ISSN: 2378-346X

Levecq et al. Int J Ophthalmol Clin Res 2017, 4:079
DOI: 10.23937/2378-346X/1410079
Volume 4 | Issue 4
Open Access

International Journal of
Ophthalmology and Clinical Research

RESEARCH ARTICLE

Visual Acuity, Visual Field, and Factors Influencing Automobile Driving Status in One-Thousand Subjects Aged 18 to 59 Years

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Abstract

Objective: To evaluate the number of people driving in accordance with European legal driving requirements, measured as far binocular visual acuity and the binocular visual field, to identify variables associated with driving habits that do not meet legal standards.

Methods: Subjects aged 18 to 59 years were recruited at a tertiary referral center. Far visual acuity was measured with the modified ETDRS charts, and defined as equal as or better than 0.3 logMAR units. The visual field was evaluated using the binocular Estermans test, and defined as normal/complying if the horizontal visual field was at least 120°; the extension was at least 50° to the left and to the right, and 20° up and down; and if no defects were present within a radius of the central 20°.

Details of demographic and socioeconomic characteristics were obtained from all of the participants by using questionnaires.

Results: One thousand subjects were enrolled in the study, of which 883 were current drivers. Among the 883 current drivers, 849 (96.1%) had both a far binocular visual acuity equal or better than 0.3 logMAR units and a normal field of view, while 34 (3.9%) did not meet these requirements. A logistic regression was performed to identify the variables statistically associated with the practice of driving among licensed drivers who did not meet the minimal visual requirements. This revealed that a non-recent ophthalmology examination ($p = 0.002$), and not having an acquaintance to drive them ($p = 0.014$) were influencing factors.

Conclusions: In our study, 81% of the subjects aged 18 to 59 years were driving, of whom 3.9% did not meet the European legal driving requirements that are set at equal or better than 0.3 logMAR units and a normal field of view. The variables associated with driving status were the time of the most recent examination, and not having an acquaintance to drive them.

Keywords

Visual acuity, Visual field, Legal driving, Vision impairment

Introduction

Driving is a complex visual task, involving several visual sensory functions [1]. Because vision testing is required to obtain a driver's license in most countries, many licensing authorities throughout the world use vision tests to measure driving fitness. However, it is not certain that these simple strategies accurately assess the skills required to drive safely [2]. Moreover, there is no agreed standard within or among countries regarding the level of visual acuity that is required. The common standard threshold used for visual acuity is 0.3 logMAR units, but this threshold varies from one country to the next [3]. In regard to the specific requirements for the field of view, there is also considerable variation from one country to the next [1].

In Europe, the legal driving requirements state that applicants for a driver's license or for the renewal of such a license must have a binocular visual acuity, with corrective lenses, if necessary, of at least 0.3 logMAR units when using both eyes together [4]. Moreover, the

Citation: Levecq L, Safi A, Jamart J, De Potter P, Oustabassidis E, et al. (2017) Visual Acuity, Visual Field, and Factors Influencing Automobile Driving Status in One-Thousand Subjects Aged 18 to 59 Years. Int J Ophthalmol Clin Res 4:079. doi.org/10.23937/2378-346X/1410079

Received: June 14, 2017: **Accepted:** October 16, 2017: **Published:** October 18, 2017

horizontal visual field should be at least 120°; the extension should be at least 50° to the left and to the right, and 20° up and down. No defects should be present within a radius of the central 20° [4].

The aim of this prospective observational study was to evaluate the number of people driving in accordance with common legal standards, measured as binocular visual acuity over 0.3 logMAR units and a normal field of view; and to identify the main variables associated with driving habits that do not comply with legal standards in a population of 1000 subjects aged 18 to 59 years.

Materials and Methods

Study population

One thousand subjects aged 18 to 59 years were prospectively recruited for this observational study over a period of 8 months through visual displays (Duo Display®, 800 × 1950 mm) placed at the entrances of a tertiary care center (CHU UCL Namur, Yvoir, Belgium). The displays invited volunteers to visit the Ophthalmology Department to get a free assessment of their visual acuity and visual field as part of a scientific research study. Written informed consent was obtained from all of the participants. The principles in the Declaration of Helsinki were followed, and the Ethics Committee of CHU UCL Namur Institutional Review Board approved the study. The exclusion criteria were individuals less than 18 years of age or 60 years of age and over, subjects with an ophthalmic emergency, and subjects who already had an appointment for an ophthalmology examination on the same day.

