Photostress Recovery Time among Commercial Drivers in Kano Metropolis, Kano State, Nigeria

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Abstract

Driving being a vision dependent task requires the drivers to have good vision. The essence of driver's license is therefore contingent upon meeting visual standards for public safety. This study aimed at determining the photostress recovery time (PSRT) of commercial drivers of Kano metropolis. A prospective analytical cross-sectional study was conducted on 134 purposively sampled commercial drivers who have clear ocular media. Prior to the testing each subject were given 5 minutes to adapt to ambient illumination. The pre-bleach distant visual acuity of each eye was determined with the Snellen's distance visual acuity chart. With one eye occluded, the other eye was dazzled for 10 seconds, measured by a stopwatch, with the light of a pen torch held at 2cm from the eye. The time required in seconds to read at least, three optotypes on the line directly above the baseline acuity was recorded as the PSRT. The 20-29 years age group recorded the least mean PSRT (12.2 seconds) for both eyes, while the 60-70 years category has the highest mean PSRT (41.8 and 41.1 seconds) for right and left eye respectively. Age associated significantly ($p<0.05$) with mean PSRT. The observed mean PSRT with glare sensitivity was statistically significant ($p<0.05$). Positive association between PSRT in relation to age and disability glare were found. This emphasizes the need to introduce photostress test as a requirement for issuance and renewal of driving license especially for older and visually impaired people.

Keywords: Photostress test, Photostress Recovery Time (PSRT), Glare Sensitivity, Night Driving.

Introduction

The retina is made up different cells among which are the photoreceptor cell (cones and rods). The rods used in scotopic vision are highly photosensitive and contains visual pigments known as rhodopsin. Rhodopsin is made up of opsin and 11-cis-retinal[1]. Upon exposure of visible light on the retina the highly photosensitive rhodopsin is photo bleached and its 11-cis-retinal is converted to all-trans-retinal. After the illumination is extinguished, the all-trans-retinal released during bleaching is either stored or reconverted to 11-cis-retinal through series of enzymatic steps known as visual cycle. The bleaching and re-synthesis of rhodopsin are clinically important as it provides a quantitative index of macular function in photostress test[1].

Photostress test is a gross test of dark adaptation in which the visual pigments are bleached by light[2]. It is considered to be a psychophysical process because of the persistence of after image in form of a scotoma when light exposure is withdrawn, which subsequently recedes to normal vision restoration.

The change in the photo pigment (rhodopsin) that occurs when it is absorbs photons is called Pigment bleaching. It can be done in two ways (based on light intensity and duration of light exposure), viz; photoflash bleaching with intense flash of light of short duration of light exposure and equilibrium bleaching with longer duration of light exposure and less intense flash light. The time taken for cone photo pigment regeneration is different in these two ways with photoflash bleaching restored within few seconds[3].

Photostress Recovery Time (PSRT) is the time taken for visual acuity to return to normal levels after the retina has been bleached by a bright light source.[4] It is only dependent on the ability of the photoreceptors to re-synthesize visual pigment after bleaching and the functional relationship between the photoreceptors and the retinal pigment epithelium (RPE), and no other part of the visual system or ocular diseases that affects them[4]. PSRT is recorded as the period between removal of light source and the subject is able to read at least three optotype above his initial visual acuity of the same chart. The normal time of recovery is about 15 – 30 seconds[4].

Glare sensitivity is a debilitating loss of visual acuity in bright light; such as when near a bright light source or outdoors in bright sunlight. The presence of bright light such as direct or reflected sunlight or artificial light such as car headlamps at night makes seeing difficult. Disability glare is recorded by re-measuring visual acuity of subjects with light source placed at 30^0 at a distance of 30cm from the eye. The normal glare sensitivity is a decrease in visual acuity of one line or less[4].

Driving is a very important practice worldwide, necessary for various purposes which include work, social life, pleasure and entertainment among others. It is the preferred and primary mode of transport for people despite being a complex activity where intact vision is the basis for road safety, thus requires both photopic and mesopic vision as there is always some amount of light available when driving both at night and day. With increasing age, glare sensitivity increases which leads to reduction in mesopic vision hence resulting in increasing number of elderly drivers having night vision difficulties[5].

