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An Assessment of Commuting Risk Factors for Air Traffic Control Specialists

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16. Abstract

Risk factors for sleepiness-related vehicle accidents have included, among others, time of accident, type of roadway, distance traveled, and reduced alertness. This study assessed risk factors for commuting incidents reported by air traffic controllers driving to and from work. Analyses were conducted on responses to a modified version of the Standard Shiftwork Index survey regarding alertness, commuting variables (i.e., number of miles and roadway types), and driving outcomes (i.e., lapses of attention, falling asleep, near misses, and accidents). Chi-square tests and odds ratio (OR) risk estimates were computed separately for air traffic controllers in Terminal/Enroute and Flight Service Station options. Reduced mental sharpness was associated with elevated ORs while driving to or from most shifts, though the greatest risk was found before early mornings and following midnight shifts. Elevated ORs for lapses of attention, falling asleep, and near misses were found for those with commutes greater than 20 miles and variably, with roadway type. In most cases, too few actual accidents were reported to compute chi-square statistics or odds ratios for this outcome.

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An Assessment of Commuting Risk Factors for Air Traffic Control Specialists

INTRODUCTION

Costa (1999) suggested that critical attention should be given to individuals engaged in work requiring schedules that change normal social and biological rhythms. Of particular concern is the disruption that occurs in sleep-wake cycles as a consequence of the periodic rotations required by typical shiftworking schedules. These disruptions are evident in records of both the quantity and quality of sleep reported by shiftworkers in subsequent expressions of sleepiness and fatigue.

U.S. Air Traffic Control Specialists (ATCSs) work a variety of rapidly rotating schedules. Many rotate in a counter-clockwise direction within the week, with, for example, afternoon shifts rotating to early morning or midday shifts then to an occasional midnight shift (Della Rocco, Dobbins, & Nguyen, 1999). Though the internal body clock makes little or no adjustment during these types of rapidly rotating schedules (Åkerstedt, 1985), alertness and sleep are affected by such factors as the time of day for the shift and the time of the sleep period (Åkerstedt, 1991).

Folkard (1989) investigated shift start times and found that early-morning shifts (starting before 0600) resulted in reduced sleep and alertness. Working during the midnight shift affects sleep and alertness because it competes with the normal time for sleep (i.e., when the biological need for sleep is greatest) and reduces sleep that follows the shift when attempting to sleep during the day (Klein & Wegmann, 1979). Previous research conducted by the Civil Aerospace Medical Institute (CAMI) found similar results of reduced sleep quantity, quality, and reports of elevated sleepiness and fatigue associated with these types of schedules (Cruz, Detwiler, Nesthus, & Boquet, 2002; Cruz, Della Rocco, & Hackworth, 2000; Cruz & Della Rocco, 1995; Nesthus et al., 2001; 2002).

The combined effects of fatigue and reduced alertness with commuting variables have been shown to promote conditions that could result in sleepiness-related vehicle incidents (Stutts, Wilkins, Osberg, & Vaughn, 2003). Conner, Whitlock, Norton, and Jackson (2001) identified 19 studies concerning fatigue and driving accidents. The studies suggested that there are both internal and external factors contributing to reduced alertness and driving degradation. An expert panel convened by the National Center on Sleep Disorders Research and the National Highway Traffic Safety Administration on Driver Fatigue and Sleepiness (Washington, DC, 1997) identified three research needs concerning this topic: 1) the quantification of the prevalence of fatigue-related accidents, 2) identification of the risk factors associated with driving drowsy and having fatigue-related accidents, and 3) the development of effective countermeasures that increase the public awareness of fatigue-related accidents.

Several evaluations of the prevalence of sleepiness-related vehicle accidents (SRVA) identified a consistent temporal pattern, suggesting that higher frequencies of accidents/incidents were a function of time-of-day and may be influenced by the circadian rhythms of the driver (Conner, Whitlock, Norton, & Jackson, 2001; Folkard, 1997; Horne & Reyner, 1995; Lennè, Triggs, & Redman, 1997; McCartt, Ribner, Pack, & Hammer, 1996; Pack, Pack, Rodgman, Cucchiara, Dinges, & Schwab, 1995).

