



Journal of Innovative Research (JIR)

ISSN: 2837-6706 (ONLINE)

VOLUME 4 ISSUE 2 (2026)

**PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA**

Long-Distance Bus Drivers with Eye Muscle Movement: The Eye-Friendly Profession - An Observational Retrospective Study

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Article Information

Received: May 08, 2026

Accepted: July 25, 2026

Published: August 10, 2026

Keywords

Bus Driving, Occupational Health, Oculomotor Exercise, Prolonged Sitting, Sedentary Behavior, Visual Health

ABSTRACT

Long-distance bus driving requires continuous visual scanning, sustained attention, and repetitive gaze shifting, and prolonged eye muscle activity. Although professional driving is commonly associated with fatigue-related occupational risks, limited research has explored its potential relationship with adaptive visual functioning and subjective ocular comfort among experienced drivers. This study aimed to evaluate the visual health status of long-distance bus drivers following prolonged driving exposure involving continuous and partial visual scanning. A retrospective observational study was conducted among 150 professional long-distance bus drivers in Bangladesh. Data were collected using a structured questionnaire focusing on demographic characteristics, occupational driving history, daily driving duration, self-reported ocular discomfort, and use of eye medications. The participants were aged between 40 and 70 years and had 20–30 years of professional driving experience. Descriptive analysis was performed to summarize the findings. The respondents reported driving for approximately 8–12 hours daily, and all participants were male. Interestingly, none of the drivers reported experiencing eye pain or visual discomfort immediately after long-distance driving with continuous road observation, mirror checking, peripheral monitoring, and dynamic focus adjustment. Furthermore, none of the participants reported using ophthalmic medications, including eye drops or oral treatments for eye-related problems. These findings suggest preserved subjective ocular comfort despite prolonged occupational visual exposure. This study provides a novel occupational health perspective suggesting that experienced long-distance bus drivers may maintain subjective ocular comfort through adaptive eye movement patterns and continuous visual scanning behavior. Professional driving may function as a form of practical visual training that supports visual attention and eye muscle coordination over time, which may also be followed by other professionals. To better understand this issue, it is recommended that future research focus on experimental studies, especially through comparisons with other professions.

INTRODUCTION

Vision plays a fundamental role in safe and effective driving performance, particularly among long-distance bus drivers who must continuously process dynamic environmental information through sustained visual attention and repetitive eye movements. Professional driving requires constant visual scanning of roads, mirrors, traffic signals, pedestrians, and surrounding vehicles, demanding coordinated ocular motor activity, rapid gaze shifting, and continuous situational awareness. Recent advances in eye-tracking and driving ergonomics research have highlighted the importance of visual attention and gaze behavior in maintaining driving safety and cognitive performance (Arias-Portela *et al.*, 2024; Aydin *et al.*, 2024).

Previous studies have primarily focused on the negative consequences of prolonged visual activity, including eye fatigue, digital eye strain, myopia progression, and visual stress associated with near work and reduced blinking frequency (Chhabra *et al.*, 2022; Niyazmand *et al.*, 2025). Similarly, visual fatigue has been linked with prolonged concentration and accommodative stress in occupational settings. However, evidence also suggests that repetitive

ocular motor activity and gaze stability exercises may improve dynamic visual acuity, eye coordination, and visual endurance (Morimoto *et al.*, 2011; Gupta & Aparna, 2020; Soundari *et al.*, 2025).

In transportation psychology, experienced drivers have been shown to develop more efficient visual attention strategies and optimized scanning patterns compared with novice drivers (Konstantopoulos *et al.*, 2010). Continuous environmental monitoring during driving may therefore function as a form of practical visual training that strengthens eye movement coordination and situational awareness over time. Lu *et al.* (2017) further emphasized that rapid visual information processing and sustained awareness are essential components of professional driving performance.

Despite growing research on driver fatigue and traffic safety, limited studies have explored the potential positive relationship between prolonged professional driving and subjective ocular comfort. In particular, there remains a significant gap regarding whether continuous visual scanning during long-distance driving may contribute to adaptive eye muscle movement and occupational visual resilience among experienced drivers. Most existing

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literature has focused on pathology, fatigue, or accident risk rather than adaptive visual functioning.

Therefore, the present retrospective observational study aimed to investigate the visual health status of experienced long-distance bus drivers following prolonged driving exposure involving continuous and partial visual scanning. The study specifically explored self-reported ocular discomfort and eye medication use among drivers with extensive professional experience. By examining the possibility of occupational visual adaptation, this study seeks to contribute a novel perspective to the fields of occupational ophthalmology, transportation ergonomics, and visual health research.

