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Visual function among commercial vehicle drivers in the central region of Ghana

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KEYWORDS
Visual defects;
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Abstract
Aim: To determine the relationship between some visual functions: colour vision defects, abnormal stereopsis, visual acuity and the occurrence of road traffic accident (RTAs) among commercial vehicle drivers in the central region of Ghana, and to assess their knowledge of these anomalies.
Method: A descriptive cross-sectional study employing a multi-stage random sampling approach was conducted in the major commercial towns within the central region of Ghana. Participants were taken through a comprehensive eye examination after the administration of a structured questionnaire.
Results: 520 male commercial vehicle drivers were enrolled for this study with a mean age of 39.23 years ±10.96 years and mean visual acuity of 0.02 ± 0.08 logMAR. Protans were more likely to be involved in RTAs ($\chi^2 = 6.194$, $p = 0.034$). However, there was no statistically significant association between abnormal stereopsis (OR = 0.89 95% CI: 0.44–1.80, $p = 0.56$), poor vision due to refractive error ($\chi^2 = 3.090$, $p = 0.388$) and the occurrence of RTAs. While 86.9% were aware of abnormal stereopsis, only 45% were aware of colour vision defects. There was a statistically significant association between stereopsis anomaly and colour vision defect ($r = 0.371$, $p < 0.005$).
Conclusion: The study found an association between protanopia and RTAs but none between stereopsis anomalies, refractive errors and the occurrence of RTAs. Drivers were less knowledgeable on colour vision defects as compared to stereopsis anomalies.
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PALABRAS CLAVE
Defectos visuales;
Función visual;
Accidente de tráfico;
Conductores comerciales

Estudio de la función visual de los conductores de vehículos comerciales en la región central de Ghana

Resumen
Objetivo: Determinación de la relación entre algunas funciones visuales -alteraciones de la visión cromática, alteraciones de la estereopsis y agudeza visual- y la ocurrencia de accidentes de tráfico entre los conductores de vehículos comerciales en la región central de Ghana, así como evaluación de su conocimiento sobre estas anomalías.
Método: Se realizó un estudio descriptivo cruzado, utilizando una muestra aleatoria de múltiples fases, en las principales ciudades comerciales de la región central de Ghana. A los participantes se les realizó un amplio examen visual tras la entrega de un cuestionario estructurado.
Resultados: Se incluyó en este estudio a 520 varones conductores de vehículos comerciales, con una edad media de 39,23 años ±10,96 años, y una agudeza visual de 0,02 ± 0,08 logMAR. Los sujetos con protanopia tuvieron más probabilidad de sufrir un accidente de tráfico (χ^2 = 6,194, p= 0,034). Sin embargo, no se produjo una asociación estadísticamente significativa entre las alteraciones de la estereopsis (OR = 0,89 95% IC: 0,44-1,80, p = 0,56), la baja visión debida a error refractivo (χ^2 = 3,090, p = 0,388), y la ocurrencia de accidentes de tráfico. Aunque el 86,9% eran conscientes de las alteraciones de la estereopsis, sólo el 45% estaba al corriente de las alteraciones de la visión cromática. Se produjo una asociación estadísticamente significativa entre las alteraciones de la estereopsis y las alteraciones de la visión cromática (r = 0,371, p < 0,005).
Conclusión: El estudio halló una asociación entre la protanopia y los accidentes de tráfico, y ninguna asociación entre las alteraciones de la estereopsis, los errores refractivos y la ocurrencia de accidentes de tráfico. Los conductores eran menos conscientes de las alteraciones de la visión cromática que de las alteraciones de la estereopsis.
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Introduction

Good vision is a fundamental component of safe driving, being one of the most important sensory factors for this activity, accounting for about 95% of all sensory requirements.[1] For this reason, drivers with good vision have an advantage over those with poor vision as far as Road Traffic Accidents (RTAs) are concerned. RTAs are a major health problem worldwide,[2] and a leading cause of death from trauma,[3–6] with an estimated annual death of 1.2 million and up to 50 million injuries worldwide.[7]