Data collection

Details on demographic and socioeconomic characteristics were obtained from all of the participants by using questionnaires. The characteristics included age, gender, race, level of education (i.e. primary school or less, secondary, tertiary or higher); professional status (e.g. student, unemployed, employed, or retired); and marital status (i.e. single, a partner who drives, or a partner who does not drive). The subjects were also asked about the time of their most recent ophthalmology examination, their access to public transport (e.g. whether available or not available), their access to shops (e.g. whether accessible or not without a car), and their reliance on acquaintances (e.g. family, friends, or neighbors) to drive them places (e.g. whether available or not available). They were also asked if they had noticed any central vision impairment (i.e. noted or not noted) or peripheral vision impairment (i.e. noted or not noted). Lastly, the participants were questioned in regard to their driving habits (e.g. non-driving, current driver, or past driver). If they had stopped driving, they were asked to provide the main reason for doing so (e.g. impaired vision or other cause).

Tests of visual function

Monocular and binocular visual acuity was measured by an ophthalmologist with the modified Early Treatment Diabetic Retinopathy Study charts (Light House Low Vision Products, New York, NY) (logarithm of the minimum angle of resolution [logMAR] unit) at a distance of 4 meters. Visual acuity measurements were performed under optical correction if the subject wore glasses for far-sighted vision. Visual acuity impairment was defined as a binocular visual acuity lower than 0.3.

The binocular field of view was tested by using the binocular Esterman visual field test with a static automated perimeter (Humphrey Field Analyzer 750i, Humphrey Instruments, Dublin, CA, USA). The test examines more than 130° of visual field, and it consists of a grid of 120 test points. Each location is tested once, in a suprathreshold manner, with a Goldmann size III white stimulus at an intensity of 10 dB. Missed points are retested, with a second negative response resulting in a recorded defect at that point. Stability of fixation is monitored indirectly by a perimetrist's observation. A score is generated from the Humphrey software ranging from 0% to 100%, based on the percentage of the 120 test points that were detected correctly during binocular visual field testing in which the patient uses both eyes.

Visual field impairment was defined as the presence of a field of view that did not reach 120° horizontally, 50° to the left and to the right, and 20° up and down, and/or impairment in the central 20°.

Visual function impairment was defined by the presence of either vision impairment or visual field impairment or both, rendering the subject unfit to drive an automobile in accordance with current European requirements for driving a light vehicle.

For subjects with visual function impairment, a complete ophthalmology examination including slit-lamp examination, funduscopy with pupillary dilatation, and eye pressure measurement was conducted by an ophthalmologist so as to probe for a specific cause for the incapacitation. Automated refractometry and subjective refraction were also performed so as to determine whether the best visual acuity remained less than 0.3.

Statistical analysis

Numerical variables were expressed as the mean ± standard deviation, and they were compared with the Wilcoxon rank sum test. Categorical and ordinal parameters were compared with the Chi-square test or the Cochran test, respectively. The simultaneous influence of various parameters on the practice of driving among licensed drivers who did not meet minimal visual requirements was studied by logistic regression with forward selection of variables by likelihood ratio tests, and expressed as Odds Ratios (ORs). All tests were two-tailed. A p-value lower than 0.05 was considered statistically significant. The analyses were performed with the SPSS 15.0 software (SPSS Inc., Chicago, IL).

Table 1: Characteristics of the one thousand individuals aged 18 to 59 years.

