Original Article

Refractive error and abnormal stereopsis association with road traffic accidents in Saudi Arabian truck drivers

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Abstract:

PURPOSE: To investigate the visual functions of truck drivers of the Kingdom of Saudi Arabia (KSA) in the region of Qassim and Dammam and to see if is there any association between these visual functions and self-reported road traffic accidents (RTA).

METHODS: It is a cross-sectional, descriptive study. LogMAR visual acuity, refractive error, color vision, stereopsis, and confrontation visual fields were measured in 300 truck drivers in the Qassim and Dammam regions of KSA. Driving-related history and incidence of RTA from the past 3 years, systemic history, and general eye compliance history were collected through a self-reporting questionnaire.

RESULTS: Among 300 truck drivers examined, 54 (18.4%) subjects have a refractive error, 14 (4.7%) subjects have color vision deficiency, 37 (12.2%) subjects have abnormal stereo acuity, and none of them have confrontation visual field defect. RTA was reported in 25 (8.3%) subjects. The current study has found RTA is significantly associated with refractive error ($P = 0.01$) and abnormal stereopsis ($P < 0.01$). Systemic history revealed that 11% of the subjects had diabetes mellitus.

CONCLUSION: The current study is the first to report on the visual functions of KSA truck drivers. Hence, the current study has found a significant association between visual functions and RTA among truck drivers, we recommend a comprehensive examination need to be part of issuing driver's licenses in KSA. More studies with larger samples from different regions of KSA are needed to extrapolate these findings.

Keywords:

Refractive error, road traffic accident, stereo acuity, visual functions

Introduction

Road traffic accidents (RTA) were the primary reason for hospital admissions for trauma around the world.[1] Road traffic injuries were ranked as the ninth most frequent cause of lost disability-adjusted life years across all age and gender groups in the 2010 World Health Report.[2] Road deaths are common in developed countries, yet they account for about three-quarters of all fatalities.[3] In the Kingdom of Saudi Arabia (KSA), 4.7% of deaths occur as a result of traffic-related incidents, compared to 1.7% in Australia, the United Kingdom (UK), and the United States of America.[4] In the past 20 years, RTAs have resulted in 86,000 fatalities, 611,000 injuries, and 7% lifelong disability in the KSA.[4] A recent study revealed that commercial drivers (CD) of KSA have the highest rate of RTA (61%) of any nation in the globe.[5]

RTAs have many different contributing factors, including poorly maintained roads and automobiles, a lack of proper traffic signage, and improper driving techniques. Deplorable driving practices such as inattentiveness, excessive speeding, wrong-way overtaking, drunk driving, drug use, poor awareness of traffic laws, and physical impairments. Out of all physical impairments, visual impairment has a significant role to play in safe driving. Driving requires a lot of visual processing. A whopping 95% of driving-related information input comes from vision alone.[6] It is assumed that a driver's visual

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function will enable him or her to swiftly read, comprehend, and respond to common traffic control signals while traveling at the top speed permitted in a variety of lighting circumstances.[7] Driving will be negatively impacted by conditions that reduce visual acuity (VA), visual field size, and color vision.[8] Driving safety and performance both heavily depend on VA, a crucial component of visual function.[9]

Driving with poor vision is a potential hazard to oneself and other road users and several studies have shown high rates of RTAs in drivers with poor visual function.[9-12] Verma *et al*. showed a significant relationship between RTAs and visual field defects in CDs.[13] Boadi-Kusi *et al*. have shown a strong association between RTA and protanopia in CDs of Ghana.[14] When driving, depth perception is crucial for determining the speed of approaching cars. Speed judgment deficiencies may increase the likelihood of crashes.[15] In addition, according to researchers, color vision and glare recovery substantially correlate with subpar driving abilities.[16,17] In India, bus and freight drivers are more involved in traffic accidents, compared to drivers of private vehicles.