Visual acuity level is the major visual function test required to obtain a driving license. A good visual function is essential for safe driving. Poor vision causes more damage at night because of difficulties of seeing pedestrians, road signs, and hazards in the road, as well as glare from oncoming vehicle headlights[6]. Recognition performance while driving is not predicted usually just by photopic VA rather with combination of either mesopic VA or photopic contrast sensitivity. This is because visibility degrades seriously during night driving which mostly affects the elderly drivers[7].

The main purpose of public policy requiring vision testing for driver's license issuance and renewal is to screen individuals with functional vision impairment and to restrict their driving when necessary. In Nigeria, though there is a minimum legal requirement for visual acuity before a driver's license can be issued, this practice is not adhered to. Road traffic accidents (RTA) in Nigeria are endemic, with seasonal epidemics[8]. Police records indicates that between 1980 and 1989, a total of 98,168 Nigerians lost their lives, and 244,864 were injured, resulting in an average of 10,000 deaths and 25,000 injuries annually[8]. This high rate of accidents on our roads could be attributed to some extent to urbanization, industrialization, as well as the increase in the number of motor vehicles on the roads.

The public automobile transport system is the most used means of transportation for majority of the Nigerian populace. Therefore, the assessment of ocular morbidities of public transport drivers is essential from the preventive point of view. The policy in most government establishments is to carry out pre-employment examination of new employees routinely including eye examinations for drivers. This screening exercise provides opportunity to identify and treat drivers with not only uncorrected refractive errors but also those with visual problems that affect driving both at night and daytime. Also, after the pre-employment examination, periodic eye examinations are usually not done except when an individual develops eye problems[9].

There has been no study that determined the photostress recovery time of commercial drivers in Kano metropolis let alone in Kano state. The purpose of this study was to determine the photostress recovery time (PSRT) of commercial drivers in Kano metropolis. Its findings will help in make recommendations to policy makers on the need to introduce other test other than visual function test as a prerequisite for issuing driving license.

Materials and Methods

This study was a prospective cross- sectional study carried out to determine the photostress recovery time (PSRT) of commercial drivers of Kano metropolis using the purposive non-probability sampling technique. This study was carried out at motor parks within Kano Metropolis for a period of 6 months (August 1st 2023 to February 2024). The study area is made up of eight (8) LGAs. They include Dala, Fagge, Gwale, Kano Municipal, Nassarawa, Tarauni and parts of Ungogo and Kumbotso local governments. The sample size was calculated using the Fisher's formula from a similar work done in Nigeria[10].

The research instruments were direct eye examination and questionnaire (semi-structured). The questionnaire was given to each driver by face- to-face interview which consists of three sections. Section A consists of socio-demographic data of the drivers. Section B consists of work training and working conditions of the drivers, level of education, updated driver's license, how they learnt to drive, years of driving, hours of driving per week and driving experience. Section C consists of the history of eye condition, last eye examination and reason, use of glasses, glare disturbance when

driving and knowledge on tints and filters. Section D consists of data recordings. The research materials were illuminated distance VA chart (Snellen acuity Chart), 2.2 volt penlight (Keeler), direct ophthalmoscope (Keeler), batteries (Duracell plus), generator (power) and Stopwatch.

Those included in the study were commercial drivers certified by the appropriate agency, who gave their consent and with no ocular pathologies that prevents them from seeing the distance VA chart, especially those involving the ocular media and posterior segment. The purpose of this study was well explained to the participants and written inform consent was obtained from them before the eye examination.

Distance Snellen acuity chart (literate/illiterate) was placed at a distance of 6m from the participant to find out the level of visual acuity. The test was done monocularly with the right eye first before the left eye. For those wearing spectacles already, the VA was taken with and without the spectacles. Acuity values were recorded in the data sheet.

