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**Title:** The impact of advanced age on driving safety in older adults with medical conditions.

**Short Title:** The impact of advanced age on driving safety.

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**Key words:** oldest-old, driving safety, fitness-to-drive, motor vehicle crash.

## **Abstract**

**Background:** Adults aged 85 and older, often referred to as the oldest-old, are the fastest growing segment of the population. The rapidly increasing number of older adults with chronic and multiple medical conditions poses challenges regarding their driving safety.

**Objective:** To investigate the effect of advanced age on driving safety in drivers with medical conditions.

**Methods:** We categorized 3,425 drivers with pre-existing medical conditions into four age groups: middle-aged (55-64, n = 1,386), young-old (65-74, n = 1,013), old-old (75-84, n = 803), or oldest-old (85+, n = 223). All underwent a formal driving evaluation. The outcome measures included fitness-to-drive recommendation by the referring physician, comprehensive fitness-to-drive decision from an official driving evaluation center, history of motor vehicle crashes (MVCs), and history of traffic violations.

**Results:** The oldest-old reported more cardiopulmonary and visual conditions, but reported less neurological conditions than the old-old. Compared with the middle-aged, the oldest-old were more likely to be considered unfit-to-drive by the referring physicians (odds ratio (OR) = 4.47, 95% confidence interval (CI) 2.20-9.10) and by the official driving evaluation center (OR = 2.74, 95% CI 1.87-4.03). The oldest-old reported more MVCs (OR = 2.79, 95% CI 1.88-4.12) compared to the middle-aged.

**Conclusion:** Advanced age adversely affected driving safety outcomes. The oldest-old are a unique age group with common medical conditions known to interfere with safe driving. Driving safety strategies should particularly target the oldest-old since they are the fastest growing group and their increased frailty is associated with severe or fatal injuries due to MVCs.

## **Introduction**

A rapid increase in the older population in the western world is driven by a longer life expectancy and aging of baby boomers [1]. Globally, it is anticipated that the number of adults aged 60 and older will increase by 56% from 901 million in 2015 to 1.4 billion in 2030, especially older adults aged 80 and older will increase by 61% from 125 million to 202 million during the same period [2]. For instance, in the United States, the number of licensed drivers aged 65 years and older is projected to rise from 40 million (15%) in 2015 to 56 million (20%) by 2025 [3-5]. This growing number of older drivers, especially those with medical conditions, may pose considerable traffic safety concerns in all western industrialized countries. Motor vehicle crashes (MVCs) are the second leading cause of unintentional injury-related fatalities among 55 to 64 (middle-aged), 65 to 74 (young-old), 75 to 84 (old-old), and 85 and older (oldest-old) [6]. Involvements in fatal MVCs per miles traveled begin to increase in older drivers aged 70 and peak after age 80 and older [7]. Although older drivers start to show higher fatality due to MVCs [6,8], only few studies have focused particularly on MVC in the oldest-old drivers [9].

Several factors for the higher involvement in fatal MVCs in advanced age have been postulated. First, the disability rate and physical frailty increase with age [8,10]. The frailty due to atherosclerosis and osteoporosis raises the likelihood of fatal chest and head injuries [11]. Second, older drivers may experience age-related changes known to affect driving. Such changes include declines in cognitive, visual, motor, and sensory functions to respond timely and accurately to a constantly changing environment [12]. Lastly, older drivers may have more difficulty making left-hand turns against opposing traffic, which may increase the risk of MVC [13,14].

Furthermore, the old-old and oldest-old have not been considered separately in most studies despite potential differences in driving related characteristics. A previous study examining driving competence in the oldest-old showed potential differences in cognitive skills associated with on-road driving performance [15]. Hence, there is a need to understand how advanced age influences all aspects of safe driving, including MVCs, traffic violations, and fitness-to-drive, especially among those with medical conditions. Such understanding will inform driving-related public policy and assist physicians in their decision-making process of fitness-to-drive.

Determining fitness-to-drive often requires physician's involvement [16]. Our previous study investigated individuals with various medical conditions [17]. We found that physicians were more likely to issue a favorable recommendation compared to a formal fitness-to-drive decision by driving evaluation specialists [17]. Yet, it remained unclear whether advanced age affects the degree of agreement between fitness-to-drive recommendations by referring physicians and comprehensive fitness-to-drive decisions by driving evaluation specialists.