Given that the KSA has vast areas and long distances between cities, both large and small businesses rely on intercity highways to transport their goods using heavy motor vehicles. Truck drivers are both the most accountable and the most at risk for highway accidents. Visual functions are extremely important for drivers of heavy vehicles. The extent to which they impact KSA heavy vehicle drivers is not well understood, though. To the best of knowledge, there is no literature exists regarding the visual functions of truck drivers in KSA. Considering the literature gap, the current study aims to measure the visual functions of heavy vehicle drivers in KSA.

Methods

It is a cross-sectional descriptive study consisting of 300 participants who have undergone visual function assessment. All the participants were truck drivers working in private firms from the two provinces: (1) Qassim, the central region of Saudi Arabia and (2) Dammam, the eastern region of Saudi Arabia. All the drivers were expats from various countries in Asia and Africa.

Approval of the study was obtained from the Qassim University Ethics Committee. The study was conducted following the tenets of the Declarations of Helsinki medical research involving human subjects. All the study population was informed about the study and prior written consent was taken from all the subjects. Any person who was ill or who did not provide their agreement to participate in the study was excluded. The investigation was conducted from January to April 2021.

All the subjects were examined in a well-lit room for Snellen VA, objective refraction using an autorefractor, stereoscopic examination using Titmus fly test, color vision examination using an Ishihara chart, and anterior and posterior segment examination using a direct ophthalmoscope. After the examination, each participant was asked to answer questions related to the driving history, systemic history, ocular history, and history of RTA in the past 3 years.

In the current study, myopia was defined as mean spherical equivalent (MSE) > −0.25 D, hyperopia as MSE > +0.25 D, and emmetropia as MSE between −0.25 D and + 0.25 D. Normal vision is defined as VA >0.2 logMAR, while impaired vision is defined as VA <0.2 logMAR. Stereopsis of more than 200 s of arc on the Titmus fly test is considered to be reduced stereopsis. Abnormal color vision is defined as if the subject misses more than 5 plates of the Ishihara chart and the type of color vision deficiency is determined based on the classification plates of the Ishihara chart.

Analysis

All the data were entered into a Microsoft Excel sheet and then transferred to SPSS version 21.0 (IBM Corp, Armonk, NY, USA) for further analysis. To report the study's findings, appropriate descriptive and inferential statistics were used and a $P \leq 0.05$ was used to determine statistical significance. The associations between categorical data were analyzed using the Chi-square test.

Results

A total of 300 participants were recruited for the study. All the participants of the study were males with ages ranging from 19 to 60 years with a mean age of 40.35 ± 9.61 years. The majority of the study participants were adults (36–59 years old, 189, 63%)), followed by young people (18–35 years old, 108, 3%) and the minority of them were the elderly (60 years and beyond, 3, 1%). The distribution of truck drivers' origin is presented in Figure 1. Most of the drivers originated from India and Pakistan followed by Nepal, Uganda, and Egypt. All the subjects' driving-related information is presented in Table 1. Most of the subjects were experienced truck drivers with a mean driving experience of 13.35 ± 7.59 years and their driving experience in KSA was 10.8 ± 6.84 years.

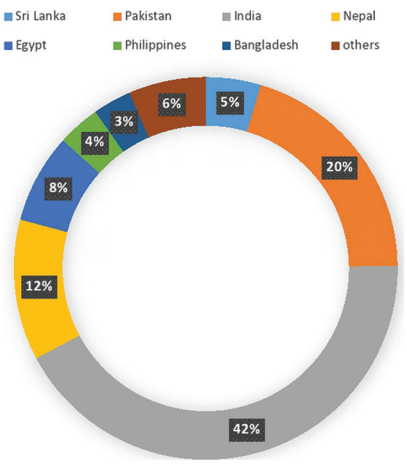

Figure 1: Shows the distribution of truck drivers' origin

Visual functions in truck drivers

The mean and the range of habitual VA, best-corrected VA, spherical equivalent refractive error, and stereo acuity of the truck drivers in the right and left eyes are presented in Table 2. The number of subjects presenting with normal and abnormal visual functions is presented in Figure 2.

Visual acuity and refractive error

The mean habitual logMAR VA of OD and OS was 0.03 ± 0.08 and 0.02 ± 0.06 respectively. Twenty-one (7%) subjects have habitual logMAR VA of >0.2 and 279 subjects have habitual logMAR VA of <0.2.

