Publication No. FHWA-MC-99-067
August 1997

COMMERCIAL MOTOR VEHICLE DRIVER FATIGUE, ALERTNESS, AND COUNTERMEASURES SURVEY

U.S. Department of Transportation
Federal Highway Administration

Notice

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-MC-99-067		

4. Title and Subtitle	5. Report Date
Commercial Motor Vehicle Driver Fatigue, Alertness, and Countermeasures Survey	August 1997
	6. Performing Organization Code
7. Author(s) C. Abrams, T. Schultz, C.D. Wylie	8. Performing Organization Report No.
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Decision Research, Santa Barbara, California Essex Corporation, Goleta, California	11. Contract or Grant No. DTFH61-89-C-096
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	Final Report, Task E
FHWA, 400 7th St., SW, Washington, DC 20590-0001	14. Sponsoring Agency Code

15. Supplementary Notes

Contracting Officer's Technical Representative: D.M. Freund

16. Abstract

This is the final report on a survey of 511 commercial motor vehicle (CMV) drivers undertaken concurrently with the Driver Fatigue and Alertness Study.

Using the same basic methods established in prior studies by other investigators, interviews were conducted at four geographically disparate locations. The demographics of participating drivers were closely matched with those who had participated in previously published research. Care should be taken extrapolating the data reported here to other segments of the CMV driver population. The drivers chosen to participate were driving loaded tractor-trailer combination vehicles (straight trucks were excluded), and who had driven at least 60,000 miles within the last year, been on the road for at least 24 hours at the time of the interview, and had stopped at weigh stations for vehicle inspection or to take a break. Information was gathered on driver demographics, job characteristics, sleeping habits (including episodes of drowsiness while driving), work habits (including length of driving period and activities during breaks), methods and activities for alertness maintenance, and their subjective alertness state at time of the interview.

The majority of the drivers drove irregular routes and operated on schedules that varied from day to day. Three-quarters of these drivers using sleeper berths usually took their rests in a single 8-9 hour period. The remainder of the sleeper berth users split their rests and spent fewer hours sleeping than their continuous-rest counterparts. Although the majority of drivers reported no drowsiness and dozing and sleepiness incidents while behind the wheel during the 30 days prior to the interview, an appreciable number did, and drivers with irregular schedules reported significantly more dozing/sleeping incidents.

A substantial number of drivers stated they have taken less sleep in order to maintain their schedules. Economic pressures and a lack of availability of suitable parking areas for taking naps or sleeping were cited. Drivers' techniques for maintaining alertness appeared to depend on personal preferences, although most considered maintaining cool cab temperatures, stretching, and listening to the radio to be beneficial.

17. Key Words	18. Distribution Statement
Truck driver, fatigue, alertness, commercial motor vehicle drivers, shift workers, driver, countermeasures, work habits, sleep habits, countermeasures, survey	No restrictions. Available through the National Technical Information Service, Springfield, Virginia

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	78	

Table of Contents

Introduction 1

Method 4

The Questionnaire 4

Locations 5

Interviewers 5

Results 6

Driver and Job Characteristics 8

Sleeping Habits 10

Work Habits 17

Alertness Maintenance 24

Drivers' Subjective State 30

Conclusions 35

References 41

Appendix A: Stanford Sleepiness Scale 43

Appendix B: The Questionnaire and Tabulated Response Frequencies 45

List of Tables

Table 1. Distribution of interviews and refusals by location. 6

Table 2. Physical descriptions of the drivers. 8

Table 3. Driver and job characteristics. 9

Table 4. Comparison of driver/job characteristics among three studies. 11

Table 5. Hours usually spent in berth (drivers using berth on the road). 12

Table 6. Reasons for daytime sleeping not being restful. 14

Table 7. Work habits of drivers as functions of type of driver. 18

Table 8. Frequency of performing various activities during break stops. 22

Table 9. Ratings of activity effectiveness for maintaining alertness while driving. 24

Table 10. Percentages of drivers reporting on use of controlled substances by fellow drivers. 27

Table 11. Percentages of drivers reporting on use of relaxants after work by fellow drivers. 28

Table 12. Causes for elapsed time (6 hours+) between awakening and driving. 30

Table 13. Relatedness of measures to the Stanford Sleepiness Scale 33

List of Figures

Figure 1. Distribution of interviews by 2-hour intervals. The fewest number of interviews were conducted between 6 and 8 a.m.; the most between 4 and 6 p.m. 7

Figure 2. The number of dozing/sleeping incidents per driver while behind the wheel during the prior 30 days. The majority (72 percent) reported no dozing at the wheel. 15

Figure 3. Frequency of dozing/sleeping at the wheel and drowsiness as a function of work schedule. Irregularly scheduled drivers reported more dozing/sleeping at the wheel. 16

Figure 4. The frequency of drowsiness episodes experienced in the prior 30 days. Only seven drivers reported >30 events. 17

Figure 5. The preferred length of drive before stopping, in 1-hour blocks. The most frequent responses were 4 to 5 hours. 20

Figure 6. The preferred length of drive in hours, for both union and nonunion drivers. Union drivers preferred to stop 32 minutes sooner. 20

Figure 7. The distribution of break durations for all drivers. The most frequent responses were 15, 30, or 60 minutes. Only 1.8 percent took breaks longer than 2 hours. 21

Figure 8. Average break length reported by solo and team drivers, in minutes. On average, team drivers reported breaks of 9.3 minutes shorter duration. 22

Figure 9. Distribution of responses to the Stanford Sleepiness Scale. 31

Introduction

The maximum amount of time that commercial motor vehicle (CMV) drivers operating in interstate commerce may drive their vehicles is specified in Title 49, Code of Federal Regulations, Part 395. In Canada, it is limited under the Federal "Commercial Vehicle Drivers Hours of Service Regulations, 1994"; SOR/DORS/94-716, November 15, 1994. The U.S. regulations were originally developed in 1935 by the Interstate Commerce Commission (ICC). On April 25, 1938, the ICC requested the United States Public Health Service (USPHS) to conduct an investigation into the hours of service (HOS) of drivers of commercial motor vehicles operating in interstate commerce. This was the first scientific study to address fatigue relating to hours of service. The USPHS found that "it would ... appear that a reasonable limitation of the HOS would, at the very least, reduce the number of drivers on the road with very low functional efficiency. This, it might reasonably be inferred, would act in the interest of highway safety." (Jones et al. 1941) No further study was undertaken by USPHS or the ICC. In December 1967, the ICC's responsibilities concerning CMV drivers and vehicle safety were transferred to the former Bureau of Motor Carrier Safety (now the Office of Motor Carriers and Highway Safety) of the Federal Highway Administration (FHWA), an agency within the then newly created U.S. Department of Transportation (DOT).

The DOT has devoted considerable resources to addressing this issue. In the 1970s three major field research studies were conducted to assess the influences on driver alertness of driving time (Mackie and Miller, 1978; Harris and Mackie, 1972), heat, noise, and vibration (Mackie et al. 1974), and physical effort expended in loading and unloading cargo (Mackie and Miller, 1978). Driver alertness was measured using a broad-spectrum approach incorporating driving task performance patterns and the drivers' physiological and behavioral responses as well as

self-evaluations. Patterns of accidents were also studied to determine whether there was a relationship between driving time and accident occurrence (Mackie and Miller, 1978; Harris, 1977; Harris and Mackie, 1972). Although causal relationships were noted, they were not considered strong enough to justify changes proposed by the DOT to the hours-of-service regulations in 1979.

Driver fatigue became a safety focus again in the mid-1980s. A 1987 Office of Technology Assessment report, "Gearing Up for Safety," pointed to driver fatigue as a growing highway safety concern. Under the Truck and Bus Safety and Regulatory Reform Act of 1988, Congress directed the DOT to conduct research to determine the relationship, if any, among federal hours-of-service regulations for operating commercial vehicles, operator fatigue, and the frequency of serious accidents involving commercial motor vehicles.

In November 1988, FHWA held a Symposium on Truck and Bus Driver Fatigue to discuss what was known about fatigue and fatigue-related accidents and to propose research on that subject. The conference brought together experts from the motor carrier industry and the scientific and medical, law enforcement, and public policy communities. The recommendations of the symposium resulted in the decision to conduct a comprehensive Driver Fatigue and Alertness Study (DFAS).

The primary goals of that study were to investigate the effects on safety-related driving performance of the primary factors commonly thought to lead to the development of fatigue and loss of alertness of commercial vehicle drivers; to investigate the relative importance of their effects; to establish objective and measurable relationships between the primary fatigue-producing factors and driving performance; and to identify effective and efficient countermeasures based on the study's findings. The DFAS included an extensive literature review and field data collection that were reported by Wylie, et al. 1996.

The literature review highlighted a need for additional data about drivers whose particular job characteristics might lead to irregular schedules, night driving, and daytime sleeping. A survey was designed and conducted to extend prior work discussed in the literature review and to determine the prevalence of factors that may contribute to fatigue in commercial truck drivers. An additional aim was to identify and assess the methods used by truck drivers to alleviate fatigue or its symptoms. The methods and results of that survey are reported here.

Using the same basic methods established in prior studies by other investigators, surveys were conducted at four geographically disparate locations. A specific segment of the population of commercial drivers, described below, was purposefully chosen to be sampled for this study. Because it was deemed important to expand upon previous work in this area of study, the demographics of participating drivers were closely matched with those who had participated in previously published research. Care should be taken in extrapolating the data reported here to other segments of the commercial driver population. The drivers chosen to participate were those

- driving loaded tractor-trailers (straight trucks were excluded),
- who had driven at least 60,000 miles within the last year,
- who had been on the road for at least 24 hours at the time of the interview, and
- who had stopped at weigh stations, either for vehicle inspection or to take a break.

Method

The Questionnaire

A questionnaire was developed that addressed the factors considered to contribute to fatigue among long-haul tractor-trailer drivers and the methods they used to counter fatigue. In addition to questions concerned with those issues, the instrument also included demographic items designed to provide data for analytic purposes as well as for comparisons with previous studies.

Because an overly lengthy questionnaire would likely preclude the willingness of at least some segment of the population of drivers to participate (and thereby perhaps bias or skew the sample of respondents), the instrument was designed to take no longer than 15 minutes to administer. Preliminary field-testing revealed that drivers found this amount of interviewing time not to be objectionably long. The final version of the questionnaire (Appendix B) averaged 12 minutes to complete.

Prior to use in the study, the instrument was pretested twice in the field and revised as necessary to ensure that questions were properly phrased and understood. Of particular concern were items related to such sensitive matters as the use of controlled and alcoholic substances and rest/sleep times. Also, because the interviews were conducted in facilities operated by law enforcement agencies, special care was taken to make known that the interviewer was not affiliated with the authorities and that the information collected would be anonymous and voluntary. In addition to a verbal disclaimer, interviewers were distinguished from facility personnel by wearing reflective safety vests, and finally, to encourage participation, drivers were told during introductory comments that they would receive a $5 honorarium for their assistance.

Locations

Interviews were conducted at truck inspection stations in California, Georgia, Missouri, and Virginia. The sites were chosen on the basis of location and hours of operation. The sites chosen afforded geographic diversity, high density of long-distance traffic, and 24-hour, around-the-clock operation.

As an additional check and evaluation of the procedures and instrument, the California interviews were conducted prior to those at the other sites. Once it was established that the procedures and questionnaire operated smoothly, the remaining interviews were conducted concurrently and were completed during February and March of 1995.

Interviewers

Local interviewers were retained to conduct the study at each location. All were professional and experienced and, because of these backgrounds, considered the questionnaire and procedures used in the study as being straightforward and self-explanatory. Nonetheless, for training purposes, both written and tape-recorded instructions were provided to minimize the possibility of differences in study administration. Further, daily telephone contact was maintained with field supervisors to ensure that the interviews progressed without difficulty.