In Ghana, RTAs, with their associated fatalities have been on the increase over the years, and are reported to be higher than in most West African countries, being second after Nigeria.[8,9] The rise in the number of RTA in Ghana is exemplified by the fact that there were 14,914 road accidents involving 21,817 vehicles which claimed 2249 lives and caused 14,181 injuries in 2012, compared to 13,572 accidents involving 19,530 vehicles in 2011.[10] These data reveal the huge burden of RTAs to the Ghanaian economy, as it results in the loss of 1.6% of her Gross Domestic Product (GDP), with an average of 1800 deaths annually of whom 60% are in the productive ages of 18–55 years.[11]

Commercial vehicles are the major source of motorized transport in many low-income countries.[1] In the absence of good public transport infrastructure such as railways, most people rely on them for commuting, with the role of commercial driver being evident. Therefore, maintaining optimum visual function, such as visual acuity, colour vision, depth perception (stereopsis), contrast sensitivity and peripheral vision, is essential.[12,13]

Colour vision plays an important role in driving, as a defect leads to difficulty in recognizing traffic signs and signals, as well as signals from other vehicles.[14] Studies on the relationship between colour vision defects and road traffic accidents have been ambivalent, as some have indicated that colour vision deficiencies increase the risks of road accidents while others do not support this assertion. For instance, a study on accident rates[15] found an increased risk for a small sample of colour deficients[15] while Norman found no such effect.[16] Another study reported that protans are precluded from holding a commercial driver's license in Australia because they have a substantially reduced ability to see red lights and had more road accidents involving signal lights.[17]

Stereopsis, the ability to appreciate depth (i.e. the ability to distinguish the relative distance of objects with an apparent physical displacement between the objects)[18] is equally important for driving. According to Omolase et al.,[19] it is needed to accurately judge distances, overtake other vehicles and change lane, especially in busy traffic. This presupposes that drivers with defective stereopsis may have difficulty judging distances in their quest to overtake other

vehicles and change lanes,[12,19] which could lead to the occurrence of RTAs.

The relevance of these visual function parameters among commercial drivers cannot be underestimated. However, there is a paucity of knowledge on the extent to which they affect commercial drivers in Ghana. This study was therefore conducted to investigate the relationship between some visual function parameters and the occurrence of road traffic accidents among commercial drivers in the Central Region of Ghana.

Methods

Study design

This descriptive cross-sectional study employed a multistage random sampling approach to enrol drivers who belonged to a drivers union in the major commercial towns within the central region of Ghana.

Sampling approach

A list of all the major commercial towns within the central region of Ghana was obtained from the Regional Directorate of Trade and Industry. A total of eight towns were identified, namely: Kasoa, Mankessim, Assin Fosu, Swedru, Cape Coast, Twifo Praso, Jukwa and Dunkwa-on-Offin with a total estimated driver population of 6000, of which five were selected. In these selected towns, the commercial parks/stations (designated as lorry stations) where most drivers are located were selected, and a list of the drivers registered with the Driver's Union was obtained from the Station Managers (Union Chairmen and Station Masters). Participants were then selected through a systematic random sampling technique, with 520 drivers being selected based on the estimated study population of all commercial vehicle drivers.

Data collection

The data was obtained from two sources; an ocular examination and a structured questionnaire, which was administered in the local language to each participant via face-to-face interviewers. It contained sections on socio-demographic characteristics (age, level of education, etc.), knowledge of colour vision and stereopsis anomaly, knowledge on alcohol consumption and driving, duration of driving, periods of renewal of drivers' license, perceived difficulties in driving related to visual function and history of road traffic accidents (Appendix 1). The probes in the questionnaire were based on other studies.[12,13] The questionnaire was first tested and re-tested in a pilot study conducted among 20 commercial drivers who did not form part of the final study. The validation of the questionnaire was obtained with a correlation of 0.72. The main results compared included the ability to identify traffic light and passing the objective colour vision test. The interviews were conducted by University graduates who had previous experience in fieldwork and were re-trained for the purpose of this study.

