Correlation between clinical tests and driving simulator performance of commercial drivers in the United States.

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Extended Abstract

Background

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. Reducing the number of accidents for Commercial Driver's License (CDL) drivers remains a critical aspect of improving road safety. Accidents involving large trucks and buses comprise approximately 13% of all fatal motor vehicle crashes in the United States [1]. Driving commercial vehicles is a highly dynamic task requiring intact cognitive and visual skills to perform safely. Understanding factors predicting driving safety can significantly advance the field of commercial driver science. The American Geriatrics Society published results concluding the Trails B, cognitive testing, Snellgrove maze, and rapid pace walk tests correlated well with on-the-road safety in older adults.[1] Translating these results to commercial drivers has not been done. This study adds to the current body of literature by correlating cognitive and visual screening tests in CDL drivers with demographic variables and simulator performance. Considering that operating vehicles is fundamental to this occupation, as well as the fact that approximately 13% of all fatal motor vehicle crashes in the United States involve commercial drivers, this population represents an important stakeholder group for enhancing on-the-road safety.

Objective

This study aimed to identify specific clinical tests and simulator parameters that correlated with commercial driver's license (CDL) driving performance. This study was a rolling study whereby CDL drivers participate annually for three years. Each year, they were given a two-hour battery of tests to assess their cognitive and visual driving fitness, identify risk factors contributing to unsafe driving, and correlating their results with their on-the-road behaviors. The battery included demographic information, cognitive tests (MOCA, Stroke Scale, Maze), attention and visual tests (Useful Field of View [UFOV], Keystone), motor tests (rapid pace walk, range of motion), and simulator performance (reaction time, speed). The ultimate aim of this study is to identify a battery of clinical tests that correlate with commercial driving performance so that they may be used in a practical, affordable, office-based assessment regimen with the goal to optimize the on-the-road safety of commercial drivers.

A unique clinical aspect of this study is the possibility of improving driving fitness by sharing their demonstrated cognitive and visual strengths and guiding them to retrain and improve such skills to ultimately drive safer and longer.

Results

The study design was a prospective case series. The participant population consisted of study participants who held a current, active commercial driver's license. Inclusion criteria were: 1. age 18 years or older; 2. current, valid, class A, B, C commercial driver's license (CDL); 3. currently employed as a commercial driver. Exclusion criteria were: 1. unable to provide written informed consent on their own behalf, and 2. unable to understand assessment directions in English. Withdrawal/termination criteria included the participants' inability to attend the assessment session or to return for assessments when scheduled. Participants were provided three rescheduling attempts per assessment before enforcing the withdrawal/termination criteria. The sample size was obtained by convenience sampling.

In October 2020, baseline assessments were completed. 31/34 participants had complete data sets; 3 were female; 28 were male. Mean (standard deviation) values were: age 52.9 (12.5), weight 230 lbs (interquartile range [IQR] 190.0-261.0), height 71 inches (3.4), BMI 32.3 (5.9), blood pressure 137 (19.4)/84 (10.6), education 14 years, CDL experience 30 years (12.1), and CDL mileage 64,194 miles annually (60,652). Number of medications was 2.0 (2.7). Mean number of accidents in past five years in both personal and commercial vehicle was 0.13 (IQR 0-1.0). Mean number of tickets in personal vehicle in past five years was 0.16 (IQR 0-2.0) and in CDL vehicle was 0.06 (IQR 0-1.0). Eight failed the CDL binocular visual acuity standard. The average score on MOCA was 26/30 (SD 2.4), Trails A 30 sec (SD 8.8), Trails B 83 sec (SD 51.0), Rapid pace walk 7.25 sec (SD 1.9) and Maze 29.45 sec. UFOV Speed of Processing was 15.7 msec (SD 3.2), Divided Attention--42 msec (SD 88) and Selective Attention 126 msec (SD 111). All but two participants (29/31, 94%) passed the stroke driver screening assessment battery. When calculated with simulator performance, the UFOV-Sustained Attention variable had the highest correlation with other variables. Pedestrians hit was most correlated with 5-year accidents in personal vehicle and 5-year tickets as CDL driver. Center line deviations were most correlated with the number of medications the CDL driver was taking.

