Driving events of professional drivers with ADHD that are monitored by their supervisors

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ABSTRACT

Drivers with ADHD are at greater risk for road accidents and are more prone to traffic violations and risky driving than drivers without ADHD. However, no study has tested if the greater risk of drivers with ADHD generalizes to a population of professional drivers that are monitored by their supervisors. We investigated the driving behavior of transport military drivers with and without ADHD (25 and 146, respectively) based on the reports from an Advanced Driving Assistance System. Results indicated that safety events were significantly more frequent for drivers with ADHD than for drivers without ADHD. Notably, the most significant difference was for speeding violations with a Relative Risk (RR) of 2.13 (113% increase). We conclude that the riskier driving of drivers with ADHD remains even among professional drivers that are monitored by their supervisors. Perhaps, drivers with ADHD might benefit from customized intervention programs.

CCS CONCEPTS

• **Applied computing** → Operations research; Transportation; • **Computer.systems.organization** → Real-time systems.

KEYWORDS

Driving.safety, Driving.behavior, ADHD, Naturalistic.driving, Fleets, Driver.assistance.systems

ACM Reference Format:
Tomer Elbaum, Assaf Botzer, Ishai Nir, Yoram Braw, Michal Shisha, and Shraga Shoval. 2023. Driving events of professional drivers with ADHD that are monitored by their supervisors. In *European Conference in Cognitive Ergonomics (ECCE '23), September 19–22, 2023, Swansea, United Kingdom.* ACM, New York, NY, USA, 4 pages. https://doi.org/10.1145/3605655.3605675

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ECCE '23, September 19–22, 2023, Swansea, United Kingdom
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ACM ISBN 979-8-4007-0875-6/23/09.
https://doi.org/10.1145/3605655.3605675

1 INTRODUCTION

Studies repeatedly show that drivers with Attention Deficit Hyperactivity Disorder (ADHD) are at greater risk for driving violations, car accidents, and severe injuries than drivers without ADHD [1, 2]. However, no study to date has investigated whether the adverse effects of ADHD on driving safety generalize to a population of professional drivers that are monitored by advanced driver assistance systems for later or immediate feedback from their supervisors [1–4]. The current naturalistic driving study on military transport drivers addresses this generalizability question.

2 LITERATURE REVIEW

Professional drivers (i.e., heavy load drivers, taxi drivers, etc.) received relatively little attention from the research community [5–8]. However, several of the studies that have been conducted suggested that professional drivers might differ from their non-professional peers by having better driving skills [9, 10]. Naturally, the relatively little knowledge on the driving behavior of professional drivers [1–4] extends to sub-populations like professional drivers with ADHD. In that respect, considering the findings on better driving skills among professional drivers [5–7], it seems necessary to test if previously reported adverse effects of ADHD on driving safety generalize to this population.

Another reason for testing the generalizability of findings on ADHD and driving safety to the population of professional drivers, apart from their possibly better driving skills, is that professional drivers are often being monitored. Such monitoring can be the basis for supervisors' interventions in the form of discussions on the reports from in-vehicle data recorders and in the form of real-time communications following risky driving alerts. Furthermore, risky driving alerts can be considered interventions in their own right [11]. Studies have shown that both, retrospective discussions, and real-time monitoring reduce risky driving behavior [12–16].

Based on the literature, we believe that one should ask if previous findings on riskier driving among drivers with ADHD generalize to professional drivers that are monitored by their supervisors. To address this question, we analyzed the naturalistic driving data of professional military transport drivers over 2-60 months.

3 METHOD

3.1 Participants

The initial study population was 228 professional military drivers in the Israeli Defense Force Transportation Corps. Drivers with a diagnosis of ADHD in their formal medical records were assigned to the ADHD group. Drivers with no formal diagnosis of ADHD and no indication of ADHD (see explanation below) were assigned to the non-ADHD group. Of the initial 228 drivers, 12 were excluded from the study because they had less than four weeks of monitored driving. An additional 45 control group drivers were suspected of having ADHD based on their responses on the ASRS questionnaire (see section 3.3.1) and were therefore also excluded. A final sample of 171 drivers was included in the analysis (ADHD n=25; non-ADHD n=146). Two of the 171 drivers were females. The average age was 22.1 years (sd=5.5) and the average experience as transportation drivers was 3.6 years (sd=5.6). All drivers underwent four months of training to become licensed army truck drivers. In addition, they routinely undergo a day-long safety training once a month. This training includes reviewing their driving performance according to the measurements of the Anna system (see section 3.3.2).

