Truck Driver Fatigue Management Survey

May 2006

U.S. Department of Transportation
Federal Motor Carrier Safety Administration

Foreword

This project identified factors related to causes of fatigue and ways to manage fatigue in Teamster commercial drivers working for the Motor Freight Carrier Association. The goal of the project was to identify best practices for managing fatigue that may be applicable to other motor vehicle operators. A survey instrument was developed and used to investigate the experiences and practices of more than 2,000 Teamster LTL drivers, some of whom had driven a million or more miles accident free. Responses from 1,128 million miler drivers were compared to those of 1,152 non-million miler drivers.

Although the report can be helpful to the general public in understanding fatigue in commercial trucking operations, the report is primarily targeted toward commercial motor carriers and drivers.

This publication is considered a final report and does not supersede another publication.

Notice

Technical Report Documentation Page (Form 1700.7)

1. Report No. FMCSA-RRR-06-008	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Truck Driver Fatigue Management		5. Report Date March 2006
		6. Performing Organization Code
7. Authors David F. Dinges, Ph.D. and Greg Maislin, M.S., M.A.		8. Performing Organization Report No.
9. Performing Organization Name and Address Trucking Management, Inc. (formerly, Motor Freight Carriers Association) 499 South Capitol Street, SW, Suite 502A Washington, DC 20003 Contacts: Timothy P. Lynch, President & Elisabeth Barna, Project Director		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DTMC75-02-C-00142
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Motor Carrier Safety Administration, Office of Research & Analysis 400 Virginia Ave., SW, Suite 600 Washington, DC 20024		13. Type of Report and Period Covered Final Report: October 2002 - March 2006
		14. Sponsoring Agency Code

15. Supplementary Notes
David F. Dinges Ph.D. is with the University of Pennsylvania School of Medicine and Greg Maislin, M.S., M.A. is with Biomedical Statistical Consulting, Inc. Robert J. Carroll was the FMCSA contracting officer technical representative for this project.

16. Abstract

This project identified factors related to causes of fatigue and ways to manage fatigue in Teamster commercial drivers working for the Motor Freight Carriers Association. The goal of the project was to identify best practices for managing fatigue that may have potential application to other motor vehicle operators. An 11-page scannable survey instrument (OMB No. 2126-0029) was developed and mailed to 5,741 Teamster drivers (2,741 million milers and 3,000 non-million milers). Responses from 1,128 million miler drivers were compared to those of 1,152 non-million miler drivers who had driven a million or more miles accident free.

Drivers averaged 53 years of age and 27.8 years operating trucks. They were generally white, non-Hispanic, married males. Million mile drivers were older by an average of 3 years, had 4.6 years more experience driving a truck, and were more likely to be married than non-million mile drivers. Both the rate of obesity and the rate of tobacco use among Teamster drivers were above the national average. Drivers reported less sleep on workdays than on non-workdays but appeared to understand the critical importance of adequate sleep taken prior starting a driving run—sleep was the major activity most engaged in prior to driving. Proportionally more non-million milers than million milers reported driving at night and that their work start times and schedules varied "quite a lot." Million milers were less likely to sleep during the daytime, and they had significantly longer sleep durations during a typical 24-hour work period and immediately prior to driving than non-million milers. The two groups did not differ in sleep duration on non-work days, which averaged 8.1 hours. This was more than an hour additional sleep than they reported for work days.

In order to identify best practices for managing fatigue, Stepwise Logistical Discriminant Analysis was used to evaluate independent predictors of million miler status. Relative to non-million milers, million miler status was associated with more years of driving experience, less variable work schedules, less night driving, taking the first break earlier when driving, less smoking, and less caffeine and cell phone / CB use to manage fatigue while driving. These findings suggest that the lessons learned from this study regarding "best practices" include the following: regularize work schedules when possible, reduce night driving when possible, encourage taking a rest break sooner when driving, and reduce smoking. In addition, the results suggest that research is needed on ways to (1) help obese drivers lose even a modest amount of weight, which can have substantial health benefits, and (2) identify drivers' vulnerability to fatigue and determining if matching driver fatigue vulnerability to work schedule would help manage fatigue even more effectively.

17. Key Words Best practices, commercial drivers, fatigue management, fatigue signs, night driving, noise, obesity, rest breaks, sleep, sleep loss, smoking, survey, truck drivers, unionized drivers, work schedules		18. Distribution Statement	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 96	22. Price

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	l
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lbs)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celsius temperature	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m2	cd/m2
		FORCE and PRESSURE or STRESS		
lbf	pound-force	4.45	newtons	N
psi	pound-force per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	Yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
ml	milliliters	0.034	fluid ounces	fl oz
l	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg	megagrams	1.103	short tons (2000 lbs)	T
		TEMPERATURE (exact)		
°C	Celsius temperature	1.8 C + 32	Fahrenheit temperature	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m2	candela/m2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	pound-force	lbf
kPa	kilopascals	0.145	pound-force per square inch	psi

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

Acknowledgments

We thank Bill Rogers for suggesting the study and helping to develop and initiate it; Nicholas Price and Sayani Niyogi for their help in survey management; Joanne Scanlon at MacDIRECT for coordinating survey scanning; Bob Hachadoorian for help with quantitative analyses of survey responses; Michele Carlin and Eleanor McGlinchey for helping in final report preparation; Timothy Lynch and Elisabeth Barna for helping to manage the survey through MFCA; the International Brotherhood of Teamsters for encouraging their members to participate in the survey; and the companies comprising the Motor Freight Carriers Association.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

APPENDIX

Executive Summary

Night driving is a known contributor to driver fatigue and its risks to safety. Teamster drivers working for Motor Freight Carriers Association (MFCA) companies, which make up the unionized less-than-truckload (LTL) segment of the trucking industry, drive during both night and day with an admirable safety record. This study sought to identify practices and factors that contribute to the safe conduct of night driving by obtaining information on the following aspects of Teamster drivers working for MFCA.

- Demographics and health (e.g., age, body mass index, tobacco use, medications).
- Sleep and circadian factors (e.g., sleep on workdays and non-workdays, sleepiness, sleep disorders).
- Operational factors (e.g., characteristics of truck, work schedules, environment).
- Fatigue management (e.g., causes and manifestations of fatigue and sleepiness while driving, strategies that mitigate fatigue on the job, breaks and naps).

Objective. The goal of the study was to identify best practices for managing fatigue, which may have potential application to other motor vehicle operators who drive at night.

Study Design. A survey instrument was developed and used to achieve the goal by reviewing the experiences and practices of a large Teamster cohort of LTL drivers. Another way to achieve the goal was by comparing fatigue management experiences and behaviors of the safest Teamster drivers who met MFCA criterion for having driven a million or more miles accident free. These "million milers", who make up 27.6% of Teamster drivers in MFCA at the time of the survey, were compared to the experiences and behaviors of the 72.4% of Teamster drivers who had not (yet) met this safety benchmark (i.e., "non-million milers").

Survey. The *Truck Driver Fatigue Management Survey* was an 11-page scannable survey (OMB No. 2126-0029—see Appendix) mailed to 5,741 Teamster drivers (2,741 million milers and 3,000 non-million milers). Sampling was adjusted to ensure proportional representation from each MFCA company, and responses from at least 1,000 million miler and 1,000 non-million miler drivers.

Completed Surveys: A total of 2,280 completed surveys were returned (1,128 million milers and 1,152 non-million milers). Stratified random sampling yielded weighted estimates of means and percentages.

SUMMARY OF KEY FINDINGS

Demographics. Drivers averaged 53 years of age and 27.8 years operating trucks. They were generally white (90%), non-Hispanic (94.5%), married (82.8%) males (97.8%). There were significant demographic differences between million milers and non-million milers. The latter were younger by an average of 3 years, had 4.6 years less experience driving a truck, and were proportionally less likely to be married.

Obesity. Half (49.8%) of drivers had a body mass index (BMI) in the obese range, which is nearly double the prevalence of obesity in the general population, including males aged 45-64 years (26.6% obese). BMI is an important public health index because it is based on the effect of excess body weight on risks of disease and death. Million milers and non-million milers did not differ on BMI. Most drivers reported relatively sedentary lifestyles.

Medications. The most frequently reported medications taken by drivers were for managing high blood pressure (34%) and lowering cholesterol (28%). Proportionally more million milers than non-million milers reported taking medications for high blood pressure and for lowering cholesterol.

Sleep disorders and complaints. Despite a high rate of obesity, which can increase the prevalence of sleep apnea, only 5.6% of drivers indicated they had been diagnosed as having a sleep disorder (89% of the diagnoses were sleep apnea, but only 67% of these drivers were currently being treated). Drivers averaged normal levels of typical sleepiness, but they had elevated scores on the frequency of complaints about difficulty sleeping, which was likely due to the day sleep necessitated by their frequent night driving. Non-million milers had significantly higher scores than million milers on the frequency of symptoms of sleepiness.

Tobacco use. Smoking was reported by 28% of drivers and tobacco chewing by nearly 9%. Like obesity, the smoking percentage was higher than prevalence estimates of tobacco use in the general population (23%). Nearly a quarter of the drivers indicated they used smoking or chewing nicotine gum to deal with fatigue while driving. Proportionally more non-million milers than million milers reported smoking, and non-million milers were more likely to use caffeinated drinks and smoke or chew nicotine gum to fight sleepiness while driving.

Night driving exposure and schedule variability. Most drivers operated trucks with double trailers (83%) and drove alone (90%). As expected, a majority (59%) reported that a typical 2-day work period would involve night driving (i.e., $\geq$ 2 hours working from 12 am to 4 am). Proportionally more non-million milers than million milers reported driving at night and that their work start times and schedules varied "quite a lot." These differences are consistent with other survey data suggesting that the seniority of million milers afforded them greater access to preferred (daytime and more regular) work schedules, than non-million milers.

Sleep on workdays and non-workdays. Drivers reported less sleep on workdays than on non-workdays but appeared to understand the critical importance of adequate sleep taken prior starting a driving run—sleep was the major activity most engaged in prior to driving. The majority of drivers (69%) recognized that daytime sleep was not as restful as nighttime sleep, and most understood that disturbed daytime sleep was due to the endogenous circadian clock, along with environmental light and noise. However, only 26% of drivers—and proportionally more non-million milers than million milers—appeared to be using the most appropriate behavioral strategies for ensuring that daytime

sleep was as restful as possible. Consistent with their greater exposure to nighttime driving and greater schedule variability, non-million milers were more likely to sleep during the daytime, and they had significantly shorter sleep durations during a typical 24-hour work period and immediately prior to driving than million milers. The two groups did not differ in sleep duration on non-workdays, which averaged 8.1 hours. This was more than an hour additional sleep than they reported for workdays. As importantly, the two groups did not differ in time devoted to any pre-work activity other than sleep.

Fatigue and sleepiness on the job. Depending on the fatigue symptom, 33%-66% of drivers reported experiencing fatigue that varied from a noticeable problem to a major problem, on half or more of their trips. The majority of drivers (63%) understood the risks posed by driving drowsy, and 51%-65% reported having experienced yawning, feeling drowsy, eyelids heavy, feeling sleepy, and struggling to be alert while driving. Many fewer reported serious driving consequences from drowsiness such as nodding off/falling asleep (13%), having a near miss (9%), running off the road (6%), and colliding with something (3%). Proportionally more non-million milers than million milers indicated they experienced heavy eyelids, struggling to be alert, yawning, and feeling fatigued while driving.

Causes of fatigue while driving. Out of 28 possible factors, 89% of drivers identified "amount of sleep before the trip" as the most relevant factor to fatigue while driving. Other top-ranked factors included driving at dawn, truck speed too slow, rough riding truck, and driving hours. Their identification of sleep before a trip and driving at dawn is consistent with scientific studies that demonstrate that the sleep period immediately prior to work, and work performance at dawn following a sleepless night, are the most potent factors in the biological modulation of alertness. Proportionally more million milers than non-million milers attributed fatigue to characteristics of the truck (ventilation, vibration, temperature), to weather and wind conditions, and to highway traffic and road conditions.

Managing fatigue using off-the-job strategies. The strategy identified by the highest proportion of drivers to manage fatigue and sleepiness off the job (from 19 different strategies) was "get a good night's sleep before departure." Non-million milers napped more when off the job to manage fatigue, but proportionally fewer of them reported being able to sleep regular hours or get a good night's sleep before departure, consistent with their having less control over their schedules, engaging in more night driving, and experiencing sleepiness more frequently while driving.

Managing fatigue on the job. Nearly half the drivers felt they could manage their fatigue quite well or very well, while the remainder felt they were either less effective or they were unsure as to how well they could manage fatigue on the job. Million milers and non-million milers did not differ in their estimates of how well they managed fatigue, and they generally used the same strategies to lessen fatigue while driving. When asked to indicate how often they used 24 different strategies when attempting to deal with fatigue while driving, a majority of drivers identified 12 strategies. Six of these involved activity while driving (e.g., stretch/change position,

adjust ventilation, have a caffeinated drink, listen to music/radio, talk on cell phone/CB radio, eat while driving). Non-million milers were more likely than million milers to use caffeinated drinks, talk on their cell phones or CB radios, and sing to themselves to help lessen fatigue while driving. The other six strategies identified by drivers for managing fatigue on the job involved stopping to eat, napping, resting without sleep or walking around.

Rest breaks while driving. Most drivers (70%) reported having pulled off the road to take a break in the month prior to completing the survey. Among those who did so, the primary reasons for the break were to use the bathroom (67%) and to rest with sleep (66%). The average driving time before taking a break was 3.7 hours, and the average length of the break was 45 minutes. Million milers took a driving break sooner than non-million milers, but non-million milers took more breaks and they were more likely to sleep (nap) during breaks than million milers, who were more likely to take a break to exercise (primarily walking). There were no differences between million milers and non-million milers in sleeper berth use, but only about 6% of drivers in both groups indicated that they ever used the sleeper berth.

Other factors drivers used to manage fatigue. Among the 13 options for reducing fatigue, a majority of drivers identified five factors that they presently find useful to manage fatigue. These are included getting a good night's sleep before departure (72%), having a CB radio available (69%), having more frequent truck stops/rest areas (53%), doing less loading/unloading (51%), and driving alone (47%). Drivers indicated driving in a team and being allowed to take stay awake medications were not useful for reducing fatigue.

Things drivers would like to have available to manage fatigue. A majority of drivers indicated that having more control over their schedules (76%), working fewer hours (70%), and sleeping regular hours (62%) would help lessen fatigue. Many drivers also felt that having fatigue monitoring technologies (64%) and receiving training in fatigue management (43%) would be helpful. Most drivers (76%) indicated they would like to have control over their schedules to help manage fatigue (another 20% indicated they did have control over their schedules and it was useful for managing fatigue). Consistent with other survey responses, a higher proportion of non-million milers than million milers indicated they would like to have control over their schedules, sleep regular hours, and get a good night's sleep before departure to manage fatigue.

Best practices of million milers from discriminant analyses. In order to identify best practices for managing fatigue, Stepwise Logistical Discriminant Analysis[1] was used to evaluate independent predictors of million miler status. Relative to non-million milers, million miler status was associated with more years of driving experience, less variable work schedules, less night driving, taking the first break earlier when driving, less smoking, and less caffeine and cell phone / CB use to manage fatigue while driving. These findings suggest that the lessons learned from this study regarding "best

[1]The logistic regression analyses implemented using the SAS procedure LOGISTIC (SAS Online Documentation Version 9.1, SAS Institute Cary, NC, http://support.sas.com/91doc/docMainpage.jsp).

practices" include the following: regular work schedules when possible, reduce night driving when possible, encourage taking a rest break sooner when driving, and reduce smoking.

Summary of Recommendations

1. Teamster drivers cope with fatigue from night driving, but more could be done.

The survey revealed Teamster drivers in the LTL industry are required to routinely drive at night and on schedules they do not control. As a consequence, they experience considerable fatigue. Survey responses and the excellent safety record of the drivers suggests they cope with fatigue, but there was also evidence that they would be receptive to and benefit from (1) less variable and more predictable work schedules, (2) fatigue management training, and (3) the use of valid fatigue management technologies. The 72% of drivers who have not yet reached a million accident-free miles (non-million milers) are especially likely to benefit from these recommendations, since they reported having less regular work schedules and more night driving than the safer and more experienced million milers. These problems were reflected in their higher reports of sleepiness and fatigue while driving, their reduced sleep off duty, and their increased use of naps, caffeine, smoking, and cell phone/CB use to ward off sleepiness while driving.

2. Weight loss and stop-smoking programs would benefit Teamster drivers.

Both the rate of obesity and the rate of tobacco use among Teamster drivers were above the national average and indicative of unhealthy lifestyles. While obesity affected 49% of drivers without regard to million-miler status, smoking was higher among non-million milers, and may have been promoted by fatigue, since non-million milers reported using nicotine (a stimulant) to counter fatigue. This group was also less likely to be on common preventative medications for cardiovascular health than million milers. Promotion of weight loss, smoking cessation, and cardiovascular health, would benefit drivers and help with fatigue management by lessening the likelihood drivers would develop disorders that directly or indirectly worsen sleepiness and fatigue (e.g., sleep apnea, metabolic syndrome, diabetes, atherosclerosis, etc.).

3. Finding ways to optimize truck cab environments may help lessen fatigue.

Although Teamster drivers used rest breaks (with and without nap sleep) to counter fatigue while driving, the survey revealed that they also relied heavily on certain activities while continuing to drive (e.g., stretching and shifting body position, adjusting ventilation, listening to music/radio, talking on the cell phone or CB radio). Conversely, among the safer million mile drivers, truck environmental factors were frequently mentioned as a common source of fatigue (e.g., truck speed too slow, rough riding truck, poor ventilation, vibration, temperature too hot or too cold). These findings suggest that truck cab environments should be evaluated to identify ways to (1) prevent truck cabs from contributing the driver fatigue, and (2) utilize truck cab environments to promote alertness when possible. More systematic attention should be paid to this area.

4. Best practices recommendations.

Teamster drivers reported a number of practices that were critical to their coping with fatigue from night driving and irregular schedules, and that may contribute to their excellent safety record. These are as follows:

A. Obtain adequate sleep before driving and on days off duty. Scientific studies have shown that obtaining adequate sleep before work is a potent fatigue countermeasure, regardless of the time of day work occurs. The survey revealed that most Teamster drivers (89%) understood this. The safer million mile drivers achieved it more than the non-million milers, showing that this practice is consistent with safe driving. Both million milers and non-million milers slept an average of 8.1 hours on non-workdays, which is more than an hour on average than they slept on work days. This suggests drivers not only ensured they were obtaining additional sleep on days off to promote recovery from cumulative sleep loss, but also that the sleep duration was in the range of what recent scientific studies suggest is likely to promote normal levels of alertness and performance. Drivers reported less sleep on workdays than on non-workdays but appeared to understand the critical importance of adequate sleep taken prior to initiating a driving run—sleep was the major activity most engaged in prior to driving.

B. Take rest breaks and naps to help manage fatigue and sleepiness. Drivers used rest breaks with and without sleep (naps) to help manage fatigue and sleepiness while over the road. Extensive scientific research has shown that naps can help reduce sleepiness during nighttime operations. Teamster drivers appeared to appreciate this. Non-million milers reported more nighttime driving than million milers and, consistent with this fact, they reported more sleepiness over the road. Non-million milers also reported taking more rest breaks that included naps, as a way of coping with fatigue and sleepiness. Since daytime sleep necessitated by night driving is inherently of shorter duration than nighttime sleep—due to the circadian termination of sleep—non-million milers were supplementing their sleep quota with naps on both workdays and non-workdays.

C. Optimize the sleeping environment. A majority of Teamster drivers (69%) recognized that daytime sleep was not as restful as nighttime sleep, and most attributed disturbed daytime sleep to being awakened by their internal clock, as well as to environmental light and noise. The remaining minority of drivers that reported day sleep was as restful a nighttime sleep indicated this was due to the sleep being taken in a dark room (77%), and the family being informed of the need for quiet sleep (58%). Non-million milers—who had to engage in more day sleeping due to more nighttime driving—were more likely to be more aware of these critical factors to optimize day sleep, than were million milers. Day sleep in a totally dark room and family sensitivity to ensuring the sleeper is not disturbed by noise or other factors are two key components that scientific studies have found can markedly help promote sleep at an adverse (daytime) circadian phase.

D. **Recognize the warning signs and risks of drowsy driving.** Many Teamster drivers understood the risks posed by driving drowsy, and a majority correctly identified the signs of sleepiness while driving (e.g., yawning, feeling drowsy, eyelids heavy, feeling sleepy, and struggling to be alert). However, serious driving consequences from drowsiness such as nodding off/falling asleep or having a near miss incident or an accident were reported as very infrequent by Teamster drivers. This suggests drivers took countermeasures before the sleepiness progressed to the point of behavioral impairment. Proportionally more non-million milers than million milers indicated they experienced heavy eyelids, struggling to be alert, and yawning while driving. Yet this group also took more rest breaks and naps while on the road. Thus, it appears Teamster drivers have an appreciation for the warning signs of sleepiness and the need to take countermeasure actions.

E. **More predictable and regular work schedules are safer.** Differences between million milers and non-million milers in the variability of their start times and work schedules were associated with greater access to preferred work schedules by drivers with more seniority (i.e., million milers), and were not associated with different circadian phase preferences. It appears that making work schedules more regular and predictable would enhance fatigue management.

5. Recommendations for future research.

Despite frequently driving at night and often on variable work schedules, Teamster drivers have an excellent safety record. This study reveals they are aware of the critical need for adequate sleep and the need to use fatigue management and countermeasures. In addition to the recommendations above, the report suggests that further research with Teamster drivers would be ideal for evaluating novel fatigue management approaches in commercial trucking, while minimizing risk. Research into the following two areas of fatigue management might be especially beneficial to Teamster drivers and provide much needed data for the trucking industry as a whole.

A. **Investigate cost-effective ways to promote weight loss.** The nearly 50% prevalence of obesity in Teamster drivers suggests the need to identify cost-effective weight loss programs in obese drivers. Obesity can result in a wide range of serious illnesses (e.g., hypertension, diabetes, sleep apnea) that can compromise safety, quality of life and employment longevity. Since the prevalence of obesity was high in both million milers and non-million milers, and both groups reported relatively sedentary lifestyles, research is needed on ways to help obese drivers lose even a modest amount of weight, which can have substantial health benefits.

B. **Study how best to identify drivers' vulnerability to fatigue.** Recent scientific work has shown that the performance vulnerability of people who must work at night can vary greatly among individuals, and that this trait is stable over time (i.e., those who are most vulnerable to performance impairment are consistently

this way, and vice versa).[2] Given the amount of nighttime driving by Teamster drivers, their understanding of the importance of sleep, and their safety record, they are an ideal group in which to conduct research targeted at determining how best to identify driver vulnerability to fatigue, and research aimed at determining if matching driver fatigue vulnerability to work schedule would help manage fatigue even more effectively.

[2]Van Dongen et al. Systematic inter-individual variability differences in neurobehavioral impairment from sleep loss: Evidence of trait-like differential variability. *Sleep* 27(3):423-433, 2004.

1.0 Background

1.1 The Need for Collection of Fatigue Information on Teamster Drivers

Truck driver fatigue, as well as techniques to manage it, has been a research and regulatory priority in the United States and Canada for the last decade. For instance, both U.S. and Canadian drivers participated in the *Driver Fatigue and Alertness Study* conducted by the Federal Highway Administration, Office of Motor Carrier, and Transport Canada in the 1990s, as well as the recently jointly funded study, *Fatigue Management Technologies Pilot Test.*[3] In addition, Transport Canada forwarded a recommended National Safety Code, Standard #9.

Congress has been particularly interested in the truck driver fatigue issue and has directed FMCSA to conduct numerous studies on various aspects of the problem, including those mentioned above. In the Senate Appropriations Committee mark-up of the FY 2002 DOT Appropriations, FMCSA was directed to conduct "a study to determine the fatigue management techniques used by truck drivers during overnight operations with an organization representing unionized motor carriers in cooperation with their labor organization." In recognition of congressional intent, on September 30, 2002, FMCSA awarded the Motor Freight Carriers Associations (MFCA) a contract to conduct a Truck Driver Fatigue Management Study.

Recent research has underscored the overwhelming influence of time of day on truck driver alertness, but the same research has shown that there are significant individual differences in alertness during night driving, even when drivers have adequate sleep. Yet, the trucking industry must operate 24 hours a day in order to meet customer demands. Because the highways are least congested between midnight and 6 am, this is the one time of day when expansion of trucks on the road is possible. One segment of the trucking industry – the unionized less-than-truckload (LTL) segment – has a long history of safe operations at night; indeed, a large proportion of its over-the-road operations occur at night. A major reason for the exemplary safety record of MFCA companies is the professionalism of the International Brotherhood of Teamsters (Teamsters) drivers they employ: at the time this study was initiated, more than 8,000 of the 42,000 drivers had at least one million accident-free driving miles with the same company. This truck driver workforce offers a tremendous untapped source of knowledge about techniques and lifestyle practices that are used to manage fatigue during night operations.

Therefore, the purpose of this study was to survey Teamster drivers in MFCA companies who regularly operate on overnight runs in order to collect detailed information on such items as the nature of their job, what helps them cope, what the challenges are, how much and how long they sleep, their physical condition, the use of naps, and the impact of other factors on their alertness.

