2012 to 2022, and 34 studies met our inclusion criteria. The findings revealed various types of tools used to screen and assess older adults' fitness to drive, including off-road screening tools (n = 54), off-road assessment tools (n = 21), and on-road assessment tools (n = 20). This review also identified five main domains evaluated by these tools: general information, physical, cognitive, vision, and driving competency. This review provides valuable insights into the screening and assessment tools available for evaluating driving rehabilitation in older adults. The results of this study may assist in the growth of the occupational therapy profession in the area of driving rehabilitation by guiding them in selecting the most appropriate tools to evaluate older adults' fitness to drive.

Keywords: Assessment Tool, Driving, Driving Rehabilitation, Occupational Therapy, Older Adult, Screening Tool

Introduction

The mounting number of senior drivers is alarming to health professionals, especially occupational therapists who are playing their roles in promoting older adults' functional performance, which also includes driving activity. In the baby boomers' generation, driving activity symbolises independence and well-being. Driving enables older people to lead active lives, maintain social ties, and contribute to self-confidence (1). The ability to drive among older people is also linked to undeniably higher access to healthcare, shopping, and social opportunities, and there will be critical impacts on the older person in terms of socialisation and isolation when the ability to drive is lost (2).

Occupational therapy practitioners play vital roles in addressing driving issues among older adults. In comparison to other health professionals, occupational therapists are more likely to recognise when a client is no longer fit to drive (3)and health professionals should advise patients accordingly. This study examined the knowledge of occupational therapists, other therapists and psychologists regarding medical standards for driving, their attitudes to advising patients about driving, and barriers to giving that advice. Method: A structured questionnaire measured knowledge of medical standards and attitudes to advising patients about driving. Analyses compared responses of occupational therapists with those of other therapists and psychologists. Semi-structured interviews were carried out with therapists and psychologists after they had watched a video-taped clinical consultation with an actor-patient who was unfit to drive. Interviewees, unaware that the study was about driving, were asked how they would advise the patient. Focus groups were held with a range of health professionals to discuss facilitators and barriers to giving driving advice. Results: Eighty-two questionnaires were completed. Occupational therapists were most aware of driving guidelines and most likely to advise patients to stop driving (p < 0.01. With the knowledge of pathology, injury, and driving activity requirements (4)public healthcare users equate the ability to drive a motor vehicle to employability and access to essential services. When injury or illness threatens the ability to drive, the multi-professional medical team usually refer the problem to the occupational therapist who will make decisions about patients' fitness to drive a motor vehicle. Method: Over the course of five years, a collaborative task team applied multiple Action Learning Action Research (ALAR, occupational therapists should be able to assist these older drivers by using their capacity as health professionals who are practising driving rehabilitation.

Driving rehabilitation is a program that helps evaluate skills and provides retraining related to driving activity, which is often staffed by occupational therapists (5). Compared to other health professionals, occupational therapists are those who are more aware of mobility issues such as driving (3)and health professionals should advise patients accordingly. This study examined the knowledge of occupational therapists, other therapists and psychologists regarding medical standards for driving, their attitudes to advising patients about driving, and barriers to giving that advice. Method: A structured questionnaire measured knowledge of medical standards and attitudes to advising patients about driving. Analyses compared responses of occupational therapists with those of other therapists and psychologists. Semi-structured interviews were carried out with therapists and psychologists after they had watched a video-taped clinical consultation with an actor-patient who was unfit to drive. Interviewees, unaware that the study was about driving, were asked how they would advise the patient. Focus groups were held with a range of health professionals to discuss facilitators and barriers to giving driving advice. Results: Eighty-two questionnaires were completed. Occupational therapists were most aware of driving guidelines and most likely to advise patients to stop driving (p < 0.01. As driving is an important means of community mobility for an individual, occupational therapists play a critical role in assessing fitness to drive and enabling clients to continue driving when it is deemed safe (3)and health professionals should advise patients accordingly. This study examined the knowledge of occupational therapists, other therapists and psychologists regarding medical standards for driving, their attitudes to advising patients about driving, and barriers to giving that advice. Method: A structured questionnaire measured knowledge of medical standards and attitudes to advising patients about driving. Analyses compared responses of occupational therapists with those of other therapists and psychologists. Semi-structured interviews were carried out with therapists and psychologists after they had watched a video-taped clinical consultation with an actor-patient who was unfit to drive. Interviewees, unaware that the study was about driving, were asked how they would advise the patient. Focus groups were held with a range of health professionals to discuss facilitators and barriers to giving driving advice. Results: Eighty-two questionnaires were completed. Occupational therapists were most aware of driving guidelines and most likely to advise patients to stop driving (p < 0.01.

As part of the rehabilitation professional, occupational therapist participates in the process of screening and assessing potentially unsafe older drivers. Screening is a process that involves administering quick tests, examinations, or other procedures to identify an unrecognised disease or defect and, therefore, determine those who need further evaluation concerning their driving safety (6). In the driving context, many often-used off-road screening tools are beneficial in screening for older drivers with enhanced risk (7). Meanwhile, assessment is a process that involves a more detailed and comprehensive evaluation of the individual's driving-specific skills and safety, particularly in domains that were identified as potential concerns during the screening process (6).

The therapist will commonly perform a pre-road screening and assessment as a preliminary step to detect problems or issues before deciding if on-road testing is appropriate (8). In order to make accurate decisions, it is crucial to use standardised assessments, which can help improve the quality and quantity of the information gathered (9). However, there is inconsistency in selecting and administering screening and assessment tools for this population. Therefore, this scoping review sought to provide an overview of the current screening and assessment tools used for driving rehabilitation in the older adult population.

Materials and Methods

This scoping review was reported in accordance with the preferred reporting items for systematic reviews and meta-analyses extension for scoping reviews (PRISMA-ScR) (10) and conducted according to the framework proposed by Arksey and O'Malley (11), which uses the following steps: (i) identifying the research question, (ii) identifying the relevant studies, (iii) study selection, (iv) charting the data; and (v) collating, summarising, and reporting the results.

Step 1: Identifying the research question

This scoping review addresses the research question: 'What are the existing screening and assessment tools used for driving rehabilitation in older adults?' and 'What are the domains assessed by those tools?'.

Step 2: Identifying relevant studies

The studies were identified in October 2022 through the following electronic databases: Web of Science, Scopus, and PubMed. The main keyword used were "screening tool", "assessment tool", "older adult", "driving", "driving rehabilitation", and "occupational therapy". The reference lists of records found through the electronic searches were extracted into reference management software (Mendeley™) for duplicate removal. A total of 728 records were screened after removing 80 duplicates, and no new potential articles were found from cross-reference and hand searching. The flow chart of study selection is illustrated in Figure 1.

Step 3: Selection of studies

A total of 728 articles were screened based on their title, abstracts, and year of publication. The inclusion criteria in this scoping review were: (i) published between 2012 and 2022 to reflect the most up-to-date literature; (ii) full-text articles published in English; (iii) screening and assessment tools used must evaluate older adults' population related to their driving activity. Articles were excluded if they were

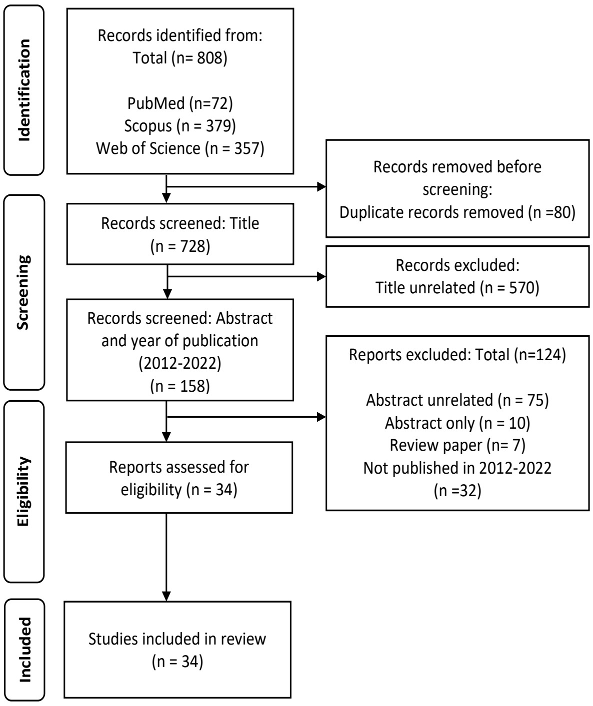

Figure 1: Flow chart of study selection.

in the form of comments, editorials, letters, or review papers or if the older adult population was not the study's highlight. Only 34 articles fulfilled the inclusion criteria and were retrieved for this review.

Step 4: Charting the data

The data was charted and summarised in Table 1 according to the characteristic of the studies, such as author, year, study design, the aim of the study, population, country, screening or assessment tool, and summary of findings. Further, the data was then extracted concerning the domain and characteristics of the tools (Table 2).

Step 5: Collating, summarising, and reporting the results

A narrative summary of the results was also presented to summarise the extracted data. The authors conducted the analysis, and the results were described in relation to the research questions of this scoping review to provide a clear understanding. This content analysis focused on the domain and characteristics of the tools used to assess older adults related to their driving activity.

Results

Thirty-four articles were eligible for this scoping review. The summaries of the selected articles can be found in Table 1, and the domains assessed by the tools and their characteristics are shown in Table 2.