Other evaluations have identified a number of common risk factors associated with SVRA worldwide. Mondini, Cavrini, Roli, Parazzini, Pizza, Contardi, and Cirignotta (2003) indicated that the prevalence of sleepiness-related driving events vary with factors related to 1) the quantity and the quality of sleep the night before driving, 2) the length of time awake prior to driving, 3) reported sleepiness and alertness during driving, and 4) general factors associated with being a shiftworker. They pointed out that other objective variables such as the time of the event (i.e., time of day), type of roadway, type of vehicle, location, gender, and day of the week were also associated with SRVA. Likewise, Horne and Reyner (2001) found that roadway-type, time of day, and the duration of the drive contributed significantly to SRVA in the UK. A relatively high incidence of SRVA occurred during early mornings, particularly in nightshift workers returning home. Another UK questionnaire assessed the levels of "tiredness" experienced by shiftworkers during their commutes to and from work (Rogers, Holmes, & Spencer, 2001), and found that both the type of shift and the traveling time (i.e., driving duration) contributed significantly to increased sleepiness and were associated with driving impairment reports, compared with non-shiftworkers.

Stutts et al. (2003) also examined driver risk factors for sleep-related motor vehicle crashes. Their results indicated that work-related factors, including working multiple jobs, working a night shift or "other" work schedules (including rotating shifts), and working long hours contributed to negative driving outcomes. Furthermore, reduced sleep quantity and poor sleep quality were also associated with increased risk estimates for these events. Nighttime driving (particularly between midnight and 0600), driving for longer periods of time, and driving after sleeping less than 5 hours the night before were also prominent predictors of increased risk.

Background

A Congressional appropriation funded a series of studies conducted by the Federal Aviation Administration (FAA) Civil Aerospace Medical Institute (CAMI) on Air Traffic Control Specialist (ATCS) shiftwork-related issues. Research objectives were to investigate the effects of current shiftwork patterns and shift rotation practices on the ATCS workforce within the FAA. One study involved an agency-wide comprehensive survey of ATCS personnel to determine general health and well being, and the extent of reported fatigue among the workforce.

In a preliminary evaluation of data from this ATCS Shiftwork and Fatigue Survey, Ramos, McCloy, and Burnfield (2001) found elevated mean scores on items pertaining to driving performance, sleep, and fatigue relative to scheduled shifts. Increased driving-related outcomes (i.e., lapses of attention, falling asleep, and near misses while driving) were reported by controllers across most of the various shifts, though most were associated with the midnight and early-morning shifts. In addition, respondents working rapidly rotating schedules with midnight shifts fell asleep more often while driving and had more near misses than respondents working schedules that rotated slowly or contained no midnight shifts. Mental sharpness levels were also reported to be lowest when beginning or ending a midnight shift compared with the other shifts.

Because the survey database contained valuable information concerning factors such as sleepiness, alertness, and fatigue and their possible influence on driving outcomes, a closer examination of this issue was conducted. Also because of differences in the work performed by each ATCS option and their different facility locations, we categorized the ATCS workforce sample into a terminal/enroute (T/E) group that control aircraft traffic throughout the National Airspace System (NAS), and a flight service station (FSS) group that communicate primarily with general aviation pilots providing critical weather information and flight planning services. The purpose of the focused investigation, therefore, was to determine separately for each group if factors associated with alertness and commuting variables (i.e., shift, driving distance, and type of roadway) represented risk exposure for lapses of attention, falling asleep, near misses, and accidents while driving to and from work.

METHOD

Survey Instrument

The survey was based on the Standard Shiftwork Index (SSI; Barton et al., 1995), an established, comprehensive survey that covered a variety of topics, including: shiftwork history, sleep and fatigue, health and well-being, social and domestic situation, coping strategies, circadian type, and background information. CAMI modified the survey to acquire additional information concerning ATC scheduling practices and to facilitate a large-scale distribution. It was administered to the entire ATC workforce. Employees were allowed administrative time to complete the survey.

Procedure

Surveys were mailed to facilities for distribution to approximately 23,958 air traffic control specialists designated in the job series 2152 (trainees, certified professional controllers, air traffic control specialists, staff specialists, supervisors, and managers). Valid surveys were returned from a little over 28% (n=6,753) of those surveyed. The length and detail of the questionnaire and the mode of distribution may have contributed to the low response rate. ATCSs, however, have traditionally had lower response rates on surveys when compared with other FAA employee groups. Due to the relatively low response rate, it was important to assess the extent to which the sample represented the ATC population. Cruz, Della Rocco, and Hackworth (2000) provided demographic information on individuals classified as "2152-ATCS," obtained from the FAA Personnel Management Information System (CPMIS). Comparisons of the responders' demographics (i.e., gender, race, and age) with the CPMIS, overall, found the shiftwork sample to be representative of the ATC population at that time. For these analyses, data from individuals identified as air traffic controllers in the T/E options (n = 3,276) and data from controllers in the Flight Service Station (FSS) option (n = 876) were analyzed separately.