The ocular examination included procedures such as visual acuity, external and internal eye examinations, tonometry, stereopsis and colour vision, which were conducted by optometrists with relevant practice experience. Visual acuity (static) was measured for each eye with the logMAR chart at 4 m and 40 cm. Pinhole acuity was done when visual acuity was less than 0.2 logMAR.[20,21] Objective refraction was conducted for all participants using a hand held retinoscope (REF, 11710, NY, USA). The measurements obtained were refined to obtain the final spectacle prescription for participants by certified optometrists. Colour vision was tested using the Hardy-Rand-Rittler (HRR) pseudo-isochromatic plate, while the Randot Stereoacuity chart was used to measure the drivers' gross and fine depth perception. Both colour vision testing and stereopsis were undertaken, while the participants wore their best corrected spectacle prescription following the refraction.

Anterior segment eye examinations with the handheld slitlamp biomicroscope and posterior segment eye examinations with the Welch Allyn direct ophthalmoscope (REF, 11710, NY, USA) were also conducted to detect the presence of any pathology. Intra-ocular pressure was measured for participants with a vertical cup-to-disc ratio of 0.5 and above or asymmetry of equal to or greater than 0.2 using the Perkins applanation tonometer (Haag Streit UK Limited, Clement Clarke Ophthalmic. Edinburgh Way Harlow. Essex C20 2TT UK). All participants who needed further examinations/evaluation were referred to specific eye clinics.

Data analysis

Data was analyzed using the Statistical Package for Social Sciences (SPSS) version 21.0. Odds ratio and their 95% confidence intervals were calculated using binary logistic regression. At the adopted confidence level of 95%, p value of 0.05 (i.e. 5%) or less was considered to be significant. The relationships between categorical data were analyzed using Chi square (χ^2) test. Visual acuity of greater than or equal to 0.2 logMAR was considered to be normal, while visual acuity of less than 0.2, either monocularly or binocularly, was classified as poor vision. This was based on the Drivers' and Vehicular License Act of 1999 (Act 569).[22] In this study, myopia was defined as the spherical power in the better eye of −0.50D or worse, and hyperopia as the spherical power in the better eye of +1.00D or more. Astigmatism was defined as −0.50D cylinder or worse in the better eye. Presbyopia was defined as inability to read the N8 letters at near (40 cm).

Ethical clearance

Approval for the study was obtained from the Department of Optometry, University of Cape Coast Ethics Review Board. Similarly, approval was obtained from the chairmen and station masters of the various commercial vehicle parks. Individual consent of the drivers was also obtained after a verbal explanation of the procedures involved in the study. The research was conducted in strict adherence to the Helsinki's declaration.

Table 1 Demographic and lifestyle characteristics of participants.

Demographic characteristics	Male $n = 520$	p value
Age		
Youth (18–35 yrs)	225 (43.3%)	
Adult (36–59 yrs)	267 (51.3%)	
Aged (>60 yrs)	28 (5.4%)	
Age/yrs. (Mean SD)	39.23 ± 10.90	
Level of education		
None	11 (2.1%)	
Primary	68 (13.1%)	
Middle/JHS	360 (69.2%)	
Sec/Tech	69 (13.3%)	
Post. Sec.	12 (2.3%)	
Duration of driving		
Mean (SD)	15.79 ± 10.23	
License renewal		
2010–2011	419 (96.0%)	
2012–2014	21 (4.0%)	
Eye examination before license renewal		
Yes	465 (89.4%)	
No	55 (10.6%)	0.013
Self reported colour vision & stereopsis anomalies		
Ability to Identify the colours of the traffic light		
Yes	488 (93.8%)	
No	32 (6.2%)	
Level of education & identification of the colours of the traffic light		0.415
Difficulty judging distances when driving		
Yes	27 (5.2%)	
No	493 (94.8%)	
Alcohol consumption and driving		
Alcohol consumption		
Yes	147 (28.3%)	
Effect on driving	16 (10.9%)	
No effect on driving	131 (89.1%)	
No	373 (71.7%)	
Alcohol consumption and occurrence of RTA		0.002
Alcohol consumption and colour vision defect		0.86
Alcohol consumption and stereopsis anomaly		0.21

