OPEN

Visual Impairment and Risk of Self-Reported Road Traffic Crashes Among Bus Drivers in Bangladesh

Munir Ahmed, MPH, Jennifer L. Patnaik, PhD†‡, Noelle Whitestone, MHA†, Mohammad Awlad Hossain, MPH†, Mohammed Alauddin, MSS*, Lutful Husain, MS*, Md. Parvez Hossain, MSS*, Mohammad Shamsal Islam, MPH*, Md. Iqbal Hossain, MSS*, Kishwar Imdad, MBA§, David H. Cherwek, MD†, and Nathan Congdon, MD, MPH†¶||*

Purpose: This study assesses the prevalence and the causes of visual impairment among bus drivers undergoing screening in Bangladesh and associations with self-reported crashes.

Methods: Eye health screenings including refraction and questionnaires were conducted at 10 bus terminals in 7 districts of Bangladesh from June through August 2019. Presenting near and distance visual impairment and self-reported road traffic crashes were recorded.

Results: Among 700 participants, nearly 1 in 5 (n = 126, 18.0%) had presented visual acuity (VA) in the better-seeing eye ≤6/9, not meeting the vision standard of Bangladesh for bus drivers. A majority of drivers (n = 492, 70.3%) had near or distance refractive error, and most who failed to reach the driving standard (88.1%, n = 111) could be improved with readily available treatment, either glasses or cataract surgery. A history of 1 or more road traffic crashes while driving a bus or minibus was reported by 62 (8.97%) participants. In multivariable models, factors significantly associated with near or distance visual impairment included older age [odds ratio (OR) per year 1.15, 95% confidence interval (CI): 1.12–1.18, $P < 0.0001$] and having no driver's license (OR 1.80, 95% CI: 1.04–3.13, $P = 0.037$). Self-reported history of a motor vehicle crash was associated with near or distance visual impairment (OR 2.45, 95% CI: 1.09–5.49, $P = 0.030$), even when adjusting for other factors such as age and weekly miles are driven.

Conclusions: Ensuring that bus drivers are screened to meet the required visual standards for driving while referring those who do not for treatment, can contribute to safer roads in this high-risk setting.

Key Words: Bangladesh, bus, road traffic crashes, transportation, visual impairment

(*Asia Pac J Ophthalmol (Phila)* 2022;11:72–78)

Traffic safety is a major public health concern, as road traffic injuries are the leading global cause of death between the ages of 5 and 29 years.[1] Moreover, the number of road traffic deaths in low- and middle-income countries (LMICs) is increasing and disproportionately higher compared to high-income countries (HIC)—while 60% of the world's motor vehicles are in LMICs, 93% of road traffic deaths occur there.[1] The World Health Organization (WHO) Status Report on Road Safety shows that traffic death rates are increasing in LMICs and decreasing in HICs,[1] and further notes that incidence of traffic deaths in Southeast Asia rose from 19.8 to 20.7 per 100,000 population between 2013 and 2016, over twice the 2016 rate in Europe.[1] In Bangladesh, between 1990 and 2017, the road crash fatality rate per capita was 3 times higher than that for the South Asia region as a whole.[2]

Both globally and locally, the need to decrease death and injury from road traffic crashes is apparent. Road traffic safety improvement is highlighted in 2 of the United Nations Sustainable Development Goals (SDGs).[3] Goal 3, target 3.6, aims to halve the number of global deaths and injuries from road traffic crashes by 2030, and Goal 11, target 11.2, calls for improved road safety by expanding public transport, with special attention to the needs of vulnerable users including women, children, persons with disabilities, and the elderly.[3] In pursuit of these goals, Bangladesh approved a National Road Safety Strategic Action Plan 2017–2020, designed to achieve a 50% reduction in road crash fatalities.[2] To lower traffic deaths, expand public transport, and address the needs of vulnerable populations, the government of Bangladesh has placed strategic emphasis on the safety of its buses.

The injury profile of road traffic crashes is notably different between HICs, where the automobile driver is the most common fatality, and in LMICs, where pedestrians, cyclists, and passengers are more likely to die.[4] In Bangladesh, the majority of pedestrians and public transit users have low- and middle-income backgrounds.[5] Between 2016 and 2018, approximately 50% of fatal crashes in the Dhaka metro area involved buses.[2] In the US and the UK, deaths of drivers or passengers of buses comprise less than 1% of traffic fatalities.[1] Furthermore, WHO data show that the fatality risk for drivers and passengers per 10,000 buses is 286.6 in Bangladesh, among the highest in the region and significantly greater than 86.7 in India and 7.9 in Sri Lanka.[2]

Visual acuity is one of the key parameters commonly measured when applying for a driver's license,[6] but studies suggest that uncorrected vision problems are common among commercial drivers in LMICs.[7–13] In partnership with the Grameen GC Eye Hospital (GHS), Orbis Bangladesh carried out free eye health

Submitted September 20, 2021; accepted November 10, 2021.