The ophthalmoscope (Keeler) was used to examine the external and internal parts of the eye. The participants were comfortably seated and instructed to look at a target. Ophthalmoscopy was done in a dimly lit room, monocularly with the right eye first before the left eye. Any serious ocular disease detected during the examination, was referred to a nearby hospital/clinic for evaluation and management. Findings were recorded in the data sheet.

PSRT was done in an ambient room illumination. After adapting to ambient illumination, the right eye was dazzled with light from pen torch held at 2cm along its visual axis for 10 seconds with the left eye occluded and distant correction removed if any. At 10 second the dazzling stimulus was removed and the subjects were instructed to read the Snellen's optotype and the time required in seconds for the subjects to read three optotypes one line above the best VA of that eye was recorded as the PSRT of that eye. This method was repeated for the left eye and both findings were recorded in the data sheet. (Normal PSRT scores were taken as 30 seconds or less).

Disability glare was measured using penlight glare test. This was done monocularly by re-measuring visual acuity of the subject with light source placed 30^0 at a distance of 30cm from the eye. Acuity values were recorded in the data sheet.

(Normal scores were taken as decrease in visual acuity of one line or less).

Frequency tables and proportions were used to summarize and present qualitative data. Mean and standard deviations were used to present quantitative data. Data was analyzed using the Statistical Product and Service Solution (SPSS) version 25. Ethical Approval was given by the Health Research Ethics Committee of the Ministry of Health, Kano State and permission sought from Nigerian Union of Road Transport Workers.

Results

A total of 134 drivers were recruited and examined, giving a 100% response. The participants were exclusively males (134) with age range of 20 –70.

Table 1: Age distribution of drivers

Age	N (%)	Mean (SD)
20-29	22(16.42)	24.9 ± 2.71
30-39	42(31.34)	34.0 ± 2.87
40-49	36(26.87)	44.0 ± 2.75
50-59	20(14.93)	53.9 ± 2.25
60-70	14(19.45)	65.0 ± 2.88
Total	134(100)	41.4 ± 12.41

The mean age and standard deviation of the participants were 41.40 ±12.41years (Table 1). It was observed that those between the age of 30 and 39 had the highest distribution of age, and the lowest was of the age distribution were between 60 and 70. (Table 1)

Table 2: Frequency distribution of Subjects' responses to visitation to an eye care practitioner, awareness of glare protection.

Variables	Yes (%)	No (%)	Total (%)
Ever Visited Eye Care Practitioner	29 (21.64%)	105 (78.36%)	134 (100%)
Glare Protection Awareness	52 (38.81%)	82 (61.19%)	134 (100%)

Table 3: Level of Education and Driving License

Level of Education	N (%)
INFORMAL	**27(20.15)**
Invalid Driving License	14(10.45)
Valid Driving License	13(9.70)
NOT INDICATED	**4(2.99)**
Invalid Driving License	2(1.49)
Valid Driving License	2(1.49)
PRIMARY	**22(16.42)**
Invalid Driving License	9(6.72)
Valid Driving License	13(9.70)
SECONDARY	**47(35.07)**
Invalid Driving License	16(11.94)
Valid Driving License	31(23.13)
TERTIARY	**34(25.37)**
Invalid Driving License	8(5.97)
Valid Driving License	26(19.40)

Majority of the participants had normal vision (using the standard defined for driving in Nigeria by the FRSC, 6/9 or better in the worse eye). (Table 3)

Table 4: Entry Visual Acuity OD and OS

Variables	**<6/18**	**>6/18**
VA of Right Eye (OD)	112 (83.6%)	115 (85.8%)
VA of Left Eye (OS)	22 (16.4%)	19 (14.2%)

Table 5: Glare Sensitivity OD and OS

	Normal	**Abnormal**
Glare Sensitivity OD	132(98.5%)	2(1.5%)
Glare Sensitivity OS	134(100%)	0(0%)

