Original Article

A Study of Visual Function Quality Along with Static and Dynamic Visual Acuity in Commercial Bus Drivers of Chandigarh, Mohali, and Panchkula

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ABSTRACT

Purpose: To evaluate the quality of visual function and visual acuity both static and dynamic in professional bus drivers in three cities of India.

Study Design: Cross sectional study.

Place and Duration of Study: Eye Clinic of Department of Optometry, Chandigarh Pharmacy College, Chandigarh Group of Colleges, Jhanjeri, Mohali, Punjab, India from April 2024 to June 2024.

Methods: A sample of 215 professional bus drivers aged 25 to 45 from the Tricity was selected with best corrected visual acuity of 6/6, with or without a refractive error (up to +/-3.00 spherical). The drivers with at least one year of driving experience and a minimum of five hours of daylight driving each day were included. Refractive error, static visual acuity (SVA) and dynamic visual acuity (DVA), colour vision, contrast vision, glare vision and stereo vision were assessed.

Results: The mean age of participants was 32±5.9. There was a significant difference in SVA and DVA of the same person ($p < 0.00001$). The time taken for the evaluation of the DVA was lesser as compared to the SVA. A moderate positive correlation was observed between visual acuity and stereopsis ($rs=0.43$) and between visual acuity and contrast sensitivity ($rs=0.41$), while other visual parameters showed weak or negligible associations.

Conclusion: Visual acuity and related visual qualities significantly influence driving performance, emphasizing the need to assess both static and dynamic visual acuity in professional drivers.

Keywords: Vision, Visual Acuity, Stereopsis, Contrast Sensitivity, Color Vision, Occupational Health.

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INTRODUCTION

The effectiveness and safety of professional bus drivers are greatly affected by their visual skills. Drivers depend significantly on their visual acuity, depth perception, peripheral vision, and speed at processing visual information when navigating bustling metropolitan streets or rural roads. Professional drivers' health is impacted by their driving hours. Fatigue and even acute or chronic sleep restriction are two major consequences. These symptoms affect driving safety in addition to their health and quality of life. Bus drivers are more likely

to experience additional illnesses in addition to exhaustion, primarily as a result of the physical and emotional strain of their jobs.[1] A road traffic accident is caused by a number of factors, including poor roads, missing or incorrect traffic lights and signs, reckless driving, intoxication, excessive speeding, unfit vehicles, traffic jams, and visual issues, like quality of visual skills. It takes motor, cerebral, sensory, and compensating skills in driving a vehicle. Driving not only requires visual acuity but other skills and senses too like reading signs and spotting approaching cars. The fact that a driver must typically manoeuvre, monitor, and view all sides of a point of fixation makes a significant contribution to the visual task in addition to the psycho motor demands of driving.[2] Due to the significant reliance on these abilities, particularly in bus operations when the safety of passengers and other road users is concerned, professional drivers must make quick decisions based on visual cues to identify traffic lights, pedestrians, or potential hazards.[3] Visual impairments, such as reduced contrast sensitivity or a smaller field of vision, have shown to significantly affect driving performance and reaction times.[4,5] Despite their critical importance, very little research has been done on the specific ways that visual abilities impact bus drivers' performance in the field. Most driver safety research focuses on more basic cognitive or physical traits, often overlooking the intricate relationship between vision and driving ability. Research on the skills of drivers particularly related to the visual functions can help in better training methods, safer procedures, and more successful regulations meant to improve the performance of bus drivers. When it comes to the quality of visual functions, visual acuity including static and dynamic, contrast, glare, depth perception, colour vision plays a very important role in driving. The relationship between visual abilities and driving outcomes in ordinary drivers has been the subject of numerous studies; however, there is currently a lack of research that exclusively focuses on professional bus drivers. The aim of this study was to evaluate the quality of visual skills along with the DVA and SVA in commercial bus drivers of Tri-city (Chandigarh, Mohali and Punjab).