From the *Orbis Bangladesh, Dhaka, Bangladesh; †Orbis International, New York, New York, US; ‡Department of Ophthalmology, University of Colorado School of Medicine, Aurora, Colorado, US; §Grameen Health Care Services Ltd, Dhaka, Bangladesh; ¶Centre for Public Health, Queen's University Belfast, Belfast, UK; and ||Zhongshan Ophthalmic Center, Sun Yat-sen University, Guangzhou, China

The authors have no conflicts of interest to declare.

Address correspondence and reprint requests to: Nathan Congdon, Orbis International, 520 8th Avenue, 12th Floor, New York, NY 10018, US. E-mail: ncongdon1@gmail.com.

ISSN: 2162-0989
DOI: 10.1097/APO.0000000000000471

screenings for Bangladeshi bus drivers in 2019. The study was designed to assess the prevalence and the causes of visual impairment among screened participants and to explore associations with self-reported crashes.

METHODS

The Human Research Ethics Committee of the Asian Institute of Disability and Development (AIDD) located in Dhaka, Bangladesh, provided review and approval for the study. Participants provided verbal consent before enrollment, and all data were analyzed in deidentified fashion. The study followed the tenets of the Declaration of Helsinki.

Setting and Participants

In partnership with GHS, eye health screenings including refraction were performed from June 30 through August 28, 2019, at 10 readily accessible bus terminals in 7 districts, all close to GHS eye hospitals capable of providing referral care as needed. Several meetings were held with the Bus Owner Committee to coordinate locations, dates, and times for the screenings.

Eye health screenings were promoted using banners and loudspeaker announcements. Consenting drivers at the selected terminals participating in the screenings were enrolled in the study. Approximately 10 drivers were booked into screening groups for vision testing sessions to minimize wait time and disruption to driving schedules.

Eye Health Screening and Ocular Examination

The clinical team for each screening consisted of 1 medical officer trained in eye health, 2 refractionists, 3 ophthalmic assistants, 1 spectacle dispenser, 1 pharmacist, and 1 administrator. Ocular examinations were carried out according to the Standard Cataract Surgery Protocols of National Eye Care Bangladesh,[14] and included:

1) Assessment of visual acuity separately in each eye using a Snellen E chart and an eye occlude;
2) Examination of the anterior segment by hand light and the posterior pole by direct ophthalmoscopy;
3) Refraction by a trained refractionist for any eye with presenting visual acuity $\leq$6/12, and dispensing of medications (predominantly topical ocular antibiotics, antiallergy drops, and artificial tears) and spectacles at subsidized rates of $3.50 to $7.00, as needed;
4) Dilation of the pupil in cases of suspected cataract (based on hand light examination), after which a medical officer performed slit-lamp examination of the anterior segment and direct ophthalmoscopy to confirm the diagnosis.

Those with confirmed cataracts were referred to the regional GHS eye hospital for treatment.

Data Collection and Management

Demographic information was recorded, and a questionnaire was administered verbally to all participants inquiring about educational status, income, years of driving experience, type of license held, hours and kilometers driven per day, vision complaints, general medical history, and self-reported road traffic crashes while driving a bus or minibus. Presenting visual acuity, refractive error, and ocular conditions diagnosed during the examination were recorded for each eye.

Patients' demographic, clinical, and questionnaire data were entered into Microsoft Access version 13 (Redmond, WA, US) by a trained data entry specialist. Orbis Bangladesh received data stored using Microsoft Excel 365 (Redmond, WA, US). A password-protected administrative database containing all respondent contact details and managed by the Orbis Bangladesh office was used for contact purposes and oversight of the data collection process. All data for research analysis were provided to the study statistician (JLP) in deidentified format.

Visual Acuity Standards for Bus Drivers in Bangladesh

According to application forms collected from the Bangladesh Road Transport Authority (BRTA), vision criteria for both professional and nonprofessional driver's licenses require a medical certificate form completed by a registered medical practitioner. Professional driver's licenses are required to be renewed every 5 years, during which time the medical certificate including vision assessment should be completed. The form inquires if there is any defect of vision; if so, whether the defect is correctable by suitable spectacles; whether red and green colors can be accurately distinguished; and whether night blindness is present. Further, it is required that the applicant can read a vehicle registration number from a distance of 25 yards (22.9 m) in daylight. An exact Snellen visual acuity is not stipulated.

