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Assessing and Improving the Cognitive and Visual Driving Fitness of CDL Drivers - Phase III

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16. Abstract

Driving is a highly dynamic task that requires intact cognitive and visual skills to perform safely. Driving a commercial motor vehicle requires careful planning and consideration. These additional factors are highly dependent on cognitive and visual skills for accuracy. This study aims to identify specific clinical tests that correlate well with commercial driver's license (CDL) driving performance. This study refined our clinical fitness-to-drive assessment battery and enabled us to create a two-hour protocol. We recruited and tested 31 drivers with commercial driver's licenses and 25 drivers without a commercial driver's license. We developed a two-hour driving fitness assessment battery consisting of tests that have been shown in the literature to be reliable and valid measures of driving-related cognitive and visual skills in drivers, with appropriate scoring systems and recommendation guidelines. On-the-road driving performance was assessed by volunteering annual elog data and a driver's self-assessment. The goals of the study were to: 1) Collaborate with local and national companies to recruit CDL and non-CDL drivers, 2) Assess the cognitive and visual fitness of CDL and drivers by implementing the battery of tests listed above, 3) Confidentially share the results with each CDL driver , 4) Share potential risk factors that contribute to unsafe driving with the CDL driver and provide resources to improve any recognized deficits, and 5) Invite medical students to join our research team to assist with recruitment and assessments. Over the course of the grant, we found that the descriptive and self-reported driving characteristics correlated better with the Cumulative Simulator Score (CSS) in CDL drivers than visuo-cognitive tests. We found the number of tickets in the past five years and years of education had the highest correlation with on-the-road safety, explaining 38% of the variance of total scores on the CSS. We also compared the CDL and non-CDL data and found that although CDL drivers had higher BMI's and performed more poorly than the non-CDL cohort, they had improved defensive driving skills as shown by fewer off-road accidents and lane excursions. We presented our data at two international venues: the Road Safety and Simulation conference in Athens, Greece and the Universite Gustave Eiffel in Lyon, France. We published a manuscript in Accident Analysis and Prevention and are currently completing our second manuscript. The technology transfer products are to: 1) Improve the annual Department of Transportation (DOT) physical by informing the DOT of these specific factors correlated with CDL driving safety, 2) Provide commercial companies with these tools to improve the safety of their CDL drivers, and 3) Increase awareness that CDL drivers have improved defensive driving skills despite poorer cognitive performance.

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List of Abbreviations

Commercial Driver’s License (CDL)
Commercial Motor Vehicle (CMV)
Federal Motor Carrier Safety Administration (FMCSA)
Iowa Department of Transportation (IaDOT)
Kansas Department of Transportation (KDOT)
Mid-America Transportation Center (MATC)
Missouri Department of Transportation (MoDOT)
National Institute for Occupational Safety and Health (NIOSH)
Nebraska Department of Roads (NDOR)
Nebraska Transportation Center (NTC)
Transportation Research Board of the National Academies (TRB)
University Transportation Center (UTC)
United States Department of Transportation (USDOT)
Useful Field of View (UFOV)

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Abstract

Driving is a highly dynamic task that requires intact cognitive and visual skills to perform safely. Driving a commercial motor vehicle requires careful planning and consideration. These additional factors are highly dependent on cognitive and visual skills for accuracy. This study aims to identify specific clinical tests that correlate well with commercial driver's license (CDL) driving performance. This study refined our clinical fitness-to-drive assessment battery and enabled us to create a two-hour protocol. We recruited and tested 31 drivers with commercial driver's licenses and 25 drivers without a commercial driver‘s license. We developed a two-hour driving fitness assessment battery consisting of tests that have been shown in the literature to be reliable and valid measures of driving-related cognitive and visual skills in drivers, with appropriate scoring systems and recommendation guidelines. On-the-road driving performance was assessed by volunteering annual elog data and a driver's self-assessment. The goals of the study were to: 1) Collaborate with local and national companies to recruit CDL and non-CDL drivers, 2) Assess the cognitive and visual fitness of CDL and drivers by implementing the battery of tests listed above, 3) Confidentially share the results with each CDL driver , 4) Share potential risk factors that contribute to unsafe driving with the CDL driver and provide resources to improve any recognized deficits, and 5) Invite medical students to join our research team to assist with recruitment and assessments. Over the course of the grant, we found that the descriptive and self-reported driving characteristics correlated better with the Cumulative Simulator Score (CSS) in CDL drivers than visuo-cognitive tests. We found the number of tickets in the past five years and years of education had the highest correlation with on-the-road safety,