The primary aim was to examine the impact of advanced age on driving safety with a particular focus on the oldest-old with reported medical conditions. A secondary aim was to compare agreements in fitness-to-drive recommendations between physicians and driving evaluation specialists involving the oldest-old with medical conditions.

## **Method**

### **Study participants**

This population-based retrospective study included individuals aged 55 and older with medical conditions. They were referred to the Center for Evaluation of Fitness to Drive and Car

Adaptations (CARA) of VIAS Institute between January 2, 2013 and December 30, 2014, because they or a third party raised driving safety concerns. Individuals were referred for a driving evaluation (1) because of a change in their medical status; (2) to extend the validity period of their driver's license; (3) to request a new driver's license category; or (4) because of a mandated referral by medical experts, courts, or insurance companies. CARA is the only official entity in Belgium to make decisions about fitness-to-drive and car adaptations [18]. The CARA database contains individual's demographic, clinical, and medical information collected from CARA in Brussels and 46 CARA clinical hubs across Belgium. We excluded individuals without a comprehensive fitness-to-drive decision record, and used the 2013 records when the individual revisited CARA in 2014.

The study ethics was approved by the Institutional Review Board of the University of Kansas Medical Center.

### **Age group**

Individuals were categorized into four age groups: 55 to 64 (middle-aged); 65 to 74 (young-old); 75 to 84 (old-old); and 85 and older (oldest-old). We adopted the definition of the World Health Organization and other governmental organizations to describe the oldest-old [19-21].

### **Fitness-to-drive procedure**

Fitness-to-drive was assessed through a two-tier legal procedure [22]. The first tier involved an appraisal by referring physicians (e.g., primary care physician). Individuals with medical conditions that may adversely affect driving were obliged to discuss their wish to

continue driving to a physician of choice. This physician might appraise the fitness-to-drive or might seek assistance from doctor-specialists or the CARA center. If drivers showed any functional deficits known to affect driving, they were obliged to seek a fitness-to-drive advice from CARA (second tier). During this first-tier procedure, the individual and the referring physician filled out a driving referral form of demographic (e.g., age, sex, etc.), medical (e.g., primary diagnosis, presence of comorbidities, etc.), and driving (e.g., numbers of MVCs and traffic violations) information.

In the second tier, the CARA team of occupational and physical therapists with expertise in on-road evaluation, neuropsychologists, and physicians conducted a comprehensive fitness-to-drive evaluation consisting of medical, visual, and on-road evaluations. When the medical referral form indicated that there were psychiatric or cognitive complaints, individuals were also evaluated by neuropsychologists. Of note, driving evaluation procedures varied depending on individual's medical condition, but always included a practical on-road evaluation and basic visual sensory screen conducted by trained occupational therapists or physical therapists. Each on-road evaluation course was standardized and included segments of residential driving and urban driving.

### **Driving safety outcome measures**

The study used four main outcome measures for driving safety: (1) first-tier fitness-to-drive recommendation by referring physician; (2) final-tier comprehensive fitness-to-drive decision by CARA; (3) number of self-reported MVCs in the past five years; and (4) number of self-reported traffic violations in the past five years.

For fitness-to-drive recommendation and comprehensive decision, referring physicians and CARA team used the same three-class categorization: (1) fit-to-drive without restrictions; (2) fit-to-drive with restrictions; and (3) unfit-to-drive. Restrictions included time (e.g., no night-time driving), speed (e.g., no highway driving), or distance (e.g., driving in limited area only). For analysis purpose, we dichotomized the three-class categorization into ‘fit-to-drive’ (continue to drive with or without restrictions) or ‘unfit-to-drive’, similar to our previous work [17].

### **Categorization of medical conditions**

The primary medical condition was defined as the principal diagnosis that individuals and their referring physicians reported on their driving referral form. These medical conditions were classified into ten different medical categories: (1) neurological conditions (e.g., stroke, multiple sclerosis, etc.) (Supplementary Table 1); (2) psychiatric conditions (e.g., psychotic disorder, schizophrenia, etc.); (3) musculoskeletal conditions (e.g., amputation, fracture, etc.); (4) visual conditions (e.g., cataract, glaucoma, etc.); (5) vestibular or hearing conditions (e.g., loss of balance, etc.); (6) cardiovascular or pulmonary conditions (e.g., hypertension, atrial fibrillation, etc.); (7) liver or renal conditions (e.g., renal insufficiency, etc.); (8) sleep disorders (e.g., sleep apnea, etc.); (9) diabetes mellitus; and (10) substance abuse (e.g., alcohol, cannabis, etc.). The categorization criteria were adopted from the National Highway Traffic Safety Administration of the US Department of Transportation [23] and other classifications [24,25].