To determine the equivalent Snellen visual acuity, calculations were made based on the stipulated distance and the height (4.8 cm) and width (3.5 cm) of each symbol on a Bangladeshi number plate, yielding a Snellen equivalent of 6/6.69. The closest value on a standard eye chart is 6/7.5. The application form does not specify whether drivers should see well in each eye independently. Therefore, the cutoff point used in the current study to establish whether this criterion was met was presenting visual acuity $\geq$ 6/7.5 in the better-seeing eye.

Statistical Methods

Data were downloaded from Microsoft Access version 13 into Microsoft Excel 365 and imported into SAS version 9.4 (Cary, NC, US) for statistical analysis. Descriptive analysis included frequencies and percentages for categorical variables and means, standard deviations, and medians for continuous variables. Myopia and hyperopia were defined by recorded clinical diagnosis during the examination and/or prescription of any negative or positive refractive power respectively. Presbyopia was defined by recorded clinical diagnosis during the examination and/or prescription of any add-in the spectacle power. When a participant presented with spectacles, presenting visual acuity was recorded. The near or distant visual impairment variable combined failure to meet the presenting distance vision standard for a bus driver ($\geq$6/7.5 in the better eye) and/or presence of presbyopia. Outliers for daily driving totals, including 35 participants reporting $>$ 18 hours/day and 10 participants reporting $>$ 800 km/day, were excluded from summary measures, and 9 participants with unknown history of self-reported road traffic crashes were excluded from analyses for this outcome.

Chi-square and Fisher exact tests were utilized to compare categorical variables and the Wilcoxon rank test for comparison of continuous variables. Associations between the outcomes of self-reported road traffic crashes, and visual impairment and other

variables of interest were explored with univariate logistic regression modeling. Multivariable logistic regression modeling included age and all variables significant in the univariate models, with the exception of daily distance driven since it was collinear with daily time-driven, and daily time was a stronger predictor of the outcome. Odds ratios, 95% CI, and *P* values were presented for univariate and multivariable models. *P* values < 0.05 were considered statistically significant.

RESULTS

A total of 700 participants (100% male, mean age 42.3 years, range 18 to 84 years) from 4 districts were recruited. Drivers reported a mean monthly income of $198, some 3-quarters (n = 545, 77.9%) had a middle-school or lower education, and the large majority (n = 679, 97.0%) were married. The majority of drivers responding to the question (387/575 = 67.3%) indicated that they had not had their vision tested before receiving a driver's license, although 17.9% did not report an answer to this question (Table 1).

Length of driving experience ranged from 1 to 45 years (median 15 years). The majority of participants (81.5%) reported being licensed, with 9.00% having a general professional license, 28.1% a license to drive light and medium vehicles, and 44.4% to drive heavy vehicles. Daily driving time per day ranged from 4 to 17 hours (median of 8 hours), and distance driven per day ranged from 50 to 800 km (median 200 km). A history of 1 or more road traffic crashes while driving a bus or minibus was reported by 62 (8.97%) participants responding to the question inquiring if they had ever experienced a road traffic crash while driving a bus or minibus.

Nearly 1 in 5 participants (n = 126, 18.0%) had presented visual acuity in the better-seeing eye, not meeting the vision standard of Bangladesh for a bus driver (≤6/9). Among these, 16.7% had the visual acuity of 6/18–6/60 in the better-seeing eye. Among drivers aged above 40 years, 25.7% (96/373) had presented visual acuity of ≤6/9, while for those aged above 50 years, the figure was 29.5% (38/129) (Table 2).

A total of 42 (6.0%) study participants were diagnosed with cataract, over half of whom (27/42 = 64.3%) were affected bilaterally. A majority of drivers (n = 492, 70.3%) had near or distance refractive error, among whom 12.6% (n = 62) had myopia, 25.4% (n = 125) hyperopia, and 2.23% (n = 11) presbyopia (some participants had more than 1 type of refractive error). A total of 114 drivers presented with spectacles and their presenting acuity was recorded. Among 126 participants with presenting distance visual acuity in the better-seeing eye ≤6/9, 86.5% (n = 109) of cases was due to refractive error and 12.7% (n = 16) was due to cataract (some participants had both conditions). The large majority of participants with presenting distance visual acuity ≤6/9 (88.1%, n = 111) could be improved with treatment, either glasses or cataract surgery (Table 3).