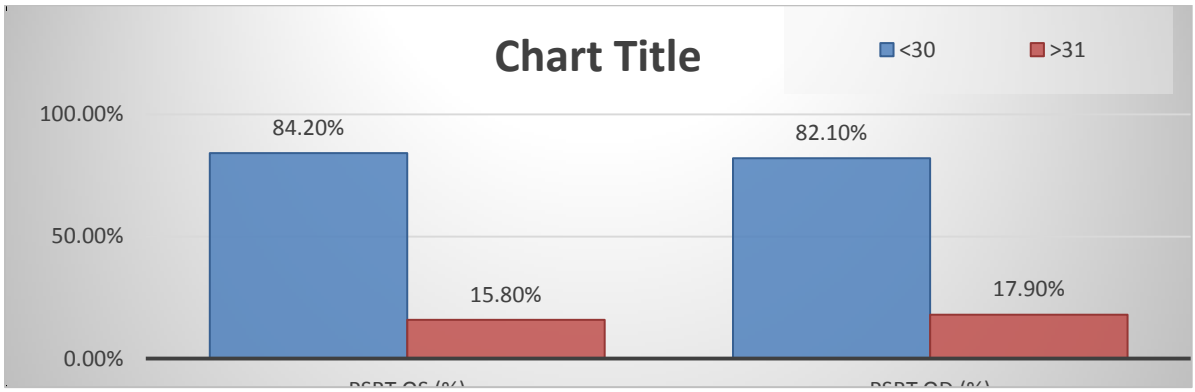

Figure 1: Distribution of PSRT scores in the sample

The Figure 1 shows the distribution of PSRT scores for both right and left eye was below 30 seconds, indicating that majority of the sample population has normal PSRT.

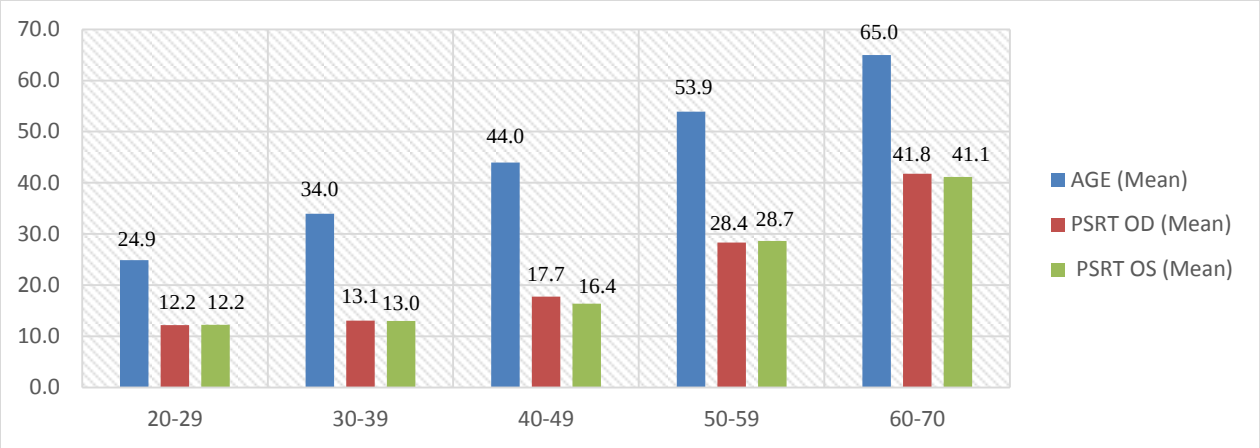

Figure 2: Mean age distribution and PSRT

Figure 2 shows the age distribution of participants according to the sample population. Chi-square goodness of fit for uniform distribution indicates a significant difference (X2= 0.001) in the sample population at confidence interval of 95% with p-value of less than 0.05.

Discussion

In this study, the participants were exclusively males 100% (134). Our mean age (41.40 ±12.41years) was similar to 41.50±11.10 years reported in Ghana[11]. However; the mean age was lower than 46±10.13 years[12]and 62±5 years[13] but higher than 33.30±12.74 years[14] and 29±6 years[15]reported by a similar research previously carried out in Dublin. The difference in the mean age is as a result of total number of participants (134) in the reports as well as age group gap (20-29).

