Neuropsychological assessment for driving capacity in older adults with neurocognitive disorders

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Abstract

Driving capacity in older adults suffering from different cognitive deficits is not thoroughly investigated in Greece and we still lack cut-off scores in classic neuropsychological tests that could be used as indicators of driving incapacity/capacity. A group of 257 Greek older individuals including three groups consisting of healthy controls, participants with a diagnosis of Mild Cognitive Impairment (MCI), as well as mild Alzheimer's disease (AD) were examined with a basic neuropsychological battery, along with the 16-item short form of the Driving Capacity Questionnaire (DCQ). Results indicated statistically significant differences between all three groups regarding each of the items of DCQ. Receiver operating characteristic curve (ROC) analysis was used and revealed that all patients with AD diagnosis who have a Mini Mental State Examination (MMSE) total score below 21.5 are evaluated as not capable to drive (Sensitivity: 90.6%, Specificity: 55.7%) as the estimated area below the ROC curve was found to be 0.738. Other widely administered neuropsychological tests in Greece such as the Clock-Drawing Test (CDT) was found to have an area under the curve (AUC) equal to 0.500 (which indicates that it cannot be used as a discrimination tool) as is the case with MMSE. Further research is needed to understand driving behavior and inform driving decisions for older adults with poor cognitive function.

Keywords: driving capacity, cut-off scores, healthy aging, MCI, mild Alzheimer's Disease

JEL Classification Codes: I12, L91

Introduction

American Occupational Therapy Association (2014) includes driving among the Instrumental Activities of Daily Living (IADLs), giving the individual the ability to live independently. The inclusion of driving in this category highlights two core dimensions of driving; firstly, the fact that to be successfully carried out the activation of clearly complex cognitive-mental and other abilities, such as motor as well as emotional control is required on behalf of the individual. Moreover, it occupies an important place in the activity of the individual daily. The successful implementation of complex activities of daily life, such as driving, is a useful source of information regarding the mental capacity of the individual (Guo & Sapra, 2020). To be used as a form of evaluating the mental abilities of a driver as well as to decide whether an older person is capable of driving or not, it is important to create neuropsychological assessments sensitive enough to detect divergences from what considered to be safe and functioning.

Taking into consideration the rapid ageing of the population and the increase in life expectancy, the resulting increase in the number of elderly people holding a driving license is put in the spotlight. Despite the fact, however, of the necessity of driving for the wellbeing of the elderly, age seems to be inversely related with their ability to drive safely (MacDonald & Hebert, 2010). During the progressive increase of the age, there are deviations in performance of complex life activities, which are indicative of deficits occurring at the level of executive functions.

Given the decline in mental and physical abilities as well as the physical vulnerability that is indicative of this age stage, safe driving is of major importance, with the risk of road accidents being increased among this category of elderly drivers (Pope et al., 2020; Söllner & Florack, 2019). Many studies suggest that driving errors are cited as the main reason for car accidents in the elderly, in contrast to younger drivers, where car accidents are attributed to a greater extent to taking risky behaviors or drinking alcohol (Allen, Beck & Zanjani, 2019; Cichino & McCart, 2015; Touliou, Panou, Maglaveras & Bekiaris, 2018).

It is the fact that mistakes are made that calls into question the adequate perception and evaluation of all the parameters that emerge in the driving environment, and, by extension, the suitability of older drivers. Among the most frequent mistakes are mentioned the incorrect adjustment of the distance from the vehicle in front and the speed of the vehicle, dangerous overtaking, daydreaming during the day, etc. (Cichino & McCart, 2015). The decline, therefore, observed in both physical and sensory as well as in mental functions of the elderly has an analogous effect on the formation of driving behavior, given the importance of these parameters in the final result, which seems to deviate from the desired driving result (Karthaus & Falkenstein, 2016). However, being elderly does not imply and should not be considered equal to inappropriate driving.

An in-depth assessment and the inclusion of all possible parameters which can lead us to safer conclusions, ruling out the possibility

that, on the one hand, driving ability is maintained in people who do not retain the necessary skills, and, on the other hand, it is removed from people who remain capable. As noted by Anstey (Anstey, Eramudugolla, Chopra, Price & Wood, 2017), any differentiation in reference to the mental functioning of the individual can impact his ability to safely handle the chosen means of transportation. Especially, in the case of a mental demanding driving environment performance may be decreasing, increasing the risk of an impending collision, even from the early stages of mental decrease, when deficiency in skills involved do not reach a statistical significance level (Touliou et al., 2018). It is, therefore, the complexity of the task that makes it susceptible to deviations from the appropriate performance even in the case where the observed mental and other deficits do not show significant deviations from normal.