In multivariable models, the following factors were significantly associated with greater risk of near or distance visual impairment: older age [odds ratio (OR) per year 1.15, 95% confidence interval (CI): 1.12–1.18, $P < 0.0001$], having no driver's license (OR 1.80, 95% CI: 1.04–3.13, $P = 0.037$), and residence outside the extreme north district (OR 7.07, 95% CI: 2.18–22.9, $P = 0.001$) (Table 4).

Table 1. Demographic and Professional Characteristics of Bangladeshi Bus Drivers Participating in the Current Study

	All Study Participants
Male, n (%)	700 (100%)
Age, y	
Mean (SD)	42.3 (10.5)
Median (range)	42.0 (18.0–84.0)
Married, n (%)	679 (97.0%)
Educational status	
Primary school only	233 (33.3%)
Middle school	312 (44.6%)
Secondary school	100 (14.3%)
University/Post-graduate	11 (1.57%)
Religious schooling only	44 (6.29%)
Monthly income ($)	
Mean (SD)	198 (57.0)
Median (range)	192 (48–661)
Type of vehicle driven	
Bus	528 (75.4%)
Minibus	172 (24.6%)
No. y driving any vehicle	
Mean (SD)	16.1 (9.76)
Median (range)	15.0 (1.00–45.0)
Type of driving license	
Professional	63 (9.00%)
Professional light and medium vehicles	197 (28.1%)
Professional heavy vehicles	311 (44.4%)
No license	129 (18.4%)
District of residence	
Northwest	51 (7.29%)
Extreme north	24 (3.43%)
North	353 (50.4%)
South	272 (38.9%)
Time driving per day, h (n = 665)*	
Median (range)	8.00 (4–17)
Driving distance per day, km (n = 690)†	
Mean (SD)	228 (114)
Median (range)	200 (50–800)
Have eyes examined with vision chart before having a license?	
Yes	188 (32.7%)
No	387 (67.3%)
Not reported	125
Self-reported history of road traffic crash	
Yes	62 (8.97%)
No	629 (91.0%)
Missing	9

$1, Taka 83.2 on April 21, 2020.

*35 participants reporting 18+ hours per day are not included in summary measures.

†10 participants reporting > 800 km per day are not included in summary measures.

SD indicates standard deviation.

DISCUSSION

A majority of bus drivers participating in the current study were visually impaired at near or distance, and nearly 1 in 5 did not meet the distance visual acuity standard for a Bangladesh commercial driver's license. Of the latter, nearly 90% could be improved with readily available treatment. Though self-selection among drivers taking part in the screening likely means that this high prevalence of vision impairment is not representative of bus drivers as a whole in this setting, nonetheless, it is clear that there is a significant burden of uncorrected and correctable impairment among drivers. This is of particular importance given the observed relationship between visual impairment and self-reported road traffic crashes, and Bangladesh's high-reported rates of bus-

Table 2. Presenting Distance Visual Acuity in the Better-Seeing Eye at the Time of Survey

		Meet Bangladesh Vision Standard for a Bus Driver # (%)	Does Not Meet the Bangladesh Vision Standard for a Bus Driver # (%)		
Age Group (y)	Total No.	≥6/7.5	6/9–6/12	6/18–6/60	Total ≤6/9
18–35	195	184 (94.4%)	10 (5.13%)	1 (0.51%)	11 (5.64%)
36–40	132	113 (85.6%)	17 (12.9%)	2 (1.52%)	19 (14.4%)
41–45	119	98 (82.4%)	18 (15.1%)	3 (2.52%)	21 (17.6%)
46–50	125	88 (70.4%)	32 (25.6%)	5 (4.00%)	37 (29.6%)
51–55	79	59 (74.7%)	18 (22.8%)	2 (2.53%)	20 (25.3%)
56–60	24	14 (58.3%)	7 (29.2%)	3 (12.5%)	10 (41.7%)
61–84	26	18 (69.2%)	3 (11.5%)	5 (19.2%)	8 (30.8%)
Total	700	574 (82.0%)	105 (15.0%)	21 (3.00%)	126 (18.0%)

related traffic fatalities. Vision screening and accessible treatment are needed to support safer driving conditions.

We defined vision impairment as including either impaired distance or near vision. The significant association with crashes remained even after adjusting for age (near vision impairment or presbyopia is strongly associated with older age, so the adjustment was required to eliminate possible confounding). This association of impaired near vision with crashes is consistent with the very limited number of studies addressing the question among drivers in LMICs.[7,11] Though driving is often thought of as depending primarily on distance vision, smartphones and other navigation aids have become more common among drivers,[15,16] and their use is impaired among those with uncorrected presbyopia,[17] likely distracting their attention from the road and increasing crash risk. Studies confirm that navigation aids are a visual distraction while driving[18] and correcting near vision can reduce the time needed to acquire information from in-vehicle devices,[19] decreasing distraction time. Unfortunately, data on the use of navigation aids were not available in our study.