explaining 38 % of the variance of total scores on the CSS. We also compared the CDL and

non-CDL data and found that although CDL drivers had higher BMI's and performed more poorly than the non-CDL cohort, they had improved defensive driving skills as shown by fewer off-road accidents and lane excursions. We presented our data at two international venues: the Road Safety and Simulation conference in Athens, Greece and the Universite Gustave Eiffel in Lyon, France. We published a manuscript in Accident Analysis and Prevention and are currently completing our second manuscript. The technology transfer products are to: 1) Improve the annual Department of Transportation (DOT) physical by informing the DOT of these specific factors correlated with CDL driving safety, 2) Provide commercial companies with these tools to improve the safety of their CDL drivers, and 3) Increase awareness that CDL drivers have improved defensive driving skills despite poorer cognitive performance.

Chapter 1 Purpose, Background, and Rationale

This five-year study explored the clinical and demographic factors that predict the on-the-road safety of commercial drivers, and compared these results to non-CDL drivers to determine if differences were found between the cohorts. One of the cardinal missions of the Federal Motor Carrier Safety Administration (FMCSA) of the United States Department of Transportation is to improve safety on our nation's highways. That includes reducing the number of accidents that involve Commercial Driver's License (CDL) drivers. Such accidents have a high potential to cause serious harm to the public and the environment. In addition to the several initiatives that have been put in place by the FMCSA to reduce accidents involving commercial vehicles, this project aimed to address CDL driver safety by (i) determining cognitive and visual fitness to improve driver fitness, (ii) rehabilitating pertinent weaknesses of drivers who drive commercial vehicles; (iii) compare the results of CDL drivers to non-CDL drivers, and (iv) share these results with national and international partners.

The Mid-America Transportation Center (MATC) was designated by the United States Department of Transportation as the Region VII University Transportation Center (UTC) in 2017. MATC is a consortium comprised of the University of Nebraska-Lincoln, University of Nebraska Omaha, University of Nebraska Medical Center, University of Kansas, University of Kansas Medical Center, Missouri University of Science and Technology, University of Iowa, Nebraska Indian Community College, and Lincoln University. MATC's partners include the Iowa Department of Transportation (IaDOT), the Kansas Department of Transportation (KDOT), Missouri Department of Transportation (MoDOT), the Nebraska Department of Roads (NDOR), the United States Department of Transportation (USDOT), and various private and public sector transportation organizations.

This project was needed to meet MATC's vision to become a nationally recognized center of transportation excellence focused on developing new knowledge, innovative solutions, and the next generation of transportation professionals necessary to sustain the U.S. transportation system in a manner that is safer, more effective, more efficient, environmentally friendly, and sustainable. CDL drivers are becoming increasingly prominent; maintaining their cognitive and visual fitness is essential for their safety and the safety of others sharing the road.

1.1 Aim and Hypothesis

Driving is a highly dynamic task that requires intact cognitive and visual skills to perform safely. Driving commercial vehicles, such as buses or trucks, require even more careful planning and consideration. Such planning and consideration are highly dependent on cognitive and visual skills for accuracy.

The study aims were to:

1) Assess CDL drivers' cognitive and visual fitness,
2) Establish the usefulness and effectiveness of these tests to drivers before embarking on the journey,
3) Identify potential risk factors that contribute to unsafe driving,
4) Evaluate the effect of an intervention program to improve reduced visual, cognitive, and driving skills, and
5) Compare CDL driver results to non-CDL drivers.

The study hypotheses are:

1) By correlating testing measures with on-the-road driving performance, we can develop a testing rubric of five tools that clinicians can use to optimally predict driving safety, and

2) CDL drivers will be safer drivers than non-CDL drivers when compared with simulator measures compared to non-CDL drivers.

1.2 Study Significance

We anticipate that this study will be helpful in identifying CDL drivers who have cognitive and/or visual impairments that may make driving a commercial vehicle unsafe. A unique aspect of this part of the study is the possibility of improving driving fitness by offering drivers with demonstrated cognitive and visual deficits resources to improve their performance.

Moreover, this project will also meet Mid-America Transportation Center's research goal to make fundamental advancements in basic and theoretical research related to improving the safety of the US and Region VII transportation systems. A key focus is to ensure that this research product will be implemented by regional and national transportation agencies and companies.

