

ORIGINAL ARTICLE

Working conditions and fatigue in professional truck drivers at Israeli ports

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Figure 2 can be viewed on our website.

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Background: Trucks represent 6% of all vehicles, but truck crashes account for 20% of road deaths in Israel, even though travel distances are usually short (<200 km) and overnight travel is uncommon.

Objective: To determine occupational and individual predictors of fatigue, falling asleep at the wheel, and involvement in crashes with injuries and deaths in truck drivers.

Setting and methods: We carried out field interviews of 160 port truck drivers regarding driver characteristics, workplace and driving conditions, employer-employee relations, medical conditions, sleep quality and fatigue, falling asleep at the wheel, and involvement in road crashes.

Results: One day before interview, 38.1% of the drivers had worked more than the 12 hour legal limit. More than 30% reported falling asleep at the wheel recently, and 13% had prior involvement in a sleep related crash. Sixty seven (41.9%) drivers said that their employer forced them to work beyond the legal 12 hour daily limit. Involvement in a crash with casualties was associated with poor sleep quality (adjusted OR=2.9; p=0.042) and frequent difficulty finding parking when tired (OR=3.7; p=0.049). Self assessment of fatigue underestimated fatigue from the Pittsburgh Sleep Quality Questionnaire. However fatigue occurred in many drivers without sleep problems and many crashes occurred without fatigue.

Conclusions: Prevention requires measures to reduce work stresses, screening drivers, speed control, and modal shifts. The work risks and adverse outcomes of truck drivers in large countries with long overnight journeys occur in a small country with small distances, relatively short work journeys, and little overnight travel.

There is much interest in the contribution of fatigue to the high risks for job related illnesses and injuries of truck drivers, especially in long haul carriers. The California Highway Patrol reported that fatigue was a cause in 67% of truck crashes.¹ UK data suggest that 10–25% of truck crashes are related to driver fatigue.² Sixty two (58%) of 107 US truck drivers involved in a crash attributed it to fatigue and 19 had fallen asleep at the wheel.³ In Finland, trailer truck drivers were responsible for 16% of all two vehicle fatal crashes accidents between 1991 and 1997.⁴

In Israel in recent years, trucks represented 6% of all vehicles and 28% of vehicle kilometers travelled,⁵ but truck crashes account for some 20% of road deaths,⁶ of which more than 90% occur in the second vehicle.⁵ The high toll, together with accumulating evidence on the role of fatigue, states the case for examining the prevalence of fatigue and its determinants in Israeli truck drivers. Fatigue is highly prevalent in long haul truck drivers covering large regions,^{7–9} and is associated with poor working conditions,^{10 11} long work hours,^{4 10} chronic illness,^{4 12} lack of sleep, and sleep disorders.^{13 14} Truck drivers unable to adequately recover from work related fatigue show higher rates of absenteeism from work due to illness.¹⁵

Data are not readily available on whether risks for fatigue and fatigue related crashes in large countries with long travel distances are present in small countries (for example, Israel which is 467 km from north to south) with shorter travel distances, and little to no overnight travel or stays away from home, roadside motels, or overnight truck stops. Yet drivers are subject to pressures from employers to complete as many pick-ups and deliveries as possible. Truck driving in Israel is not protected by a powerful union, employees tend to be low on the socioeconomic ladder, and lacks even minimal benefits. Drivers start the workday extremely early, between 0500 and 0600, before the rapid increase in traffic congestion and outdoor heat, and after extremely long work days, they will arrive home to spend the night with their families.

Our objectives are (1) to report workplace and driving conditions, employer-employee relations, and personal health status—notably sleep quality—in a group of container truck drivers delivering cargo to and from major seaports in Israel and (2) to estimate the association between working conditions and fatigue, falling asleep at the wheel, and previous involvement in truck crashes with casualties.