Characteristics	Overall (n = 1000)	Drivers (n = 883)	Non-drivers (n = 117)	p-value
Males, n (%)	404 (40.4)	360 (40.8)	44 (37.6)	NS
Caucasians, n (%)	980 (98)	867 (98.2)	113 (96.6)	NS
Age groups (in years), n (%)				< 0.001
18-29	254 (25.4)	203 (23)	51 (43.6)	
30-39	159 (15.9)	144 (16.3)	15 (12.8)	
40-49	264 (26.4)	239 (27.1)	25 (21.4)	
50-59	323 (32.3)	297 (33.6)	26 (22.2)	
Mean patient age (years ± SD)	40.8 ± 12.6	41.5 ± 12.2	35.1 ± 14	< 0.001
Education level, n (%)				< 0.001
Primary or less	31 (3.1)	25 (2.8)	6 (5.1)	
Secondary	332 (33.2)	268 (30.4)	64 (54.7)	
Tertiary of higher	637 (63.7)	590 (66.8)	47 (40.2)	
Employment status, n (%)				< 0.001
Student	127 (12.7)	87 (9.9)	40 (34.2)	
Never worked	182 (18.2)	138 (15.6)	44 (37.6)	
Worker	638 (63.8)	607 (68.7)	31 (26.5)	
Retired	53 (5.3)	51 (5.8)	2 (1.7)	
Marital status, n (%)				NS
Single or without a partner who drives	393 (39.3)	341 (38.6)	52 (44.4)	
With a partner who drives	607 (60.7)	542 (61.4)	65 (55.6)	
Time interval between last ophthalmological examination and the study visit (in years)				NS
< 1	244 (24.4)	210 (23.8)	34 (29)	
> 1 and < 5	400 (40)	356 (40.3)	44 (37.6)	
> 5	356 (35.6)	317 (35.9)	39 (33.4)	
Far vision corrective lenses, n (%)	480 (48)	430 (48.7)	50 (42.7)	NS
Access to public transport, n (%)	745 (74.5)	648 (73.4)	97 (82.9)	0.026
Resort to acquaintances, n (%)	839 (83.9)	744 (84.2)	95 (81.2)	NS
Access to shops, n (%)	686 (68.6)	607 (68.7)	79 (67.5)	NS
Self-reported central vision impairment, n (%)	249 (24.9)	199 (22.5)	50 (42.7)	< 0.001
Self-reported peripheral vision impairment, n (%)	37 (3.7)	26 (2.9)	11 (9.4)	< 0.001
Mean visual acuity (logMAR units ± SD)				
Right eye	0.05 ± 0.70	0.05 ± 0.70	0.07 ± 0.48	NS
Left eye	0.04 ± 0.71	0.04 ± 0.78	0.08 ± 0.50	0.004
Binocular	0.02 ± 0.84	0.02 ± 0.90	0.06 ± 0.65	< 0.001
Esterman visual field score	96%	97%	88%	< 0.001
Visual field impairment, n (%)	13 (1.3)	7 (0.8)	6 (5.1)	< 0.001
Visual function impairment, n (%)	53 (5.3)	34 (3.9)	19 (16.2)	< 0.001

NS: Not Significant.

Results

One thousand subjects (596 women and 404 men) were enrolled in the study over a period of 8 months between January 2016 and August 2016. The mean age was 40.8 ± 12.6 years (median: 43 years; range: 18-59 years), of whom 883 were current drivers (Table 1). When comparing drivers and non-drivers, the non-drivers were more likely to be younger, have a lower level of education, and were less engaged in the work force. They had more access to public transport. Non-drivers were also more likely to self-report visual acuity and visual field impairments. The non-drivers also had lower measured levels of visual acuity, a field of view that was altered more, and they tended to more often not meet the legal requirements. Lastly, there was no difference between the two groups in terms of gender, race, marital status, time interval between their last ophthalmology examination and the study visit, wearing of glasses for far-sightedness, resorting to acquaintances, or with being able to access shops.

A logistic regression revealed that the variables statistically associated with the practice of driving were being older ($p < 0.001$), a higher level of education ($p < 0.001$), a higher professional status ($p = 0.002$), a lack of shared transport ($p = 0.002$), awareness of impaired visual function ($p < 0.001$), and a level of vision that meets the legal requirements ($p < 0.001$).

Among the 117 non-drivers, 81 (69.2%) never drove, 18 (15.4%) stopped driving due to their impaired vision, and 18 (15.4%) stopped driving for other reasons.