1.3 Literature Review

There are approximately 1.7 million long-haul truck drivers in the USA, either for hire or in private fleets (Hege et al., 2015). Truck driving is the second most common occupation in the USA (following retail sales), employing 1 in 35 adult men. Commercial motor vehicle (CMV) drivers, including bus drivers, make up a substantial proportion of the workforce, however, it is anticipated there will be a shortage of CDL drivers in the coming years in the United States. Many studies in the US have examined crash risk in CMV (Chen & Xie, 2014). Data from the US show that truck drivers account for 16–20% of all crashes, costing billions of dollars annually (Mayhew et al., 2011). While reducing the number of injurious and fatal accidents is paramount to public safety, determining causative factors are equally important in reducing crash risk.

One review found associations between fatigue and crash risk as well as other factors related to truck design and maintenance, such as unsecure cargo and weather conditions (Robb, Sultana, Ameratunga, & Jackson, 2008). Yet, this review was not inclusive of long-haul truck drivers; it included taxi drivers, professional drivers, company car drivers, as well as studies related to medical personnel and nurses. The review also included studies from countries that are not analogous to the North American model (Robb et al., 2008).

Recent US studies show that factors related to demographics as well as health and wellness are associated with crash risk including age, gender (men), low back pain, cardiovascular disease, stress, untreated sleep apnea and diabetes, as well as obesity (Apostolopoulos et al., 2012; Apostolopoulos, Sonmez, Shattell, & Belzer, 2010; Apostolopoulos et al., 2011). Thus, CDL drivers are considered a vulnerable or high-risk segment of the population by the US Federal Motor Carrier Safety Administration (FMCSA), the Transportation Research Board of the National Academies (TRB), and the National Institute for Occupational Safety and Health (NIOSH). CDL drivers are plagued with high rates of disease often attributed directly to the nature of the job (Lemke, Apostolopoulos, Hege, Sönmez, & Wideman, 2016).

The work environment exposes all CDL drivers to long work hours (up to 14 hours/day), prolonged sitting, excessive noise and vibration and generally unhealthy lifestyles (Lemke et al., 2016). CDL drivers are more likely to use tobacco, to be physically inactive, to have poor diets, and to have disrupted sleep cycles and higher levels of stress), leading to an increased risk of cardiovascular disease and psychological and musculoskeletal disorders compared to the general population (Apostolopoulos et al., 2012). These risk factors and conditions, particularly among long-haul drivers, can produce work-place injuries and impact work productivity and driving performance.

Taking the above factors into consideration, the average life expectancy of CDL drivers in the US is 12–20 years lower than the general population (Crizzle et al., 2017). The first International Conference on Commercial Driver Health and Wellness was sponsored by the FMCSA, The US Department of Transportation and NIOSH in 2010. Several priority areas emerged from this conference, particularly the need for a better understanding of the combined impact of multiple risk factors (i.e., irregular schedules, long hours of work, poor diet and nutrition, stress) on driver health and wellness, as well as productivity and safety.

While there is consensus that CDL drivers are an at-risk population for poorer health, there has been no critical appraisal of the motor, cognitive, and visual determinants of driving safety. This study delved into this arena.

Chapter 2 Methodology and Findings

Drivers over age 18 with an active CDL license were recruited and completed a 120-item, two-hour battery of assessments. Questions were a series of items to: 1) Assess their cognitive and visual fitness, 2) Provide a self-assessment of their driving, and 3) Identify potential risk factors that contribute to unsafe driving. All CDL subjects were asked to return for a one and two-year follow-up assessment with each participant being given the same tests but in randomized order to prevent bias and to limit confounding factors. Thirty-one CDL participants were recruited. Table 2.1 provides demographic information of the CDL participants. Participants who were unable to provide written informed consent were excluded from the study results. Laboratory testing was not needed in this study.

2.1 Methodology and Study Procedure

Participants were recruited to the University of Kansas Medical Center during years 2-5 to administer a battery of cognitive and visual tests. Participants received $50 compensation for their time and effort upon each visit. Test results were shared only with the subjects and did not affect their professional licensing status.