Results

Biographical characteristics of drivers

Age and gender distribution

A total of 520 male commercial vehicle drivers were enrolled for the study. Their ages ranged from 20 to 75 years with a mean age (±SD) of 39.23years ±10.96 years. Most of the drivers (267, 51.3%) were adults (36–59 years) followed by the youth (18–35 years) who accounted for 225 (43.3%) drivers, and the aged (60 years and above) constituted 28 (5.4%) (Table 1).

Level of education

Apart from 11 (2.1%) drivers who had no formal education, most of them (360, 69.2%) had completed middle school/junior high school (9 years duration), 69 (13.3%) had secondary/technical (12 years duration) education, 68 (13.1%) had primary (6 years duration) education, while 12 (2.3%) had post-secondary (13–15 years duration) education (Table 1).

History of road traffic accidents

Among the participants, 117 (22.5%) reported a history of road traffic accident in their work as drivers. The reported causes of the RTA were mechanical failure ($n = 43$, 36.8%), level crossing and obstruction ($n = 19$, 16.2%), poor judgement of the distance ($n = 17$, 14.5%), skid and road surface defects ($n = 8$, 6.8%), dazzling light ($n = 6$, 5.1%), overloading ($n = 3$, 2.6%) and others ($n = 21$, 18.0%).

Duration of driving and license renewal

The mean duration of continuous driving was 15.79 ± 10.23 years, with the longest serving commercial vehicle driver

Table 2 Visual characteristics of participants.

Characteristics	Male *n* = 520	*p* value
Static visual acuity		
≥0.2LogMAR	507 (97.5%)	
<0.2LogMAR	13 (2.5%)	
Dynamic visual acuity		
≥0.2LogMAR	495 (95.2%)	
<0.2LogMAR	25 (4.8%)	
Visual defects		
No	208(40.0%)	
Yes	312(60.0%)	
Myopia	10 (1.9%)	
Hyperopia	66(12.7%)	
Astigmatism	30 (5.8%)	
Presbyopia	206 (39.6%)	
Refractive error & occurrence of RTA		0.388
Colour vision		
Normal	483 (92.9%)	
Abnormal	37 (7.1%)	
Binocular anomaly	31 (83.8%)	
Monocular anomaly (OD)	4 (10.8%)	
Monocular anomaly (OS)	2 (5.4%)	
Type of colour vision defect		
Protan	17 (45.9%)	
Deutan	13 (35.1%)	
Tritan	7 (18.9)	

Type of defect	Extent of colour vision defect		
	Mild	Medium	Strong
Protan	6 (35.3%)	9 (52.9%)	2 (11.8%)
Deutan	11(84.6%)	2 (15.4%)	
Tritan	5 (71.4%)	2 (28.6%)	

History of RTA	Protan	Deutan	Tritan	Total	*p* value
No	8	9	7	24	
Yes	9	4	0	13	
Total	17	13	7	37	
Colour vision defect & occurrence of RTA					0.034[a]

Knowledge on colour vision defect		
Yes	286 (55.0%)	
No	234 (45.0%)	
Effect of alcohol on colour vision		
Yes	457 (87.9%)	
No	63 (12.1%)	
Stereopsis		
Normal	440 (84.6%)	
Abnormal	80 (15.4%)	
Abnormal stereopsis & occurrence of RTA		0.561
Knowledge on stereopsis anomaly		
Yes	452 (86.9%)	
No	68 (13.1%)	
Effect of alcohol on stereopsis		
Yes	458 (88.1%)	
No	62 (11.9%)	
Colour vision defect & stereopsis anomaly		0.001