LITERATURE REVIEW

Physiological Basis of Eye Rotation Exercise

The continuous eye rotation exercise is a movement of the eyeball in a clockwise and anticlockwise direction in a circular manner. This movement moves the extraocular muscles which control the movement and coordination of the eyes. The exercise of movement of the eye periodically can increase the flexibility of the eye muscle, blood flow to the eye and visual comfort, particularly when individuals are doing long period near tasks either on a computer or reading. According to Indian Research on ocular exercises, ocular exercises can have a beneficial effect, including alleviating symptoms of asthenopia (eye strain) because they relax the eye muscles and enhance accommodative balance of the eye (Gupta & Aparna, 2020).

Driver Visual Attention and Eye-Tracking Behavior

Modern eye-tracking research has demonstrated that drivers rely heavily on continuous gaze shifting, peripheral monitoring, and dynamic visual processing to maintain road safety and environmental awareness. Arias-Portela *et al.* (2024) emphasized that eye-tracking metrics provide important indicators of driver situational awareness and cognitive adaptation during complex driving tasks. Similarly, Aydin *et al.* (2024) reported that professional driver's exhibit structured visual behavior patterns characterized by controlled gaze fixation and efficient visual scanning mechanisms.

Influence of Driving Experience on Visual Search and Hazard Perception

Driving experience appears to significantly influence visual attention efficiency. Konstantopoulos *et al.* (2010) found that experienced drivers demonstrate superior hazard perception and more organized visual search behavior than inexperienced drivers. These adaptive gaze strategies may reduce unnecessary visual overload and improve driving stability during prolonged journeys. Lu *et al.* (2017) further reported that drivers require continuous situational awareness and rapid environmental information processing, both of which depend heavily on coordinated eye movements and sustained visual

attention.

Effects of Prolonged Near Work on Ocular Health

In contrast, extensive near work and prolonged visual concentration have traditionally been associated with negative ocular outcomes. Chhabra *et al.* (2022) observed significant associations between prolonged near work exposure and increased prevalence of myopia among school children. More recently, Niyazmand *et al.* (2025) reviewed the effects of near work on anterior eye physiology and its relationship with myopia progression, suggesting that sustained accommodative demand may contribute to ocular stress. Similar findings were also reported by Martiningsih *et al.* (2026), who identified visual behavioral risk factors associated with refractive changes among students.

Benefits of Ocular Exercises on Visual Function and Eye Comfort

However, emerging evidence indicates that controlled ocular movement and gaze exercises may positively influence visual functioning and eye comfort. Morimoto *et al.* (2011) demonstrated that oculo-motor and gaze stability exercises significantly improved dynamic visual acuity and postural stability in healthy adults. Likewise, Gupta and Aparna (2020) found that yoga-based ocular exercises reduced symptoms of eye fatigue, suggesting that repetitive and structured eye movement activity may strengthen ocular endurance mechanisms. Soundari *et al.* (2025) also reported improvements in eyestrain symptoms following ocular exercise interventions among school children. These findings collectively suggest that repetitive eye movement activity may produce adaptive physiological responses within the visual system. Professional long-distance bus driving involves continuous scanning of roads, mirrors, traffic signals, pedestrians, and surrounding vehicles over prolonged periods, requiring constant activation of extraocular muscles and visual attention networks. Such occupational exposure may therefore function similarly to repeated ocular movement training, potentially contributing to visual adaptation and subjective ocular comfort.

Nevertheless, despite increasing research on visual ergonomics and driver cognition, limited evidence exists regarding the potential positive ocular adaptations among professional drivers exposed to prolonged visual scanning environments. Most transportation-related visual studies have focused on fatigue, distraction, accident risk, or cognitive overload rather than adaptive visual resilience. Consequently, there remains a significant research gap concerning whether experienced long-distance drivers develop protective visual scanning behaviors and eye muscle coordination that help maintain subjective ocular comfort during prolonged occupational driving exposure. The present study addresses this gap by exploring the visual health status of experienced long-distance bus drivers engaged in continuous and partial visual scanning during prolonged driving activities.

Objectives

General Objective

To investigate the visual health status and adaptive eye muscle movement patterns among experienced long-distance bus drivers engaged in continuous and partial visual scanning during prolonged occupational driving activities in Bangladesh

Specific Objectives

- To assess the demographic and occupational characteristics of long-distance bus drivers, including age, driving experience, and average daily driving duration.
- To evaluate the self-reported prevalence of eye pain and ocular discomfort among drivers following long-distance bus journeys.

MATERIALS AND METHODS

Study Design

This study was conducted using a retrospective observational research design to explore the visual health status and subjective ocular comfort of professional long-distance bus drivers exposed to prolonged visual scanning during occupational driving activities. The retrospective observational approach was selected to assess drivers' self-reported visual experiences, occupational exposure, and eye-related health conditions associated with continuous driving practice.