### **Statistical analysis**

Kolmogorov-Smirnov test was used to assess the normality. Kruskal-Wallis tests (KW) or chi-squared tests ( $\chi^2$ ) were utilized for group comparisons with an alpha level at 5%.



Bonferroni correction for multiple comparisons ( $p = 0.008$  or  $0.05/6$ ) was used for post-hoc tests including Mann-Whiney U tests and  $\chi^2$ .

To investigate the effect of age on driving safety outcomes, odds ratios (ORs) and 95% confidence intervals (CIs) were calculated using separate logistic regression models for each of the four main outcome measures. The middle-aged (55 to 64 years old), which was closest to the median age (55 years old) of the entire CARA database [17], was used as a reference group in each model.

The agreement between physician's recommendation of fitness-to-drive and comprehensive fitness-to-drive decision was calculated using the prevalence- and bias-adjusted kappa (PABAK). The interpretation of PABAK followed Landis and Koch's interpretation [26]. Substantial agreement reflected PABAK between 0.61 and 0.80. Almost perfect agreement reflected PABAK between 0.81 and 1.00.

Statistical analyses were conducted using SPSS 23 (IBM Corp., Armonk, NY) and SAS Enterprise Guide 6.1 (SAS Institute Inc., Cary, NC).

## **Results**

### **Demographic and medical characteristics**

Among 6,584 individuals who visited CARA for a driving evaluation between 2013 and 2014, 3,425 individuals were aged 55 and older (Table 1). Among those, 40% were middle-aged ( $n = 1,386$ ), followed by 30% young-old ( $n = 1,013$ ), 23% old-old ( $n = 803$ ), and 7% oldest-old ( $n = 223$ ). The age range of the oldest-old was from 85 to 95 years old. In all groups, males represented the majority, representing more than 70% of the database. The percentage of males in the young-old and old-old were significantly higher compared with the middle-aged (post-hoc

$p < 0.008$ ). Individuals were mostly referred to CARA to extend their driver's license, followed by change in medical conditions, mandated referral, and request for a new driver's license. Of particular importance was the significantly high percentage of old-old ( $n = 178$ ; 26%) and oldest-old ( $n = 41$ ; 22%) who were mandated by court, law enforcement, medical experts, or insurance companies to seek a fitness-to-drive evaluation (post-hoc  $p < 0.008$ ). Moreover, insurance companies referred significantly more individuals in the old-old and oldest-old, while those in the middle-aged and young-old were primarily referred by medical experts ( $\chi^2 = 61.32$ ;  $p < 0.001$ ).

The distribution of primary medical conditions significantly differed across age groups ( $p < 0.001$ ) (Table 1). The oldest-old showed a significantly lower percentage of neurological conditions than the old-old and middle-aged (post-hoc  $p < 0.008$ ). Per cardiovascular or pulmonary conditions, the oldest-old had a significantly higher percentage than other age groups (post-hoc  $p < 0.008$ ). Per visual conditions, the percentage in the oldest-old was the highest among all groups (post-hoc  $p < 0.008$ ). The percentage of musculoskeletal conditions was not significantly different across groups. The results of the post-hoc analyses are shown in Table 1.

Although the proportions of medical conditions across groups were significantly different, neurological conditions represented the major medical category that made individuals referred for a driving evaluation. To illustrate, stroke was the most common neurological condition across all age groups. The second most common neurological condition in the middle-aged and young-old groups was multiple sclerosis, whereas it was dementia including Alzheimer's dementia in the old-old and oldest-old groups. Parkinson's disease was the third most common disease in the young-old and old-old groups (Supplementary Table 1).