Overview of the studies

1. Study design

There were fourteen cross-sectional studies, four validation studies, four case-control studies, two observational studies,

Table 1: Articles summary

Author(s)	Study design	Aim	Population/ Country	Screening tool	Assessment tool	Summary of findings
Bowers et al. (2013) (33)	Validation study	To evaluate the predictive value of MoCA and a brief test of MOT relative to other tests of cognition and attention in identifying at-risk older drivers.	n= 47, age 58–95 USA	1. MoCA 2. MOT 3. MMSE 4. TMT 5. MARS chart 6. ETDRS	1. UFOV 2. Standardised road test	The best four-test combination of MMSE, UFOV subtest 2, visual acuity and contrast sensitivity was able to identify at-risk drivers with 95% specificity and 80% sensitivity.
Classen et al. (2013a) (23)	Cross-sectional	To determine whether Trails B predicted pass–fail outcomes of an on-road test similar to the UFOV RI and the UFOV 2 in a group of community- dwelling older licensed drivers.	n=198, ages 65–89 USA	1. Demographic data 2. Self-reported medications 3. Medical conditions and comorbidity 4. Driving history and driving behaviour 5. MMSE 6. TMT- B	1. UFOV 2. On-road test	Trails B yields similar results to UFOV 2. Trails B is cheaper and easier to administer than UFOV 2 and may be used as a screening tool by clinicians who do not have access to the UFOV testing battery to identify at-risk older drivers.
Classen et al. (2013b) (13)	Retrospective, cross-sectional design and prospective observational design	To examine gender differences among older drivers who participated in a comprehensive driving evaluation (CDE) that was conducted by a certified driving rehabilitation specialist (CDRS)	n= 294, age 65–89 USA	1. Demographic data 2. Self-reported medications 3. Medical conditions and comorbidity 4. MMSE 5. RPW	1. Driving history and information on driving behaviours 2. UFOV 3. On-road test	Within-group comparisons showed that older males and females >75 years were 3.2 and 3.5 times more likely to fail the on-road test than younger males and females (aged between 63 and 75), respectively.

Table 1: Articles summary (continued)

Author(s)	Study design	Aim	Population/ Country	Screening tool	Assessment tool	Summary of findings
Crizzle et al. (2013a) (25)	Validation study	To determine the validity of the MMSE to predict pass/fail outcomes of an on-road driving test.	n= 168, age ≥ 65 USA	1. Demographic data 2. Driving history questionnaires 3. MMSE	1. On-road driving evaluation	The current cut-off point of ≤24 on the MMSE is not adequately sensitive to predict on-road performance in community-dwelling older drivers and drivers with PD. This supports the current best practice of not using the MMSE in isolation to predict on-road performance.
Crizzle et al. (2013b) (26)	Prospective observational study	To determine gender differences between men and women drivers with Parkinson's disease (PD).	n= 84, age ≥60, diagnosed PD USA	1. Demographic data 2. Medications 3. Medical conditions and comorbidity 4. Driving history and driving habit 5. RPW 6. MMSE	1. UFOV 2. On-road test	Both genders with PD made similar driving errors and were equally as likely to fail an on-road test.
Ferreira et al. (2013) (27)	Cross-sectional	To examine the accuracy with which different cognitive and psychomotor assessment tools could predict driving ability among older primary care patients.	Older drivers (n= 50) aged 65-88 Portugal	1. Demographic data 2. Driving history 3. ACE-R 4. TMT 5. Key Search 6. WAIS-III-Vocabulary and block design	1. SDB 2. UFOV 3. SDSA 4. DBOG	The participants' performances on the SDSA, ACE- R, UFOV and SDB were the best predictors of on-road driving.
Jones et al. (2013) (28)	Longitudinal study	To identify high, medium, and low-risk impairment among older drivers and to explore high-risk drivers' reactions to being told their results.	n= 67, mean age of 79 years USA	1. Demographic data 2. MFVPT 3. TMT	1. UFOV	Most (57%) of the sample passed all the assessment tests and were determined low-risk impaired, whereas 13% were considered high-risk impaired.
Woolnough et al. (2013) (21)	Longitudinal study	To analyse the Assessment of Driving Related Skills (ADReS) and crash rate among older driver.	n=1230, age ≥70 Canada, Australia, and New Zealand	1. Demographic data 2. Driving characteristics 3. ADReS		Sixty-three older drivers were involved in an MVC within the two years preceding the baseline assessment. There were no significant associations between abnormal performance on the tests constituting the ADReS and a crash history in the previous two years.
Berndt et al. (2015) (58)	Cross-sectional	To determine what measures of driving performance could optimally be applied to occupational therapy on-road driving assessments.	n= 117, age 48-88 Australia		1. On-road assessment	The study identified 80 sufficiently challenging driving tasks and described the relationship of driving error to that task, such as critical errors at unguided intersections.
Papandonatos et al. (2015) (41)	Secondary analyses	To assess the clinical utility of TMTs as screens for impaired road test performance of older drivers.	n= 392, age ≥70 USA	1. TMT	1. Rhode Island Road Test	TMTs may be helpful to screen driving impairment in older drivers in general practice settings.
Allan et al. (2016) (37)	Cross-sectional	To investigate the relationship between the DriveSafe and DriveAware assessments and driving restrictions.	n = 380, age ≥75 Australia	1. MARS Chart 2. TMT	1. DHQ 2. Driving Confidence Scales 3. DriveSafe/ DriveAware	Older drivers with worse functions drive less, stay closer to home, and tend to avoid more challenging driving situations.

Table 1: Articles summary (continued)

Author(s)	Study design	Aim	Population/ Country	Screening tool	Assessment tool	Summary of findings
Bhorade et al. (2016) (32)	Case-control	To compare on-road driving performance of patients with moderate or advanced glaucoma to control and evaluate factors associated with unsafe driving.	n=21, age 55–90 USA	1. ETRDS 2. Pelli-Robson CS chart 3. Vector Vision chart, 4. Visual field testing 5. Short Blessed Test 6. CDT 7. Snellgrove Maze Task 8. MFVPT 9. Cervical range of motion 10. Jamar grip dynamometer 11. RPW 12. 9-Hole Peg Test 13. TMT 14. GDS 15. ESS	1. UFOV 2. Braking Response Time Monitor 3. Written driving test and road sign recognition 4. DHQ 5. On-road test	Patients with bilateral moderate or advanced glaucoma are at risk for unsafe driving.
Blane et al. (2016) (35)	Case-control	To explore the influence of personal and socioeconomic factors and existing cognitive impairment on the decision of post-stroke adults to return to driving.	n= 48 (post-stroke adults), n=22 (healthy control drivers), age ≥50 Australia	1. BJLO 2. MoCA 3. Digit Vigilance Test 4. TMT B	1. Road Sign Recognition Test 2. Driving simulator	Older post-stroke adults exhibit cognitive deficits and poorer driving performance than healthy adults of the same age.
Hemmy et al. (2016) (31)	Observational study	To evaluate the correspondence of patient and caregiver reports of driving concerns relative to objective behind-the-wheel (BTW) testing.	n = 151, mean age 77.6 USA	1. Pre-BTW Interview (Patient- and Caregiver-Reported Driving Concerns)	1. BTW testing	Most patients are evaluated for driving concerns far too late, with only 3% of the sample being evaluated as independent to drive without restrictions.
Rapoport et al. (2016) (16)	Longitudinal study	To examine whether changes in cognitive performance are associated with intra-individual changes in driving attitudes and behaviour over 2 years.	n=928, age 70-94 Canada	1. Demographic data 2. MoCA 3. MMSE 4. TMT 5. Months Task 6. Digit-Span Task 7. MFVPT	1. PDA 2. DBP	Cognitive slowing and executive dysfunction appear to be associated with modestly lower perceived driving abilities and more avoidance of driving situations over time.
Stern et al. (2016) (17)	Validation study	To examine the predictive validity of a combination of office-based screening tests for on-road driving performance in older adults with and without MCI/dementia.	n= 84, mean age of 75.6 years USA	1. Demographic data 2. Snellen-type eye chart 3. Visual field confrontation testing 4. RPW 5. Manual test range of motion 6. Test of motor strength 7. NAB 8. CDT 9. TMT 10. MMSE 11. CDR scale	1. UFOV 2. Boston University Road Test	The combination of UFOV-Divided Attention and NAB Driving Scenes may be a helpful screening battery to inform appropriate referral of older adults to evaluate actual driving abilities to determine driving risk.
Unsworth et al. (2016) (42)	Cross-sectional	To determine whether drivers in the early stages of AD/ cognitive decline can drive safely and if this could be predicted using the OT-DORA Battery.	n=63, mean age 73.6 Australia		1. OT-DORA 2. On-road assessment	Forty samples passed as fit to drive, of whom 33 had at least one condition placed on their licence. Client age and four OT-DORA battery subtests can help determine the client driving status for people with AD/cognitive decline.

