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VISUAL FUNCTION AND SAFE DRIVING AMONG DRIVERS IN KAKAMEGA, KENYA

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Abstract:
Vision and driving were first related in early 1967. Many countries did not adopt vision tests as a requirement for driving since road traffic accidents were said to be due to poor infrastructure and intoxication. Improvement to the latter brought forth little change. Vision tests were then adopted as a requirement for driving, and visual acuity was the ubiquitous visual test. Visual acuity alone is not a good measure of how well or safely a person can drive; hence, there is a need for a more compressive test. Only 28 countries worldwide have adopted a more compressive visual function test for drivers. This study evaluated the effects of visual function on safe driving among the driving population of Kakamega. The study determined the relationship between vision loss and road accidents among drivers, the prevalence of road traffic accidents, and the effects of visual function impairment on the affected drivers in Kakamega.

Keywords: visual acuity, drivers, road safety, road accidents, vision

1. Introduction

Vision is a crucial aspect of our day-to-day activities and is closely related to driving (Kotecha *et al.*, 2008). The earliest large-scale association of vision to driving safety is that of Burg (1967). A driver is a person in control of a coach, carriage, vehicle, wagon or any other with horses or mules. In Kenya, a driver is a person who drives or guides or is in physical control of any vehicle or cattle (Kenyan const. CAP 403 sec 6A). A driving license is a license to drive a vehicle issued under the Kenyan Driving Act. In Kenya, driving is regulated by the National Transport and Safety Authority. This body categorized the driving license into category A1- motorcycle up to 50 C.C, age 16 years; category A2-

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motorcycles above 50 C.C load up to 60kg, age 18 years; category A3- motorcycle taxi; category B1-light vehicle up to 3500kg, category B2-automatic light vehicle maximum 750kg, category B3-professional maximum of 7 passengers minimum age is 21, category C1-light truck with one light trailer age is 22, category C-medium truck age is 24 with two-year experience in category C1, category CE-heavy truck with heavy trailer age is 28 and four-year experience in category C, category D1-van with maximum 14 passengers age is 22, category D2-minibus maximum 32 passengers age is 25, category D3-bus more than 33 passengers age is 30, category E particular professional driving, category F-special driving license for disabled people, category G-industrial and agricultural plants equipment. Conditions for granting a driving license in Kenya include that the driver certifies to the licensing officer that they passed the test for competency driving conducted under (CAP 403 sect 39). Makes a declaration that they do not suffer from any physical disability that would cause driving to be dangerous on the road, can read with glasses if worn a motor vehicle identification plate at a distance of 25 meters (The Traffic Act, Part 5; Kenyan Constitution).

Visual function is how well the eye and the visual system work. It comprises visual acuity, colour vision, contrast sensitivity, visual field and adaptability. Since driving is a visually intensive task, a legal minimal requirement is set for all motorists (Colenbrander, 2005). Safe driving has no stable definition due to the different scenarios and situations on the road. For this study, we define safe driving as "*properly and conveniently implementing the driving curricula and license testing and driving protocols*" (Hirsch, P., 1995). In Kenya, a driver is described as a person who guides or is in physical control of a vehicle. A legal driver is a driver who is licensed to drive a particular class of vehicles. (Kenyan Const. CAP 403. S 2, 2019). Conditions for granting a license in Kenya include the license should not be issued to persons under the age of 16 years, a person has to pass the test of competence to drive that class of motor vehicle, be able to read with glasses if wears a vehicle identification number at a distance of twenty-five meters. (Kenyan Const. CAP 403. Act no 33, 2012). Vehicle classification is motor omnibuses, heavy commercial vehicles, commercial vehicles, tractors, motorcars, motorcycles not exceeding fifty cubic centimetres of engine capacity, and motorcycles exceeding fifty cubic centimetres of engine capacity (Const. CAP 403. Act no 33. S 62).

Driving is a visually demanding task (Kotecha *et al.*, 2008). There has been a fourfold increase in accidents in the last 30 years, and buses and matatus are the most involved (Odero *et al.*, 2003). The East Africa region has experienced many fatalities, with Uganda leading one of the three countries. In Kenya, road traffic accidents constitute 59.6% of injuries and 28.2 deaths per 100,000 people (Gichagi *et al.*, 2015). The visual function has been ignored as a probable cause of increased road accidents. This study would help determine visual function impairments in drivers and their effect on road safety in Kakamega. In a study involving drivers with a crash history, it was found that out of 403 population, 8.2% had a known ocular condition, including cataract, non-proliferative diabetic retinopathy, and visual trauma, 16% wore glasses (Behboudi *et al.*, 2017). This shows the significance of visual function to safe driving. Findings from a

study show supporting evidence that photopic vision is not optimal for predicting mesopic, scotopic driving (Kimlin *et al.*, 2017).