### **Fitness-to-drive, MVCs, and traffic violations across age groups**

Overall, most drivers were safe drivers. For all groups, more than 80% of drivers were considered fit-to-drive according to physicians or CARA (Figure 1). Yet, the fit-to-drive rate of physician's recommendation and comprehensive decision by CARA decreased with advancing age (both  $p < 0.001$ ) (Figure 1). Physicians judged 93% of individuals in the oldest-old as fit-to-drive, which was considerably lower compared with the fit-to-drive rate of the middle-aged (98%) and young-old (98%) (post-hoc  $p < 0.008$ ). Likewise, the CARA team judged a significantly lower percentage of oldest-old (81%) as fit-to-drive compared with the middle-aged (92%) and young-old (91%) (post-hoc  $p < 0.008$ ). No significant differences between oldest-old and old-old groups were observed in physician's recommendation and comprehensive fitness-to-drive decisions (Figure 1).

The oldest-old (30%) and old-old (26%) reported significantly more MVCs in the past five years compared with the middle-aged (13%) and young-old (13%) (post-hoc  $p < 0.008$ ) (Figure 1). The number of traffic violations did not differ between age groups ( $p = 0.88$ ).

Logistic regression models were employed for each outcome measure. Significant ORs and CIs were noted in the following ( $p < 0.05$ ):

Per the physician's fitness-to-drive recommendation, an increase of one decade in the oldest-old increased the odds of being declared unfit-to-drive with 4.47 (95% CI 2.20-9.10) compared with the middle-aged. Likewise, the odds of being declared unfit-to-drive by the physician was 2.09 (95% CI 1.16-3.98) times greater than the middle-aged.

A similar pattern was observed for the comprehensive decision. Compared with the middle-aged, the odds of being declared unfit-to-drive was 2.74 (95% CI 1.87-4.03) in the oldest-old and 1.82 (95% CI 1.38-2.41) in the old-old.

The odds of MVC also increased with advanced age. Compared with the middle-aged, the OR of MVC in the oldest-old was 2.79 (95% CI 1.88-4.12) and 2.35 (95% CI 1.81-3.05) in the old-old. No differences in OR were observed for traffic violations.

The oldest-old also differed from the old-old regarding driving safety outcomes. Compared to the old-old, the odds of being declared unfit-to-drive in the oldest-old was 2.13 (95% CI 1.06-4.27) by the referring physician and 1.51 (95% CI 1.02-2.22) by the CARA team.

### **Agreement between physician's fitness-to-drive recommendation and comprehensive fitness-to-drive decision**

Across all groups, the agreement between physician's recommendation and comprehensive fitness-to-drive decision was substantial to almost perfect (Table 2). Yet, the percentage of agreement decreased with aging. The percentage of agreement was the lowest in the oldest-old.

Of all disagreed cases, referring physicians were more likely to issue a favorable fitness-to-drive recommendation compared with the comprehensive fitness-to-drive decision. The percentage of overestimation by referring physicians ranged from 85% in the old-old to 91% in the oldest-old and young-old. The PABAK agreement between referring physicians and CARA assessors decreased with advanced age. The agreements in the oldest-old (PABAK = 0.72, 95% CI 0.66-0.79) and old-old (PABAK = 0.78, 95% CI 0.74-0.81) were only substantial, whereas those in the young-old (PABAK = 0.86, 95% CI 0.83-0.89) and middle-aged (PABAK = 0.88, 95% CI 0.85-0.91) were almost perfect (Table 2).

## **Discussion**

This study investigated driving safety in the older population in a medical fitness-to-drive setting with a special focus on the oldest-old aged 85 and older. The main findings include: (1) the oldest-old are a distinct and unique group of drivers who not uncommonly had medical conditions that affect driving safety; (2) advanced age negatively affects several outcomes of driving safety; and (3) advanced age negatively affects fitness-to-drive agreements between referring physicians and driving evaluation specialists.

The oldest-old reported more cardiopulmonary and visual conditions compared with any other age group, yet they also presented fewer neurological conditions compared to the old-old. Although this results seem counterintuitive, it is likely that adults with neurological conditions cease driving prior to 85 years old. Neurological conditions impair motor, visual, and cognitive abilities and may be accompanied with comorbidities that can directly impact their fitness-to-drive [27]. In addition, it is possible some of the oldest-old could have neurological diseases such as dementia, but were either not diagnosed or lacked insight into their presence [28]. Meanwhile, the percentage of cardiopulmonary and visual conditions increased with aging, suggesting older adults continued to drive with these conditions. For instance, nearly half of the cardiovascular conditions in this database were hypertension or fibrillation [17]. These conditions, in the absence of serious or major complications, may not affect motor and cognitive skills needed to drive safely, even in the oldest-old. Likewise, mild visual conditions such as reduced visual acuity may be remediated using corrective glasses. Mild visual field defects do not preclude safe driving either since drivers can be taught to use panoramic mirrors, compensatory head and eye scanning, or other driving strategies [16]. It is also possible that oldest-old drivers were more likely to be referred to CARA because of age-related comorbidity other than neurological conditions.