Table 1: Articles summary (continued)

Author(s)	Study design	Aim	Population/ Country	Screening tool	Assessment tool	Summary of findings
Anstey et al. (2017) (39)	Cross-sectional	To evaluate the risk of unsafe on-road driving performance among older adults with Mild Cognitive Impairment (MCI).	n = 302, age 65-96 Australia	1. Questionnaires on driving habits, medical condition 2. Neurocognitive test battery - Stroop colour-word test- Victoria vers. - Digit-span backwards - TMT B - California Verbal Learning Test - Benton Visual Retention Test - Letter Fluency - BNT 3. MCQ	1. On-road driving test (ORT) 2. UFOV 3. DriveSafe 4. Multi-D	Adults with MCI exhibit a similar range of driving ability to cognitively normal adults, although on average, they scored lower on off-road and on-road assessments.
Choi & Lee (2017) (36)	Cross-sectional	To analyse the cognitive functions according to risk level for the Driver 65 Plus measure.	n=47, mean age 74 Korea	1. TMT 2. MOCA-K (Korean)	1. Driver 65 Plus	TMT and MOCA-K showed a significant difference between the three groups ("safe," "caution", and "stop"). The safe group showed significantly higher ability than the other groups in the three cognitive tests.
Fuermaier et al. (2017) (34)	Cross-sectional	To explore whether the selected variables would be equally predictive for a closely related group of patients with MCI.	n= 18, age 49-79 Netherlands	1. CDR Scale 2. MMSE	1. Reaction Time S2 2. Hazard Perception Test 3. Traffic theory test 4. Driving simulator 5. On-road driving assessments	Twelve patients with MCI passed, and six failed the on-road driving assessment. A combination of neuropsychological test performance and simulated driving behaviour proved to be the most valid predictors of practical fitness to drive.
Venkatesan et al. (2018) (20)	Cross-sectional	To examine the relationship of visuospatial search and binding to driving in patients with early AD and elderly controls (EC)	n= 42 (AD), n= 37 (EC), mean age 55–80 USA	1. Demographic data 2. MMSE 3. CDR 4. TMT 5. CDT	1. Rhode Island Road Test 2. CDAS 3. Visual Search Task (computerised)	Patients performed worse than controls on most cognitive and driving indices. Visual search and clinical measures were differentially related to driving behaviour across groups.
Choi et al. (2019) (60)	Cross-sectional	To identify attentional deteriorations that may underlie crashes in various situations.	n= 82, age 65–92 USA		1. ANT	Significant associations exist between executive attentional efficiency and crash risks in situations that demand a driver quickly resolve conflicts among multiple competing tasks or information.

Table 1: Articles summary (continued)

Author(s)	Study design	Aim	Population/ Country	Screening tool	Assessment tool	Summary of findings
Crivelli et al. (2019) (24)	Case control	To identify the cognitive tests that best predict driving ability in subjects with mild dementia.	n=28 (older drivers with mild dementia), n=28 (healthy older drivers), Argentina	1. Demographic data 2. MMSE 3. Logical Memory Immediate and Logical Memory Delayed 4. Digit Span Forward and Backward 5. TMT 6. Category Fluency (animals and vegetables) 7. BNT	1. Driving simulator 2. On-Road Driving Test (ORDT)	Drivers with mild dementia made more mistakes on the ORDT and had slower responses in the simulator tasks, and cognitive tests correlated strongly with on-road and simulator driving performance.
Kandasamy et al. (2019) (29)	Observational study	To examine whether the MoCA, which mainly tests cognitive ability, may identify older adults who might benefit from fit-to-drive testing.	Older drivers (n= 264), age ≥65 years USA	1. Demographic data 2. MoCA 3.	1. FTD road test	Most (83%) had abnormal (fail or conditional pass) FTD test results. MoCA may be valuable to identify those who might benefit from FTD evaluations, especially considering factors like gait speed, age, and gender.
Kunishige et al. (2019) (40)	Cross-sectional	To measure the effects of spatial navigation skills and eye movements on driving ability.	n=34 (older drivers), age 60-76, n=20 (young drivers), age 22-30 Japan	1. BJLO 2. CPT A & B 3. Raven's Colored Progressive Matrices (RCPM)	1. Stroke Drivers' Screening Assessment (SDSA) 2. Driving simulator	Older drivers have poorer eye movement control and spatial navigation. This will likely cause delayed responses and difficulty predicting the on-coming driving environment.
Unsworth et al. (2019) (43)2	Cross-sectional	To investigate the effect of navigational difficulties, location of assessment and assessment order, and undertaking a second assessment on passing an on–road driving assessment.	n = 43, age 60-86 Australia		1. OT-DHMT 2. On-road assessment	Drivers with Alzheimer's disease (AD) who have navigational problems and are slow to complete the DHMT are unlikely to pass an on–road assessment.
Anstey et al. (2020) (38)	Validation study	To validate off-road brief screening tests to predict on-road driving ability.	n= 560, age 63-94 Australia	1. TMT-B	1. UFOV 2. OT-DHMT 3. DriveSafe/ DriveAware 4. Multi-D battery 5. Hazard Perception Test 6. 14-item Road Rules and Road Craft test	A combination of Multi-D, HPT, and UFOV tests provided the most robust assessment of driving safety off-road.
Bakhtiari et al. (2020) (12)	Case-control	To identify unsafe drivers in a population of healthy and at-risk for driving older adults by using the application of tablet-based cognitive tasks.	n= 49 (at-risk for driving impairment), n=48 (control drivers), age 54-81 Canada	1. Demographic data	1. DriveABLE on-road evaluation (DORE) 2. Tablet-Based Cognitive Tasks (TBCT)	The performance of the at-risk group in all cognitive tasks was significantly worse than the control group's performance, even after statistically excluding age as an effect.
Ma'u et al. (2020) (15)	Cross-sectional	To evaluate the ability of the MNT, MoCA and TMT A & B to predict on-road driving performance in current drivers diagnosed with dementia.	n=34, mean age 73.3 New Zealand	1. Demographic data 2. MNT 3. MoCA 4. TMT	1. DriveSafe/ DriveAware 2. On-road test	Nineteen samples retained their full license, and 15 received driving restrictions. Only completion time for the MNT the MoCA domain of attention and a combination of the MoCA domain of attention and visuospatial/ executive predicted outcome.

Table 1: Articles summary (continued)

Author(s)	Study design	Aim	Population/ Country	Screening tool	Assessment tool	Summary of findings
Tinella et al. (2020) (19)	Cross-sectional	To investigate the relationship between overall cognitive functioning, self and object-based spatial mental transformation skills, and driving performance in younger and older adult drivers.	n=83 (older drivers) n= 100 (younger drivers) Italy	1. Demographic data 2. MoCA 3. MRT 4. OPT	1. DRIVESC package of the Vienna Test System	Traffic stress resilience, reaction time and perceptual speed were negatively affected by age.
Yamin et al. (2020) (22)	Retrospective study	To test serial trichotomization using four common neuro-psychological tests (TMT, CDT, M-MMSE) to help assess FTD among older adults with cognitive impairment	n=105, mean age 70.7 Canada	1. Demographic data 2. Medical condition 3. TMT 4. CDT 5. M-MMSE		After applying the model, participants were classified as unfit (38.1%,) fit (25.8%,), or requiring further testing (36.1%,). This study provides further evidence that trichotomization can facilitate the assessment of FTD.
Swain et al. (2021) (18)	Cohort study	To evaluate the association between CDRS ratings of on-road driving performance by older drivers and at-fault crash and near-crash involvement using naturalistic driving techniques.	n=144, age ≥70 USA	1. Demographic data 2. Pelli-Robson chart 3. MMSE 4. CES-D scale 5. Interview-chronic medical problems	1. UFOV 2. On-road assessment	CDRS ratings of older drivers' performance are a valid measure of older driver safety, as worse CDRS scores were associated with an increased rate of at-fault and near-crash involvement per everyday naturalistic driving.
Krasniuk et al. (2022a) (30)	Retrospective study	To determine the driving errors that predicted failing an on-road assessment in drivers with cognitive impairment (CI).	n = 80, mean age 76.1 Canada	1. Demographic data 2. MoCA 3. TMT	1. UFOV 2. On-road assessment	The driving errors are critical for failing an on-road assessment in older drivers with CI who were referred by physicians to undergo a CDE.
Krasniuk et al. (2022b) (14)	Retrospective study	To determine the predictive ability of Trails B and UFOV on pass/ fail on-road outcomes in drivers with CI referred for CDE.	n =100, mean age 76.2 Canada	1. MoCA 2. TMT	1. UFOV 2. On-road assessment	Trails B and UFOV performed only moderately well when used to identify drivers with CI who were referred for a CDE to determine their medical fitness to drive.

Screening tools: ACE-R= Addenbrooke's Cognitive Examination Revised, ANT= Attention Network Test, BJLO= Benton Judgment of Line Orientation Test, BNT= Boston Naming Test, CDAS= Composite Driving Assessment Scale, CDT= Clock Drawing Test, CES-D= Center for Epidemiological Studies – Depression scale, CPTA= Card-Placing Test, ESS= Epworth Sleepiness Scale, ETRDS= Early Treatment Diabetic Retinopathy Study, GDS= Geriatric Depression Scale, MARS= Mars Letter Contrast Sensitivity chart, MFVPT= Motor-Free Visual Perception Test, MMSE= Mini-Mental State Examination, MNT= Maze Navigation Test, MOCA= Montreal Cognitive Assessment, MOT= Multiple Object Tracking, MCQ= Memory Complaint Questionnaire, MRT= Mental Rotation Test, NAB= Neuropsychological Assessment Battery, OPT= Object Perspective Taking Test, RPW= Rapid Pace Walk, TMT= Trail Making Test, WAIS-III= Wechsler Adult Intelligence Scale.