[a] Fisher's exact.

having driven for 54 years and the least being one year. Four hundred and ninety nine (96.0%) had their license renewal from 2012 to 2014, whiles 21 (4.0%) had theirs from 2000 to 2011, this breaching the two year renewal of license programme in Ghana. Four hundred and sixty five (89.4%) drivers reported going through an eye examination (mainly visual acuity measurement) prior to their license renewal, while 55 (10.6%) reported otherwise. Drivers who did not undergo any form of eye examination before renewal of their licenses had a significantly higher risk of road traffic accident (OR: 2.13, 95% CI 1.16–3.91, $p = 0.013$) (Table 1).

Self reported colour vision and stereopsis anomalies

Thirty-two (6.2%) drivers reported that they could not correctly identify all the three colours of the traffic light (Red, Yellow and Green). Twenty-five (4.8%) reported seeing red and green, 6 (1.2%) reported seeing red and yellow, and only 1 (0.2%) driver reported seeing yellow and green. There was no statistically significant association between the level of education and reported ability to identify the different colours of the traffic light ($\chi^2 = 12.39$, $p = 0.415$, df = 12). Of the 520 drivers who participated in the study, 27 (5.2%) reported difficulties judging distances when driving, of whom 17 (63.0%) were adults (Table 1)

Alcohol consumption and driving

Sixteen, (10.9%) of the 147 (28.3%) drivers who reported consume alcohol while on duty indicated that its intake affected their driving skills, while the remaining 131 (89.1%) reported the opposite. Binary logistic regression indicated that drivers who consumed alcohol had a higher risk of road traffic accident than those who did not (OR = 1.64 CI: 1.05–2.57, $p = 0.002$). However, there was no statistically significant association between alcohol consumption and colour vision defect ($\chi^2 = 0.03$, $p = 0.86$) or stereopsis anomaly ($\chi^2 = 1.55$, $p = 0.21$) (Table 1).

Drivers vision

Spectacle use

Twenty-eight (5.4%) drivers had a positive history of spectacles use, which were prescribed by qualified eye care practitioners. However, 43 (8.3%) drivers reported owning and wearing a spectacle correction without appropriate prescription. Of these, 37 (86.0%) wore their correction for near work, two (4.7%) wore them for distance work and four (9.3%) wore bifocals.

Visual acuity of drivers

The majority of drivers had visual acuity of 0.2 LogMAR (6/9 Snellen acuity) or better in the worse (489, 94%) or better (491, 94.4%) eyes, which by law, allows them to drive in Ghana (Table 2). The distance unaided binocular visual acuity among the participants revealed that 507 (97.5%) had a visual acuity better or equal to 0.2 LogMAR (6/9 snellen acuity,) which met the vision requirement for driving in Ghana, while 13 (2.5%) had a visual acuity worse than 0.2 LogMAR (6/9 snellen acuity) (i.e. visually impaired), which precluded them from holding a driver's license. Among them, five (1.0%) were monocularly blind drivers, while of the 13 (2.5%) who had visual acuity of less than 0.2 LogMAR (6/9 snellen acuity), only two (0.4%) remained visually impaired binocularly following refraction.

Table 3 Refractive conditions and RTAs.

Refractive condition	OR (95% CI)	*P*-value
Myopia	0.99 (0.41–2.4)	0.986
Hyperopia	0.00 (0.00–0.00)	–
Astigmastism	0.885 (0.32–2.5)	0.816

Refractive conditions

Among the participants, 312 (60.0%) had some form of refractive conditions, with the remaining being emmetropic. Of the 312 drivers with visual defects, 66 (12.7%) were hyperopic, 30 (5.8%) were astigmatic, 10 (1.9%) were myopic and 206 (39.6%) were presbyopic (Table 2). There was no statistically significant association between poor vision due to refractive error and road traffic accident ($\chi^2 = 3.090$, $p = 0.388$) (Tables 2 and 3)