The interviewers were instructed to approach a standing vehicle (either undergoing inspection or parked in a rest zone), to briefly introduce themselves to the driver, and to ask the driver to participate in a study concerned with alertness and fatigue. For drivers who were willing and who were qualified, i.e., those driving loaded tractor-trailers *and* who had driven at least 60 thousand

miles last year *and* who had been on the road at least 24 hours, the interviews were conducted in parking areas adjacent to the inspection bays. Drivers whose vehicles were being inspected during the initial approach were asked to pull into the parking area of the facility upon concluding the inspection. As in Braver et al. (1992), straight trucks were excluded because they tend to be involved mostly in local pick-up and delivery. Depending on conditions, interviews were conducted on the pavement or in the vehicle cab. Prior to beginning the interview proper, the interviewer reiterated the purpose of the study, that it was voluntary and confidential, and that the driver would receive an honorarium at the conclusion. Drivers' responses were recorded on the questionnaire and also taped to ensure that the interviews were conducted properly. Interviews were conducted around the clock; however, traffic flow was the prime determinant of the number of interviews completed on each 8-hour shift.

Results

A total of 511 interviews were completed. Table 1 shows the number of participants and refusals at each location. The relatively large number of refusals in Georgia may have been due to the level of inspection performed at that station. Only weight and license checks were conducted, which did not require drivers to stop for any extended time; hence, many drivers declined to stop for the interview.

Table 1. Distribution of interviews and refusals by location.

	Totals	California	Georgia	Missouri	Virginia
Interviews	511	129	124	128	130
Refusals	241	7	146	19	69

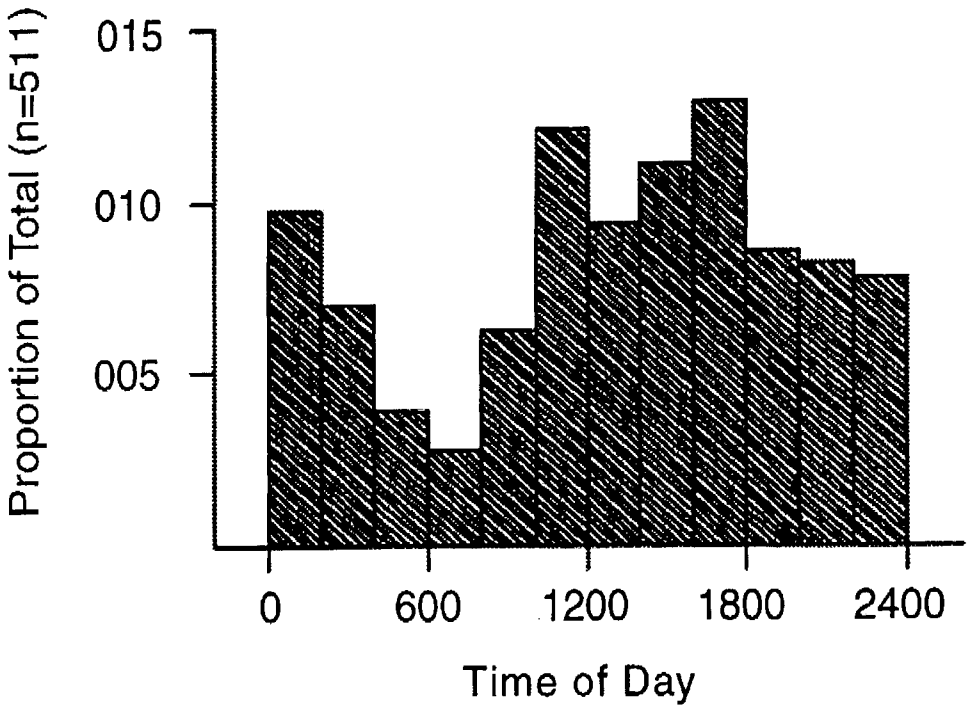

Figure 1. Distribution of interviews by 2-hour intervals. The fewest number of interviews were conducted between 6 and 8 a.m.; the most between 4 and 6 p.m.

Figure 1 shows the distribution of interviews by 2-hour time intervals beginning at midnight. The fewest number of interviews (n = 14) were completed during the 6 a.m. to 8 a.m. period and the largest number between 4 and 6 p.m. (n = 66). This distribution of interviews is consistent with that of Braver et al. (1992) and was largely determined by diurnal changes in traffic density at the four locations where interviews were conducted.[1]

[1] In a personal communication, Carol W. Preusser, one of the authors of Braver et al. (1992), noted that traffic flow was consistently low during early morning hours, and hence the number of interviews conducted during that time period was appreciably smaller than during other periods.

Driver and Job Characteristics

Table 2 provides some physical descriptions of the drivers. As might be expected, they were predominantly male (96.5 percent) and ranged in age from 22 years to 67; the mean and median ages were virtually the same (42 and 43 years, respectively). The weights of the drivers varied from 105 to 420 lbs.; again, the mean and median weights were nearly identical (202 and 200 lbs., respectively).

Table 2. Physical descriptions of the drivers.

	Height	Weight (lbs.)	Age
Range	5'0" - 6'9"	105 - 420	22 - 67
Mean	5'10"	202	42
Median	5'11"	200	43
Mode	6'0" (n=85)	200 (n=39)	44 (n=23)

Table 3 lists some driver and job characteristics examined in the study. Overall, nearly one-third of the drivers (31.5 percent) were owner-operators. The percentages of owner-operators were uniform across three of the interviewing sites, ranging from 23.3 percent to 25 percent for California, Georgia, and Missouri, but more than doubled to 53.8 percent in Virginia. One in 20 (5.3 percent) drivers responded that they were union members, with little variation among the four interviewing sites (4.7 percent to 6.2 percent) in the proportion of drivers who were union affiliated.

The large majority of respondents (84.1 percent) usually drove irregular routes, i.e., routes changed from trip to trip. Fewer drivers interviewed in California (74.4 percent) drove irregular

routes than did those interviewed in Georgia, Missouri, and Virginia (83.9 percent, 88.3 percent and 89.2 percent, respectively).

Table 3. Driver and job characteristics.

Characteristic	Total	California	Georgia	Missouri	Virginia
Base for Percent	511	129	124	128	130
Owner-Operator	31.5%	23.3%	23.4%	25.0%	53.8%
Union Member	5.3%	4.7%	4.8%	5.5%	6.2%
Irregular Route	84.1%	74.4%	83.9%	88.3%	89.2%
Variable Hours	84.7%	84.5%	83.1%	82.0%	89.2%
Drive Solo	84.1%	82.9%	86.3%	79.7%	87.7%

The large majority of respondents (84.7 percent) had irregular schedules, i.e., the working hours varied from day to day. Fewer drivers interviewed in Virginia (10.8 percent) tended to have the same working schedule than did those interviewed at the other three sites (range from 15.5 percent to 18 percent). Further examination of the data revealed that drivers who had irregular routes were more likely to have irregular schedules (76.1 percent) than those who had regular routes (8.6 percent). The large majority of drivers interviewed (84.1 percent) drove solo, with little variation among the four sites. Additionally, the data showed that a significantly greater proportion of union drivers (30 percent) drove a regular schedule than did nonunion drivers (14 percent); ($x^2 = 4.52$, $df = 1$, $p = .033$).

Other job and driver characteristics examined included the length of usual road trip and years of driving experience. The average trip lengths reported by drivers were quite varied, ranging from 1

day to more than 99 days, with an average of approximately 13 days. However, the median (50th percentile) trip length was 7 days and the 75th percentile was 18 days, which demonstrates the skewed nature of responses toward the lower end of the range. The variation in the number of years of experience driving trucks was also substantial, ranging from 1 to 47 years, with the average being 15 years. Half the drivers had at least 14 years of experience.

As mentioned earlier, some of the methodology used in the present study was modeled after Beilock (1989) and Braver et al. (1992). In those studies, substantially larger numbers of drivers (1,285 and 1,249, respectively) were surveyed than in the present study. However, comparisons of the driver demographics and job characteristic data common to the three studies reveal very similar distributions, thereby supporting the notion that the current sample is representative of the same populations studied by Beilock and by Braver et al. The comparisons are summarized in Table 4.

Sleeping Habits

By far the most effective way to alleviate fatigue is to rest, and the most efficacious manner of rest is sleep. For this reason, an appreciable number of questionnaire items were concerned with the sleep habits of drivers.

To feel totally rested on an average or normal day, the large majority of drivers (76.7 percent) reported that they needed between 6 and 8 hours of sleep, with an average of 7 hours (6.98 hours). Four to 10 hours of sleep encompassed the need of nearly all (98.4 percent) drivers to feel totally rested.

Table 4. Comparison of driver/job characteristics among three studies.

Driver Demographics	Beilock (1989)	Abrams et al. (1997)
Age:		
Mean	41 yrs	42 yrs
Percent in 20s	15%	10%
Percent from 30 to 49	63%	63%
Percent from 50 to 59	19%	17%
Percent in 60s	4%	2%
Mean Years Driving	15	15
Union Member	7%	5%
Owner-Operator	26%	32%

Job Characteristic	Braver et al. (1992)	Abrams et al. (1997)
Irregular Route	78%	84%
Co-Driver	19%	16%
Usual Trip Length		
7 or Fewer Days	58%	55%
8–14 Days	18%	16%
15–21 Days	10%	11%
22 or More Days	14%	14%

There were no statistically significant differences in the rest requirements between owner-operators and company drivers, between regular- and irregular-route drivers, between regular- and irregular-schedule drivers, or between solo and team drivers. The average required-sleep-time to feel totally rested reported by union drivers was 6 hours, 29 minutes; the average

for nonunion drivers was 31 minutes greater (Mann-Whitney U = 4894, $df = 1$, $p = .024$). Though the union drivers were slightly older than the nonunion drivers, analyses of the age differences revealed that age was not the underlying factor for the greater sleep requirements of nonunion drivers.

Table 5. Hours usually spent in berth (drivers using berth on the road).

Type of Operation	Rest Mode*	2–3 Hrs	4–5 Hrs	6–7 Hrs	8–9 Hrs	10–12 Hrs
Solo	One Stretch	1 (.3%)	11 (3.6%)	97 (31.7%)	183 (59.8%)	14 (4.6%)
	Split Rest	11 (13.8%)	51 (63.8%)	10 (12.5%)	8 (10.0%)	0
Team	One Stretch	0	4 (11.8%)	7 (20.6%)	18 (52.9%)	5 (14.7%)
	Split Rest	0	29 (78.4%)	5 (13.5%)	2 (5.4%)	1 (2.7%)

* Seven drivers did not respond as to rest mode; percentages are based on *n* in each mode.

Ninety-one percent of the drivers interviewed responded that while on the road, they usually took their main sleep in the berth, and an additional 6.7 percent slept in motels. Three-quarters (74.7 percent) of the drivers who used the berth, usually took their sleep in one stretch, and most of them reported spending 8 to 9 hours in the berth. In contrast, more than two-thirds (69 percent) of those drivers who split their rest periods usually spent 4 to 5 hours in the berth at one time. Table 5 shows the distribution of the rest period durations reported by the 465 drivers who rested in the sleeper berth.

Drivers reported a wide variation in the number of sleep/rest hours during their last main sleep prior to the interview, ranging from 1 to 15 hours, with an average of 8. Examination of these data revealed, as might be expected, that drivers who split their rests tended to sleep fewer hours than those who rested in one stretch ($C = .44$, $p < .001$)[2]. For example, more than half the split-rest drivers (56.4 percent) slept between 1 and 6 hours, as opposed to only 12.9 percent of the one-stretch drivers who slept similar amounts.