METHODS

A cross-sectional study was conducted from April 2024 to June 2024. A total of 215 professional bus drivers between the age group of 25-45 years from the Tricity (Chandigarh, Mohali & Punjab) were recruited based on the formula of $n = Z\alpha 2p\ (1-p)/d2$ with level of significant [1.96] P = 15.7%.[6]The minimum sample size was 215 (203+12) including for the dropouts if any. The participants were invited via directly communicate with the drivers from the Tricity. Informed consent was taken after ethical approval from Chitkara University, Punjab (**EC/NEW/INST2024/531/259).** The study was conducted in the Eye Clinic of Department of Optometry, Chandigarh Group of College, Jhanjeri, Mohali, Punjab, India. All the bus drivers with a best corrected visual acuity of 6/6 with a refractive error (up to +/-3.00 Sph) or 6/6 without any refractive error, driving experience of more than 1 year and a minimum of 5 hours of driving per day especially driving at daytime were included. The purpose of inclusion of participants with a best corrected visual acuity of 6/6 was to first compare both the visual acuity (static and dynamic) and secondly, to find-out the quality of visual skills among all the participants with a normal visual acuity. Drivers with any ocular or systemic disorders like cataract, ocular trauma and ocular infection were excluded. Similarly, drivers who drive at night were also excluded because lower illumination at night time affect visual acuity differently as compared to the day light driving. All the participants were asked to fill the Visual Activities Questionnaire (VAQ) which was written in English language and was also translated for the drivers who did not understand English.[7] There were 33 questions with scoring from 1 to 5 (never=1, rarely=2, sometimes=3, often=4, always=5). The objective of this questionnaire was to provide a composite score for every visual function. All the participants underwent visual evaluation for refractive error, SVA, DVA, colour vision, contrast vision, glare and stereoacuity. SVA was evaluated using Log Mar chart and the DVA with DVOP-Chart 2020.[8]While LogMAR chart is based on the principle of minimum angle of resolution and scored in log units, in the DYOP chart for dynamic optotype, the patient sees two random rotating circles out of which the patient has to respond to the direction of rotation of the circle. Sstatistical analysis was done using IBM SPSS version 29. Shapiro-Wilk test was applied to check the normality of data which was not normally distributed.

RESULTS

The mean age of participants was 32 ± 5.9 years. Table 1 shows VAQ scores of commercial bus drivers across eight visual functions, including patient scores, means, medians, totals, relevant question numbers, and

Table 1: *Visual Activity Questionnaire Score of Commercial Bus Drivers.*

VAQ Visual Functions	Patient Score	Mean	Median	Total	Q. No	Percentage %
Color ddiscrimination	1231	1.83	1.8	3225	5,17,25	38%
Glare ddisability	1232	1.87	1.9	3225	4,14,29	38%
Light/Dark aadaptation	1819	2.1	2.05	4300	1,12,23,28	43%
Acuity/Spatial vision	1634	1.85	1.9	4300	7,10,15,27	38%
Depth perception	1230	1.83	1.9	3225	9,21,32	38%
Peripheral vision	2156	1.94	1.9	5375	2,11,19,26,31	40%
Visual search	2166	1.94	1.9	5375	3,6,16,20,24	40%
Visual processing speed	2586	1.96	1.95	6450	8,13,18,22,30,33	43%

percentages. It reveals that challenges like color discrimination and glare disability were common (38%), while light/dark adaptation and visual processing speed showed the highest prevalence (43%), and peripheral vision and visual search were in an intermediate range (40%). Overall, the mean and median scores across all functions showed consistent self-reported visual activity levels.

The Mann Whitney-U test was applied to compare the difference between the SVA with a mean rank of 160.5 and the DVA (DYOP) with a mean rank of 269.2 in all the 215 participants. Table 2 shows that extremely small P values for both OD and OS (less than 0.00001) indicate a highly significant difference between the LogMAR and DYOP measurements.

The evaluation time for DVA using the DYOP chart was found to be significantly less compared to the time required for SVA evaluation with the LogMAR chart. The range of the time taken for SVA was between 154 seconds to 160 seconds and that for DVA was between 144 seconds to 149 seconds (Figure 3).

