·Investigation·

Prevalence of refraction errors and color blindness in heavy vehicle drivers

Haydar Erdoğan [1], Levent Özdemir [2], Seher Arslan [2], Ilhan Çetin [2], Ayşe Vural Özeç [1], Selma Çetinkaya [3], Haldun Sümer [2]

[1]Department of Ophthalmology, Faculty of Medicine, Cumhuriyet University, Tıp Fakültesi, Halk Sağlığı AD. 58140 Sivas/ Turkey
[2] Department of Public Health, Faculty of Medicine, Cumhuriyet University, Tıp Fakültesi, Halk Sağlığı AD. 58140 Sivas/ Turkey
[3]Department of Medical Education, Faculty of Medicine, Cumhuriyet University, Tıp Fakültesi, Halk Saglıgı AD. 58140 Sivas/ Turkey
Correspondence to: Levent Özdemir. Department of Public Health, Faculty of Medicine, Cumhuriyet Üniversitesi Tıp Fakültesi, Halk Saglıgı AD. 58140 Sivas/ Turkey. lozdem99@yahoo.com
Received:2011-01-05 Accepted:2011-04-25

Abstract

• AIM: To investigate the frequency of eye disorders in heavy vehicle drivers.

• METHODS: A cross-sectional type study was conducted between November 2004 and September 2006 in 200 driver and 200 non-driver persons. A complete ophthalmologic examination was performed, including visual acuity, and dilated examination of the posterior segment. We used the auto refractometer for determining refractive errors.

• RESULTS: According to eye examination results, the prevalence of the refractive error was 21.5% and 31.3% in study and control groups respectively (P<0.05). The most common type of refraction error in the study group was myopic astigmatism (8.3%) while in the control group simple myopia (12.8%). Prevalence of d*yschromatopsia* in the rivers, control group and total group was 2.2%, 2.8% and 2.6% respectively.

• CONCLUSION: A considerably high number of drivers are in lack of optimal visual acuity. Refraction errors in drivers may impair the traffic security.

• KEYWORDS: refractive error; myopia; hypermetropia; colour blindness
DOI:10.3980/j.issn.2222-3959.2011.03.23

Erdoğan H, Öemir L, Arslan S, Çtin I, Özeç AV, Çetinkaya S, Sümer H. Prevalence of refraction errors and color blindness in heavy vehicle drivers. *Int J Ophthalmol* 2011;4(3):319-322

INTRODUCTION

Vision is the most important source of information during driving and many driving related injuries have been associated with visual problems. Visual assessment for driving is thus a major public health issue. Visual functions, such as acuity, field, contrast, color, night vision, etc. can be measured as part of eye examination. Functional vision includes performance of daily living skills, reading ability, mobility skills, driving skills, *etc* [1]. Refractive errors occur when the eye is not able to correctly focus images on the retina. The result is blurred vision, which is sometimes so severe that it creates functional blindness for affected individuals [2]. WHO in 2002 estimated that globally 161 million people were visually impaired from eye diseases such as cataract, glaucoma and macular degeneration. It is estimated that an additional 153 million people are visually impaired globally because of uncorrected refractive errors [3]. Red/green color blindness is a sex-linked recessive trait or anomaly. The genes responsible for red/green color blindness are located on the X-chromosome within the Xq28 band[4]. In humans, color sensations are produced by different combinations of the primary colors red, green and blue Deficiencies in color perception may result from partial anomaly) or complete (-anopia) inability to perceive any of the primary colors [5]. We conducted the present study to determine the prevalence of dyschromatopsia and errors of refraction in heavy vehicle drivers.

MATERIALS AND METHODS

Subjects This cross-sectional study was conducted between November 2004 and September 2006, the number of registered heavy vehicle drivers to Sivas Professional Driver Association is 1200 (492 bus and 708 truck drivers). A total of 200 male persons (82 bus and 118 truck drivers) were randomly selected from the heavy vehicle driver population (p=0.08, q=0.92, N=1200, p=0.01, d=0.045). A total of 200 male non-driver persons of the same ages, with similar socioeconomic levels were used as a control group. Registry of Health Houses of the Territory of Cumhuriyet University was used to identify the control