The quality as well as the quantity of sleep plays a role in the development of fatigue. Overall, three out of five drivers (59.7 percent) felt that daytime sleeping was not as restful as nighttime sleeping. The opinions of drivers on a regular schedule did not differ from those working irregular schedules or irregular routes. However, appreciably more owner-operators (70 percent) responded that daytime sleeping was not as restful as nighttime sleeping, as compared to 55 percent of the company drivers ($x^2 = 10.2$, $df = 1$, $p = .001$). A statistically significant difference was also found between team and solo drivers, with the majority (55.6 percent) of team drivers reporting daytime sleep to be just as restful as nighttime sleep, while only a third (37.4 percent) of solo drivers considered it to be so ($x^2 = 9.4$, $df = 1$, $p = .002$).

Drivers who found daytime sleep not as restful as nighttime sleep offered a variety of reasons for their opinions, which are summarized in Table 6. Team drivers were more likely than their solo counterparts to find light bothersome but less likely to find noise bothersome.

[2] A modification of the chi-square (x^2) statistic, the contingency coefficient, C, describes the extent of association between two sets of attributes when one or both do not have any underlying continuity or order.

Unquestionably the most dangerous consequence of fatigue on drivers is dozing or falling asleep at the wheel. While the large majority of drivers interviewed (72 percent) did not report having such experiences during the previous month, the number who did report falling asleep at the wheel (143 or 28 percent) was nonetheless substantial and appreciably greater than the 19 percent reported by Braver et al. (1992)[3]. Figure 2 shows the number of dozing/sleeping incidents reported per driver while behind the wheel during the prior 30 days.

Table 6. Reasons for daytime sleeping not being restful.

Reasons	Total (n = 297)	Teams (n=35)	Solo (n=262)
Light Is Bothersome	21.6%	28.6%	20.6%
Noise Is Bothersome	11.1%	2.9%	12.2%
Internal Clock	11.8%	17.1%	11.1%
Habit/Night Seems Normal	30.6%	25.7%	31.3%
Other Reasons	24.9%	25.7%	24.8%

Of the group of drivers who reported dozing or sleeping at the wheel, more than half (53.1 percent) did so once or twice during the prior month, and an additional third (32.2 percent) reported they had experienced the problem between three and six times. A few (3.5 percent) responded that they had dozed or slept at the wheel at least once per day during the prior month.

[3] One possible explanation for the difference may be the manner in which the question was put to drivers. Though identically worded in both studies (see Appendix B, Q.26), Braver et al. preceded their question with the statement "Many drivers have reported dozing or falling asleep at the wheel occasionally. Has that ever happened to you?" This lead-in may have had an influence on the driver's response (bracketed categories in the Braver et al. study but open-ended in the present investigation). The direction in which drivers may have been influenced (either denial or agreement) can be equally argued.

Of the drivers who reported having dozed or slept at the wheel, 9.8 percent indicated that they were never aware of the pending problem, i.e., theoretically they could not take any action to circumvent the danger. But another 28 percent said they were *sometimes* aware, and 59 percent reported they were *always* aware of the pending problem. The latter percentages, especially of those drivers who were *always* conscious of the potential for dozing, raise concerns about drivers who continue driving while aware of the impending potential of dozing or falling asleep. The reasons for continued driving under such circumstances were not explored in this study.

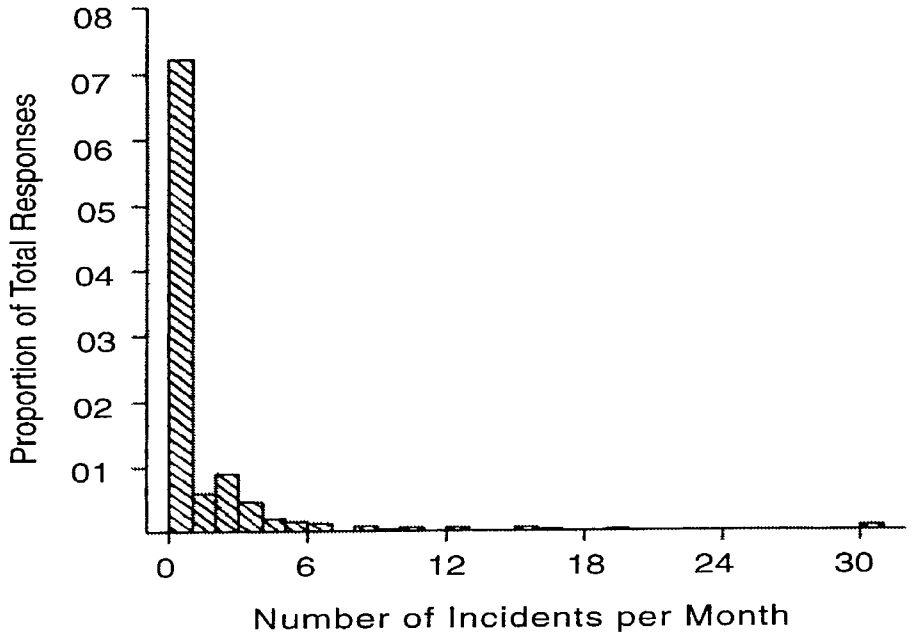

Figure 2. The number of dozing/sleeping incidents per driver while behind the wheel during the prior 30 days. The majority (72%) reported no dozing at the wheel.

Drivers who had irregular schedules reported significantly more incidents of dozing/falling asleep at the wheel than those with regular schedules ($t = 3.8$, $df = 473$, $p = .0002$). These differences are illustrated in Figure 3. No other demographic comparisons revealed statistically significant differences.

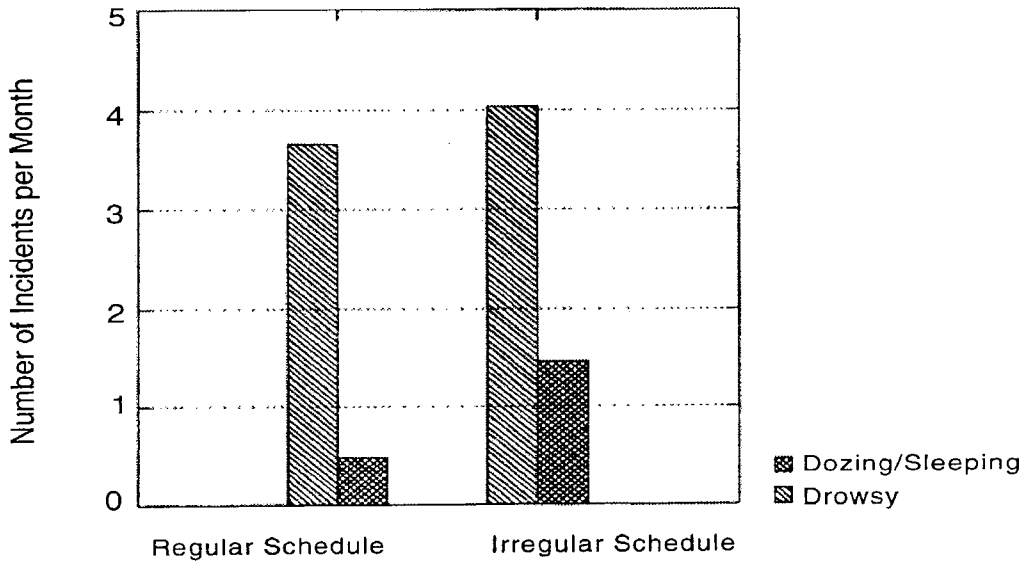

Figure 3. Frequency of dozing/sleeping at the wheel and drowsiness as a function of work schedule. Though irregularly scheduled drivers experienced both more drowsiness and more dozing/sleeping at the wheel, only the difference in dozing is statistically significant.

Because the act of dozing or falling asleep at the wheel may be viewed as the end of a process usually preceded by such symptoms as drowsiness and/or difficulty in keeping eyes open, drivers were also asked whether they had experienced these precursors during the prior month. More than half the drivers (56.7 percent), twice as many as who had reported dozing or sleeping at the wheel, responded that they had experienced these symptoms[4]. Figure 3 also illustrates the incidence of drowsiness for regular- and irregular-schedule drivers. Of those who had bouts of drowsiness, 47.7 percent indicated that they had felt drowsy or fought to keep their eyes open once or twice during the previous month, and an additional 36.9 percent reported they experienced such episodes between three to six times during that time period. Some 4.9 percent of the drivers

[4] Though differing from the present investigation with respect to the population studied, the time frame used, and the response scale used, it is nonetheless interesting to note that a telephone survey of 1,000 randomly selected New York State drivers found that 55 percent of them (virtually the same number as in the present study) had driven while drowsy during the preceding year; 17 percent of the drivers reported that they had **sometimes** or **very often** driven while drowsy (New York State Governor's Traffic Safety Committee and the Institute for Traffic Safety Management and Research, 1994).

indicated that, on average, they experienced drowsiness daily, i.e., 30 or more times during the month. Figure 4 shows the frequency-of-occurrence of these precursors to dozing or sleeping.

No statistically significant differences in drowsiness reports were found between owner-operators and company drivers, between union and nonunion drivers, between solo and team drivers, between irregular- and regular-schedule drivers, or between varying- and regular-route drivers.

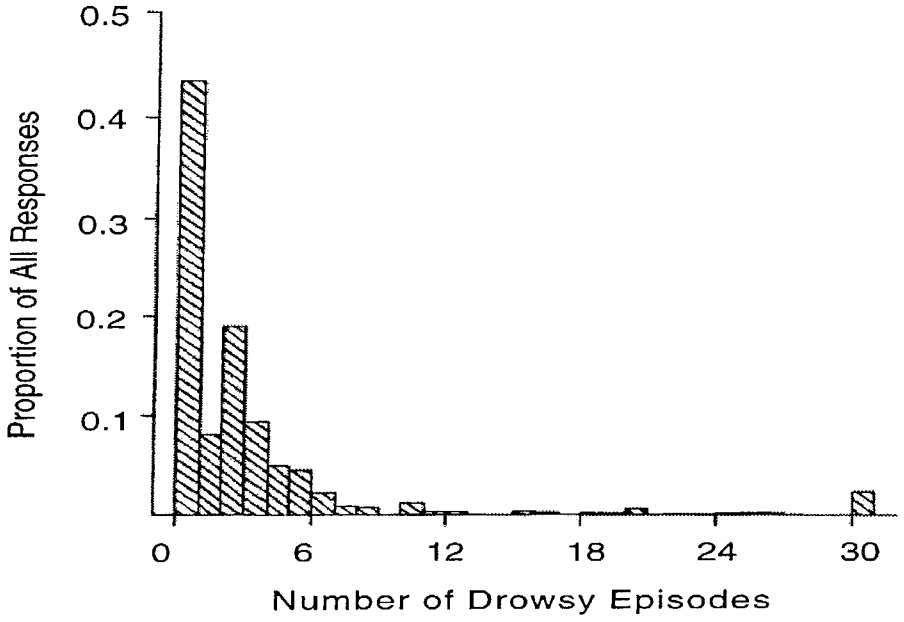

Figure 4. The frequency of drowsiness episodes experienced in the prior 30 days. Only seven drivers reported >30 events.