[3]Dinges DF, Maislin G, Krueger GP, Redmond et al: *Pilot Test of Fatigue Management Technologies.* Final report for the Federal Motor Carrier Safety Administration, U.S. Department of Transportation and Transport Canada, Canadian Ministry of Transportation, May 31, 2004.

A primary objective of this data collection was to compile a compendium of best practices for managing fatigue, based on real world experience that may be applicable to other motor vehicle operators who must drive at night. Data for this project was generated from a one-time, mailed survey.

There had never been a survey of Teamster drivers with one million accident-free miles. There have been numerous mail surveys of truck drivers over the last decade, particularly in the United States and Australia, but very few of the drivers were union drivers (typically 5%) since the researchers concentrated on truckload drivers. The research team reviewed surveys used in prior studies and selected applicable questions as well as formulated new questions directly targeted at unionized drivers.

1.2 Compliance with 5 CFR 1320.8:

A Pre-solicitation Notice was published in the Federal Register on July 1, 2002:

> "The Federal Highway Administration, on behalf of the Federal Motor Carrier Safety Administration, anticipates a sole source award to Motor Freight Carriers Association for the congressionally-directed study to determine fatigue management techniques used by truck drivers during overnight operations representing unionized motor carriers in cooperation with their labor organization. Motor Freight Carriers Association is the only known organization representing unionized motor carriers in cooperation with their labor organization. It is anticipated that an award will be made by 30 Sep 02. Parties interested in additional details concerning this sole source award should contact Anthony Rowell, Federal Highway Administration, Office of Acquisition Management at 202-366-6870."

No comments were received.

1.3 Initial Planning

Prior to conducting the survey, MFCA contacted its member companies and received listings of accident-free drivers in five-year age increments. The CEOs of the companies were briefed on the survey and gave their support to provide the names and mailing addresses of randomly selected drivers to be surveyed. The International Brotherhood of Teamsters was contacted. They agreed to work with MFCA on the coordination of mailing out the survey, return of the surveys, and the electronic scanning of survey forms by MACDirect. The University of Pennsylvania and their designees agreed to analyze the survey data.

2.0 Description of Study Population and Respondent Selection

2.1 Background

With the nation's highways already straining to meet the needs of all road users, capacity increases are crucial to the continued economic health of the nation; yet, it will be

impossible to reverse two decades of neglect in highway construction in the foreseeable future. However, there is a way to increase highway capacity at no cost: use them when they are underutilized, particularly at night – if it can be done safely. Nighttime operations are crucial to the efficiency and profitability of the LTL industry.

2.2 Motor Freight Carriers Association

At the time of study initiation, most of the Teamster LTL drivers were employed by five companies that comprise the Motor Freight Carriers Association: ABF Freight System, New Penn Motor Express, Roadway Express, USF Holland, and Yellow Transportation. They serve more than 2.5 million customers in all 50 states, and operate nearly 1,300 terminals and sorting facilities. In 2001, MFCA companies reported freight revenues of almost $10 billion generated by 42,000 drivers. Teamster drivers are among the highest paid drivers in the industry, with road drivers averaging more than $60,000 annually.

Subsequent to the original study design, **USF Holland,** based in Holland, Michigan, was acquired by Yellow Transportation, requiring a modification of the stratified sampling plan.

The four remaining companies that comprise MFCA are among the oldest and largest trucking companies in the United States. The following is a brief description of the companies and their operational characteristics at the time of study initiation.

ABF Freight System: ABF was formed in 1923 and is now the fourth largest national LTL motor carrier in the United States. It provides direct service to more than 40,000 communities and virtually all of the cities in the United States having a population over 25,000. More than 96% of all shipments handled are delivered direct through its 311 terminal facilities. ABF has 6,674 drivers and is headquartered in Fort Smith, Arkansas.

New Penn Motor Express: Based in Lebanon, Pennsylvania, New Penn commenced its operations in 1931 with two trucks. It is now a next-day regional LTL with 23 terminals in the Northeastern United States, Quebec, and Puerto Rico. The company employs 1,313 drivers.

Roadway Express: Founded in 1930 and headquartered in Akron, Ohio, Roadway is now the second largest LTL carrier in the United States and also has operations in Canada and Mexico. Roadway has 388 terminals and employs 11,823 drivers.

Yellow Transportation: Based in Overland Park, Kansas, Yellow Freight is the largest LTL in the United States and was formed in 1926 with two trucks. The company has operations at 400 terminals in the United States, Canada, and Mexico, and employs 15,853 drivers.

MFCA companies have consistently ranked among the safest in the trucking industry. Four factors distinguish MFCA companies from the rest of the trucking industry. First, in contrast to the high driver turnover in most of the industry, Teamster drivers that MFCA companies employ have, on average, 25-30 years of driving experience with the same

company, a hallmark of professional drivers. Second, MFCA drivers usually operate on regular schedules over familiar routes which minimizes the risk of unpredictable roads and is designed to get drivers home every day, thereby minimizing fatigue. Third, the movement of freight from terminal to terminal – the very essence of LTL operations – results in daily management supervision of the drivers. Fourth, through the collective bargaining process as enumerated in the National Master Freight Agreement, all parties governed by the Agreement must comply with all applicable Federal, State, and local regulations pertaining to worker safety and health.

The online FMCSA inspection data supports MFCAs contention that compliance with the current Hours-of-Service (HOS) rules can have exemplary safety results. Over the thirty months preceding the original study design, MFCA-company drivers were inspected 20,598 times by State and Federal officials. The results are enlightening: there were three drivers who violated the 60/70 hour weekly limit and 16 who violated the 10/15 hour daily limit.

As the data clearly shows, MFCA companies do not have to rely on outside agencies to ensure compliance with the hours of service rules. It occurs by the very nature of the LTL business and naturally as a result of the National Master Freight Agreement (the collective bargaining agreement with the International Brotherhood of Teamsters). For example, the majority of runs are bid according to seniority. The runs are known – indeed, they are jointly established by management and the union – and they are recurring and designed to be completed in less than 10 hours of driving. Drivers are paid for the known mileage of the run as well as any unavoidable delay. There is no incentive for drivers to exceed the HOS rules. If management attempted to force drivers to exceed the HOS rules, the driver would refuse to drive under Article 16 (Equipment, Safety and Health) of the National Master Freight Agreement – and management could not retaliate.

At the time of the original study design, more than 8,000 of the MFCA-company drivers had at least one million driving miles without an accident – no other segment of the U.S. trucking industry can boast of such an achievement. Yet, most operations occur at night because there is less congestion and customers demand morning delivery. Thousands of drivers have made the same overnight runs for years. They are under daily management supervision because they drive from terminal to terminal. They have the opportunity for at least 8 hours of continuous sleep every day; indeed, they cannot be called for duty until they have been off duty for 8 hours and then must be given 2 hours notice to report.

Recent research has underscored the profound influence night driving during habitual sleep time has on truck driver alertness, but most of the research has also shown that there are significant individual differences in alertness during night driving. The major factors believed to be associated with truck driver alertness are quantity and quality of previous sleep, regular schedules, and adequate time off duty. The unionized LTL industry operates in a manner that encourages driver alertness and compliance with the current HOS rules even though much of the driving occurs at night. It also operates safely – at the time of the original study design more than 8,000 drivers in MFCA-member companies had at least one million accident-free miles with the same company.

This truck driver workforce offers an untapped source of knowledge about techniques and lifestyle practices that are used to manage fatigue during night operations.

3.0 Statistical Methods

3.1 Nature of Collected Information

Survey data were collected on the following:

1. **Demographics and health of drivers:** Age, gender, weight, height, marital status, tobacco use, and medications taken.

2. **Characterization of sleep and circadian systems:** Sleep times and durations, degree of sleepiness (Epworth Sleepiness Scale), Morningness - Eveningness preference, sleep disorder, and sleep apnea prediction scales.

3. **Nature of work-rest factors:** Type and timing of typical driving pattern, timing of work and rest schedules, locations for sleep, frequency and duration of sleep episodes, use of naps, factors that help and hinder sleep at home and on the road, and sleep-wake patterns on days off.

4. **Perceptions of fatigue:** The frequency with which manifestations of fatigue occur on the job, factors that promote fatigue, strategies that mitigate fatigue while driving, behaviors used to prevent or reduce fatigue on the job, and factors that the drivers do not control but they believe would help reduce fatigue.

3.2 Study Design

This study used self-administered mail surveys to collect data from drivers at four large LTL companies: ABF Freight System, Roadway Express, New Penn Motor Express, and Yellow Transportation. As of February 2005, these companies provided contact information for their 9,915 road drivers. The study design involved comparison of the fatigue management behaviors of the proven safe drivers who met MFCA criteria for "Million Miler" status, to the behaviors of drivers who did not (yet) have this status. Of the 9,915 Teamster drivers involved in the MFCA industry, 2,741 (27.6%) had at least one million accident-free driving miles (i.e., met criteria for million miler status in the MFCA database). The remaining 7,174 drivers (72.4%) had not met these criteria (i.e., were classified as non-million milers.)

Table 1a summarizes the numbers and percentages of drivers from each MFCA company within the million miler and non-million miler subpopulations. The sampling plan was designed to over-sample million milers to ensure that they represented approximately 50% of the sample data, even though they represented 27.6% of the population. Sample size analyses showed that approximately 1,000 million miler responses and 1,000 non-million miler responses would result in adequate statistical power to detect differences between million milers and non-million milers, and would also result in good precision of statistical estimates of population characteristics. Previous experience of research studies at the University of Pennsylvania suggested an expected 33% response rate. Therefore,

the decision was made to mail survey forms to all million-mile drivers and to a randomly selected sample of non-million mile drivers. Also, since the population from New Penn Motor Express was relatively small compared to the other companies, all drivers from New Penn Motor Express were mailed survey forms regardless of million mile status. The survey package included detailed instructions and a postage paid return envelope addressed to the International Brotherhood of Teamsters (IBT).

Table 1a: Total Million Miler and Non-Million Miler Drivers in the Population of Over-the-Road Drivers as of February 2005

	Million Milers		Non-Million Milers	
Company	n	%	n	%
ABF	710	25.9%	2,077	29.0%
New Penn	66	2.4%	298	4.2%
Roadway	1,313	47.9%	2,798	39.0%
Yellow Freight	652	23.8%	2,001	27.9%
Total	2,741	100.0%	7,174	100.0%

Table 1b summarizes the target numbers of survey responses desired. The MFCA companies provided electronic files containing the million miler status for each driver. These files were integrated and re-formatted to permit the printing of mailing labels, and subjected to a random selection of drivers from the ABF Freight System, Roadway Express, and Yellow Transportation non-million miler drivers by the University of Pennsylvania research team. The surveys were mailed with a cover letter–jointly signed by James Hoffa, General President of the IBT, and the CEO of the appropriate company–to each of the selected drivers.

Table 1b: Target Numbers of Million Milers and Non-Million Milers Per Company Among Road Drivers

	Million Milers		Non-Million Milers	
Company	n	%	n	%
ABF	237	25.9%	272	27.2%
New Penn	22	2.4%	99	9.9%
Roadway	438	47.9%	367	36.7%
Yellow Freight	217	23.7%	262	26.2%
Total	914	100.0%	1,000	100.0%

Based on the University of Pennsylvania research team's prior experience, a 33% survey response rate was expected. **Table 1c** summarizes the number of surveys mailed in order to achieve the target numbers of million milers and non-million milers from each company specified in **Table 1b**. **Table 1d** summarizes the road driver population percentages within each population-defined sampling stratum.

Table 1c: Numbers of Surveys Per Stratum Mailed in Order to Achieve Target Assuming a One-Third Response Rate

	Million Milers		Non-Million Milers	
Company	n	%	n	%
ABF	710	25.9%	815	27.2%
New Penn	66	2.4%	298	9.9%
Roadway	1,313	47.9%	1,100	36.7%
Yellow Freight	652	21.7%	786	26.2%
Total	2,741	100.0%	3,000	100.0%

Table 1d: Percentages of Road Driver Population for Each Sample Stratum

	Million Milers		Non-Million Milers	
Company	n	%	n	%
ABF	710	7.2%	2,077	20.9%
New Penn	66	0.7%	298	3.0%
Roadway	1,313	13.2%	2,798	28.2%
Yellow Freight	652	6.6%	2,001	20.2%
Total	2,741	27.6%	7,174	72.4%

Table 1e summarizes the numbers of responses actually obtained within each of these 8 strata. Sampling weights used in the estimation of overall population characteristics including means and percentages are also listed in **Table 1e**. These sampling weights adjust for: 1) the over sampling of million miler drivers, 2) the over sampling of New Penn drivers, and 3) differences among strata in response rates. The weights were standardized such that the sum of the weights was equal to the actual obtained sample size of 2,280. Each weight is computed as the ratio of the expected number of respondents for a particular stratum (if the sample proportion was equal to the population proportion) divided by the actual sample. For example, the sampling weight for ABF million milers was computed as (0.072 x 2,280 = 164.16)/299 = 0.549. Thus, the weight of each ABF million miler is reduced when estimating population characteristics to account for the over sampling of million mile drivers.

Table 1e. Stratum Specific Sampling Weights Used to Construct Population Based Estimates

	Million Milers		Non-Million Milers	
Company	**Responses**	**Weight**	**Responses**	**Weight**
ABF	299	0.546	323	1.479
New Penn	33	0.460	145	0.473
Roadway	543	0.556	400	1.609
Yellow Freight	253	0.593	284	1.620
Total	1,128	2.155	1,152	5.180

3.3 Outcomes

The survey was designed to accomplish two major goals. The first was to characterize the demographics, work-rest behaviors, and fatigue management behaviors of MFCA drivers. The second goal was to compare million milers and non-million milers to determine if responses discriminated them on any of the following questions:

1. What factors (e.g., practices, demographics) predict safe and alert night driving?

2. What factors do drivers perceive as challenges to safety and alertness during night driving?

3. What factors do drivers perceive as most helping them cope with being alert and safe during night driving?

4. What factors determine sleep in drivers (i.e., timing, frequency, duration, quality)? What sleep-wake behaviors are associated with mitigation of fatigue and maintenance of driver alertness during nighttime operations?

In addition, the survey was designed to facilitate development of a compendium of recommended practices for managing fatigue, based on real world experience, that were applicable to other motor vehicle operators who must drive at night.

3.4 Estimation of Target Population Characteristics

The stratified random sampling scheme permitted the use of weighted estimates of means and percentages. These weighted estimates accounted for the over-sampling of million mile drivers and the 100% sampling from New Penn Motor Express. Sampling weights for each stratum are summarized in **Table 1e**. These were derived based on the known numbers of drivers within each of the eight strata as of February 2005. These weights allowed statistical analyses to adjust for the differences between the percentages of drivers in each of the eight strata in the population and the percentages of drivers in each of the eight strata in the sample. Thus, the stratified sampling scheme enabled over-sampling of drivers with million miler status while preserving the ability to construct estimates relevant to the entire road driver MFCA population. A set of population

weights reflecting the relative sizes of strata defined on the basis of the relative proportions of million milers and non-million milers within each company was used when estimating characteristics of the entire MFCA road driver population. All standard errors and confidence intervals accounted for the sampling weights and stratified sampling using the SAS procedure SAS Proc SURVEYMEANS.[4]

3.5 Million Miler Drivers vs. Non-Million Miler Drivers

Responses from million milers were compared to those from non-million milers in order to determine if drive and driver characteristics, sleep behaviors, incidents associated with fatigue and sleepiness, countermeasures employed, and desired counter- measures differed between these two groups. Statistical significance of group differences was established using t-tests for variables assessed as continuous variables and chi-square tests for nominal variables. For simplicity and because there was no *a priori* reason to believe that the characteristics under study would vary by company, accounting for company in comparisons between million milers and non-million milers would have little effect on statistical precision.[5] Thus, unweighted analyses were performed when comparing million milers to non-million milers since these analyses were already stratified on the primary factor causing need for weighted analyses.

3.6 Sample Size Analyses

Confidence intervals for million milers and non-million milers separately. At the time of study design, it was determined that 1,000 million mile drivers and 1,000 non-million mile drivers would result in proportions to be estimated to within 0.031 (with 95% confidence). That is, the margin-of-error would be +/-0.031 (3.1%).

Confidence intervals for differences between million milers and non-million milers. Similarly, 1,000 million milers and 1,000 non-million milers enabled differences in proportions to be estimated to within 0.044 (with 95% confidence). The precision of these estimates is sufficient for most purposes. For example, if the estimated proportion of million milers using Strategy A is 0.30, sample sizes of this magnitude can rule out with 95% confidence that the true proportion is less than 0.27 or greater than 0.33 reflecting the relatively large precision in the estimate.

Statistical power for detecting differences between million milers and non-million milers. The most conservative estimate of statistical power is obtained when the group difference is centered at 0.50. With 1,000 respondents per group, statistical power is at least 80% for group differences in proportions larger than 0.064 (i.e., 0.532 vs. 0.468) assuming a two-sided alpha=0.05 chi-square test.[6] For proportions closer to 0.1 or 0.9, power is larger and the minimum difference detectable with at least 80% power is smaller. Thus, the study was designed to be able to demonstrate, as statistically significant, group differences that reflect important factors differentiating million milers from non-million milers.

---

[4]SAS OnlineDoc® 9.1, SAS Institute Inc., Cary, NC 2003.

[5]Cochran WG, *Sampling Techniques*, New York, NY, Wiley & Company, page 109, 1977.

[6]Elashoff, JD, *nQuery Advisor Version 5.0 User's Guide*, Dixon Associates, Los Angeles, CA, 2002.

Confidence interval for population of drivers not stratified. The margin-of-error for estimating overall population percentages was no more than 0.022 (2.2%).

4.0 Results for Estimated Population

Tables 2 through **20** summarize estimates of population characteristics for the 2,280 drivers who completed surveys. Means and percentages along with standard errors and 95% confidence intervals are presented.

4.1 Estimated Population Demographics and Health

Demographics. **Table 2a** reveals that respondents averaged 53 years of age and 27.8 years experience driving trucks. **Table 2b** indicates that respondents were predominantly white (90.2%), non-Hispanic (94.5%), and married (82.8%) males (97.8%). The majority (59.2%) reported that a typical 2-day work period would involve night driving (i.e., ≥ 2 hours working from 12 am to 4 am). This is consistent with the fact that Teamster drivers operate both day and night driving routes.

Table 2a: Demographic and Descriptive Characteristics[1]

Factor (Question number)	**Population Estimate**			**95% CI**	
	n[2]	**Mean[3]**	**SE**	**LB**	**UB**
Height (inches) (Q4)	2185	70.5	0.07	70.4	70.7
Weight (pounds) (Q5)	2170	226.7	1.30	224.2	229.3
BMI (Body Mass Index, weight in kg / height in m^2)	2128	32.0	0.18	31.6	32.4
Age (years) (Q3)	2188	52.6	0.18	52.3	53.0
Years driving truck (Q7)	2203	26.9	0.23	26.5	27.4

[1] Interval variables were approximated by taking the midpoint of response categories (e.g., 1-2 = 1.5).
[2] n is the total sample size across the 8 sampling strata (4 outfits by million miler status).
[3] Means, standard errors (SE), and lower (LB) and upper bounds (UB) of 95% confidence intervals (CI) determined based on population weights and accounting for stratified sampling plan.

Table 2b: Demographic and Descriptive Characteristics for Estimated Population

Factor (Question number)		Population Estimate n	%[1]	SE	95% CI LB	UB
Ethnicity (Q1C)	Hispanic	113	5.5	0.5	4.3	6.3
	Not Hispanic	1924	94.5	0.5	93.7	95.7
Race (Q1D)	American Indian	36	1.7	0.3	1.1	2.1
	Asian	31	1.5	0.3	0.9	1.9
	White	1918	90.2	0.6	89.3	91.8
	Black	132	6.2	0.5	5.1	7.1
	Native/Hawaiian	9	0.4	0.1	0.1	0.7
Sex (Q2)	Male	2041	97.8	0.3	97.3	98.5
	Female	46	2.2	0.3	1.5	2.7
Marital status (Q6)	Married	1653	82.8	0.9	80.8	84.2
	Single	344	17.2	0.9	15.8	19.2
Night worker[2] (Q15)						
	Yes	1341	59.2	1.0	57.1	61.2
	No	939	40.8	1.0	38.8	42.9

[1]Population %, standard error (SE), and lower (LB) and upper bounds (UB) of 95% confidence intervals (CI) determined based on population weights and accounting for stratified sampling plan.
[2]≥2 hours working 12 am to 4 am over 2 typical days.

Obesity. Respondents had a mean body mass index (BMI)[7] of 32.0 (**Table 2a**). The Center for Disease Control (CDC) lists a BMI that is greater than or equal to 30 to be in the range of "obese" (see http://www.cdc.gov/nccdphp/dnpa/bmi/bmi-adult.htm). The National Heart, Lung, Blood Institute (NHLBI) of the U.S. National Institutes of Health further specifies degrees of obesity using BMI. **Table 3** reveals that half (49.8%) of the survey respondents had BMIs in the obese range, and that the population average BMI of 32.0 was within the Obesity I category by NHLBI standards. Remarkably, only 10.3% of survey respondents were normal weight; 39.9% were overweight but not obese; 26.3% were in the Obesity I category; 11.3% were in Obesity II; and 12.3% were in Obesity III. The 49.8% obesity rate among survey respondents was nearly twice that of CDC estimates of obesity in the general population, including comparisons to males 45-64 years (26.6% obese), to white non-Hispanic males (21.6% obese), and to all married males (23.9% obese).[8]

The high prevalence of obesity among teamster respondents is a serious finding. BMI is considered an important public health index because the measure is based on the effect body weight has on disease and death. As BMI increases, the risks for some diseases

[7]BMI = (weight in pounds/[height in inches] x [height in inches]) x 703.
[8]*Health Behaviors of Adults: USA 1999-2001*, Vital & Health Statistics, Series 10, Vol. 219, US DHHS, Center for Disease Control & Prevention, National Center for Health Statistics, Feb. 2004.

increase, including cardiovascular disease, high blood pressure, diabetes, osteoarthritis, some cancers, and premature death. However, BMI is only one of many factors used to predict risk for disease. It cannot be used to determine whether a person has a disease such as diabetes or cancer; nevertheless, reducing excess weight among Teamster drivers should lead to better health outcomes.

Table 3: Prevalence of Obesity by BMI and NHLBI Categories

	Population Estimate			95% CI	
	n	%[1]	SE	LB	UB
BMI ≥ 30 (obese)					
Yes	1052	49.8	1.1	47.6	52.0
No	1076	50.2	1.1	48.0	52.4
NHLBI Categories					
Normal: BMI <25	216	10.3	0.7	9.0	11.7
Overweight: BMI 25.0-<29.9	860	39.9	1.1	37.8	42.0
Obesity I: BMI 30.0-<34.9	564	26.3	1.0	24.4	28.2
Obesity II: BMI 35.0-<39.9	229	11.3	0.7	9.9	12.6
Obesity III: BMI >=40.0	259	12.3	0.7	10.9	13.7

[1]Population %, standard error (SE), and lower (LB) and upper bounds (UB) of 95% confidence intervals (CI) determined based on population weights and accounting for stratified sampling plan.

Caffeine, nicotine, and alcohol use. Table 4 displays the reported caffeine, nicotine, and alcohol use of drivers. Smoking was reported by more than a quarter of respondents, and tobacco chewing by nearly 9%. The 28.2% who reported smoking was 2%-7% higher than the 1999-2001 prevalence estimates of smoking in the general population (23.1%), smoking among men between the ages of 45 and 64 years (26.2%), smoking among white non-Hispanic males (25.5%), and smoking among married males[6] (21.2%), but comparable to estimates of smoking prevalence by men in 1991[9] (28.1%). It suggests that smoking may not be declining among truckers at the same rate as in the general population.

It appears that nicotine use may be facilitated by fatigue in this population. When asked if they used smoking or chewing nicotine gum to deal with fatigue during driving, 24.1% of respondents indicated they did so often (18.1%) or sometimes (7.1%)—see **Table 19b**.

Reported caffeinated drink intake was at or below 4 drinks per day for 78.3% of drivers. Only 4.6% showed excessive caffeine intake of 8 or more drinks per day. A majority of respondents (66.4%) also reported not drinking alcohol when off duty. Thus, most drivers reported moderate use of caffeine and very modest use of alcohol.

[9]Giovino, G.A., et al. *Surveillance for Selected Tobacco-Use Behaviors,--United States,, 1900-1994*, Office on Smoking & Health, CDC, Atlanta, GA, MMWR CDC Surveillance Summaries, 43(3):1-43, Nov. 18, 1994.