METHODS

Of approximately 640 drivers whom we approached at the registration points in the ports of Haifa and Ashdod—the two largest marine distribution ports in Israel—160 (25%) agreed to be interviewed (see Discussion, Limitations). All drivers delivering or receiving shipments must pass through the registration areas, where two trained researchers (SSE and LF) interviewed them on six separate days in March–April 1997. Field interviews took approximately 10 minutes and were anonymous. We report data on driver characteristics, workplace conditions, employer-employee relations, driving conditions, sleep quality, self-reported fatigue, and history of truck occupational road crashes while working.

The questionnaire was composed of 80 closed ended questions (that is, mostly multiple choice) based on prior information¹⁶ and three exploratory interviews with Israeli truck drivers. We included a validated questionnaire on sleep quality and disorders used at the Israel Institute of Technology-Technion Sleep laboratory (Haifa, Israel) based on the Pittsburgh Sleep Quality Index,¹⁷ which measures sleep quality at home and at work. A score of 5 or more on a scale of 10 indicates poor sleep quality and its diagnostic sensitivity reaches approximately 90% compared with sleep laboratory findings. After review of the questionnaire by

Abbreviations: BMI, body mass index; ILO, International Labor Organization.

experts on sleep disorders, we pre-tested it on 10 truck drivers.

STATISTICAL ANALYSIS

We used SAS for Windows (version 8.0) for the statistical analysis. We use χ^2 tests for analysis of categorical variables. We calculated Crude odds ratios (OR) and confidence intervals for the outcome variable associated with each predictor variable. We fitted a multiple logistic regression model including potential predictors to estimate adjusted odds ratios (OR), confidence intervals, and p values for reported fatigue, falling asleep while driving, and involvement in a casualty related crash. The models include the following variables: sleep quality, difficulty finding parking when tired, frequency of driving more than 12 hours/day, employer request to work beyond the legal hour, years of driving experience, body mass index, and reported high blood pressure.

RESULTS

Driver characteristics

Table 1 summarizes personal and occupational information on truck drivers we interviewed. Only 25.9 (15.6%) worked a regular route. Eighty five (53.1%) reported driving irregular shifts during the daytime and night-time. Drivers reported being paid by kilometer (n = 1), hour (n = 8), premium (n = 31), salary (n = 52), weight delivered (n = 9), and other (n = 54). One hundred and six (66.3%) reported they were regular smokers.

Workplace conditions

Maximum distances for most trips from the major container port were <200 km (125 miles), journeys were relatively short, drivers rarely spent overnight away from home, and overnight sleeping in truck cabins was extremely uncommon. However 61 (38.1%) reported working more than 12 hours during the shift prior to the interview (fig 1), 99 (62%) reported driving >12 hours/day one or more days per week, 48 (30%) reported working >12 hours/day almost everyday, and four (2.5%) reported working 20 hours or more. The most frequent reason for working >12 hours/day was a busy work schedule (n = 89).

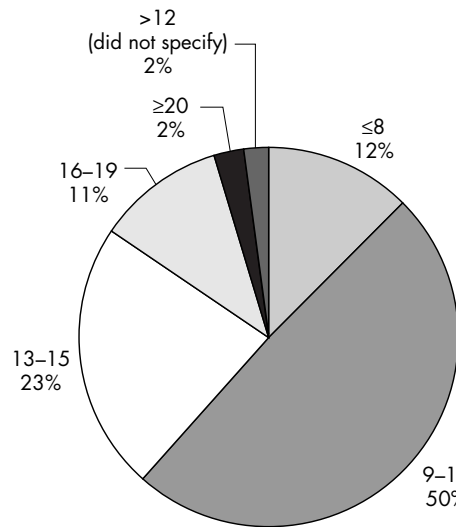


Figure 1 Number of driving hours during shift prior to interview Israeli marine port drivers, 1997.

Forty nine (30.6%) drivers worked >68 hours during their last working week, of which 36 (22.5%) worked >84 hours. Only 18 (11.3%) of the drivers reported working 48 hours/week or less during the week before the interview.

Employer-employee relations

Sixty seven (41.9%) drivers said that their employer forced them to work beyond the legal 12 hour daily limit. Twenty two drivers (13.8%) reported that they were fined or fired for arriving late to a destination. Thirty seven (23.1%) were verbally rebuked for being late to a destination.

