Fatigue Management in First Responders

Developing Evidence Based FRM Guidelines for EMS
Expert Panel Meeting
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HARVARD MEDICAL SCHOOL

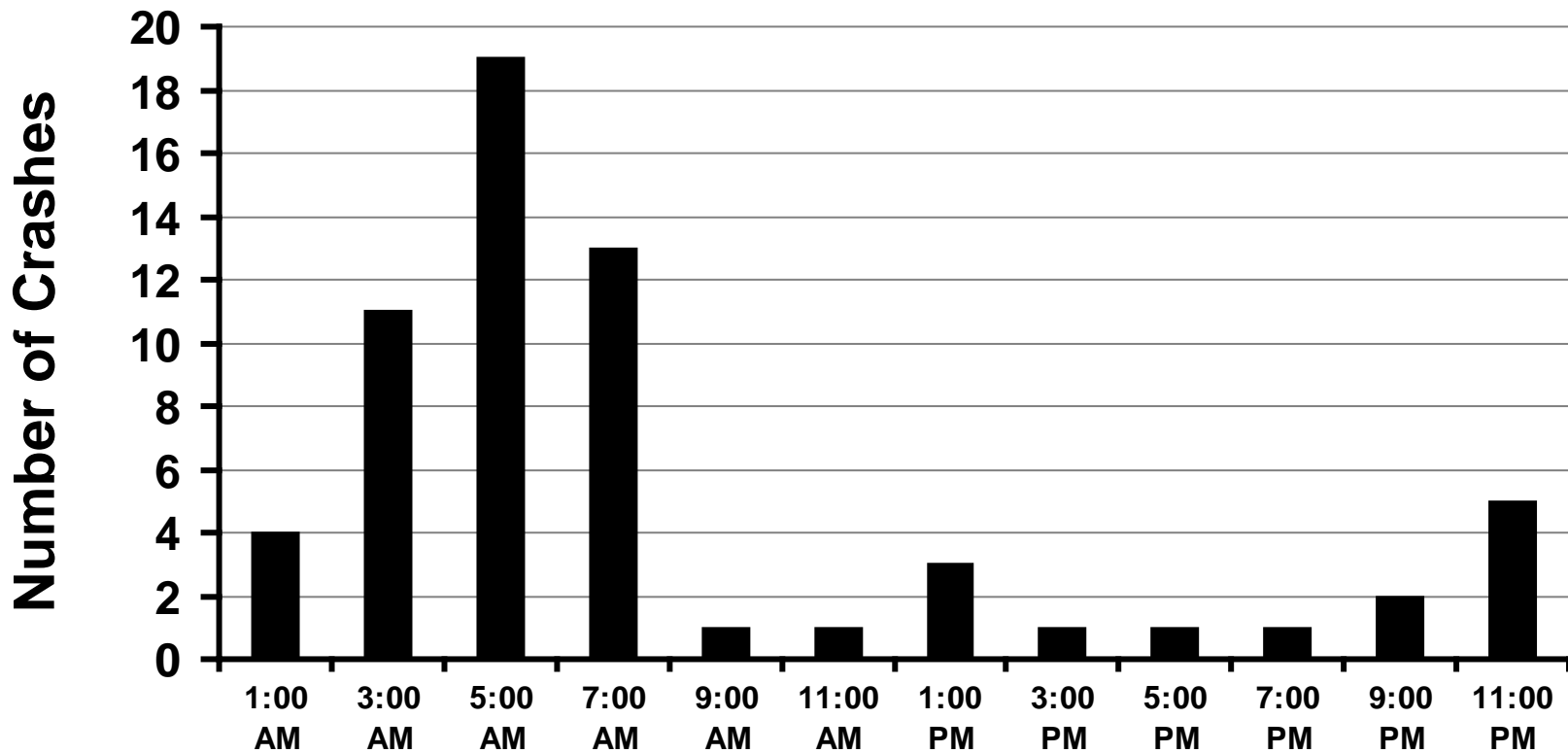BWH BRIGHAM AND WOMEN'S HOSPITAL

Determinants of Alertness

- Biological time of day (circadian rhythms)
- Consecutive waking hours