3.2 Task and procedure

An Israeli Defense Force (IDF) research psychiatrist who was part of the research team addressed the drivers during their weekly safety briefings. He explained the procedure of the study and asked for participation. Drivers that consented[1] to participate completed an ADHD questionnaire and a short demographic and medical questionnaire (see section 3.3.1). The psychiatrist retrieved an ADHD diagnosis (yes/no) from their medical records database. A Transportation Corps safety officer who was part of the research team aggregated the weekly monitoring system reports that were generated for each driver.

3.3 Measures

3.3.1 Questionnaires. The study included the Adult-Self Report Scale for ADHD (ASRS) and a short demographic and medical questionnaire to supplement and validate the information retrieved from the IDF databases. The ASRS contains 18 self-reported items, which rate the frequency of ADHD symptoms according to a 5-point Likert scale, ranging from 0 (never) to 4 (very often). The 18 items correspond to the 18 ADHD symptoms defined by the DSM-5 [17]. The ASRS is commonly used as an ADHD symptom-based assessment. The current study utilized its Hebrew version [18]. It has high reliability (Cronbach's alpha of 0.88), high specificity (99.6%), and moderate sensitivity (68.4%) [17].

3.3.2 Natural Driving Study (NDS) measures. Risky driving behavior was studied by analyzing the reports from the Anna system. Anna is a road safety system that is installed on operational IDF vehicles, mainly trucks. The system's reports are based on the output of 3D accelerometers and algorithms for detecting the following safety events that were defined in previous NDS investigations [19]: (1) Hard brakes- abrupt decelerations; (2) Abrupt Turns; (3) Swerving-abrupt Lane change; (4) Speeding; (5) Total number of events. In addition, the Anna system logs the distance traveled in km. All information is continuously stored on the cloud. There are three primary road safety services that Anna provides. First, it enables the commanders to intervene immediately after receiving online safety alerts to their phones. Second, each driver has a monthly meeting with his commander to review a monthly summarized Anna report. Third, it provides real-time feedback to the driver (i.e., a soft beep sound) once a safety event occurs. The Anna report allowed us to compare the Rate of Safety Events (RSE), i.e., the number of safety events per 1000 Kms between the ADHD and the non-ADHD group, and to compute the relative risk (RR) for safety events between the groups, i.e., RSE(ADHD)/RSE(non-ADHD).

[1]The study was approved by the Israel Medical Corps Research Ethics Board

4 RESULTS

We employed a Generalized Linear Model (GLM) Poisson regression with ADHD (yes or no) as a binary predictor on the Safety Events (SE) count data. The model is presented in Eq.1:

$$Ln(E(SE_i)) = \beta_0 + \beta_1 ADHD_i + Ln\,(Km_i/1000) \quad (1)$$

Where $E(SE_i)$ is the expected count of safety events for driver i. The model's intercept is β_0, the natural logarithm of the expected SE for the non-ADHD drivers (reference group), and β_1 is the natural logarithm of the expected SE for drivers with ADHD. Ln(Kmi/1000) is the natural logarithm of the aggregated driving distance in 1000 Kms of driver i. This variable allowed us to compute the rate of safety events (RSE) per 1000 kms and thereby offset the higher risk for safety events over longer driving distances (offset exposure). The Poisson regression in Eq.1 was run four times, once for each type of safety event: braking, turning, speeding, and swerving. Table 1 provides the Poisson model estimates for RSE and for RR ($RSE_{(ADHD)}/RSE_{(non\text{-}ADHD)}$).

Table 1 shows that the rate of all events was higher for the ADHD than for the non-ADHD group. Furthermore, the last column in the table suggests that the RRs for speeding and braking were greater than for turning, and that the RR for turning was greater than for swerving. Inferential statistics on the differences between the four RRs in Table 1 confirmed this observation: RR(Swerving)<***RR(turning)<***RR(speeding)=RR(braking), where ***< 0.001. Hence, the RR between the groups was the greatest for speeding and braking, next for turning, and lowest for swerving.