Road conditions

Only 41 (25.6%) reported never having a problem finding a place to rest when tired on the road. Twenty (12.5%) reported that it was a daily problem, and 96 (60%) as an occasional problem. Drivers reporting frequent difficulty finding rest places were at a higher risk of fatigue compared with drivers with no such difficulty (unadjusted OR 7.8; 95% CI 2.9 to 21.2).

Medical conditions

Only 28 (17.5%) of the drivers had a medical check up before being hired by their current employer. Twenty four (15%) had a body mass index indicating obesity (BMI >30), a risk for sleep disorders, including sleep apnea. 107 (66.9%) had one or more of the following health problems: hypertension (n = 8), constipation (n = 10), gastritis/peptic ulcer (n = 25), paresthesias of legs or arms (n = 38), lower back pain (n = 67), gluteal pain (n = 23), and hemorrhoids (n = 21). Sleep quality scores indicated that 34 (21.3%) had moderate to severe sleep quality, of which 16 (10.0%) had indications of severe sleep disturbance. BMI was strongly associated with moderate to severe sleep quality (unadjusted OR 1.2; 95% CI 1.1 to 1.3). Based on these findings, for each 10 unit increase in BMI there was an associated risk of moderate to severe sleep quality of OR 5.078 (unadjusted; 95% CI 1.8 to 14.2).

Driving conditions and reported fatigue and falling asleep at the wheel

Sixty three (39.4%) truck drivers recalled reported having experienced fatigue while driving, of whom 58 (92%) recalled frequent difficulties finding parking when tired, 37 (59%) were pressured to work beyond permitted work hour limits, and 52 (83%) drove more than 12 hours/day.

Table 1 Characteristics of the Israeli marine port drivers

	n†	%
Mean age, years (range)	39 (21-66)	NA
Sex		
Male	159	99.4
Female	1	0.6
Body mass index (BMI)*		
<25	58	36.3
25-29	60	37.5
30-40	23	14.4
>40	1	0.6
Regular smokers	106	66.3
Truck driving experience		
≤2 years	9	5.6
3-9 years	36	22.5
≥10 years	115	71.9
Average truck weight		
<16 tonnes	5	3.1
16-33.9 tonnes	26	16.3
34-54 tonnes	118	73.8
55+	11	6.9
Salary less than 4500 NIS/month (equivalent to \$16000/year)‡	62	39

*No data available for 18 drivers.

†Absolute numbers unless otherwise specified.

‡At 1995 exchange rate; first quarter of 1997 US\$1 exchanged for 3.361 NIS (New Israeli Shekel).

Fifty (31.3%) reported having fallen asleep at the wheel at least once during their entire occupational trucking careers, of whom 17 (10.6%) reported falling asleep at the wheel during the past month. The overwhelming majority of drivers reporting this outcome recalled frequent difficulty finding parking when tired, (n = 48; 96%), employer demands (n = 27; 54%), and long work hours (n = 41; 82%).

Forty drivers (31.8%) out of 126 with scores indicating good sleep quality reported suffering from fatigue while driving, compared with eight drivers (44.4%) of 18 with slight to moderate sleep quality, and 12 (75.0%) of 16 with severe problems with sleep quality. Thus, although there appears to be a dose-response relation between impairments in sleep quality and fatigue, the majority of drivers with fatigue on the job did not suffer from sleep quality.

There were strong positive associations between falling asleep while driving and moderate to severe sleep quality (OR 2.1), frequent difficulty finding parking when tired (OR 14.8), employer demanding the driver to work more than the legal hour limit (OR 2.1), and working more than 12 hours/day several times a week. But there was an inverse association with driving more than 12 hours/day less than several times a month. (table 2). However after adjustment for the other variables, the predominant predictor of falling asleep while driving is frequent difficulty finding parking when tired (adjusted OR 12.7; p = 0.001). Overall, the work problems producing the strongest associations with fatigue, falling asleep at the wheel, as well as crashes with injuries/fatalities (see next section) were seen in the majority of the drivers, without the sleep difficulties seen in the others.