Colour vision (HRR Pseudoisochromatic Plate)

Most of the participants (483, 92.9%) were trichromats while 37 (7.1%) had different forms of colour vision defects; 31 (83.8%) had binocular defects, and six (16.2%) had monocular defects in the right ($n = 4$, 10.8%) and left ($n = 2$, 5.4%) eyes. Among the participants with colour vision defects, 17 (45.9%) were protans, 13 (35.1%) were deutans and 7 (18.9%) were tritans (Tables 2 and 3). Protans were more likely to report RTAs than deutans ($\chi^2 = 6.194$, $p = 0.034$), the two defects that were found among participants who reported RTAs. Most of the drivers ($n = 286$, 55.0%) were aware that some individuals could not differentiate between shades of colours, while the majority ($n = 457$, 87.9%) indicated that consumption of alcohol could impact on their colour vision (Table 2).

Stereopsis (Randot Stereotest)

Eighty (15.4%) drivers had abnormal stereopsis, of whom 20 (25%) had been involved in RTAs (Table 2). However, poor judgement of distance accounted for only (10.0%) of these accidents. Others were due to level crossing and obstruction ($n = 5$, 25.0%), mechanical failure ($n = 4$, 20.0%), dazzling light ($n = 3$, 15.0%) and overloading ($n = 1$, 5.0%), while 5 (25.0%) were due to other unspecified causes. There was no statistically significant association between abnormal stereopsis and RTAs (OR = 0.89 95% CI: 0.44–1.80, $p = 0.561$). Most of the drivers ($n = 452$, 86.9%) were aware of the existence of stereopsis anomalies, while 68 (13.1%) were not aware of that. Similarly, most drivers ($n = 458$, 88.1%) indicated that consumption of alcohol could impact on their ability to judge distance, while 62 (11.9%) were not aware (Table 2).

Colour vision and stereopsis

Twenty-one (56.8%) of the 37 drivers who had colour vision defects also had abnormal stereopsis. There was a weak positive correlation and a statistically significant relationship between colour vision defect and abnormal stereopsis ($r = 0.371$, $p < 0.005$). Drivers with abnormal stereopsis had a significantly higher risk of having colour vision defect (OR = 19.43 95% CI: 4.66–19.01, $p = 0.001$). However,

there was no correlation between RTAs and stereopsis, [$F(0.338) = 0.44$, $p = 0.561$] or between RTAs and colour vision [$F(3.659) = 0.241$, $p = 0.056$].

Discussion

The findings of this study does not provide evidence to support a relationship between the occurrence of RTAs and refractive errors and stereopsis anomalies. However, the study found that protans were more likely to report RTAs among participants who had colour vision defects. Nearly 2.5% of the drivers had visual acuity worse than the minimum required for driving in Ghana (6/9 Snellen acuity).

The study provides valuable information on the eye health of commercial drivers in the central region of Ghana. The results of this study confirm that commercial driving is dominated by males in the central region of Ghana, as is the case in the entire country.[23] This may be due to the fact that driving is perceived to be a risky venture, which males are better placed to endure than females.[24] The dominance of an active workforce with a mean age of 39.23 ± 10.96 years is also a reflection of the demanding nature of commercial driving in Ghana, requiring a strong and energetic workforce who can endure the stress related to this occupation.[25]

Of the 37 drivers who had colour vision defects, 13 had a positive history of RTAs. Among the 13 drivers, protans were more likely to report RTAs than deutans ($\chi^2 = 6.194$, $p = 0.034$), which has been reported by other authors[17,26] who asserted that colour vision defects may constitute hazard to safe driving due to a difficulty in identifying road signs and signals, as well as recognizing traffic light. In the case of this study, drivers with protanopia were more likely to miss the red signal from the traffic light that could have led to RTAs. However, other authors[27–29] have found no association between RTAs and colour vision defects. The prevalence of colour vision defect in the current study (7.1%) was approximately two times higher than that reported by Ovenseri-Ogbomo and Adofo[30] in the Cape Coast Municipality of Ghana, and that of Pepple and Adio[12] and Emerole and Nneli[31] in Nigeria. This may be due to the differences in instruments used, as the current study utilized the HRR pseudoisochromatic plate, which is capable of revealing both congenital and acquired defects compared to the use of the Ishihara pseudoisochromatic plate used in the previous studies, which is only sensitive to congenital defects.[32]

