Timing of drowsiness events in heavy vehicle fleets

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Abstract

Data collected from long-haul trucking fleets were analysed to examine the timing of drowsiness events while driving. Drowsiness event data were collected over a two-month period from 49 trucks. Events were recorded by a commercially available camera-based system mounted on the dashboard that measures head and eyelid metrics to assess drowsiness. By the 90th minute of driving, 75% of drivers who commenced their trip between 6pm-12pm had experienced a fatigue event. Future work will incorporate measures to account for the total trip duration to more fully assess the impact of time of day and trip start time on event rates.

Background

Driver drowsiness is implicated to be a casual factor in up to 20% of road traffic crashes (Conner et al., 2002; Horne & Reyner, 1995). While crash-based studies employ various criteria to identify fatigue, researchers generally acknowledge derived values to be likely underestimates and lacking the desired levels of accuracy with regard to identifying a definite involvement of drowsiness (Armstrong et al., 2013: Williamson et al., 2011). Most existing data are based on observational, survey, naturalistic and crash-based approaches where surrogate indicators of fatigue are used including time of day. This study analyses a large existing database of real-time drowsiness events collected from long-haul trucking fleets to examine the prevalence of drowsiness events while driving.

Method

Data for the analysis were collected from 49 trucks across three medium-sized long haul transport companies in South Africa over a two-month period in 2015. A camera-based driver monitoring system was mounted on the dashboard and measured the position and orientation of the head in three dimensions, as well as the extent of eyelid opening, to make assessments of driver drowsiness. Data are drawn from the baseline period where the system logged data but did not alert the driver. The time-to-first drowsiness event and duration (seconds) of the first drowsiness event by time of trip commencement were analysed (Hosmer et al., 2008).

Results

The mean time to the first drowsiness event being detected was 63 minutes, with observed differences by time of trip commencement not being statistically significant (Table 1). The median indicates that 50% of the sample experienced their first drowsiness event by 45 minutes into the trip, and the mean duration of the detected event was as long as 3.8 seconds on average for drivers commencing their trip in the evening.

Table 1. Summary statistics of time-to-first drowsiness event (minutes) and duration (seconds) of the first drowsiness event, by time of trip commencement

	Time of trip commencement				
	12.00 am - 5:59 am	**6.00 am - 11:59am**	**12:00 pm – 5.59pm**	**6.00 pm – 11.59pm**	**Entire day**
Time to first drowsiness event					
Mean (SD)	67.7 (64.3)	57.5 (46.3)	61.6 (55.8)	64.0 (53.7)	63.0 (56.7)
95th% CI	55.0-80.4	45.4-69.6	44.9-78.3	50.6-77.4	56.7-70.5
Median	44	42	48	50	45
Duration of first drowsiness event					
Mean (SD)	2.7 (3.4)	2.7 (2.1)	3.2 (4.1)	3.8 (4.9)	3.1 (3.7)
95th% CI	2.2-3.4	1.3-2.8	2.2-4.2	2.9-5.0	2.6-3.5
Median	1.85	1.85	1.82	2.06	1.87
Number trips	99	56	43	62	260

The point at which 50% of drivers experience their first drowsiness event can be seen to be range from 42 to 50 minutes (Figure 1). By way of example, the 90th minute of driving, 75% of drivers who commenced their trip between 6pm-12pm had experienced a drowsiness event. This is a standard way to present Kaplan-Meyer curves. While there is no statistical difference, it is an interesting observation that drivers who commenced their trip between 12am-5:59am either experienced an event quickly (i.e., nearly 40% within 30 minutes), or took longer to experience their first event; this difference is apparent from 90 minutes onwards compared to the other driver commencement time groups.