Among 300 truck drivers, 54 (18.4%) subjects have a refractive error. Among refractive error subjects, 23 (7.7%) people were myopes, 32 (10.7%) people were hyperopes, and the remaining 245 (82.6%) were emmetropes.

Table 1: Driving-related information among truck drivers of Kingdom of Saudi Arabia

Parameter	Mean±SD
Age (years)	40.35±9.63
Total driving experience (years)	13.35±7.59
Driving experience in KSA (years)	10.8±6.84
Average driving time (h)	9.5±1.2

KSA: Kingdom of Saudi Arabia, SD: Standard deviation

Table 2: Mean values of descriptive statistics of visual functions in truck drivers

	Minimum	Maximum	Mean±SD
Age (years)	19.00	60.00	40.35±9.63
Habitual_VA_OD	0.00	0.62	0.03±0.08
Habitual_VA_OS	0.00	0.40	0.03±0.07
Sph_equv_OD (Diopters)	−4.75	1.88	0.01±0.51
Sph_equv_OS (Diopters)	−1.75	2.00	0.06±0.39
BCVA_OD	0.00	0.10	0.00±0.01
BCVA_OS	0.00	0.00	0.00±0.00
Stereo acuity (seconds of arc)	20.00	400.00	160±101.6

SD: Standard deviation, VA: Visual acuity, BCVA: Best-corrected VA

Color vision and stereopsis

Among 300 study participants**,** color vision is found abnormal in 14 (4.7%) participants. Among them, 11 (3.7%) were deuteranopes and 3 (1) were protanopes.

Among 300 subjects, 37 (12.2%) subjects have reduced stereo acuity and 263 (87.8%) subjects have normal stereo acuity.

Visual field

None of the study participants have shown any visual field defects in the current study.

History of road traffic accidents and eye injuries

Among the 300 participants, 25 (8.3%) of them have reported a history of RTA and all of them had reported that they had minor crashes and only 13 (4.4%) of them had mild injuries. Out of 25 participants who had an RTA, only two subjects reported ocular injuries. One subject had a mild lid tear and the other had a subconjunctival hemorrhage. The association between RTA and visual functions is summarized in Table 3. RTA seems

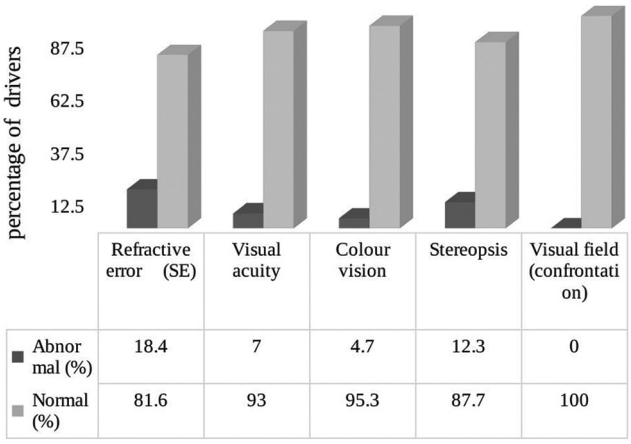

Figure 2: Visual functions in truck drivers of the Kingdom of Saudi Arabia in the current study. All the values represented in the figure were in percentages. Dark bars represent the drivers with abnormal visual function and light bars represent drivers with normal visual function. SE: Standard error

Table 3: Association between visual function and road traffic accidents among the truck drivers of Kingdom of Saudi Arabia

Visual function	History of RTA (*n*=25)	No history of RTA (*n*=275)	Total (*n*=300)	Chi-square statistics	*P*
VA					
>0.2	3	18	21	1.05	0.31
<0.2	22	257	279		
Refractive error (SE)					
Having refractive error	9	45	54	5.98	0.01*
No refractive error	16	230	246		
Color vision					
Color vision deficiency	2	12	14	0.68	0.41
No color vision deficiency	23	263	286		
Stereopsis					
Having reduced stereopsis	13	24	37	39.68	<0.01**
Normal stereopsis	12	251	263		

*Significance level <0.05, **Significance level <0.01. SE: Standard error, RTA: Road traffic accident, VA: Visual acuity

to have not been associated with impaired VA ($P = 0.56$) and color vision defect ($P = 0.21$) but a significant association was noted with refractive error ($P = 0.01$) and abnormal stereopsis ($P < 0.01$).