Table 2: Characteristics of 883 car drivers aged 18 to 59 years.

Characteristics	Total (n = 883)	Drivers meeting visual function requirements (n = 849)	Drivers not meeting visual function requirements (n = 34)	p-value
Males, n (%)	360 (40.8)	339 (39.9)	21 (61.8)	0.011
Caucasians, n (%)	867 (98.2)	836 (98.5)	31 (91.2)	< 0.001
Age groups (in years), n (%)				0.007
18-29	203 (23)	200 (23.6)	3 (6.8)	
30-39	144 (16.3)	139 (16.4)	5 (14.7)	
40-49	239 (27.1)	232 (27.3)	7 (20.6)	
50-59	297 (33.6)	278 (32.7)	19 (55.9)	
Mean patient age (years ± SD)	41.5 ± 12.2	41.3 ± 12.2	47.5 ± 10.6	0.002
Education level, n (%)				< 0.001
Primary or less	25 (2.8)	20 (2.3)	5 (14.7)	
Secondary	268 (30.4)	258 (30.4)	10 (29.4)	
Tertiary of higher	590 (66.8)	571 (67.3)	19 (55.9)	
Employment status, n (%) Student	87 (9.9)	85 (10)	2 (5.9)	NS
Never worked	138 (15.6)	130 (15.3)	8 (23.5)	
Worker	607 (68.7)	586 (69)	21 (61.8)	
Retired	51 (5.8)	48 (5.7)	3 (8.8)	
Marital status, n (%)				< 0.001
Single or without a partner drives	341 (38.6)	311 (36.6)	30 (88.2)	
With a partner who drives	542 (61.4)	538 (63.4)	4 (11.8)	
Time interval between last ophthalmological examination and the study visit (years)				0.001
< 1	210 (23.8)	209 (24.6)	1 (2.9)	
> 1 and < 5	356 (40.3)	345 (40.6)	11 (32.4)	
> 5	317 (35.9)	295 (34.7)	22 (64.7)	
Far vision corrective lenses, n (%)	430 (48.7)	412 (48.5)	18 (52.9)	NS
Access to public transport, n (%)	648 (73.4)	636 (74.9)	12 (35.3)	< 0.001
Resort to acquaintances, n (%)	744 (84.2)	734 (86.5)	10 (29.4)	< 0.001
Access to shops, n (%)	607 (68.7)	594 (70)	13 (38.2)	< 0.001
Self-reported central vision impairment, n (%)	199 (22.5)	188 (22.1)	11 (32.4)	NS
Self-reported peripheral vision impairment, n (%) Mean visual acuity (logMAR units ± SD)	26 (2.9)	23 (2.7)	3 (8.8)	0.039
Right eye	0.05 ± 0.70	0.03 ± 0.80	0.37 ± 0.56	< 0.001
Left eye	0.04 ± 0.78	0.03 ± 0.84	0.34 ± 0.63	< 0.001
Binocular	0.02 ± 0.90	0.02 ± 0.86	0.31 ± 0.60	< 0.001
Esterman visual field score	97%	98%	80%	< 0.001

NS: Not Significant.

Of the 1000 subjects, 53 (5.3%) were found to be unfit to drive an automobile based on their low level of visual acuity and their field of view. Of the 53 who were unfit, 19 (35.8%) did not drive and 34 (64.2%) continued unabated with driving.

Among the 883 current drivers, 849 (96.1%) met the legal requirements in terms of far binocular visual acuity and the field of view, while 34 (3.9%) did not meet at least one of these two criteria (Table 2). The drivers who did not meet the visual function requirements tended to be young Caucasian males, have a lower level of education, and to be without a partner or an acquaintance that could drive them. Their last ophthalmology examination was less recent. They had less access to public transport and shops, and they less often reported visual field impairment. They also had a lower level of visual acuity. There was no difference between the two groups in terms of professional status, wearing of glasses for far-sightedness, or self-reporting of poor central vision.

Of the 34 who were unfit to drive, 27 (79.4%) had a binocular visual acuity below 0.3 associated with a normal visual field and 7 (20.6%) had a binocular visual acuity below 0.3 associated with an abnormal visual field. None of them failed to meet only the visual field requirement.