group. They were contacted through phone calls and after a brief explanation of the study they were invited to participate into the study. A total of 181 heavy vehicle drivers were included in the study (75 bus and 106 truck drivers). Only drivers with full-time, permanent employment were included into the study. Recently hired drivers were also included. The drivers were reached *via* Sivas Professional Driver Association registry, and were asked for their participation and informed consent. Drivers in a firm were reached by going to their firms and given information about the study. Twenty-three drivers that were working for their own profit were contacted by telephone, and their participation into the study was provided. All employed drivers in the region were eligible for the study. The ones that were unwilling to participate and did not come to their appointments on 2 occasions were excluded from the study. No data for these 19 non-participants is available. Working as a driver before, unemployment, being students and retired persons were regarded as exclusion criteria from the control group. Two cases that were realized to be professional driver and 11 cases that did not attend their appointment were excluded from the control group. Also, 8 cases refused to participate in the second step of the study and were excluded (totally 179 persons in the control group). The current study was approved by Cumhuriyet University Ethic Committee and participant's confidentiality was guaranteed and the cases were told to feel free to withdraw from the study without any consequences whatsoever. There was no significant difference between the ages of study group (41.4±7.0, range 23 to 60) and control group (39.3±9.7, range 22 to 65).

Methods We visited the drivers after getting an appointment by phone, and had a brief conversation with the study participants about the aim and scope of the study. A complete ophthalmologic examination was performed including visual acuity, applanation tonometry, gonioscopy and dilated examination of the posterior segment at the second step. A standard Snellen chart was used to assessments of visual acuity, which was viewed at a distance of 6 m and externally illuminated to 150 cdm^{-2}. The acuity scale of the chart used ranged from 6/60 to 6/4.5. A normal clinical procedure was adopted for scoring the Snellen chart, vision being defined as the smallest line at which majority of letters were read. The measurement of intraocular pressure was taken with a Goldmann applanation tonometer (Zeiss AT 030 Applanation Tonometer; Carl Zeiss, Jena, Germany) under topical anesthesia using proparacaine 0.5% and fluorescein staining of the tear film. The mean of the 3 measurements was taken for further statistical analysis. Gonioscopy was performed to assess the angle of anterior chamber.

Dilated ocular examination by a trained clinician using a standardized protocol, with tropicamide (0.5%) and cyclopentolate hydrochloride (1%), was performed in all participants. After pupil dilatation and cycloplegia, the auto refractometer was used to determine refractive errors.

The refractive errors of our subjects were corrected with glasses before the test. Ishihara's Test for Color Blindness (Kanehara, Tokyo) was used to examine the ability of the subjects to recognize certain numbers in 17 plates. The test was given by an ophthalmologist in the same room with sufficient indirect daylight during morning hours. The plates were viewed binocularly at a distance of 50 cm. The number of correct answers was noted as the test score for that person. A person with a test score below 7 was considered color blind and then classified as having either protanopia or deuteranopia.

Statistical Analysis The data were analyzed statistically using the Student's *t* test and Chi-square test.

RESULTS

The most common type of refractive error in the study group was myopic astigmatism (8.3%) while in the control group simple myopia (12.8%). Twenty three persons in the study group (12.7%) and 37 persons in the control group (20.7%) were determined to have myopia. Twelve persons (6.6%) in the study group and 16 (8.9%) persons in the control group were determined to have hypermetropia. Twenty-six persons in the study group (14.5%) and 25 persons in control group (14.0%) had astigmatism. According to eye examination results, the prevalence of the refractive error were 21.5% and 31.3% in study and control groups, respectively($P<0.05$, Table 1). Fifteen percent of study group who had refractive error did not know that they had refractive error and hence did not use glasses.

Prevalence of d*yschromatopsia* in the drivers, control group and total group was 2.2%, 2.8% and 2.6% respectively (Table 2).

DISCUSSION

The relationship between visual acuity and driving performance has been evaluated by a number of authors. The study done by Hills and Burg [6] indicated that for young and middle-aged drivers, there was no relationship between poor visual performance and crash rates. With respect to older drivers, visual acuity demonstrated significant relationships with crash rates. A number of authors also have reported positive correlations between visual acuity and crash involvement [7-9]. These data make us to think that visual acuity effects driving performance and safety in professional driving. In this study we aimed to investigate the prevalence

Table 1 Distribution of refractive errors in heavy vehicle drivers

Refractive errors	Drivers(n=181, %)	Control(n=179, %)	Total(n=360, %)
Simple myopia	8(4.4)	23(12.8)	31(8.6)
Simple hypermetropia	4(2.2)	6(3.3)	10(2.8)
Hypermetropic astigmatism	8(4.4)	10(5.6)	18(5.0)
Myopic astigmatism	15(8.3)	14(7.8)	29(8.0)
Mixed astigmatism	3(1.7)	1(0.6)	4(1.1)
Right eye anisometric amblyopia	1(0.6)	1(0.6)	2(0.6)
Left eye anisometric amblyopia	-	1(0.6)	1(0.3)
Normal(no refractive error)	142(78.4)	123(68.7)	265(73.6)
Total	181(100.0)	179(100.0)	360(100.0)