Each study participant underwent all procedures and tests on the same day. The estimated time for testing evaluation, excluding informed consent overview, was no more than two hours. Informed consent was obtained prior to participation in the study, during the scheduled time of their testing session. The informed consent document detailed the procedures and rights of the individual partaking in the study. Any subject who found the procedures objectionable for any reason was given the opportunity to terminate participation as described above. To date, this has not occurred for any subjects. In addition, subjects were informed that they can discuss any

Table 2.1 Demographic, Driving History and Clinical Characteristics, n = 31

Variable	Mean (SD),Median (IQR Quartile 1- Quartile 3) ,or frequency (%)
Age, years	53 (13)
Sex, male	28 (90)
Height, m	1.80 (0.08)
Weight, kg	102 (86–118)
BP, systolic	136 (19)
BP, diastolic	84 (11)
BMI	32 (6)
Number of Years of Education, years	14 (2)
Number of Medical Conditions	2 (2)
Number of Medications	2 (3)
CDL driving experience, years	32 (13)
CDL annual mileage, 10^3 miles	36.5 (5–120)
CDL crashes, past 5 years	0 (0–0)
CDL tickets, past 5 years	0 (0–0)
PV annual mileage, 10^3 miles	11 (8–15)
PV crashes, past 5 years	0 (0–0)
PV tickets past 5 years	0 (0–0)
MOCA, out of 30	27 (25–28)
TMT-A time, seconds	28 (23–36)
TMT-A errors	0 (0–0)
TMT-B time, seconds	66 (52–94)
TMT-B errors	0 (0–1)
UFOV-SOP, milliseconds	15 (15–15)
UFOV-DA, milliseconds	15 (15–22)
UFOV-SA, milliseconds	109 (62–148)
DC time, seconds	367 (326–469)
DC false positives	0 (0–0)
DC errors	6 (3–13)
SMD, /32	32 (30–32)
SMC, /32	32 (24–32)
RSR, /12	10 (8–10)
SDSA Participant Pass	29 (94 %)

Key: BP = Blood Pressure; BMI = Body Mass Index; CDL = Commercial Driver License; PV = Personal Vehicle; MOCA = Montreal Cognitive Assessment; RSR, road sign recognition; SMD = Square Matrix Direction; SMC = Square Matrix Compass; TMT-A = Trail Making Test-Part A; TMT-B = Trail Making Test-Part B; UFOV-SOP = Useful Field of View-Speed of Processing; UFOV-DA = Useful Field of View-Divided Attention; UFOV-SA = Useful Field of View-Sustained Attention; DC = Dot Cancellation Test; SMD = Square Matrices Direction Test; SMC = Square Matrices Compass Test; RSR = Road Sign Recognition Test; SDSA = Stroke Disease Severity Assessment. Variables are described as means (standard deviation); medians (Quartile 1–Quartile 3), or frequencies (percentage).

questions they have about the research procedures or their performance with the research investigators.

Prior to beginning each testing session, demographic and clinical information including age, sex, BMI, blood pressure, level of education, and driving history was collected for each subject (Table 2.1). As a part of each subject's scheduled testing session, they underwent a series of cognitive, visual, and physical assessments. These assessments included the following:

2.1.1 Cognitive assessment (20 minutes)

The cognitive assessment for all subjects included the Stroke Drivers Screening Assessment (Akinwuntan et al., 2013), the Useful Field of View (Edwards et al., 2006), the Montreal Cognitive Assessment/MOCA (Nasreddine et al., 2005), Snellgrove Maze Test, and Trail Making Tests A and B.

2.1.2 Visual assessment (5 minutes)

The Keystone vision screener was used in all subjects to assess visual acuity, depth perception, visual field, glare recovery, color perception, depth perception, and eye coordination (stereopsis).

2.1.3 Range of motion and gait speed (5 minutes)

A standard physical exam including blood pressure, height, weight, range of motion testing and gait speed was performed on all subjects.

2.1.4 Simulator assessment (20 minutes)

All subjects completed an evaluation in a driving simulator. This evaluation comprised a 20-minute drive in daily-life traffic while obeying the rules of the road. Driving abilities under low and high cognitive demand, and complex brake response time were assessed. Participants were asked to accelerate to 45 miles per hour, maintain this speed, then safely respond to a stop sign by coming to a complete stop. One practice trial and four test trials were used. Average seeing time (time from presentation of stop sign to removing foot from accelerator pedal), average movement time (removing foot from accelerator to the brake pedal), and average brake response time (time to a complete stop) were calculated.

2.1.5 Pupil recording

During the simulator tests, raw pupillary size of the left and right eye was recorded using the Tobii Pro Glasses 2 head mounted eye tracker (Tobii Inc, Sweden) at 60 Hz. Corrective glasses were fitted on the eye tracker for people who are near- or far-sighted. EyeWorks™ software (EyeTracking, Inc) was used to calculate the Index of Cognitive Activity (ICA). This ICA was scored on a continuous scale from 0 (no cognitive workload) to 1 (maximum cognitive workload) by transforming the pupil diameter through signal processing algorithms of wavelet analysis (Marshall, 2007). Other variables that may also affect pupillary response, such as lighting, accommodation, and stress, will be filtered out by the ICA algorithm and by exposing all subjects to identical test conditions.