5 DISCUSSION

We tested if the recurrent finding in the literature, that drivers with ADHD are more likely to commit driving violations, and that their driving is otherwise less safe than that of drivers without ADHD [1, 2] generalizes to a population of professional drivers that are monitored by their supervisors. Our findings showed that the recurrent findings in the literature generalized to the current study population.

We found that drivers with ADHD had 61% more swerving events, 87% more turning events, 113% more speeding violations, and 121% more hard braking events than drivers without ADHD. Merkel et al. [20] conducted an NDS like in the current study, yet on non-professional drivers that were not supervised by commanders. The differences in the rate of risky events between drivers with and without ADHD in their study were not greater than in ours (they were even smaller). This provides further evidence that

Table 1: Rate of safety events per 1000 kms (RSE) for drivers with and without ADHD (2nd and 3rd columns, respectively), the estimates of the Poisson model (4th column) and the relative risk (RR, last column)

Type of event	Rate of safety events (CI[a])		Relative Risk (RR[b])	
	ADHD	non-ADHD	Parameter (SE[c])	RR (Exp(B1))
Braking	10.90 (10.60-11.20)	4.92 (4.86-4.99)	B0=1.59 (.006) ***	2.21
			B1=0.79 (.155) ***	
Turning	21.78 (21.36-22.20)	11.65 (11.55-11.75)	B0=2.45 (.004) ***	1.87
			B1=0.62 (.011) ***	
Speeding	2.03 (1.91-2.16)	0.95 (0.92-0.98)	B0=-0.04 (.016) **	2.13
			B1=0.75 (.036) ***	
Swerving	2.71 (2.56-2.86)	1.68 (1.64-1.72)	B0=0.51 (.012) ***	1.61
			B1=0.48 (.030) ***	

[a] CI is Confidence Interval. [b] RR is the Relative Risk ($RSE_{(ADHD)}/RSE_{(non\text{-}ADHD)}$). [c] SE is Standard Error.

professional drivers with ADHD exhibit an increased risk of safety events, despite being monitored by their supervisors.

Replicating the findings on riskier driving of drivers with ADHD in our study population resonates with Barkley's view on ADHD and on the means for addressing its symptoms. According to Barkley [21], the core of ADHD is failure of executive functions. Therefore, only a multidisciplinary treatment for ADHD may lead to a behavioral change. Further support for Barkley's view comes from the pattern of RRs in the last column of Table 1.

We found that the RR of speeding violations was significantly higher than that of turning and swerving, and like that of hard braking. This finding presents a unique concern. Namely, compared to turning, swerving, and braking that were also reported to the drivers' commanders, speeding is the only explicit violation of traffic laws. In other words, speeding events have a more straightforward definition than, for example, hard braking or swerving and, therefore, should be more easily dealt with by military commanders. Nevertheless, speeding, a recurrent violation among drivers with ADHD in reports on unsupervised drivers [20, 22], remained unmoderated by supervision in the current study population.

We acknowledge that because military service is mandatory in Israel, IDF's drivers are generally younger and less experienced than other professional drivers. In addition, the young age of drivers in our sample may also be responsible for failing to represent the growing number of women professional drivers [23]. Another limitation that is related to the settings of the study is that military regulations did not allow us to take steps to isolate the effects of monitoring from those of in-vehicle safety alerts (drivers are not allowed to turn off the alerts). Future studies should examine these variables separately. Finally, our data did not allow us to test if the training and the steps that were taken by the drivers' commanders affected the behaviors of the drivers without ADHD. Yet, we note that the relatively large RRs that we found may suggest that supervision could have had a differential effect on drivers with and without ADHD.

Notwithstanding the study's limitations, our findings show that the risky driving of drivers with ADHD may generalize to professional drivers that are being supervised. In this respect, our findings may also emphasize the challenges in designing behavioral modification programs for drivers with ADHD. Future studies may explore possible differential effects of interventions on drivers with and without ADHD as a means for developing customized intervention strategies.

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