Measures

For this study, the survey database was parsed relative to questions concerning specific commuting variables to and from early-morning shifts (starting before 0759), day shifts (starting at 0800), mid-day shifts (starting at 1000), afternoon shifts (starting at 1300), and midnight shifts (starting at 2000). The commuting variables included distance traveled to work, in miles; type of commute roadway (i.e., country roads, city traffic, and highway); and mental sharpness, from "not at all sharp" to "very sharp" (on a 6-point scale). The outcome variables included frequencies of momentary *lapses of attention*, *falling asleep*, falling asleep and having a *near miss*, and falling asleep and having an *accident* while driving to or from work in the last year. Response options for these variables included "never," "once," "twice," and "three or more times."

Analysis

Chi-square frequency analysis and Odds Ratio (OR) risk estimates were computed separately for T/E controllers and for the FSS controllers with regard to each driving outcome (i.e., lapses of attention, falling asleep, near misses, and accidents). Potential risk factor variables such as commute distance and mental sharpness were dichotomized for purposes of conducting the analyses. Commute miles were dichotomized into 1-20 miles and greater than 20 miles. Mental sharpness was dichotomized into low and high mental sharpness based on the median split-score for the beginning and the end of each shift, separately. Each type of roadway (i.e., highway, city traffic, country roads) was assessed separately with regard to commuting distance. Because of the exploratory nature of the research design and the large sample size, alpha was set at 0.01. In addition, to be considered noteworthy, OR risk estimates were required to be at least 2.0 and to have a confidence interval (CI) with a lower bound of no less than 1.5 and a relatively tight range.

RESULTS

Due to the large sample size, most of the Pearson Chi-square analyses were statistically significant, with the exception of those for accident outcomes, which had much smaller frequencies of occurrence. OR risk estimates and CIs are presented and discussed.

Mental Sharpness

Because time of day, sleepiness, and fatigue directly affect an individual's alertness, an evaluation of mental sharpness was conducted to determine if this measure might also predict the reporting of driving outcomes. Average scores of mental sharpness for the beginning and end of each shift are presented in Figure 1 for both T/E and FSS respondents. It is important to note the consistency across the two operational environments reflecting stability in this measure. With the exception of early-morning shifts where ratings at the beginning and end of the shift were similar, respondents generally reported greater mental sharpness at the beginning of shifts than at the end. Mental sharpness was lowest, as expected, at the end of the midnight shifts and markedly lower than during any other shift start/end times.

An examination of the relationship between reported mental sharpness and driving outcomes (Table 1) revealed that those with lower self-reported mental sharpness were at increased risk for *lapses in attention* while driving to or

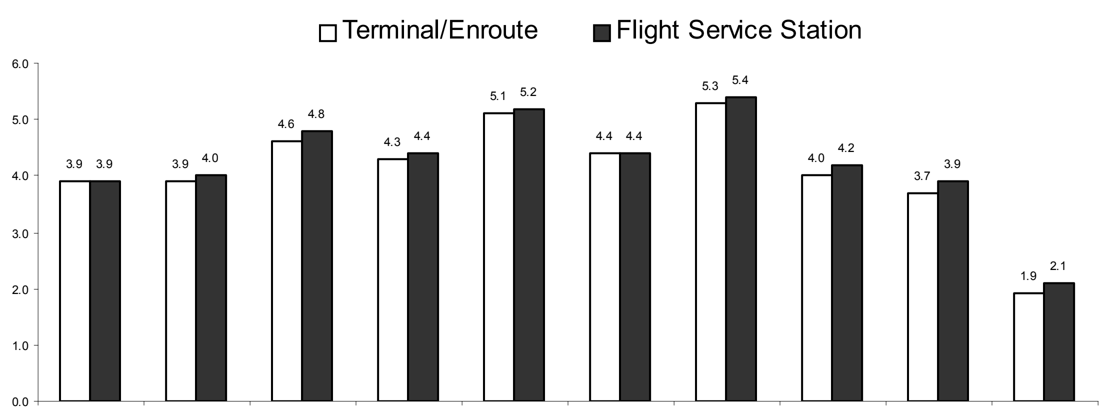

Figure 1. Average Ratings of Mental Sharpness by Shift for Terminal/Enroute and Flight Service Station Employees (EM – early morning, MD – mid-day, Aft – Afternoon, and Mid – midnight).