Video recordings of the scene camera from the eye tracker were timestamped to mark the beginning and end of the simulator tests. Mean ICA, peak ICA, and standard deviation (SD) of ICA of both eyes were used as outcome variables.

3.0 Results

In total, we spoke to 174 potential CDL participants, of which 31 completed assessments. Thirty non-CDL participants completed the study. Participants came from the Kansas and Missouri bi-state area.

Significant demographic values were:

- 92% of our participants were male,

- Average age was 50,
- Most common class of medications was for hypertension (high blood pressure), and
- Body Mass Index (BMI) was 32.4, falling within the obese range (BMI over 30).

Table 2.2 outlines the demographic differences between the CDL and non-CDL cohorts.

Table 2.2 Demographic differences between CDL and non-CDL drivers

Variable	Commercial Truck Drivers (CDL) n=31	Non-commercial drivers (Non-CDL) n=30	Significance
Age (years)	52.58 (12.20)	44.93 (21.44)	0.09[a]
Gender (Men, Women)	28, 3	13, 17	0.0001[b]
BMI	32.22 (5.97)	25.95 (5.70)	<0.001[a]*
Number of prescription medicines(n)	1.97 (2.76)	1.90 (2.95)	0.93[a]
Driving experience (years)	30.26 (10.96)	26.57 (23.02)	0.42[a]
Accidents in the past 5 years (n)	0 (0 – 0)	0 (0 – 0)	0.16[c]
Tickets in the past 5 years (n)	0 (0 – 0)	0 (0 – 1)	0.03[c]*
Annual mileage (x1000 miles)	13.37 (9.15)	9.65 (6.84)	0.08[a]
Rapid Walk Test (sec)	7.25 (1.90)	6.91 (1.43)	0.44[a]

Variables were described as mean (standard deviation); median (Q1 – Q3) and frequencies. [a] Independent t-test; [b] Fisher's Exact test; [c] Wilcoxon Rank Sum Test

All results were discussed with the subjects individually on each visit. The protocol we followed for providing recommendations is described in the table below. Those that failed 50% or more of their tests were asked to receive a full formal evaluation by their primary care physician; those that failed 25-50% of their tests received advice to begin rehabilitation with physical or occupational therapy; those that failed under 25% of the tests had a low cause for concern. Passing scores for each test were determined by their individual cut-offs, as noted in the literature. Table 2.3 summarizes the recommendation protocol.

Table 2.3 Threshold cut-offs for the variables missed

Threshold of items missed	**Number of variables missed (of total 10)**	**Recommendation**
≥ 50%	≥ 5	Needs full formal evaluation by primary care provider.
25-49%	3-4	Advice for referral to rehabilitation
< 25%	1-2	Low cause for concern

Of the tests listed above, rehabilitation options offered are described in Table 2.4.

Table 2.4 Rehabilitation options offered with each test measure

Test	**Rehabilitation Option**
UFOV	Physical Therapy
SDSA	Simulator training
TMT-A	Simulator training
TMT-B	Simulator training
Visual Acuity without cues	Referral to Ophthalmology
MOCA	Simulator training
Maze	Simulator training
Rapid Pace Walk	Simulator training, Physical Therapy
Simulator: Driving Performance	Simulator training
Simulator: Reaction Time	Simulator training

Table 2.5 describes the stepwise multiple regression statistical analyses of the CDL group. It demonstrates that the number of years of education and the number of tickets over the past five years were the variables most highly correlated with simulator performance for CDL drivers.

Table 2.5 Stepwise multiple regression model for CDL drivers

Stepwise Multiple Regression Model.

Variable	Estimate	Standard error	F value	P value	Partial R^2
Intercept	−4.75	2.67	3.16	0.09	
Education	0.56	0.18	9.32	0.005	0.26
Number of tickets CDL	5.23	1.76	8.77	0.006	0.12

Cognitive testing between CDL and non-CDL drivers are shown in Table 2.6. Notably, Montreal Cognitive Testing (MoCA) scores were lower and the time to complete the dot cancellation test was higher in CDL drivers.