Work Habits

The needs of shippers and consumers pressure drivers to maintain their delivery schedules. Because driving conditions often interfere with schedules, drivers were asked how frequently they do with less sleep to compensate for adverse conditions. While nearly half (46.7 percent) indicated that they do so *sometimes*, 10.6 percent responded that they *always* do with less sleep to

keep up with schedules. It seemed reasonable to assume that owner-operators, because of their inherently greater investment and concern with maintaining schedules, would be more inclined than company drivers to do with less sleep. As shown in Table 7, both groups, owner-operators and company drivers, indicated that they would *sometimes* (46.6 percent each) do with less sleep. As expected, however, more owner-operators than company drivers (14.3 percent vs. 8.9 percent) reported they would *always* do with less sleep, and more company drivers than owner-operators (43.7 percent vs. 37.3 percent, respectively) responded that they would *never* sacrifice sleep to maintain their schedule.

Table 7. Work habits of drivers as functions of type of driver.

Sleep Less to Maintain Schedule	Owner-Operator	Company Driver	Solo Driver	Team Driver
Always	14.3%	8.9%	40.3%	51.9%
Sometimes	46.6%	46.6%	47.9%	43.2%
Never	37.3%	43.7%	11.8%	4.9%
Load / Unload	**Owner-Operator**	**Company Driver**	**Solo Driver**	**Team Driver**
Yes	24.2%	19.7%	22.7%	13.6%
No	75.2%	80.0%	77.3%	86.4%

Similarly, team drivers were more likely than solo drivers (51.9 percent and 40.3 percent, respectively) to *always* do with less sleep when behind schedule and were less likely (4.9 percent vs. 11.8 percent) to *never* sacrifice sleep.

In addition to their main task of transporting goods, drivers sometimes perform the physical task of loading or unloading their vehicles. Overall, about a fifth of the drivers (21.1 percent) reported that they usually perform that task, and owner-operators were somewhat more likely to do so (24.2 percent) than company drivers (19.7 percent).

Interestingly, about a quarter of the drivers (23.1 percent) who loaded and unloaded goods reported that the task had a positive effect on their alertness in that they were able to sustain their alertness for a longer time, while about a third of the drivers (34.3 percent) who performed the task reported they could not maintain their alertness as long, i.e., the task contributed to fatigue. The plurality of drivers (42.6 percent), however, did not attribute any effects, either positive or negative, to the loading and unloading of goods.

As in most occupations, one way of combating the effects of fatigue or monotony is to take periodic breaks from the work task. Truck drivers have, at least in theory, the option of taking breaks at their discretion. Approximately half the drivers (51.4 percent) prefer to drive 4 hours or less before stopping for a break. Another 39.6 percent prefer to drive between 5 and 6 hours before stopping; on average, drivers prefer to drive about 4.6 hours before stopping. The preferences for all drivers combined are depicted in Figure 5. There were no statistically significant differences in preferred length of drive between owner-operators and company drivers, between solo and team drivers, nor between regular and irregular schedules. However, the preferred length of drive between breaks reported by the 25 union-affiliated respondents was half an hour (32 minutes) less than that reported by nonunion drivers, as shown in Figure 6 (Mann-Whitney $U = 4422$, $df = 1$, $p = .039$).

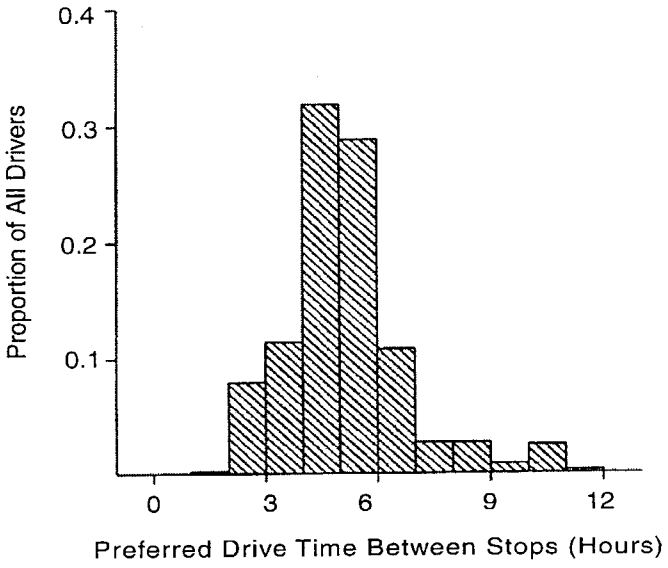

Figure 5. The preferred length of drive before stopping, in 1-hour blocks. The most frequent responses were 4 to 5 hours.

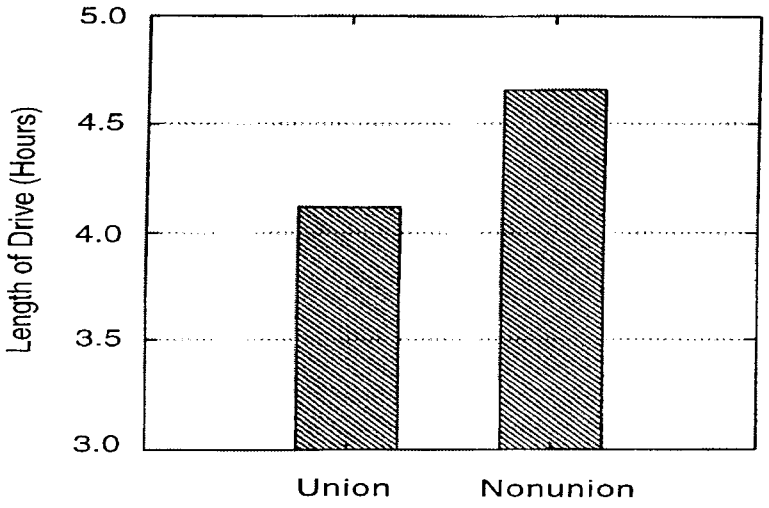

Figure 6. The preferred length of drive in hours, for both union and nonunion drivers. Union drivers preferred to stop 32 minutes sooner.

The length of the rest breaks usually taken by drivers is considerably more variable, ranging from less than 5 minutes (1.6 percent) 3 hours or more (1.4 percent). The distribution of preferred break lengths is shown in Figure 7. The distribution is bimodal, with nearly equal numbers of drivers reporting the length of their usual stop as 30 to 45 minutes (28.9 percent) and 60 to 75 minutes (31.0 percent), respectively. The median length of breaks was 45 minutes; the mean length was 50 minutes.

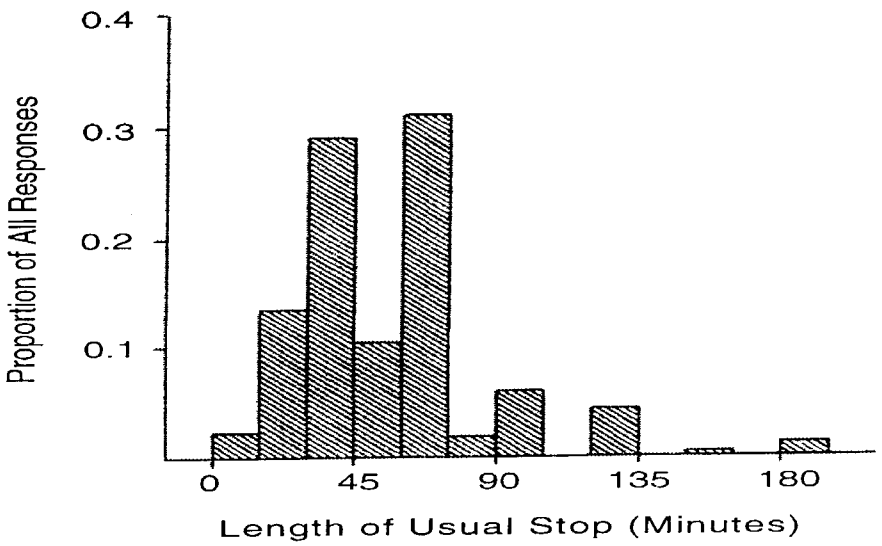

Figure 7. The distribution of break durations for all drivers. The most frequent responses were 15, 30, or 60 minutes. Only 1.8% took breaks longer than 2 hours.

There were no statistically significant differences in reported break length between owner-operators and company drivers, union and nonunion drivers, regular- and irregular-route drivers, nor regular- and irregular-schedule drivers. However, the lengths of breaks reported by team drivers averaged 9.3 minutes less than that those taken by solo drivers (Mann-Whitney U = 18851, df = 1, p = .013), as shown in Figure 8.

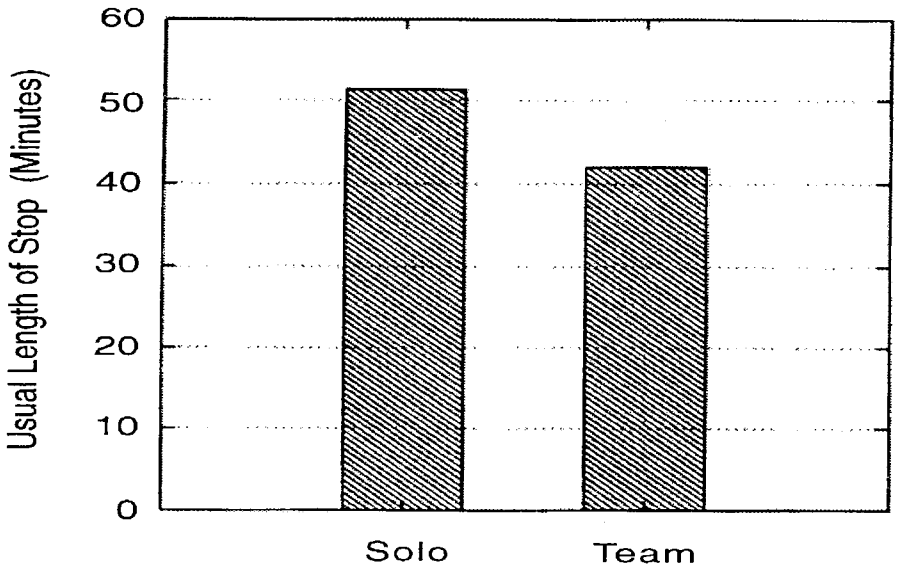

Figure 8. Average break length reported by solo and team drivers, in minutes. On average, team drivers reported breaks of 9.3 minutes shorter duration.

During these break times, drivers perform a variety of tasks and activities. The frequencies of the major activities are shown in Table 8.

Table 8. Frequency of performing various activities during break stops.

Activity	Always	Sometimes	Never
Eat	18.8%	78.9%	2.3%
Check Truck	72.8%	22.7%	4.5%
Fuel Up	5.5%	89.2%	4.9%
Nap	3.1%	62.6%	33.9%
Jog/Exercise	7.2%	32.3%	60.5%
Make Phone Calls	26.4%	70.6%	2.7%
Use Rest Room	60.7%	31.9%	.2%

Virtually all drivers use the break stop, either always or sometimes, to eat (98 percent), to check their truck and cargo (96 percent), to fuel up (95 percent), to make phone calls (97 percent), and to use the rest-room facilities (93 percent). Considerably fewer drivers use the rest stops to take naps (66 percent) or to jog/exercise (40 percent), activities which potentially could serve to reduce fatigue or to increase alertness. There were no statistically significant differences between owner-operators and company drivers in the break stop activities reported.

In comparison to drivers who always drive at the same time of day, the drivers with irregular work shifts are more likely to report that they *sometimes* fuel up when they stop, rather than *always* or *never* ($x^2 = 32.5$, $df = 2$, $p < .0005$).

In comparison to regular route drivers, drivers with varying routes are more likely to report that they *sometimes*, rather than *always* or *never,* eat ($x^2 = 6.6$, $df = 2$, $p = .036$), and *sometimes*, rather than *always* or *never*, fuel up ($x^2 = 16.5$, $df = 2$, $p < 0.0005$). It would appear that drivers with varying routes were necessarily more flexible in break activities, since they did not differ from others in their preferred drive length between stops; and, because of varying routes, facilities for eating or fueling would only be *sometimes* available at the chosen stop location.