Despite the majority of older individuals with medical conditions being safe drivers, advanced age reduced their fitness-to-drive. Individuals with advanced age were more likely to receive unfit-to-drive decisions by referring physicians and driving evaluation specialists. The oldest-old showed greater odds of being declared unfit-to-drive by their physician and CARA team compared with the old-old. Decreased fitness-to-drive and higher risks of unsafe driving in older adults were also reported in previous studies [29,30]. Furthermore, we found that the oldest-old and old-old age groups reported more MVCs than other age groups. Since this study lacked data on population numbers or mileage, comparisons with studies that investigated the impact of aging on crash rates per population or per miles traveled is not possible. Tefft's study [31] found that the crash rate per miles traveled in older age groups (60 and above) decreased with advanced age whereas the crash rate per population increased with aging. Future studies need to investigate relative crash rates per population or per miles traveled to compare how older population with medical conditions differs from general older population.

Percentage agreements between fitness-to-drive decisions by referring physicians and driving evaluation specialists at CARA decreased from 92% in the middle-aged to 82% in the oldest-old. In previous studies involving neurological conditions, the percentage agreements were 43% in individuals with Alzheimer's disease [32], 64% in Parkinson's disease [33], 73% in stroke [34], and 88% in multiple sclerosis [35]. In these past studies, the percentage agreement decreased with reduced fit-to-drive rates on comprehensive fitness-to-drive decisions. Likewise, the reduced fitness-to-drive in the oldest-old may have resulted in more disagreement between the medical and comprehensive fitness-to-drive recommendations. Another study suggested age-related bias of driving evaluation specialists may result in the increased percentage of negative fitness-to-drive decisions [9]. Referring physicians were more likely to overestimate the fitness-

to-drive, which was consistent with previous studies suggesting that physicians are hesitant to give an unfavorable recommendation due to fear of harming the doctor-patient relationship [36], ambiguous fitness-to-drive criteria [36], and potential lawsuits [37]. Awareness of these factors implies a need to develop more objective and clinician-friendly tools for fitness-to-drive evaluation.

The main strength of this study is the comparison of four real-world outcomes of driving safety in older adults with medical conditions, including more than 200 drivers aged 85 and above. In addition, we did not employ stringent inclusion and exclusion criteria to obtain the representative sample of older adults with medical conditions that interfered with driving. Thus, the group of older individuals studied in this study was inherently heterogeneous in their medical diagnosis, comorbidities, reasons for referral, and their performance on on-road and off-road testing.

The main limitation of the study includes a number of missing variables, inherent in a retrospective study design. However, the separate analysis of the oldest-old drivers provides a unique view on how advanced age affects driving safety. In addition, this study focused on older adults with medical conditions referred to driving evaluation, which may reduce the generalizability of the results to general population. The results of practical driving evaluation could be biased since the on-road assessors might not be blinded to patient's medical condition or other assessment at CARA. However, this may not cause a confounding result since the comprehensive fitness-to-drive decision was decided under consideration of all aspects of in-office and on-road assessments at CARA. Also, we found that insurance companies were more likely to refer individuals aged 75 and older compared with younger individuals, which needs to be confirmed by comparing insurance policies across different age groups. Insurance companies

in other countries may not have similar approaches in pursuing fitness to drive evaluations and thus, may also limit the generalizability of these findings.

Our findings call for particular attention to treat the oldest-old as a separate entity from the old-old with specific medical conditions that challenge their fitness-to-drive. Physicians, healthcare providers, and policymakers need to be particularly vigilant to the driving safety of the oldest-old, since they are the fastest growing segment of the aging population [38] and their increased frailty often leads to fatal injuries when MVCs occur [11]. To fully understand the effect of advanced age on driving outcomes, longitudinal studies are warranted to evaluate visual, cognitive, and motor predictors of fitness-to-drive in the oldest-old. Also, the oldest-old may have a unique combination of comorbidities, which can be an important factor affecting fitness-to-drive [34]. Future studies should examine the effect of comorbidities on driving safety using standardized comorbidity scales (e.g., Cumulative Illness Rating Scale for geriatrics and Charlson Comorbidity Index) [39], which will provide additional insights on the role of comorbidities in driving safety [40]. This study utilized self-reported MVC and traffic violation records, which might cause an underestimation of the actual numbers. However, police or insurance-reported MVC records might also be underreported since minor MVCs are often unreported [41]. Lastly, our findings regarding traffic violations may not be generalizable to other countries with different traffic regulations and enforcement levels, since we used data collected in Belgium.