We also compared the group of 34 current drivers without adequate visual function with the group of 19 former drivers without adequate visual function but who had voluntarily stopped driving due to their impaired vision (Table 3). The results of this analysis indicate that the factors influencing self-cessation of driving were a higher professional status, a recent ophthalmology examination, being able to access shops or public transport, having an acquaintance available to

Table 3: Characteristics of 53 licensed drivers, aged 18 to 59 years, who do not meet the visual function requirements.

Characteristics	Current drivers (n = 34)	Gave up driving due to visual impairment (n = 19)	p-value
Males, n (%)	21 (61.8)	10 (52.6)	NS
Caucasians, n (%)	31 (91.2)	18 (94.7)	NS
Age groups (in years), n (%)			NS
18-29	3 (6.8)	3 (15.8)	
30-39	5 (14.7)	3 (15.8)	
40-49	7 (20.6)	4 (21.1)	
50-59	19 (55.9)	9 (47.3)	
Mean patient age (years ± SD)	47.5 ± 10.6	44.6 ± 10.9	NS
Education level, n (%)			NS
Primary or less	5 (14.7)	2 (10.5)	
Secondary	10 (29.4)	8 (42.1)	
Tertiary of higher	19 (55.9)	9 (47.3)	
Employment status, n (%)			0.015
Student	2 (5.9)	5 (26.3)	
Never worked	8 (23.5)	9 (47.3)	
Worker	21 (61.8)	4 (21)	
Retired	3 (8.8)	1 (5.3)	
Marital status, n (%)			NS
Single or without a partner who drives	30 (88.2)	15 (78.9)	
With a partner who drives	4 (11.8)	4 (21.1)	
Time interval between last ophthalmological examination and the study visit (years)			< 0.001
< 1	1 (2.9)	14 (73.7)	
> 1 and < 5	11 (32.4)	5 (26.3)	
> 5	22 (64.7)	0 (0)	
Far vision corrective lenses, n (%)	18 (52.9)	9 (47.3)	NS
Access to public transport, n (%)	12 (35.3)	13 (68.4)	0.021
Resort to acquaintances, n (%)	10 (29.4)	17 (89.5)	0.001
Access to shops, n (%)	13 (38.2)	18 (94.7)	
Self-reported central vision impairment, n (%)	11 (32.4)	14 (73.7)	0.004
Self-reported peripheral vision impairment, n (%)	3 (8.8)	7 (36.8)	0.012
Mean visual acuity (logMAR units ± SD)			
Right eye	0.37 ± 0.56	0.41 ± 0.50	NS
Left eye	0.34 ± 0.63	0.45 ± 0.56	NS
Binocular	0.31 ± 0.60	0.33 ± 0.63	NS
Esterman visual field score	80%	73%	NS

NS: Not Significant.

drive them, and self-reporting acuity and visual field impairments. There was no difference between the two groups in terms of gender, race, age, level of education, marital status, wearing of glasses for far-sightedness, or visual acuity but the number of patients involved in this analysis is obviously smaller than the others.

Lastly, a logistic regression was performed to identify the variables statistically associated with the practice of driving among licensed drivers who did not meet the minimal visual requirements. This revealed that a non-recent ophthalmology examination [OR = 48, p = 0.002], and the unavailability of an acquaintance to drive them [OR = 32, p = 0.014] were influencing factors.

Of the 53 who were unfit to drive an automobile, a lack of or incorrect corrective lenses was encountered with 19 individuals (36%), a cataract in 10 individuals (18%), a diabetic retinopathy in 9 individuals (17%), a glaucoma in 5 individuals (9%), an amblyopia in 3 individuals (6%), a hereditary retinal dystrophy in 2 individuals (4%), a uveitis in 2 individuals (4%), a hereditary corneal dystrophy in 1 individual (2%), an optic neuritis in 1 individual (2%), and sequelae from trauma in 1 individual (2%).