Table 1. Odds Ratio Risk Estimates for Driving Outcomes Based on Self-reported Mental Sharpness.

	Lapses of Attention			
	Terminal/Enroute		Flight Service Station	
Shift	Beginning	End	Beginning	End
Early Morning	5.2 (4.0-6.9)	3.2 (2.5-4.0)	6.7 (3.5-12.5)	5.9 (3.4-10.5)
Day	3.7 (2.6-5.3)	2.8 (1.9-4.0)	5.6 (2.0-16.0)	11.6 (2.6-52.0)
Mid-Day	2.7 (1.7-4.3)	3.3 (2.1-5.2)	ns	4.0 (1.2-13.4)
Afternoon	2.3 (1.7-3.0)	3.6 (2.6-5.0)	8.4 (2.4-29.4)	10.9 (2.5-47.7)
Midnight	3.7 (2.9-4.7)	5.8 (4.5-7.5)	3.3 (2.0-5.2)	7.5 (4.6-12.1)
	Falling Asleep			
	Terminal/Enroute		Flight Service Station	
Shift	Beginning	End	Beginning	End
Early Morning	1.8 (1.5-2.2)	2.0 (1.7-2.5)	2.7 (1.8-4.2)	2.4 (1.6-3.6)
Day	1.7 (1.2-2.3)	1.6 (1.1-2.1)	2.7 (1.3-5.5)	3.4 (1.5-7.8)
Mid-Day	2.0 (1.3-3.0)	1.8 (1.2-2.6)	ns	ns
Afternoon	1.6 (1.3-2.0)	2.3 (1.8-3.0)	ns	2.3 (1.2-4.5)
Midnight	1.4 (1.2-1.7)	2.0 (1.7-2.4)	ns	2.3 (1.6-3.3)
	Near Misses			
	Terminal/Enroute		Flight Service Station	
Shift	Beginning	End	Beginning	End
Early Morning	1.8 (1.4-2.4)	2.3 (1.8-3.0)	2.3 (1.3-4.2)	2.8 (1.6-4.9)
Day	2.1 (1.3-3.3)	2.3 (1.4-3.7)	ns	ns
Mid-Day	2.9 (1.4-5.9)	3.4 (1.7-7.0)	ns	ns
Afternoon	1.7 (1.2-2.4)	2.5 (1.7-3.7)	ns	ns
Midnight	1.6 (1.3-1.9)	2.5 (2.0-3.2)	ns	1.9 (1.2-3.0)

ns – not significant Chi-square statistic

from most shifts. Among T/E employees, this risk was highest for those reporting low mental sharpness at the beginning of early-morning shifts (OR = 5.2) and the end of midnight shifts (OR = 5.8). Among FSS employees, this risk was highest for those reporting low mental sharpness at the beginning and end of early-morning shifts (OR = 6.7 and 5.9, respectively), at the beginning of day shifts (OR = 5.6), and at the end of midnight shifts (OR = 7.5). T/E employees reporting low mental sharpness at the end of early morning (OR = 2.0), afternoon (OR = 2.5), and midnight shifts (OR = 2.5) were at more risk of falling asleep while driving to or from these shifts. FSS employees reporting low mental sharpness at both the beginning and end of early morning shifts (OR = 2.7 and 2.4, respectively), and at the end of day (OR = 3.4) and midnight shifts (OR = 2.3) were at more risk for falling asleep while driving to or from these shifts. T/E employees with low mental sharpness at the end of shifts were at risk for experiencing *near misses while driving*. Mental sharpness was not generally a risk factor for *driving near misses* among FSS employees, with the exception of low mental sharpness at the end of early morning shifts (OR = 2.8). Accidents were too few to compute or were not significant, with the exception of increased risk for T/E employees with low ratings of mental sharpness at the beginning of midnight shifts (OR = 3.9, CI = 1.4-10.9).