History of prior truck crashes

One hundred (15.6%) drivers reported being involved in a crash, of which 33 involved injuries or fatalities. Twenty one (67% out of 33) attributed the reported crash to fatigue and 11 (33% out of 33) said that the crash was related to sleep problems. Among these 33, many recalled parking problems when tired, (n = 29), long working hours at least several times a week (n = 24), and employer demands (n = 15). For a subgroup of 12 drivers, involvement in a crash with casualties was associated with moderate to severe sleep quality (adjusted OR 2.9; p = 0.04) and frequent difficulty finding parking when tired (adjusted OR 3.7; p = 0.05).

DISCUSSION

Working conditions among the Israeli container truck drivers that we interviewed appear to be severe, despite short travel distances and journey lengths, in addition to the very low frequency of all-night trips. Approximately 38% of the drivers had worked more than the legal 12 hour daily driving limit one day before interview. A driver starting work at 0500 could log 12 hours by 1700 and 19 hours by midnight, as happened with a small subgroup.

More than 30% the 160 drivers recalled falling asleep at least once while driving, and 10.6% had fallen asleep while driving in the month before the interview. Among the drivers, 21.3% had indications they suffered from sleep disorders. Falling asleep at the wheel and being involved in a crash with casualties was strongly associated with difficulty finding parking and rest stops, an extremely common problem, and poor sleep quality in the subgroup reporting this problem. The finding that fatigue on the job, falling asleep on the wheel, and prior involvement in crashes occurred more often than not without self reported problems with sleep quality suggests that working conditions were the major risk for all three outcomes. Subjective assessment of fatigue underestimated its occurrence as verified by the Pittsburgh Sleep Quality Questionnaire.

Table 2 Risks associated with fatigue, falling asleep at the wheel, and casualty related crashes: Israeli marine port drivers, 1997 (n = 160)

Determinants and conditions	Intermediate				Final							
	Experienced fatigue while driving		Fell asleep while driving (during entire career) [§]		Crash with deaths/injuries [¶]							
	+	-	OR	OR adjusted	+	-	OR	OR adjusted				
Moderate to severe sleep quality	20	14	2.8 (1.3-6.0)	1.8 (0.7-4.8)	15	19	2.1 (0.9-4.5)	1.3 (0.5-3.3)	12	22	2.7 (1.8-6.4)	2.9 (1.0-8.2)
Experienced fatigue while driving	58	58	7.8 (2.9-21.2)	6.9 (2.2-21.2)	48	68	14.8 (3.4-64.2)	12.7 (2.8-59.2)	15	48	1.4 (0.6-3.0)	0.6 (0.2-1.5)
Frequent difficulty finding parking when tired	37	30	3.2 (1.6-6.2)	2.8 (1.3-6.4)	27	40	2.1 (1.0-4.0)	1.7 (0.9-4.0)	29	87	3.3 (1.1-10.1)	3.7 (1.0-13.9)
Employer demand: driver work beyond legal hour limit	52	47	4.4 (1.8-11.1)	2.0 (0.6-6.0)	41	58	2.8 (1.1-7.1)	1.2 (0.4-3.5)	15	52	1.2 (0.6-2.6)	1.2 (0.5-3.1)
Workday >12 hours several times a week to daily	4	22	0.73 (0.2-2.8)	0.291 (0.1-1.5)	2	24	0.3 (0.1-1.8)	0.2 (0.0-1.1)	24	75	1.9 (0.7-5.5)	1.3 (0.4-4.7)
Workday >12 hours/several times a month	63	97			50	110			4	33	1.1 (0.3-4.5)	0.7 (0.1-3.1)
Total									33	127		

*All variables are categorical variables except for years of experience and body mass index.

†Odds ratios (OR) and 95% confidence intervals (95% CI) for the outcome variable for each predictor variable, adjusted for all other variables including body mass index, reported high blood pressure and years of driving experience. ORs and CIs were obtained by using multiple logistic regression. p Value for adjusted model.