Table 2 Prevalences of dyschromatopsia in heavy vehicle drivers

		Drivers(n= 181, %)	Control (n= 179, %)	Total (n=360, %)
Dyschromatopsia :	Yes	4(2.2)	5(2.8)	9(2.6)
	No	177(97.8)	174(97.2)	351(97.5)
	Tota	181(100.0)	179(100.0)	360(100.0)

of diseases that effects vision acuity in professional drivers. It is reported that in younger drivers refractive errors were the prime cause and in most cases correction with glasses was possible [10]. Two-thirds of the drivers with inadequate visual acuity consider their vision to be "sufficient" or "good" for driving. Although, as many as two-thirds of the drivers who consider their acuity to be "insufficient" they keep on drive during darkness. The prevalence of myopia and hypermetropia in men in Bangladesh were reported as 26.3% and 15.8% respectively by Bouerne *et al* [11]. At the same study the prevalence of astigmatism was detected as 32.4% among total subjects. In the study which was conducted by Tarczy-Hornoch *et al*[12] in adult Latinos the prevalence of myopia was reported as 16.1% in man . Ho *et al*[13] in a study that involved young girls in Singapore reported a prevalence of refraction errors as 22.3%. Hashemi *et al* [14] in their study conducted in Tahran found myopia frequency of 21.8%, hyperopia frequency of 26.0% . The evaluation after cycloplegia revealed the frequencies of myopia and hyperopia as 17.2% and 56.6% respectively. Karaca *et al* [15] in their study has reported an prevalence of myopia of 30.6% and of hypermetropia of 21.7% . The results of our study for refraction error prevalence are in accordance to the results of Ho and Hashemi. As reported in other studies myopia is more frequent than hypermetropia. The myopia, hypermetropia and astigmatism prevalence are less than the results of Bouerne *et al*[11]from Bangladesh. The results of other studies revealed similar results for our country. Wu study's [16] data provide the first population-based comparison of myopia between different ethnic groups in a high-risk East Asian country. Ethnic differences in the prevalence of severe myopia persisted after adjusting for education, which implied that this outcome could not be fully explained by differences in education exposure. It could be attributed to differences in genetic predisposition to the condition or to the exposure to other environmental risk factors [16]. The results of our study support this idea.

Musa *et al* [17] in their study reported a prevalence of color blindness of 8.72% in boys and 0.33% in girls among young Jordanians. The frequency of red/green color blindness was found to vary between different races, tribes and ethnic groups. The average frequency of red/green color blindness was found to be about 8% among males and 0.4%-0.7% among females. Rogosic *et al* [18] in their study in cases at age of 15 to 45 years reported a congenital dyschromotopsia frequency of 8.48%. Grassivaro *et al* [19] reported a color blindness frequency of 4.9%. Çıtırık *et al* [20] in their study from Turkey reported a red-green color blindness prevalence of 7.33%. Osuobeni in his study that included Arabian children reported the prevalence of red-green color blindness as 2.9%[21].

In our study, 2.2% of drivers and 2.8% of the control group had dyschromotopsia. The total population had a dyschromotopsia rate of %2.6. The prevalences of color blindness in our study are similar to that of Osuobeni [21] but lower than the other reported prevalences.

In our study 23.7% of drivers had at least one type of eye disorder, however the frequency in the control group was significantly higher (34.0%, P<0.05). Among drivers the most frequent refraction error was myopia with astigmatism (5.6%). However in the control group the most frequently noticed refraction error was simple myopia (10.6%). The myopia prevalence among drivers and the control group was

13.9% and 20.8% respectively. The most common type of refraction error in the study group was myopic astigmatism (8.3%) while in the control group have been identified as simple myopia (12.8%). Twenty three persons in the study group (12.7%) and 37 persons in the control group (20.7%) was determined to have myopia. Twelve person (6.6%) in the study group and 16 (8.9%) person in the control group was determined to have hypermetropia. Twenty six persons in the study group (14.5%) and 25 persons in control group (14.0%) was determined to have astigmatism.

CONCLUSION

We in this study tried to address the importance of visual acuity in driving. A considerably high number of drivers are in lack of optimal visual acuity. Refractive errors in drivers may impair traffic security. The drivers should be scheduled to have regular examinations to detect further impairment in visual acuity.