Table 2.6 Mean difference between CDL and Non-CDL drivers in cognitive tests

Variable	Mean score (SD) of CDL n = 31	Mean score (SD) of NCDL n = 30	P value
MoCA	26.09 (2.59)	28.30 (1.78)	.0006
TMTAtimesec	30.33 (8.78)	29.29 (12.12)	0.70
TMTBtimesec	82.43 (50.96))	70.24 (41.91)	0.28
DCTimesec	391.40 (83.94)	349.60 (64.77)	0.03
SMD	30 (4.34)	31 (3.63)	0.34
SMC	26.71 (7.75)	28.96 (5.93)	0.21
RSR	9.48 (1.50)	9.99 (1.42)	0.28

Variables were described as mean (standard deviation). Independent t-tests were used to evaluate differences between groups.

Simulator performance between the CDL and non-CDL groups are shown in Table 2.7. Of note, complex reaction time was higher in the CDL group, however the prevalence of off-road accidents and road edge excursions were lower. The number of pedestrians hit was equal for both cohorts.

Table 2.7 Difference in driving performance between CDL and Non-CDL drivers on a driving simulator

Variable	Mean score (SD) of CDL n = 31	Mean score (SD) of NCDL n = 30	P value
Complex Reaction Time	3.90 (0.57)	3.38 (0.80)	0.01
Off Road Accidents	0 (0 – 0)	1 (0 – 1)	<0.001
Collision	2 (1 – 2)	1 (1 – 2)	0.91
Ped hit	0 (0 – 0)	0 (0 – 0)	0.51
Total Accidents	1.81 (1.46)	1.93 (1.01)	0.62
Speed Ticket	10 (5 – 14)	7 (6 – 14)	0.56
Stop sign errors	1 (0 - 2)	1 (0 – 2)	0.62
Total tickets	10.92 (5.73)	13.50 (8.36)	0.19
Center line excursion	5.23 (2.86)	7.59 (7.59)	0.13
Road edge excursion	2.50 (1.74)	5.00 (3.39)	0.001

Chapter 3 Conclusions and Recommendations

This five-year study had two major conclusions. The first was that the number of tickets over the past five years and the number of years of education were the highest correlators to simulator performance in CDL drivers. Since simulator performance was our proxy for on-the-road safety, this has safety implications for the Department of Transportation.

Recommendation 1: These two demographic questions can be added to the DOT annual physical.

The second major conclusion from this study was that when comparing CDL to non-CDL drivers, although CDL drivers performed lower on cognitive testing, they practiced better defensive driving skills. Their numbers of off-road accidents and lane excursions were lower than the non-CDL cohort.

Recommendation 2: Increase education and awareness to CDL drivers and to the lay public that CDL drivers practiced better defensive driving skills. Their experience and attention to detail likely play a role in this.

In addition to these findings, an added benefit was that we created local contacts with the Kansas Highway Patrol, the National Motor Carriers Association, the Kansas Motor Carriers Association, and multiple companies to help in awareness, education, and future collaborative efforts. Our invited presentations to the Road Safety and Simulation conference in Athens, Greece and to the Universite Gustave Eiffel strengthened our international presence and presented opportunities for future projects.

Since we are at an academic medical center, we had the opportunity to work with at least four medical students and graduate students annually. It provided them an opportunity to conduct, write, and present research, which they highly valued.

Participants received compensation for the time and travel required to participate in the study. We did not receive any complaints or negative feedback during the study period.

Challenges included:

1. Years 2 and 3 were during the COVID pandemic. This significantly changed our recruitment strategy, our testing procedure, and our recruitment numbers. However, we were able to complete recruitment for both arms of this study after the pandemic ended.

2. We began collecting TEPR data on our participants in August 2019. The technological interface was not always reliable. As a result, this data was not consistent amongst all participants.

3. Since this was a pilot, our numbers were low. More research is needed on larger numbers to validate our findings. We hope to continue our next phase of work with commercial drivers with further funding.

Our work correlating demographic and visuo-cognitive tests with simulator performance in CDL drivers was published in the renowned journal *Accident Analysis and Prevention* in 2023 (Bhattacharya, 2023). We are currently writing our second manuscript comparing CDL to non-CDL data.

This study provided an opportunity to explore the clinical and demographic tools to predict the on-the-road safety of a crucial cohort: commercial drivers. Implementing these simple questions to DOT physicals should be done. Sharing the reassuring data that CDL drivers have better defensive driving skills than non-CDL drivers is important from a public education perspective. Hopefully this can help increase the recruitment and retention of CDL drivers in the United States.

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