The assessment of specific capacities in old age, such as medical consent, sexual consent, financial capacity, testamentary capacity, driving capacity, independent living, which are all related to legal matters is not adequately investigated in Greece, mainly due to lack of relevant instruments (Giannouli, Stamovlasis & Tsolaki, 2018). Although driving capacity is considered to be a complex task requiring the integrity and the cooperation of three domains, namely cognition, motor, and somatosensory skills (Stamelos et al., 2021), we still have little research evidence to support whether there are differences in the profiles regarding driving behaviors in patients with a formal diagnosis of Alzheimer's Disease (AD), Mild Cognitive Impairment (MCI) and healthy controls and if there is a specific numerical cut-off score in a neuropsychological test that could depict this incapacity.

More specifically, even mild deviations in cognitive functioning can affect driving, increasing the risk of car accidents (Fraade-Blanar et al., 2018). Dementia and the mental deficits that accompany it, seem to reduce a person's ability to drive safely. Consequently, the performance of dementia patients in driving tasks is consistently lower than that of the mentally healthy elderly (Carr & Ott, 2010; Freund, Gravenstein, Ferris & Shaheen, 2002). However, it is already possible to observe deficits in driving-related parameters even from the stage of MCI, differentiating them in important driving parameters from their healthy peers (Beratis et al., 2017; Fraade-Blanar et al., 2018).

The correct assessment of the speed and distance from the vehicle ahead as well as remaining in the correct lane are included in the parameters that deviate even from the stage of MCI, while the total performance they present when their driving ability is examined seems to deviate from the desired one (Anstey et al., 2017; Hird et al., 2016). The different patterns of dysfunction that patients with cognitive impairments of different etiology seem to have (Piersma et al., 2018), along with the increasing ageing of the population, make it imperative to develop tests that will guide clinical practice.

Due to the lack of relevant instruments measuring driving capacity in Greece, this study uses a brief version of the Driving Capacity

Questionnaire (DCQ) in a group of Greek older adults (Katsouri, 2018) with the main aims 1) to assess whether scores in DCQ can discriminate between healthy controls (HC), participants with Mild Cognitive Impairment (MCI), and mild Alzheimer's disease (AD), and 2) to find a cut-off score in other administered classic neuropsychological tests that could be used for indicating driving incapacity/capacity.

Methods

Participants

257 participants were recruited through the 3rd Department of Neurology of the "G. Papanikolaou" General Hospital, Aristotle University of Thessaloniki and the Daycare Units for patients with dementia located in Athens and Thessaloniki. The patient groups had already a diagnosis from the clinic and were examined during their regular testing, while healthy older adults were community-dwelling with no official diagnosis of cognitive or health problems.

Tools-Measures

All participants were examined individually during in-person assessments with a number of widely used basic neuropsychological tests that are also included in capacity assessments in Greece (Giannouli, 2023). These tests are in use in Greek geriatric populations (Giannouli & Tsolaki, 2023) including: a) Mini Mental State Examination (MMSE), which is a measure of general cognition(Fountoulakis et al., 2000), (b)Functional Rating Scale for Symptoms of Dementia (FRSSD),which assesses the patient's ability to carry out routine tasks and identify the functional difficulties in everyday living according to the caregiver's perspective(Hutton, 1990) , (c) Geriatric Depression Scale (GDS), which measures geriatric depression (Fountoulakis et al., 1999), (d)Hamilton's Depression Rating Scale (HDRS)(Hamilton, 1967; Lykouras et al., 1989), (e) Functional-Cognitive Assessment Scale (FUCAS), which examines executive cognitive functioning regarding daily life activities(Kounti et al., 2006), (f) Montreal Cognitive Assessment (MoCA), which is used as a screening tool similar to MMSE measuring basic cognitive domains(Konstantopoulos et al., 2016), and (g) Neuropsychiatric Inventory (NPI), which measures behavioral and mood disturbances such as hallucinations/delusions, irritability/aggression, depressive and anxiety symptoms, inappropriate behaviors, and psychomotor delay or agitation (Politis et al., 2004). (Table 1). In addition to the above tests and questionnaires, more specific neuropsychological tests were also administered such as the Clock-Drawing Test (CDT), which assesses two important cognitive functions; executive functioning and visual-spatial functioning (Bozikas et al., 2008). The above tests were selected based on their brief and not time-consuming administrations.