Systemic diseases

From the questionnaire data, it is revealed that 35 (11.6%) truck drivers are suffering from diabetes and none of them have reported suffering from any other systemic disease. Among 35 diabetic drivers, 32 subjects were using insulin regularly and 3 subjects were not on any medication.

Eye health and general eye care

Only 6 (2%) participants reported having eye allergies. Among the 300 participants, 43.7% of them wear sunglasses and 64.7% of the people irrigate their eyes regularly with water. Among the 55 study participants who had a refractive error, 38 (69.1%) wore glasses all the time during driving. The average duration of driving by truck drivers is 9.5 h and 67.3% of them prefer driving during the day.

Discussion

The current study is the first to report on the visual functions of truck drivers in Saudi Arabia. Aldakhil *et al*.,[5] have recently reported visual functions in CDs of KSA. RTAs were found to be 61.3% in CDs of KSA in their study, however, RTAs were only 8.3% in the current study. The significant difference in RTA between CDs and truck drivers of KSA could be for various reasons. One reason for this would be that most truck drivers prefer to drive their vehicles during the day on vast highways which have wide roads and spend less time driving on city roads with congested traffic, whereas CDs drive on city streets with narrow streets and crowded traffic. This may reduce the likelihood of RTAs in truck drivers. We also believe that truck drivers feel more responsible compared to CDs as they carry large amounts of goods.

Regarding truck drivers' visual functions, many studies from India have reported the visual functions of truck drivers,[18-21] but few are from other parts of the world.[22] In Indian individuals, Verma and Bharadwaj[18] reported a refractive error of 18.8% and color vision defect in 1.4% of the subjects. Jayaseelan and Veeramani[19] found that 31% of truck drivers had refractive errors and 2% had color vision defects. Vidya *et al*.[20] found a refractive error in 37% of the subjects and none of the subjects had color vision defects. Similar to the Verma *et al*.'s study,[13] the current investigation found a prevalence of refractive error of 18.4%. The number of participants with color vision defects (4.7%) in the current study is slightly higher than that reported in Indian studies.

The current study reported reduced stereopsis in a large number of participants (56%). To the best of our knowledge, no study has measured the stereopsis in truck drivers. However, a study by Aldakhil *et al*.[5] reported abnormal binocular vision was reported in 9% of the CDs of KSA. Verma *et al*.[13] have reported unacceptable depth perception in 29% of the CDs. Both of these studies have not mentioned the stereopsis values.

Association between visual functions and road traffic accidents

To the best of our knowledge, the current study is the first one from KSA to evaluate the link between RTA and visual functions in truck drivers.

Refractive error

The prevalence of refractive error in the current study is 18.4% and it is much lower than the studies reported by Aldakhil *et al*.[5] in CDs of KSA (48.3%). The discrepancy in the prevalence of refractive error could be due to two reasons. (1) The current study used the retinoscope for measuring the refractive error, on the other hand, Aldakhil *et al*.[5] used an autorefractor in their study. (2) The current study involved participants from two regions of KSA whereas Aldakhil *et al*.[5] involved participants from one region of KSA. Local differences in the prevalence of refractive error in different regions of KSA may account for this variation.

There are contradictory opinions regarding the relationship between refractive error and the occurrence of RTA; some studies have shown a weak link between refractive error and RTA,[5,14,23] while others show a strong link.[24-26] However, the current study has found a significant association between visual functions and the incidence of RTA.