In a study by Black *et al.*, 2019, it was found that correction of astigmatism using a toric contact lens significantly improved mesopic, photopic visual acuity and contrast sensitivity. With the population ageing, the number of people living with vision impairment is expected to increase (Nguyen *et al.*, 2020). This necessitates more efforts to study this area and come up with recommendations. In a cohort study in urban Africa, one of two commercial drivers was involved in an accident, and one-third of the drivers did not take eye tests prior to obtaining their driving license (Pepple & Adio, 2014). In another study, a relationship was found between visual health driving fitness issues and the risks perceived by the drivers (Lijarcio *et al.*, 2020). Most studies have found a relationship between vision and road safety. Few studies have been done in Kenya on this topic. Kakamega County had a population of 1,867,579 people as per census 2019. More people are buying vehicles, hence an increment of road accidents, and this presents a research gap.

2. Literature Review

Vision is considered to be the most important component of safe driving (Owsley & McGwin, 1999) Awareness of visual measurability and its effects on safe driving has been found to be significantly important for a secure traffic system (Thorslund & Strand, 2016). There is no worldwide standard visual requirement for driving but it ranges from 6/9 to 6/60. Visual function impairment has a higher prevalence in the older population, who constitute the larger percentage of drivers (Kimlin *et al.*, 2017).

WHO estimates about 1.3 million people die on roads every year. In Kenya, road traffic accidents claimed 3114 lives in 2020, according to NTSA. In a study in Nigeria by Pepple & Adio, 2014, some drivers acquired driving licenses without undertaking any visual assessment and half of them had a crash history. Vision and driving have been linked only recently and there are a lot of studies being conducted. Conditions that can impair visual function and affect driving include cataracts, macular degeneration, glaucoma, dry eye, diabetic retinopathy and many other conditions. Some visual functions are affected by different light conditions. Correction of astigmatism was found to significantly improve night driving (Kimlin *et al.*, 2017). Errors of perception were found to be a significant contributory factor to accidents (Hills, 1980). Factors that affect driving include driver behaviour, state of infrastructure, vehicle safety, vision and the driver's cognitive state (Komakova, Poliak, 2016).

Different countries have different visual requirements to be allowed on the roads as a driver. Some have strict policies for their drivers while others are lenient. In the United Kingdom, visual requirements for a Group 1 driver (light vehicle drivers) are the ability to read a car number plate at a distance of 20 meters with correction if needed. Group 2 drivers (heavy goods vehicles and PSV) should have uncorrected visual acuity of at least 6/60 and a corrected visual acuity of 6/9 in the better eye and 6/12 in the worse eye (Kotecha *et al.*, 2008). Both categories of drivers were expected to have a visual field

of 120° tested using Goldman III4e. The driver is expected to notify the DVLA of any defects in their vision or risk losing their license. In the United States of America, they use principally two measures; visual acuity and visual field. Studies in the USA are said to have found a weak correlation between vision and safe driving (Owsley & McGwin, 2010). The measures are left in place since they are practical. A newer assessment method has been developed, known as the useful field of view, but has not been incorporated by the licensing bureaus. In Australia, visual acuity of 6/12 and 110° horizontal field is mandatory for private drivers. For commercial drivers, 6/9 in the better eye and 140° horizontal field is a requirement. VA of less than 6/24 leads to withdrawal of driving license. Color vision, except for protanopia, is not mandatory for safe driving (Honavar, 2019). In India, the Motor Vehicle Act amendment of 2017 did not mention vision-specific driving requirements. However, for monocular people, a visual acuity of 6/40, a visual field of 120 and a monocular adaptation of about 6 months is required (Santosh, 2019). In New Zealand, a driver has to prove that their vision is up to standard each time they apply for a new license and the test certificate should not be older than 60 days. In Kenya, the visual requirement for driving is the ability to read a car number plate at a distance of 25 meters with the best correction if required (ecitizen, driving license 2017). There are so many gaps in the Kenyan way of assessing visual function. The numbers and letters used on a car plate are not of Snell equivalent (Owsley & McGwin, 2010). The method also does not estimate the ability to drive safely at night.