Procedures

All assessments took place at the 3rd Department of Neurology of the "G. Papanikolaou" General Hospital, Aristotle University of Thessaloniki and at Daycare Units for patients with dementia in Athens and Thessaloniki as part of regular assessments organized by these clinics during 2015-2018. Tests were administered in the same order to all groups of participants in a quiet room.

Table 1. Performance of three groups of participants in the classic administered tests and questionnaires

		Mean	*SD*	*P*
MMSE	Controls	29.07	1.10	0.000
	MCI	26.78	1.76	
	AD	18.83	6.09	
GDS	Controls	2.31	2.39	0.000
	MCI	2.11	1.96	
	AD	2.91	2.75	
HAMILTON	Controls	6.89	4.28	0.005
	MCI	7.45	7.56	
	AD	11.09	6.39	
FUCAS	Controls	42.54	1.05	0.000
	MCI	44.70	2.67	
	AD	60.03	16.20	
FRSSD	Controls	2.80	2.17	0.000
	MCI	4.27	3.12	
	AD	12.33	7.23	
NPI	Controls	8.00	.00	0.161
	MCI	3.33	3.20	
	AD	12.09	11.70	
MOCA	Controls	27.09	1.92	0.009
	MCI	23.14	3.80	
	AD	21.00	3.91	

Ethics

Participation was voluntary, research participants did not receive any monetary or other compensation for their time, and written consent was signed in advance by the patients or their caregivers. The research was approved by the Scientific and Ethics Committee of Alzheimer Hellas (Scientific Committee decision of approval 121/2021 AI). In addition to that, the study complied with the EU General Data Protection Regulation (GDPR).

Statistical analyses

Descriptive statistics such as means (M), standard deviations (SD) and frequencies (n%) were used to statistically analyze with Chi

square test the data obtained from the administration of the Short Driving Capacity Questionnaire (DCQ) as well as ROC analysis was used in order to investigate the possible cut-off scores for the classic neuropsychological tools used in geriatric neuropsychological assessment (e.g., MMSE). Statistical analysis caried out using the SPSS 22.0 statistical package (IBM Inc., Armonk. NY). P-values less than 0.05 were considered statistically significant.

Results

The distribution of the population according to the diagnosis was: n = 88 healthy older adults (M_{age} = 77.02, SD = 10.11; $M_{education}$ = 11.51, SD = 4.37); n = 100 with Mild Cognitive Impairment (MCI) (M_{age} = 72.47, SD = 6.63; $M_{education}$ = 11.95, SD = 4.61); and n = 69 with a diagnosis of mild AD (M_{age} = 75.15, SD = 6.82; $M_{education}$ = 10.61, SD = 4.65); all with no mobility problems. The AD patients were diagnosed according to the NINCDS-ARDRA criteria and the MCI ones according to the Petersen and Winblad criteria.

Results revealed that there are several statistically significant differences between all groups regarding the 16 DCQ items (see Table 2).

Table 2. Performance of controls, MCI, and AD patients regarding their responses to DCQ (short version).

Driving Capacity Questionnaire (DCQ) items	Responses	Controls n (%)	MCI n (%)	AD n (%)	Total (n)	P
1.Driving the same amount of km as in the past	Yes	32 (44.4)	23 (31.9)	12 (16.7)	72	0.028
	No	56 (26.3)	77 (23.2)	57 (26.8)	213	
2.Complaints from the family members about driving behavior	Yes	17 (27.4)	16 (25.8)	20 (32.3)	62	0.105
	No	71 (31.8)	84 (37.7)	49 (22.0)	223	
3.Recommendations about ceasing driving from the family	Yes	10 (15.4)	16 (24.6)	31 (47.7)	65	0.000
	No	78 (35.5)	84 (38.2)	38 (17.3)	220	
4.Medication that affects driving	Yes	1 (3.8)	4 (15.4)	15 (57.7)	26	0.000
	No	87 (33.6)	96 (37.1)	54 (20.8)	259	
5.Easily distracted during driving for ex. In urban areas	Yes	11 (19.3)	13 (22.8)	26 (45.6)	57	0.000
	No	77 (33.8)	87 (38.2)	43 (18.9)	228	
6.Difficulties in concentrating during driving for over half an hour	Yes	6 (14.3)	12 (28.6)	18 (42.9)	42	0.005
	No	82 (33.7)	88 (36.2)	51 (21.0)	243	
7.Difficulties in concentrating when someone speaks to them	Yes	20 (20.4)	33 (33.7)	30 (30.6)	98	0.006
	No	68 (36.4)	67 (35.8)	39 (20.9)	187	