Residence in the extreme north district is associated with a greater risk for a road traffic crash, potentially due to a variety of factors particular to this location, including increased travel distances to other cities and parts of Bangladesh, and the presence of heavy winter fog and narrow roadways in the region.

Despite existing requirements, 67.3% of participants in the current study responding to the question reported not having their eyes checked before receiving a driver's license, consistent with previous reports.[7,9,13,20] Driving without a license was also associated with visual impairment in the current study, suggesting participants might have been hesitant to apply for a license if they knew they would not pass the vision test.

The current study is one of the very few providing data on vision and traffic safety among a critically important class of drivers, those operating within the public transportation sector. This sector has been specifically targeted for strengthening by the SDGs and for safety improvements by Bangladesh's national road safety plan. Our results are consistent with a smaller study (n = 120) in Pakistan[7] showing refractive errors are common among bus drivers and are associated with increased risk of traffic crashes. Further, the 18.0% figure we observed for drivers not meeting vision standards for licensure is similar to the range of 11.5 to 18.8% reported for commercial drivers by studies in Nigeria,[8,18,21] Ghana,[12] and India.[22]

While the importance of vision to safe driving is generally agreed, reports vary with respect to the existence of an association between distance visual acuity and road traffic crashes. Studies in India[11,22] and Pakistan[7] reported an association between vision impairment, refractive error or visual field defects and increased risk of road traffic crashes, consistent with our findings, while a number of African studies found no such association.[8,12,18,21] This variation may reflect differences in the definition of impairment and ascertainment of crash events, or in variable infrastructure conditions and road safety legislation between countries and regions.

Table 3. Refractive Error and Other Ocular Conditions Diagnosed Among Participants

Ocular Condition	Among All Study Participants N = 700	Among Participants With Refractive Error† n = 492	Among Participants With Presenting Distance Visual Acuity <6/7.5 n = 126
Cataract noted during examination	42 (6.0%)*	36 (7.32%)	16 (12.7%)
Refractive error			
Any type	492 (70.3%)	–	109 (86.5%)
Myopia‡	62 (8.86%)	62 (12.6%)	30 (23.8%)
Hyperopia‡	125 (17.9%)	125 (25.4%)	38 (30.2%)
Presbyopia‡	421 (60.1%)	421 (85.6%)	76 (60.3%)
Could be improved with treatment (cataract and/or any refractive error)§			111 (88.1%)

*27/42 cataracts were bilateral.

†Participants could have ≥1 type of refractive error.

‡Myopia/hyperopia was defined by recorded clinical diagnosis during examination or prescription of negative/positive refractive power without a recorded diagnosis of myopia/hyperopia. Presbyopia was defined by recorded clinical diagnosis during examination or prescription of any add in the spectacle power.

§Some participants had both cataract and refractive error.

Table 4. Univariate and Multivariate Associations With Near or Distance Visual Impairment Among 700 Bangladeshi Bus Drivers

Condition	Rate of Near or Distance Visual Impairment† N = 471 (67.3%)		Univariate Odds Ratio (95% CI) *P* value*	Multivariate Odds Ratio (95% CI) *P* value*
Categorical Variables	**Condition Present**	**Condition Absent**		
Married	471/679 (69.4%)	0/21 (0%)	−0.974	–
Educational level of primary school only	174/233 (74.7%)	297/467 (63.6%)	1.69 (1.19–2.40) 0.003	1.03 (0.67–1.57) 0.898
Drive bus (versus minibus)	371/528 (70.3%)	100/172 (58.1%)	1.70 (1.19–2.43) 0.003	1.33 (0.84–2.09) 0.221
No driving license	97/129 (75.2%)	374/571 (69.5%)	1.60 (1.03–2.47) 0.035	1.80 (1.04–3.13) 0.037
No eye exam before receiving license	258/387 (66.7%)	118/188 (62.8%)	1.19 (0.82–1.71) 0.357	–
Residence outside the extreme north district	466/676 (68.9%)	5/24 (20.8%)	8.42 (3.10–22.9) <0.0001	7.07 (2.18–22.9) 0.001
Continuous Variables				
	Mean (SD) for Visually Impaired	**Mean (SD) for Nonvisually Impaired**		
Age (y)	45.9 (8.26)	34.8 (10.8)	1.15 (1.12–1.18) <0.0001	1.15 (1.12–1.18) <0.0001
Monthly income ($)	204 (57.5)	187 (54.4)	1.00 (1.00–1.00) 0.0002	1.00 (1.00–1.00) 0.136
Time (h) driving / day	9.11 (3.02)	8.29 (2.46)	1.08 (1.03–1.13) 0.002	1.01 (0.96–1.08) 0.650
Distance (per 10 km driven / day)	237 (120)	209 (97.9)	1.00 (1.00–1.00) 0.014	–

CI indicates confidence interval; SD, standard deviation.