Assessment tools: DBOG= Driving Behaviours Observation Grid, DBP= Decisional Balance Plus, DHQ= Driving Habits Questionnaire, PDA= Perceived Driving Abilities, SDB= Senior Drivers Battery, SDSA= Stroke Drivers Screening Assessment, OT-DHMT= Occupational Therapy-Drive Home Maze Test, UFOV= Useful Field of View

Table 2: Characteristic of screening and assessment tools

Domain	Sub-domain	Tools	Screening	Assessment	No of item/ question	Administration mode/time	Scoring	Sources
				Off-road assessment				
General information		Demographic data	√		NA	Interview/ questionnaire	NA	(12–30)a wide range of motor, sensory, and cognitive skills that are imperative for driving are affected in older adults. Though on-road tests are most indicative of driving ability, they are costly, stressful, time-consuming, and risky. Application of tablet-based cognitive tasks is investigated in identifying unsafe drivers in a population of healthy and at-risk for driving older adults. Method: Forty-nine older adult participants aged 54 to 81 (M = 78.08, SD = 9.78
		Medical condition and comorbidity	√		NA	Interview/ questionnaire	NA	(13,22,23,26)caused by errors of yielding, gap acceptance, and speed regulation, all of which are assessed in a comprehensive driving evaluation (CDE
		Medication intake	√		NA	Interview/ questionnaire	NA	(13,23,26)caused by errors of yielding, gap acceptance, and speed regulation, all of which are assessed in a comprehensive driving evaluation (CDE
		Driving history and driving behaviour	√		NA	Interview/ questionnaire	NA	(21,23,25–27)caused by errors of yielding, gap acceptance, and speed regulation, all of which are assessed in a comprehensive driving evaluation (CDE
		Pre-BTW Interview (Patient- and Caregiver-Reported Driving Concerns)	√		NA	Interview	NA	(31)leaving subjective reports of concerns by the patient or family as common initiators of objective driving evaluation referral. This observational study evaluated the correspondence of patient and caregiver report of driving concerns relative to objective behind-the-wheel (BTW
		Geriatric Depression Scale- 5 Item	√		5 items	Self-rated	Score ≥ 2 = presence of depressive symptoms	(32)
		Center for Epidemiological Studies – Depression (CES-D) scale			20 questions	Self-rated	Score ≥16 = presence of depressive symptoms	(18)
		Epworth Sleepiness Scale	√		8 questions	Self-rated	Score ≥8 = abnormal sleepiness	(32)
Physical	Range of motion	Range of motion- Standard goniometric techniques	√		Cervical, upper and lower extremity range of motion	Clinician-reported	Either normal or abnormal	(17,32)
	Muscle strength	Test of motor strength- Manual muscle testing	√		Bilateral upper and lower extremity muscle strength	Clinician-reported	Score 5 = normal Score ≤4 = abnormal	(17)
	Muscle strength	Grip strength- Jamar grip dynamometer	√		Both hands	Clinician-reported	Averaging the sum of 3 trials	(32)

Table 2: Characteristic of screening and assessment tools (continued)

Domain	Sub-domain	Tools	Screening	Assessment	No of item/ question	Administration mode/time	Scoring	Sources
	Motor speed and coordination	Nine-Hole Peg Test	√		Both hands	Performance-based	An average healthy adult can complete the test with their right hand: Male = 19 seconds Female = 17.9 seconds	(32)
	Motor speed and coordination	Rapid Pace Walk (RPW)	√		NA	Performance-based	Ambulation speed over a 20-foot distance: ≥7 seconds = predictive of adverse driving	(13,17,26,32)mean age = 73.86, standard deviation = 6.05
Cognitive	Cognitive screening tool	Montreal Cognitive Assessment (MoCA)	√		30 items	Pencil-and-paper	Score range: 0–30, with higher scores representing better functioning ≥26 = considered normal	(14–16,19,29,30,33,35,36) and to determine which combination of tests provided the best overall prediction. Methods Forty-seven currently licensed drivers (58-95 years
	Cognitive screening tool	Mini-Mental State Examination (MMSE)	√		11 questions	Pencil-and-paper	Score range: 0–30, with higher scores representing better functioning <24 = cognitive impairment	(13,16–18,20,23,25,26,33,34) and to determine which combination of tests provided the best overall prediction. Methods Forty-seven currently licensed drivers (58-95 years
	Cognitive screening tool	Modified Mini-Mental State (3MS) Examination	√		15 questions	Pencil-and-paper	Scored using a 100-point range. A cut-off point of 79/80 for the presence of cognitive impairment	(22)Clock Drawing Test, and Modified Mini-Mental State Examination
	Cognitive screening tool	Short Blessed Test (SBT)	√		6 items	Pencil-and-paper	0 – 4 = Normal cognition 5 – 9 = Questionable impairment ≥10 = impairment consistent with dementia	(32,35)
	Cognitive screening tool (to detect mild cognitive impairment and dementia)	Addenbrooke's Cognitive Examination Revised (ACE-R)	√		5 sub-scores (attention and orientation, memory, letter and category B fluency, language and visuospatial ability)	Pencil-and-paper	Higher scores indicate better cognitive functioning	(27)
	Rating dementia severity	Clinical dementia rating (CDR) scale	√		6 components	Clinician-reported	Score 0.5 = MCI or very mild dementia	(17,20,34)a strategy was composed for the assessment of fitness to drive, consisting of clinical interviews, a neuropsychological assessment, and driving simulator rides, which was compared with the outcome of an expert evaluation of an on-road driving assessment. A selection of tests and parameters of the new approach revealed a predictive accuracy of 97.4% for the prediction of practical fitness to drive on an initial sample of patients with Alzheimer's dementia. The aim of the present study was to explore whether the selected variables would be equally predictive (i.e., valid

Table 2: Characteristic of screening and assessment tools (continued)

Domain	Sub-domain	Tools	Screening	Assessment	No of item/ question	Administration mode/time	Scoring	Sources
	Executive function	Trail- Making Tests (TMT)	√		2 parts (Part A & Part B)	Pencil-and-paper	TMT-A ≥ 48 seconds, TMT-B ≥ 108 seconds may be useful in separating unsafe from safe and marginal drivers. Lower values indicate better performance	(13–17, 20, 22, 27, 28, 30, 32, 33, 35–41)Australia. Questionnaires were administered to assess driving habits and functional assessments to assess driving-related function. Self-reported restriction was prevalent in this cross-sectional sample (62%
	Executive function-planning	Maze Navigation Test (MNT)	√		8 mazes	Pencil-and-paper	Scored on both completion time and number of errors	(15)
	Executive function-planning	Occupational Therapy-Drive Home Maze Test (OT-DHMT)	√		1 maze	Pencil-and-paper	Score <100 seconds = suggesting a return to driving is possible	(38)
	Executive function	Snellgrove Maze Task	√		1 maze	Pencil-and-paper	≥61 seconds (with or without errors) = not cognitively fit to drive safely	(32)
	Attention	Digit-Span Task	√		2 portions (forward and backward)	Pencil-and-paper	"Forward" portion= Maximum score is 16 "Backward" portion= Maximum score is 14 Higher scores indicate better performance on the task	(16,24,39)there is a marked increase in the elderly population eager to continue driving. A large proportion of these elderly drive safely, however, patients with mild dementia are high-risk drivers. Objective: to identify the cognitive tests that best predict driving ability in subjects with mild dementia. Methods: 28 drivers with mild dementia and 28 healthy elderly subjects underwent an extensive cognitive assessment (NACC Uniform Data Set Neuropsychological Battery
	Attention	Months Task	√		NA	Pencil-and-paper	Lower values (seconds required to complete the task and number of errors) indicate better performance	(16)attitudes, and self-regulatory behaviors among older adults. Healthy older adults (n = 928
	Attention during rapid visual tracking	Digit Vigilance Test	√		59 rows of single digits.	Pencil-and-paper	Total time taken and errors/ omissions were recorded	(35)
	Sustained dynamic attention	Multiple object tracking (MOT)	√		50 experimental trials	Computer-based	Higher scores represent better performance	(33)
	Complex attention	Stroop color word test- Victoria version	√		3 conditions (24 items for each condition)	Pencil-and-paper	The completion time and the number of errors are compiled	(38)
	Sensory binding and selective attention	Visual Search Task	√		2 conditions (12 practice and 108 real trials)	Computer-based	Summary scores based on responses to trials	(20)analogs of within and across visual processing stream binding, respectively. Standardized road test (RIRT
	Nonverbal planning ability	Key Search			NA	Pencil-and-paper	The score is based on several criteria related to the efficiency of the participant's problem-solving strategy	(27)
	Memory complaint	Memory Complaint Questionnaire (MCQ)			30 items	Pencil-and-paper	≥25= Clinically significant subjective concerns	(39)

Table 2: Characteristic of screening and assessment tools (continued)

Domain	Sub-domain	Tools	Screening	Assessment	No of item/ question	Administration mode/time	Scoring	Sources
	Immediate delayed recall	California Verbal Learning Test			2 lists (each list includes 16 words)	Pencil-and-paper	Computer scoring system to generate scores	(39)
	Verbal episodic memory	Logical Memory Immediate and Logical Memory Delayed			2 stories	Pencil-and-paper	Each correct detail will be awarded one score point	(24)
	Semantic memory and language	Category Fluency (animals and vegetables)			2 categories (animal and vegetables)	Pencil-and-paper	Time is limited to 60 seconds for each category. The score is given to the number of correct, non-repeated responses	(24)
	Semantic memory and language	Boston Naming Test (BNT)			60 items	Pencil-and-paper	The total score is the sum of correct spontaneous answers and correct answers followed by a semantic clue	(24,39)
	Language	Letter Fluency			3 letters (F, A, S)	Pencil-and-paper	Total number of correct answers within a time limit	(39)
	Verbal comprehension	Wechsler Adult Intelligence Scale (WAIS-III)- Vocabulary			33 items	Pencil-and-paper	The maximum score is 66 points	(27)
	Visual perception	Motor-Free Visual Perception Test (MFVPT)			36 items	Pencil-and-paper	The higher number of correct responses represented better performance	(16,28,32)St. Louis, MO and 38 community-dwelling controls were enrolled. Participants, ages 55–90 years, underwent a comprehensive clinical evaluation by a trained occupational therapist and an on-road driving evaluation by a masked driver rehabilitation specialist. Overall driving performance of pass vs. marginal/fail and number of wheel and/or brake interventions were recorded. Results—Fifty-two percent of glaucoma participants scored a marginal/fail compared to 21% of controls (odds ratio [OR], 4.1; 95% CI, 1.30–13.14;p=.02
	Visual perception	Raven's Colored Progressive Matrices (RCPM)			3 sets (total of 36 matrices)	Paper and pencil	The raw score ranges between 0 and 36. The correct answer is given one score.	(40)
	Perceptual organisation	Wechsler Adult Intelligence Scale (WAIS-III)- block design			9 test items	Performance-based	The maximum score is 68 points	(27)
	Visuospatial	Benton Visual Retention Test			3 forms (each composed of 10 items of visual stimuli)	Pencil-and-paper	Points are given if the reproduction of the design matches the original	(24)
	Visuospatial function and visual recognition	Benton Judgment of Line Orientation Test (BJLO)			15 total test trials	Pencil-and-paper	One point is given for each correct trial with 15 being the maximum score possible.	(35,40)