In comparison to nonunion drivers, the 27 union drivers reporting break activities were more likely to report that they *always* fuel up, rather than *sometimes* or *never*, ($x^2 = 50.0$, $df = 2$, $p < .0005$).

In comparison to solo drivers, team drivers were more likely to report that they *always* or *never* nap, rather than *sometimes* nap, during breaks ($x^2 = 14.1$, $df = 2$, $p = .001$), and *never*, rather than *sometimes*, use the rest room ($x^2 = 6.1$, $df = 2$, $p = .048$).

Alertness Maintenance

Drivers employ a variety of methods and activities for maintaining alertness while driving. The ratings of the effectiveness of these activities are summarized in Table 9.

Table 9. Ratings of activity effectiveness for maintaining alertness while driving.

Activity	Very Effective	Somewhat Effective	Not Effective	Not Used/ Performed
Cooling Truck Cab	45.0%	45.2%	9.8%	
Stretching	34.4%	54.8%	10.6%	.2%
Listening to AM/FM	47.0%	42.1%	10.4%	.5%
Talking on CB	47.0%	35.4%	15.7%	1.9%
Drinking Coffee	33.9%	45.2%	18.2%	2.7%
Chewing Gum/ Eating Candy	22.5%	33.7%	41.3%	2.5%
Eating Food	15.3%	30.9%	52.4%	1.4%
Using Tobacco Products	25.6%	20.4%	43.4%	10.6%
Singing/Talking	17.2%	27.8%	49.9%	5.7%
Taking OTC Pills	2.7%	5.3%	65.0%	27.0%

No single activity stands out as being significantly more effective in maintaining alertness than others; however, inspection of the data suggests that the activities can be categorized into four groups, which received distinctively different effectiveness ratings. The primary group of activities, which included cooling the cab by air conditioning or opening windows; stretching or

changing sitting positions; and listening to AM/FM radio, tapes, and CDs, received combined *very* and *somewhat* effective ratings from the drivers, ranging from 89.1 percent to 90.2 percent.

The second most effective group of alertness-maintaining activities included talking on the CB and drinking coffee and other caffeine-containing beverages. The combined *very* and *somewhat* ratings ranged from 79.1 percent to 82.4 percent. Interestingly, the more passive activity of listening to radio/tape was rated more effective (89.1 percent) than the more interactive and hence, one would assume the more alerting activity of communicating on the CB (82.4 percent).

The third had a wider range of effectiveness ratings, 45.0 percent to 56.2 percent, and included the activities of chewing gum/candy, eating food, using tobacco (nicotine) products, and singing/talking to oneself.

The final and least-effective group consisted of only one activity, using over-the-counter (OTC) medications such as No-Doz, and was rated by only 8 percent of the drivers as being very or somewhat effective. Twenty-seven percent of the drivers, more than twice as many as for the penultimate activity (tobacco usage, 11 percent), indicated that they do not use such OTC products for maintaining alertness while driving.

The categorization discussed above entailed combining the *very* and *somewhat* effective ratings options; another approach that can be used to assess the reported effectiveness of alertness-maintaining activities is to consider only the *very effective* ratings. Using this criterion, Table 9 shows that the most effective activities are communicating on the CB and listening to the radio (each 47 percent) and maintaining a cool cab (45 percent), followed by stretching (34.4 percent) and caffeine-containing beverage consumption (33.9 percent).

Nearly twice as many owner-operators (15.5 percent) as company drivers (8.1 percent) reported that listening to AM/FM radio/tape/CD was very effective. This may reflect a greater tendency by owner-operators who always drive the same tractor to install audio entertainment devices, as compared to company drivers who may drive a different tractor each trip. There were no statistically significant differences in reported alertness maintainers between the union and nonunion drivers, nor between the regular- and irregular-schedule drivers.

Other options for maintaining alertness while driving include the use of controlled substances. Because of the potential for drivers perceiving their response to questions concerned with the use of controlled substances as being self-incriminating, this issue was addressed by couching the question in terms of use of such substances by "other drivers known to the respondent."[5]

Table 10 shows that more than three-quarters of the drivers interviewed (76.7 percent) responded that none of the drivers known to them use Benzedrine ("bennies"), or "speed." Fewer than a fifth (18.8 percent) indicated that only some of their fellow drivers use bennies or speed; and small numbers of drivers (about 2 percent each) replied that as many as half, or most, of the drivers they knew used the substance to stay alert while working. There were no statistically significant differences in the responses of owner-operators and company drivers, union and nonunion drivers, regular- and irregular-schedule drivers, nor solo and team drivers.

[5] Subpart B, Prohibitions, of the Controlled Substance and Alcohol Use and Testing Regulations of the Federal Motor Carrier Safety Regulations prohibits a driver from reporting for duty or remaining on duty requiring the performance of safety-sensitive functions while having an alcohol concentration of 0.04 percent or greater, or if the driver tests positive for controlled substances. No employer having actual knowledge that a driver has an alcohol concentration of 0.04 percent or greater, or has tested positive for controlled substances, shall permit the driver to perform or continue to perform safety-sensitive functions.

The majority of interviewed drivers (92.4 percent) responded that none of their fellow drivers used cocaine as an alertness aid, while 6.5 percent replied that at least some drivers known to them used the substance. Fewer than 1 percent felt that as many as half the drivers used cocaine to stay alert.

The flip side of staying alert while working is relaxing or unwinding after work. Here again, to avoid the perception of possible self-incrimination, drivers were asked how many of their fellow drivers used various aids to help them relax after work. Table 11 summarizes the responses.

The data show that the relaxant of choice among this sample of truck drivers is alcoholic in nature. Seventy percent of the drivers interviewed responded that at least some of the drivers they know use alcohol to relax after work; however, fewer than a quarter (22.8 percent) reported that half or more of the drivers they know use alcohol for relaxing and nearly a third of the drivers (29.7 percent) indicated that none of the drivers known to them use alcohol.

Table 10. Percentages of drivers reporting on use of controlled substances by fellow drivers.

How Many Drivers You Know Use:	All	Most	Half	Some	None
Benzedrine/Speed		1.6%	2.3%	18.8%	76.7%
Cocaine			.8%	6.5%	92.4%

Table 11. Percentages of drivers reporting on use of relaxants after work by fellow drivers.

How Many Drivers You Know Use:	All	Most	Half	Some	None
Alcohol	1.0%	10.6%	11.2%	47.4%	29.7%
Marijuana	----	.2%	.6%	11.2%	87.5%
Sleeping Pills	.2%	.8%	.8%	12.5%	85.3%
Narcotics	----	.4%	1.2%	6.8%	91.2%
Tranquilizers	----	.2%	1.4%	5.9%	92.2%

The large majority of drivers interviewed indicated that none of their friends used marijuana (87.5 percent) or sleeping pills (85.3 percent) to help them relax and the non-use percentages are even higher for of narcotics (91.2 percent) and tranquilizers (92.2 percent). Eleven percent of the drivers reported that some of their fellow drivers use marijuana off-duty, and a similar number (12.5 percent) replied that some use sleeping pills. Fewer than 1 percent (.8 percent) of the drivers responded that as many as half or more of the drivers they knew used marijuana, and fewer than 2 percent (1.8 percent) indicated that half or more of the drivers known to them used sleeping pills.

While 6.8 percent of the interviewed drivers reported that some drivers used narcotics off-duty, only 1.2 percent of interviewees felt that as many as half their fellow drivers used narcotics. The off-duty use of tranquilizers by truckers, according to the respondents, is similar to that of narcotics; 5.9 percent of the respondents felt that some of their friends used tranquilizers, while 1.4 percent believed that half used tranquilizers.

There were no statistically significant differences between owner-operators and company drivers in reported off-duty use of aids to relaxing, nor were there differences between changing and non-changing route drivers, nor regular- and irregular-schedule drivers. However, more nonunion drivers (79.2 percent) than union drivers (40.7 percent) reported that all or most drivers use alcoholic beverages after work ($x^2 = 21.6$, $df = 1$, $p < .00001$). In addition (though not statistically significant at conventional levels), more team drivers (78.8 percent) than solo drivers (69.1 percent) reported that all or most drivers use alcoholic beverages after work ($x^2 = 3.61$, $df = 1$, $p = .057$).[6]

It can be assumed safely that most people having conventional jobs arrive at their places of employment not too long after they awake and begin working in a relatively refreshed state. Because of the nature of their employment, however, truckers are often awake for a longer period of time before taking their vehicles on the road and, depending in part on how that time is spent, it is possible that drivers may be somewhat fatigued before actually beginning their job. When asked how long they had been awake prior to beginning their current trip, drivers' responses averaged about 5 3/4 hours (5.83). Nearly half the drivers (44.6 percent) reported that they had been awake for 6 or more hours: 38.4 percent had been awake between 6 to 12 hours; 3.7 percent between 13 and 16 hours; and 2.5 percent for more than 17 hours. Table 12 summarizes the most frequently cited causes for the elapsed time between waking and beginning to drive for those drivers who had been awake for 6 hours or longer prior to driving. Work-related causes comprise the majority of responses (67.2 percent). Nonwork-related responses are subsumed under "Other causes." Although there were diverse responses in the latter group, by far the most prevalent could be categorized as personal/familial obligations and activities, e.g., chores, errands, playing with/caring for children, etc. Additional "other" causes included waiting for improved weather or

[6] The response categories were collapsed into [all, most] and [half, some, none].

traffic conditions, self-imposed delay, and travel distance to terminal. The cause cited most often by drivers who experienced a 6-or-more-hour interval between awakening and getting behind the wheel was that the trip was initiated at the end of the day (37.3 percent). A question remains as to the extent of the drivers' control over such delays. The trips may have been scheduled to begin at the end of the day so that drivers could have reduced the interval by sleeping later; or, on the other hand, the interval may have been attributable to factors beyond the driver's control, such as having to await a call from the dispatcher before reporting for work, which was the second most cited cause (20.2 percent).

Table 12. Causes for elapsed time (6 hours +) between awakening and driving.

Cause of Elapsed Time	Percent*
Trip began at end of day	37.3%
Waited for dispatcher to call	20.2%
Had to load/unload truck	7.5%
Had to wait for load to arrive	2.2%
Other causes	36.0%

* Based on 228 respondents. Multiple responses given by some respondents.

Drivers' Subjective State

In addition to addressing drivers' opinions regarding the causes of and remedies for fatigue, the drivers were also asked to rate their level of alertness at the time of the interview. The Stanford Sleepiness Scale (SSS), a seven-point instrument commonly used in research on the effects of sleep debt and, by implication fatigue and alertness, was used in the present study. Shortly after

the interview was initiated, the driver was shown the scale [see Appendix A] and asked to rate his/her level of alertness. As shown in Figure 9, more than eight of 10 drivers (86.5 percent) responded with a scale value of 1 or 2 indicating that they were functioning at a high level of alertness. An additional 9.2 percent responded with a scale value of 3, indicative of a moderate level of alertness. Fewer than 5 percent of the drivers responded with scale levels between 4 and 6 and none at a 7 level.