This population-based study investigated driving safety in the older population with medical conditions. The majority of older adults were safe drivers, yet the risk of unsafe driving increased with advanced age. The oldest-old are a unique group of drivers with medical conditions that may affect their driving safety.



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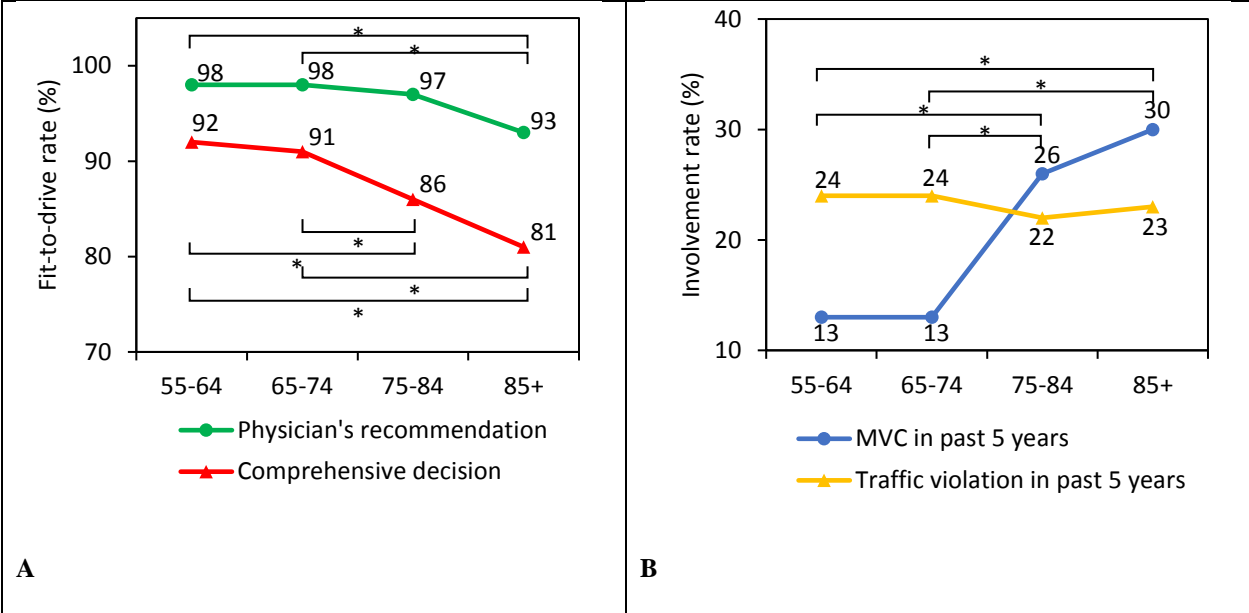
Table 1. Comparison of demographic and medical characteristics across age groups