Table 2: Characteristic of screening and assessment tools (continued)

Domain	Sub-domain	Tools	Screening	Assessment	No of item/ question	Administration mode/time	Scoring	Sources
	Spatial visualisation	Mental Rotation Test (MRT)			20 items	Pencil-and-paper	Participants must select the correct alternatives. Each line is considered correct if both choices are correct	(19)
	Spatial mental transformation	Object Perspective Taking Test (OPT)			12 items	Pencil-and-paper	A high total score corresponds to a lower level of ability in OPT	(19)
	Spatial navigation	Card-Placing Test			2 parts	Performance-based	Scored 1 point if the location of a card that the subject replaced was correct. The total score is 30 points	(40)
Visual	Visual field	Visual field testing			NA	Computer-based	NA	(32)
	Visual field functioning	visual field confrontation testing			NA	Clinician-reported	Scores ranged from 0 to 10, with lower scores reflective of worse performance	(17)
	Visual acuity	Snellen-type eye chart			NA	Clinician-reported	Normal visual acuity = 10/10, whereas a lower number implies a reduced vision	(17)
	Visual acuity	Early Treatment Diabetic Retinopathy Study			NA	Clinician-reported	Higher scores indicate worse performance	(32,33)
	Low contrast visual acuity	Mars Letter Contrast Sensitivity chart			48 letters	Clinician-reported	Higher scores indicate better performance Normal age >60 =1.52—1.76	(33,37)
	Contrast sensitivity	Pelli-Robson CS chart			NA	Clinician-reported	The cut-off point for impairment was worse than 1.5 log sensitivity	(18,32)
	Glare testing	Vector Vision chart			NA	Clinician-reported	NA	(32)
Driving competency	Driving practices	Driving Habits Questionnaire (DHQ)		√	34 items	Self-reported	<90 = having driving difficulty	(32,37)
	Driving confidence	Driving Confidence Scales		√	12 driving situations	Self-reported	Scores were totalled, and participants were grouped into those scoring above and below the median.	(37)
	Driving perception	Perceived Driving Abilities (PDA)		√	15 items	Self-reported	Total scores range from 0 to 45, with higher scores indicating the better self-rated driving ability	(16)attitudes, and self-regulatory behaviors among older adults. Healthy older adults (n = 928
	Driving attitudes	Decisional Balance Plus (DBP)		√	45 items	Self-reported	Higher scores indicate fewer negative attitudes	(16)attitudes, and self-regulatory behaviors among older adults. Healthy older adults (n = 928
	Driving safety	DriveSafe/ DriveAware		√	15 images	Computer-based	DriveSafe: >95, no concern regarding driving ability. Drive Aware: 3 to 12 indicate intact awareness	(37–39)
	Driver safety	Multi-D battery		√	3 subtests (Choice reaction time, Dot motion, Sway path length)	Computer-based	Based on the algorithm	(38)

Table 2: Characteristic of screening and assessment tools (continued)

Domain	Sub-domain	Tools	Screening	Assessment	No of item/ question	Administration mode/time	Scoring	Sources
	Cognitive function	Tablet-Based Cognitive Tasks (TBCT)		√	4 tasks (Reaction speed, Decision making, Memory, Bi-manual perceptual motor)	Computer-based	Averaging the performance of each participant over all trials of all stages	(12)
	Driving risk	Driver 65 Plus		√	5 questions	Self-reported	0 to 15 = Go! Safe driving 16 to 34 = Caution! Engaging in some practices that need improvement to ensure safety. ≥35 = Stop! Engaging in too many unsafe driving practices might pose a hazard	(36)
	Attentional functions	Attention Network Test (ANT)		√	3 attentional functions (alerting, orienting, and executive functions)	Computer-based	A higher score on the alerting or orienting indices indicates better alerting or orienting attentional functioning. A higher executive score indicates worse executive attentional functioning	(60)
	Attention and executive abilities	Stroke Drivers Screening Assessment (SDSA)		√	4 tests (Dot Cancellation, Square Matrices Directions, Square Matrices Compass, Road Sign Recognition)	Pencil-and-paper	A higher value for the pass equation indicates the client's cognitive abilities are such that driving is feasible, but physical and medical aspects must be checked.	(27,40)
	Visual attention	Neuropsychological Assessment Battery (NAB)-driving scenes		√	6 driving scenes	Pencil-and-paper	Total scores range from 0 (worst) to 70 (best)	(17)
	Cognitive and psychomotor	Senior Drivers Battery (SDB)		√	4 tests (Cognitrone, Continuous Visual Recognition Task, Reaction Time, Determination Test)	Computer-based	Scores for each test include the total number of reactions, number of correctly recognised items, mean reaction time and number of correct reactions	(27)
	Cognitive prerequisites for fitness-to-drive	DRIVESC package of the Vienna Test System		√	3 different subtests: Reaction Test (RT), Determination Test (DT), and Adaptive Tachistoscopic Traffic Perception Test (ATAVT).	Computer-based	The total scores of the three subtasks were reported as percentile ranks with higher scores indicating a better performance	(19)

Table 2: Characteristic of screening and assessment tools (continued)

Domain	Sub-domain	Tools	Screening	Assessment	No of item/ question	Administration mode/time	Scoring	Sources
	Visual processing speed	Useful Field of View (UFOV)		√	3 subtests (UFOV 1 = visual search and visual processing; UFOV 2 = divided attention; and UFOV 3 = selective attention)	Computer-based	Longer durations represent the poorer performance	(13,14,17,18,23,26–28,32,33,38,39)Setting, and Participants: This prognostic study was conducted between October 31, 2013, and May 10, 2017, using the criterion standard for screening tests, an on-road driving test, with analysis conducted from August 1, 2019, to April 2, 2020. A volunteer sample of older drivers was recruited from community advertisements, rehabilitation and driver assessment clinics, and an optometry clinic in Canberra and Brisbane, Australia. Exposures: Off-road driver screening measures, including the Useful Field of View, DriveSafe/DriveAware, Multi-D battery, Trails B, Maze test, Hazard Perception Test, DriveSafe Intersection test, and 14-item Road Law test. Main Outcomes and Measures: Classification as unsafe on a standardized 50-minute on-road driving assessment administered by a driving instructor and an occupational therapist masked to the participant's clinical diagnosis and off-road test performance. Results: A total of 560 drivers aged 63 to 94 years (mean [SD] age, 74.7 [6.2] years]; 350 [62.5%] men
	Traffic hazard	Hazard Perception Test		√	20 video clips	Computer-based	Scores based on the number of correct trials	(34,38)Setting, and Participants: This prognostic study was conducted between October 31, 2013, and May 10, 2017, using the criterion standard for screening tests, an on-road driving test, with analysis conducted from August 1, 2019, to April 2, 2020. A volunteer sample of older drivers was recruited from community advertisements, rehabilitation and driver assessment clinics, and an optometry clinic in Canberra and Brisbane, Australia. Exposures: Off-road driver screening measures, including the Useful Field of View, DriveSafe/DriveAware, Multi-D battery, Trails B, Maze test, Hazard Perception Test, DriveSafe Intersection test, and 14-item Road Law test. Main Outcomes and Measures: Classification as unsafe on a standardized 50-minute on-road driving assessment administered by a driving instructor and an occupational therapist masked to the participant's clinical diagnosis and off-road test performance. Results: A total of 560 drivers aged 63 to 94 years (mean [SD] age, 74.7 [6.2] years]; 350 [62.5%] men

Table 2: Characteristic of screening and assessment tools (continued)