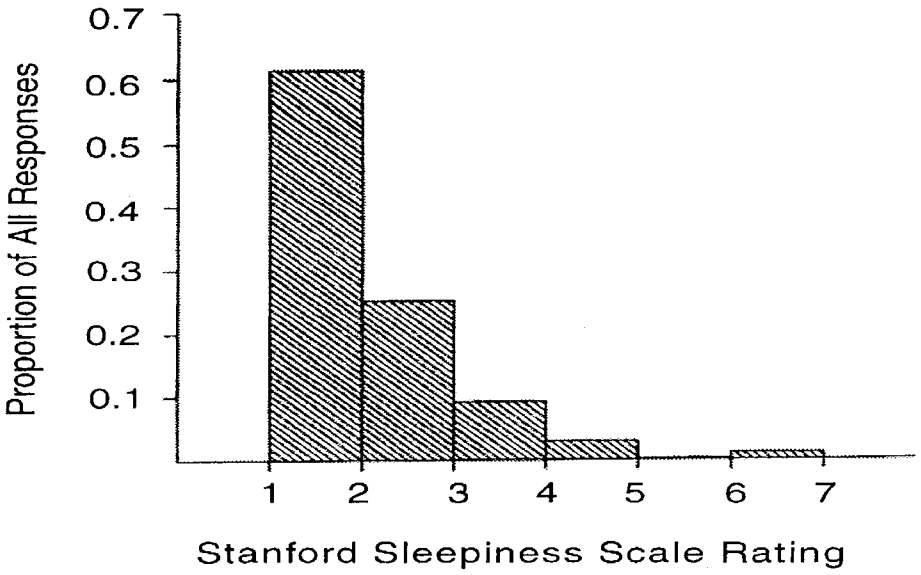

Figure 9. Distribution of responses to the Stanford Sleepiness Scale.

The markedly skewed nature of the responses toward the low end of the scale largely precludes using these data as precise indicants of the relative amount of fatigue ascribable to the various aspects of the driver's milieu examined in this study. However, some analyses were conducted to obtain a notion of the degree to which some of the measures are related to fatigue. The results are summarized in Table 13. Because of the ordinal nature of the Stanford Sleepiness Scale and the

observation that the responses were not normally distributed, Kendall's rank order correlation coefficient, *tau*[7] (Siegel, 1956), was calculated for measures that logically would be expected to be associated with fatigue. The small values of *tau* shown in Table 13 demonstrate the rather meager association observed between the self-report of fatigue using the SSS and the other measures. The statistical significance of the relationships is attributable to the relatively large sample of respondents and should not be construed as necessarily indicative of meaningful associations.

Obvious candidates for inclusion in the group of measures was the number of hours of rest drivers had during their last main sleep and the amount of sleep they had in the previous 2 days. The negative relationships (-.152 and -.117, respectively) were expected because the low-end of the SSS is indicative of alertness or lack of fatigue—which, logically, would be associated with greater amounts of rest/sleep.

Another variable, sleep debt, was calculated by subtracting the amount of sleep drivers obtained during their last main sleep from their stated number of hours required to feel totally rested. Using that criterion, only a fifth of the drivers were classified as experiencing sleep debt; more than half the drivers (60.3 percent) reported getting *more* rest during their last main sleep than they needed, while approximately equal numbers reported getting either the same amount of sleep as required (18.9 percent) or less sleep than required (20.8 percent). Of those drivers who obtained less sleep (n=106), about two-thirds (63 percent) slept 1 or 2 hours less than required, 28 percent slept 3 or

[7] Kendall's τ is a nonparametric measure of association for ordinal data. Although the τ calculated between the two sets of data differs markedly from that calculated on the same data by other common rank-order methods, such as Spearman's *rho*, it is nevertheless normally distributed and the probabilities associated with a given τ are easily calculated. The contingency coefficient, C, a modification of the chi-square (x^2) statistic, describes the extent of association between two sets of attributes when one or both do not have any underlying continuity or order.

4 hours less than required, and only 8 percent had between 5 and 8 fewer hours of sleep than required. The overall low-order correlation (.151) is exemplified by the finding that only one driver in the greatest sleep debt subgroup reported an SSS value of 6, which was indicative of fatigue. A non-significant, low-order association (.046) was obtained when the number of days since having a continuous 48-hour break from work was correlated with SSS scores.

Table 13. Relatedness of measures to the Stanford Sleepiness Scale.

Measure	n	Statistic	P
Length of sleep/rest in last main sleep period	509	τ = -.152	.0001
Total hours slept in last 48 hours	509	τ = -.117	.0015
Sleep debt (sleep required minus sleep obtained)	509	τ = .151	.0001
Number of days since last work-break of 48 hours	493	τ = .046	ns
Time segment in which interview was conducted	511	τ = .033	ns
Split/Continuous rest	459	C = .192	.003
Regular/Irregular schedule	511	C = .133	ns
Snoring	501	C = .133	ns
Apnea	511	C = .127	ns

As discussed previously, interviews were conducted around the clock; for analytic purposes, this schedule was broken into 4-hour blocks: 00:00 to 03:59, 04:00 to 07:59, and so on. The comparatively small number of drivers (n=99) interviewed during the initial two blocks (incorporating the hours from midnight to 8 a.m., when fatigue might be expected to be most pronounced because of circadian factors), in combination with the skewed distribution of the SSS responses, mitigated against obtaining a significant statistical relationship between the two variables.

Two other measures that might be related to fatigue were the sleep pattern of berth users (split or continuous rests) and the regularity of duty schedule from day to day (same or variable). A statistically significant C (.192) was observed between sleep pattern and SSS; appreciably more drivers who split their rests (10.3 percent) responded with SSS values ranging from 4 through 6 (suggestive of greater levels of fatigue) than did drivers who took their rests in one continuous stretch (2.3 percent).

A non-significant C (.133) resulted from the analysis of duty schedule and SSS. Though 5.1 percent of drivers whose schedules were irregular responded with SSS values ranging from 4 through 6 and none of the drivers whose schedule was regular responded in this range, it is likely that the overall small number of regular-schedule drivers (15.3 percent) mitigated against the significance of the association. It is nonetheless interesting to note the schism in response between the two types of duty schedules and to consider further investigation of this variable. Nearly two-thirds of the drivers (64.4 percent) reported that they snore, and 16.4 percent responded that they have been told that they sometimes stop breathing or gasp for air while asleep, i.e., they might be apneics. Because it has been suggested that snoring and apnea may have adverse effects on the quality or fitfulness of sleep and hence possibly contribute to fatigue, analyses were performed to assess the relationships between SSS and these behavioral conditions. Low-order, non-significant relationships (C=.133 and .127, respectively) were obtained.

Conclusions

One goal of this research was to expand systematically the body of knowledge and data concerning truck drivers and fatigue. To minimize the potential for conflicts in findings due to methodological differences, the current investigation was modeled after those of Beilock (1989) and Braver et al. (1992); their procedures and instruments served as the basis for those used in this research effort.

A question often raised in comparing results among studies is whether the populations from which the participants were drawn were the same or whether they differed sufficiently to affect the findings. Though significantly greater numbers of drivers participated in the previously cited studies, comparisons of job and demographic attributes (which can be used to describe and define the populations) revealed a high degree of similarity between those studies and this one. This finding supports the notion that the samples of participating drivers were drawn from the same population and that the results of this study can be viewed, where applicable, as extensions of those of the earlier studies.

It is generally accepted that on-the-job behavior in virtually all industries is driven to a large degree by economic considerations. However, the consequences of certain job and behavior patterns, whether self- or industry-imposed, may be more dire among long-haul drivers than among other types of workers, particularly when considering the importance of rest and alertness to the safety of the driver and other road travelers.

For example, the majority of respondents in this study drove irregular routes and operated on schedules that varied from day to day. These elements, irregular routes and irregular schedules, have been reported by Mackie and Miller (1978) to generally result in less sleep and earlier onset of fatigue so that driving performance could be adversely affected. Though the only dependent measure of fatigue used in this investigation was the SSS (which proved to be insufficiently sensitive as used in this study), other indicators of fatigue, such as the incidence of drowsiness and falling asleep at the wheel, tend to lend credence to these reports.

Also, about a quarter of the drivers who used their berths while on the road split their rests and spent fewer hours sleeping than their continuous-rest counterparts. Besides the statistically significant positive association between tiredness and split rests, it is also reasonable to assume that split-rests may not be as beneficial as continuous rests, quality wise, since some of the berth time likely takes place during daylight hours which, a majority of drivers reported, is not as restful as conventional night-sleeping. Indeed, Hertz (1991, cited by Braver et al. 1992) reported that drivers who split their rests increased their risk of fatal-crash involvement.

Sleep debt and resultant fatigue are likely consequences of irregular routes, irregular schedules, split-rests, and poor quality sleep. The most dangerous manifestation of fatigue is dozing or falling asleep at the wheel. The appreciable number of drivers who reported experiencing this problem in the present study may be taken as indicative of the forthrightness of their responses to the survey in general. And while that percentage was substantial, of perhaps greater import is the number of drivers (more than half) who reported having been drowsy or having had trouble keeping their eyes open. The frequency of such reports in this study is alarming because these behaviors are precursors to dozing or falling asleep at the wheel and underscore the potential

severity of the problem of fatigue in the driving environment. The majority of drivers who reported having fallen asleep at the wheel reported that they were sometimes or always aware of the pending problem, but continued to drive. This behavior may or may not be voluntary in nature or under the driver's control, or it may simply be due to poor judgment stemming from fatigue.

A substantial number of drivers in this study responded that they have done with less sleep to maintain their schedule. They may have done so because of overwhelming economic pressures to keep on schedule. A related issue is the availability (or lack) of suitable areas in which commercial drivers can take naps or sleep. Some states, e.g., New York, have recognized the need for improvement in their rest-area system, and no doubt similar needs exist in other states (New York State, 1994). The FHWA's recently completed research (FHWA, 1996) on the adequacy of parking for commercial vehicles evaluated the availability and demand for spaces at both public rest areas and commercially operated private rest stops along the interstate system. The final report, based on a survey of commercial vehicle operators and the development of utilization and demand models, determined that there was an apparent shortage of approximately 28,400 spaces at public rest areas. However, the report also concluded that additional private truck stop spaces are projected to be available over the next 3 years, and these might help reduce the reported nighttime shortage of public spaces. Two out of three drivers surveyed preferred private rest stops for extended stays because of safety and security reasons.

Besides sleep (or a lack of it), the work habits of drivers also may exacerbate the development of fatigue. Loading or unloading of goods, for example, may be one such contributor. While some drivers interviewed felt that those tasks had deleterious effects on alertness, others felt that they

benefited from the activity, while yet other drivers could not ascribe an effect, either positive or negative, to the activity. Clearly, individual differences among drivers seem to be important.

Some compensatory behaviors, such as periodic breaks from driving, may serve to alleviate the effects of fatigue. While drivers said they took such respites on the average of every 4.5 hours, the lengths of the breaks taken were quite variable and were probably determined by personal preferences and by trip conditions, one of which, likely, is the availability and condition of rest stops, which were referred to earlier. It was reported in this study that more owner-operators than company drivers responded that they do with less sleep to make up lost time or to maintain a schedule. Length of drive times and break-lengths might be determined similarly. During such breaks drivers seem to prefer performing house-keeping chores (eating, fueling, checking cargo) rather than activities that ostensibly would reduce fatigue (i.e., napping) or enhance alertness (i.e., exercise).

Alertness maintenance techniques seem also to depend on personal preferences, although most drivers consider cool cab-temperatures, stretching, and listening to the radio to be beneficial. In this investigation, drivers reported that controlled substances are used by very few of their fellow drivers to maintain alertness while driving, a finding in rather sharp contrast to that of Haworth et al. (1991) who reported that interviewed Australian drivers (133 of whom were crash-involved and 152 noncrash-involved) estimated that "maybe 50 percent" and perhaps "all" drivers take pills to stay awake on the job. At the other end of the spectrum, relaxation after work, few drivers in this study (at most 15 percent) reported that their fellow drivers used drugs to help them unwind, though most drivers responded that alcoholic (nonspecific) beverages were used for that purpose.