Table 4: Caffeine, Nicotine, and Alcohol Use

Factor (Question number)		Population Estimate n	%[1]	SE	95% CI LB	UB
Current smoker (Q10)	Yes	617	28.2	1.0	27.4	31.3
	No	1570	71.8	1.0	68.7	72.6
Chew tobacco (Q11)	Yes	188	8.8	0.6	7.5	10.0
	No	1954	91.2	0.6	90.0	92.5
Drink alcohol (off duty) (Q13)	Yes	745	33.6	1.0	31.3	35.3
	No	1469	66.4	1.0	64.7	68.7
Caffeinated drinks per day (Q12)	< 2	550	24.7	0.9	22.2	25.8
	2-4	1194	53.6	1.1	51.3	55.5
	5-7	379	17.0	0.8	16.0	19.3
	≥ 8	103	4.6	0.5	4.0	5.9

[1]Population %, standard error (SE), and lower (LB) and upper bounds (UB) of 95% confidence intervals (CI) determined based on population weights and accounting for stratified sampling plan.

Sleep-related health characteristics. Drivers' responses to sleep-related health questions are shown in **Tables 5a** and **5b**. **Table 5a** reveals that the majority of drivers preferred a morning circadian peak phase[10] (60.1%) and indicated awakening refreshed (76.2%). The preference to being awake in the morning likely reflects the influence of

[10]Horne JA, Östberg O. A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. *Int J Chronobiol* 4:97–110, 1976.

Table 5a: Sleep-Related Health Characteristics

Factor (Question number)		Population Estimate n	%	SE	95% CI LB	UB
Morning vs. evening type of person (Q39E)						
Definitely a 'morning' type		652	29.9	1.0	28.0	31.9
More 'morning' than 'evening'		668	30.2	1.0	28.3	32.2
More 'evening' than 'morning'		580	26.4	1.0	24.5	28.2
Definitely an 'evening' type		317	13.5	0.7	12.1	14.9
Tiredness within 30 min. after waking (Q39B)						
Very tired		77	3.6	0.4	2.8	4.4
Fairly tired		453	20.2	0.9	18.5	21.9
Fairly refreshed		1261	55.5	1.1	53.4	57.6
Very refreshed		464	20.7	0.9	19.0	22.4
Diagnosed with sleep disorder (Q38A1)	No	2116	94.4	0.5	93.3	95.3
	Yes	126	5.6	0.5	4.7	6.7
If yes, disorder? (Q38A2): Sleep apnea		111	89.5	2.5	85.6	95.4
Insomnia		5	4.0	1.6	0.5	6.8
Narcolepsy		0	0.0	1.5	0.1	6.2
Restless legs syndrome		4	3.2	1.3	0.1	5.3
Other		4	3.2	n/a	n/a	n/a
If yes, currently treated? (Q38B):	Yes	84	67.7	4.2	61.9	78.4
	No	40	32.3	4.2	21.6	38.1

early workday start work schedules, as well as the influence of age (mean = 53 years old) — early awakening increases as people age.

When asked if they had been diagnosed with a sleep disorder, 94.4% of the weighted population estimate indicated they had not, but of the drivers who had (n = 126, or 5.6%), 89.5% of the population estimate indicated they had been diagnosed with sleep apnea, and of these 67.7% (n = 84), were currently being treated. An apnea prevalence of 5% is not consistent with an FMCSA study of sleep apnea prevalence in truck drivers, where 10.5% had moderate to severe apnea.[11]

Table 5b shows respondents' composite scores on the four sleep disturbance indices from the Multivariable Apnea Prediction (MAP) questionnaire.[12] MAP is a screening tool for sleep apnea and other sleep disturbances, that relies on the frequency of certain symptoms combined with age and BMI. Scores range from 0 to 4 (0 = never, 1 = rarely [< 1 time/week], 2 = sometimes [1-2 times/week], 3 = frequently [3-4 times/week], 4 = always [5-7 times/week]) and are computed by averaging non-missing responses. The

[11]Pack, A.I.; Dinges, D.F.; Maislin, G. *A Study of Prevalence of Sleep Apnea Among Commercial Truck Drivers.* Federal Motor Carrier Safety Administration, Washington, DC; 20024.

[12]Maislin, G.; Pack, A.I.; Kribbs, N.B.; Smith, P.L., Schwartz, A.R.; Kline, L.R.; Schwab, R.J.; Dinges, D.F. A survey screen for prediction of apnea. *Sleep* 18 (3):158-166, 1995.

ability of both the overall MAP Index and the apnea symptom score to discriminate between patients with and without sleep apnea has been validated in populations, including sleep clinic patients[10] and commercial truck drivers.[9] The Teamster results for MAP indices suggest that drivers were more likely to have complaints of difficulty sleeping (Index 2) than sleep apnea symptoms (Index 1), daytime sleepiness symptoms (Index 3), or narcolepsy-like symptoms (Index 4). The higher complaints of difficulty sleeping would be consistent with the fact that approximately 59% of the respondents reported night driving and, therefore, day sleeping in a "typical 2-day period in a typical workweek" (**Table 2b**). It is extensively documented that night shift work disrupts daytime sleep.

Drivers' responses to questions on the likelihood of falling asleep, which make up the clinical Epworth Sleepiness Scale,[13] yielded an average sleepiness of 7.3, which is in the normal range (see bottom of **Table 5b**).

Table 5b: Sleep-Related Health Characteristics[1]

Factor (Question number)	**Population Estimate**			**95% CI**	
	n[2]	**Mean[3]**	**SE**	**LB**	**UB**
Multivariable Apnea-MAP (Q45a-n):	1894	0.54	0.01	0.53	0.55
Index 1: Apnea symptoms	2155	0.76	0.02	0.72	0.80
Index 2: Difficulty sleeping symptoms	2243	1.38	0.02	1.34	1.42
Index 3: Daytime sleepiness symptoms	2239	0.50	0.01	0.47	0.52
Index 4: Narcolepsy-like symptoms	2221	0.21	0.01	0.19	0.22
Epworth Sleepiness Scale score (Q40)	2257	7.3	3.6	7.2	7.5

[1] Interval variables were approximated by taking the midpoint of response categories (e.g., 1-2 = 1.5) in some cases.
[2] n is the total sample size across the 8 sampling strata (4 outfits by million miler status).
[3] Means, standard errors (SE), and lower (LB) and upper bounds (UB) of 95% confidence intervals (CI) determined based on population weights and accounting for stratified sampling plan.

Medication use. Table 6 shows that the most frequently reported medications taken by drivers were for hypertension (34.1%) and lowering cholesterol (28%). Fewer than 8% of drivers reported taking any of the other medications listed on the survey. It is noteworthy that an estimated 4.8% of drivers reported taking sleeping pills. This is consistent with the 4% who reported having been diagnosed with insomnia (**Table 5a**) and the elevated MAP difficulty sleeping symptom index for the population estimate (**Table 5b**). Drivers were not asked about wake-promoting prescription medications, because the survey was finalized (approved by OMB, FMCSA, MFCA, The International Brotherhood of Teamsters, and the CEOs of the participating companies) before the novel wake-promoting drug modafinil was approved by the FDA for Shift Work Sleep Disorder.

[13] Johns, M.W. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. *Sleep* 14(6):540-5, 1991. This measure asks the respondent to indicate the degree of sleepiness on a 4-point scale ranging from "would never doze" to "high chance of dozing" for eight different soporific situations. The summed score can range from 0-24. Scores >10 indicate excessive sleepiness.

4.2 Work and Sleep Characteristics of Estimated Population

Tables 7-14 summarize drivers' responses to questions about the nature of their work and their sleep on workdays and non-workdays.

Table 6: Current Medication Types Reported

Factor (Question number)	**Population Estimate**			**95% CI**	
	n	**%**[1]	**SE**	**LB**	**UB**
Blood pressure medicine (Q14A)	765	34.1	1.0	32.1	36.1
Breathing pills for lungs (Q14B)	25	1.1	0.2	0.7	1.5
Breathing pills for heart (Q14C)	6	0.3	0.1	0.1	0.6
Breathing sprays or inhalers (Q14D)	99	4.9	0.5	4.0	5.9
Heart pills (Q14E)	145	6.8	0.6	5.7	7.8
Water pills (Q14F)	158	7.9	0.6	6.7	9.0
Sleeping pills (Q14G)	104	4.8	0.5	3.9	5.8
Pills to lower cholesterol (Q14H)	640	28.0	1.0	26.1	29.9
Antihistamine and/or decongestant (Q14I)	158	7.7	0.6	6.6	8.9
Thyroid medicine (Q14J)	87	4.3	0.5	3.4	5.2
Tranquilizers (Q14K)	9	0.4	0.2	0.1	0.7

[1]Population %, standard error (SE), and lower (LB) and upper bounds (UB) of 95% confidence intervals (CI) determined based on population weights and accounting for stratified sampling plan.

Type of work-related driving. Table 7 reveals that the vast majority of drivers reported that they normally operate trucks with double trailers (83.6%) and that they drive alone (90.1%). Only 3.5% indicated they did team driving, while 6.4% indicated their driving patterns varied between solo and team driving. Among the team drivers, most had been doing it for 6 or more years (53.6%), but among those currently driving as part of a team, the majority (56.6%) indicated they did not drive with the same partner consistently.

When asked about start time and work schedule variability, 46.0% of drivers (weighted population estimate) indicated these factors vary "quite a lot," while 37.7% indicated they vary "a little," and 16.3% indicated they do not vary (**Table** 7). This suggests that drivers differ considerably in the regularity of their work schedules, with 46% experiencing what they perceive to be considerable variation. The majority of respondents (76.0% of the population estimate) indicated that they would like to have control over their schedules to help manage fatigue, and another 19.9% indicated they do have control over their schedules and it is useful for managing fatigue (see **Table 20a**, Q46A). Therefore, it is likely that increased variation in work schedule contributes to greater fatigue in drivers who experience it. Seniority (and therefore age and years of driving) may be associated with it, such that older drivers with more seniority may have less variable schedules; however, this issue was not quantified in the current data.

Sleep on workdays and non-workdays. Drivers reported an average of 6.94 hours sleep in a typical 24-hour period when working, compared to an average of 8.09 hours sleep in a typical 24-hour period when not working (**Table 8**). This resulted in a mean difference of 1.15 hours more sleep on non-workdays relative to workdays. They also reported more

awakenings during the main sleep period on work days (mean = 1.76) compared to non-workdays (mean = 1.44). This data is consistent with other data collected on truck drivers and other workers indicating that sleep is reduced on workdays

Table 7: Type of Work-Related Driving

Factor (Question number)	**Population Estimate** n	%[1]	SE	**95% CI** LB	UB
Vehicle type normally driven (Q8)					
Semi	270	9.3	0.5	8.2	10.3
Double	1687	83.6	0.7	82.2	85.1
Triple	162	7.1	0.5	6.0	8.2
Driving operation normally (Q9A)					
Single	1853	90.1	0.7	88.8	91.4
Team	78	3.5	0.4	2.7	4.3
Varies	120	6.4	0.6	5.3	7.5
Team driving duration (Q9B) (teams only)					
< 1 year	70	21.5	2.3	17.1	26.0
1 - 5 years	79	24.9	2.4	20.2	29.6
6 - 10 years	93	23.2	2.2	18.9	27.4
> 10 years	114	30.4	2.4	25.6	35.2
Usually same partner (Q9C) (current teams)					
Yes	125	43.4	3.1	37.3	49.4
No	142	56.6	3.1	50.6	62.7
Start time and schedule vary (Q27)					
Quite a lot	907	46.0	1.1	43.9	48.1
A little	910	37.7	1.0	35.7	39.7
Not at all	402	16.3	0.8	14.8	17.8

[1]Population %, standard error (SE), and lower (LB) and upper bounds (UB) of 95% confidence intervals (CI) determined based on population weights and accounting for stratified sampling plan.

Table 8: Sleep Characteristics on Workdays and Non-Workdays[1]

Factor (Question number)	Population Estimate			95% CI	
	n[2]	Mean[3]	SE	LB	UB
Sleep (hours) in typical 24-hour period when working (Q16)	2215	6.94	0.03	6.88	7.00
Sleep (hours) in typical 24-hour period when not working (Q17)	2251	8.09	0.03	8.03	8.15
Difference between non-workday & workday sleep (Q17-Q16)	2213	1.16	0.03	1.10	1.22
Number of awakenings during main sleep when working (Q20)	2216	1.76	0.03	1.71	1.82
Number of awakenings during main sleep when not working (Q21)	2202	1.44	0.03	1.38	1.49
Hours between wake up and drive start on typical workday (Q19)	2237	3.27	0.05	3.17	3.37

[1]Interval variables were approximated by taking the midpoint of response categories (e.g., 1-2 = 1.5) in some cases.
[2]n is the total sample size across the 8 sampling strata (4 outfits by million miler status).
[3]Means, standard errors (SE), and lower (LB) and upper bounds (UB) of 95% confidence intervals (CI) determined based on population weights and accounting for stratified sampling plan.

relative to non-workdays. The increased number of awakenings on workdays may reflect the fact that some work days involve daytime sleep in Teamster drivers, which would be expected to result in more awakenings.

Drivers reported that they typically awakened an average of 3.27 hours prior to the start of their driving on workdays (**Table 8**), but there was large inter-subject variability in the response to this question, which was likely due to the considerable variability in the work schedules of many drivers (**Table 7**).

The survey asked drivers to indicate the amount of time they generally spent engaged in various activities before a driving run (the results of these questions are shown in **Tables 9, 10a,** and **10b**). **Table 9** indicates that drivers reported an average of 6.23 hours sleep prior to starting their work run, while **Table 10a** shows that among the activities inquired about in the survey, sleeping occupied the largest proportion of time prior to a work run—43.5% of drivers reported sleeping 7-8 hours before starting a driving run, while 39.8% reported 5-6 hours sleep before a run. Surprisingly, 5.7% of drivers reported sleeping only 3-4 hours prior to driving; 2.6% reported sleeping only 1-2 hours; and 3.0% reported sleeping less than one hour before a driving run. While it is unclear what factors contributed to 11.3% of drivers obtaining 4 or fewer hours of sleep before work-related driving, this finding is of concern since studies have shown that reduction of sleep to this level results in reduced waking alertness.[14] In fact, considerable research, including studies on truck drivers, indicates that 5-6 hours sleep per 24 hours is likely to lead to reduced alertness in the majority of people, especially if decreased sleep becomes chronic.[12,15,16,17] Therefore, only the drivers reporting sleep of 7-8 hours or longer

[14]Dinges, D.F. et al., Chronic Sleep Restriction. In: Kryger, M.H., Roth, T., Dement, W.C. (Eds.) *Principles and Practice of Sleep Medicine* (4th edition), W.B. Saunders, Philadelphia, PA, pp. 67-76, 2005.
[15]Dinges, D.F., et al, Cumulative sleepiness, mood disturbance, and psychomotor vigilance performance decrements during a week of sleep restricted to 4-5 hours per night. *Sleep* 20:267-277, 1997.
[16]Van Dongen et al: The cumulative cost of additional wakefulness: Dose-response effects on neurobehavioral

(48.8%) prior to a work run were above the sleep duration that is known to maintain alertness. However, drivers likely slept at other times in the 24 hours prior to a run, which may explain the difference between the mean of 6.23 hours sleep pre-run on workdays (**Table 9**), and the mean of 6.94 hours sleep reported for a typical 24-hour period when working (**Table 8**).

Resting/relaxing but not sleeping prior to a run was the activity of drivers that occupied the second highest duration of time (mean = 2.31 hours, **Table 9**), with nearly 80% of drivers resting for one or more hours before a run (**Table 10a**). Activities related to checking/repairing or loading/unloading a heavy vehicle were common (**Table 10a**) but occupied less than an hour on average (**Table 9**). Yard work and driving a personal vehicle were also common prior to a driving run, averaging about an hour each (**Table 9** and **Table 10b**). Driving a heavy vehicle prior to work-related run was also common, and averaged 2.17 hours (**Table 9**). However, this average was due to extreme differences among drivers—80.1% of whom reported driving less than an hour, while 17.5% reported driving 7 or more hours (**Table 10b**). It is unclear why the latter drivers (n = 316) would be operating a heavy vehicle for 7 to >10 hours prior to starting a run.

Table 9: Time (Hours) Spent in Various Activities Before Starting Run[1]

Factor (Question number)	**Population Estimate**			**95% CI**	
	n[2]	**Mean[3]**	**SE**	**LB**	**UB**
Sleeping (Q18A)	2188	6.23	0.04	6.15	6.31
Resting/Relaxing (Q18B)	2154	2.31	0.04	2.23	2.39
Checking/repairing heavy vehicle (Q18C)	1911	0.61	0.02	0.58	0.65
Loading/unloading heavy vehicle (Q18D)	1736	0.65	0.02	0.60	0.69
Other yard work (Q18E)	1868	0.90	0.02	0.86	0.94
Driving personal vehicle (Q18F)	2160	1.10	0.02	1.06	1.14
Driving heavy vehicle (Q18G)	1802	2.17	0.08	2.01	2.34

[1]Interval variables were approximated by taking the midpoint of response categories (e.g., 1-2 = 1.5) in some cases.
[2]n is the total sample size across the 8 sampling strata (4 outfits by million miler status).
[3]Means, standard errors (SE), and lower (LB) and upper bounds (UB) of 95% confidence intervals (CI) determined based on population weights and accounting for stratified sampling plan.

functions and sleep physiology from chronic sleep restriction and total sleep deprivation. *Sleep* 26:117-126, 2003.
[17]Belenky, G., et al: Patterns of performance degradation and restoration during sleep restriction and subsequent recovery: A sleep dose-response study. *J Sleep Res* 12:1-12, 2003.

Table 10a: Time Spent in Various Activities Before Starting Run

Factor (Question number)	**Population Estimate**			**95% CI**	
	n	**%**[1]	**SE**	**LB**	**UB**
Sleeping (Q18A)					
<1 hour	60	3.0	0.4	2.2	3.7
1-2 hours	57	2.6	0.3	1.9	3.3
3-4 hours	115	5.7	0.5	4.7	6.8
5-6 hours	856	39.8	1.1	37.7	41.9
7-8 hours	987	43.5	1.1	41.4	45.6
9-10 hours	95	4.5	0.5	3.6	5.4
>10 hours	18	0.8	0.2	0.4	1.2
Resting/Relaxing (Q18B)					
<1 hour	433	20.8	0.9	19.1	22.6
1-2 hours	967	44.4	1.1	42.3	46.6
3-4 hours	524	24.1	0.9	22.3	26.0
5-6 hours	145	7.1	0.6	6.0	8.2
7-8 hours	47	1.9	0.3	1.4	2.5
9-10 hours	19	0.7	0.2	0.4	1.1
>10 hours	19	0.9	0.2	0.5	1.3
Loading/unloading heavy vehicle (Q18D)					
<1 hour	1675	96.5	0.4	95.7	97.4
1-2 hours	18	0.8	0.2	0.4	1.2
3-4 hours	26	1.6	0.3	1.0	2.3
5-6 hours	2	0.1	0.1	0.0	0.3
7-8 hours	1	0.1	0.1	0.0	0.2
9-10 hours	6	0.3	0.1	0.1	0.6
>10 hours	8	0.5	0.2	0.1	0.8

[1]Population %, standard error (SE), and lower (LB) and upper bounds (UB) of 95% confidence intervals (CI) determined based on population weights and accounting for stratified sampling plan.

Table 10b: Time Spent in Various Activities Before Starting Run

Factor (Question number)	Population Estimate n	% [1]	SE	95% CI LB	UB
Checking/repairing heavy vehicle (Q18C)					
<1 hour	1814	94.8	0.5	93.8	95.9
1-2 hours	69	3.6	0.4	2.8	4.5
3-4 hours	17	0.9	0.2	0.4	1.3
5-6 hours	3	0.2	0.1	0.0	0.4
7-8 hours	2	0.2	0.1	0.0	0.4
9-10 hours	2	0.2	0.1	0.0	0.4
>10 hours	4	0.2	0.1	0.0	0.3
Other yard work (Q18E)					
<1 hour	1376	73.9	1.0	71.9	75.9
1-2 hours	384	20.5	0.9	18.7	22.4
3-4 hours	87	4.4	0.5	3.5	5.4
5-6 hours	16	0.9	0.2	0.4	1.3
7-8 hours	4	0.3	0.1	0.0	0.5
9-10 hours	1	0.0	0.0	0.0	0.1
>10 hours	0	n/a	n/a	n/a	n/a
Driving personal vehicle (Q18F)					
<1 hour	1129	51.8	1.1	49.7	54.0
1-2 hours	933	43.3	1.1	41.2	45.4
3-4 hours	82	4.1	0.4	3.3	5.0
5-6 hours	10	0.5	0.2	0.2	0.8
7-8 hours	6	0.3	0.1	0.0	0.5
9-10 hours	0	n/a	n/a	n/a	n/a
>10 hours	0	n/a	n/a	n/a	n/a
Driving heavy vehicle (Q18G)					
<1 hour	1447	80.1	1.0	78.2	81.9
1-2 hours	14	0.9	0.2	0.4	1.3
3-4 hours	18	1.0	0.2	0.5	1.4
5-6 hours	7	0.6	0.2	0.2	1.0
7-8 hours	38	2.0	0.3	1.4	2.6
9-10 hours	161	8.6	0.7	7.3	9.9
>10 hours	117	6.9	0.6	5.7	8.1

[1]Population %, standard error (SE), and lower (LB) and upper bounds (UB) of 95% confidence intervals (CI) determined based on population weights and accounting for stratified sampling plan.

Breaks and sleep when on the job. Tables 11-14 detail drivers' responses to questions about taking breaks and obtaining sleep when on the road. The average driving time before taking a break in a normal workday was 3.69 hours, and the average length of the break was 45.6 minutes (**Table 11**). Most drivers (68.2%) took at least a half-hour break (**Table 12**).

Table 11: Breaks Taken During Driving[1]

Factor (Question number)	Population Estimate			95% CI	
	n[2]	Mean[3]	SE	LB	UB
Hours driven before break (Q30)	2249	3.69	0.03	3.63	3.74
Length of break (Q31)	2252	0.76	0.01	0.73	0.78

[1]Interval variables were approximated by taking the midpoint of response categories in some cases.
[2]n is the total sample size across the 8 sampling strata (4 outfits by million miler status).
[3]Means, standard errors (SE), and lower (LB) and upper bounds (UB) of 95% confidence intervals (CI) determined based on population weights and accounting for stratified sampling plan.

A majority of drivers (n = 1,531, 70.2% of the population estimate) reported having pulled off the road to take a break in the month prior to completing the survey (**Table 12**). Among those who did so, the primary reasons for pulling off the road were to use the bathroom (67.5%), to rest with sleep (66.0%), to eat (42.6%), and to rest without sleep (28.3%). A quarter of respondents (24.7%) indicated they typically stopped when working to exercise, and among these the most common mode of exercise was a leisurely walk (59.3%). The second most common form of exercise was the unidentified "Other" category (22.6%).

Drivers were asked where they usually took their main sleep of greater than 4 hours when working—eight category options were provided. As shown in **Table 13**, the most common response was "Other" (57.1% of respondents). It is likely that this response indicates a category we failed to include in the survey, namely "Home." The second most common response came from the 26.5% of drivers who indicated they did not sleep greater than 4 hours when working. The third highest category was sleeping in a "Dorm" at 9.6%. The fourth highest category was "Sleeper berth" at 4.9%, which is close to the 6.0% of drivers who indicated they used the sleeper berth while on the road, regardless of the duration of sleep (**Table 14**). The remaining four categories for the location of main sleep (greater than 4 hours) during work were: "In cab," "Break room," "Truck stop/Rest area," and "Day cab." Each category had less than 1% of the estimated population (**Table 13**). If the assumption is correct that responses of "Other" meant sleeping at home, then it appears the vast majority of drivers (83.6%) either sleep at home when working or do not sleep greater than 4 hours when working (57.1% and 26.5% respectively). Conversely, only 16.4% of drivers reported sleeping grater than 4 hours while working (**Table 13**), and only 4.9% reported having their main sleep (greater than 4 hours) in the sleeper berth. Of those who reported any use the sleeper berth (n = 125, 6.0%), slightly more than half (53.4%) reported split sleep periods. The majority of these drivers (n = 125) indicated their average time in the sleeper berth was 4 hours or longer (**Table 14**). This is consistent with the drivers (n = 107) who indicated their main sleep was in the sleeper berth when working (**Table 13**). It appears that few Teamster drivers take their major sleep in their trucks while working, and of the small percentage that use the sleeper berth, most do so for a main sleep period.