Bolded cells are significant at the $P < 0.05$ level.

Self-reported history of a motor vehicle crash was associated with the following predictors in multivariable models: near or distance visual impairment [odds ratio (OR) 2.45, 95% confidence interval (CI) 1.09–5.49, $P = 0.030$], residence in the extreme north district (OR 7.34, 95% CI: 2.49–21.7, $P = 0.0003$), and longer daily time spent on driving (OR for each additional hour = 1.13, 95% CI: 1.06, 1.20, $P = 0.0002$) (Table 5).

†Visual impairment includes failure to meet the distance vision standard for a bus driver (≥6/7.5 in the better eye) or presence of presbyopia.

*P values from the logistic regression model.

This study has several important messages for traffic policymakers. Most importantly, as vision impairment was associated with greater crash risk in this setting, specific vision standards are needed for licensure, spelled out in clear terms with respect to visual acuity cutoffs and the requirement to test each eye separately. Further, there is a need to ensure that such standards, once enacted, are enforced by rigorous testing of all applicants for licensure, particularly those responsible for the safety of numerous other road users. Finally, given the very high proportion of drivers with vision impairment due to readily treatable causes, referral for affordable and accessible care must be made for all those failing screening. Besides benefits at the individual level from a reduced burden of road traffic crashes, a reduction in crashes in LMICs has also been shown to be associated with increases in gross domestic product (GDP).[23]

Strengths of the current study include a large number of participants, the performance of eye examinations according to a standard protocol, and the focus on bus drivers as an important and less-studied group from the perspective of improving road safety. Limitations must also be acknowledged—as noted above, selection bias in recruitment of participants wishing to take part in an eye examination likely means that rates of visual impairment are an over-representation of the prevalence among local bus drivers in general. This is reflected in the fact that over 3-quarters of participants recorded a visual complaint at the time of examination. However, such high rates of visual disability are consistent with other reports among South Asian drivers.[10,11,22] Alternatively, drivers aware of vision requirements for licensure, and suspecting that they have a vision defect, may avoid eye health screening for fear of impact on their ability to work legally. Further understanding of the uptake of the visual assessment amongst all bus drivers eligible to participate is limited by insufficient records of bus drivers available at the bus terminals, or an accessible database of all bus drivers in Bangladesh or Dhaka. It should also be mentioned that our study utilized self-reported data rather than hospital or police records to tabulate road traffic crashes. However, it has been suggested that police and hospital registers frequently under-estimate crashes in LMIC settings,[24] and self-reporting of road traffic crashes is a validated method.[25,26] Further, the lack of a functional system to record road traffic crashes provided drivers in the current study the option to respond honestly to inquiries about their history of road traffic crashes with minimal fear of being identified as responsible.

CONCLUSIONS

Despite its limitations, the present study is among the first to provide information regarding vision and road safety among public transportation workers in LMICs, a particularly important group in reducing the global burden of road traffic injuries and deaths. Our findings are consistent with a significant burden of unaddressed visual impairment in this important cohort, the

Table 5. Univariate and Multivariate Associations With Self-Reported History of a Road Traffic Crash Among 691 Bangladeshi Bus Drivers