Fatigue has long been considered an important issue in highway accidents and a major cause of commercial motor vehicle accidents resulting in fatality and injury. Several of the underlying causes of fatigue have been examined in this survey. One of the indices used in this survey to assess the incidence of fatigue, drowsiness, and difficulty in keeping the eyes open suggests that the problem may perhaps be more pronounced in the commercial driver community than previously thought. It would be prudent to encourage additional research and development of appropriate methods to counter or alleviate the potentially devastating results of fatigue. These might include educating drivers as to the importance of sleep and napping and the powerful effects of time-of-day; alertness maintainers (driving hour regulations, devices installed in the driving environment, etc.); and alarm systems based on driver performance and/or psychophysiological arousal.

References

Beilock, R. (1989). *1988 RCCC Motor Carrier Safety Survey.* Alexandria, VA: Regular Common Carrier Conference.

Braver, E.R., Preusser, C.W., Preusser, D.F., Baum, H.M., Beilock, R., and Ulmer, R. (1992, January). "Who violates work hour rules? A survey of tractor-trailer drivers." *Insurance Institute for Highway Safety.* Arlington, VA.

FHWA (1996). "Commercial driver rest area requirements: Making space for safety." Trucking Research Institute, Apogee Research Inc., Wilber Smith Associates. Publication Number FHWA-MC-96-0010.

Haworth, N.L., Vulcan, P., Schulze, M.T., & Foddy, B. (1991). *Truck Driver Behavior and Perceptions Study.* (Final Report. Report No. 18). Australia: Monash University, Accident Research Centre.

Hertz, R.P. (1991). "Hours of service violations among tractor-trailer drivers." *Accident Analysis and Prevention,* pp. 23, 29-36.

Mackie, R.R. and Miller, J.C. (1978). "Effects of hours of service, regularity of schedules, and cargo loading on truck and bus driver fatigue." *HRF Technical Report* 1765-F, (NHTSA, DOT-HS-803-799) (NTIS PB-290-957). Goleta, CA Human Factors Research, Inc.

New York State Governor's Traffic Safety Committee and the Institute for Traffic Safety Management and Research (1994). *New York State Task Force on the Impact of Fatigue in Driving.*

Siegel, S. (1956). *Nonparametric Statistics for the Behavioral Sciences.*, McGraw-Hill, New York.

Wylie, C.D., Shultz, T.E., Miller, J. C., Mittler, M.M., & Mackie, R.R. (1996) *Commercial Motor Vehicle Driver Fatigue, and Alertness Study: Project Report.* Publication Number FHWA-MC-97-001, Federal Highway Administration. November 1996.

Preceding Page Blank

Appendix A

Stanford Sleepiness Scale

Sleepiness

1. Feeling Active And Vital; Alert; Wide Awake
2. Functioning At A High Level, But Not At Peak
3. Relaxed; Not At Full Alertness; Responsive
4. A Little Foggy; Not At Peak; Let Down
5. Fogginess; Losing Interest In Staying Awake; Slowed Down
6. Sleepiness; Prefer To Be Lying Down
7. Almost In Reverie; Sleep Onset Soon; Hard To Stay Awake

Appendix B

The Questionnaire and Tabulated Response Frequencies

1. Are you driver of a tractor-trailer?

2. About how many miles did you drive last year?

3. Have you been away from home ***at least*** 24 hours?

4. Are you an owner-operator?

Response	Frequency	Percent
Yes	161	31.5
No	350	68.5
Missing	0	0

5. Are you a union member?

Response	Frequency	Percent
Yes	27	5.3
No	483	94.5
dk / na	1	0.2

6. Do you usually drive a regular route or does your route change from trip to trip?

Response	Frequency	Percent
Regular	81	15.9
Irregular	429	84.0
dk / na	1	0.2

7. Are your working hours the same from day to day or do they change?

Response	Frequency	Percent
Same	78	15.3
Change	433	84.7
Missing	0	0.0

8. About how long are you usually on the road from the time you leave your home until you return?

Response	Frequency	Percent
1	10	2.0
2	45	8.8
3	20	3.9
4	38	7.4
5	69	13.5
6	35	6.8
7	61	11.9
8	17	3.3
9	3	0.6
10	15	2.9
11–20	86	16.8
21–30	74	14.5
>30	36	7.0
dk / na	2	0.4

9. On this trip are you driving solo or sharing driving as a team?

Response	Frequency	Percent
Solo	430	84.1
sharing	81	15.9
dk / na	0	0.0

10. When you're on the road, where do you usually take your *main* sleep?

Response	Frequency	Percent
Sleeper Berth	465	91
Motel / Hotel	34	6.7
Other	5	1.0
dk / na	7	1.4

11. Do you usually rest or sleep in the sleeper birth in:

Response	Frequency	Percent
One stretch	342	66.9
Split rests	117	22.9
dk / na	6	1.2
missing	46	9.0

12. How long do you usually spend in the berth at one time? (hours)

Response	Frequency	Percent
2	6	1.2
3	6	1.2
4	55	10.8
5	40	7.8
6	69	13.5
7	52	10.2
8	181	35.4
9	33	6.5
10	17	3.3
11	3	0.6
12	1	0.2
dk / na	48	9.4

13. Please read these statements and tell me which **number** best describes how you feel right now.

Response	Frequency	Percent
1. Feeling active and vital; alert; wide awake	313	61.3
2. Functioning at a high level, but not at peak	129	25.2
3. Relaxed; not at full alertness; responsive	47	9.2
4. A little foggy; not at peak; let down	15	2.9
5. Fogginess; losing interest in staying awake; slowed down	1	0.2
6. Sleepiness; prefer to be lying down	6	1.2
7. Almost in reverie; sleep onset soon; hard to stay awake	0	0.0
dk / na	0	0.0

14. When did you begin your **last** main sleep?

Time Interval	Frequency	Percent
00:00–00:59	38	7.4
01:00–01:59	22	4.3
02:00–02:59	22	4.3
03:00–03:59	13	2.5
04:00–04:59	12	2.3
05:00–05:59	6	1.2
06:00–06:59	2	0.4
07:00–07:59	8	1.6
08:00–08:59	10	2.0
09:00–09:59	9	1.8
10:00–10:59	13	2.5
11:00–11:59	6	1.2
12:00–12:59	7	1.4
13:00–13:59	6	1.2
14:00–14:59	14	2.7
15:00–15:59	10	2.0
16:00–16:59	15	2.9
17:00–17:59	9	1.8
18:00–18:59	12	2.3
19:00–19:59	19	3.7
20:00–20:59	51	10.1
21:00–21:59	71	13.9
22:00–22:59	80	15.7
23:00–23:59	50	9.8
dk/na/missing	6	1.2
Total	511	100.0

15. How long did you rest? (hours)

Response	Frequency	Percent
1	1	0.2
2	5	1.0
3	6	1.2
4	22	4.3
5	35	6.8
6	45	8.8
7	47	9.2
8	155	30.3
9	62	12.1
10	70	13.7
11	15	2.9
12	33	6.5
13	7	1.4
14	5	1.0
15	1	0.2
missing	2	0.4

16. Where did you sleep?

Response	Frequency	Percent
Sleeper Berth	441	86.3
Motel	45	8.8
Home	16	3.1
Elsewhere	7	1.4
dk / na	2	0.4

17. How long were you awake before you started to drive? (hours)

Response	Frequency	Percent
0	6	1.2
1	252	49.3
2	110	21.5
3	36	7.0
4	23	4.5
5	23	4.5
6	12	2.3
7	5	1.0
8	14	2.7
9	1	0.2
10	9	1.8
11	4	0.8
12	9	1.8
13	1	0.2
14	1	0.2
15	2	0.4
16	1	0.2
24	2	0.4
dk / na	0	0.0

18. When did you begin your main sleep *the time before last?*

Time Interval	Frequency	Percent
00:00–00:59	44	8.6
01:00–01:59	20	3.9
02:00–02:59	12	2.3
03:00–03:59	10	2.0
04:00–04:59	3	0.6
05:00–05:59	8	1.6
06:00–06:59	4	0.8
07:00–07:59	8	1.6
08:00–08:59	4	0.8
09:00–09:59	2	0.4
10:00–10:59	7	1.4
11:00–11:59	5	9.8
12:00–12:59	6	1.2
13:00–13:59	5	9.8
14:00–14:59	5	9.8
15:00–15:59	4	0.8
16:00–16:59	12	2.3
17:00–17:59	6	1.2
18:00–18:59	14	2.7
19:00–19:59	20	3.9
20:00–20:59	54	10.6
21:00–21:59	67	13.1
22:00–22:59	96	18.8
23:00–23:59	58	11.3
dk/na/missing	37	7.2
Total	511	100.0

19. How long did you rest then? (hours)

Response	Frequency	Percent
0	1	0.2
1	2	0.4
2	3	0.6
3	4	0.8
4	19	3.7
5	34	6.7
6	49	9.6
7	47	9.2
8	155	30.3
9	76	14.9
10	72	14.1
11	14	2.7
12	21	4.1
13	3	0.6
14	3	0.6
15	2	0.4
16	1	0.2
18	1	0.2
19	2	0.4
24	1	0.2
50	1	0.2
dk / na	0	0.0

20. Where did you sleep that time?

Response	Frequency	Percent
Sleeper Berth	361	70.6
Motel	53	10.4
Home	88	17.2
Elsewhere	9	1.8
dk / na	0	0.0

21. When do you expect to get your **next** main sleep?

Time Interval	Frequency	Percent
00:00–00:59	37	7.2
01:00–01:59	18	3.5
02:00–02:59	22	4.3
03:00–03:59	15	2.9
04:00–04:59	16	3.1
05:00–05:59	7	1.4
06:00–06:59	14	2.7
07:00–07:59	9	1.8
08:00–08:59	6	1.2
09:00–09:59	4	0.8
10:00–10:59	4	0.8
11:00–11:59	7	1.4
12:00–12:59	13	2.5
13:00–13:59	7	1.4
14:00–14:59	7	1.4
15:00–15:59	10	2.0
16:00–16:59	9	1.8
17:00–17:59	9	1.8
18:00–18:59	22	4.3
19:00–19:59	16	3.1
20:00–20:59	48	9.4
21:00–21:59	60	11.7
22:00–22:59	80	15.7
23:00–23:59	43	8.4
dk/na/missing	28	5.5
Total	511	100.0

22. How long do you expect to sleep then? (hours)

Response	Frequency	Percent
0	5	1.0
1	1	0.2
2	3	0.6
3	5	1.0
4	26	5.1
5	30	5.9
6	38	7.4
7	29	5.7
8	255	49.9
9	52	10.2
10	38	7.4
11	10	2.0
12	14	2.7
13	2	0.4
14	2	0.4
16	1	0.2
dk / na	0	0.0

23. Where do you expect to take that main sleep?

Response	Frequency	Percent
Sleeper Berth	431	84.3
Motel	37	7.2
Home	39	7.6
Elsewhere	4	0.8
dk / na	0	0.0

24. Do you find daytime sleeping as restful as nighttime sleeping?

Response	Frequency	Percent
Yes	205	40.1
No	304	59.5
dk / na	2	0.4

25. (If NO) Why is that?

Response	Frequency	Percent
Light	64	12.5
Noise	33	6.5
Internal Clock	35	6.8
Habit / better rest	91	17.8
other	74	14.5
dk / na	7	1.4
missing	207	40.5

26. How often have you found yourself dozing or falling asleep at the wheel **this past month**?

Response	Frequency	Percent
0	368	72.0
1	30	5.9
2	46	9.0
3	23	4.5
4	10	2.0
5	7	1.4
6	6	1.2
8	4	0.8
9	1	0.2
10	3	0.6
12	3	0.6
15	3	0.6
16	1	0.2
19	1	0.2
30	4	0.8
60	1	0.2
dk / na	0	0.0

27. When you dozed or fell asleep at the wheel, were you aware beforehand that you were in danger of falling asleep?

Response	Frequency	Percent
Never	14	2.7
Sometimes	40	7.8
Always	85	16.6
dk / na	4	0.8
missing	368	72.0

28. How often have you found yourself feeling drowsy or fighting to keep your eyes open while at the wheel **during this last month**?