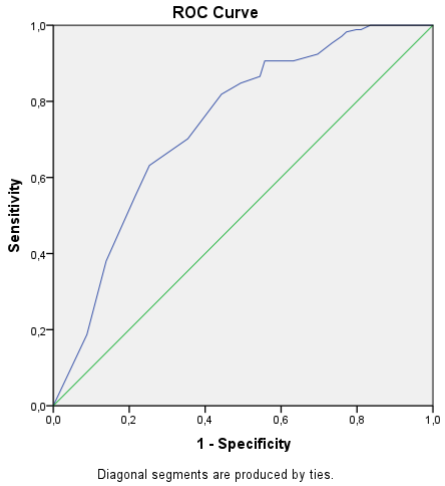
8.Inability to react quickly when necessary	Yes	14 (20.6)	21 (30.9)	24 (35.3)	68	0.028
	No	74 (34.1)	79 (36.4)	45 (20.7)	217	
9.Avoiding driving in urban areas	Never	72 (40.4)	66 (37.1)	26 (14.6)	178	0.000
	Always	16 (15.0)	34 (31.8)	43 (40.2)	107	
10.Avoiding driving in highways	Never	77 (35.80	84 (39.1)	36 (16.7)	215	0.000
	Always	11 (15.7)	16 (22.9)	33 (47.1)	70	
11.Avoiding driving at night	Never	57 (35.4)	58 (36.0)	30 (18.6)	161	0.063
	Always	31 (25.0)	42 (33.9)	39 (31.5)	124	
12.Avoid turning at difficult intersections	Never	74 (36.1)	77 (37.6)	35 (17.1)	205	0.000
	Always	14 (17.5)	23 (28.8)	34 (42.5)	80	
13.Avoiding driving without company	Never	83 (37.4)	88 (39.6)	32 (14.4)	222	0.000
	Always	5 (7.90	12 (19.0)	37 (58.7)	63	
14.Avoiding driving under time pressure	Never	73 (37.6)	73 (37.60	32 (16.5)	194	0.000
	Always	15 (16.5)	27 (29.7)	37 (40.7)	91	
15.Average speed is slower than when they were younger (45 y.o.)	Yes	37 (22.6)	53 (32.3)	52 (31.7)	164	0.000
	No	51 (42.1)	47 (38.8)	17 (14.0)	121	
16.Avoiding driving in unknown areas	Never	62 (39.20	61 (38.6)	20 (12.7)	158	0.000
	Always	26 (20.50	39 (30.7)	49 (38.6)	127	

The receiver operating characteristics curve (ROC) analysis was used for the DCQ total score along with selected neuropsychological tests. Sensitivity and specificity values were calculated for all of the possible cut-off scores to facilitate the selection of the best cut-off score, which could be based on the criteria of maximizing sensitivity, maximizing specificity or maximizing using the Youden's index (sensitivity + specificity −1), which identifies the optimal combination of sensitivity and specificity as performed in similar previous research in psychometrics in neuropsychological tools used in older adults in Greece (Giannouli, Stamovlasis & Tsolaki, 2018).

Results indicated that a MMSE total score below 21.5 points can define an older person as incapable to drive (Sensitivity: 90.6%, Specificity: 55.7%) as the estimated area below the ROC curve was found to be 0.738 (see Figure 1). This was not the case for other widely administered neuropsychological tests in Greece, such as the Clock-Drawing Test (CDT), which was found to have an area under the

curve (AUC) equal to 0.500, a finding that indicates that it cannot be used as a discrimination tool.