Commute Distance

An evaluation of commute distance revealed that those with commute distances over 20 miles were at least twice as likely to report *lapses of attention*, *falling asleep*, and *near misses* driving to or from shifts in the previous year (Table 2). Generally, T/E employees with longer commutes reported increased risk for *falling asleep* and experiencing *near misses* while driving on all shifts and for *lapses of attention* on early morning, day, and afternoon shifts. FSS employees reported increased risk of *lapses of attention*

Table 2. Odds Ratio Risk Estimates for Driving Outcomes Based on Commute Distance (> 20 miles vs. ≤ 20 miles).

	Driving Outcomes for T/E Employees			
Shift	Lapse of Attention	Falling Asleep	Near Misses	Accidents
Early Morning	2.8 (2.2-3.5)	2.9 (2.4-3.5)	3.0 (2.3-3.9)	*
Day	2.7 (2.0-3.8)	3.0 (2.2-4.1)	3.2 (2.0-5.0)	*
Mid-Day	2.0 (1.4-3.0)	2.9 (2.0-4.2)	4.4 (2.4-8.2)	*
Afternoon	2.8 (2.1-3.6)	3.1 (2.5-3.9)	3.6 (2.5-5.1)	4.8 (1.3-17.7)
Midnight	2.1 (1.6-2.6)	2.2 (1.9-2.6)	2.4 (1.9-2.9)	2.8 (1.1-7.0)
	Driving Outcomes for FSS Employees			
Shift	Lapse of Attention	Falling Asleep	Near Misses	Accidents
Early Morning	3.5 (2.1-5.9)	5.0 (3.4-7.5)	5.4 (3.0-9.6)	*
Day	2.4 (1.0-5.6)	4.7 (2.4-9.0)	5.6 (2.1-14.9)	*
Mid-Day	ns	3.7 (1.5-9.3)	5.6 (1.4-21.8)	*
Afternoon	3.2 (1.3-7.8)	3.2 (1.8-5.7)	6.0 (2.4-14.9)	*
Midnight	2.3 (1.5-3.6)	3.3 (2.3-4.8)	2.7 (1.8-4.3)	*

ns – not significant Chi-square statistic
* – too few cases to compute Chi-square statistic

on early morning shifts; *falling asleep* on early morning, day, and midnight shifts; and *near misses* while driving on early-morning, day, and afternoon shifts. *Accidents* were too infrequent to be analyzed, with the exception of the afternoon and midnight shifts for T/E employees. While these were statistically significant, the lower bound of the confidence intervals for the odds ratios were too low to consider them valid.

Roadway Type

An evaluation of commute distance by the type of roadways traveled was also conducted. The majority of T/E employees reported commuting on highways (54%) and city traffic roads (33%) compared with 14% traveling country roads. The majority of FSS employees also reported highway (42%) and city traffic (35%) road types; however, a larger percentage of FSS employees reported country roads (23%) than T/E employees. While many of the chi-square statistics revealed significant relationships between commute distance and driving outcomes for each of the road types, most of them were associated with very small ORs or CIs with lower bounds near 1.0. In addition, as with the previous analyses, there were often too few accidents to compute chi-square statistics. Results with meaningful estimates of risk are provided for T/E and FSS employees.

For T/E employees driving country roads, commute distance was not a significant factor for driving outcomes on most shifts. In city traffic, however, T/E employees with commutes of more than 20 miles were at greater risk for *lapses of attention* (OR = 4.4, CI = 2.4-7.9) and *falling asleep* (OR = 2.9, CI = 1.7-4.9) while driving to or from afternoon shifts, and for having *near misses* driving to or from early morning shifts (OR = 3.1, CI = 1.7-5.6). On the highway, T/E employees with commutes of more than 20 miles were at greater risk for a number of driving outcomes on a variety of shifts (Table 3).

For FSS employees with long commutes on country roads, there was an increased risk of *lapses of attention* (OR = 6.3, CI = 1.9-21.1) and *falling asleep* (OR = 5.0, CI = 2.0-12.6) while driving to or from early morning shifts. The CI for both outcomes, however, had fairly large ranges and should not be over interpreted. Driving distance was not a significant factor for *lapses of attention* on shifts other than the early morning shift. Although driving distance had a statistically significant relationship with *falling asleep* on day, afternoon, and midnight shift commutes, the CIs for the ORs had lower bounds that were less than 1.5. *Near misses* and *accidents* on country roads were not significant outcomes based on long commutes.