Initial Findings

Preliminary baseline analysis demonstrates a population with obesity, high levels of experience and strong performance on cognitive and physical measures. Visual testing, however, was poor indicating the need for closer visual testing for CDL drivers, despite annual physicals.

Self-reported data and Simulator Performance:

The number of personal vehicle accidents in the past five years yielded the greatest number of statistically significant correlations of all self-reported variables. Total number of accidents on the simulator was correlated with both history of accidents and tickets, in the past five years as a CDL driver, non-parametric Spearman correlation coefficient (rs) = 0.39, p = .03; rs = 0.42, p = .02, respectively. Tickets in the past five years as a CDL driver, was also correlated with number of pedestrians hit on the simulator, rs = 0.39, p = 0.04. Notably, “Pedestrians Hit” was the most commonly correlated simulator variable amongst all self-reported measures. Although not statistically significant, both “Number of medications” and “Years of education” yielded negative correlation coefficients with “Brake time” and “Complex Reaction Time”. “CDL driving experience” and “Pedestrians Hit” on the simulator were significantly correlated, $r_s = 0.43$, p = .02. A significant correlation was also found between annual mileage as a CDL driver and “Complex Reaction time”, $r_s = 0.41$, p = .02. “Number of medications”, “Number of years of education”, and “Driving experience with a personal vehicle” were not significantly correlated with any simulator variables.

Cognitive and Visual tests and Simulator Performance:

The Selective Attention parameter on the UFOV assessment yielded the highest number of significant correlations amongst the UFOV measures; specifically, between Exceeding the Speed Limit, Speeding Tickets, Time Over Speed Limit, and Distance Over Speed Limit.

Cognitive and Visual tests and Self-reported Data:

MoCA performance yielded statistically significant positive associations with both number of accidents and tickets, $r_s = 0.48$, p = .0060; $r_s = 0.36$, p = .0486, respectively. Time taken on the Trail-making B test and years of CDL driving experience were significantly associated ($r_s = 0.41$, p = .0226). Trail-making test B errors was associated with Number of Years of Education and Tickets ($r_s = 0.37$, p = .0410; $r_s = 0.38$, p =

.0335). The speed of processing parameter on the UFOV had the highest number of statistically significant correlation coefficients of the UFOV variables, with the strongest correlation found with Annual Mileage as a CDL driver. Divided and Sustained Attention variables on the UFOV were significantly associated with age (r_s= 0.37, p= .0417; r_s= 0.54, p= .0018, respectively). UFOV-RA was associated with number of tickets in the past five years as a CDL driver, "Tickets 5yr CDL" (r_s= 0.39, p= .0319). Errors on the dot cancellation test was associated with both "Number of Medication" and driving experience as a CDL driver (r_s = 0.40, p= .0256; r_s = 0.49, p= .0044, respectively).

In conclusion, this study has found that CDL driver performance on visual and cognitive assessment tools, including UFOV, MoCA, Dot cancellation, and Trail making Tests A and B, was correlated with self-reported driving data, and driving simulator performance. We found that the total number of accidents in the simulator was significantly positively correlated with both self-reported accidents and tickets in the past 5 years as a CDL driver. Those who reported more tickets and accidents in the past 5 years were likely to have a greater number of accidents in the simulator. Tickets in the past 5 years as a CDL driver were also significantly correlated with the number of pedestrians hit in the simulator. Finally, a significant positive correlation was found between annual mileage as a CDL driver and complex reaction time. It was also interesting to find that the higher number of CDL driving experience a participant had, the higher the number of pedestrians were hit during simulation.

Additionally, the data also found that the higher number of medications and the higher number of years of education one had, reduced brake time and complex reaction time. These findings indicate that simulator variables such as total number of accidents, number of pedestrians hit, and complex reaction time could be used in Department of Transportation physicals to predict on-road driving safety and driving fitness of CDL drivers.

Future steps may include correlating year 1 results with years 2 and 3 data and on-the-road driving safety self-assessment questionnaires. Other steps could entail reviewing driving log data looking specifically at near misses, speed violations, and accidents.

Keywords: Driving fitness, Commercial Driver, Safety.