Drivers were also asked whether sleep in the daytime was as refreshing as sleep at night — a question relevant to a population of professional truck drivers, most of whom drive

during both daytime and nighttime (**Table 2b**), and therefore sleep at both times. Consistent with scientific studies of night shift workers showing reduced sleep quality

Table 12: Break Behaviors During Work

Factor (Question number)	**Population Estimate** n	% [1]	SE	**95% CI** LB	UB
Length of workday break (Q31)					
< 1/2 hour	741	31.7	1.0	29.8	33.7
1/2 to 1 hour	1113	49.7	1.1	47.6	51.8
1 to 1 1/2 hours	247	11.5	0.7	10.2	12.9
1 1/2 to 2 hours	74	3.4	0.4	2.6	4.2
2 or more hours	77	3.6	0.4	2.8	4.4
Past month, times pulled off road to take a rest (Q35A)					
0	713	29.8	1.0	27.9	31.7
1-5	860	39.0	1.0	37.0	41.1
5-10	247	12.0	0.7	10.6	13.4
10-15	165	7.7	0.6	6.6	8.9
15-20	105	4.5	0.4	3.6	5.3
>20	154	7.0	0.5	5.9	8.0
If response to Q35A is more than 0, reason was to (check all that apply) (Q35B)					
rest without sleep (Q35B1)	420	28.3	1.2	26.0	30.6
rest with sleep (Q35B2)	990	66.0	1.2	63.6	68.4
use bathroom (Q35B3)	1048	67.5	1.2	65.1	69.9
eat (Q35B4)	647	42.6	1.3	40.1	45.1
reached driving hours limit (Q35B5)	30	1.9	0.4	1.2	2.6
other (Q35B6)	118	7.6	0.7	6.2	8.9
Typically stop when working to exercise? (Q28A)					
Yes	568	24.7	0.9	22.9	26.5
No	1664	75.3	0.9	73.5	77.1
If yes, what types of exercise? (check all that apply) (Q28B)					
Leisurely walk (Q28B1)	325	59.3	2.1	55.3	63.4
Jog (Q28B2)	38	6.7	1.1	4.6	8.8
Strength (Q28B3)	81	14.7	1.5	11.7	17.7
Brisk walk (Q28B4)	0	0.0	n/a	n/a	n/a
Run (Q28B5)	20	3.8	0.8	2.2	5.5
Other (Q28B6)	132	22.6	1.8	19.1	26.1

[1]Population %, standard error (SE), and lower (LB) and upper bounds (UB) of 95% confidence intervals (CI) determined based on population weights and accounting for stratified sampling plan.

and quantity during day sleep relative to night sleep,[18] the majority of drivers (69.0%) indicated daytime sleep was not as restful as nighttime sleep (**Table 13**). (Another 4.7% indicated they did not sleep during the daytime.) Drivers were asked to select the reasons why they felt daytime sleep was or was not as refreshing as nighttime sleep. Among the estimated 69% (n = 1,547) who indicated day sleep was not as refreshing, the most common reasons were that "my internal clock awakened me" (68.6%), followed by "too much noise" (57.9%) and "too much light" (54.5%). Among the 26.3% (n = 582) of drivers who indicated day sleep was as refreshing as night sleep, the reasons they felt that way were in the following order of endorsement: "I sleep in a dark room" (77.7%), "I make sure my family knows how important quiet sleep is for me" (58.7%), "I disconnect the phone" (41.2%), "I sleep in a separate room" (29.7%), and "I get all of my chores done before I sleep" (27.9%) (**Table 13**). This data highlights the fact that the majority ofdrivers (n = 1,547; 69%) not only suffer disturbed daytime sleep, but recognize that it is due to their endogenous circadian clock disturbing their daytime sleep, along with environmental light and noise. Only a minority of Teamster drivers (n=582; estimated 26.3%) appear to be using the most appropriate strategies for ensuring that daytime sleep is as restful as possible. It may be that the majority of drivers who feel that daytime sleep is less restful find these latter approaches ineffective due to circadian disruption of day sleep (which can be much worse in some people than in others, for reasons not yet understand scientifically).[16] It may also be the case, however, that most drivers have not yet tried the techniques that seem to work for the approximately 26% who find daytime sleep as restful a nighttime sleep.

[18] Åkerstedt T. Shift work and disturbed sleep/wakefulness. *Occupational Medicine* 53:89-94, 2003.

Table 13: Sleep Behaviors at Work

Factor (Question number)		Population Estimate n	% [1]	SE	95% CI LB	UB
When working — usual location of main sleep (>4h) (Q22)						
	Don't sleep	614	26.5	0.9	24.7	28.3
	Sleeper berth	107	4.9	0.5	4.0	5.9
	In cab	13	0.7	0.2	0.3	1.1
	Break room	1	0.0	0.0	0.0	0.1
	Truck stop/rest area	10	0.5	0.2	0.2	0.8
	Day cab	13	0.6	0.2	0.3	0.9
	Dorm	205	9.6	0.6	8.4	10.8
	Other	1251	57.1	1.1	55.1	59.2
When working — usual location of nap (Q23)						
	Don't sleep	856	36.6	1.0	34.6	38.6
	Sleeper berth	21	0.9	0.2	0.5	1.4
	In cab	524	24.1	0.9	22.3	25.9
	Break room	10	0.3	0.1	0.1	0.5
	Truck stop/rest area	175	8.2	0.6	7.0	9.3
	Day cab	584	26.7	1.0	24.8	28.6
	Dorm	2	0.0	0.0	0.0	0.1
	Other	65	3.2	0.4	2.4	3.9
Daytime sleep as restful as nighttime sleep? (Q29A)	No	1547	69.0	1.0	67.1	71.0
	Yes	582	26.3	0.9	24.5	28.2
	Don't sleep during daytime	115	4.7	0.4	3.8	5.5
If yes, why? (check all that apply)	Sleep in a dark room (Q29B1)	450	77.7	1.7	74.3	81.1
	Get chores done before sleep (Q29B2)	169	27.9	1.9	24.2	31.6
	Disconnect the phone (Q29B3)	248	41.2	2.1	37.2	45.3
	Sleep in a separate room (Q29B4)	175	29.7	1.9	26.0	33.5
	Inform family of need for quiet sleep (Q29B5)	359	58.7	2.1	54.6	62.8
If no, why? (check all that apply)	Too much light (Q29C1)	836	54.5	1.3	52.0	57.0
	Too much noise (Q29C2)	901	57.9	1.3	55.5	60.4
	My internal clock wakes me (Q29C3)	1043	68.6	1.2	66.2	70.9
	Hunger wakes me (Q29C4)	111	7.2	0.7	5.9	8.6
	Other (Q29C5)	298	19.2	1.0	17.2	21.1

[1] Population %, standard error (SE), and lower (LB) and upper bounds (UB) of 95% confidence intervals (CI) determined based on population weights and accounting for stratified sampling plan.

Table 14: Sleeper Berth Use During Work

Factor (Question number)	Population Estimate n	% [1]	SE	95% CI LB	UB
Do you use the sleeper berth on the road (Q24)					
No	2066	94.0	0.5	93.0	95.0
Yes	125	6.0	0.5	5.0	7.0
If yes, do you rest or sleep in the berth in (Q25)					
one stretch	55	46.6	4.7	37.4	55.9
split rests	67	53.4	4.7	44.1	62.6
Average time in sleeper berth at one time (Q26)					
<1 hours	0.0	---	---	---	0.0
1 - < 4 hours	6.1	2.3	1.6	10.6	6.1
4 - < 6 hours	62.3	4.4	53.7	71.0	62.3
6 - < 8 hours	10.9	2.6	5.7	16.0	10.9
> = 8 hours	20.7	3.7	13.4	28.0	20.7

[1]Population %, standard error (SE), and lower (LB) and upper bounds (UB) of 95% confidence intervals (CI) determined based on population weights and accounting for stratified sampling plan.

4.3 Fatigue and Sleepiness on the Job in the Estimated Population

Tables 15, 16a, 16b, 17a, 17b, and **17c** contain the results for survey questions about fatigue and sleepiness in the driver population during the past year.

Fatigue as a problem on the job. Table 15 presents the results for questions regarding fatigue on the job. When asked how much fatigue on the job was a personal problem for each driver, 13.0% indicated it was a "major problem" and 27.8% indicated it was a "noticeable problem." The remaining drivers felt it was either a "minor problem" (39.6%) or "not a problem at all" (19.5%). Although 29.5% of drivers indicated that they rarely or never became fatigued on the job, an equivalent proportion (33.0%) indicated that they became fatigued on the job on at least half of their trips (**Table 15**). The remaining third of drivers (37.5%) felt fatigue "occasionally" affected them on the job. It appears that among Teamster drivers, the incidence of fatigue on the job (i.e., ≥ 50% of trips) and the severity of the problem (i.e., from a noticeable problem to a major problem) it poses to the drivers, is relevant to between one-third and two-thirds of drivers. This range is consistent with 59.2% of drivers reporting that they typically drove at night (during habitual sleep time) in the past month (**Table 2b**), when fatigue would be expected to be worse, although night driving (and day sleep) are not the only contributing factors to fatigue.

The largest proportion of drivers (38.1%) felt they could manage fatigue fairly well, while 20.7% felt they could manage it quite well, and 27.0% felt they could manage it very well (**Table 15**). Only 5.2% of drivers felt they could not manage fatigue very well,

while 3.5% did not know if they could, and 5.5% had no opinion on the question. Thus 85.8% of respondents felt they could manage their fatigue on the job from fairly well to very well.

Table 15: Fatigue as a Problem On the Job

Factor (Question number)	Population Estimate n	% [1]	SE	95% CI LB	UB
How much is fatigue a problem to you on the job? (Q32)					
Major problem	274	13.0	0.7	11.6	14.5
Noticeable problem	616	27.8	1.0	25.9	29.7
Minor problem	890	39.6	1.0	37.6	41.7
Not a problem at all	469	19.5	0.8	17.9	21.2
How often do you become fatigued while driving? (Q33)					
On every trip	97	4.3	0.4	3.4	5.1
On most trips	309	14.5	0.8	13.0	15.9
On about half of the trips	307	14.2	0.8	12.7	15.6
Occasionally	836	37.5	1.0	35.5	39.6
Rarely	632	26.3	0.9	24.5	28.1
Never	68	3.2	0.4	2.5	4.0
How well do you think you can manage fatigue? (Q36)					
Not very well	104	5.2	0.5	4.2	6.2
Fairly well	851	38.1	1.0	36.0	40.1
Quite well	478	20.7	0.9	19.0	22.4
Very well	621	27.0	0.9	25.2	28.9
Don't know	76	3.5	0.4	2.7	4.2
No opinion	120	5.5	0.5	4.5	6.5
While driving at work, when you felt drowsy, did you think you were in danger of falling asleep? (Q37)					
Yes	1368	62.6	1.0	60.6	64.6
No	852	37.4	1.0	35.4	39.4

[1] Population %, standard error (SE), and lower (LB) and upper bounds (UB) of 95% confidence intervals (CI) determined based on population weights and accounting for stratified sampling plan.

Sleepiness while driving. Drivers were asked a series of questions about sleepiness while driving. The first was as follows: "While driving at work, when you felt drowsy or were fighting to keep your eyes open, did you think that you were in danger of falling asleep?" Of the 2,220 drivers who answered this question, 62.6% responded affirmatively (**Table 15**). This suggests that Teamster drivers generally understand the risks posed by driving drowsy.

Drivers were asked to indicate the frequency with which they experienced certain drowsiness-related manifestations or consequences during the past year while driving on the job (**Tables 16a** and **16b**). "Yawning" was experienced most frequently, with 74.2%

of respondents indicating it occurred sometimes or often while driving. This was followed by "Feeling drowsy" (65.0%), "Eyelids heavy" (64.6%), "Feeling sleepy" (59.4%), "Struggling to be alert" (51.8%), "Finding it difficult to stay awake" (44.6%), and "Feeling fatigued" (23.4%). Much lower frequencies were found for "Nodding off/falling asleep" (13.1%), "Having a near miss" (9.5%), "Running off the Road" and

Table 16a: Frequency of Sleepiness-Related Events While Driving in Past Year

	Population Estimate			95% CI	
Factor (Question number)	**n**	**%[1]**	**SE**	**LB**	**UB**
Eyelids heavy (Q43A)					
Often	263	12.5	0.7	11.1	13.9
Sometimes	1108	52.1	1.1	50.0	54.2
Rarely	712	30.1	1.0	28.2	32.0
Never	114	5.4	0.5	4.4	6.4
Struggling to be alert (Q43B)					
Often	165	8.4	0.6	7.1	9.6
Sometimes	910	43.4	1.1	41.3	45.5
Rarely	857	38.2	1.1	36.1	40.3
Never	213	10.0	0.7	8.7	11.3
Yawning (Q43C)					
Often	340	17.5	0.8	15.8	19.1
Sometimes	1237	56.7	1.1	54.5	58.8
Rarely	531	23.6	0.9	21.8	25.4
Never	47	2.3	0.3	1.6	2.9
Feeling drowsy (Q43D)					
Often	223	11.1	0.7	9.7	12.4
Sometimes	1155	53.9	1.1	51.8	56.0
Rarely	679	30.6	1.0	28.7	32.6
Never	94	4.4	0.5	3.5	5.3
Difficulty staying awake (Q43E)					
Often	135	6.7	0.6	5.6	7.7
Sometimes	787	37.9	1.1	35.8	40.0
Rarely	995	44.4	1.1	42.3	46.5
Never	248	11.0	0.7	9.7	12.4

[1]Population %, standard error (SE), and lower (LB) and upper bounds (UB) of 95% confidence intervals (CI) determined based on population weights and accounting for stratified sampling plan.

"Colliding with something" (3.5%). This data suggests that drivers commonly experience sleepiness and its biobehavioral manifestations, but actual driving mishaps or near-miss events from sleepiness are much less common. This is consistent with other research on drowsy driving in commercial motor vehicles.[19]

[19]Mitler MM, et al. The sleep of long-haul truck drivers. *New England Journal of Medicine* 337(11): 755-761, 1997.

Table 16b: Frequency of Fatigue-Related Events While Driving in Past Year

Factor (Question number)	Population Estimate n	% [1]	SE	95% CI LB	UB
Feeling sleepy (Q43F)					
Often	182	9.1	0.6	7.8	10.4
Sometimes	1056	50.3	1.1	48.1	52.4
Rarely	774	34.1	1.0	32.1	36.1
Never	139	6.6	0.5	5.5	7.6
Nodding off/falling asleep (Q43H)					
Often	73	3.6	0.4	2.8	4.4
Sometimes	197	9.5	0.6	8.2	10.7
Rarely	745	34.5	1.0	32.5	36.5
Never	1150	52.4	1.1	50.3	54.5
Feeling fatigued (Q43G)					
Often	243	11.3	0.7	10.7	13.6
Sometimes	1077	12.1	0.7	10.7	13.6
Rarely	721	50.2	1.1	48.1	52.4
Never	103	32.5	1.0	30.5	34.5
Having a near miss (Q43I)					
Often	51	2.3	0.3	1.7	2.9
Sometimes	153	7.2	0.6	6.1	8.3
Rarely	839	38.2	1.1	36.1	40.2
Never	1110	52.4	1.1	50.2	54.5
Running off the road (Q43J)					
Often	49	2.2	0.3	1.6	2.8
Sometimes	88	4.3	0.5	3.4	5.2
Rarely	540	25.0	0.9	23.1	26.8
Never	1483	68.5	1.0	66.5	70.5
Colliding with something (Q43K)					
Often	44	1.9	0.3	1.4	2.5
Sometimes	34	1.6	0.3	1.1	2.1
Rarely	106	5.4	0.5	4.4	6.5
Never	1964	91.0	0.6	89.8	92.3

[1] Population %, standard error (SE), and lower (LB) and upper bounds (UB) of 95% confidence intervals (CI) determined based on population weights and accounting for stratified sampling plan.

Factors contributing to fatigue while driving. Tables 17a, 17b, and **17c** show drivers' responses to 28 different factors which contribute most to their fatigue while driving. Based on the high proportion of drivers (89.0%) who selected it, "Amount of sleep before the trip" was the number 1 factor they felt was either most relevant (53.8%) or somewhat relevant (35.2%) to fatigue while driving (**Table 17a**). Second was "Weather conditions" (85.5%): most relevant (42.9%) and somewhat relevant (42.6%) (**Table 17b**). Third was "Driving hours" (84.4%): most relevant (44.0%) and somewhat relevant (40.4%) (**Table 17a**). Fourth was "Truck speed too slow" (83.9%): most relevant (48.0%) and somewhat relevant (35.9%) (**Table 17c**). Fifth was "Driving at dawn" (82.2%): most relevant

(45.4%) and somewhat relevant (36.8%) (**Table 17a**). Sixth was "Truck ventilation" (80.4%): most relevant (35.2%) and somewhat relevant (45.2%) (**Table 17b**). Seventh was "Rough riding truck" (78.1%): most relevant (45.1%) and somewhat relevant (33.0%) (**Table 17a**). Eighth was "Amount of nighttime sleep" (78.7%): most relevant (43.1%) and somewhat relevant (35.6%) (**Table 17a**). Ninth was "Truck vibration" (76.2%): most relevant (33.9%) and somewhat relevant (42.3%) (**Table 17c**). Tenth was "Road conditions" (74.2%): most relevant (28.2%) and somewhat relevant (46.0%) (**Table 17b**).

Ranked 11th through 20th were: "Physical fatigue" (75.3%); "Driving at night" (74.8%); "Amount of sleep during trips" (69.7%); "Highway traffic" (69.4%); "Noise" (69.1%); "Resting away from home" (66.1%); "Temperature (too hot/too cold)" (64.4%); "Steering in cross winds" (62.1%); "Diet/eating patterns" (59.6%); "Anxiety/worry" (50.8%). Ranked lowest for relevance to fatigue were: "Family" (47.8%); "Non-driving hours" (47.0%); "Driving at dusk" (45.8%); "Scenery along route" (38.3%); "Having to load/unload" (29.6%); "Driving in early afternoon" (29.6%); "Use of alcohol" (6.5%); and "Effects of stay awake drugs" (5.5%).

Among the 28 conditions drivers had to rate on the survey for relevance to their fatigue while driving were conditions involving sleep and circadian factors (e.g., sleep during trips, night driving), conditions involving work load (e.g., driving time, loading/unloading), conditions involving environmental factors (e.g., traffic, weather, wind, roadway), conditions involving the truck (noise, temperature, ventilation, speed), and family and personal factors.

It is noteworthy that Teamster drivers selected the amount of sleep before a trip as the top factor, followed by weather conditions, driving hours, truck speed too slow, and driving at dawn. The first (sleep) and fifth (circadian) factors are consistent with scientific studies that demonstrate that the sleep period immediately prior to a work period and work performance at dawn following a sleepless night, are the most potent factors in the sleep and circadian modulation of alertness.[20] They are even more important than the amount of nighttime sleep attained (ranked 9) and the presence of nighttime driving (ranked 12). Based on their experience, Teamster drivers seem to be fully aware of these fatigue risk factors.

It is perhaps not surprising that weather conditions (ranked 2) and truck speed too slow (ranked 4) were rated as contributing to fatigue, since both can markedly affect the travel time and, therefore, the temporal workload of drivers. Apparently many drivers also felt that the driving hours they operate under contribute to their fatigue.

Table 17a: Factors Contributing to Fatigue While Driving

[20]Van Dongen, H.P.A., Dinges, D.F., Circadian Rhythm in Sleepiness, Alertness and Performance. In: Kryger, M.H., Roth, T., Dement, W.C. (Eds.) *Principles and Practice of Sleep Medicine* (4th edition), W.B. Saunders, Philadelphia, PA, pp. 435-443, 2005.

Factor (Question number)	Population Estimate n	%	SE	95% CI LB	UB
Driving hours (Q41A)					
Most relevant to me	979	44.0	1.1	41.9	46.1
Somewhat relevant to me	902	40.4	1.1	38.3	42.5
Not relevant to me	336	15.6	0.8	14.0	17.1
Non-driving hours (Q41B)					
Most relevant to me	276	11.9	0.7	10.5	13.2
Somewhat relevant to me	763	35.1	1.0	33.0	37.1
Not relevant to me	1165	53.1	1.1	51.0	55.2
Rough riding truck (Q41C)					
Most relevant to me	1025	45.1	1.1	43.0	47.1
Somewhat relevant to me	736	33.0	1.0	31.0	35.0
Not relevant to me	454	21.9	0.9	20.2	23.7
Having to load/unload (Q41D)					
Most relevant to me	375	16.1	0.8	14.6	17.7
Somewhat relevant to me	273	13.5	0.8	12.0	15.0
Not relevant to me	1548	70.3	1.0	68.4	72.3
Resting away from home (Q41E)					
Most relevant to me	460	21.5	0.9	19.8	23.3
Somewhat relevant to me	985	44.6	1.1	42.5	46.7
Not relevant to me	776	33.9	1.0	31.9	35.8
Amount of sleep during trips (Q41F)					
Most relevant to me	634	30.0	1.0	28.0	32.0
Somewhat relevant to me	875	39.7	1.1	37.6	41.8
Not relevant to me	702	30.3	1.0	28.4	32.2
Amount of sleep before trip (Q41G)					
Most relevant to me	1187	53.8	1.1	51.7	55.9
Somewhat relevant to me	776	35.2	1.0	33.2	37.2
Not relevant to me	253	11.0	0.7	9.7	12.3
Amount of nighttime sleep (Q41H)					
Most relevant to me	925	43.1	1.1	41.0	45.2
Somewhat relevant to me	782	35.6	1.0	33.5	37.6
Not relevant to me	509	21.4	0.9	19.7	23.0
Driving at night (Q41I)					
Most relevant to me	701	32.4	1.0	30.4	34.4
Somewhat relevant to me	937	42.4	1.1	40.3	44.5
Not relevant to me	578	25.2	0.9	23.4	27.0
Driving at dawn (Q41J)					
Most relevant to me	984	45.4	1.1	43.3	47.5
Somewhat relevant to me	827	36.8	1.0	34.8	38.9
Not relevant to me	409	17.8	0.8	16.2	19.4

Table 17b: Factors Contributing to Fatigue While Driving

	Population Estimate			95% CI	
Factor (Question number)	**n**	**%**	**SE**	**LB**	**UB**
Driving at dusk (Q41K)					
Most relevant to me	233	10.8	0.7	9.4	12.1
Somewhat relevant to me	775	35.0	1.0	33.0	37.0
Not relevant to me	1207	54.2	1.1	52.1	56.4
Physical fatigue (Q41L)					
Most relevant to me	587	26.3	0.9	24.4	28.1
Somewhat relevant to me	1089	49.0	1.1	46.9	51.1
Not relevant to me	545	24.7	0.9	22.9	26.5
Anxiety/Worry (Q41M)					
Most relevant to me	266	11.3	0.7	10.0	12.6
Somewhat relevant to me	871	39.5	1.1	37.4	41.5
Not relevant to me	1075	49.3	1.1	47.2	51.4
Temperature (too hot/cold) (Q41N)					
Most relevant to me	443	19.3	0.8	17.7	21.0
Somewhat relevant to me	1023	45.1	1.1	43.0	47.2
Not relevant to me	754	35.6	1.0	33.6	37.6
Driving in early afternoon (Q41O)					
Most relevant to me	129	5.6	0.5	4.6	6.5
Somewhat relevant to me	525	24.0	0.9	22.2	25.8
Not relevant to me	1558	70.5	1.0	68.5	72.4
Road conditions (Q41P)					
Most relevant to me	652	28.2	1.0	26.3	30.0
Somewhat relevant to me	1024	46.0	1.1	43.9	48.1
Not relevant to me	541	25.9	1.0	24.0	27.8
Scenery along route (Q41Q)					
Most relevant to me	155	6.8	0.5	5.7	7.8
Somewhat relevant to me	702	31.5	1.0	29.5	33.5
Not relevant to me	1357	61.7	1.0	59.7	63.8
Highway traffic (Q41R)					
Most relevant to me	593	25.6	0.9	23.8	27.4
Somewhat relevant to me	960	43.8	1.1	41.7	45.9
Not relevant to me	656	30.6	1.0	28.6	32.6
Weather conditions (Q41S)					
Most relevant to me	971	42.9	1.1	40.8	45.0
Somewhat relevant to me	947	42.6	1.1	40.5	44.7
Not relevant to me	303	14.5	0.8	13.0	16.0
Truck ventilation (Q41T)					
Most relevant to me	791	35.2	1.0	33.2	37.2
Somewhat relevant to me	1008	45.2	1.1	43.1	47.3
Not relevant to me	416	19.6	0.9	17.9	21.3

Surprisingly, other top contributors to fatigue were characteristics of the truck that included truck ventilation (ranked 6), rough riding truck (ranked 7), and truck vibration (rank 8). These factors are rarely considered relative to fatigue, despite evidence that they can affect performance and fatigue. Their high presence on the list of factors that contribute to fatigue suggests that Teamster drivers feel this is an area that should be improved to lessen fatigue.

It is noteworthy that a number of factors that are assumed to be critical to fatigue in commercial drivers were not ranked as highly as other factors. These included having to load/unload (ranked 25) and driving in early afternoon (ranked 26). This, however, may be related to the fact that teamster drivers have more control over mitigating these factors.