‡Full model for Y(fatigue): likelihood ratio χ^2 is 41.455 (df=8), p<0.0001, reject the null hypothesis that all ORs are equal to 1.0.

§Full model for Y(asleep): likelihood ratio χ^2 is 31.586 (df=8), p<0.0001, reject the null hypothesis that all ORs are equal to 1.0.

¶Full model for Y(crashes): likelihood ratio χ^2 is 20.32 (df=9), p=0.016, reject the null hypothesis that all ORs are equal to 1.0.

Limitations

These findings are limited to a “grab sample” type group of marine port container drivers—a relatively select group of truck drivers. As regards selection biases, we surmise we were more likely to interview drivers with more time between loading and unloading and those not afraid of being fined by the police for violations of the permitted daily driving limits. The fact that some interviewees refused to continue to answer questions when asked about their relationship with their employers or their driving histories suggests that we were unable to interview drivers working under the most severe driving conditions.

The rushed working conditions at the registration centers accounted for the high non-response rate (75%). We were unable to ascertain the direction, if any, of biases from this high non-response rate, nor rule out recall bias. However the general direction of associations and internal fit between all indicators of work conditions and the three outcomes of increasing severity were strikingly coherent, and consistent with findings reported elsewhere. The positive associations between a heavy work schedule (working several days a week >12 hours) and fatigue, falling asleep at the wheel, and crashes, compared with negative associations found between a lighter work schedule and the same outcomes adds internal coherence to the findings.

We suspect that our findings underestimated hazards and risks. Also, so as to not deter interviewees, we did not ask about drink and drug use, which make a non-trivial contribution to one vehicle fatal crashes (a virtually non-existent outcome for drivers of container trucks in Israel) as well as two vehicle fatal night-time crashes.¹⁸

Fatigue is generally well correlated with sleep quality.¹⁹ Previous involvement in a crash with injuries or fatalities was positively associated with moderate to severe impairments in sleep quality as assessed from the Pittsburgh Sleep Quality

Index and negatively associated with answers from a simple query (“do you experience fatigue when driving?”; a far less sensitive question). The simplest and most plausible explanation for this discrepancy is that drivers themselves underestimate, ignore, or deny levels of fatigue associated with increased risk for crashes.

Preventive implications

The three main occupational determinants of fatigue are reported to be length of work day, duration of time spent away from work for rest, and work-rest pattern in a 24 hour day.²⁰ Israeli container drivers are at risk for work related fatigue, falling asleep at the wheel, involvement in crashes resulting from difficulty finding rest stops, employer pressures, and long work hours—even in the majority without sleep quality impairments.

In 1988, Hertz reported that 41% of heavy truck crashes occurred after 16 hours or more on duty.²¹ Among Australian long haul drivers, 51% exceeded 14 hours of driving, 40% of dangerous events occurred among those who reported sleeping less than 6 hours, and crash risks were 2.5 times greater after 14 hours of work compared with less than 10 hours.²² Our findings show that Israeli short haul truckers with journeys usually much shorter than 200 km (approximately 120 miles) and workdays exceeding 12 hours/day had increased risks for falling asleep at the wheel (unadjusted OR 2.8; p<0.05; adjusted 1.2; p>0.05).

The high toll of road deaths from truck crashes and the adverse working conditions of many Israeli truck drivers state the case for preventive measures. The fact that self-reported fatigue and falling asleep at the wheel occurred in most drivers without problems in sleep quality points to the importance of the work conditions—above all, problems with finding parking and rest spots, along with long hours and employer pressure, as the most important determinants of

Table 3 Truck crashes: preventing death and injury

Phase	Drivers	Vehicle	Environment
Pre	80 kph limit (motorway) 30 kph (urban residential) Three second headway rule Frequent rest breaks (every 4 hours) Buddy system—irregular hours Selection—older drivers Young truck drivers at greater risk Sleep >7 hours Enforce daily permissible work limit (12 hours/day)* Evaluate implementation of ILO recommended daily work limit (9 hours/day) Hydration: thermos for drinking (see my notes in rebuttal and condense into note Unpublished investigation, 1985, for Israel Defense Forces) Screening and treatment for sleep disorders Selective licensing—hazardous chemicals	Tachygraphs—routine monitoring Governors Light reflective markings Prevent overloading	Side ports on steep planes Electronic speed roadside cameras – on line – off line Rest stops for drivers and publicly promote their locations Modal shifts: rail, roll-on, roll-off containerization
During		Maintenance checks Tire shock absorbers—front and rear—retrofit Tire standards	
Post		First aid kits Two way radio Protective clothing—hazardous material	