Abnormal stereopsis was found in 15.4% of all the drivers. All drivers with monocular blindness were also found to have abnormal stereopsis, mainly because it is a function of binocular vision. Although there was no statistically significant association between abnormal stereopsis and the occurrence of RTAs ($\chi^2 = 0.34$, $p > 0.05$), as reported by other authors in Nigeria,[13,26] as well as Ovenseri-Ogbomo and Adofo[30] in Cape Coast, Ghana, the rate cannot be overlooked, as 5.2% of the drivers admitted to having difficulties in correctly judging distances when driving. Further studies are needed in this area to establish the contribution of stereopsis anomalies to RTA in Ghana in a much larger driver population.

It must be noted that attempts to find a link between simple visual function deficits and accidents have proved largely fruitless.[33] This may be because drivers with worse visual capabilities may be aware of their abilities and drive within them. Alternatively, it may be that the visual capabilities measured are too simple. While a driver's task is a complex one, involving both visual and cognitive factors, the failure to relate simple visual function to accidents does not mean that visual capabilities and lighting conditions that support them are unimportant. Rather, the evidence of the effect of visual capabilities on driving performance means that visual capabilities and lighting conditions that support them are part of the problem and part of the solution, but not the whole problem nor the whole solution.[33]

In spite of the above, there was a statistically significant association between colour vision defect and stereopsis anomaly ($r = 0.371$, $p = <0.005$). This may be due to the fact that colour vision and stereopsis occur within the extrastriate cortex, a structure beyond the striate cortex that contains cells that differ in selectivity for different features of stimuli such as colour, motion and stereopsis.[34] Hence, any insult to that region of the brain affects both colour vision and stereopsis. There may therefore be the need to include these tests in any routine examination of drivers to provide further evidence in this regard. Although the rates of colour vision defects and stereopsis anomaly was high in this study, most of the participants were unaware of the existence of colour vision disorders. There is therefore a need for ocular health education for drivers in order to inform them of this information and the potential dangers they might pose.

Ingesting alcohol while on duty has been implicated in RTAs by several reports.[12,35,36] Alcohol depresses the central nervous system, with a subsequent release of inhibition, thus causing the driver to overestimate his ability while underestimating his deficiencies.[12] This study found evidence to support this assertion, as those who reported alcohol consumption were 1.64 times more likely to have been involved in RTAs than those who did not consume alcohol. This suggests a need to intensify campaigns against drink-drive among commercial drivers in Ghana, as has been championed by the National Road Safety Commission of Ghana.[37] Regular spots checks to arrest offenders of this law on drink-drive by the Motor Traffic Unit of the Ghana Police Service may also need to be intensified.

Approximately 2.5% of the drivers had a visual acuity worse than the minimum required for driving in Ghana (6/9), which was comparable to that reported in Nigeria.[33] However, this was lower than that reported by Ovenseri-Ogbomo and Adofo[30] in the Cape Coast municipality in Ghana. This may be due to an increased awareness on the vision requirement for attainment of driver's license in Ghana, as well as a possible stricter regime that enforces the law on driving in Ghana. However, the rate of worse vision recorded in this study indicates that some drivers acquire their license without meeting the minimum standard criteria, among them were 5 (1.0%) who were monocularly blind. This may be due, in part, to the use of unskilled persons in conducting vision assessments in most parts of Ghana, other than the prescribed professionals; ophthalmologists or optometrists, as stated in the law.[22] Drivers with monocular vision pose a great risk to themselves, their passengers and other road users, as they may have considerable limitations in undertaking their task of driving accurately. There is therefore the need for the Drivers' and Vehicular License Authority (DVLA) to enforce the law on vision testing by eyecare professionals, as this will promote road safety. This should be done with

strict compliance, as drivers who did not go through eye examinations were 2.13 times more likely to be involved in RTAs (OR: 2.13, 95% CI: 1.16–3.91, $p = 0.013$).