Table 17c: Factors Contributing to Fatigue While Driving

	Population Estimate			95% CI	
Factor (Question number)	**n**	**%**	**SE**	**LB**	**UB**
Truck vibration (Q41U)					
Most relevant to me	779	33.9	1.0	31.9	35.8
Somewhat relevant to me	942	42.3	1.1	40.2	44.4
Not relevant to me	495	23.8	0.9	22.0	25.6
Family (Q41V)					
Most relevant to me	370	16.4	0.8	14.8	17.9
Somewhat relevant to me	723	31.4	1.0	29.5	33.4
Not relevant to me	1115	52.2	1.1	50.1	54.3
Diet/eating patterns (Q41W)					
Most relevant to me	358	16.2	0.8	14.7	17.8
Somewhat relevant to me	978	43.4	1.1	41.3	45.5
Not relevant to me	883	40.4	1.1	38.3	42.4
Effects of stay-awake drugs (Q41X)					
Most relevant to me	53	2.6	0.4	1.9	3.3
Somewhat relevant to me	60	2.9	0.4	2.2	3.6
Not relevant to me	2092	94.5	0.5	93.5	95.5
Use of alcohol (Q41Y)					
Most relevant to me	64	3.1	0.4	2.4	3.9
Somewhat relevant to me	80	3.4	0.4	2.7	4.2
Not relevant to me	2054	93.5	0.5	92.4	94.5
Truck speed too slow (Q41Z1)					
Most relevant to me	1094	48.0	1.1	45.9	50.1
Somewhat relevant to me	790	35.9	1.0	33.9	38.0
Not relevant to me	341	16.1	0.8	14.5	17.7
Noise (Q41Z2)					
Most relevant to me	680	28.7	0.9	26.8	30.5
Somewhat relevant to me	901	40.4	1.1	38.3	42.4
Not relevant to me	631	30.9	1.0	29.0	32.9
Steering in cross winds (Q41Z3)					
Most relevant to me	400	17.2	0.8	15.6	18.7
Somewhat relevant to me	996	44.9	1.1	42.8	47.0
Not relevant to me	825	37.9	1.0	35.9	40.0

4.4 Management of Fatigue by the Estimated Population

Tables 18a, 18b, 19a, 19b, 19c, 20a, and **20b** contain the results for survey questions pertaining to what drivers do off the job (**Tables 18a** and **18b**), and while driving (**Tables 19a, 19b,** and **19c**) to manage fatigue and sleepiness, as well as things they would like to do, but currently cannot, to lessen fatigue.

Strategies to lessen fatigue or sleepiness off the job. Tables 18a and **18b** summarize drivers' responses to 19 different strategies for lessening fatigue or sleepiness while off the job. Based on the majority of driver responses, only one of these categories was actively used by most drivers to manage fatigue and sleepiness when not working. That factor was "Get a good night's sleep before departure," which 46.4% of drivers indicated they used to manage fatigue (**Table 18b**). Another 36.4% indicated they did it, but not to manage fatigue, while 17.1% indicated they did not do it regularly at all. This behavior is consistent with drivers' recognition that the amount of sleep before a trip is the key factor in managing fatigue when working (**Table 17a**). Given this awareness, it was surprising that so few drivers indicated they would "Sleep regular hours" to manage fatigue (28.6%); or "Sleep longer hours than during the week" to manage fatigue (27.9%). According to their sleep-duration reports on workdays versus non-workdays, drivers actually did sleep longer on non-workdays than on workdays (see **Table 8**). Why so many of them indicated that they did not regularly "sleep longer hours during the week" (37.1%), "sleep regular hours" (39.7%), or "take daytime naps" (55.2%) is unknown, but their answers to these questions may reflect the variable nature of their work-rest schedules, which prevents them from using sleep to effectively manage fatigue. Consistent with this speculation is data in **Table 7** showing that 46.0% of drivers had start times and schedules that varied "quite a lot."

A majority of drivers reported they took part in the following activities, but not to manage fatigue (**Tables 18a** and **18b**): strive to maintain good family life (79.3%), relax by watching TV or reading (78.2%), eat healthily (71.8%), complete family duties before resting (70.5%), visit friends, relatives, neighbors (67.2%), relax by going out socially (51.9%), physical exercise (50.9%), and diet to keep weight down (50.9%). Most drivers indicated they did not regularly partake in the following activities: relax by drinking alcohol (78.7%), relax by smoking (76.3%), play recreational sports (72.8%), relax by attending sports events (69.4%), relax by hunting or fishing (59.6%), engage in crafts or hobbies (53.0%), and relax by gardening or farming (52.8%).

Strategies to lessen fatigue while driving. Tables 19a, 19b, and **19c** summarize drivers' responses to how often they used 24 different strategies when attempting to deal with fatigue during driving hours. Based on drivers' responses, these 24 factors can be subdivided into 12 factors which the majority of drivers use often or sometimes to manage fatigue at work, and 12 factors which the majority of drivers rarely or never use to manage fatigue at work. The 12 factors that drivers used often or sometimes to manage fatigue while driving were in order of percentages: stretch/change position (91.9%); adjust ventilation (88.4%); have a caffeine drink (86.6%); listen to music/radio (84.8%); kick tires, walk around (84.2%); talk on cell phone/CB radio (74.4%); stop to eat snack

(63.0%); eat while driving (56.3%); stop to nap (greater than one hour) (55.7%); stop to eat meal (53.4%); stop to rest (no sleep) (52.6%); and have a non-caffeine drink (46.4%).

Table 18a: Off-the-Job Strategies to Lessen Fatigue or Sleepiness On the Job

	Population Estimate			95% CI	
Factor (Question number)	**n**	**%**	**SE**	**LB**	**UB**
Physical exercise (Q42A)					
No, I don't regularly do this at all	866	41.1	1.1	39.0	43.2
Yes, but not to manage fatigue	1138	50.9	1.1	48.8	53.1
Yes, to manage fatigue	177	8.0	0.6	6.8	9.1
Diet to keep weight down (Q42B)					
No, I don't regularly do this at all	907	41.9	1.1	39.8	44.0
Yes, but not to manage fatigue	1115	50.9	1.1	48.8	53.1
Yes, to manage fatigue	157	7.2	0.6	6.1	8.3
Play recreational sports (Q42C)					
No, I don't regularly do this at all	1582	72.8	1.0	70.9	74.7
Yes, but not to manage fatigue	525	23.9	0.9	22.1	25.7
Yes, to manage fatigue	72	3.3	0.4	2.5	4.1
Eat healthily (Q42D)					
No, I don't regularly do this at all	419	19.8	0.9	18.1	21.5
Yes, but not to manage fatigue	1560	71.8	1.0	69.9	73.7
Yes, to manage fatigue	179	8.4	0.6	7.2	9.6
Relax by gardening or farming (Q42E)					
No, I don't regularly do this at all	1124	52.8	1.1	50.7	55.0
Yes, but not to manage fatigue	919	41.4	1.1	39.3	43.5
Yes, to manage fatigue	126	5.8	0.5	4.8	6.8
Engage in crafts or hobbies (Q42F)					
No, I don't regularly do this at all	1137	53.0	1.1	50.9	55.1
Yes, but not to manage fatigue	929	42.6	1.1	40.5	44.7
Yes, to manage fatigue	100	4.4	0.4	3.5	5.3
Relax by hunting or fishing (Q42G)					
No, I don't regularly do this at all	1281	59.6	1.1	57.5	61.7
Yes, but not to manage fatigue	776	34.9	1.0	32.9	36.9
Yes, to manage fatigue	115	5.5	0.5	4.5	6.5
Relax by attending sports events (Q42H)					
No, I don't regularly do this at all	1480	69.4	1.0	67.5	71.3
Yes, but not to manage fatigue	642	28.0	1.0	26.1	29.9
Yes, to manage fatigue	57	2.6	0.3	1.9	3.3
Relax by watching TV or reading (Q42I)					
No, I don't regularly do this at all	254	12.0	0.7	10.6	13.3
Yes, but not to manage fatigue	1718	78.2	0.9	76.4	79.9
Yes, to manage fatigue	208	9.9	0.7	8.6	11.2

Table 18b: Off-the-Job Strategies to Lessen Fatigue or Sleepiness On the Job

	Population Estimate			95% CI	
Factor (Question number)	**n**	**%**	**SE**	**LB**	**UB**
Relax by going out socially (Q42J)					
No, I don't regularly do this at all	942	44.2	1.1	42.1	46.3
Yes, but not to manage fatigue	1143	51.9	1.1	49.7	54.0
Yes, to manage fatigue	88	3.9	0.4	3.1	4.7
Relax by drinking alcohol (Q42K)					
No, I don't regularly do this at all	1700	78.7	0.9	76.9	80.4
Yes, but not to manage fatigue	421	19.0	0.9	17.4	20.7
Yes, to manage fatigue	49	2.3	0.3	1.6	2.9
Relax by smoking (Q42L)					
No, I don't regularly do this at all	1677	76.3	0.9	74.5	78.1
Yes, but not to manage fatigue	414	20.0	0.9	18.3	21.8
Yes, to manage fatigue	73	3.7	0.4	2.9	4.5
Visit friends, relatives, neighbors (Q42M)					
No, I don't regularly do this at all	621	29.5	1.0	27.6	31.5
Yes, but not to manage fatigue	1487	67.2	1.0	65.2	69.2
Yes, to manage fatigue	68	3.3	0.4	2.5	4.1
Sleep regular hours (Q42N)					
No, I don't regularly do this at all	825	39.7	1.1	37.6	41.8
Yes, but not to manage fatigue	718	31.7	1.0	29.7	33.7
Yes, to manage fatigue	635	28.6	1.0	26.7	30.5
Sleep longer hours than during week (Q42O)					
No, I don't regularly do this at all	820	37.1	1.0	35.1	39.2
Yes, but not to manage fatigue	767	34.9	1.0	32.9	37.0
Yes, to manage fatigue	581	27.9	1.0	26.0	29.9
Take daytime naps (Q42P)					
No, I don't regularly do this at all	1211	55.2	1.1	53.1	57.4
Yes, but not to manage fatigue	513	23.1	0.9	21.4	24.9
Yes, to manage fatigue	444	21.6	0.9	19.8	23.4
Get good night's sleep before departure (Q42Q)					
No, I don't regularly do this at all	356	17.1	0.8	15.5	18.8
Yes, but not to manage fatigue	816	36.4	1.0	34.4	38.5
Yes, to manage fatigue	1004	46.4	1.1	44.3	48.6
Complete family duties before resting (Q42R)					
No, I don't regularly do this at all	313	14.2	0.8	12.7	15.7
Yes, but not to manage fatigue	1554	70.5	1.0	68.6	72.5
Yes, to manage fatigue	316	15.3	0.8	13.7	16.8
Strive to maintain good family life (Q42S)					
No, I don't regularly do this at all	101	4.5	0.4	3.6	5.4
Yes, but not to manage fatigue	1733	79.3	0.9	77.5	81.0
Yes, to manage fatigue	341	16.2	0.8	14.6	17.8

Table 19a: Strategies to Lessen Fatigue While Driving

Factor (Question number)	**Population Estimate** n	%	SE	**95% CI** LB	UB
Stop driving to eat a meal (Q44A)					
Often	267	12.6	0.7	11.2	14.1
Sometimes	898	40.8	1.1	38.7	42.9
Rarely	703	31.0	1.0	29.0	32.9
Never	365	15.6	0.8	14.1	17.1
Stop driving to eat snack (Q44B)					
Often	263	12.2	0.7	10.8	13.6
Sometimes	1145	50.8	1.1	48.6	52.9
Rarely	566	25.7	0.9	23.9	27.5
Never	249	11.3	0.7	10.0	12.7
Eat chocolate or candy (Q44C)					
Often	151	7.4	0.6	6.2	8.5
Sometimes	707	31.5	1.0	29.6	33.5
Rarely	789	35.3	1.0	33.3	37.3
Never	563	25.8	0.9	23.9	27.6
Eating while driving (Q44D)					
Often	379	17.3	0.8	15.7	18.9
Sometimes	870	39.0	1.0	36.9	41.0
Rarely	637	28.5	1.0	26.6	30.4
Never	333	15.2	0.8	13.7	16.7
Chewing gum (Q44E)					
Often	471	22.1	0.9	20.3	23.9
Sometimes	487	21.8	0.9	20.1	23.5
Rarely	416	18.6	0.8	17.0	20.2
Never	854	37.5	1.0	35.5	39.6
Chewing ice (Q44F)					
Often	72	3.3	0.4	2.5	4.0
Sometimes	285	13.3	0.7	11.9	14.8
Rarely	389	17.1	0.8	15.5	18.7
Never	1447	66.3	1.0	64.3	68.3
Stopping to rest (no sleep) (Q44G)					
Often	169	7.7	0.6	6.6	8.8
Sometimes	999	44.9	1.1	42.8	47.0
Rarely	701	32.0	1.0	30.0	34.0
Never	360	15.4	0.8	13.9	16.9
Stopping to sleep (≥4 hours) (Q44H)					
Often	8	0.3	0.1	0.1	0.6
Sometimes	19	0.9	0.2	0.5	1.4
Rarely	125	6.2	0.5	5.2	7.3
Never	2052	92.5	0.6	91.4	93.7

Table 19b: Strategies to Lessen Fatigue While Driving

Factor (Question number)	**Population Estimate** n	%	SE	**95% CI** LB	UB
Stopping to sleep (1-4 hours) (Q44I)					
Often	111	5.2	0.5	4.3	6.2
Sometimes	345	16.9	0.8	15.3	18.5
Rarely	443	21.4	0.9	19.6	23.2
Never	1288	56.4	1.1	54.3	58.6
Stopping to nap (<1 hour) (Q44J)					
Often	353	16.1	0.8	14.6	17.7
Sometimes	828	39.6	1.1	37.5	41.7
Rarely	601	26.8	1.0	25.0	28.7
Never	417	17.4	0.8	15.8	18.9
Having a caffeine drink (Q44K)					
Often	1071	50.1	1.1	48.0	52.2
Sometimes	840	36.5	1.0	34.5	38.5
Rarely	214	9.1	0.6	7.9	10.3
Never	96	4.3	0.4	3.5	5.2
Having a non-caffeine drink (Q44L)					
Often	287	13.3	0.7	11.9	14.8
Sometimes	742	33.1	1.0	31.1	35.1
Rarely	576	26.0	0.9	24.1	27.8
Never	612	27.6	1.0	25.7	29.5
Smoking / chewing nicotine gum (Q44M)					
Often	375	18.1	0.8	16.5	19.8
Sometimes	156	7.1	0.6	6.0	8.2
Rarely	56	2.5	0.3	1.9	3.2
Never	1625	72.2	1.0	70.3	74.1
Taking stay-awake drugs (Q44N)					
Often	6	0.4	0.1	0.1	0.7
Sometimes	38	2.0	0.3	1.4	2.6
Rarely	77	3.5	0.4	2.8	4.3
Never	2091	94.1	0.5	93.1	95.1
Ignoring driving hour regs. to finish trip (Q44O)					
Often	8	0.3	0.1	0.1	0.6
Sometimes	45	2.1	0.3	1.5	2.7
Rarely	158	7.4	0.6	6.3	8.6
Never	1992	90.1	0.7	88.8	91.4
Kicking the tires, walking around (Q44P)					
Often	793	35.9	1.0	33.8	37.9
Sometimes	1088	48.3	1.1	46.2	50.4
Rarely	277	12.5	0.7	11.1	14.0
Never	72	3.3	0.4	2.6	4.1

Table 19c: Strategies to Lessen Fatigue While Driving

Factor (Question number)	Population Estimate n	%	SE	95% CI LB	UB
Taking a shower (Q44Q)					
Often	216	10.5	0.7	9.2	11.8
Sometimes	151	6.9	0.6	5.9	8.0
Rarely	168	8.0	0.6	6.8	9.1
Never	1661	74.6	0.9	72.8	76.5
Play mind games (e.g., count license plates) (Q44R)					
Often	144	6.6	0.5	5.6	7.7
Sometimes	390	17.6	0.8	16.0	19.2
Rarely	423	19.7	0.9	18.0	21.4
Never	1252	56.0	1.1	53.9	58.1
Listen to music/radio (Q44S)					
Often	1500	65.7	1.0	63.7	67.8
Sometimes	409	19.1	0.9	17.4	20.7
Rarely	148	6.7	0.5	5.7	7.8
Never	180	8.5	0.6	7.3	9.6
Talking on cell phone/CB radio (Q44T)					
Often	778	35.7	1.0	33.6	37.7
Sometimes	867	38.7	1.0	36.6	40.7
Rarely	407	18.0	0.8	16.4	19.6
Never	178	7.7	0.6	6.6	8.8
Turn on dome light (Q44U)					
Often	116	5.1	0.5	4.1	6.0
Sometimes	482	22.0	0.9	20.3	23.8
Rarely	632	28.3	1.0	26.4	30.2
Never	991	44.6	1.1	42.6	46.7
Singing (Q44V)					
Often	217	10.7	0.7	9.4	12.1
Sometimes	651	29.6	1.0	27.7	31.6
Rarely	516	23.0	0.9	21.3	24.8
Never	827	36.6	1.0	34.6	38.6
Adjusting ventilation (Q44W)					
Often	929	42.1	1.1	40.0	44.1
Sometimes	1058	46.3	1.1	44.3	48.4
Rarely	200	9.2	0.6	7.9	10.4
Never	49	2.4	0.3	1.7	3.1
Stretching/changing position (Q44X)					
Often	1163	52.7	1.1	50.6	54.8
Sometimes	887	39.2	1.0	37.1	41.2
Rarely	149	6.5	0.5	5.5	7.6
Never	36	1.6	0.3	1.1	2.1

The 12 factors that drivers indicated they never or rarely used to manage fatigue while driving were in order of percentages (from **Tables 19a, 19b**, and **19c**): stop to sleep (≥ 4 hours) (98.7%); take stay-awake drugs (97.6%); ignore driving hour regulations (97.5%); chew ice (83.4%); take a shower (82.6%); stop to sleep (1-4 hr) (77.8%); play mind games (75.7%); smoke or chew nicotine gum (74.7%); turn on dome light (72.9%); eat chocolate or candy (61.1%); sing (59.6%); and chew gum (56.1%).

It is noteworthy that stopping to sleep for any duration over an hour was not among the list of strategies drivers used either often or sometimes to manage fatigue while driving — in fact, stopping to sleep ≥ one hour was among the behaviors the majority of Teamster drivers never used (**Tables 19a** and **19b**). The 5.2% of drivers who indicated they often stopped to sleep between 1-4 hours likely included many of the 6.0% who indicated they used a sleeper berth on the road (**Table 14**). On the other hand, most drivers (86.6%) indicated they used caffeine to fight fatigue, and many (55.7%) also indicated they used naps of less than one hour to manage fatigue. However, nearly as many indicated they would stop to rest without sleep (52.6%) or to eat a meal (53.4%) to manage fatigue. Other behaviors that the vast majority of drivers reported using to deal with fatigue involved activities while driving, such as stretching or changing positions, adjusting ventilation, listening to music or the radio, talking on a cell phone or CB radio, and eating while driving. These behaviors often have much shorter duration benefits for reducing fatigue than a nap and/or caffeine, but because they can be performed in the cab, they are more time efficient.

Things drivers would like to do to reduce fatigue, but cannot. Tables 20a and **20b** summarize drivers' responses to 13 options for reducing fatigue. A majority of drivers who responded to each question identified five of these options as things they would like to do but cannot. These five factors are listed below in the order in which drivers endorsed them. The percentage of drivers and the total number of respondents are provided for each factor.

1. Have control over my schedule (76.0% of 2,056 respondents)
2. Work fewer hours per week (70.3% of 1,733 respondents)
3. Have fatigue monitoring technology (64.9% of 858 respondents)
4. Sleep regular hours (62.5% of 2,150 respondents)
5. Receive training on fatigue management (43.5% of 993 respondents)

Consistent with other responses in the survey, a clear majority of drivers felt that control over their schedules, working fewer hours, and sleeping regular hours would help lessen fatigue. This result was unexpected; however, it was consistent with findings from the recent Fatigue Management Technologies Study[21] which showed that a majority of drivers also felt that having fatigue monitoring technologies and receiving training in fatigue management would be helpful, although few drivers responded to these questions.

[21]Dinges, D.F.; Maislin, G.; Brewster, R.M.; Krueger, G.P.; Carroll, R.J.: Pilot Test of Fatigue Management Technologies. *Journal of the Transportation Research Board*, No. 1922; Transportation Research Board of the National Academies, Washington, DC, pp. 175-182, 2005.

Drivers feel that even more could be done to help them cope effectively with fatigue from driving at night and schedules they cannot control. While the opportunity for the vast majority of drivers to control their schedules, work fewer hours and sleep regularly (i.e., at the same time of day) may not be achievable, fatigue management training and, ultimately, fatigue management technologies are being developed and studied at DOT. Fatigue management training is available now and fatigue management technologies are quickly becoming available.

Table 20a: Things Drivers Would Like to Do (But Cannot) to Lessen Fatigue

	Population estimate			95% CI	
Factor (Question number)	**n**	**%**	**SE**	**LB**	**UB**
Have control over my schedule (Q46A)					
Would like but cannot do	1497	76.0	0.9	74.2	77.7
Can do, useful to reduce fatigue	466	19.9	0.8	18.3	21.6
Can do, but not useful	93	4.1	0.4	3.3	5.0
Work fewer hours per week (Q46G)					
Would like but cannot do	1191	70.3	1.1	68.1	72.4
Can do, useful to reduce fatigue	330	17.7	0.9	16.0	19.5
Can do, but not useful	212	12.0	0.8	10.5	13.5
Receive training on fatigue management (Q46J)					
Would like but cannot do	441	43.5	1.6	40.4	46.6
Can do, useful to reduce fatigue	292	30.4	1.5	27.5	33.4
Can do, but not useful	260	26.0	1.4	23.3	28.8
Have fatigue monitoring technology (Q46K)					
Would like but cannot do	558	64.9	1.6	61.6	68.1
Can do, useful to reduce fatigue	105	12.0	1.1	9.8	14.2
Can do, but not useful	195	23.1	1.4	20.3	25.9
Have CB radio available (Q46L)					
Would like but cannot do	38	2.3	0.4	1.6	3.0
Can do, useful to reduce fatigue	1352	69.5	1.1	67.4	71.6
Can do, but not useful	543	28.2	1.0	26.2	30.3
Have more frequent truck stops/rest areas (Q46M)					
Would like but cannot do	454	25.4	1.0	23.4	27.5
Can do, useful to reduce fatigue	974	53.2	1.2	50.9	55.5
Can do, but not useful	382	21.4	1.0	19.4	23.3
Do less loading/unloading (Q46F)					
Would like but cannot do	55	27.4	3.1	21.2	33.6
Can do, useful to reduce fatigue	108	51.8	3.5	44.9	58.7
Can do, but not useful	42	20.8	2.9	15.0	26.6
Drive in a team (Q46B)					
Would like but cannot do	18	7.1	1.6	4.0	10.2
Can do, useful to reduce fatigue	57	19.7	2.4	15.0	24.4
Can do, but not useful	211	73.2	2.7	67.9	78.5
Drive alone (Q46C)					
Would like but cannot do	73	4.2	0.5	3.3	5.2
Can do, useful to reduce fatigue	914	47.9	1.2	45.6	50.2
Can do, but not useful	880	47.9	1.2	45.6	50.2

Table 20b: Things Drivers Would Like to Do (But Cannot) to Lessen Fatigue

Factor (Question number)	**Population estimate** n	%	SE	**95% CI** LB	UB
Get good night's sleep before departure (Q46D)					
Would like but cannot do	494	24.3	1.0	22.4	26.1
Can do, useful to reduce fatigue	1552	72.1	1.0	70.2	74.1
Can do, but not useful	84	3.6	0.4	2.8	4.4
Sleep regular hours (Q46E)					
Would like but cannot do	1256	62.5	1.0	60.5	64.6
Can do, useful to reduce fatigue	843	35.1	1.0	33.1	37.1
Can do, but not useful	51	2.3	0.3	1.7	3.0
Be allowed to take stay-awake meds (Q46I)					
Would like but cannot do	164	37.0	2.3	32.4	41.6
Can do, useful to reduce fatigue	50	14.0	1.8	10.5	17.5
Can do, but not useful	201	49.0	2.5	44.1	53.8

Among the 13 options for reducing fatigue (**Tables 20a** and **20b**), a majority of drivers also identified five factors that they presently find useful to manage fatigue. These are listed below in the order in which drivers endorsed them.

1. Get a good night's sleep before departure (72.1% of 2,130 respondents)
2. Have a CB radio available (69.5% of 1,933 respondents)
3. Have more frequent truck stops/rest areas (53.2% of 1,810 respondents)
4. Do less loading/unloading (51.8% of 205 respondents)
5. Drive alone (47.9% of 1,867 respondents)

A majority of drivers listed the two following factors as things they can do now, but are not useful for reducing fatigue. They were: "drive in a team" (73.2% of 286 drivers who answered this question) and "be allowed to take stay-awake meds" (49.0% of 415 drivers who answered this question).

4.5 Demographics and Health of Million Milers vs. Non-Million Milers

As described in the Study Design section (3.2), a major goal of this survey study was to compare the fatigue management behaviors of the proven safe drivers who met MFCA criteria for "Million Miler" status to the behaviors of drivers who did not (yet) have this status. Million milers had at least one million accident-free driving miles (MFCA database criteria). The results that follow in **Tables 21 – 35** have the same organizational flow as those presented above for the estimated population; however, from this point forward, the focus is on presentation of the data for both million milers and non-million milers and how these two groups compare on fatigue factors. As displayed in **Table 1e**, 1,128 million milers (41.15%) and 1,152 non-million milers (38.4%) returned completed surveys. Comparisons between responses of million mile drivers and non-million mile drivers were assessed using t-tests for continuous variables and chi-square tests for nominal variables.

Demographics: million milers vs. non-million milers. Comparisons between million milers and non-million milers in height, weight, and BMI revealed no differences (**Tables 21a and 22**). However, **Table 21a** shows that million mile drivers were older than non-million mile drivers by an average of 3 years ($p = 0.001$), and they had approximately 4.5 years more experience driving a truck ($p = 0.001$). **Table 21b** reveals that proportionately more million milers were married than non-million milers ($p = 0.038$).