For FSS employees driving in city traffic, most outcomes for each shift were not significantly related to driving distance. *Lapses of attention* were not at increased risk for any shifts based on driving distance. *Falling asleep* on the drive to or from the early morning shift was more likely on

Table 3. Odds Ratio Risk Estimates Based on Commute Distance (> 20 miles vs. ≤ 20 miles) for Driving Outcomes on Highway Road Types for T/E Employees.

	Driving Outcomes for T/E Employees		
Shift	Lapse of Attention	Falling Asleep	Near Misses
Early Morning	2.6 (1.9-3.6)	2.8 (2.2-3.6)	3.1 (2.1-4.5)
Day	2.3 (1.4-3.6)	2.7 (1.8-4.1)	2.2 (1.2-3.9)
Mid-Day	ns	2.8 (1.7-4.7)	4.8 (1.9-12.5)
Afternoon	2.4 (1.6-3.4)	2.7 (2.0-3.7)	3.3 (2.0-5.4)
Midnight	1.9 (1.4-2.6)	2.0 (1.6-2.5)	2.4 (1.8-3.2)

ns – not significant Chi-square statistic

Table 4. Odds Ratio Risk Estimates Based on Commute Distance (> 20 miles vs. ≤ 20 miles) for Driving Outcomes on Highway Road Types for FSS Employees.

	Driving Outcomes for FSS Employees		
Shift	Lapse of Attention	Falling Asleep	Near Misses
Early Morning	2.7 (1.2-5.7)	2.9 (1.7-4.9)	4.9 (2.1-11.4)
Day	ns	3.6 (1.4-9.3)	ns
Mid-Day	ns	4.6 (1.0-21.8)	ns
Afternoon	6.1 (1.3-28.5)	3.1 (1.3-7.7)	0.9 (0.9-1.0)
Midnight	ns	2.6 (1.5-4.3)	2.6 (1.3-5.1)

ns – not significant Chi-square statistic longer commutes (OR = 6.6, CI = 2.2-19.9) but was not more likely on other shifts. *Near misses* were a statistically significant outcome on day (OR = 15.3, CI = 2.0-119.0), mid-day (OR = 7.1, CI = 1.1-45.9), and afternoon shifts (OR = 5.1, CI (0.9-28.4), but the CIs were extremely wide or included a lower bound of near 1.0. *Accidents* were too few to analyze or not significant.

For highway travel, FSS employees with longer commutes were at increased risk for *falling asleep* (OR = 2.9, CI = 1.7-4.9) and *near misses* (OR = 4.9, CI = 2.1-11.4) while driving to or from early morning shifts. Results for a number of other outcomes on a variety of shifts were significant; however, most had lower bounds on the CI of the OR of less than 1.5 (Table 4). *Accidents* were too few to analyze or were not significant.

DISCUSSION

The results of this evaluation support much of the previous research that has been published regarding sleepiness-related driving risk factors. Briefly, the study indicated that mental sharpness and driving distance were significant risk factors associated with driving to and from a variety of work-shifts for a large sample of ATCSs. Some evidence of a temporal component to driving outcomes was found in these data and may reflect the known circadian rhythm for alertness and performance. Lennè et al. (1997), for example, documented performance impairment of several simulation driving variables in the laboratory that corresponded quite well with the actual increased automobile accidents found by Langlois, Smolensky, His, and Weir (1985); Lisper, Eriksson, Fagerstrom, and Lindholm (1979); Schwing (1990); and Summala and Mikkola (1994), regarding time of day effects.

Folkard (1997) also found reliable time of day effects with a "macro-analysis" of previous research and reported "…like accident risk, sleep propensity was clearly highest in the early hours of the morning and showed a secondary, minor peak in the early afternoon" (p.422). Horne and Reyner (1995) reported three time-peaks for elevated SRVA, based on data from the UK, at around 0200-0259, 0600-0659, and 1600-1659, which coincides with a circadian rhythm of reduced alertness. In contrast, low incidences of sleep-related accidents were found during 0900-1059 and 1900-2050, which are times of the day when people normally feel more alert. Likewise, Pack et al. (1995) reported the highest number of crashes attributed to falling asleep occurred between midnight and 0700 and during mid-afternoon around 1500.