Participants with secondary level education had the highest respondents with 47(35.07%). This is similar to that reported in Ghana[11] whose majority participants are in middle school, unlike that reported in North Central Nigeria[12]with primary level 145(44.3%) having the highest respondents. This difference may be attributed to various approaches to education in the locations, which is being influenced by factors such as cultural norms and available resources.

A total number of 85(63.43%) had valid up to date license and the remaining 49(36.57%) either had an expired license or did not register for a license at all. Majority of participants with a valid license has a tertiary or secondary education while those with informal education are the majority with invalid license. This is similar to the study that all the participants had a valid up to date license and in the middle level of

education[11]. Perhaps the issue of having a valid license has to do with level of education, meaning their knowledge and attitude on the importance of abiding by laws and regulations or how demanding and strict the commercial drivers associations, as well as the inter-state licensing authorities.

The outcome of people that had ever visited an eye care practitioner among participants were 29(21.64%) which was drastically low considering majority of which were above the age of 40 years. This is in contrast to work where 70% [11] have got in contact with an eye practitioner once or more in 2 years and that with 32.3%[12]who had regular eye check. A study that reported how good vision is important for night driving and decrease in visual functions happens with increased age and visual impairment which is triggered more in mesopic light condition (night driving condition)[16]. Also among the participants only 52(38.81%) were aware of glare protective wears, which is lower than 220(67.1) reported in North Central Nigeria[12]. The difference lies in increased number of participants engaging with eye care practitioners which enhances awareness and knowledge about optimal eye protection, including the use of eye protective wear.

This study shows that only 28(20.9) of the commercial drivers had an entry visual acuity below the visual acuity requirement for eligibility to drive in Nigeria (VA=6/9) and are required to check in with an eye practitioner.

Majority of respondents had a normal PSRT 110 (82.1%) and 112 (84.2) i.e. below 30seconds with mean PSRT of 19.46sec and 19.07sec for right and left eye respectively. This is similar to mean PSRT from reports gotten from North Central Nigeria[18] with mean PSRT of 22.45±20.07sec and 18.27±18.13sec for right and left eye respectively and that from Owerri, Nigeria[1] with 21.6±10.7sec using pen torch. However it was lower than mean PSRT results of 27.7±2.9sec reported in Dublin Ireland[15] and 25.77±12.49sec and 25.04±11.83sec in male and female respondents respectively reported in Edo, Nigeria[14]. The similarity and difference in mean PSRT among reports was due to technique used (automated perimeter instead of dazzling light method) and age gap.

At 95% confidence interval, the mean PSRT ranged from 12.2sec to 41.8sec for an age range of 20 to 70 years. Using chi-square goodness of fit a significant relationship was established between age and PSRT with p

value of 0.001. This is similar to reports in Dublin, Ireland[15], with p value < 0.05, who found a mean increase significance of 27.46%. This relationship is as established through the increased PSRT score with increasing age which indicates how photoreceptive elements takes more time to return to their pre-bleached acuity level. Hence explains the gradual non-pathologic deterioration of macular with age. However another researcher from Ilorin, Nigeria[8]reported non-significant relationship between PSRT and age with p=0.435 and 0.634 in right and left eye respectively, despite using same method with most study (light dazzling method). There is a marginal difference in the mean age of participants of studies that exhibit a significance relationship, as demonstrated in the analysis.

They were 132 (98.5%) and 134 (100%) that had normal glare sensitivity score in their right and left eye respectively using the snellen letter visual acuity unlike that reported by a researcher[13] who used halo meter claiming the traditional measurement of vision (snellen letter visual acuity) can provide an inadequate measure of forward light scatter relevant to glare effects in drivers.

The relationship between PSRT and GS was established at confidence interval of 95% with p value of 0.0001 in both eyes. The correlation between macular pigment (MP), glare disability and PSRT as with increased in MP there is improvement in glare disability and PSRT[16]. This maybe as a result of significant relationship between VA with both PSRT and disability glare[12,13] .