It is difficult to determine if an accident was due to visual function impairment or other causes unless it is self-reported. The rate of road traffic accidents is rising significantly. Globally, in an article by CDC, it was said that 1.35 million people are killed in road crashes. It was also estimated that road accidents cost the world economy about 1.8 trillion dollars (in 2010 USD). Low- and middle-income countries are the most affected constituting around 60% of registered road accidents. It costs these countries about 834 billion dollars (in 2010 USD). In Africa, the death rate is at 24.1 deaths per 100000 population per year, which was above the global rate of 18.0 per 100000 population per year (Road safety in WHO African region., 2013). Africa has the lowest level of motorization in the six world regions and has the highest rate of road traffic accidents (Road Safety in WHO African region, 2013). In Kenya, the rate of road accidents has been on a steady rise. About 3000 Kenyans lose their lives each year due to road traffic accidents (Odero *et al.*, 2003). Vision is not regarded as essential for driving and, therefore, presents a research gap. Pedestrians and passengers are the most affected, accounting for up to 80% of all fatalities. Buses and matatus are the most involved in these accidents (Odero *et al.*, 2003). Global distribution by road user group in different regions includes fatalities in Africa 55%, America and Europe 15% (Naci *et al.*, 2009). Distribution across income levels includes; 45% in low-income countries, 29% in middle income and 18% in higher income countries. In Kenya, the PSV sector is responsible for the rising rate of road traffic accidents. Poor roads and human error are the major factors to blame for the increase in road accidents (Muchene, 2010). Pedestrians constitute 42%, passengers 38%, drivers 12% and cyclists 8% (Odero, 1995). Human factors constituted 85% of all accidents (Odero, 1995).

Driving is one of the major means of transport, which requires combining visual, cognitive and physical skills for safe maneuvers (Nguyen *et al.*, 2020). With ageing population, the number of people with visual problems is set to increase. Older drivers represent one-third of the driving population (Higgins, 2003). In a study involving older persons, poor visual acuity, contrast sensitivity and visual fields were associated with avoidance of driving (Freeman *et al.*, 2006). Drivers with certain eye conditions restrict their driving to better conditions. There is evidence that some eye conditions are accompanied by higher risks of accidents (Owsley & McGwin, 1999). Diabetes has complications that can significantly affect driving, they include; vision cognition and peripheral neural function (Graveling *et al.*, 2015). In another study, mesopic vision has been correlated to impaired night driving (Gruber *et al.*, 2013). The study also found that photopic visual acuity is a good predictor of nighttime driving ability (Gruber *et al.*, 2013). There are fewer studies evaluating predictors for night driving hence the need for further research. Deterioration in driving performance in the older population is multifactorial but visual impairment is the most significant factor (Wood, 2009).

The global prevalence of visual impairment was more than 161 million in 2002(Resnikoff *et al.*, 2008). In a study in Europe, visual acuity in 0.5% of the younger population and 5.3% of the older population was below the standard requirement (Van Rijn *et al.*, 2011). The visual field below the required standards was 2.7% and 2.4% (Van Rijn *et al.*, 2011). With an increase in the older population visual impairment becomes more prevalent (Owsley *et al.*, 2013) In a study in Nigeria a strong relationship was found between RTA and drivers' vision, drivers with impaired vision were 3.1% and monocular blindness was 2.4%, refractive errors 20.2% (Bekibele *et al.*, 2007).in the USA 2000 census it was found that 2.4 million people had visual impairment (Congdon, 2004). In 2006, a study involving a sample population 12 years and older found that the visual impairment in the USA was 14 million (Vitale *et al.*, 2006). In Malaysia in 2009, it was found that about 780,000 drivers had unsatisfactory vision but were still driving on the roads (Haliza *et al.*, 2010). In Canada, 35.6 per 100000 population had visual impairment, and cataract and visual pathway diseases contributed to 40% of all cases (Maberley *et al.*, 2006).

In Africa, around 30 million people have a visual impairment (Resnikoff *et al.*, 2002.) In another study in Nigeria, among commercial truck drivers, 9.1% had poor VA, 19.5% had impaired visual field, and 9.5% had impaired colour vision (Ngozi Charity Chidi-Egboka, 2015). In a study in western Africa, it was found to be 17% which reduced to 6% after refraction (Budenz *et al.*, 2012). Major causes of visual impairment in Africa were cataracts, uncorrected refractive error, age-related macular degeneration and trachoma, which have significantly reduced (Khairallah *et al.*, 2014). In Kenya, a study was done in Nairobi involving 1480 people found that the prevalence of visual impairment was 6.2% (Ndegwa *et al.*, 2006). Refractive error was the leading with 58.1%, it also found that 2.5% of Kenyans in the rural regions had impactful visual impairment (Whitfield *et al.*, 1990). The overall prevalence of visual impairment is 3.7% according to a study (Whitfield *et al.*, 1990). Refractive error was the major cause of visual impairment, and cataracts were the major cause of blindness in the slum population of Nairobi

(Karimurio *et al.*, 2008). The prevalence of significant refractive error in Kenya is 17% (Nyamai, 2016).