An unexpected difference between million milers and non-million milers was found for drivers' reports of the hours they worked in "a typical 2-day period during a typical work week". For this comparison, night work was defined as 2 or more hours working between the hours of midnight and 4 am (i.e., during the initial portion of a typical nocturnal sleep period). While overall, there were somewhat more respondents who met the criteria for night workers than those who did not during a typical work week (**Table 2b**), there were 9.2% more night workers among non-million milers than among million milers (**Table 21b**). **Figure 1** shows the percentage of drivers in each group who reported working at each hour of the 24-hour day. There were proportionally more non-million milers indicating they worked between the hours of 10 pm and 6 am than million milers.

Figure 1: Percentage of drivers reporting each hour of the day they work during a typical 2-day period in a typical workweek.

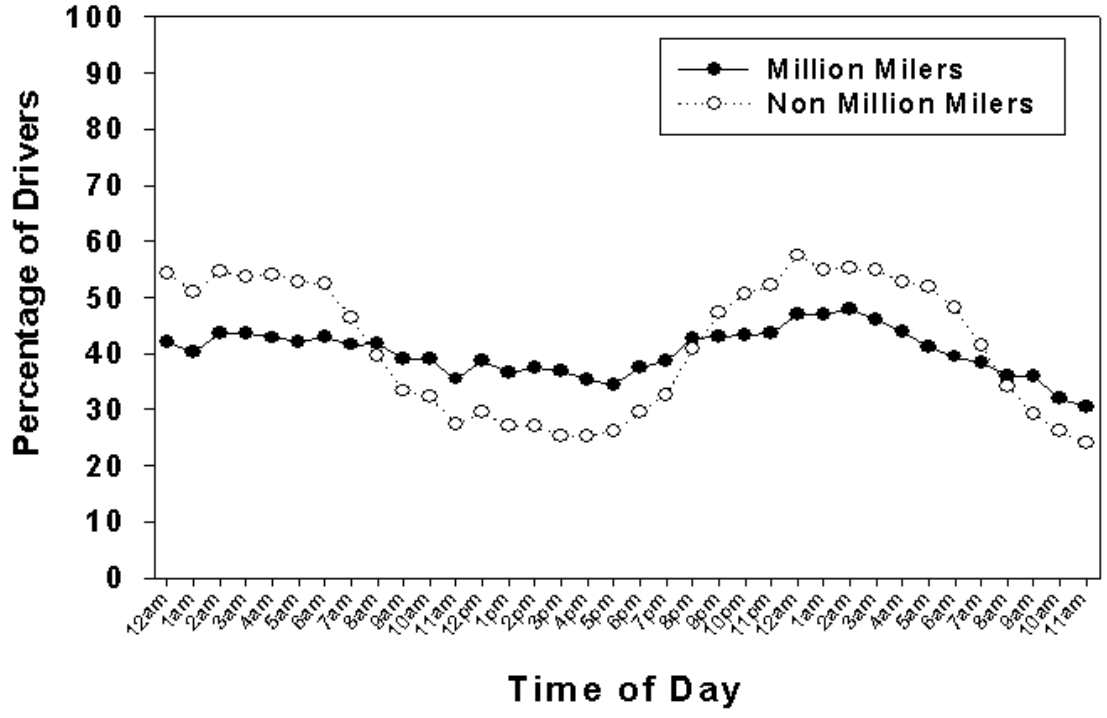


Table 21a: Demographic and Descriptive Characteristics for Million Milers vs. Non-Million Milers[1]

	Million Milers						Non-Million Milers					
Factor (Question number)	**n**	**Mean**	**SD**	**Med**	**Min**	**Max**	**n**	**Mean**	**SD**	**Med**	**Min**	**Ma**
Height (inches) (Q4)	1097	70.6	3.1	71.0	60	80	1088	70.6	3.1	71.0	60	80
Weight (pounds) (Q5)	1086	226.5	59.5	213.0	101	498	1084	226.8	59.4	212.0	101	488
BMI (weight in kg / height in m^2)	1072	31.9	8.3	29.8	13	76	1056	32.0	8.3	30.0	14	87
Age (years) (Q3)	1091	54.6	7.2	58.0	29.0	66.0	1097	51.6	8.7	53.0	29.0	66
Years driving truck (Q7)	1103	30.1	9.1	33.0	3.0	48.0	1100	25.5	11.1	28.0	3.0	48

[1]Interval variables are approximated by taking the midpoint of response categories (e.g., 1-2 = 1.5).

Table 21b: Demographic and Descriptive Characteristics for Million Milers vs. Non-Million Milers[1]

		Million Milers		Non-Million Milers		
Factor (Question number)		**N**	**%**	**N**	**%**	**p value[2]**
Ethnicity (Q1C)	Hispanic	63	6.2	50	4.9	0.209
	Not Hispanic	953	93.8	971	95.1	
Race (Q1D)	American Indian	19	1.8	17	1.6	0.384
	Asian	17	1.6	14	1.3	
	White	942	89.0	976	91.4	
	Black	76	7.2	56	5.2	
	Native/Hawaiian	4	0.4	5	0.5	
Sex (Q2)	Male	1020	97.9	1021	97.7	0.882
	Female	22	2.1	24	2.3	
Marital status (Q6)	Married	838	84.6	815	81.0	**0.038**
	Single	153	15.4	191	19.0	
Night worker (≥2 hrs working 12 am to 4 am over 2 typical days) (Q15)						
	Yes	611	54.2	730	63.4	
	No	517	45.8	422	36.6	

[1]Interval variables are approximated by taking the midpoint of response categories (e.g., 1-2 = 1.5).
[2]Fisher's Exact test

Table 22: Prevalence of Obesity by BM) and NHLBI Categories in Million Milers vs. Non-Million Milers

	Million Milers		Non Million Milers		
	n	%	n	%	p value[1]
BMI ≥ 30 (obese)					
Yes	523	48.8	529	50.1	0.546
No	549	51.2	527	49.9	
NHLBI Categories					
Normal: BMI < 24.9	103	9.6	113	10.7	0.667
Overweight: BMI 25.0 -< 29.9	446	41.6	414	39.2	
Obesity I: BMI 30.0 -< 34.9	283	26.4	281	26.6	
Obesity II: BMI 35.0 -< 39.9	108	10.1	121	11.5	
Obesity III: BMI >= 40.0	132	12.3	127	12.0	

[1]Chi-Square Test

The difference in typical work time between million milers and non-million milers was examined further by plotting the times of day respondents in each group reported they were likely to be fatigued while working (Q. 34: **Figure 2**); the times of day they would get up if they were entirely free to plan the day (Q. 39A: **Figure 3**); and the times of day they think they reach their "feeling best" peak (Q. 39D: **Figure 4**). All of these comparisons showed no differences between million milers and non-million milers. This suggests that differences in the likelihood of working at night (**Figure 1**) were associated with greater access to preferred work schedules by drivers with more seniority (i.e., million milers), and were not associated with different circadian phase preferences.

Figure 2: Percentage of drivers reporting that they are likely to feel fatigued while working at each hour of the day.

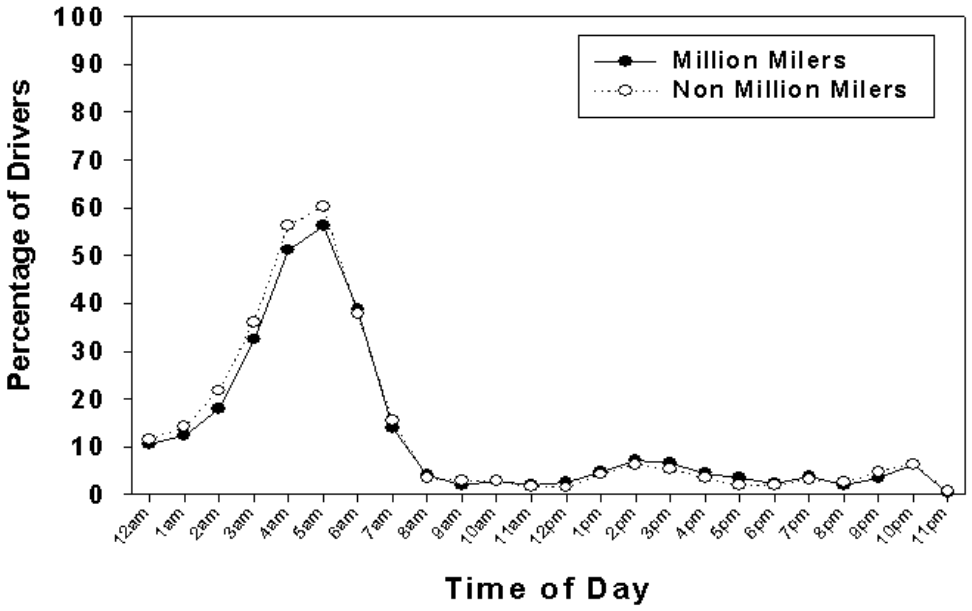


Figure 3: Percentage of drivers reporting the time of day they would get up in order to "feel best" if they were entirely free to plan their day.

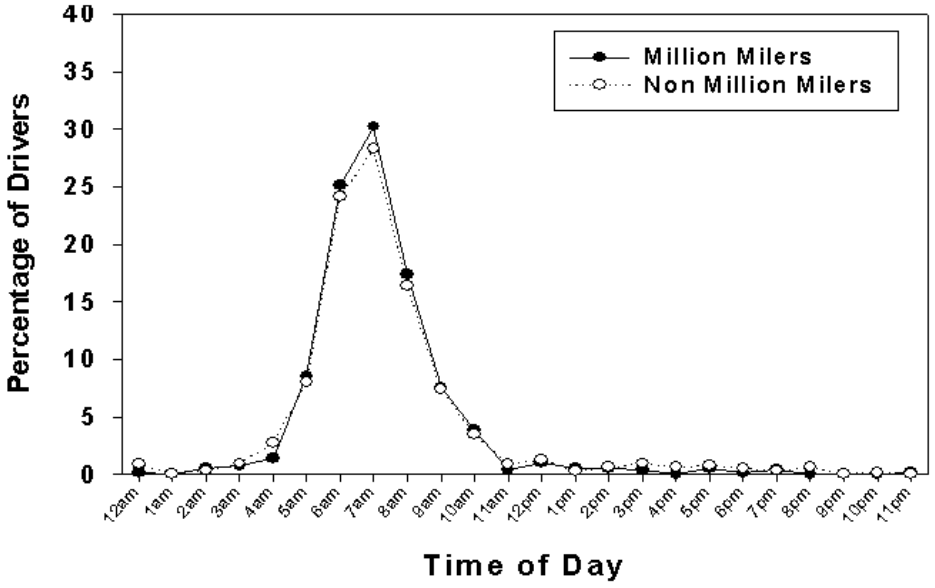
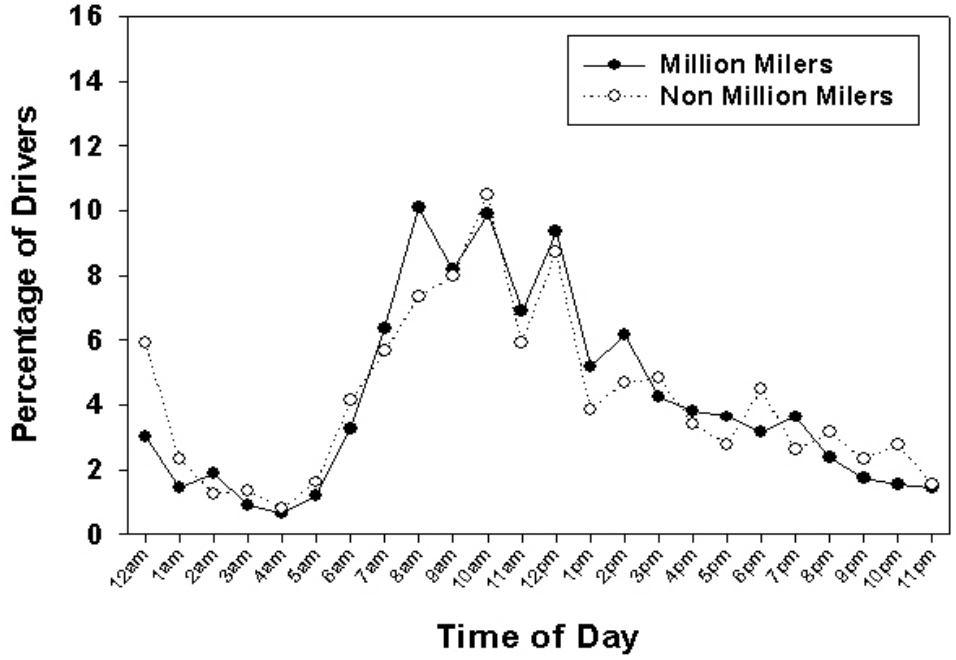


Figure 4: Percentage of drivers reporting the time of day they reach their "feeling best" peak.



Caffeine, nicotine, and alcohol use by million milers vs. non-million milers. Table 23 shows that million milers and non-million milers did not differ in reported use of alcohol and caffeine, but a higher proportion of non-million milers than million milers were smokers (p = 0.002).

Table 23: Caffeine, Nicotine, and Alcohol Use in Million Milers vs. Non-Million Milers

		Million Milers		Non-Million Milers		
Factor (Question number)		n	%	n	%	p value
Current smoker (Q10)	Yes	274	25.2	343	31.2	**0.002**
	No	813	74.8	757	68.8	
Chew tobacco (Q11)	Yes	97	9.1	91	8.5	0.647
	No	971	90.9	983	91.5	
Drink alcohol (off duty) (Q13)	Yes	365	33.3	380	34.0	0.753
	No	731	66.7	738	66.0	
Caffeinated drinks per day (Q12)	< 2	272	24.7	278	24.7	0.870
	2 - 4	597	54.3	597	53.0	
	5 - 7	181	16.5	198	17.6	
	≥ 8	49	4.5	54	4.8	

Sleep-related health characteristics in million milers vs. non-million milers. The responses of the two groups to sleep-related health questions are shown in **Tables 24a** and **24b**. Consistent with **Figures 2-4**, million milers and non-million milers did not differ in morningness-eveningness scores (circadian phase preference) or their degree of tiredness after morning awakening.

The proportion of drivers in each group who reported having been diagnosed with a sleep disorder was comparable (5.8% for million milers vs. 5.4% for non-million milers). Also, there were no differences between groups in the prevalence of sleep disorder types or the proportions of drivers who reported being currently treated (**Table 24a**).

Sleepiness in million milers vs. non-million milers. Although the two groups were comparable in age, BMI, circadian phase preference, and sleep disorder diagnoses and treatments, **Table 24b** illustrates that non-million milers had higher overall MAP scores (p = 0.032). This was exclusively the result of non-million milers reporting more frequent symptoms of excessive sleepiness (Index 3) than million mile drivers (p = 0.001). However, the higher MAP Index 3 sleepiness of non-million milers was not frequent or severe enough to result in their also having significantly higher Epworth Sleepiness Scores for daytime sleepiness.

Medication use in million milers vs. non-million milers. Table 25 shows that the two groups were not comparable in medication use. A higher proportion of million milers than non-million milers reported taking medications for high blood pressure (p = 0.005), and for lowering cholesterol (p = 0.001). This data suggests that proportionally more million milers are health conscious in comparison to non-million milers.

Table 24a: Sleep-Related Health Characteristics in Million Milers vs. Non-Million Milers

Factor (Question number)		**Million Milers**		**Non-Million Milers**		**p value**
		n	**%**	**n**	**%**	
Morning vs. evening type of person (Q39E)						
Definitely a 'morning' type		331	30.2	321	28.7	0.537
More 'morning' than 'evening'		336	30.6	332	29.6	
More 'evening' than 'morning'		272	24.8	308	27.5	
Definitely an 'evening' type		158	14.4	159	14.2	
Tiredness within 30 min. after waking (Q39B)						
Very tired		34	3.0	43	3.8	0.763
Fairly tired		228	20.4	225	19.8	
Fairly refreshed		630	56.3	631	55.5	
Very refreshed		227	20.3	237	20.9	
Diagnosed with sleep disorder (Q38A1)	No	1047	94.2	1069	94.6	0.648
	Yes	65	5.8	61	5.4	
If yes, disorder? (Q38A2)	Sleep apnea	57	89.1	54	90.0	0.842
	Insomnia	2	3.1	3	5.0	
	Narcolepsy	0	0.0	0	0.0	
	Restless legs syndrome	2	3.1	2	3.3	
	Other	3	4.7	1	1.7	
If yes, currently treated? (Q38b)	Yes	40	62.5	44	73.3	0.249
	No	24	37.5	16	26.7	

4.6 Work and Sleep Characteristics of Million Milers vs. Non-Million Milers

Tables 26-34 summarize the responses of million miler and non-million milers to questions regarding the nature of their work and their sleep on workdays and non-workdays.

Type of work-related driving in million milers vs. non-million milers. There were a number of work-related differences between million milers and non-million milers beyond the differences in day versus night work, which were highlighted in **Table 21b** and **Figure 1**. **Table 26** shows that million milers were more likely to report operating a double or triple trailer truck combination than were non-million milers ($p = 0.001$); million milers were also more likely to be team drivers than non-million milers ($p = 0.015$). In addition, million milers who drove in teams had more years of experience doing so than non-million milers who also drove in teams ($p = 0.001$). It is particularly noteworthy in **Table 26** that a significantly higher proportion of non-million milers (48.6%) than million milers (33.0%) indicated their work start times and schedules as varying "quite a lot" ($p = 0.001$).

ep-Related Health Characteristics in Million Milers vs. Non-Million Milers

tion number)	Million Milers						Non-Million Milers						t-test
	n	Mean	SD	Med	Min	Max	n	Mean	SD	Med	Min	Max	p valu
Apnea-MAP (Q45a-n):	946	0.55	0.21	0.54	0.01	1.00	948	0.53	0.22	0.51	0.05	1.00	**0.034**
lex 1: Apnea symptoms	1061	0.79	0.93	0.50	0.00	4.00	1094	0.74	0.91	0.33	0.00	4.00	0.192
lex 2: Difficulty sleeping symptoms	1103	1.33	0.90	1.25	0.00	4.00	1140	1.39	0.94	1.25	0.00	4.00	0.130
lex 3: Daytime sleepiness symptoms	1100	0.43	0.54	0.33	0.00	3.67	1139	0.52	0.58	0.33	0.00	3.50	**0.001**
lex 4: Narcolepsy-like symptoms	1089	0.20	0.45	0.00	0.00	4.00	1132	0.20	0.46	0.00	0.00	4.00	0.801
epiness Scale score (Q40)	1117	7.4	3.6	7.0	0.0	23.00	1140	7.3	3.7	7.0	0.0	24.00	0.785

Table 25: Current Medication Types Reported in Million Milers vs. Non-Million Milers

Factor (Question number)	Million Milers		Non-Million		p value[1]
	n	%	n	%	
Blood pressure medicine (Q14A)	410	37.9	355	32.1	**0.005**
Breathing pills for lungs (Q14B)	17	1.7	8	0.8	0.066
Breathing pills for heart (Q14C)	3	0.3	3	0.3	0.989
Breathing sprays or inhalers (Q14D)	52	5.1	47	4.5	0.556
Heart pills (Q14E)	81	7.8	64	6.1	0.122
Water pills (Q14F)	75	7.2	83	7.9	0.587
Sleeping pills (Q14G)	55	5.3	49	4.7	0.523
Pills to lower cholesterol (Q14H)	361	33.8	279	25.6	**0.001**
Antihistamine and/or decongestant (Q14I)	79	7.6	79	7.5	0.930
Thyroid medicine (Q14J)	40	3.9	47	4.5	0.497
Tranquilizers (Q14K)	4	0.4	5	0.5	0.746

[1]Fisher's Exact Test

Table 26: Type of Work-Related Driving in Million Milers vs. Non-Million Milers

Factor (Question number)	**Million Milers** n	%	**Non-Million Milers** n	%	p value
Vehicle type normally driven (Q8)					
Semi	89	8.4	181	17.1	**0.001**
Double	874	82.6	813	76.6	
Triple	95	9.0	67	6.3	
Driving operation normally (Q9A)					
Single	916	89.6	937	91.1	**0.015**
Team	51	5.0	27	2.6	
Varies	55	5.4	65	6.3	
Team driving duration (Q9B) (teams only)					
< 1 year	30	16.6	40	22.9	**0.001**
1 - 5 years	28	15.5	51	29.1	
6 - 10 years	60	33.1	33	18.9	
> 10 years	63	34.8	51	29.1	
Usually same partner (Q9C) (current teams)					
Yes	71	52.6	54	40.9	0.056
No	64	47.4	78	59.1	
Start time and schedule vary (Q27)					
Quite a lot	362	33.0	545	48.6	**0.001**
A little	483	44.0	427	38.1	
Not at all	253	23.0	149	13.3	

Sleep on workdays and non-workdays in million milers vs. non-million milers. Table 27 presents drivers' reports of sleep on workdays and non-workdays. Non-million milers had a mean reported sleep duration of 6.9 hours (SD = 1.4 hours) during a typical 24-hour work period, while million milers had a mean of 7.0 hours (SD = 1.5 hours). This difference, while modest, was statistically significant by both parametric ($p = 0.016$) and nonparametric tests ($p = 0.026$). There were no differences between the two groups in reported sleep on non-work days, which averaged 8.1 hours for both groups (**Table 27**). The two groups also did not differ in the reported number of awakenings on work and non-work nights, or in the hours from wake-up and drive start on a typical workday.

.

Table 27: Sleep Characteristics on Workdays and Non-Workdays in Million Milers vs. Non-Million Milers[1]

	Million Milers						Non-Million Milers						t-test	Wilcoxon
Factor (Question Number)	**n**	**Mean**	**SD**	**Med**	**Min**	**Max**	**n**	**Mean**	**SD**	**Med**	**Min**	**Max**	**p value**	**p value**
Sleep (hours) in typical 24-hour period when working (Q16)	1094	7.0	1.5	7.0	0.5	12.0	1121	6.9	1.4	7.0	0.5	12.0	**0.016**	**0.026**
Sleep (hours) in typical 24-hour period when not working (Q17)	1113	8.1	1.3	8.0	0.5	12.0	1138	8.1	1.4	8.0	1.0	12.0	0.757	0.548
Difference between non-work & workday sleep (Q17-Q16)	1093	1.1	1.4	1.0	-5.5	6.5	1120	1.2	1.4	1.0	-5.0	7.5	0.052	0.073
Number of awakenings in main sleep when working (Q20)	1094	1.7	1.2	2.0	0.0	11.0	1122	1.8	1.3	2.0	0.0	11.0	0.407	0.249
Number of awakenings in main sleep when not working (Q21)	1090	1.5	1.2	1.0	0.0	11.0	1112	1.4	1.2	1.0	0.0	11.0	0.113	0.057
Hours from wake up and drive start on typical workday (Q19)	1105	3.2	2.3	3.5	0.5	16.5	1132	3.3	2.4	3.5	0.5	16.5	0.279	0.303

[1]Interval variables are approximated by taking the midpoint of response categories (e.g., 1-2 = 1.5) in some cases.

Table 28: Time (Hours) Spent in Various Activities Before Starting Run in Million Milers vs. Non-Million Milers[1]

	Million Milers						Non-Million Milers						t-test	Wilcoxon
Factor (Question number)	**n**	**Mean**	**SD**	**Med**	**Min**	**Max**	**n**	**Mean**	**SD**	**Med**	**Min**	**Max**	**p value**	**p value**
Sleeping (Q18A)	1088	6.4	1.7	7.5	0.5	10.5	1100	6.1	1.9	5.5	0.5	10.5	**0.001**	**0.001**
Resting/Relaxing (Q18B)	1068	2.4	2.0	1.5	0.5	10.5	1086	2.3	1.8	1.5	0.5	10.5	0.096	0.106
Checking/Repairing heavy vehicle (Q18C)	943	0.6	0.6	0.5	0.5	10.5	968	0.6	0.8	0.5	0.5	10.5	0.316	0.836
Loading/Unloading heavy vehicle (Q18D)	851	0.6	0.9	0.5	0.5	10.5	885	0.7	1.0	0.5	0.5	10.5	0.614	0.998
Other yard work (Q18E)	918	0.9	0.9	0.5	0.5	9.5	950	0.9	0.9	0.5	0.5	7.5	0.192	0.160
Driving personal vehicle (Q18F)	1073	1.1	0.8	0.5	0.5	7.5	1087	1.1	0.8	0.5	0.5	7.5	0.891	0.652
Driving heavy vehicle (Q18G)	900	2.2	3.5	0.5	0.5	10.5	902	2.1	3.5	0.5	0.5	10.5	0.593	0.687

[1]Interval variables are approximated by taking the midpoint of response categories (e.g., 1-2 = 1.5) in some cases.