REFERENCES

1 Colenbrander A, De Laey JJ, editors. Visual standards. Vision requirements for driving safety. International Councill of Ophthalmology; 2005 Dec. Report prepared for the International Council of Ophthalmology at the 30th World Ophthalmology Congress. Sao Paulo, Brazil, Feb, 2006

2 Sawada A, Tomidokoro A, Araie M, Yamamoto T. Tajimi Study Group Refractive errors in an elderly Japanese population: the Tajimi Study. *Ophthalmology* 2008; 115(2):363-370

3 Developing an Action Plan, to prevent blindness at national, provincial, and district levels. P:4,2004, WHO. Available from URL: http://www.who.int/ncd/vision2020_actionplan/documents/DevelopingAnActionPlanV2.pdf

4 Filosa S, Calabr ò V, Lania G, Vulliamy TJ, Brancati C, Tagarelli A, Luzzatto L, Martini G. G6PD haplotypes spanning Xq28 from F 8 C to red/green color vision. *Genomics* 1993;17(1): 6-14

5 Welsh D, Hoyt C. Clinical Neuro-Ophthalmology, ed 3. Balitmore, Williams & Wilkins,1969, vol. 1

6 Hills BL, Burg A. A Reanalysis of California Driver Vision Data: General Findings. (1977) Crowthorne, England: Transport and Road Research Laboratory

7 Ball K, Owsley C, Sloane ME, Roenker DL, Bruni JR. Visual attention problems as a predictor of vehicle crashes in older drivers. *Invest Ophthalmol Vis Sci* 1993; 34(11):3110-3123

8 Davison PA. Inter-relationships between British drivers' visual abilities, age and road accident histories. *Ophthalmic Physiol Opt* 1985;5(2):195-204

9 Marottoli RA, Richardson ED, Stowe MH, Miller EG, Brass LM, Cooney LM Jr, Tinetti ME. Development of a test battery to identify older drivers at risk forself-reported adverse driving events. *J Am Geriatr Soc* 1998;46(5):562-568

10 Harms H, Kroner B, Dannheim R. Ophthalmological experiences with automobile drivers with inadequate vision. *Klin Monatsbl Augenheilkd* 1984;185 (2):77-85

11 Bourne RR, Dineen BP, Ali SM, Noorul Huq DM, Johnson GJ. Prevalence of refractive error in Bangladeshi adults: results of the National Blindness and Low Vision Survey of Bangladesh. *Ophthalmology* 2004;111(6):1150-1160

12 Tarczy-Hornoch K, Ying-Lai M, Varma R; Los Angeles Latino Eye Study Group. Myopic refractive error in adult Latinos: the Los Angeles Latino Eye Study. *Invest Ophthalmol Vis Sci* 2006;47(5):1845-1852

13 Ho CS, Ng CB, Chan E, Ngeow A, Wijaya R, Ashok V, Tang W, Gazzard G, Chua WH, Saw SM. Uncorrected refractive error in Singapore teenagers. *Br J Ophthalmol* 2006;90(2):202-207

14 Hashemi H, Fotouhi A, Mohammad K. The age and gender-specific prevalences of refractive errors in Tehran: the Tehran Eye Study. *Ophthalmic Epidemiol* 2004;11(3):213-225

15 Karaca A, Saatci AO, Kaynak C. The result of Farnsworth-Munsell 100 Hue test in Turkish population. *Ret-Vit* 2005;13(2):119-123

16 Wu HM, Seet B, Yap EP, Saw SM, Lim TH, Chia KS. Does education explain ethnic differences in myopia Prevalence? A population-based study of young adult males in Singapore. *Optom Vis Sci* 2001;78(4):234-239

17 Musa T. Al-Aqtum Mohammed H. Al-Qawasmeh. Prevalence of colour blindness in young Jordanians. *Ophthalmologica* 2001;215(1):39-42

18 Rogosic V, Bojic L, Karaman K, Lakos-Krzelj V, Mendes D, Ivanisevic M. Frequency of congenital dyschromatopsias in male population of the Split-Dalmatian County in Croatia. *Arh Hig Rada Toksiko* 2003;54(1):1-4

19 Grassivaro Gallo P, Panza M, Viviani F, Lantieri PB. Congenital dyschromatopsia and school achievement. *Percept Mot Skills* 1998;86(2):563-569

20 Citirik M, Acaroglu G, Batman C, Zilelioglu O. Congenital color blindness in young Turkish men. *Ophthalmic Epidemiol* 2005;12(2):133-137

21 Osuobeni EP. Prevalence of congenital red-green color vision defects in Arab boys from Riyadh, Saudi Arabia. *Ophthalmic Epidemiol* 1996;3(3):167-170