Color vision

The link between color vision deficiencies and RTA is ambiguous. For instance, a study done by Boadi-Kusi *et al*. in CDs of Ghana have reported that there is a significant association between Protanopia and RTA.[14] On the other hand, studies done by Aldakhil *et al*.[5] and Pepple and Adio[27] have not reported any association between color vision deficiency and RTA. Current studies have not shown any association between color vision deficiency and RTA. Color vision is vital in driving because a deficiency makes it harder to recognize traffic signs and signals as well as indications from other vehicles. According to Cole[28] all protons, regardless of the severity of their defect, have a reduced capacity to notice red signals compared to color vision normal observers, which increases their likelihood of being involved in a car accident. Hence, color vision definitely plays an important role independent of its relationship to RTA and it should be incorporated as part of the screening test for issuing the driving license.

Visual acuity

In the current study, 7% of the subjects have a visual impairment. The prevalence of visual impairment found in the current study is higher than in some studies[5,10,14] and lower than in some studies.[19,20] This can be explained in part by the fact that the other studies used the best or pinhole-corrected VA for their analysis, whereas this study used the presenting VA. If this study had used corrected VA, the prevalence of visual impairment would have been lower because some

visually impaired drivers would have been improved into the normal VA category. In this study, the presenting VA was used because it was the driver's habitual VA which would better estimate the visual impairment. However, the study was done by Oladehinde *et al*.,[24] who measured habitual VA among the study participants similar to the current study and found a visual impairment prevalence of 3.3% in Nigerian CDs which is less than the current study. Independent of differences in the prevalence of impaired VA among the studies, none of them found a significant relationship between VA and the occurrence of RTA.

Stereopsis

The current study has shown that 12.2% of the subjects had reduced stereopsis. In contrast, studies from Ghana[14] and Nigeria[25] have reported 18% and 5% of the CDs have reduced stereopsis, respectively.

The cutoff point for determining abnormal stereopsis may be the cause of the disparity between the current study and the studies described above. The threshold for the stereopsis in the current study was a stereopsis of 200 s of arc and studies from Ghana and Nigeria have not defined the cutoff for the abnormal stereopsis in their studies. Current studies have found there is a significant association between abnormal stereopsis and RTA ($P < 0.01$) while studies from Ghana and Nigeria have not found any association between abnormal binocular vision and RTA.

Many countries have recognized the need to improve public safety and have implemented a variety of licensing requirements. Various countries imposed different vision standards for driving. In the United States, the VA must be 6/12 (20/40) or better (one or both eyes) with or without corrective lenses to obtain a driver's license, and the binocular visual field must be 110° to 140° in most states. In the UK, a binocular visual field of at least 120 horizontally is required, with no binocular visual field defect of more than 20° above or below the horizontal meridian.[29] Unfortunately, according to the council of ministers in Act No 364, there are no specific visual requirements that must be met before obtaining a driving license in KSA. The traffic department, which represents the Ministry of Interior, also did not provide any clarification on the visual requirements for driving. According to the present study, a significant number of truck drivers have abnormal visual functions, which could be concerning and could lead to RTAs in the near future. Hence, we propose that Saudi regulations for obtaining a driver's license should be amended to require a comprehensive eye examination before obtaining or renewing a driver's license.

The limitations of the current study are mainly due to technical difficulties and unable to carry the full ophthalmic instruments to the area where the drivers were examined. Other limitations were (a) final refractive error is measured using a retinoscopy, not by subjective refraction. It could lead to a discrepancy in the total number of subjects having a refractive error. (b) Visual fields were reported using a confrontation test which may not reflect the localized visual field defects. (c) RTA data were self-reported by the participants. Some of the participants would have not been able to recollect the incidence of a traffic accident which could have underestimated the percentage of people who had RTA (d) the findings of the current study should be extrapolated to KSA with caution as the data in the current study is collected from two regions only.

Conclusion

The current study is the first one to report the visual functions among truck drivers of KSA. As of now, there are no clear guidelines for measuring the visual functions of truck drivers of KSA. 8.3% of the truck drivers had a history of minor RTA in the current study. Considering the significant association between some of the visual functions and RTA in the current study, it is strongly recommended that a comprehensive eye examination is very important and needs to be incorporated in issuing the driver's license in KSA. More studies with large samples need to be conducted from different regions to extrapolate these findings in KSA truck drivers.

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Conflicts of interest

There are no conflicts of interest.

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