Table 28 displays the time drivers reported spending in various activities before starting a run in million milers vs. non-million milers. Million milers averaged 6.4 hours (SD = 1.7) of sleep prior to starting work, while non-million milers averaged 6.1 hours (SD = 1.9 hours) of sleep before work-related driving (p = 0.001). **Table 29a** confirmed this finding through a sleep interval analysis. Nearly 8% more non-million milers reported sleep durations prior to a work run of less than 6 hours compared to million milers (p = 0.004). Just as important, the two groups did not differ in time devoted to any pre-run activity other than sleep (**Tables 28, 29a** and **29b**). This difference is similar to the results in **Table 27,** which indicate that non-million milers sleep less then non-million milers. The fact that non-million milers reported less sleep before work runs (**Table 28**) and on workdays (**Table 27**) is consistent with their reports of more night driving (**Table 21b** and **Figure 1**) and the higher prevalence of complaints that their start times and work schedules were more variable than those of non-million milers (**Table 26**)

Table 29a: Time Spent in Activities Before Starting Run in Million Milers vs. Non-Million Milers

Factor (Question number)	**Million Milers** n	%	**Non-Million Milers** n	%	p value[1]
Sleeping (Q18A)					
< 1 hour	24	2.2	36	3.3	**0.004**
1 - 2 hours	20	1.8	37	3.4	
3 - 4 hours	47	4.3	68	6.2	
5 - 6 hours	408	37.5	448	40.7	
7 - 8 hours	531	48.8	456	41.5	
9 - 10 hours	48	4.4	47	4.3	
> 10 hours	10	0.9	8	0.7	
Resting/Relaxing (Q18B)					
<1 hour	205	19.2	228	21.0	0.398
1 - 2 hours	472	44.2	495	45.6	
3 - 4 hours	272	25.5	252	23.2	
5 - 6 hours	70	6.6	75	6.9	
7 - 8 hours	27	2.5	20	1.8	
9 - 10 hours	13	1.2	6	0.6	
> 10 hours	9	0.8	10	0.9	
Checking/Repairing heavy vehicle (Q18C)					
< 1 hour	894	94.8	920	95.0	0.243
1 - 2 hours	37	3.9	32	3.3	
3 - 4 hours	10	1.1	7	0.7	
5 - 6 hours	0	0.0	3	0.3	
7 - 8 hours	0	0.0	2	0.2	
9 - 10 hours	0	0.0	2	0.2	
> 10 hours	2	0.2	2	0.2	
Loading/Unloading heavy vehicle (Q18D)					
< 1 hour	821	96.5	854	96.5	0.343
1 - 2 hours	12	1.4	6	0.7	
3 - 4 hours	11	1.3	15	1.7	
5 - 6 hours	0	0.0	2	0.2	
7 - 8 hours	0	0.0	1	0.1	
9 - 10 hours	4	0.5	2	0.2	
> 10 hours	3	0.4	5	0.6	

[1]Chi-Square Test

Table 29b: Time Spent in Activities Before Starting Run in Million Milers vs. Non-Million Milers

Factor (Question number)	**Million Milers** n	%	**Non-Million Milers** n	%	p value[1]
Other yard work (Q18E)					
< 1 hour	664	72.3	712	74.9	0.110
1 - 2 hours	193	21.0	191	20.1	
3 - 4 hours	51	5.6	36	3.8	
5 - 6 hours	9	1.0	7	0.7	
7 - 8 hours	0	0.0	4	0.4	
9 - 10 hours	1	0.1	0	0.0	
> 10 hours					
Driving personal vehicle (Q18F)					
< 1 hour	553	51.5	576	53.0	0.527
1 - 2 hours	476	44.4	457	42.0	
3 - 4 hours	35	3.3	47	4.3	
5 - 6 hours	5	0.5	5	0.5	
7 - 8 hours	4	0.4	2	0.2	
9 - 10 hours	n/a	n/a	n/a	n/a	
> 10 hours	n/a	n/a	n/a	n/a	
Driving heavy vehicle (Q18G)					
< 1 hour	719	79.9	728	80.7	0.304
1 - 2 hours	5	0.6	9	1.0	
3 - 4 hours	11	1.2	7	0.8	
5 - 6 hours	1	0.1	6	0.7	
7 - 8 hours	22	2.4	16	1.8	
9 - 10 hours	85	9.4	76	8.4	
> 10 hours	57	6.3	60	6.7	

[1]Chi-Square Test

Breaks and sleep when on the job in million milers vs. non-million milers. Tables 30-33 summarize responses to questions regarding breaks and sleep when on the road. **Table 30** reveals that million milers stopped to take their first driving break after driving an average of 3.5 hours (SD = 1.2 hours), while non-million milers stopped later, after an average 3.8 hours (SD = 1.3 hours)—a difference that was statistically significant (p = 0.001). The duration of the first break was not different between the two groups. Despite waiting longer to take their first driving break, non-million milers indicated that they took more driving breaks than million milers (**Table 31**). In addition, proportionally more million milers than non-million milers indicated that in the past month they did not pull off the road to take a rest (p = 0.001). The majority of drivers in both groups took a rest break in the past month. Among those who did so, non-million milers were more likely to sleep during rest breaks than were million milers (p = 0.001) (**Table 31**)—this result was also seen in response to a question concerning whether drivers napped during work rest-breaks (p = 0.002) (**Table 32**). In contrast, **Table 31** shows that million milers were more likely to take a break to "exercise" than non-million milers (p = 0.006), and among those non-million milers who did break, the exercise was more likely to be a leisurely walk (p = 0.019).

Although approximately three times as many million milers and non-million milers felt that daytime sleep was less refreshing than nighttime sleep (**Table 32**), million milers were more likely to respond that they do not sleep during the daytime ($p = 0.001$). This is consistent with other evidence that million milers experience less exposure to nighttime driving than do non-million milers (**Table 21b** and **Figure 1**).

There were no differences between million milers and non-million milers in sleeper berth use, but only about 6% of drivers in both groups indicated that they ever used the sleeper berth (**Table 33**).

4.7 Fatigue and Sleepiness on the Job in Million Milers vs. Non-Million Milers

Tables 34, 35a, 35b, 36a, 36b, and **36c** contain the comparative results for survey questions about fatigue and sleepiness in the driver population during the past year.

Fatigue as a problem on the job in million milers vs. non-million milers. When asked how much fatigue was a problem on the job and while driving, million milers and non-million milers did not differ in their responses, nor did they differ in their estimates of how well they managed fatigue (**Table 34**).

Sleepiness while driving in million milers vs. non-million milers. A majority of respondents in each group agreed that when they felt drowsy while driving, they knew they were in danger of falling asleep. However, when asked about the frequency of sleepiness-related events while driving in the past year, a higher proportion of non-million milers indicated they "often" or "sometimes" experienced "heavy eyelids" ($p = 0.006$), "struggling to be alert" ($p = 0.024$), "yawning" ($p = 0.001$), and "feeling fatigued" ($p = 0.007$) (**Tables 35a** and **35b**).

Factors contributing to fatigue while driving: million milers vs. non-million milers. **Tables 36a, 36b** and **36c** show that proportionally more million milers than non-million milers reported that the following factors contributed to their fatigue while driving: "rough riding truck" ($p = 0.001$), "having to load/unload" ($p = 0.005$), "physical fatigue" ($p = 0.046$), "anxiety/worry" ($p = 0.012$), "temperature (too hot/too cold)" ($p = 0.006$), "road conditions" ($p = 0.001$), "highway traffic" ($p = 0.01$), "weather conditions" ($p = 0.027$), "truck ventilation" ($p = 0.014$), "truck vibration" ($p = 0.001$), "family" ($p = 0.004$), "truck speed too slow" ($p = 0.001$), "noise" ($p = 0.001$), and "steering in cross winds" ($p = 0.001$).

Although million mile drivers were more likely than non-million milers to attribute their fatigue while driving to roadway and truck conditions, non-million mile drivers were more likely to report signs and symptoms of sleepiness while driving (e.g., **Table 35a**). Thus, the two groups appeared to be focused on somewhat different aspects of fatigue: non-million milers placed more emphasis on sleepiness-related fatigue, while million milers placed more emphasis on environmental factors related to fatigue. However, the two groups did not differ in their perceptions of fatigue as a problem on the job (**Table 34**).

Table 30: Breaks Taken During Driving in Million Milers vs. Non-Million Milers[1]

	Million Milers						Non-Million Milers						t-test	Wilcoxon
Factor (Question number)	**n**	**Mean**	**SD**	**Med**	**Min**	**Max**	**n**	**Mean**	**SD**	**Med**	**Min**	**Max**	**p value**	**p value**
Hours driven before break (Q30)	1111	3.5	1.2	3.5	1.0	8.0	1138	3.8	1.3	4.0	1.0	8.0	**0.001**	**0.001**
Length of break (Q31)	1116	0.7	0.5	0.8	0.3	3.8	1136	0.7	0.6	0.8	0.3	3.8	0.784	0.432

[1]Interval variables are approximated by taking the midpoint of response categories (e.g., 1-2 = 1.5) in some cases.

Table 31: Break Behaviors During Work in Million Milers vs. Non-Million Milers

Factor (Question number)	**Million Milers** n	%	**Non-Million Milers** n	%	p value[1]
Length of workday break (Q31)					
< 1/2 hour	354	31.7	387	34.1	0.497
1/2 to 1 hour	565	50.6	548	48.2	
1 to 1 1/2 hours	125	11.2	122	10.7	
1 1/2 to 2 hours	39	3.5	35	3.1	
2 or more hours	33	3.0	44	3.9	
Past month, times pulled off road to take a rest (Q35A)					
0	410	36.9	303	26.7	**0.001**
1 - 5	410	36.9	450	39.7	
5 - 10	101	9.1	146	12.9	
10 - 15	75	6.8	90	7.9	
15 - 20	47	4.2	58	5.1	
> 20	67	6.0	87	7.7	
If response to Q35A is more than 0, reason was to (check all that apply) (Q35B)					
rest without sleep (Q35B1)	180	25.7	240	28.9	0.167
rest with sleep (Q35B2)	430	61.4	560	67.4	**0.015**
use bathroom (Q35B3)	489	69.9	559	67.3	0.278
eat (Q35B4)	304	43.4	343	41.3	0.396
reached driving hours limit (Q35B5)	17	2.4	13	1.6	0.224
other (Q35B6)	56	8.0	62	7.5	0.694
Typically stop when working to exercise (check all that apply) (Q28A)					
Yes	309	28.0	259	23.0	**0.006**
No	795	72.0	869	77.0	
If yes, what types of exercise? (check all that apply) (Q28B)					
Leisurely walk (Q28B1)	163	52.8	162	62.5	**0.019**
Jog (Q28B2)	19	6.1	19	7.3	0.573
Strength (Q28B3)	41	13.3	40	15.4	0.460
Brisk walk (Q28B4)	0	0.0	0	0.0	---
Run (Q28B5)	8	2.6	12	4.6	0.188
Other (Q28B6)	77	24.9	55	21.2	0.301

[1]Chi-Square Test

Table 32: Sleep Behaviors at Work in Million Milers vs. Non-Million Milers

Factor (Question number)		**Million Milers** n	%	**Non-Million Milers** n	%	**p value**[1]
When working — usual location of main sleep (>4h) (Q22)						
	Don't sleep	321	29.4	293	26.1	0.298
	Sleeper berth	60	5.5	47	4.2	
	In cab	4	0.4	9	0.8	
	Break room	1	0.1	0	0.0	
	Truck stop/Rest area	5	0.5	5	0.4	
	Day cab	6	0.5	7	0.6	
	Dorm	96	8.8	109	9.7	
	Other	600	54.9	651	58.1	
When working — usual location of nap (Q23)						
	Don't sleep	468	42.4	388	34.3	**0.002**
	Sleeper berth	12	1.1	9	0.8	
	In cab	246	22.3	278	24.6	
	Break room	2	0.2	8	0.7	
	Truck stop/Rest area	84	7.6	91	8.0	
	Day cab	264	23.9	320	28.3	
	Dorm	2	0.2	0	0.0	
	Other	27	2.4	38	3.4	
Daytime sleep as restful as nighttime sleep? (Q29A)	No	771	69.5	776	68.4	
	Yes	263	23.7	319	28.1	
	Don't sleep during daytime	75	6.8	40	3.5	**0.001**
If yes, why? (check all that apply)	Sleep in a dark room (Q29B1)	202	76.8	248	77.7	0.788
	Get chores done before sleep (Q29B2)	82	31.2	87	27.3	0.302
	Disconnect the phone (Q29B3)	119	45.2	129	40.4	0.243
	Sleep in a separate room (Q29B4)	82	31.2	93	29.2	0.596
	Inform family of need for quiet sleep (Q29B5)	174	66.2	185	58.0	0.044
If no, why? (check all that apply)	Too much light (Q29C1)	413	53.6	423	54.5	0.710
	Too much noise (Q29C2)	445	57.7	456	58.8	0.677
	My internal clock wakes me (Q29C3)	510	66.1	533	68.7	0.287
	Hunger wakes me (Q29C4)	53	6.9	58	7.5	0.647
	Other (Q29C5)	151	19.6	147	18.9	0.749

[1]Chi-Square Test

Table 33: Sleeper Berth Use During Work in Million Milers vs. Non-Million Milers

Factor (Question number)	**Million Milers** n	%	**Non-Million Milers** n	%	**p value**[1]
Do you use the sleeper berth on the road (Q24)					
No	1015	94.0	1051	94.6	0.533
Yes	65	6.0	60	5.4	
If yes, do you rest or sleep in the berth in (Q25)					
one stretch	27	42.2	28	48.3	0.500
split rests	37	57.8	30	51.7	
Average time in sleeper berth at one time (Q26)					
< 1 hours	0	0.0	0	0.0	0.517
1 -< 4 hours	3	4.6	4	6.8	
4 -< 6 hours	37	56.9	38	64.4	
6 -< 8 hours	11	16.9	5	8.5	
>= 8 hours	14	21.5	12	20.3	

[1]Chi-Square Test

Table 34: Fatigue as a Problem On the Job in Million Milers vs. Non-Million Milers

Factor (Question number)	**Million Milers** n	%	**Non-Million Milers** n	%	**p value**[1]
How much is fatigue a problem to you on the job? (Q32)					
Major problem	125	11.3	149	13.1	0.336
Noticeable problem	303	27.3	313	27.5	
Minor problem	436	39.3	454	39.9	
Not a problem at all	246	22.2	223	19.6	
How often do you become fatigued while driving? (Q33)					
On every trip	48	4.3	49	4.3	0.187
On most trips	143	12.8	166	14.6	
On about half of the trips	141	12.7	166	14.6	
Occasionally	420	37.7	416	36.6	
Rarely	333	29.9	299	26.3	
Never	28	2.5	40	3.5	
How well do you think you can manage fatigue? (Q36)					
Not very well	45	4.0	59	5.2	0.829
Fairly well	427	38.2	424	37.4	
Quite well	240	21.5	238	21.0	
Very well	311	27.8	310	27.4	
Don't know	37	3.3	39	3.4	
No opinion	57	5.1	63	5.6	
While driving at work, when you felt drowsy, did you think you were in danger of falling asleep? (Q37)					
Yes	667	60.5	701	62.8	0.268
No	436	39.5	416	37.2	

[1]Chi-Square Test

Table 35a: Frequency of Sleepiness-Related Events While Driving in Past Year in Million Milers vs. Non-Million Milers

Factor (Question number)	**Million Milers** n	%	**Non-Million Milers** n	%	p value[1]
Eyelids heavy (Q43A)					
Often	123	11.4	140	12.6	**0.006**
Sometimes	515	47.6	593	53.2	
Rarely	389	36.0	323	29.0	
Never	55	5.1	59	5.3	
Struggling to be alert (Q43B)					
Often	74	7.0	91	8.4	**0.024**
Sometimes	431	40.6	479	44.2	
Rarely	458	43.2	399	36.8	
Never	98	9.2	115	10.6	
Yawning (Q43C)					
Often	138	13.0	202	18.5	**0.001**
Sometimes	610	57.3	627	57.5	
Rarely	292	27.4	239	21.9	
Never	24	2.3	23	2.1	
Feeling drowsy (Q43D)					
Often	102	9.6	121	11.2	0.184
Sometimes	561	52.6	594	54.8	
Rarely	359	33.6	320	29.5	
Never	45	4.2	49	4.5	
Difficulty staying awake (Q43E)					
Often	61	5.7	74	6.8	0.136
Sometimes	370	34.5	417	38.2	
Rarely	510	47.5	485	44.4	
Never	132	12.3	116	10.6	

[1]Chi-Square Test

Table 35b: Frequency of Fatigue-Related Events While Driving in Past Year in Million Milers vs. Non-Million Milers

Factor (Question number)	**Million Milers** n	%	**Non-Million Milers** n	%	**p value**[1]
Feeling sleepy (Q43F)					
Often	80	7.5	102	9.4	0.114
Sometimes	510	48.1	546	50.1	
Rarely	406	38.3	368	33.8	
Never	65	6.1	74	6.8	
Nodding off/falling asleep (Q43H)					
Often	33	3.1	40	3.7	0.842
Sometimes	97	9.0	100	9.1	
Rarely	365	34.0	380	34.8	
Never	577	53.8	573	52.4	
Feeling fatigued (Q43G)					
Often	106	10.0	137	12.6	**0.007**
Sometimes	540	50.9	537	49.5	
Rarely	376	35.5	345	31.8	
Never	38	3.6	65	6.0	
Having a near miss (Q43I)					
Often	26	2.4	25	2.3	0.503
Sometimes	76	7.1	77	7.1	
Rarely	432	40.5	407	37.5	
Never	533	50.0	577	53.1	
Running off the road (Q43J)					
Often	26	2.4	23	2.1	0.731
Sometimes	39	3.6	49	4.5	
Rarely	271	25.3	269	24.7	
Never	735	68.6	748	68.7	
Colliding with something (Q43K)					
Often	23	2.2	21	1.9	0.090
Sometimes	18	1.7	16	1.5	
Rarely	40	3.8	66	6.1	
Never	985	92.4	979	90.5	

[1]Chi-Square Test

4.8 Management of Fatigue by Million Milers vs. Non-Million Milers

Tables 37a, 37b, 38a, 38b, 38c, 39a, and **39b** contain the comparative results for survey questions about strategies drivers use to manage fatigue and sleepiness, and factors that they feel would further lessen fatigue.

Strategies to lessen fatigue or sleepiness off the job: million milers vs. non-million milers. There were a few differences between million milers and non-million milers in off-the-job strategies for lessening fatigue and sleepiness (**Tables 37a** and **37b**). A higher proportion of non-million milers indicated they did not "sleep regular hours" ($p = 0.009$) or "get a good night's sleep before departure" ($p = 0.017$), both of which are consistent with having less control over their schedules (**Table 26**), engaging in more night driving (**Table 21b** and **Figure 1**), sleeping less on workdays and before runs (**Tables 27, 28,** and **29a**), and experiencing sleepiness more frequently while driving (**Tables 24b** and **35a**).

Tables 37a and **37b** also show that a higher proportion of non-million milers reported taking daytime naps when off the job to manage fatigue ($p = 0.003$), which is consistent with their increased use of napping when on the job (**Table 31**). Non-million milers were also more likely to smoke off the job ($p = 0.007$) and less likely to garden or farm than million milers ($p = 0.005$).

Strategies to lessen fatigue while driving: million milers vs. non-million milers. In general, million milers and non-million milers used the same strategies to lessen fatigue while driving (**Table 38a**). However, they differed on a subset of questions that specifically dealt with napping and stimulant use at work. As **Table 38b** shows, a higher proportion of non-million milers reported napping less than an hour "often" or "sometimes" to lessen fatigue when driving ($p = 0.001$), and they were also more likely to use caffeinated drinks ($p = 0.001$), smoke or chew nicotine gum ($p = 0.013$), and take "stay-awake drugs" ($p = 0.015$)—although this latter category represented a very small percentage. Finally, non-million milers were more likely than million milers to talk on their cell phones or CB radios ($p = 0.001$) and sing to themselves ($p = 0.003$) to help lessen fatigue while driving.

Things drivers would like to do to reduce fatigue, but cannot—million milers vs. non-million milers. Tables 39a and **39b** show that, consistent with other responses throughout the survey, a higher proportion of non-million milers than million milers would like to have "control over their schedules" ($p = 0.001$), "sleep regular hours" ($p = 0.001$), and "get a good night's sleep before departure" ($p = 0.049$) to manage fatigue. (Although only a small number of drivers responded, a higher proportion of non-million milers indicated that "stay awake medications" can be useful to lessen fatigue [$p = 0.001$].) All of these differences are consistent with a large number of other responses in the survey that show non-million milers having less control over their more variable work schedules. In comparison to the schedules of million milers, the schedules of non-million milers involve more night driving, less sleep before workdays and on workdays, more sleepiness while driving, and more napping during rest breaks.

4.9 Multivariate Analysis to Discriminant Million Milers from Non-Million Milers

In order to identify best practices for managing fatigue, Stepwise Logistical Discriminant Analysis[22] was used to evaluate whether group differences in million miler status could be parsimoniously summarized by a subset of survey variables. All survey variables significant in bivariate analyses ($p < 0.05$) comparing million milers and non-million milers were candidates for inclusion in the model. Several variables were not included in the model due to missing values. The stepwise procedure utilized $p < 0.25$ to enter a factor into the model, and $p < 0.05$ for the factor to remain in the model. The final model controlled the influence of all the other variables in the model on a specific variable.

A single model was found to best capture the primary independent factors that discriminate million-milers from non-million milers. **Table 40** presents the statistically significant results of this discriminant model. Odds ratios greater than one in this table indicate that million milers were more likely to report this factor than non-million milers. Conversely, odds ratios below one indicate that non-million milers were more likely to report this factor than million milers. The variables listed in **Table 40** are in the order that they first appeared in the model. They are each described below.

Years of driving experience. The first factor in the multivariate discriminate model in **Table 40** was "years of driving experience." This factor alone had a discrimination index of $c = 0.636$. Million milers had more years of driving experience than did non-million milers. Every 10 years of additional experience increased the odds of being a million miler nearly 1.6 times. Thus, Teamster drivers continue to learn to drive safely the more years they drive commercially.

Variability of driving schedule and night work. Variability in start time and work schedule, independent of years of driving experience or any other factor in **Table 40**, also contributed to discriminating million milers from non-million milers. The odds of being a non-million miler increased nearly 2.3-fold (1/0.44) if start and work time varied "quite a lot" versus "not at all". More driving at night (i.e., at least 2 hours during the period from midnight to 4 am) also increased the odds of being a non-million milers, independent of variability in schedule. Sleep duration on either workdays or non-workdays did not survive in the model, suggesting that any discriminatory variance it accounted for was also accounted for by years of driving experience, variability in work schedule, night driving and other factors ion **Table 40**.

Driving time prior to stopping for a break. Million miler status was associated with a 19% higher likelihood (1/0.84) of stopping sooner to take a driving break than non-million milers (**Table 40**).

Noise, truck speed, and fatigue while driving. Million milers were approximately 50% more likely to indicate that slow truck speed (OR = 1.51) and noise (ORs = 1.48 and 1.57) contributed to their fatigue while driving (**Table 40**). Million miler status was also associated with any frequency report (from "rarely" to "sometimes" to "often") of feeling

[22]The logistic regression analyses implemented using the SAS procedure LOGISTIC (SAS Online Doc 9.1, SAS Institute Cary, NC, http://support.sas.com/91doc/docMainpage.jsp).

fatigue on the job (ORs = 2.2 to 2.65). This finding was due to differences between million milers and non-million milers in the reference category (i.e., "never" feel fatigued while driving) against which the other response categories were compared. A small but significantly higher proportion of non-million milers (6.0%) than million milers (3.6%) indicated they "never" felt fatigued while driving in the past year (**Table 35b**). Consequently, this item in the discriminant analysis is of limited interpretability. In contrast, million miler status was 50% (1/0.67) less likely to be associated with yawning often while driving in past year (**Table 40**) than was non-million milers status.

Caffeine and cell phone/CB use while driving. Table 40 reveals that million milers status was associated with less frequent use of caffeine to deal with fatigue while driving (OR = 0.75), and million milers were less likely to smoke (OR = 0.78) than non-million milers. The elevated prevalence of the consumption of caffeine and smoking by non-million milers apparently reflects something more than the increased need for these chemical stimulants as a result of variability of work schedules or night driving, since these factors are controlled for in the Stepwise Logistical Discriminant Analysis. On the other hand, since both caffeine and smoking (nicotine) are addictive behaviors, they may be sustained even in the absence of a need for stimulation. In addition to caffeine use to help cope with fatigue while driving, non-million miler status was associated with more frequent use of cell phone and CB radio to deal with fatigue while driving (OR = 2.12 [1/0.47]). Again, this item was independent of all other factors in **Table 40**.

Discrimination index of the final model. The final model made up of the items in **Table 40** achieved a discrimination index (area under ROC) of c = 0.722 (i.e., 72.2% of the time randomly selected million milers would be discriminated from randomly selected non-million milers using the items in **Table 40** to make the discrimination). A value of $c \geq 0.80$ is considered high enough to be useful in making individual clinical decisions. The discrimination index of c = 0.722 achieved with the model was nearly as high as that found by a preliminary fixed model that contained all candidate variables from the survey (c = 0.746). Consequently the final model of 11 survey items captured virtually all of the discriminatory variance possible from the entire survey.