Variable <sup>a</sup>	Age group <sup>b</sup>				p value (Statistical test)	Post-hoc test (p < 0.008)
	55-64 (n = 1,386)	65-74 (n = 1,013)	75-84 (n = 803)	85+ (n = 223)		
<b>Demographic characteristics</b>						
Age, y	59 (57-62)	69 (66-71)	79 (77-82)	87 (86-89)	< 0.001 (KW)	MA<YO, MA<OO, MA<ODO, YO<OO, YO<ODO, OO<ODO
Sex, male, n	980 (71)	780 (77)	630 (78)	174 (78)	< 0.001 ( $\chi^2$ )	MA<YO, MA<OO
Reason for application, n						
Change in medical condition	461 (39)	297 (35)	198 (29)	47 (25)	< 0.001 ( $\chi^2$ )	MA>OO, MA>ODO
Extension of driver's license	552 (46)	432 (50)	279 (42)	100 (53)		YO>OO, YO<ODO
New driver's license	18 (2)	14 (2)	17 (3)	1 (0)		None
Mandated referral <sup>c</sup>	160 (13)	114 (13)	178 (26)	41 (22)		MA<OO, MA<ODO, YO<OO, YO<ODO
<b>Medical characteristics</b>						
Primary medical condition, n						
Neurological	1078 (78)	811 (80)	553 (69)	119 (54)	< 0.001 ( $\chi^2$ )	MA>OO, MA>ODO, OO>ODO
Psychiatric	40 (3)	12 (1)	16 (2)	9 (4)		MA>YO, YO<ODO
Musculoskeletal	162 (12)	97 (10)	73 (9)	20 (9)		None
Visual	14 (1)	7 (1)	33 (4)	20 (9)		MA<OO, MA<ODO, YO<OO, YO<ODO, OO<ODO
Vestibular or hearing	1 (0)	2 (0)	2 (0)	3 (1)		MA<ODO
Cardiovascular or pulmonary	34 (2)	32 (3)	90 (11)	42 (19)		MA<OO, MA<ODO, YO<OO, YO<ODO, OO<ODO
Liver or renal	6 (0)	3 (0)	7 (1)	1 (0)		None
Sleep	8 (1)	4 (0)	4 (1)	2 (1)		None
Diabetes mellitus	34 (2)	37 (4)	23 (3)	6 (3)		None
Substance abuse	7 (1)	8 (1)	2 (0)	1 (0)		None
Presence of comorbidity, n						
Yes	624 (45)	527 (52)	454 (57)	115 (52)	< 0.001 ( $\chi^2$ )	MA<YO, MA<OO
No	762 (55)	486 (48)	349 (43)	108 (48)		
Values are presented as median (Q1-Q3) or frequency (%). Abbreviation: $\chi^2$ = chi-squared test; KW = Kruskal-Wallis test; MVC = motor vehicle crash. <sup>a</sup> Missing variable: reason for application (n = 516). <sup>b</sup> Age group: 55-64 = middle-aged; 65-74 = young-old; 75-84 = old-old; 85+ = oldest-old. <sup>c</sup> Mandated referral (insurance / medical expert / court or law enforcement): middle-aged (26% / 69% / 5%); young-old (23% / 71% / 6%); old-old (77% / 22% / 1%); oldest-old (82% / 18% / 0%).						

Table 2. Agreements between fitness-to-drive decisions by the referring physicians and the driving evaluation specialists at CARA

Age group <sup>a</sup>	Agreement, n (%)	Disagreement, n (%)		PABAK	95% CI	<i>p</i> value
		Overestimation <sup>b</sup>	Underestimation <sup>c</sup>			
55-64	1163 (92)	90 (89)	11 (11)	0.88	0.85-0.91	< 0.001
65-74	854 (91)	79 (91)	8 (9)	0.86	0.83-0.89	< 0.001
75-84	596 (85)	89 (85)	8 (15)	0.78	0.74-0.81	< 0.001
85+	151 (82)	31 (91)	10 (9)	0.72	0.66-0.79	< 0.001

<sup>a</sup> Age group: 55-64 = middle-aged; 65-74 = young-old; 75-84 = old-old; 85+ = oldest-old.  
<sup>b</sup> Overestimation: the referring physician judged a driver fit-to-drive, but the driver received unfit-to-drive decision by the driving evaluation specialists at CARA.  
<sup>c</sup> Underestimation: the referring physician judged a driver unfit-to-drive, but the driver received fit-to-drive decision by the driving evaluation specialists at CARA.



(A) Fit-to-drive rate in physician's fitness-to-drive recommendation and comprehensive fitness-to-drive recommendation across age groups. (B) Involvement rate in MVCs and traffic violations in the past 5 years across age groups.

Abbreviation: MVC = motor vehicel crash.

Age group: 55-64 = middle-aged; 65-74 = young-old; 75-84 = old-old; 85+ = oldest-old.

Missing variables: physician recommendation (n = 334); MVC in past 5 years (n = 1011); and traffic violation in past 5 years (n = 973).

\*Post-hoc analysis ( $p < 0.008$ ):

- Physician's fitness-to-drive recommendation (MA>ODO, YO>ODO).
- Comprehensive fitness-to-drive recommendation (MA>OO, MA>ODO, YO>OO, YO>ODO).
- MVC in the past 5 years (MA<OO, MA<ODO, YO<OO, YO<ODO).
- Traffic violation in the past 5 years (not significant).

Figure 1. Outcomes of unsafe driving across age groups