Figure 1: Receiving Operating Characteristics (ROC)curve



Discussion

Our findings support that distinct patterns of driving behavior exist for older adults with different neurocognitive diagnoses. More specifically, MMSE seems to be a very useful tool to get in an easy and fast way a first picture regarding the driving capacity of older individuals before proceeding to a more detailed neuropsychological assessment with specific tools such as DCQ. As far as the Greek population of elderly population is concerned, that was the point of interest for this study, the cut-off score was calculated below 21.5 points, being sensitive and specific enough to discriminate capable from incapable drivers, taking into account the mental deficiencies that characterize this population.

According to the review of Iverson et al. (2010), a score less than or equal to 24 points is indicative of unsafe driving on the part of the individual. On the other hand, a trichotomy of patients was suggested by Versijpt and colleagues (2017) based on the score they achieve. They suggest that those who achieve a score of less than or equal to 19 points are considered unsafe to continue driving, while those who achieve scores greater than or equal to 25 points are considered safe drivers. Those people who achieve scores between 20 and 24 points seem to be on a borderline between safe and non-driving. To conclude with, it seems that MMSE has a diagnostic value, taking always into account the cut-off score that is proposed for the population of interest. This finding was supported by this study and, along with the other studies in the literature, highlights the usefulness of MMSE as a screening test to differentiate safe from unsafe drivers also in the Greek population.

However, as Piersma and colleagues pointed out (2018), the MMSE has little predictive capacity in separating adequate from inadequate

drivers when used alone, hence they suggest evaluation with a set of tools, as is done in this study. It seems that we cannot solely rely on the score of MMSE to exclude an elderly from driving and this could, also, be explained if we consider not only the complex character of the driving task, that requires the activation of a combination of mental skills, but also, the drawbacks that seizing driving has for an individual. Moreover, and although this study demonstrates the extremely important role of MMSE in relevant driving assessments, the importance of MMSE performance is corroborated by numerous studies in Greece assessing other Instrumental Activities of Daily Living (IADLs) such as financial capacity in different groups of older patients suffering from neurocognitive disorders (Giannouli, Stamovlasis & Tsolaki, 2018; Giannouli & Tsolaki, 2019; 2021a; 2021b; 2021c; 2022). Consequently, it is important to establish more neuropsychological tests with similar characteristics as far as their specificity and sensitivity is concerned.

On the other hand, Clock-Drawing test failed to achieve the appropriate sensitivity and specificity to be used as a discrimination tool between safe and unsafe drivers in the Greek population. Besides the fact that its discriminative is value, the fact that the differences in score between the different diagnoses reached statistical significance ($p<0.001$), highlights its usefulness to extract some core qualitive information about the mental state of the driver but it cannot be used as a point of distinction between those who are able and those who are not able to maintain the identity of the driver. This finding was also supported by Rapport et al. (2013) who claimed the usefulness of the tool under discussion as a powerful predictor for making decision to cease driving in the case of MCI.

Limitations and future studies

As this study is explorative , future studies should include larger and more diverse samples of older adults with varying demographics to enhance generalizability. While the face validity for its use in this context is high, the need for a thorough validation of the DCQ for the use in this context is obvious. In addition to that, it is necessary to examine participants coming from a variety of rural and urban areas across Greece where there may be differences in driving behavior and conditions (e.g., roads, traffic etc.) as well as to include and compare more groups of older patients suffering from other neurocognitive disorders.

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References

Allen, H. K., Beck, K. H., & Zanjani, F. (2019). Driving concerns among older adults: Associations with driving skill, behaviors, and experiences. *Traffic Injury Prevention*, *20*(1), 45–51.

American Occupational Therapy Association (2014). Occupational therapy practice framework: Domain and process (3rded.). *The American Journal of Occupational Therapy, 68* (Suppl.1), 1-48.

Anstey, K. J., Eramudugolla, R., Chopra, S., Price, J., & Wood, J. M. (2017). Assessment of driving safety in older adults with mild cognitive impairment. *Journal of Alzheimer's Disease, 57*(4), 1197–1205.

Beratis, I. N., Pavlou, D., Papadimitriou, E., Andronas, N., Kontaxopoulou, D., Fragkiadaki, S., Yannis, G., & Papageorgiou, S. G. (2017). Mild Cognitive Impairment and driving: Does in-vehicle distraction affect driving performance? *Accident Analysis and Prevention, 103,* 148–155.

Bozikas, V. P., Giazkoulidou, A., Hatzigeorgiadou, M., Karavatos, A., & Kosmidis, M. H. (2008). Do age and education contribute to performance on the clock drawing test? Normative data for the Greek population. *Journal of Clinical and Experimental Neuropsychology, 30*(2), 199-203.