Table 2: *Difference between Log Mar and DYOP in both eyes.*

	U score	Z score	P value
OD	11345	-10.009	<0.00001
OS	11355.5	-10.111	<0.00001

There was significant difference between the SVA and DVA. The SVA showed a range of visual acuity from 0.00 log unit to 0.02 log unit, whereas the range of DVA was from 0.00 to 0.13 log unit.(Figure 1). Contrast sensitivity was in the range of 6.5 in right (OD) and 6.4 in left (OS) which was not very significant (Figure 2).

The One sample Wilcoxon Signed Rank Test was applied for color vision analysis. The results showed that the color vision n=215 with a Z value of 2.933.

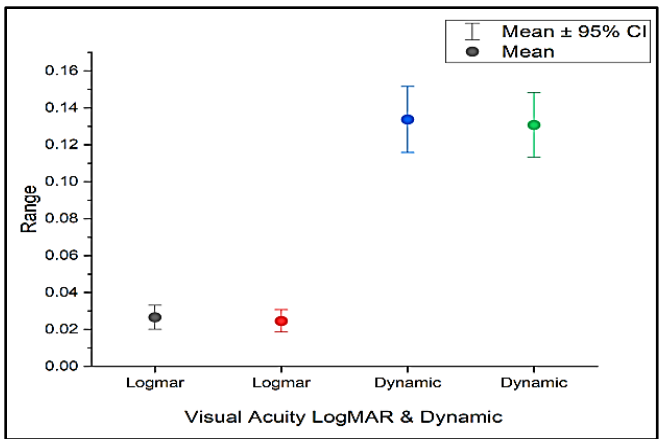

Figure 1: Illustrate the range of SVA and DVA in both the eyes.

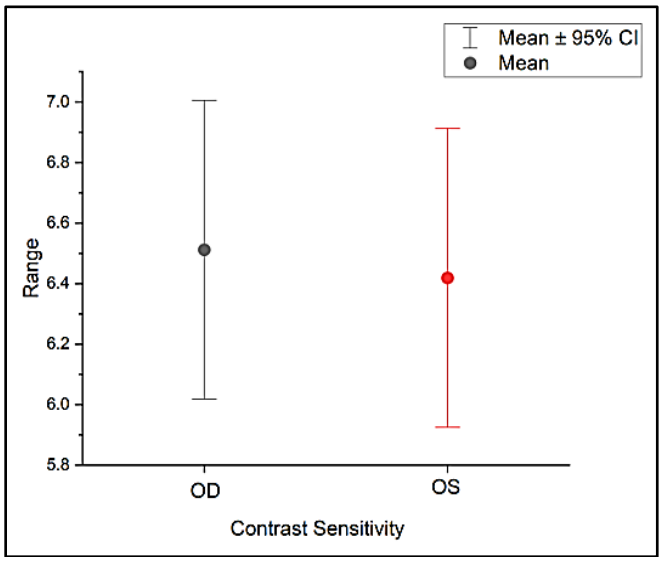

Figure 2: Illustrate contrast sensitivity at 6.5 in right eye (OD) and 6.4 in the left eye (OS).

So, at 0.05 level, the population median was significantly different from the test median (0).

Applying spearman correlation, it was found that Visual Acuity showed a moderate positive correlation with both Stereopsis and Contrast Sensitivity, while

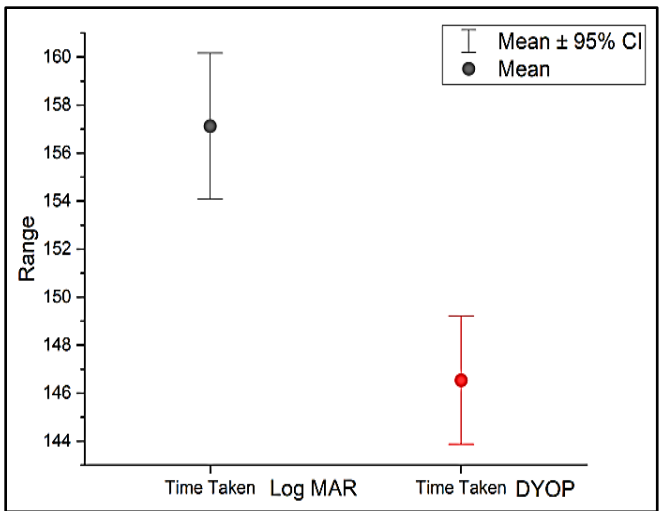

Figure 3: Shows the range of time taken for the evaluation of SVA (LogMAR) and DVA (DYOP-Chart 2020).