The present evaluation found that low mental sharpness was generally found to be associated with an elevated risk for lapses in attention and falling asleep. For the T/E employees, greater risk appeared to be associated with the beginning of early morning shifts and following the midnight shift. The results for FSS employees followed a similar trend. However, while low mental sharpness and an increased risk of near misses appeared to be associated with the end of shifts for T/E employees, the same was not true for FSS employees. One should note that the commutes following the midnight shifts and before the early morning shifts showed lower alertness but less risk than expected. One explanation might be in the apparent interaction commuters have with traffic density during those times, and not controlled for in this study.

While the risk for adverse driving outcomes increased for longer commutes (i.e., >20 mi) regardless of workgroup or shift type, there was some evidence that under certain circumstances early morning shifts showed an even greater risk for FSS employees. Notably, Rogers et al. (2001) found that both the type of shift (i.e., time of day) and the traveling time (i.e., driving duration), much like our driving distance, contributed significantly to increased sleepiness driving impairments.

When road type was considered, a complex picture appeared in the results. For T/E employees driving country roads, commute distance was not a significant factor on most shifts. However, in city traffic T/E employees with commutes of more than 20 miles were at greater risk for *lapses of attention* and *falling asleep* while driving to or from afternoon shifts and for having *near misses* driving to or from early morning shifts. Likewise, on the highway, T/E employees with commutes of more than 20 miles had a greater risk for almost every driving outcome on all shifts.

For FSS employees, an increased risk for *falling asleep* occurred both on highways and in city traffic during longer commutes to or from early morning shifts. *Near misses* also appeared to occur more frequently during long commutes on highways to or from early morning shifts. However, unlike their T/E counterparts, FSS employees with long commutes on country roads showed an increased risk of *lapses of attention* and *falling asleep* while driving to or from early morning shifts. Some caution is warranted regarding this latter finding, given the wide confidence interval ranges seen with both outcomes.

Nonetheless, the consistency of our results with previous studies on this topic suggests that the effects of commuting to and from work during various times of the day, as required by shiftworking schedules, should also be addressed. These issues were the focus of the National Summit to Prevent Drowsy Driving at the National Academies of Sciences in Washington, D.C., on November 20-21, 2002 (Drobnich, 2005). Recommendations and two products were developed as a result of this Summit, including: creation of the Web site dedicated to the prevention of drowsy driving (www.drowsydriving.org; National Sleep Foundation, 2004) and the creation of a national action plan. The plan recommended that an educational approach for shiftworking employees should be developed to raise the awareness of the critical issues associated with driving to and from work, particularly during the early morning hours.

Prevention of fatigue is, of course, the best recommendation one could make, but once driving has begun, the National Sleep Foundation suggests that the motorist attend to the following: Look for the warning signs of fatigue, including (a) can't remember the last few miles driven, (b) drift from your lane or hit a rumble strip, (c) experience wandering or disconnected thoughts, (d) yawn repeatedly, (e) have difficulty focusing or keeping your eyes open, (f) tailgate or miss traffic signs, (g) have trouble keeping your head up, and (h) keep jerking your vehicle back into the lane. If these signs are apparent, recognize that you are in danger of falling asleep and cannot predict when a micro sleep may occur. Don't count on the radio, opening windows, or other "tricks" to keep you awake. Respond to symptoms of fatigue by finding a safe place to stop for a break. Pull off into a safe area away from traffic, and take a brief nap (15 to 45 minutes) if tired. Likewise, drinking coffee or a functional energy drink may promote short-term alertness, although it takes about 30 minutes for caffeine to enter the bloodstream.

SUMMARY

Shiftwork schedules can contribute to conditions that promote driving-related incidents during commutes to or from the workplace. Prevention of fatigue associated with shiftworking schedules is difficult with the 24/7 operational requirements found in many industries today. But, "…as public health research continues to give a clearer understanding of temporal patterns of driver fatigue or sleep, the knowledge generated can be used as an educational tool for public information campaigns directed toward drivers of all ages" (Bruno, 2004; p. 55).

We found evidence that air traffic controllers experience similar responses to work schedules with elevated reporting of fatigue-related driving outcomes. Bruno (2004) suggested that "…increased driver awareness of fatigue related traffic issues would potentially encourage positive changes in driving habits and prevent accidents or at least reduce the frequency and severity…" (p.55). Therefore, our recommendations are consistent with this educational suggestion to promote an awareness of fatigue-related vehicle driving incidents and the development of effective mitigation strategies.

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