Carr, D. B., & Ott, B. R. (2010). The older adult driver with cognitive impairment: "It's a very frustrating life". JAMA, 303(16), 1632–1641

Cicchino, J. B., McCartt, A. T. (2015). Critical older driver errors in a national sample of serious U.S. crashes. *Accident Analysis and Prevention, 80*, 211–219.

Fraade-Blanar, L. A., Ebel, B. E., Larson, E. B., Sears, J. M. Thompson, H. J., Chan, K. C. G., & Crane, P. K. (2018). Cognitive decline and older driver crash risk. *Journal of the American Geriatrics Society, 66*(6), 1075-1081.

Fountoulakis, K. N., Tsolaki, M., Iacovides, A., Yesavage, J., O'hara, R., Kazis, A., & Ierodiakonou, C. (1999). The validation of the short form of the Geriatric Depression Scale (GDS) in Greece. *Aging Clinical and Experimental Research, 11,* 367-372.

Fountoulakis, K. N., Tsolaki, M., Chantzi, H., & Kazis, A. (2000). Mini mental state examination (MMSE): A validation study in Greece. *American Journal of Alzheimer's Disease & Other Dementias®, 15*(6), 342-345.

Freund, B., Gravenstein, S., Ferris, R., &Shaheen, E. (2002). Evaluating driving performance of cognitively impaired and healthy older adults: A pilot study comparing on-road testing and driving simulation. *Journal of the American Geriatrics Society, 50*(7), 1309–1310.

Giannouli, V. (2023). Neuropsychological assessment and financial capacity in older adults: A review based on up-to-date knowledge. Global Perspectives on Health Assessments for an Aging Population, 21-47.

Giannouli, V., Stamovlasis, D., & Tsolaki, M. (2018). Exploring the role of cognitive factors in a new instrument for elders' financial capacity assessment. *Journal of Alzheimer's Disease, 62*(4), 1579-1594.

Giannouli, V., & Tsolaki, M. (2019). Are left angular gyrus and amygdala volumes important for financial capacity in mild cognitive impairment? *Hellenic Journal of Nuclear Medicine, 22,* 160-164.

Giannouli, V., & Tsolaki, M. (2021a). Is depression or apathy playing a key role in predicting financial capacity in Parkinson's disease

with dementia and frontotemporal dementia? *Brain Sciences, 11*(6), 785.

Giannouli, V., & Tsolaki, M. (2021b). Mild Alzheimer disease, financial capacity, and the role of depression: Eyes wide shut? *Alzheimer Disease & Associated Disorders, 35*(4), 360-362.

Giannouli, V., & Tsolaki, M. (2021c). Unraveling Ariadne's thread into the labyrinth of aMCI: Depression and financial capacity. *Alzheimer Disease & Associated Disorders, 35*(4), 363-365.

Giannouli, V., & Tsolaki, M. (2022). Financial incapacity of patients with Mild Alzheimer's Disease: What neurologists need to know about where the impairment lies. *Neurology International, 14*(1), 90-98.

Giannouli, V., & Tsolaki, M. (2023). Brain volumes and metacognitive deficits in knowledge of self, task and strategies in mathematics: A preliminary pilot one-year longitudinal study in aMCI patients compared to healthy controls. *Diagnostics, 13*(4), 680.

Guo, H. J. & Sapra, A. (2020). *Instrumental Activity of Daily Living. In Stat Pearls*. Stat Pearls Publishing.

Hamilton, M. A. X. (1967). Development of a rating scale for primary depressive illness. *British Journal of Social and Clinical Psychology, 6*(4), 278-296.

Hird, M. A., Egeto, P., Fischer, C. E., Naglie, G., & Schweizer, T. A. (2016). A Systematic Review and Meta-Analysis of On-Road Simulator and Cognitive Driving Assessment in Alzheimer's Disease and Mild Cognitive Impairment. *Journal of Alzheimer's disease: JAD, 53*(2), 713–729.

Hutton, J.T. (1990). *Alzheimer's Disease in Conn's Current Therapy*. 778–781.