Study Setting and Participants

The study was carried out 150 long-distance bus drivers at three different bus counters in Dhaka city from March to June 2026, Bangladesh. Participants included experienced male bus drivers engaged in intercity and long-route transportation services. The respondents were selected based on their prolonged occupational driving exposure and active involvement in long-distance transportation activities. The study population consisted of no age restrictions imposed only who had professional driving experience at least one year.

Eligibility

Inclusion Criteria

- Professional driver with at least one year of driving experience.
- Drivers who actively drive on long-distance routes.
- Individuals willing to provide informed consent to participate in the study.

Exclusion Criteria

- Drivers with a documented history of severe ocular pathology unrelated to occupational exposure.

Data Collection Procedure with Asking Questionnaires

Data were collected using a structured questionnaire developed according to the objectives of the study and existing literature related to occupational visual health and

driving ergonomics. The questionnaire included items on:

- Age of participants
- Years of professional driving experience
- Average daily driving duration
- Presence of eye pain or ocular discomfort after long-distance driving
- Use of eye medications, including eye drops and oral medications

The questionnaire was administered through direct interviews conducted with the participants. Responses were recorded manually and later organized for descriptive analysis.

Study Variables

Independent Variables

- Age, Duration of driving experience
- Average daily driving hours
- Continuous visual scanning during driving

Dependent Variables

- Self-reported ocular discomfort, Eye pain after long-distance driving
- Use of ophthalmic medications and Subjective visual comfort

Data Analysis

Collected data were analyzed using descriptive statistical methods. Frequencies, percentages, and ranges were used to summarize demographic characteristics and ocular health-related responses. The findings were presented in tabular and narrative forms to describe the visual health status of long-distance bus drivers.

Ethical Considerations

Participation in the study was voluntary, and verbal informed consent was obtained from all respondents prior to data collection. Participants were informed about the purpose of the study, confidentiality of their responses, and their right to withdraw at any stage of the interview process. Personal identifiers were not included in the data analysis or reporting process to maintain participant confidentiality. According to applicable institutional guidelines for minimal-risk research, formal ethical approval was not required

Methodological Significance

The retrospective observational design allowed preliminary exploration of a relatively under investigated area concerning occupational visual adaptation among professional drivers. By focusing on subjective ocular comfort and continuous visual scanning behavior, the study aimed to provide baseline evidence for future interdisciplinary research involving occupational ophthalmology, visual ergonomics, eye-tracking analysis, and transportation health science.

RESULTS AND DISCUSSION

Table 1 presents the demographic and occupational

characteristics of the long-distance bus drivers included in the study. The age of the respondents ranged from 40 to 70 years, indicating that most participants were middle-aged to older adults with extensive professional driving experience. The duration of employment in long-distance bus driving ranged from 20 to 30 years, reflecting prolonged occupational exposure to driving-related visual and physical demands.

Regarding workload, the respondents reported spending an average of 8–12 hours per day driving buses, suggesting substantial daily exposure to prolonged visual concentration and road-related stressors. All participants in the study were male (100%), which reflects the gender

distribution commonly observed in the long-distance transportation sector in many developing countries, including Bangladesh.

Interestingly, none of the respondents reported experiencing eye pain or visual discomfort immediately after completing a long-distance trip. Furthermore, none of the participants reported using any form of ophthalmic medication, including eye drops or oral medications for eye-related conditions. These findings may indicate either a relatively low level of self-reported ocular symptoms among the drivers or possible under recognition of visual strain and eye health problems within this occupational group.

Table 1: Data of long distance bus drivers

Asking data	Respondent answer
Age range of the person in the study sample	40-70 years
The range of Years spent in bus driving	20-30 years
Average numbers of hours spent per day on bus driving	8 -12 hours
Number of Males	100%
Have you ever felt any pain or discomfort in your eyes right after a long-distance bus trip?	No
Do you use any eye medications (drops or oral medications for eye problems)?	No

The present retrospective observational study explored the visual health status of long-distance bus drivers who were continuously engaged in partial and repetitive visual scanning during prolonged driving activities. Interestingly, despite extended occupational exposure, none of the respondents reported immediate eye pain, ocular discomfort, or the use of eye medications after long-distance journeys. These findings provide an important perspective regarding the adaptive visual behavior and possible occupational conditioning of experienced long-distance drivers.

