Original Article

Assessment of Visual Functions in Night Drivers

Author's Affiliation

Fatima Aarrij

Arif Hussain

Sadam Hussain

Abdul Shakoor

Correspondence Author:

Correspondence to:
Dr. Arif Hussain
Ophthalmologist
College of Ophthalmology and
Allied Vision Sciences/ Mayo Hospital,
Lahore.

Purpose: To check the visual functions (visual acuity, visual fields, colour vision, contrast sensitivity and glare sensitivity) in people who routinely drive vehicles at night, and draw recommendation for safe driving.

Method: A cross-sectional study was conducted among people who routinely drove vehicles at night. According to personal complaints and taking full ocular and driving history, data of 55 night drivers was recorded by self-designed proforma. Visual acuity was recorded on Snellen chart, visual field by Confrontation method, color vision by Ishihara chart and contrast sensitivity with LEA number chart. Stereopsis, dominant eye determination and ocular mobility were also assessed.

Results: The result deducted from the questionnaire and proforma showed that among 55 male respondents 67% belong to young age group (31-50years) 58% have 20-25 years and 42% have driving experience in-between 5-20 years. 65% have 5-7 hours of night driving. 13% have abnormal visual acuity, 33% with some grade of color vision deficiency and 9% with constricted visual field. 8% had abnormal stereopsis and 18% drivers have sub-normal contrast sensitivity.

Conclusion: It is concluded from our survey that visual functions are strongly associated with potential skill of driving. Along with visual acuity, visual field, color vision, contrast sensitivity, and stereopsis affect the driving abilities especially at night. As by license agencies of Pakistan only visual acuity is considered as standard, but the other visual function such as visual field, color vision and stereopsis should also be evaluated to acquire a driving license. All of visual functions are equally contributors for safe driving and their assessment is imperative to avoid road traffic accidents.

Key Words: Visual functions, Night drivers

Introduction

Good visual acuity (VA) in addition to good stereopsis, normal color vision, satisfactory eye coordination and the ability to adapt to innumerable levels of illumination are essential to driver in order to avoid Road Traffic Accidents. When examining for visual functions it is essential to check for visual acuity using high contrast and good light conditions. These are essential to ensure driving safety.[1,2] Additionally, other changes in light such as the glare or low illumination often encountered during night driving are also assessed..[3,4] The drivers' visual information depends on the practical condition of the road and more accurately on the general lighting of the most hazardous spots of heavy traffic roads. In order to lessen both the frequency and severity of accidents, it is necessary to standardize the eye examination so as to include the minimum ability of the normal eye functioning.[5]

Driving in low light can become even more dangerous due to visual disturbance occurring as a result of dimness, and which in turn could make recognition of road signs, oncoming traffic and pedestrians/animals etc quite difficult. The elderly drivers often ascribe poor vision as the main barrier to their driving particularly in heavy traffic, high speed highways, long journeys and poor light conditions.[6-7] Especially, traveling in twilight (e.g. at dawn, dusk etc) even a driver having good vision may have to use all his visual faculties to their limit. These limits of adaptation to different levels of illumination, object size, contrast and color can be determined by assessing real traffic situations under numerous conditions of weather and light. In addition, characteristic distributions of luminance in the visual field of the driver and the disseminations of size and location of relevant objects can also be measured.[8]

Driving at night can become challenging due to a variety of reasons such as hazards of headlight glare of oncoming traffic, dim street-lights, and is compounded by the need to adapt quickly to different intensities of light at different areas. Conditions such as those mentioned here, particularly under the glare and dim light conditions of the roads and streets at night, make night-driving quite difficult for senior citizens who already suffer from age-related deterioration in vision.[9-10] Visual function decreases to a greater extent and at an earlier age for low contrast target and dim light conditions rather than high contrast targets and bright light conditions.