Iverson, D. J., Gronseth, G. S., Reger, M. A., Classen, S., Dubinsky, R. M., Rizzo, M., & Quality Standards Subcomittee of the American Academy of Neurology (2010). Practice parameter update: evaluation and management of driving risk in dementia: report of the Quality Standards Subcommittee of the American Academy of Neurology. *Neurology, 74*(16), 1316–1324.

Karthaus, M., & Falkenstein, M. (2016). Functional Changes and Driving Performance in Older Drivers: Assessment and Interventions. *Geriatrics, 1*(2), 12.

Katsouri, I. (2018) *Evaluating the driving ability of older adults with dementia. Thesis/dissertation.* Medical Department, Aristotle University of Thessaloniki.

Konstantopoulos, K., Vogazianos, P., & Doskas, T. (2016). Normative data of the Montreal Cognitive Assessment in the Greek population and parkinsonian dementia. *Archives of Clinical Neuropsychology, 31*(3), 246-253.

Kounti, F., Tsolaki, M., & Kiosseoglou, G. (2006). Functional cognitive assessment scale (FUCAS): A new scale to assess executive cognitive function in daily life activities in patients with dementia and mild cognitive impairment. *Human Psychopharmacology: Clinical and Experimental, 21*(5), 305-311.

Lykouras, E., Ioannidis, C., Voulgari, A., Jemos, J., & Tzonou, A. (1989). Depression among general hospital patients in Greece. *Acta Psychiatrica Scandinavica, 79*(2), 148-152.

MacDonald, N., & Hébert, P. C. (2010). Driving retirement program for seniors: Long overdue. *CMAJ, 82*(7), 645.

Piersma, D., Fuermaier, A., De Waard, D., Davidse, R. J., De Groot, J., Doumen, M. J., ... & Tucha, O. (2018). Adherence to driving cessation advice given to patients with cognitive impairment and consequences for mobility. *BMC Geriatrics, 18*(1), 1-12.

Politis, A. M., Mayer, L. S., Passa, M., Maillis, A., & Lyketsos, C. G. (2004). Validity and reliability of the newly translated

Hellenic Neuropsychiatric Inventory (H-NPI) applied to Greek outpatients with Alzheimer's disease: A study of disturbing behaviors among referrals to a memory clinic. *International Journal of Geriatric Psychiatry, 19*(3), 203-208.

Pope, C. N., Fazeli, P. L., Bell, T. R., Gaini, M. S., Mrug, S., Vance, D. E., & Ball, K. K. (2020). A longitudinal investigation of falls and motor vehicle crashes in older drivers. *Journal of Aging and Health, 32*(9), 1258–1266.

Rapoport, M. J., Naglie, G., Herrmann, N., Sarracini, C. Z., Mulsant, B. H., Frank, C., Kiss, A., Seitz, D., Vrkjian, B., Maseltis, M., Tang-Wai, D., Pimlott, N., Molnar, F.(2013) Developing physician consensus on the reporting of patients with Mild Cognitive Impairment and Mild Dementia to transportation authorities in a region with mandatory reporting legislation. *The American Journal of Geriatric Psychiatry, 22* (12), 1530-43.

Söllner, M., &Florack, A. (2019). Age stereotypes and compliance with feedback in elderly drivers. *Transportation Research Part F: Traffic Psychology and Behaviour, 67,* 66–77.

Stamatelos, P., Economou, A., Stefanis, L., Yannis, G., & Papageorgiou, S. G. (2021). Driving and Alzheimer's dementia or mild cognitive impairment: A systematic review of the existing guidelines emphasizing on the neurologist's role. *Neurological Sciences, 42,* 4953-4963.

Touliou, K., Panou, M., Maglaveras, N. & Bekiaris, E. (2018). Executive, emotional and physiological functioning in older drivers with mild cognitive impairment. *International Journal of Transportation and Technology, 8,* 129-135.

Versijpt, J., Tant, M., Beyer, I., Bier, J. C., Cras, P., De Deyn, P. P., De Wit, P., Deryck, O., Hanseeuw, B., Lambert, M., Lemper, J. C., Mormont, E., Petrovic, M., Picard, G., Salmon, E., Segers, K., Sieben, A., Thiery, E., Tournoy, J., Vandewoude, M., … Ivanoiu, A. (2017). Alzheimer's disease and driving: review of the literature and consensus guideline from Belgian dementia experts and the Belgian road safety institute endorsed by the Belgian Medical Association. *Acta Neurologica Belgica, 117*(4), 811–819.