Domain	Sub-domain	Tools	Screening	Assessment	No of item/ question	Administration mode/time	Scoring	Sources
	Knowledge of road law	14-item Road Rules and Road Craft test		√	14 questions	Pencil-and-paper	Total score 37, with higher scores indicating greater knowledge	(38)
	Knowledge of traffic theory	Traffic theory test		√	28 pictures	Computer-based	The number of correct answers and the mean response time was registered	(34)a strategy was composed for the assessment of fitness to drive, consisting of clinical interviews, a neuropsychological assessment, and driving simulator rides, which was compared with the outcome of an expert evaluation of an on-road driving assessment. A selection of tests and parameters of the new approach revealed a predictive accuracy of 97.4% for the prediction of practical fitness to drive on an initial sample of patients with Alzheimer's dementia. The aim of the present study was to explore whether the selected variables would be equally predictive (i.e., valid
	Knowledge of road signs	Road Sign Recognition Test		√	39 signs	Pencil-and-paper	Each item was given: 2 points = correct response 1 point = partial response 0 points = incorrect response	(32,35)
	Reaction	Reaction Time S2		√	NA	Performance-based	NA	(34)a strategy was composed for the assessment of fitness to drive, consisting of clinical interviews, a neuropsychological assessment, and driving simulator rides, which was compared with the outcome of an expert evaluation of an on-road driving assessment. A selection of tests and parameters of the new approach revealed a predictive accuracy of 97.4% for the prediction of practical fitness to drive on an initial sample of patients with Alzheimer's dementia. The aim of the present study was to explore whether the selected variables would be equally predictive (i.e., valid
	Brake reaction time	Braking Response Time Monitor		√	NA	Performance-based	The brake reaction time of the right lower extremity	(32)
	Driving skills	Driving simulator		√	2 subtests (Traffic Signal Reaction Task and Brake Reaction Task)	Computer-based	Reaction to the target is measured in distance	(24,34,40)there is a marked increase in the elderly population eager to continue driving. A large proportion of these elderly drive safely, however, patients with mild dementia are high-risk drivers. Objective: to identify the cognitive tests that best predict driving ability in subjects with mild dementia. Methods: 28 drivers with mild dementia and 28 healthy elderly subjects underwent an extensive cognitive assessment (NACC Uniform Data Set Neuropsychological Battery

Table 2: Characteristic of screening and assessment tools (continued)

Domain	Sub-domain	Tools	Screening	Assessment	No of item/ question	Administration mode/time	Scoring	Sources
Multi-domain	Sensory, physical, and cognitive skills	Occupational Therapy-Driver Assessment Off Road Assessment (OT-DORA) Battery **Section A:** Initial Interview **Section B:** Medical History **Section C:** Medication Screen **Section D:** Sensory Assessments—for communication and hearing, vision, and proprioception **Section E:** Physical Assessments—for motor skills, balance, and endurance **Section F:** Cognitive Assessments **Section G:** Summary of Issues **Section H:** Further Assessments.	√					(42,43)2
	Visual, cognitive and motor assessment	Assessment of Driving Related Skills (ADReS) **Vision:** Snellen visual acuity test, visual fields by confrontation test, **Cognitive**: TMT B, CDT **Motor:** Rapid Pace Walk, and manual tests of range of motion and motor.	√					(21)
				On-road assessment				
Driving competency		On-road driving test	√		NR	50 min, automatic vehicle	Error-based scale of 1 to 10. Scores 1 to 3 demonstrated multiple serious driving errors	(39)
				√	110 pre-programmed on-road performance tasks.	>60 min, automatic/ manual car, driving distance 24 km	Score ≥3 critical errors= Fail the assessment	(58)
				√	31 variables	Driving distance of 3 km, drive own vehicles	NR	(24)
				√	91 manoeuvres	45–60 min,	Global Rating Score (GRS) 3 = Pass 2 = Pass with restrictions or recommendations 1 = Fail with remediation 0 = Fail not remediable The demerit point system ranges from 0 to 7 (higher demerit point score = worse infraction). 0 points (considered the safest)	(25,26)few studies have shown the predictive validity of the MMSE in determining on-road performance. In a sample of 168 community dwelling older adults, including 20 with Parkinson's disease (PD

Table 2: Characteristic of screening and assessment tools (continued)

Domain	Sub-domain	Tools	Screening	Assessment	No of item/ question	Administration mode/time	Scoring	Sources
				√	95 manoeuvres	45–60 min,	Those who failed performed <47.5 total manoeuvres correctly (or <50% of manoeuvres)	(14,30)
				√	NR	40–60 min, own car and usual driving environment.	3 possible outcomes: un-conditional driving, driving with restrictions or driving cessation	(15)
				√	NR	15-mile standard route took about 60 min	1 being very poor with many errors, to 5 being no obvious driving errors.	(18)
				√	>100 expected behaviours	40 min, within the familiar and unfamiliar area	NR	(43)2
				√	NR	30 to 90 minutes and followed a set route on a public road	On-road assessment outcome: Fit to drive Fit to drive condition(s) Not fit to drive	(42)and if this could be predicted using the occupational therapy – driver off-road assessment battery (OT-DORA Battery
				√	NR	NR	Global Rating Score (GRS) 3 = Pass 2 = Pass with restrictions or recommendations 1 = Fail with remediation 0 = Fail not remediable	(13,25,26)mean age = 73.86, standard deviation = 6.05
		Washington University Road Test		√	93 items	45 min, driving distance 7.5 mile	Two global ratings were averaged and then coded as "at-risk" (average global rating ≥ 0.5) or "safe" (average global rating < 0.5)	(33)
		Modified Washington University Road Test		√	NR	50–60 min, standard sedan, driving distance 13 miles	Overall performance was scored as pass, marginal, or fail.	(32)
		DriveABLE on-road evaluation (DORE)		√	NR	30-40 min, automatic vehicle, driving distance 16.2 km	Compared to each class threshold to define the final fail, borderline or pass result.	(12)
		Driving Behaviours Observation Grid (DBOG)		√	50-item	NR	3-point scale: 2= correct driving behaviour 1 = minor error (error that does not affect safety) 0 = major error (error that is severe enough to affect safety)	(27)

Table 2: Characteristic of screening and assessment tools (continued)

Domain	Sub-domain	Tools	Screening	Assessment	No of item/ question	Administration mode/time	Scoring	Sources
		Test Ride Investigating Practical fitness to drive (TRIP)		√	NR	NR	Overall performance is scored as pass, doubtful or fail outcome.	(34)a strategy was composed for the assessment of fitness to drive, consisting of clinical interviews, a neuropsychological assessment, and driving simulator rides, which was compared with the outcome of an expert evaluation of an on-road driving assessment. A selection of tests and parameters of the new approach revealed a predictive accuracy of 97.4% for the prediction of practical fitness to drive on an initial sample of patients with Alzheimer's dementia. The aim of the present study was to explore whether the selected variables would be equally predictive (i.e., valid
		Behind-the-wheel (BTW) testing		√	14 elements	start driving in a parking lot. If able to demonstrate safe driving behavior, s/he was allowed to progress to more difficult driving environments	Outcome recommendations: (1) unrestricted driving; (2) continued driving with added restrictions (3) retire from driving	(31)leaving subjective reports of concerns by the patient or family as common initiators of objective driving evaluation referral. This observational study evaluated the correspondence of patient and caregiver report of driving concerns relative to objective behind-the-wheel (BTW
		FTD road test		√	NR	NR	Standardised FTD protocols considering key driving skills "Abnormal" FTD test scores comprised "fail" (unsafe to drive/ irremediable) or "conditional pass" (unsafe to drive, but remediable/ safe to drive with restrictions and recommendations)	(29)
		Rhode Island Road Test (RIRT)		√	28 driving behaviors	NR	(0 = unimpaired, 1=mildly impaired, 2=moderately-to-severely impaired). Global assessment of the participant's overall driving ability (i.e., pass, marginal, fail).	(20,41)89 controls
		Boston University Road Test (BURT)		√	87 items	NR	Higher scores indicated greater impairment. At-risk driving= score of 20 or higher	(17)
		Composite Driving Assessment Scale (CDAS)		√	30 behaviors	NR	0 = unimpaired, 1=mildly impaired, 2=moderately-to-severely impaired	(20)analogs of within and across visual processing stream binding, respectively. Standardized road test (RIRT

*NA= Not applicable, NR= Not reported

three longitudinal studies, three retrospective studies, one prospective observational study, one secondary analysis, one cohort study, and one retrospective, cross-sectional, and prospective observational study.

2. Sample of population

All of the studies included in this review used older adults as their sample of the population. 74% (25 studies) and 24% (9 studies) had older adults as their sample of the population aged more than 60 years old and 45 years old, respectively.

3. Location and setting

Out of thirty-four eligible studies in this review, fourteen were conducted in the United States of America (USA), seven in Australia, six in Canada, and 1 in New Zealand, Italy, Japan, Korea, Argentina, Portugal, and the Netherlands. The included studies ranged from the year 2012 until 2022.

4. Screening and assessment tools

There were many variations in the types of tools used to screen and assess older adults' fitness to drive. The tools included were off-road screening tools (n = 54), off-road assessment tools (n = 21), and on-road assessment (n = 20). All tools were either self-rated, clinician-reported, interview/questionnaire, pencil-and-paper, performance-based or computer-based. The characteristics of the tools are given in Table 2.

5. Main findings

There were five main domains covered by the screening and assessment tools utilised for older adults to examine their fitness to drive: general information, physical, cognitive, visual, and driving competency.

General information

Health practitioners, such as occupational therapists in particular, would always start with the gathering of general information (e.g., demographic data (12–30)a wide range of motor, sensory, and cognitive skills that are imperative for driving are affected in older adults. Though on-road tests are most indicative of driving ability, they are costly, stressful, time-consuming, and risky. Application of tablet-based cognitive tasks is investigated in identifying unsafe drivers in a population of healthy and at-risk for driving older adults. Method: Forty-nine older adult participants aged 54 to 81 (M = 78.08, SD = 9.78, medical condition and comorbidity (13,15,22,23,25)Montreal Cognitive Assessment (MoCA, medication intake (13,23,26)mean age = 73.86, standard deviation = 6.05, driving history and driving behaviour (13,21,25–27)mean age = 73.86, standard deviation = 6.05, patient- and caregiver-reported driving concerns (31)leaving subjective reports of concerns by the patient or family as common initiators of objective driving evaluation referral. This observational study evaluated the correspondence of patient and caregiver report of driving concerns relative to objective behind-the-wheel (BTW, depression scale (32) and sleepiness scale (18).