The number of accidents occurring at night time is two to four times higher than that occurring during the daytime and visual factors are the main reason for this.[12]

Methodology

A cross-sectional study was conducted among people who routinely drive vehicles at night. Sampling method was Non probability convenient, and sample size was 55 night drivers. Two methods were employed to gather data; ocular examination of the nighttime drivers and responses gathered by getting a semi-structured questionnaire filled in by them. Questions regarding overall driving experience, duration and experiences during night driving, difficulties felt by them during driving particularly those related to visual functions, color vision and contrast sensitivity, history of road traffic accidents, and knowledge on visual acuity and visual field etc. The ocular examination consisted of measuring visual acuity and general external eye examinations. Visual acuity was measured for each eye with Snellen chart at 6 metres and 40 cm. Visual acuity was checked with spectacles on if it was less than 6/12. Objective refraction was done by using streak retinoscope. Color vision was tested using Ishihara chart, while contrast sensitivity measured with LEA number chart. Visual field recorded with confrontation method, stereopsis grossly measured with Lang pensile test. Ocular dominancy and ocular movements were also checked. All data was entered and analyzed using Statistical Package for Social Science (SPSS 22.00).

Results

Table 1: Duty hours of night drivers

Duty Hours	Frequency	Percent
5 - 7 hours	36	65.5
7 - 10 hours	19	34.5
Total	**55**	**100**

65.5% of all participant drivers had night duty hours of 5-7 hours, and 34.5% drivers had a duty of 7-10 hours of night.

Table 2: Distance visual acuity

Visual acuity	Frequency	Percent
Normal	48	87.3
Defective	7	12 .7
Total	**55**	**100**

Table 2 depicts that 7/55 (almost 13%) of the night time drivers had defective visual acuity

Table 3: Color vision

Color vision	Frequency	Percent
Defective	18	32.7
Normal	37	67.3
Total	**55**	**100**

Table 3 shows that almost a third (33%) of subjects were

having defective color vision.

Table 4: Contrast sensitivity

Contrast Sensitivi	Frequency	Percent
Decreased	10	18.2
Normal	45	81.8
Total	**55**	**100.0**

10/55 (18%) of the total subjects had decreased contrast sensitivity.

Table 5: Visual field

Visual Field	Frequency	Percent
Constricted	5	9.1
Non - constricted	50	90.9
Total	**55**	**100**

A total of 5/55 subjects (9%) had constricted visual field.

Discussion

It may be almost impossible to imagine life without an automobile these days. In some countries travelling by some sort of motor vehicle has indeed become the main mode of transport. However, while doing this we are unaware of extensive impact of driving on our health and well-being. According to Cynthia Owsley controlling a vehicle is a high visual task involving visual sensory functions; such as visual acuity, light sensitivity, and contrast sensitivity. Driving goes beyond visibility issues and involves time sensitive gathering of visual information used to support decision making and motor activity. Controlling a vehicle involves simultaneous use of central and peripheral visual field. As the vehicle moves visual world change rapidly.[13] We have examined a little sample of 55 night drivers, as driving is a difficult task but it become more risky when luminance is low especially at night. Most of the driver can't fulfill the inclusive criteria, so it was too much difficult to collect data.

We selected those drivers, who drive minimum 5 and maximum 10 hours of night. Questions were asked to detect their sleepiness and tiredness during driving. Most of them had potential to remain attentive and alert during the whole hours of their shift. Visual acuity is most important visual function, having direct impact on driving ability. 13% of night drivers had defective distance visual acuity. This percentage was high because we checked presenting visual acuity without refractive correction. 13% defective distance visual acuity was greater than 4% visual defect presented in the study of Samuel Bert Boadi-kusi et al.[14]

Color vision defects were significant in our results, 33% had defective color vision. Due to recessive gene of color vision, males are more prone to color vision defect and we consider this findings as normal. Other studies also found similar results; that color vision may constitute hazard to safe driving due to difficulty in identifying road signs and traffic signals.[15,16] Many other studies explained that there is no association between color vision defects and road traffic accidents.[17,18] The prevalence of color vision defects of our results was greater than that reported by Ovenseri-Ogbomo,[19] and that of Emerole in Nigeria.[20]

Visual field is another important visual function, recommended to check before issuing driver's license. In our study, out of 55 night drivers 9% had visual field defect. Both the central and peripheral visual fields should be normal for driving. In most of countries 20˚-30˚ of fixation above or below horizontal meridian is considered as normal for obtaining a driver's license. Oladehinde, et al, however, found that there is no significant association between visual field defects and road traffic accidents.[21] Burg evaluated the relationship of visual field defects and road traffic accidents.[22,23] However, despite these differences visual field should be evaluated to acquire a driving license.

18% (n=10) of night drivers had defective contrast sensitivity. Contrast sensitivity along with stereopsis has significant impact to recognize different signs and speed-breakers. Abnormal contrast sensitivity may cause glare, which is a substantial risk factor for driving at night.