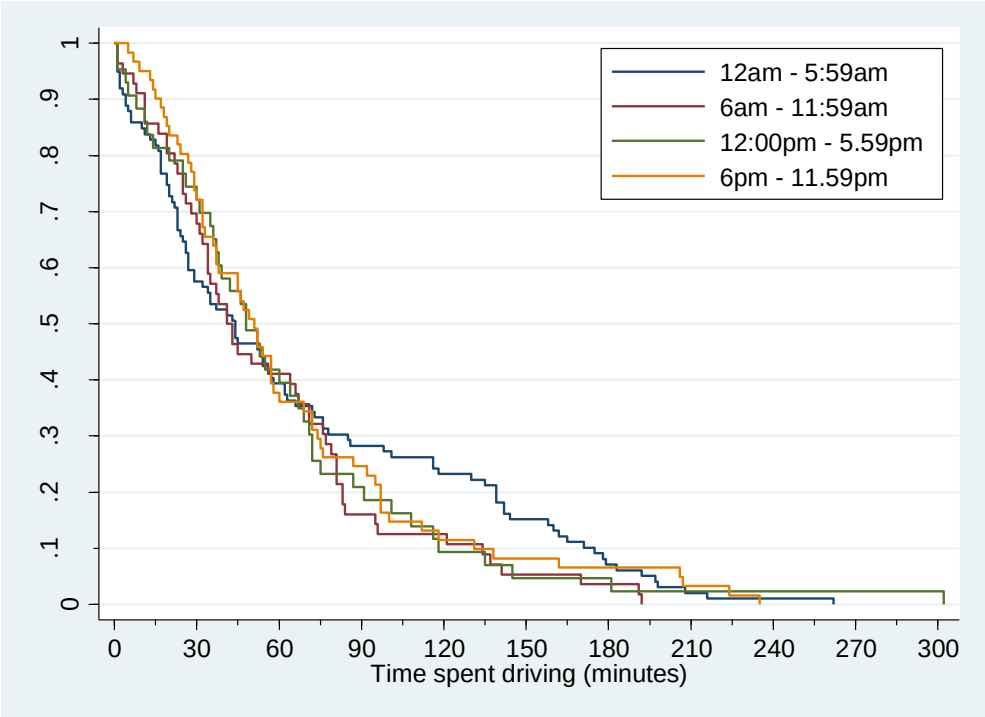

Figure 1. Probability of remaining drowsiness event free by time spent driving, given trip commencement time

Conclusion

Half of the drivers experienced a drowsiness event within their first 45 minutes of driving, and these events were on average 3.1 seconds in duration. At high speeds of travel (average speed: 77 km/h), the distance covered by these trucks within these drowsiness events was 66 metres on average. Importantly, these drivers experienced multiple drowsiness events across their trip. Future work will incorporate measures to account for the total trip duration to assess whether the total number of drowsiness events experienced by drivers differs firstly across the day, but also based on the time they commenced the trip.

References

Armstrong, K., A. J. Filtness, C. N. Watling, P. Barraclough, and N. Haworth. (2013). Efficacy of proxy definitions for identification of fatigue/sleep-related crashes: An Australian evaluation, *Transportation Research Part F: Traffic Psychology and Behaviour, 21*, 242-252.

Connor, J., R. Norton, S. Ameratunga, E. Robinson, I. Civil, R. Dunn, R., J. Bailey, and R. Jackson. (2002). Driver sleepiness and the risk of serious injury to car occupants: Population-based case control study. *British Medical Journal*, 324, 1125-1129.

Horne, J. A., and L. A. Reyner. (1995). Sleep related vehicle accidents. *British Medical Journal*, 310, 565–567.

Hosmer, D.W., Lemeshow S., May, S. (2008). *Applied Survival Analysis: Regression Modeling of Time to Event Data*, 2nd Edition. John Wiley & Sons: NJ.

McDonald, A. D., J. D. Lee, C. Schwarz, and T. L. Brown. (2014). Steering in a Random Forest: Ensemble Learning for Detecting Drowsiness-Related Lane Departures. *Human Factors, 56*, 986-998.

StataCorp.(2014) STATA v.12 MP [computer program]. College Station: TX.

Williamson, A., D. A. Lombardi, S. Folkard, J. Stutts, T. K. Courtney, and J. L. Connor. (2011). The link between fatigue and safety. *Accident Analysis & Prevention, 43*, 498-515.