Response	Frequency	Percent
0	219	42.9
1	41	8.0
2	96	18.8
3	47	9.2
4	25	4.9
5	23	4.5
6	11	2.2
7	5	1.0
8	4	0.8
10	6	1.2
11	2	0.4
12	2	0.4
15	2	0.4
16	1	0.2
18	1	0.2
19	1	0.2
20	3	0.6
24	1	0.2
25	1	0.2
26	1	0.2
30	12	2.3
60	1	0.2
75	1	0.2
99	5	1.0
dk / na	0	0.0

29. When you are slowed down by driving conditions, how often do you get less sleep in order to keep up with your delivery schedule?

Response	Frequency	Percent
Never	213	41.7
Sometimes	238	46.6
Always	54	10.6
dk / na	6	1.2

30. Do you usually load or unload your truck?

Response	Frequency	Percent
Yes	108	21.1
No	401	78.5
dk / na	2	0.4

31. How does the physical work of loading or unloading affect your alertness on the road?

Response	Frequency	Percent
Alert longer	25	4.9
Same	46	9.0
Not as long	37	7.2
dk / na	403	78.9

32. In normal situations, how many hours do you like to drive before stopping for a break?

Response	Frequency	Percent
1	1	0.2
2	39	7.6
3	56	11.0
4	156	30.5
5	141	27.6
6	53	10.4
7	13	2.5
8	13	2.5
9	4	0.8
10	12	2.3
11	1	0.2
12	1	0.2
dk / na	21	4.1

33. In normal situations, how long is your usual stop?

Response	Frequency	Percent
1	1	0.2
3	1	0.2
5	6	1.2
10	2	0.4
11	1	0.2
15	42	8.2
18	4	0.8
20	10	2.0
22	8	1.6
25	2	0.4
30	130	25.4
38	12	2.3
45	45	8.8
50	1	0.2
52	5	1.0
60	151	29.5
68	1	0.2
75	8	1.6
82	1	0.2
90	29	5.7
120	21	4.1
150	2	0.4
180	6	1.2
210	1	0.2
dk / na	21	4.1

34. When you stop, how often do you:

34a. Eat:

Response	Frequency	Percent
Never	12	2.3
Sometimes	403	78.9
Always	96	18.8
dk / na	0	0.0

34b. Check truck / cargo:

Response	Frequency	Percent
Never	23	4.5
Sometimes	116	22.7
Always	372	72.8
dk / na	0	0.0

34c. Fuel up:

Response	Frequency	Percent
Never	25	4.9
Sometimes	456	89.2
Always	28	5.5
dk / na	2	0.4

34d. Nap:

Response	Frequency	Percent
Never	173	33.9
Sometimes	320	62.6
Always	16	3.1
dk / na	2	0.4

34e. Jog / exercise:

Response	Frequency	Percent
Never	309	60.5
Sometimes	165	32.3
Always	37	7.2
dk / na	0	0.0

34f. Make phone calls:

Response	Frequency	Percent
Never	14	2.7
Sometimes	361	70.6
Always	135	26.4
dk / na	1	0.2

34g. Use the rest room:

Response	Frequency	Percent
Never	1	0.2
Sometimes	200	39.1
Always	310	60.7
dk / na	0	0.0

34h. Other activities:

Response	Frequency	Percent
Sometimes	43	8.4
Always	24	4.7
dk / na	444	86.9

35. How ***effective*** are the following in keeping you alert while driving?

35a. Talking on CB:

Response	Frequency	Percent
Very	240	47.0
Somewhat	181	35.4
Not	80	15.7
dk / na	10	2.0

35b. Listening to AM/FM radio, tape, CD:

Response	Frequency	Percent
Very	240	47.0
Somewhat	215	42.1
Not	53	10.4
dk / na	3	0.6

35c. Opening window, AC, cool cab:

Response	Frequency	Percent
Very	230	45.0
Somewhat	231	45.2
Not	50	9.8
dk / na	0	0.0

35d. Singing, talking out loud to yourself:

Response	Frequency	Percent
Very	88	17.2
Somewhat	142	27.8
Not	255	49.9
dk / na	26	5.1

35e. Stretching, changing positions:

Response	Frequency	Percent
Very	176	34.4
Somewhat	280	54.8
Not	54	10.6
dk / na	1	0.2

35f. Eating food:

Response	Frequency	Percent
Very	78	15.3
Somewhat	158	30.9
Not	268	52.4
dk / na	7	1.4

35g. Chewing gum, candy:

Response	Frequency	Percent
Very	115	22.5
Somewhat	172	33.7
Not	211	41.3
dk / na	13	2.5

35h. Drinking coffee, caffeinated drinks:

Response	Frequency	Percent
Very	173	33.9
Somewhat	231	45.2
Not	93	18.2
dk / na	14	2.7

35i. Over-the-counter pills like NoDoz:

Response	Frequency	Percent
Very	14	2.7
Somewhat	27	5.3
Not	332	65.0
dk / na	138	27.0

35j. Nicotine in cigarettes, tobacco:

Response	Frequency	Percent
Very	131	25.6
Somewhat	104	20.4
Not	222	43.4
dk / na	54	10.6

35k. Other effective way:

Response	Frequency	Percent
Very	33	6.5
Somewhat	20	3.9
dk / na	458	89.6

36. Some drivers use certain things to help them ***relax or unwind after work***. Of the drivers you know, how many would you say use:

36a. Beer, liquor, or wine:

Response	Frequency	Percent
All	5	1.0
Most	54	10.6
Half	57	11.2
Some	242	47.4
None	152	29.7
dk / na	1	0.2

36b. Marijuana or hash:

Response	Frequency	Percent
All	0	0.0
Most	1	0.2
Half	3	0.6
Some	57	11.2
None	447	87.5
dk / na	3	0.6

36c. Sleeping Pills:

Response	Frequency	Percent
All	1	0.2
Most	4	0.8
Half	4	0.8
Some	64	12.5
None	436	85.3
dk / na	2	0.4

36d. Narcotics:

Response	Frequency	Percent
All	0	0.0
Most	2	0.4
Half	6	1.2
Some	35	6.8
None	466	91.2
dk / na	2	0.4

36e. Tranquilizers:

Response	Frequency	Percent
All	0	0.0
Most	1	0.2
Half	7	1.4
Some	30	5.9
None	471	92.2
dk / na	2	0.4

36f. Other:

Response	Frequency	Percent
All	5	1.0
Most	9	1.8
Half	11	2.2
Some	15	2.9
dk / na	471	92.2

37. Some drivers us things to help keep them ***alert while driving***. Of the drivers you know, how many would you say use:

37a. Amphetamines, speed:

Response	Frequency	Percent
All	0	0.0
Most	8	1.6
Half	12	2.3
Some	96	18.8
None	392	76.7
dk / na	3	0.6

37b. Cocaine:

Response	Frequency	Percent
All	0	0.0
Most	0	0.0
Half	4	0.8
Some	33	6.5
None	472	92.4
dk / na	2	0.4

37c. Other:

Response	Frequency	Percent
All	4	0.8
Most	8	1.6
Half	6	1.2
Some	25	4.9
dk / na	468	91.6

38. Do you usually snore during sleep?

Response	Frequency	Percent
Yes	329	64.4
No	172	33.7
dk / na	10	2.0

39. Have you ever been told that you sometimes stop breathing or gasp for air during sleep?

Response	Frequency	Percent
Yes	84	16.4
No	427	83.6
dk / na	0	0.0

40. During a normal or average day, how many hours of sleep do you need to feel ***totally rested***?

Response	Frequency	Percent
2	2	0.4
3	1	0.2
4	26	5.1
5	44	8.6
6	144	28.2
7	72	14.1
8	176	34.4
9	10	2.0
10	31	6.1
11	1	0.2
12	4	0.8
dk / na	0	0.0

41. When did your last work-break of two or more days end?

Number of Days	Frequency	Percent
0	11	2.2
1	52	10.2
2	115	22.5
3	79	15.5
4	54	10.6
5	37	7.2
6	26	5.1
7	13	2.5
8	13	2.5
9	9	1.8
10	16	3.1
11	7	1.4
12	2	0.4
13	4	0.8
14	4	0.8
15	2	0.4
16	5	1.0
17	4	0.8
18–30	16	3.1
31–45	13	2.5
46–75	11	2.2
dk/na/missing	18	3.5
Total	511	100.0

42. How many hours were you up before you started to drive that day?

Response	Frequency	Percent
0	11	2.2
1	52	10.2
2	78	15.3
3	56	11.0
4	48	9.4
5	38	7.4
6	55	10.8
7	16	3.1
8	45	8.8
9	15	2.9
10	35	6.8
11	3	0.6
12	27	5.3
13	3	0.6
14	8	1.6
15	5	1.0
16	3	0.6
17	1	0.2
18	4	0.8
20	3	0.6
24	3	0.6
32	1	0.2
48	1	0.2
dk / na	0	0.0

43. Were you awake that long because:

Alternative	Frequency	Percent
End-of-day trip start	85	16.6
Waited for dispatch to call	46	9.0
Had to load/unload truck	17	3.3
Waited for a load	5	1.0
Other	82	16.0

DEMOGRAPHICS

Gender:

	Frequency	Percent
Male	493	96.5
Female	18	3.5
dk / na	0	0

Height:

Inches	Frequency	Percent
60	2	0.4
63	4	0.8
64	7	1.4
65	8	1.6
66	25	4.9
67	33	6.5
68	38	7.4
69	53	10.4
70	63	12.3
71	79	15.5
72	85	16.6
73	33	6.5
74	36	7.0
75	20	3.9
76	15	2.9
77	2	0.4
78	4	0.8
79	2	0.4
81	1	0.2
dk / na	1	0.2

Age:

Years	Frequency	Percent
<20	0	0.0
20–25	18	3.5
26–30	45	8.8
31–35	66	12.9
36–40	88	17.2
41–45	99	19.4
46–50	90	17.6
51–55	66	12.9
56–60	26	5.1
61–65	8	1.6
66–70	4	7.8
dk / na	1	0.0

Weight:

Pounds	Frequency	Percent
<100	0	0.0
100–110	1	0.2
111–120	2	0.4
121–130	2	0.4
131–140	19	3.7
141–150	23	4.5
151–160	26	5.0
161–170	39	7.6
171–180	43	8.4
181–190	59	11.5
191–200	66	12.9
201–210	48	9.4
211–220	43	8.4
221–230	35	6.8
231–240	31	6.0
241–250	19	3.7
251–260	16	3.1
261–270	1	0.2
271–280	11	2.1
281–290	7	1.4
291–300	4	0.8
301–350	12	2.3
>350	1	0.2
dk / na	3	0.6

How long driving (years):

Years	Frequency	Percent
0	3	0.6
1	30	5.9
2	25	4.9
3	23	4.5
4	14	2.7
5	20	3.9
6	19	3.7
7	22	4.3
8	14	2.7
9	13	2.5
10	29	5.7
11–15	77	15.0
16–20	72	14.1
21–25	74	14.5
25–30	53	10.4
31–40	36	7.0
41–50	7	1.4
dk / na	0	0.0

☆U.S. GOVERNMENT PRINTING OFFICE: 1999 - 450-995/10212