Visual impairment of 2.5% found in the current study was higher than the 1.7% reported by Pepple and Adio[12] in a similar population. It was however, lower than the Ibadan study,[38] with a prevalence of 3.1%. The prevalence of refractive error in this study (20.4%) compared favourably with a study conducted by earlier authors[12,13] in urban Africa, but lower than that reported among drivers of public institutions in Nigeria.[39] This group of drivers may presents a risk to themselves, passengers and other road users, as they require optical corrections for driving and yet most did not utilize their prescribed spectacles.[12] In spite of this assertion, there was no statistically significant association between refractive error and reported RTA in this study ($\chi^2 = 3.090$, $p = 0.388$).

Conclusion

The current study found an association between protanopia and the occurrence of RTAs. A relatively high prevalence's of colour vision defects and stereopsis were recorded in this study. However, few participants were aware of the existence of colour vision anomalies, while a limited number reported that they were unaware of stereopsis anomalies. This highlights the need for intensified health education to encourage drivers who experience these defects to seek prompt medical help and advice. The prevalence of refractive errors and monocular blindness among the study population also indicates the need to enforce the law on comprehensive eye examination by appropriate professionals, as enshrined in the law, rather than just measuring visual acuity prior to acquiring or renewing drivers' licenses, as is currently the case.

Conflict of interest

None declared.

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Appendix 1.

Please indicate the correct response for each of the questions below

Participant's Code _____

Demographic Data

1. Gender: M F
2. Date of Birth: DD/MM/YR ___/___/19___ Age:_____
3. What is your highest level of education: ☐ None ☐ Primary ☐ Middle/JHS ☐ Secondary/Technical ☐ Post-Secondary ☐ Tertiary ☐ Other (Specify)_____

Occupational Data and knowledge on ocular defects

4. In which year did you start driving? _____
5. How often do you renew your drivers' license? ☐ Every 2yrs ☐ 3-5yrs ☐ >5yrs
6. When was the last time you renewed your drivers' license? _____
7. Did you go through an eye examination prior to the renewal of the license? ☐ Yes ☐ No
8. Can you easily identify the colours of the traffic light? ☐ Yes ☐ No
9. If Yes in quest 8, mention the colours: ☐ Red ☐ Yellow ☐ Green
10. If No, which of the colours do you have difficulty identifying? ----------
11. Are you aware that, there are some individuals who cannot differentiate between colours? ☐ Yes ☐ No

12. Do you have difficulty judging distances correctly when driving? ☐ Yes ☐ No

13. Are you aware there are some individuals who cannot judge distances correctly?

☐ Yes ☐ No

14. Have you ever been involved in any road accident while driving your commercial vehicle before? ☐ Yes ☐ No **If NO GOTO 17**

15. In which year did the accident occur? _____

16. What was the cause? ☐ Difficulty seeing road signs/traffic light ☐ lack of proper judgment of the distance between your car and the oncoming car ☐ dazzling light ☐ defective light ☐ Over loading ☐ machine failure ☐ skid and road surface defect ☐ level crossing and obstruction ☐ Other (specify) _____

Alcohol Intake Status

17. Do you take in alcohol in a normal working day? ☐ Yes ☐ No

18. For how long have you been drinking alcohol? _____

19. What quantity do you take in a day? _____

20. Does your intake of alcohol affect your driving skills? ☐ Yes ☐ No

21. Do you know continuous alcohol intake can affect your ability to differentiate between colours of the traffic light? ☐ Yes ☐ No

22. Do you know alcohol intake can affect your ability to properly judge distances? ☐ Yes ☐ No

Thank you for your participation

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