3. Material and Methods

This was a cross-sectional research design. Assessments from the sample population were collected at a single point in time between July 2021 and September 2022. The study focused on Kakamega County's driving population, which ranges in age from 18 to 80. Candidates for the study had to be registered legal Kenyan drivers with a valid license. Active drivers with higher mileage were included in the study, regardless of the type of vehicle they were permitted to drive. Candidates not Kenyans by nationality and with expired licenses were excluded from the study. The convenience sampling technique was used in this study, and participants were chosen at random. 384 participants were recruited for the study, and a structured self-administered questionnaire was used to collect information such as demographics, driving time, visual problems encountered while driving, involvement in road accidents, and frequency of eye check-ups. Visual acuity was measured for all participants using a Log MAR chart, colour vision with an HRR standard pseudoisochromatic plate, the central visual field with an Amsler grid, and the peripheral field with the confrontational method. The Pelli Robson chart was used to assess contrast sensitivity.

4. Results and Discussion

The study included 384 drivers, with 75% being men and 25% being women. The study's participants had an average age of 38.63 and an average driving experience of 8.75 years. The participants had to be 19 years old and have at least one year of driving experience. The oldest driver was 71 years old, and the most extended driving period was 32 years. 29.9% of drivers reported excellent health, with 70.1% reporting good health. According to the study, 86.5% of participants had no difficulties driving during the day, while the remaining 13.5% had problems. 84.4% had no trouble reading street and road signs, while 15.6% struggled to read them. 85.9% of drivers had no trouble seeing pedestrians, while 14.1% did. In contrast, 52.1% of participants reported no difficulties, while 47.9% reported some difficulties. 19.3% of drivers reported no problems with glare while driving at night, while 80.7% reported problems with glare. The study found that all participants with excellent vision had no accidents. Individuals with fair vision reported most accidents (15%) compared to those with good vision (5%). The likelihood ratio calculated using chi-square was 0.055.

A similar study conducted in Melbourne by Keeffe *et al.* (2002) found that people with visual acuity less than 6/12 were more likely to be in a car accident. Older drivers with impaired vision were more likely to cause traffic accidents. According to a study conducted in Nigeria by Oladehinde *et al.* (2007), 31.8% of drivers with one eye reported an accident, while 25.9% reported a standard visual field. In addition, the study found that 5.2% of participants were involved in a traffic accident. The majority (94.8%) reported

no traffic accidents. A similar study in Ghana's Central Tongu District found that 75% of commercial motorists were involved in accidents (Konlan, 2020). Kimlin *et al.* (2017) found that intermittent glare significantly reduced overall driving performance scores, with pedestrian detection decreasing by 38%. Overall driving scores were most strongly linked to motion sensitivity and mesopic high contrast vision, rather than photopic or glare-based tests. Motion sensitivity explained more than twice the variation in driving performance compared to photopic high contrast VA (29% vs. 14%). According to a study conducted in Ghana by Boadi-Kusi *et al.* (2016), 45% of drivers had colour vision problems and 86.9% had abnormal stereopsis. The majority of drivers had poor vision due to refractive errors.

5. Recommendations

The study suggests that visual examinations prior to the issuance of driving licenses be performed by a licensed optometrist or ophthalmologist to ensure comprehensive eye exams. The government should issue strict policies to driving schools governing eye tests and checkups prior to issuing driving licenses, as well as follow-up checkups prior to license renewal. Further studies should be done to determine how different ocular diseases affect driving and the intervention measures that can be put in place to improve the driving status of those affected.

6. Conclusion

Finally, poor vision is linked to road accidents among drivers. The prevalence of road accidents among drivers with visual impairment in Kakamega is 2.04%, which is significant and necessitates a comprehensive eye examination before issuing driving licenses. Visual function impairment significantly impacts driving and should be considered when assessing vision before allowing drivers onto the road.

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Conflict of Interest Statement
All authors declare that they have no conflicts of interest.

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