Potential Predictor	Self-Reported History of a Road Traffic Crash		Univariate Odds Ratio (95%CI)	Multivariate Odds Ratio (95%CI)
	N = 62 (8.97%)		*P* value*	*P* value*
Categorical Variables	**Condition Present**	**Condition Absent**		
Presenting distance vision does not meet Bangladesh standard for bus drivers (≥6/7.5 in better eye)	14/122 (11.5%)	48/569 (8.44%)	1.41 (0.75–2.64) 0.288	–
Any Distance refractive error	49/486 (10.1%)	13/205 (6.34%)	1.66 (0.88–3.12) 0.119	–
Myopia	3/61 (4.92%)	59/630 (9.37%)	0.50 (0.15–1.65) 0.255	–
Hyperopia	12/125 (9.60%)	50/566 (8.83%)	1.10 (0.56–2.12) 0.786	–
Presbyopia	44/415 (10.6%)	18/276 (6.52%)	1.70 (0.96–3.01) 0.068	–
Near or Distance visual impairment†	49/464 (10.6%)	13/227 (5.73%)	1.94 (1.03–3.66) 0.040	2.45 (1.09–5.49) 0.030
Married	61/670 (9.10%)	1/21 (4.76%)	2.00 (0.26–15.2) 0.501	–
Educational level of primary school only	27/229 (11.8%)	35/462 (7.58%)	1.63 (0.96–2.77) 0.070	–
Drive bus (versus minibus)	55/519 (10.6%)	7/172 (4.07%)	2.79 (1.25–6.26) 0.012	2.18 (0.95–5.01) 0.067
No driving license	8/129 (6.20%)	54/562 (9.61%)	0.62 (0.30–1.34) 0.226	–
No eye exam before receiving license	39/382 (10.2%)	15/184 (8.15%)	1.28 (0.69–2.39) 0.436	–
Residence in extreme north district	7/24 (29.2%)	55/667 (8.25%)	4.58 (1.82–11.5) 0.001	7.34 (2.49–21.7) 0.0003
Continuous Variables				
	Mean (SD) for Self-Reported History of a Road Traffic Crash	**Mean (SD) for No Self-Reported History of a Road Traffic Crash**		
Age (y)	43.8 (9.50)	42.0 (10.6)	1.02 (0.99–1.04) 0.198	0.99 (0.96–1.02) 0.668
Monthly income ($)	16,774 (4123)	16,437 (4825)	2.79 (1.25–6.26) 0.595	–
Time (h) driving / day	11.5 (4.95)	9.13 (3.42)	1.15 (1.08–1.22) <0.0001	1.13 (1.06–1.20) 0.0002
Distance (per 10 km driven / day)	305 (208)	232 (143)	1.02 (1.01–1.04) 0.0007	–

CI indicates confidence interval; SD, standard deviation.

Bolded cells are significant at the $P < 0.05$ level.

Note: Nine participants with unknown history of self-reported road traffic crashes are excluded.

†Visual impairment includes failure to meet the distance vision standard for a bus driver (≥6/7.5 in better eye) or presence of presbyopia.

*P values from logistic regression model.

very large majority of which can be readily addressed with accessible and affordable refractive services. There are important implications for policymakers on the need to better codify and enforce vision standards for licensure of these important drivers. Finally, given the growing importance of navigational aids as potential risk factors for crashes, our findings on the potential importance of near vision for road safety, require further study.

ACKNOWLEDGEMENTS

The authors would like to acknowledge and thank the following persons and institutions: Noble Peace Laureate Professor Muhammad Yunus, Chairman of Grameen Health Care Services Ltd, Bangladesh Road Transport Authority, Dhaka, Mr. Arifur Rahman, Chairman, Bogura District Bus, Mini-Bus, Micro-Bus Workers' Union and his team, Mr. Zahedul Islam, Chairman, Bogura Inter Sub-District Transport Workers Union and his team, Advocate Kamrul Islam, Chairman, Natore District Transport Workers Union and his team, Mr. Jahangir Hossain, Chairman, Barishal District Transport Workers Union and his team, Panchagor Bus and Minibus Labour Union, Thakurgaon District Transport Workers Union, Dinajpur District Transport Workers Union, Naogaon District Transport Workers Union, Grameen GC Eye Hospital Bogura, Grameen GC Eye Hospital Barisal, and Grameen Eye Hospital Thakurgaon.