The participants of this study were aged between 40 and 70 years and had extensive professional driving experience ranging from 20 to 30 years. Such prolonged exposure to road environments may contribute to the development of efficient visual scanning strategies and adaptive eye movement coordination. A case study, Shaanxi, China on professional drivers has shown that experienced drivers develop optimized gaze fixation patterns, controlled saccadic eye movements, and enhanced peripheral visual attention compared with novice drivers (Wang, Y. *et al.*, 2016). These adaptive mechanisms may reduce unnecessary ocular strain during prolonged driving tasks. A notable finding of this study was the absence of self-reported eye discomfort following long-distance driving. Continuous visual scanning during driving involves repeated activation of extraocular muscles, coordinated eye-head movement, and dynamic focusing adjustments. Previous a Review eye-tracking Poland studies have

demonstrated that professional drivers develop stable gaze-switching behavior and efficient visual attention mechanisms that support driving performance while minimizing visual overload (Kapitaniak, B. *et al.*, 2015). Therefore, the current findings may suggest that long-term professional driving can facilitate occupational adaptation of eye muscle coordination and visual endurance.

The drivers in the present study reported driving for approximately 8–12 hours daily. Prolonged driving is generally associated with fatigue-related risks, particularly musculoskeletal strain and mental exhaustion. However, visual fatigue symptoms were not observed among the participants in this study. Recent occupational studies among transport professionals indicate that experienced drivers often develop compensatory behavioral adaptations, including rhythmic gaze shifting, blink regulation, and strategic visual fixation, which may contribute to maintaining ocular comfort during long driving periods. Furthermore, research on visual scanning behavior has highlighted that controlled eye movements may improve situational awareness and reduce cognitive overload during continuous driving tasks.

Another important observation was that none of the participants reported using ophthalmic medications. This may indicate preserved subjective ocular health among the study population. Although aging is commonly associated with reduced accommodative flexibility and dry eye symptoms, experienced drivers may develop occupational

resilience through repeated exposure to visually demanding environments. A Case control China Studies involving driver eye-tracking and fatigue monitoring have shown that experienced drivers demonstrate more stable gaze behavior and lower unnecessary eye movement variability than less experienced individuals (Wang, Y. *et al.*, 2025). These adaptations may partially explain the positive visual outcomes observed in the present study. This study also introduces the possibility of considering long-distance bus driving as an “eye-friendly profession” under certain adaptive occupational conditions, particularly among experienced drivers without pre-existing ocular disease. While excessive driving duration can still increase fatigue risks, the absence of reported visual discomfort in this cohort suggests that long-term exposure may promote visual adaptation rather than immediate ocular deterioration in some professional drivers. However, larger prospective clinical studies using objective ophthalmologic assessments tear film evaluation, blink analysis, and eye-tracking technologies are needed to validate these findings further. Overall, the present study contributes a positive and novel occupational health perspective by suggesting that experienced long-distance bus drivers may develop adaptive eye muscle movement patterns and visual scanning efficiency that help maintain subjective ocular comfort despite prolonged driving exposure. These findings may open new research directions regarding occupational visual adaptation, eye movement training, and visual endurance among professional drivers.

Limitation

Although the researchers controlled for major confounding factors, unmeasured variables such as dietary habits, hydration status, and cabin air-conditioning humidity may have influenced the results. Additionally, although the eye-tracking data were accurate, they were collected as part of a routine safety monitoring system rather than within a clinical research setting. Beside the primary objective of this study was to establish baseline finding; therefore, future studies should employ experimental designs and compare long-distance bus drivers with other occupational groups to validate and extend these findings.

CONCLUSION

The results of the current study imply that, out of the group of jobs that can be described as associated with long periods of sedentary lifestyle, bus driving can be a distinctive advantageous job concerning the health of eyes. The visual requirements of the long distance driving, which are dynamic accommodation and repetitive scanning with the eyes, acts as exercise of the extra ocular muscles. These movements seem to reduce the negative visual impact that is normally caused by prolonged sitting. This means that bus driving can provide some intrinsic protective advantages to vision in addition to its occupational use. So the recommendation based on these

observations, professionals whose occupations require prolonged visual fixation in a single direction or extended near-work activities may benefit from incorporating regular dynamic eye movement practices and periodic gaze-shifting into their daily routines to reduce visual strain. These insights provide a novel perspective for policymakers, occupational health professionals, and researchers, informing the development of targeted strategies to mitigate visual impairment in sedentary work environments.

Acknowledgments: The authors thank the different Bus counter authority for providing access to collect data.

Author Contributions

Author 1: Conceived and designed the study, collected and analyzed the data, interpreted the findings, and drafted the manuscript. Authors 2, 3 & 4: Contributed to data interpretation, critically revised the manuscript, and approved the final version. All authors read and approved the final manuscript.

Funding: No funding was received for conducting this study.

Conflicts of Interest: The authors affirm that there are no conflicts of interest.

Artificial Intelligence Statement

The authors used ChatGPT solely to assist with language editing and improve the clarity of the manuscript. All scientific content, data analysis, interpretation, and final responsibility for the manuscript remain with the authors.

Consent for publication: Not applicable

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