Conclusion

Positive association between PSRT in relation to age and disability glare were found, this emphasizes the need to introduce photostress test as a requirement for issuance and renewal of driving license especially for older people. There is the need for periodic eye screening among commercial drivers. Intervention targeted at generating awareness regarding the need for regular eye examinations, use of glare protective wears and the necessity of maintaining valid and up to date license at all time. License should be issued according to visual function i.e. some drivers should be restricted to day and intrastate driving only. Future researchers should consider securing adequate resources to accurately replicate real world condition (e.g. using car headlamps instead of penlight).

Conflict of Interest

There is no conflict of interest.

References

1. Akujobi AU, Uzomah GO, Ike OO, Ekenze JC, Obioma-Elemba JE, Akogu OA. Photostress Recovery Time among Welders in Owerri Municipal Council, Southeast Nigeria. Journal of the Nigerian Optometric Association*;* 2021;*23*(1): 4-10.
2. Salmon JF. *Kanski's Clinical Ophthalmology* (9th ed); 2020 Elsevier limited.
3. Messenio D, Marano G, Gerosa S, Iannell F & Biganzoli E. The influence of age on the recovery of the ERG photostress test. Documenta Ophthalmologica; 2012; 87-97.
4. Elliot DB. *Clinical procedure in primary eye care* (3rd ed.); 2007 Elsevier Limited.
5. Gruber N, Mosimann UP, Müri RM & Nef T. Vision and night driving abilities of elderly drivers. Traffic injury prevention, 2013; 477-485.
6. Mumtaz S, Hameed A & Arif H. Frequency of refractive errors in bus drivers. Biometrics & Biostaisticst International Journal; 2016; *4* (4), 218-220.
7. Wood JM. Standard measures of visual acuity do not predict drivers' recognition performance under day or night conditions. Optometry and Vision Science; 2005, 698-705.
8. Oladehinde MK, Adeoye AO, Adegbehingbe BO & Onakoya A. Visual functions of commercial Drivers in relation to road accidents in Nigeria. Indian Journal of Occupational and Environmental Medicine; 2007; *11* (12), 71-75.
9. Bekibele CO, Fawole AI, Bamgboye AE, Adekunle LV, Ajayi R, & Baiyeroju AM. Prevalence of refractive error and attitude to spectacle use among drivers of public institutions in Ibadan. *Jos Journal of medicine* ; 2007, *6* (1), 26-30.
10. Chidi-Egboka N, Bolarinwa O & Awoyemi A. Photostress recovery time among commercial drivers in Nigeria. The Tropical Journal of Health Sciences; 2016, 20-27.
11. Boadi-Kusi, SB, Austin E, Abu S, Holdbrook S & Morny EKA. Disability glare and nighttime driving performance among

commercial drivers in Ghana. Journal of occupational Health; 2021,54-63.

12. Chidi-Egboka NC, Bolarinwa OA, Awoyemi AO & Patrick C. Eye care practices among commercial drivers in a developing country. Research. Journal of Health Science; 2017, 82-93.
13. Babizhayev MA. Glare Disability and Driving Safety. Ophthalmic Research; 2003, 19-25.
14. Omokhua, P., & George, O. (2010). Photostress recovery time among Nigerians. Journal of the Nigerian Optometric Association; 2010, *16*,16-20.
15. Loughman JMC, Nolan JM, Howard AN, Connolly E & Meagher KA. The relationship between macular pigment and visual performance. Vision Research, 2010, 1249-1256.
16. Wood JM. Night time driving: visual, lighting and visibility challenges. Ophthalmic and Physiological Optics*;* 2020, 187-201.
17. Stringham JM & Hammond Jr BR. Macular pigment and visual performance under glare conditions. Optometry and Vision Science; 2008, 82-88.
18. Aslam TM & Haider D. Principles of disability glare measurement: an ophthalmological perspective. Acta Ophthalmologica Scandinavica; 2007, 354-360.