Discussion

Because vision impairment is much more prevalent later on in adulthood, many studies of vision and driver safety and performance have focused on older adults [1]. Although many studies have reported in regard to estimates of the number of older drivers who do not meet the minimal visual requirements to drive legally, no prospective study measuring the specific number of potentially illegal drivers aged 18 to 59 years has been published to date. To our knowledge, this is the first prospective study conducted in a tertiary referral center to assess the proportion of 18 to 59-year-old drivers who meet European legal driving requirements.

Although jurisdictions throughout the world have recognized the importance of enhancing public safety on the roadways, and they have set requirements for obtaining a driver's license, in Europe only a few countries -such as Finland, Greece, Italy, Luxembourg, Spain, and Sweden- regularly perform screening for driver vision impairments [5]. Thus, in Spain for example, holders of a driving license must pass a medical test every 10 year while they are under 45 years of age, every 5 years for those between 45-70 years of age, and every 2 years for those over the age of 70 [6]. Others, such as Ireland, the Netherlands, Portugal, Switzerland, and the United Kingdom for example, perform regular vision checks only for older drivers [5,6]. Yet other countries, such as Austria, Belgium, France and Germany for example do not have regular testing [5,6]. Similarly, in the USA, each jurisdiction has different tests and requirements for minimal visual acuity standards and visual fields, and the age at which a vision test is required for a driver's license renewal ranges from 40 years of age (in Maryland) to 80 years of age (in Virginia) [3,7].

Overall, there is no common standard throughout the world for the tests performed and the level of vision required for driving [1]. Since vision is a complex sense, there is no single definition of visual function impairment. Thus, while the process of vision includes many functions, such as central resolution (visual acuity), minimal light sensitivity, contrast sensitivity, detection of motion, color perception, and peripheral vision; vision testing is often based only on visual acuity [8]. Visual acuity measures the morphoscopic sense, or the capacity of the eye to distinguish details through distance vision and near vision. On the other hand, the visual field measures the sense of space and the extent of the visual field. Visual acuity assesses central vision, while the visual field assesses peripheral vision. Steering a vehicle along a road and through intersections requires simultaneous use of both central and peripheral vision. Yet these visual tests that were originally designed for the diagnosis and monitoring of eye diseases, do not, on their own, reflect the visual complexity of the tasks involved in driving a vehicle. Indeed, other types of screening approaches, like the useful field of view, night driving capacity measurement, glare and contrast sensitivity measurement, driving simulator or actual driving conditions test may be of relevance to safe driving [1,6,7,9,10].

The useful field of view can be measured using commercially available software (Visual Awareness Research Group, Inc., Chicago, IL, USA). This measures processing speed, divided attention, and selective attention, using computer screen presentations with decreasing presentation times. The processing speed is determined by measuring the minimal presentation time required for the subject to distinguish between a truck and a car in the central field. Divided attention is determined by measuring the minimal presentation time required for the subject to distinguish between a truck and a car in the central field and to localize a peripheral car. The measurement of selective attention is similar to that for divided attention, but visual distracters are present throughout the visual field. Studies have shown that poor performance in the useful field of view task equated with an elevated risk for older drivers of having a car crash [1].

Contrast is the difference between the target and its surroundings, and contrast-sensitivity measurement differs from visual acuity measurement. Thus, visual acuity is a measure of the spatial-resolving ability of the visual system under conditions of very high contrast, whereas contrast sensitivity is a measure of the threshold contrast for seeing a target [8,11]. In this case, contrast is not kept constant during the test but is varied so that the minimum level of contrast for seeing a target can be determined. Contrast sensitivity tests can provide useful information by uncovering vision impairments that are not identifiable by visual acuity tests. Similarly, contrast sensitivity impairments are independently associated with visual performance problems, including difficulties with mobility and driving [11]. There are numerous tests for measuring contrast sensitivity, although there is no consensus in regard to a gold standard [7,12]. Furthermore, it is still unclear what level of contrast sensitivity reduction poses a risk to drivers [10].