REFERENCES

1. World Health Organization. Global Status Report on Road Safety 2018. Geneva, Switzerland: World Health Organization, 2018. https://www.who.int/violence_injury_prevention/road_safety_status/2018/en/. Accessed June 3, 2020.
2. World Bank. Delivering Road Safety in Bangladesh: Leadership Priorities and Initiatives to 2030. Washington DC, US: World Bank, 2020. https://openknowledge.worldbank.org/handle/10986/33338. Accessed June 4, 2020.
3. United Nations Sustainable Development Knowledge Platform. Transforming Our World: the 2030 Agenda for Sustainable Development. New York, US: United Nations, 2021. https://sdgs.un.org/2030agenda. Accessed October 21, 2021.
4. Heydari S, Hickford A, McIlroy R, et al. Road safety in low-income countries: state of knowledge and future directions. *Sustainability*. 2019;11:6249. doi:10.3390/su11226249.
5. Mustaqeem MN, Jalauddin F, Hassan R. Bus network coverage analysis of Dhaka City along with its service quality. *Asian J Innov Res Sci Eng Tech*. 2016;1:1–8.
6. Colenbrander A, De Laey JJ. Vision requirement for driving safety. International Council of Ophthalmology (ICO). Proceedings of the 30th World Ophthalmology Congress, Sao Paulo, Brazil, 2006. http://www.icoph.org/dynamic/attachments/resources/visionfordriving.pdf. Accessed July 7, 2020.
7. Mumtaz SN, Hameed A, Arif H, et al. Frequency of refractive errors in bus drivers. *Biom Biostat Int J*. 2016;4:218–220.
8. Dairo MD, Okechukwu-Nwankpa P, Nwankpa R. Survey on visual acuity among intra-city commercial vehicle drivers in Ibadan, southwestern Nigeria. *J Pub Health in Afr*. 2019;10:789.
9. Oladehinde MK, Adeoye AO, Adegbehingbe BO, et al. Visual functions of commercial drivers in relation to road accidents in Nigeria. *Indian J Occup Environ Med*. 2007;11:71–75. doi:10.4103/0019-5278.34532.
10. Haliza AM, Syah MMS, Md M, Norliza MF. Visual problems of new Malaysian drivers. *Malays Fam Physician*. 2010;5.
11. Central Road Research Institute. Assessment of visual limitations of commercial drivers in metropolitan cities in India. Interim report submitted to Vision Impact Institute 2017. https://www.visionimpactinstitute.org/research/assessment-of-visual-limitations-of-commercial-drivers-in-metropolitan-cities-in-india-(interim-report). Accessed July 7, 2020.
12. Ovenseri-Ogomo G, Adofo M. Poor Vision, refractive errors and barriers to treatment among commercial vehicle drivers in the Cape Coast municipality. *Afr Health Sci*. 2011;11:97–102.
13. Adekoya B, Owoeye JFA, Adepoju FG, et al. Visual function survey of commercial intercity vehicle drivers in Ilorin, Nigeria. *Can J Ophthalmol*. 2009;44:261–264. doi:10.3129/i09-049.
14. National Eye Care Bangladesh. Standard Cataract Surgery Protocols (2nd ed). 2015.
15. World Health Organization. Mobile Phone Use: A Growing Problem of Driver Distraction. Geneva, Switzerland: World Health Organization, 2011. https://www.who.int/publications/i/item/mobile-phone-use-a-growing-problem-of-driver-distraction. Accessed July 7, 2020.
16. Fottrell Q. GPS, Smartphones and Speed Keep Road Deaths at 10-Year High. New York, US: Market Watch, 2018. https://www.marketwatch.com/story/forget-texting-the-most-dangerous-distractions-for-drivers-come-with-the-car-2017-10-05. Accessed July 7, 2020.
17. Wang C, Wang X, Jin L, et al. Influence of presbyopia on smartphone usage among Chinese adults: a population study. *Clin Exp Ophthalmol*. 2019;47:909–917. doi:10.1111/ceo.13559.
18. Dong C, Ma R, Zhang D, et al. Research on the influence of smartphone navigation on driving behaviour based on real vehicle driving. *Mobile Information Syst*. 2019;1–10. doi:10.1155/2019/9527890.
19. Chu BS, Wood JM, Collins MJ. The effect of presbyopic vision corrections on nighttime driving performance. *Invest Ophthalmol Vis Sci*. 2010;51:4861–4866.
20. Pepple G, Adio A. Visual function of drivers and its relationship to road traffic accidents in urban Africa. *SpringerPlus*. 2014;3:47.
21. Onabolu OO, Bodunde OT, Otulana TO, et al. Visual acuity of commercial motor drivers in Ogun State of Nigeria. *Niger Postgrad Med J*. 2021;19:225–229.
22. Verma R, Bharadwaj P. Assessment of visual function of truck drivers travelling on national highway of central India: A prospective study. *Int J Sci Study*. 2015;3:140–142. doi:10.17354/ijss/2015/322.
23. World Bank. The High Toll of Traffic Injuries: Unacceptable and Preventable. Washington DC, US: World Bank, 2017. https://openknowledge.worldbank.org/bitstream/handle/10986/29129/HighTollofTrafficInjuries.pdf?sequence=5&isAllowed=y. Accessed July 7, 2020.
24. Kamaluddin NA, Abd Rahman MR, Varhelyi A. Matching of police and hospital road crash casualty records – a data-linkage study in Malaysia. *Int J Inj Contr Saf Promot*. 2018;26:52–59. doi:10.1080/17457300.2018.1476385.
25. Kamaluddin NA, Andersen CS, Larsen MK, et al. Self-reporting traffic crashes – a systematic literature review. *Eur Trans Res Rev*. 2018;10. doi:10.1186/s12544-018-0301-0.
26. Owsley C, Wood JM, McGwin G. A roadmap for interpreting the literature on vision and driving. *Surv Ophthalmol*. 2015;60:250–262. doi:10.1016/j.survophthal.2015.01.005.