Conclusion

It is concluded from our survey, visual functions are strongly associated with potential skill of driving. Along with visual acuity, visual field, color vision, contrast sensitivity, and stereopsis affect the driving abilities especially at night. As by license agencies of Pakistan only visual acuity consider as standard, but the other visual function such as visual field, color vision and stereopsis should be evaluated to acquire a driving license. All of visual functions are equally contributor for safe driving and their assessment is imperative to avoid road traffic accidents.

References

1. Wood JM, D Alfred OW. Standard measures of visual acuity do not predict drivers' recognition performance under day or night conditions. Optom Vis Sci. 2005;82(1):698-705.
2. Owsley C, Stalvey BT, Wells J, Sloane ME, McGwin G. Visual risk factors for crash involvement in older drivers with cataract. Arch Ophthalmol. 2001;119(6):881-7.

3. Hertenstein H, Bach M, Gross NJ, Beisse F. Marked dissociation of photopic and mesopic contrast sensitivity even in normal observers. Graefes Arch ClinExpOphthalmol. 2016;254(2):373-84.
4. Pesudovs K, Marsack JD, Donnelly WJ, Thibos LN, Applegate RA. Measuring visual acuity-mesopic or photopic conditions, and high or low contrast letters?. J Refract Surg. 2004;20(5):508-14.
5. Perdriel G. Visual information and road safety. Bull AcadNatl Med. 1994;178(6):1075-82.
6. Betz ME, Lowenstein SR. Driving patterns of older adults: results from the Second Injury Control and Risk Survey. J Am Geriatr Soc. 2010;58(10):1931-5.
7. Naumann RB, Dellinger AM, Kresnow MJ. Driving self-restriction in high-risk conditions: How do older drivers compare to others?. J Safety Res. 2011;42(1):67-71.
8. Lachenmayr B, Buser A, Müller S. What visual information does the automobile driver need for safe driving in street traffic?.Ophthalmologe. 1994;91(3):383-94.
9. Owsley C. Aging and vision. Vision Res. 2011;51(13):1610-22.
10. Puell MC, Palomo C, Sánchez-Ramos C, Villena C. Mesopic contrast sensitivity in the presence or absence of glare in a large driver population. Graefes Arch ClinExpOphthalmol. 2004;242(9):755-61.
11. Anderson SJ, Holliday IE. Night driving: effects of glare from vehicle headlights on motion perception. Ophthalmic Physiol Opt. 1995;15(6):545-51.
12. Owens DA, Sivak M. Differentiation of visibility and alcohol as contributors to twilight road fatalities. Human Factors. 1996;38(4):680-9.
13. Owsley C. The vision and driving challenge.
14. Boadi-Kusi SB, Kyei S, Asare FA, Owusu-Ansah A, Awuah A, Darko-Takyi C. Visual function among commercial vehicle drivers in the central region of Ghana. J Optom. 2016;9(1):54-63.
15. Cole BL. Protancolour vision deficiency and road accidents. ClinExpOptom. 2002;85(4):246-53.
16. McMoli TE, Ogunmekan IO. Road traffic accidents in Nigeria–observation on controllable human factors in Lagos.Afr Ann Med. 1983;1:30-3.
17. Cashell GT. Visual functions in relation to road accidents. Trans OphthalmolSoc UK. 1966;86.
18. Nwosu SN, Osuntokun O, Ajayi BK. The prevalence of subnormal vision among government motor vehicle drivers in Oyo State, Nigeria. Niger Med J. 1991;2:51-3.
19. Ovenseri-Ogomo G, Adofo M. Poor vision, refractive errors and barriers to treatment among commercial vehicle drivers in the Cape Coast municipality. Afr Health Sci. 2011;11(1).
20. Emerole CG, Nneli RO. Visual indices of motor vehicle drivers in relation to road safety in Nigeria. Niger J Physiol Sci. 2013;28(1):57-62.
21. Oladehinde MK, Adeoye AO, Adegbehingbe BO, Onakoya AO. Visual functions of commercial drivers in relation to road accidents in Nigeria. Indian J Occup Environ Med. 2007;11(2):71.
22. Burg A. Vision and driving: A report on research. J Traffic Med. 1975;3(2):18-22.
23. Cashell WGT. Visual function in relation to road accidents. Trans OphthalmolSoc UK. 1986;1(1):76-80.