Best practices of million milers from discriminant analyses. The goal of the project was to identify best practices for managing fatigue that may have potential application to other motor vehicle operators. Beyond comparisons between million milers and non-million milers for individual survey items summarized in **Tables 21-39** and discussed in this report, the results of the Stepwise Logistical Discriminant Analysis (**Table 40**) identified a subset of independent predictors of million miler status. Although both million milers and non-million milers did a considerable amount of night driving, there was less of this activity among the former than the latter. Million miler status was also associated with less variable work start times and schedules—factors that have been identified in other research to be associated with more fatigue and fatigue-related accidents. Importantly, million miler status was associated with stopping sooner to take the first driving break, and less frequent use of caffeine and cell phones/CB radios to ward off fatigue while driving.

In summary, relative to non-million milers, million miler status was associated with more years of driving experience, less variable work schedules, less night driving, earlier driving breaks, less smoking, and less caffeine and cell phone/CB use to manage fatigue while driving. These findings suggest that the lessons learned from this study regarding "best practices" include the following: regularize work schedules when possible, reduce night driving when possible, encourage taking the first rest break sooner when driving, and reduce smoking. It is not possible to determine whether caffeine intake and cell phone/CB use should be reduced, as these factors were reported by drivers as coping techniques for dealing with fatigue while driving, but cell phone/CB use could also be an added distraction for a driver.

Table 36a: Factors Contributing to Fatigue While Driving in Million Milers vs. Non-Million Milers

Factor (Question number)	**Million Milers** n	%	**Non-Million Milers** n	%	p value[1]
Driving hours (Q41A)					
Most relevant to me	508	46.2	471	42.2	0.064
Somewhat relevant to me	442	40.2	460	41.2	
Not relevant to me	150	13.6	186	16.7	
Non-driving hours (Q41B)					
Most relevant to me	152	13.9	124	11.2	0.062
Somewhat relevant to me	386	35.3	377	33.9	
Not relevant to me	554	50.7	611	54.9	
Rough riding truck (Q41C)					
Most relevant to me	545	49.5	480	43.1	**0.001**
Somewhat relevant to me	362	32.9	374	33.6	
Not relevant to me	194	17.6	260	23.3	
Having to load/unload (Q41D)					
Most relevant to me	211	19.4	164	14.8	**0.005**
Somewhat relevant to me	120	11.0	153	13.8	
Not relevant to me	757	69.6	791	71.4	
Resting away from home (Q41E)					
Most relevant to me	219	19.9	241	21.5	0.643
Somewhat relevant to me	491	44.6	494	44.1	
Not relevant to me	390	35.5	386	34.4	
Amount of sleep during trips (Q41F)					
Most relevant to me	302	27.5	332	29.8	0.498
Somewhat relevant to me	441	40.2	434	39.0	
Not relevant to me	354	32.3	348	31.2	
Amount of sleep before trip (Q41G)					
Most relevant to me	590	53.6	597	53.5	0.718
Somewhat relevant to me	379	34.5	397	35.6	
Not relevant to me	131	11.9	122	10.9	
Amount of nighttime sleep (Q41H)					
Most relevant to me	470	42.8	455	40.7	0.076
Somewhat relevant to me	399	36.3	383	34.3	
Not relevant to me	230	20.9	279	25.0	
Driving at night (Q41I)					
Most relevant to me	339	30.8	362	32.5	0.500
Somewhat relevant to me	479	43.5	458	41.1	
Not relevant to me	283	25.7	295	26.5	
Driving at dawn (Q41J)					
Most relevant to me	474	43.0	510	45.7	0.445
Somewhat relevant to me	421	38.2	406	36.3	
Not relevant to me	208	18.9	201	18.0	

Table 36b: Factors Contributing to Fatigue While Driving in Million Milers vs. Non-Million Milers

Factor (Question number)	**Million Milers** n	%	**Non-Million Milers** n	%	p value[1]
Driving at dusk (Q41K)					
Most relevant to me	116	10.5	117	10.5	0.148
Somewhat relevant to me	406	36.9	369	33.1	
Not relevant to me	578	52.5	629	56.4	
Physical fatigue (Q41L)					
Most relevant to me	309	28.1	278	24.8	**0.046**
Somewhat relevant to me	542	49.4	547	48.7	
Not relevant to me	247	22.5	298	26.5	
Anxiety/Worry (Q41M)					
Most relevant to me	154	14.1	112	10.0	**0.012**
Somewhat relevant to me	428	39.1	443	39.7	
Not relevant to me	514	46.9	561	50.3	
Temperature (too hot/cold) (Q41N)					
Most relevant to me	231	21.0	212	18.9	**0.006**
Somewhat relevant to me	532	48.3	491	43.9	
Not relevant to me	338	30.7	416	37.2	
Driving in early afternoon (Q41O)					
Most relevant to me	68	6.2	61	5.5	0.095
Somewhat relevant to me	279	25.5	246	22.0	
Not relevant to me	748	68.3	810	72.5	
Road conditions (Q41P)					
Most relevant to me	357	32.5	295	26.4	**0.001**
Somewhat relevant to me	503	45.8	521	46.6	
Not relevant to me	239	21.7	302	27.0	
Scenery along route (Q41Q)					
Most relevant to me	84	7.7	71	6.4	0.286
Somewhat relevant to me	356	32.5	346	30.9	
Not relevant to me	656	59.9	701	62.7	
Highway traffic (Q41R)					
Most relevant to me	325	29.7	268	24.1	**0.010**
Somewhat relevant to me	463	42.3	497	44.6	
Not relevant to me	307	28.0	349	31.3	
Weather conditions (Q41S)					
Most relevant to me	505	45.8	466	41.6	**0.027**
Somewhat relevant to me	466	42.3	481	43.0	
Not relevant to me	131	11.9	172	15.4	
Truck ventilation (Q41T)					
Most relevant to me	419	38.2	372	33.3	**0.014**
Somewhat relevant to me	495	45.1	513	45.9	
Not relevant to me	184	16.8	232	20.8	

Table 36c: Factors Contributing to Fatigue While Driving in Million Milers vs. Non-Million Milers

Factor (Question number)	**Million Milers** n	%	**Non-Million Milers** n	%	p value[1]
Truck vibration (Q41U)					
Most relevant to me	426	38.8	353	31.6	**0.001**
Somewhat relevant to me	461	42.0	481	43.0	
Not relevant to me	211	19.2	284	25.4	
Family (Q41V)					
Most relevant to me	203	18.6	167	15.0	**0.004**
Somewhat relevant to me	376	34.4	347	31.1	
Not relevant to me	514	47.0	601	53.9	
Diet/eating patterns (Q41W)					
Most relevant to me	182	16.5	176	15.7	0.141
Somewhat relevant to me	503	45.7	475	42.4	
Not relevant to me	415	37.7	468	41.8	
Effects of stay-awake drugs (Q41X)					
Most relevant to me	24	2.2	29	2.6	0.504
Somewhat relevant to me	26	2.4	34	3.1	
Not relevant to me	1042	95.4	1050	94.3	
Use of alcohol (Q41Y)					
Most relevant to me	31	2.8	33	3.0	0.856
Somewhat relevant to me	42	3.9	38	3.4	
Not relevant to me	1017	93.3	1037	93.6	
Truck speed too slow (Q41Z1)					
Most relevant to me	606	55.0	488	43.5	**0.001**
Somewhat relevant to me	360	32.7	430	38.3	
Not relevant to me	136	12.3	205	18.3	
Noise (Q41Z2)					
Most relevant to me	383	34.9	297	26.6	**0.001**
Somewhat relevant to me	456	41.6	445	39.9	
Not relevant to me	257	23.4	374	33.5	
Steering in cross winds (Q41Z3)					
Most relevant to me	232	21.1	168	14.9	**0.001**
Somewhat relevant to me	503	45.9	493	43.9	
Not relevant to me	362	33.0	463	41.2	

[1]Chi-Square Test

Table 37a: Off-the-Job Strategies to Lessen Fatigue or Sleepiness On the Job in Million Milers vs. Non-Million Milers

	Million Milers		Non-Million Milers		
Factor (Question number)	**n**	**%**	**n**	**%**	**p value**[1]
Physical exercise (Q42A)					
No, I don't regularly do this at all	411	38.1	455	41.3	0.297
Yes, but not to manage fatigue	580	53.8	558	50.6	
Yes, to manage fatigue	87	8.1	90	8.2	
Diet to keep weight down (Q42B)					
No, I don't regularly do this at all	438	40.6	469	42.7	0.591
Yes, but not to manage fatigue	564	52.2	551	50.1	
Yes, to manage fatigue	78	7.2	79	7.2	
Play recreational sports (Q42C)					
No, I don't regularly do this at all	794	73.5	788	71.8	0.638
Yes, but not to manage fatigue	251	23.2	274	25.0	
Yes, to manage fatigue	36	3.3	36	3.3	
Eat healthily (Q42D)					
No, I don't regularly do this at all	202	18.9	217	19.9	0.527
Yes, but not to manage fatigue	783	73.3	777	71.3	
Yes, to manage fatigue	83	7.8	96	8.8	
Relax by gardening or farming (Q42E)					
No, I don't regularly do this at all	520	48.3	604	55.3	**0.005**
Yes, but not to manage fatigue	492	45.7	427	39.1	
Yes, to manage fatigue	64	5.9	62	5.7	
Engage in crafts or hobbies (Q42F)					
No, I don't regularly do this at all	558	52.0	579	53.0	0.312
Yes, but not to manage fatigue	459	42.7	470	43.0	
Yes, to manage fatigue	57	5.3	43	3.9	
Relax by hunting or fishing (Q42G)					
No, I don't regularly do this at all	635	59.0	646	58.9	0.496
Yes, but not to manage fatigue	390	36.2	386	35.2	
Yes, to manage fatigue	51	4.7	64	5.8	
Relax by attending sports events (Q42H)					
No, I don't regularly do this at all	718	66.7	762	69.1	0.308
Yes, but not to manage fatigue	333	30.9	309	28.0	
Yes, to manage fatigue	26	2.4	31	2.8	
Relax by watching TV or reading (Q42I)					
No, I don't regularly do this at all	122	11.3	132	12.0	0.183
Yes, but not to manage fatigue	864	80.2	854	77.4	
Yes, to manage fatigue	91	8.4	117	10.6	

Table 37b: Off-the-Job Strategies to Lessen Fatigue or Sleepiness On the Job in Million Milers vs. Non-Million Milers

Factor (Question number)	**Million Milers** n	%	**Non-Million Milers** n	%	p value[1]
Relax by going out socially (Q42J)					
No, I don't regularly do this at all	466	43.3	476	43.4	0.949
Yes, but not to manage fatigue	564	52.5	579	52.7	
Yes, to manage fatigue	45	4.2	43	3.9	
Relax by drinking alcohol (Q42K)					
No, I don't regularly do this at all	848	78.7	852	78.0	0.772
Yes, but not to manage fatigue	207	19.2	214	19.6	
Yes, to manage fatigue	22	2.0	27	2.5	
Relax by smoking (Q42L)					
No, I don't regularly do this at all	858	80.1	819	74.9	**0.007**
Yes, but not to manage fatigue	186	17.4	228	20.9	
Yes, to manage fatigue	27	2.5	46	4.2	
Visit friends, relatives, neighbors (Q42M)					
No, I don't regularly do this at all	295	27.4	326	29.7	0.060
Yes, but not to manage fatigue	757	70.2	730	66.5	
Yes, to manage fatigue	26	2.4	42	3.8	
Sleep regular hours (Q42N)					
No, I don't regularly do this at all	377	34.9	448	40.8	**0.009**
Yes, but not to manage fatigue	384	35.6	334	30.4	
Yes, to manage fatigue	318	29.5	317	28.8	
Sleep longer hours than during week (Q42O)					
No, I don't regularly do this at all	436	40.5	384	35.2	**0.010**
Yes, but not to manage fatigue	379	35.2	388	35.5	
Yes, to manage fatigue	261	24.3	320	29.3	
Take daytime naps (Q42P)					
No, I don't regularly do this at all	619	57.7	592	54.0	**0.003**
Yes, but not to manage fatigue	265	24.7	248	22.6	
Yes, to manage fatigue	188	17.5	256	23.4	
Get good night's sleep before departure (Q42Q)					
No, I don't regularly do this at all	161	14.9	195	17.8	**0.017**
Yes, but not to manage fatigue	435	40.3	381	34.7	
Yes, to manage fatigue	483	44.8	521	47.5	
Complete family duties before resting (Q42R)					
No, I don't regularly do this at all	153	14.1	160	14.5	0.132
Yes, but not to manage fatigue	789	72.9	765	69.5	
Yes, to manage fatigue	141	13.0	175	15.9	
Strive to maintain good family life (Q42S)					
No, I don't regularly do this at all	53	4.9	48	4.4	0.377
Yes, but not to manage fatigue	868	80.4	865	78.9	
Yes, to manage fatigue	158	14.6	183	16.7	

[1]Chi-Square Test

Table 38a: Strategies to Lessen Fatigue While Driving in Million Milers vs. Non-Million Milers

Factor (Question number)	**Million Milers** n	%	**Non-Million Milers** n	%	**p value**[1]
Stop driving to eat a meal (Q44A)					
Often	126	11.5	141	12.4	0.718
Sometimes	453	41.3	445	39.2	
Rarely	344	31.4	359	31.6	
Never	174	15.9	191	16.8	
Stop driving to eat snack (Q44B)					
Often	118	10.8	145	12.9	0.328
Sometimes	579	52.8	566	50.3	
Rarely	283	25.8	283	25.1	
Never	117	10.7	132	11.7	
Eat chocolate or candy (Q44C)					
Often	60	5.5	91	8.2	0.065
Sometimes	364	33.2	343	30.8	
Rarely	397	36.3	392	35.2	
Never	274	25.0	289	25.9	
Eating while driving (Q44D)					
Often	174	16.0	205	18.1	0.566
Sometimes	436	40.1	434	38.3	
Rarely	316	29.1	321	28.4	
Never	161	14.8	172	15.2	
Chewing gum (Q44E)					
Often	211	19.3	260	23.0	0.125
Sometimes	238	21.7	249	22.0	
Rarely	218	19.9	198	17.5	
Never	429	39.1	425	37.5	
Chewing ice (Q44F)					
Often	35	3.2	37	3.3	0.396
Sometimes	140	13.0	145	13.0	
Rarely	207	19.1	182	16.4	
Never	699	64.7	748	67.3	
Stopping to rest (no sleep) (Q44G)					
Often	80	7.3	89	7.9	0.447
Sometimes	495	45.1	504	44.5	
Rarely	333	30.4	368	32.5	
Never	189	17.2	171	15.1	
Stopping to sleep (≥ 4 hours) (Q44H)					
Often	5	0.5	3	0.3	0.797
Sometimes	9	0.8	10	0.9	
Rarely	58	5.3	67	6.0	
Never	1014	93.4	1038	92.8	

Table 38b: Strategies to Lessen Fatigue While Driving in Million Milers vs. Non-Million Milers

Factor (Question number)	**Million Milers** n	%	**Non-Million Milers** n	%	p value[1]
Stopping to sleep (1 - 4 hours) (Q44I)					
Often	58	5.4	53	4.8	0.778
Sometimes	163	15.1	182	16.4	
Rarely	216	20.1	227	20.5	
Never	640	59.4	648	58.4	
Stopping to nap (< 1 hour) (Q44J)					
Often	161	14.8	192	17.3	**0.001**
Sometimes	372	34.2	456	41.0	
Rarely	321	29.5	280	25.2	
Never	234	21.5	183	16.5	
Having a caffeine drink (Q44K)					
Often	474	43.4	597	52.8	**0.001**
Sometimes	451	41.3	389	34.4	
Rarely	114	10.4	100	8.8	
Never	52	4.8	44	3.9	
Having a non-caffeine drink (Q44L)					
Often	129	11.8	158	14.0	0.497
Sometimes	366	33.6	376	33.3	
Rarely	288	26.4	288	25.5	
Never	306	28.1	306	27.1	
Smoking/chewing nicotine gum (Q44M)					
Often	156	14.3	219	19.5	**0.013**
Sometimes	76	7.0	80	7.1	
Rarely	27	2.5	29	2.6	
Never	829	76.2	796	70.8	
Taking stay-awake drugs (Q44N)					
Often	1	0.1	5	0.4	**0.015**
Sometimes	11	1.0	27	2.4	
Rarely	33	3.0	44	3.9	
Never	1043	95.9	1048	93.2	
Ignoring driving hour regs. to finish trip (Q44O)					
Often	5	0.5	3	0.3	0.878
Sometimes	23	2.1	22	2.0	
Rarely	79	7.3	79	7.1	
Never	978	90.1	1014	90.7	
Kicking the tires, walking around (Q44P)					
Often	395	36.0	398	35.1	0.408
Sometimes	543	49.5	545	48.1	
Rarely	123	11.2	154	13.6	
Never	35	3.2	37	3.3	

Table 38c: Strategies to Lessen Fatigue While Driving in Million Milers vs. Non-Million Milers

Factor (Question number)	**Million Milers** n	%	**Non-Million Milers** n	%	**p value**[1]
Taking a shower (Q44Q)					
Often	98	9.0	118	10.6	0.284
Sometimes	84	7.8	67	6.0	
Rarely	84	7.8	84	7.5	
Never	817	75.4	844	75.8	
Play mind games (e.g., count license plates) (Q44R)					
Often	66	6.0	78	7.0	0.566
Sometimes	196	17.9	194	17.4	
Rarely	200	18.3	223	20.0	
Never	630	57.7	622	55.7	
Listen to music/radio (Q44S)					
Often	751	68.4	749	65.8	0.513
Sometimes	189	17.2	220	19.3	
Rarely	69	6.3	79	6.9	
Never	89	57.7	91	8.0	
Talking on cell phone/CB radio (Q44T)					
Often	340	31.0	438	38.7	**0.001**
Sometimes	442	40.3	425	37.5	
Rarely	211	19.2	196	17.3	
Never	104	9.5	74	6.5	
Turn on dome light (Q44U)					
Often	59	5.4	57	5.0	0.908
Sometimes	231	21.2	251	22.2	
Rarely	315	28.9	317	28.1	
Never	486	44.5	505	44.7	
Singing (Q44V)					
Often	86	7.9	131	11.7	**0.003**
Sometimes	303	27.9	348	31.0	
Rarely	264	24.3	252	22.4	
Never	434	39.9	393	35.0	
Adjusting ventilation (Q44W)					
Often	446	40.6	483	42.4	0.385
Sometimes	538	49.0	520	45.7	
Rarely	93	8.5	107	9.4	
Never	21	1.9	28	2.5	
Stretching/changing position (Q44X)					
Often	551	50.1	612	53.9	0.363
Sometimes	452	41.1	435	38.3	
Rarely	77	7.0	72	6.3	
Never	19	1.7	17	1.5	

[1]Chi-Square Test

Table 39a: Things Drivers Would Like to Do (But Cannot) to Lessen Fatigue in Million Milers vs. Non-Million Milers

Factor (Question number)	**Million Milers** n	%	**Non-Million Milers** n	%	p value[1]
Have control over my schedule (Q46A)					
Would like but cannot do	673	66.7	824	78.7	**0.001**
Can do, useful to reduce fatigue	281	27.8	185	17.7	
Can do, but not useful	55	5.5	38	3.6	
Work fewer hours per week (Q46G)					
Would like but cannot do	589	67.5	602	69.9	0.132
Can do, useful to reduce fatigue	182	20.9	148	17.2	
Can do, but not useful	101	11.6	111	12.9	
Receive training on fatigue management (Q46J)					
Would like but cannot do	207	45.1	234	43.8	0.786
Can do, useful to reduce fatigue	130	28.3	162	30.3	
Can do, but not useful	122	26.6	138	25.8	
Have fatigue monitoring technology (Q46K)					
Would like but cannot do	264	64.2	294	65.8	0.834
Can do, useful to reduce fatigue	53	12.9	52	11.6	
Can do, but not useful	94	22.9	101	22.6	
Have CB radio available (Q46L)					
Would like but cannot do	15	1.6	23	2.3	0.338
Can do, useful to reduce fatigue	650	69.2	702	70.6	
Can do, but not useful	274	29.2	269	27.1	
Have more frequent truck stops/rest areas (Q46M)					
Would like but cannot do	219	24.9	235	25.3	0.742
Can do, useful to reduce fatigue	481	54.7	493	53.0	
Can do, but not useful	180	20.5	202	21.7	
Do less loading / unloading (Q46F)					
Would like but cannot do	31	28.4	24	25.0	0.322
Can do, useful to reduce fatigue	60	55.0	48	50.0	
Can do, but not useful	18	16.5	24	25.0	
Drive in a team (Q46B)					
Would like but cannot do	4	2.6	14	10.5	**0.023**
Can do, useful to reduce fatigue	32	20.9	25	18.8	
Can do, but not useful	117	76.5	94	70.7	
Drive alone (Q46C)					
Would like but cannot do	37	3.9	36	3.9	**0.001**
Can do, useful to reduce fatigue	501	53.3	413	44.6	
Can do, but not useful	402	42.8	478	51.6	

Table 39b: Things Drivers Would Like to Do (But Cannot) to Lessen Fatigue in Million Milers vs. Non-Million Milers

Factor (Question number)	**Million Milers** n	%	**Non-Million Milers** n	%	p value[1]
Get good night's sleep before departure (Q46D)					
Would like but cannot do	229	21.9	265	24.4	**0.049**
Can do, useful to reduce fatigue	764	73.2	788	72.6	
Can do, but not useful	51	4.9	33	3.0	
Sleep regular hours (Q46E)					
Would like but cannot do	543	51.0	713	65.7	**0.001**
Can do, useful to reduce fatigue	493	46.3	350	32.3	
Can do, but not useful	29	2.7	22	2.0	
Be allowed to take stay awake meds (Q46I)					
Would like but cannot do	80	47.6	84	34.0	**0.001**
Can do, useful to reduce fatigue	8	4.8	42	17.0	
Can do, but not useful	80	47.6	121	49.0	
[1]Chi-Square Test					

Table 40: Results from Stepwise Logistic Discriminant Analysis[1] on Factors that Independently Segregate Million Milers from Non-Million Milers

Variable (Question number)	**Odds Ratio**[2]	**LB**[3]	**UB**[3]	**p-value**[4]
Years driving a truck (10 year increase) (Q7)	1.59	1.42	1.79	**<.0001**
Start time and work schedule vary (Q27)				**<.0001**[5]
Quite a lot vs. not at all	0.44	0.32	0.61	
A little vs. not at all	0.65	0.47	0.89	
Noise contributes to fatigue while driving (Q41Z2)				**0.007**
Most relevant vs. not relevant	1.57	1.14	2.15	
Somewhat relevant vs. not relevant	1.48	1.12	1.96	
Drive longer time before stopping for a break (Q30)	0.84	0.77	0.92	**0.0001**
Take caffeinated drink to deal with fatigue while driving (Q44K)				**0.003**
Often vs. never	0.75	0.44	1.27	
Sometimes vs. never	1.20	0.70	2.05	
Rarely vs. never	0.90	0.49	1.66	
Truck speed too slow contributes to fatigue while driving (Q41Z1)				**0.004**
Most relevant vs. not relevant	1.51	1.06	2.16	
Somewhat relevant vs. not relevant	1.01	0.71	1.44	
Talk on cell phone/CB radio to deal with fatigue while driving (Q44T)				**0.008**
Often vs. never	0.47	0.29	0.73	
Sometimes vs. never	0.57	0.36	0.89	
Rarely vs. never	0.63	0.38	1.01	
Night driving (≥ 2 hr work reported from 12 am to 4 am over a typical 2-day period (Q15)	0.75	0.60	0.95	**0.02**
Feeling fatigued while driving in past year (43G)				**0.02**
Often vs. never	2.50	1.24	5.11	
Sometimes vs. never	2.65	1.45	4.94	
Rarely vs. never	2.20	1.21	4.07	
Yawning while driving in past year (43C)				**0.02**
Often vs. never	0.67	0.25	1.76	
Sometimes vs. never	1.05	0.42	2.66	
Rarely vs. never	1.21	0.48	3.09	
Smoking to any extent (Q10)	0.78	0.61	0.99	**0.04**

[1]Variables significant in bivariate analysis ($p<0.05$) were candidates for inclusion. Several variables were not included due to missing values. Preferences for alternative fatigue strategies also not assessed since drivers did not answer these questions if they deemed them not to be applicable to them. The stepwise procedure utilized $p<0.25$ to enter a factor into the model, and $p<0.05$ for the factor to remain in the model. The variables listed in Table 40 are in the order that they first appeared in the model. The final model achieved a discrimination index (area under ROC) of c = 0.722.

[2]Odds ratios great than 1 indicate that million milers are more likely to have this factor than non-million milers. Conversely, odds ratios below 1 indicate that non-million milers are more likely to have this factor than million milers.
[3]LB, UB - lower and upper bounds of 95% confidence interval for the odds ratio.
[4]Final chi-square p-value to remain in model.
[5]P values listed in rows without odds ratios refer to the significance of the overall chi-square for a factor with at least 3 levels.

U.S. Department of Transportation

Federal Motor Carrier Safety Administration

Report No. FMCSA-RRR-06-008

For more information on the Federal Motor Carrier Safety Administration and the Office of Research and Technology, check our website at www.fmcsa.dot.gov.