Physical

A total of five off-road screening tools were identified in evaluating the physical domain of older adults, with the most used tool was the Rapid Pace Walk (RPW) (17,23,26,32)St. Louis, MO and 38 community-dwelling controls were enrolled. Participants, ages 55–90 years, underwent a comprehensive clinical evaluation by a trained occupational therapist and an on-road driving evaluation by a masked driver rehabilitation specialist. Overall driving performance of pass vs. marginal/fail and number of wheel and/or brake interventions were recorded. Results—Fifty-two percent of glaucoma participants scored a marginal/fail compared to 21% of controls (odds ratio [OR], 4.1; 95% CI, 1.30–13.14;p=.02, which was represented in four studies. Other significant tools included were the range of motion (ROM) test which was administered by using the standard goniometer (17,32), motor strength test, by using manual muscle testing (17), grip strength, by using the Jamar dynamometer (32), and nine-hole peg test (32).

Cognitive

Thirty-two off-road tools related to the cognitive domain were found in this review. Administration methods of the tools to screen older adults' cognitive domain were dominated mainly by pencil-and-paper based (n = 27), followed by performance-based (n = 2), computer-based (n = 2), and clinician-rated (n = 1). From the result, it was notable that Mini-Mental State Examination (MMSE) (n = 10) (13,16–18,20,23,25,26,33,34)and to determine which combination of tests provided the best overall prediction. Methods Forty-seven currently licensed drivers (58-95 years and Montreal Cognitive Assessment (MoCA) (n = 9) (14–16,19,29,30,33,35,36)and to determine which combination of tests provided the best overall prediction. Methods Forty-seven currently licensed drivers (58-95 years were the most utilised older adults' cognitive screening tools to identify their fitness to drive. Other functional cognitive screening tools used include the Modified Mini-Mental State (3MS) Examination (22)Clock Drawing Test, and Modified Mini-Mental State Examination, Short Blessed Test (SBT) (32,35), and Addenbrooke's Cognitive Examination Revised (ACE-R) (27). Trail-Making Tests (TMT) (14–17,20,22,23,27,28,30,32,33,35–41)Australia. Questionnaires were administered to assess driving habits and functional assessments to assess driving-related function. Self-reported restriction was prevalent in this cross-sectional sample (62% were another remarkable screening tool widely known for its ability to screen older adults' executive functions. In addition, three studies administered the Clinical dementia rating (CDR) scale (17,20,34)a strategy was composed for the assessment of fitness to drive, consisting of clinical interviews, a neuropsychological assessment, and driving simulator rides, which was compared with the outcome of an expert evaluation of an on-road driving assessment. A selection of tests and parameters of the new approach revealed a predictive accuracy of 97.4% for the prediction of practical fitness to drive on an initial sample of patients with Alzheimer's dementia. The aim of the present study was to explore whether the selected variables would be equally predictive (i.e., valid to rate the severity of dementia before continuing with the other screening tools. Besides, we found that three studies utilised Digit-Span Task (16,24,39)drivers with mild cognitive impairment (MCI to screen the older adults' attention span. Attention was a significant sub-area in screening older adults' cognitive function to identify their driving fitness. Other significant sub-areas include visual perception, which was commonly screened using Motor-Free Visual Perception Test (MFVPT) (16,28,32)St. Louis, MO and 38 community-dwelling controls were enrolled. Participants, ages 55–90 years, underwent a comprehensive clinical evaluation by a trained occupational therapist and an on-road driving evaluation by a masked driver rehabilitation specialist. Overall driving performance of pass vs. marginal/fail and number of wheel and/or brake interventions were recorded. Results—Fifty-two percent of glaucoma participants scored a marginal/fail compared to 21% of controls (odds ratio [OR], 4.1; 95% CI, 1.30–13.14;p=.02, a pencil-and-paper-based screening tool.

Vision

There were seven screening tools found in this review concerning the vision domain. Six of them were administered based on clinician-rated: visual field confrontation testing (17), Snellen-type eye chart (17), Early Treatment Diabetic Retinopathy Study (32,33), Mars Letter Contrast Sensitivity chart (33,37), Pelli-Robson CS chart (18,32) and Vector Vision chart (32). One study used a computer-based screening tool for visual field testing (32).

Driving competency

The driving competency domain could be evaluated using both off-road and on-road assessments. Overall, twenty-one off-road assessment tools were used to specifically address older adults' driving competence. Five of them were based on self-reported assessments: Driving Habits Questionnaire (DHQ) (32,37), Driving Confidence Scales (37), Perceived Driving Abilities (PDA) (16)attitudes, and self-regulatory behaviors among older adults. Healthy older adults (n = 928, Decisional Balance Plus (DBP) (16)attitudes, and self-regulatory behaviors among older adults. Healthy older adults (n = 928 and Driver 65 Plus (36) with each of the tools assessed driving practices, confidence, perception, attitudes and risks respectively. Another ten tools were computer-based assessments. Upon analysing, Useful Field of View (UFOV) (13,14,17,18,23,26–28,32,33,38,39) Setting, and Participants: This prognostic study was conducted between October 31, 2013, and May 10, 2017, using the criterion standard for screening tests, an on-road driving test, with analysis conducted from August 1, 2019, to April 2, 2020. A volunteer sample of older drivers was recruited from community advertisements, rehabilitation and driver assessment clinics, and an optometry clinic in Canberra and Brisbane, Australia. Exposures: Off-road driver screening measures, including the Useful Field of View, DriveSafe/DriveAware, Multi-D battery, Trails B, Maze test, Hazard Perception Test, DriveSafe Intersection test, and 14-item Road Law test. Main Outcomes and Measures: Classification as unsafe on a standardized 50-minute on-road driving assessment administered by a driving instructor and an occupational therapist masked to the participant's clinical diagnosis and off-road test performance. Results: A total of 560 drivers aged 63 to 94 years (mean [SD] age, 74.7 [6.2] years]; 350 [62.5%] men was the most utilised and well-established computer-based tool which examined the older adults' visual processing speed and therefore indicated the sign of driving impairment. Next, a computer-based driving simulator (24,34,40)cognitive and visual functions. We compared perceptual and cognitive skills and driving behaviour in a Japanese population. Methods: We used a driving simulator to measure the effects of spatial navigation skills and eye movements on driving ability. Participants were 34 older and 20 young adults who completed a simulated driving task involving a lane change and a right turn at an intersection. We used an eye tracker to measure gaze. We measured visual recognition (Benton Judgment of Line Orientation Test (BJLO was often used to assess older adults' driving skills by controlling the steering wheel or the brake to respond appropriately. The driving simulator used computer graphics to produce road traffic scenes in exchange for real-world driving situations. To assess older adults' cognitive function related to driving, two studies were identified using the Stroke Drivers Screening Assessment (SDSA) (27,40), a pencil-and-paper-based tool and one of the best predictors of on-road driving performance. Other available pencil-and-paper-based tools related to driving tasks were the Neuropsychological Assessment Battery (NAB)- driving scenes (17), 14-item Road Rules and Road Craft test (38), and Road Sign Recognition Test (32,35) with each of the tools assessed the older adults' visual attention, knowledge of road law and knowledge of road signs respectively.

Findings from this review revealed that all of the older adults' driving performances were also assessed by the administration of the on-road assessment. There were a total of twenty different on-road driving tests used to assess older adults' driving performances. Two studies were found to use the Rhode Island Road Test (RIRT) (20,41)89 controls, which was modified from the Washington University Road Test (33). RIRT assessed 28 driving behaviours which were rated by the professional driving instructor or trained specialist. Each behaviour was rated in a trichotomous manner; 0 = unimpaired, 1 = mildly impaired, 2 = moderately-to-severely impaired. Upon completion of the test, the instructor or specialist rated the individual's driving performance as 'safe', 'marginal', or 'unsafe'.

Meanwhile, the Washington University Road Test (33) assessed 93 items along 7.5 miles (45-minute) route in a dual-control car. For scoring, a certified driving rehabilitation instructor rated the global judgment driving safety of overall performance as 'pass', 'marginal', or 'fail'. Aside from these two mentioned standardised on-road assessments, other assessments were also used with slightly different protocols (e.g., routes, road course, items assessed, and scoring method) but had the same purpose; to assess the individual's on-road driving performance.

Multi-domain

This review identified two multi-domain tools to screen older adults' fitness to drive. These two tools were categorised separately as 'multi-domain' due to their ability to screen an individual's sensory, physical, and cognitive functions. A few sub-tests were brought together in the Occupational Therapy-Driver Assessment Off-Road Assessment (OT-DORA) Battery (42,43)and if this could be predicted using the occupational therapy – driver off-road assessment battery (OT-DORA Battery and Assessment of Driving Related Skills (ADReS) (21), and thus, making it easier to screen the client's functions before proceeding to an on-road assessment.

Discussion

The result of this review provides evidence that occupational therapists had functionally utilised various off-road screening and assessment tools to determine older adults' fitness to drive. These off-road tools employ either self-rated, clinician-reported, interview/questionnaire, pencil-and-paper, performance-based or computer-based. Conducted away from the vehicles, off-road procedures are set out to provide the occupational therapist with the client's information to guide further evaluation during the on-road assessment and to screen out clients who are inappropriate for on-road assessment (44)mobility and freedom (Korteling & Kaptein, 1996. A comprehensive driving evaluation commonly includes off-road and on-road assessments (6,45). Although it is a time-consuming process, the combination of these two procedures is viewed as the gold standard in determining driving fitness of an individual (42)and if this could be predicted using the occupational therapy – driver off-road assessment battery (OT-DORA Battery. However, due to the availability and administrative issues, Malaysian occupational therapists, in particular, are faced with challenges in deciding on applicable assessment tools for their clients (46). To date, there are only two online publications provided briefly by the web portal of the Ministry of Health Malaysia, which are "Functional Assessment of The Older Driver" (47) and "Medical Assessment of the Older Driver" (48) which explain on occupational therapists' roles in driving rehabilitation specifically for older drivers and within the Malaysian context. However, both are not thoroughly explained and are not specified for the use of the occupational therapy profession.