*The recommendations above are those stated in the standards and recommendations issued by the International Labor Organization (ILO) and Transport & General Workers Union.²⁶

fatigue. But the fact that many crashes with injuries occurred without fatigue suggests that interventions based on targeting fatigue and work conditions alone cannot be expected to prevent all truck related deaths and injuries. Therefore, other measures, including speed control and shifts to alternative modes of transportation are required.

We present a list of preventive measure in the framework of the Haddon Grid (table 3), and a model (fig 2, which can be found at <http://www.injuryprevention.com/supplemental>) that examines reinforcing interrelations between job stressors, individual host risks, non-work risks, and individual acute reactions and the mitigating effects of interventions. The destructive combination of mass and velocity, the role of raised speed limits in increasing deaths from truck crashes, and the success of speed cameras in the UK and Australia in reducing road deaths state the case for their benefits,²³ with or without measures specifically targeting fatigue risks. Additional measures include regulatory monitoring of tachygraphs (for speed and work hours), and industry wide screening of truckers for sleep disorders and poor sleep quality to identify this high risk group. Such screening for high risk individuals should not serve as an alternative to improving work conditions.

The dominant role of searching for parking and rest stops as a risk for fatigue, falling asleep at the wheel, and crashes states the case for roadside rest stops. Enforcement of International Labor Organization (ILO)²⁴ standards—would curb many dangerous practices. These standards specify a ceiling of nine hours of work per day or 48 hours per week, which is substantially less than 12 hours/day and 68 hours/week permitted by Israeli regulations. The ILO also specifies not driving for more than four hours without rest.

We recommend higher base wages and doing away with incentive productivity premiums for trips completed. Low base pay and premiums, promoting travel at higher speeds, increase the risks. Because interventions targeted at risks for fatigue and falling asleep at the wheel and crashes will not by themselves prevent all truck related injuries, there is a strong case for “out of the box” solutions based on modal shifts to rail shipment, and roll-on/roll-off rail truck container systems.

Our findings indicate that fatigue, falling asleep while driving, and fatal crashes among truck drivers can occur without the so-called tyranny of long travel distances and overnight travel. Furthermore, involvement in crashes can occur without fatigue or problems with sleep. The economic profit margins and competitiveness of truck transport create pressures for maximum amounts of mass moved from source to destination in a minimum of time through use of double trailers, maximum loads, higher travel speeds, and long working hours.

Israel's trucker union is weak and only a small minority of interviewed truckers belonged to it. Therefore policy change must come from government agencies. The US Department of Transportation Truck and Bus Safety Summit²⁵ ranked fatigue as the first priority out of 17 target issues.

We hypothesize that reducing fatigue related truck crashes, together with speed control, would save many lives.²⁶⁻²⁷ But experimental intervention is required to determine which combination of interventions drawn from ILO standards and the Haddon Grid give the largest, swiftest, and most cost effective reductions in the toll of death and injury.

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Key points

- Trucks represent 6% of all vehicles, but account for 20% of road deaths in Israel even though travel distances are short (<200 km) and overnight travel is uncommon.
- Long work hours, falling asleep at the wheel, and employer pressures to work long hours were common in port container truck drivers. Involvement in crashes with casualties was associated with poor sleep quality and frequent difficulty finding parking when tired.
- Fatigue occurred in many drivers without sleep problems, and many crashes occurred without fatigue. Self assessment was an insensitive indicator of fatigue.
- Prevention requires measures to reduce work stresses, screening drivers, speed control, and modal shifts—even in a small country without “the tyranny of distance”.

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