Color Vision exhibited virtually no correlation with Stereopsis, Visual Acuity, or Contrast Sensitivity. Stereopsis and Contrast Sensitivity had a weak positive correlation (Table 3).

Table 3: *Correlation table r_s value (spearman correlation).*

Sr. No	Variables	r_s
1.	Visual Acuity and Stereopsis	0.43
2..	Visual Acuity and Contrast sensitivity	0.41
3..	Stereopsis and Contrast sensitivity	0.1
4.	Color vision and Stereopsis	0.00
5.	Color vision and Visual acuity	0.001
6.	Color vision and contrast sensitivity	0.00

DISCUSSION

Professional bus drivers' visual abilities are vital to make snap decisions that affect their own and other people's safety. The results of this study showed that vvisual acuity and related visual qualities significantly influence driving performance, emphasizing the need to assess both static and dynamic visual acuity in professional drivers.

LogMAR and Snellen's charts are commonly used for assessing the SVA and for DVA there are three methods: Dynamic Visual Acuity Tests (DVATs) with moving optotypes, DVATs with non-moving optotypes and the DVATs with motion perception behavior.[9] Our daily lives involve several tasks that demand us to pay attention to a variety of items, most of which are in motion and not static. Thus, dynamic visual acuity has a strong connection to our lives.[10,11]

Therefore, it is imperative that DVA must be evaluated in a clinical setting along with the static visual acuity.[12-14]

Quality of visual functions is another factor in professions like driving, and it involves multiple sensory visual functions. Previous studies have shown that not only visual acuity, but depth perception, contrast sensitivity, and glare affect driving.[15,16]They are crucial for a driver's ability to identify hazards, evaluate traffic, and respond to changes on the road. It was also reported that the risk of an accidents had a significant association with visual acuity ($p < 0.001$), whereas no significant associations were observed with visual field, stereopsis, contrast sensitivity, binocular balance, or intraocular pressure ($p > 0.05$).[17]

Depth perception, another crucial visual skill, is necessary for tasks like determining the proper braking distances and evaluating the distance between cars. Research indicates that the likelihood of rear-end crashes and parking problems is higher for drivers with poor depth perception.[18] The bus drivers are particularly vulnerable to these issues if they have impaired depth perception because they frequently operate large vehicles in constrained spaces. This demands strict regulations regarding ocular health and mandatory ocular examinations to ensure road safety in professional drivers.

The usual practice focuses only on visual acuity and does not address the quality of vision. Therefore, despite passing vision screening, bus drivers might not have all the visual skills required for safe driving. There is a need for improved vision testing especially for professional drivers, particularly in sectors like public transportation where safety is a top priority. Given the critical role that visual skills play in driving performance, visual function training and screening must be a part of professional development programs for bus drivers. Optimal visual performance is a key determinant of driving safety, reducing the risk of accidents, particularly fatal ones.[19,20]

This study was limited by its cross-sectional design. The sample was restricted to professional bus drivers aged 25–45 years from three cities in India, which may limit the generalizability of findings to other age groups, geographic regions, or types of drivers. Only drivers with best-corrected visual acuity of 6/6 and refractive errors within ±3.00D were included, excluding those with poorer vision who may be at higher risk.

CONCLUSION

The DVA and optimal visual functions are essential for driving efficacy, safety, and general quality of life. Additional study on professional bus drivers is essential to elucidate the relationship between visual capabilities and driving safety, therefore enhancing public transportation safety and mitigating road accidents.

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Patient's Consent: Researchers followed the guide lines set forth in the Declaration of Helsinki.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board **(EC/NEW/INST2024/531/259)**.

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Authors Designation and Contribution

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Renu Thakur; Professor: *Design, Statistical Analysis.*

Anitha Arvind; Associate Professor: *Manuscript Editing, Manuscript Review.*