This review also reported five main domains evaluated by the screening and assessment tools for older adults to evaluate their fitness to drive. The first domain covered is general information which commonly includes information on demographic data, medical condition, medication intake, and driving history. It is worth noting that a comprehensive evaluation should begin with the taking driving history of the older driver (49). The information asked usually includes recent changes in driving habits, history of traffic accidents, and history of driving license withdrawal (50)Vaud, Neuchâtel and Jura, which can also be elicited from family members or close relatives (49,50) Vaud, Neuchâtel and Jura. Medical history is as crucial as driving history. Compared to younger counterparts, older drivers are more prevalent for having multiple chronic medical conditions. The use of medications may potentially impair the driving performances of older drivers, mainly if there are side effects after consuming, such as drowsiness, confusion, low blood pressure, low blood sugar, nausea, loss of consciousness, weak muscle tone, and poor coordination (51). Thus, information that can be obtained may include the list of current medications used and a history of any cardiovascular, neurological, or psychiatric diseases (50)Vaud, Neuchâtel and Jura.

The second domain evaluated by occupational therapists is the physical domain. This review showed that the RPW was the most common tool used to screen older drivers' physical functions. A previous study found that older drivers who performed poorer on the RPW had a 45% increase in chances of failing the on-road test (23). A review of critical appraisal also concluded that RPW has good reliability and excellent validity due to its evidence of linking scores with on-road performance (45). Meanwhile, in current practice, a cross-sectional study in Malaysia found that the most utilised standardised assessment by occupational therapists was the ROM test, followed by manual muscle testing (52). Both ROM and manual muscle testing were used to evaluate the drivers' physical capacity.

The third domain evaluated by occupational therapists is the cognitive domain. From the result, MMSE and MoCA were the most utilised older adults' cognitive screening tools to identify their fitness to drive. However, MMSE was less accurate in predicting on-road performance and, thus, amplifies the evidence that the MMSE should not be used as a stand-alone test to evaluate driving performance (25)few studies have shown the predictive validity of the MMSE in determining on-road performance. In a sample of 168 community dwelling older adults, including 20 with Parkinson's disease (PD. On the contrary, as the most common used tool for the geriatric population, MoCA may be a valuable first screening tool in determining the need for further in-depth evaluation (29). A previous study highlighted that the specific MoCA domains of attention and visuospatial/executive were beneficial in determining the driving ability and identifying the need for further evaluation with cut-scores of <5/6 for MoCA-attention (sensitivity 73.3%, specificity 72.2%) and <8/11 for MoCA-visuospatial/executive+attention (sensitivity 80%, specificity 66.7%) (15). Another tool found in this review was TMT, which was commonly utilised to screen an individual's executive function. A previous study had suggested cut-off points to separate safe and unsafe drivers from those who are uncertain to promote the clinical utility of TMT on older adults (41)89 controls. The cut-off points were as follows; TMT-A less than 48 seconds or TMT-B less than 108 seconds (41)89 controls.

Vision is another significant domain tested to evaluate older drivers' driving fitness. In this review, seven different vision screening tools were identified. Vision impairment is more common among older adults and could result in challenges during driving tasks as it requires high demands on visual processing and visual awareness (53). This impairment can impede the driver's perception of road signs or hazards, increase safety errors, and cause greater crash risk (54)real-world driver safety behavior in at-risk drivers with age-related dysfunction. Older drivers are at risk for age-related cognitive and visual dysfunction, which may reduce mobility and increase errors that lead to crashes. Understanding patterns of real-world behavior, exposure, and cognitive–perceptual processes underlying risk in environmental context and in older drivers requires new approaches. Methods: We assessed patterns of objective, real-world driver risk exposure and vehicle control related to steering, braking, and accelerating in older adults with a range of cognitive and visual functional abilities. Real-world driver behavior was collected from passive-monitoring systems installed in 77 drivers' vehicles and analyzed across 242,153 km (150,467 miles. The older adults' visual function was usually examined by testing their visual acuity and contrast sensitivity using Snellen-type eye chart, Early Treatment Diabetic Retinopathy Study, Mars Letter Contrast Sensitivity chart, and Pelli-Robson CS chart. A previous study mentioned that vision tests were examined using the individual's normal corrective lenses (32), and if needed, specialised examination by an ophthalmologist can be employed (55). This is because some visual examinations such as contrast sensitivity assessment need their specialisation and specialised equipment (55).

Last but not least, this review also determined the domain of driving competency, which could be evaluated using both off-road and on-road assessments. Based on the result, UFOV was the most utilised off-road, computer-based assessment used to identify older adults' driving impairment. UFOV subtest 2 (divided attention), in particular, confirmed its utility among older adults by demonstrating the best single predictor of at-risk drivers with an area under the curve (AUC) of .84 (33). Moreover, a recent study reported that UFOV subtest 3 (selective attention) could optimally predict pass/fail outcomes with a sensitivity of 78.9% and a specificity of 73.5% (14). Besides, this review also identified pencil-and-paper-based tools such as the SDSA, which could also use to predict on-road driving performance specifically. SDSA had reported the ability to successfully predict pass/fail classification of on-road performance with $p < 0.05$; 78.9% agreement with the principal evaluator sensitivity, 71.4%-79.3%; specificity, 77.8% (40). Those who failed the SDSA should be advised to cease driving, and these recommendations are about 80% accurate (56). Another off-road assessment found from this review was the driving simulator which used computer graphics in producing driving situations. Compared to middle-aged adults, older adults were found to perform the simulation test at significantly slower speeds (57). Analysis of performance from a previous study had also successfully revealed that older drivers with MCI had significantly slower responses on both tasks of the driving simulator, as shown by the Traffic Signal Reaction Score ($p < 0.0001$) and the Brake Reaction Score ($p < 0.01$) (24). Receiver Operating Characteristic (ROC) analyses of the driving simulator demonstrated good predictive accuracies in determining individuals' fitness to drive with AUC = 0.861, SE = 0.089, $p = 0.015$ (34)a strategy was composed for the assessment of fitness to drive, consisting of clinical interviews, a neuropsychological assessment, and driving simulator rides, which was compared with the outcome of an expert evaluation of an on-road driving assessment. A selection of tests and parameters of the new approach revealed a predictive accuracy of 97.4% for the prediction of practical fitness to drive on an initial sample of patients with Alzheimer's dementia. The aim of the present study was to explore whether the selected variables would be equally predictive (i.e., valid. On-road assessments, on the other hand, are administered in real environments and are designed to accurately understand the most significant aspects of driving needs (58). Several different on-road driving tests were used to assess older adults' driving performances are found in this review. A previous study had identified that older drivers who passed the on-road driving test recorded fewer errors than those who failed. (range 1–53 versus 14–99 errors, Z = -6.83, $p < 0.001$) (58). Therefore, on-road driving tests have been considered to be the gold standard in predicting driving ability among the older adult population (17,24) and are usually accompanied by a professional evaluator, such as a driver rehabilitation specialist (DRS) (17).

Overall, this review indicated that various screening and assessment tools are used to examine older adults' fitness to drive. It is significant to note that most of the tools were widely used in the USA and Australia, thus reflecting insufficient research done for the Asian population, especially Malaysian in particular. This is supported by a recent study in Malaysia which found that there is indeed a limitation of local research evidence, as well as insufficient specialised training in the field of driving rehabilitation (52). While aiming for the best practice for older adults' care, occupational therapists need evidence-based findings to guide their practice related to driving rehabilitation (59). The older population is increasing, and the need to support them with driving and community mobility is also increasing. However, there is limited evidence in the literature related to occupational therapists' practice in addressing driving issues among older adults, specifically in the Malaysian context. Therefore, the exploration of contextually appropriate screening and assessment tools that can be used by Malaysian occupational therapists in addressing driving issues among this group of population are highly encouraged.

Limitation

This review has a few limitations. Aforementioned, only three databases were included, and non-English articles were excluded. Besides, this review only incorporated evidence over the past ten year's period of time to ensure its relevance to the current practices. Hence, other potential studies might be missed during the review process. In addition, this study did not evaluate the quality assessment of the included studies as this scoping review focused on identifying available evidence and the existing gaps. Nonetheless, this review adhered to the systematic framework by Arksey and O'Malley (11) to strengthen the confidence and trustworthiness of these findings.

Conclusion

This review has significantly provided critical information on screening and assessment tools currently available to determine older adults' driving fitness. Overall, this scoping review found five main domains (general information, physical, cognitive, vision, and driving competence) and two main types (off-road and on-road) of screening and assessment tools utilised for this group of population. Considering most of the tools identified were western-oriented, future research should focus on identifying if the tools are indeed contextually sensitive and practical for the Malaysian population. Nevertheless, the results of this review may still potentially assist the growth of the occupational therapy profession in the area of driving rehabilitation and, thus, guide them in selecting the best tools to evaluate older adults' fitness to drive.

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Competing interests

The authors have no conflict of interest to declare.

Ethical clearance

We obtained approval from UiTM Research Ethics Committee, registered under REC/10/2022 (PG/MR/247).

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