Disability glare describes the loss of retinal image contrast as a result of intraocular light scatter or stray light. This is caused by imperfections in the optical media causing a non-uniform passage of light on its way from its source to the subject's retina [9]. It has been described as a reduction of visual acuity caused by light elsewhere in the field of vision. For example, driving during sunny days or at night in the presence of oncoming headlights, might reduce visual function while visual acuity may in fact be normal [9]. Its measurement has proven difficult despite a range of available approaches [9,12].

In a study of 2422 drivers recruited from a broad area around five European clinics, van Rijn, et al. noted the occurrence of impairment of visual functions that are not included in current standards (e.g. contrast sensitivity, glare sensitivity, and the useful field of view), at rates much higher than for visual acuity and visual field impairments [6]. Yet they acknowledge that due to a lack of standardized measurement methods and a lack of validated cut-off values, the exact level at which this occurs depends on the definition of impairment.

Furthermore, regarding driving standards across Europe, there is no difference in terms of visual acuity or visual field, as the legislation is derived from a European directive applicable in all 28 countries of the European

Union. Regarding other visual abilities, such as twilight vision, glare and contrast sensitivity, the European legislation is less clear, and it allows each country to set its own minimal requirements and tests to be performed [4].

Lastly, in our study, we focused only on visual acuity and the visual field. Our subject recruitment strategy could conceivably create a bias, as it consisted of including self-recruited subjects interested in a free ophthalmological examination, and not individuals visiting the Ophthalmology Department for a regular examination or for an emergency procedure. However, we used this approach to screen as much as possible within the general population. In addition, because data were mostly obtained by questionnaire concerning the activities or habits of an individual, there is always the possibility that the information is faulty or incorrect. Furthermore, we did not analyze individuals who self-reduced their driving habits, but only those who had ceased to drive altogether.

In the present study based on a specific population of subjects visiting a tertiary referral center and willing to care for their health, 88.3% of the 18 to 59-year-old subjects were driving, of whom 3.9% did not meet the European legal driving requirements set at equal to or greater than 0.3 and a normal visual field. The variables associated with driving status were the time that had lapsed since their last examination, and lack of an acquaintance to drive them. Lack of a recent ophthalmology examination can thus be considered to be a risk factor for driving without meeting the legal requirements.

Another prospective observational study performed with subjects 60 years of age and over that was carried out with the same recruitment conditions has already found that the lack of a recent ophthalmology examination is a risk factor associated with driving without meeting the legal requirements [13].

In our present study, among the causes for not being qualified to drive an automobile, a lack of or having incorrect corrective lenses was encountered with 19 individuals (36%). This could be related with the fact that a lack of a recent ophthalmology examination was found to be a risk factor for driving without meeting the legal requirements.

Likewise, the frequency of the unknown impaired visual acuity and the possibility of reversing the problem reported by Fournié, et al. highlights the role of ophthalmologists in screening and informing patients [5]. In their study, a lack of or having incorrect corrective lenses also constituted the main etiology for the inadequacy (34.5% of cases). However, only 100 subjects older than 60 years of age were analyzed, and all of them were recruited through the Ophthalmology Department. The values obtained can thus hardly be extrapolated to the general population.

In a study of 2422 drivers recruited from a broad area around five European clinics, van Rijn, et al. compared visual acuity of the subjects over 45 years of age with a group of subjects who were 20 to 30-years-old [6]. It was found that the level of impaired visual acuity for driving increased with age from 0.5% in the younger group (i.e. drivers aged from 20 to 30) to 5.3% in the eldest group (i.e. drivers aged 75 and older), and that in the majority of cases visual acuity after proper refraction adhered to the standard.

Nonetheless, although there are some studies in regard to the frequency and causes of impaired vision, there is no data in the literature on the number of traffic accidents secondary to uncorrected visual function impairments.

Further studies should also be performed in other countries, and involving the general population, to confirm the proportion observed and the risk factors identified here, and to assess the need to encourage drivers to have their vision tested regardless of their age.

Conclusions

The results of the present study showed that 81% of the subjects aged 18 to 59 years were driving, of whom 3.9% did not meet the European legal driving requirements. The variables associated with illegal driving status were the time of the most recent examination, and not having an acquaintance to drive them. Inappropriate or missing glasses were found to be the main etiology for the inadequacy.

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