- Nightly sleep duration
- Sleep inertia
- Sleep disorders
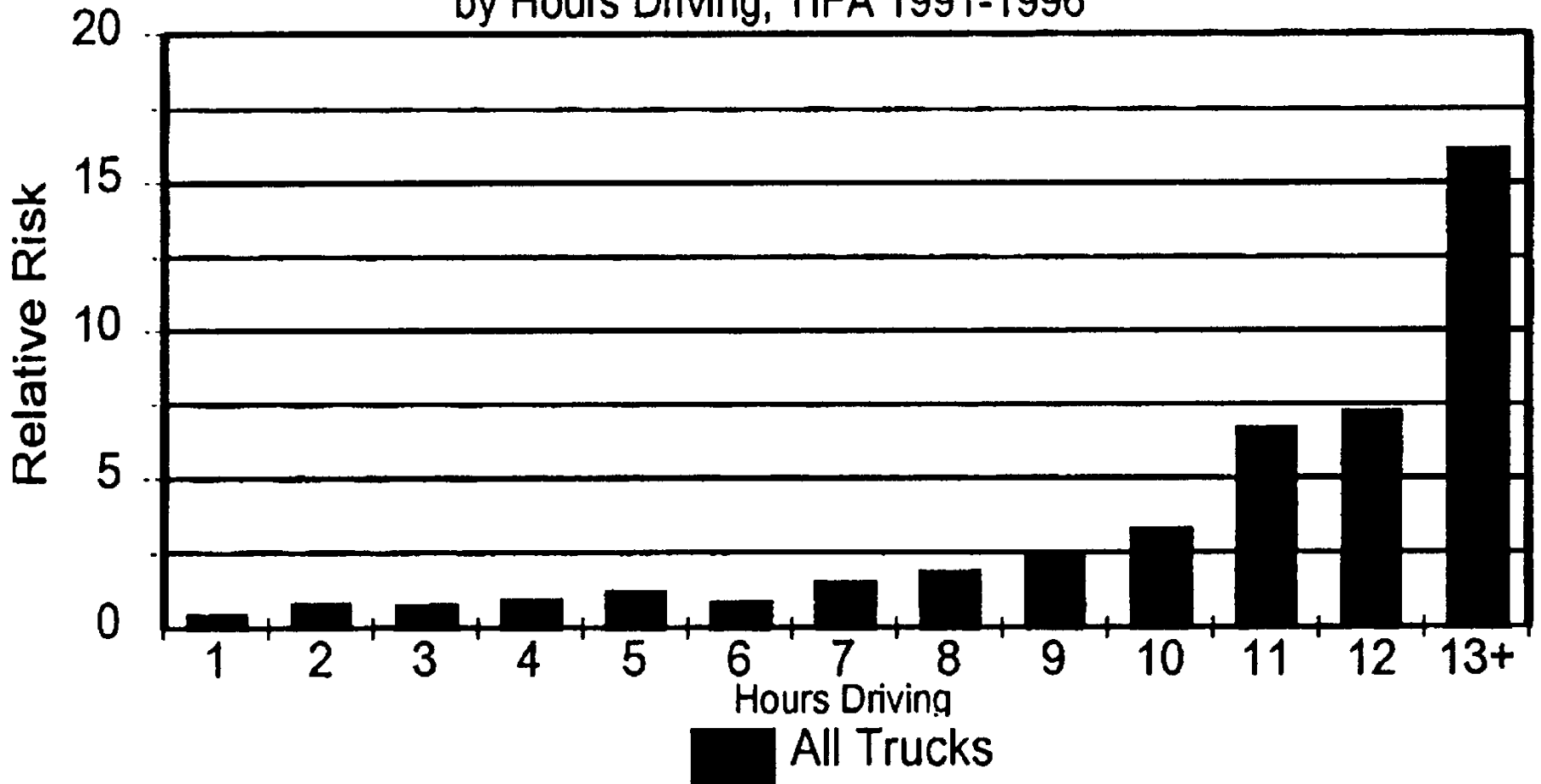
Biological Time of Day

Temporal Distribution of Fatigue-related Single Vehicle Truck Crashes

National Transportation Safety Board Safety Study (SS-1995/01)

Consecutive Hours Awake

Relative Risk of Fatigue Crash
by Hours Driving, TIFA 1991-1996
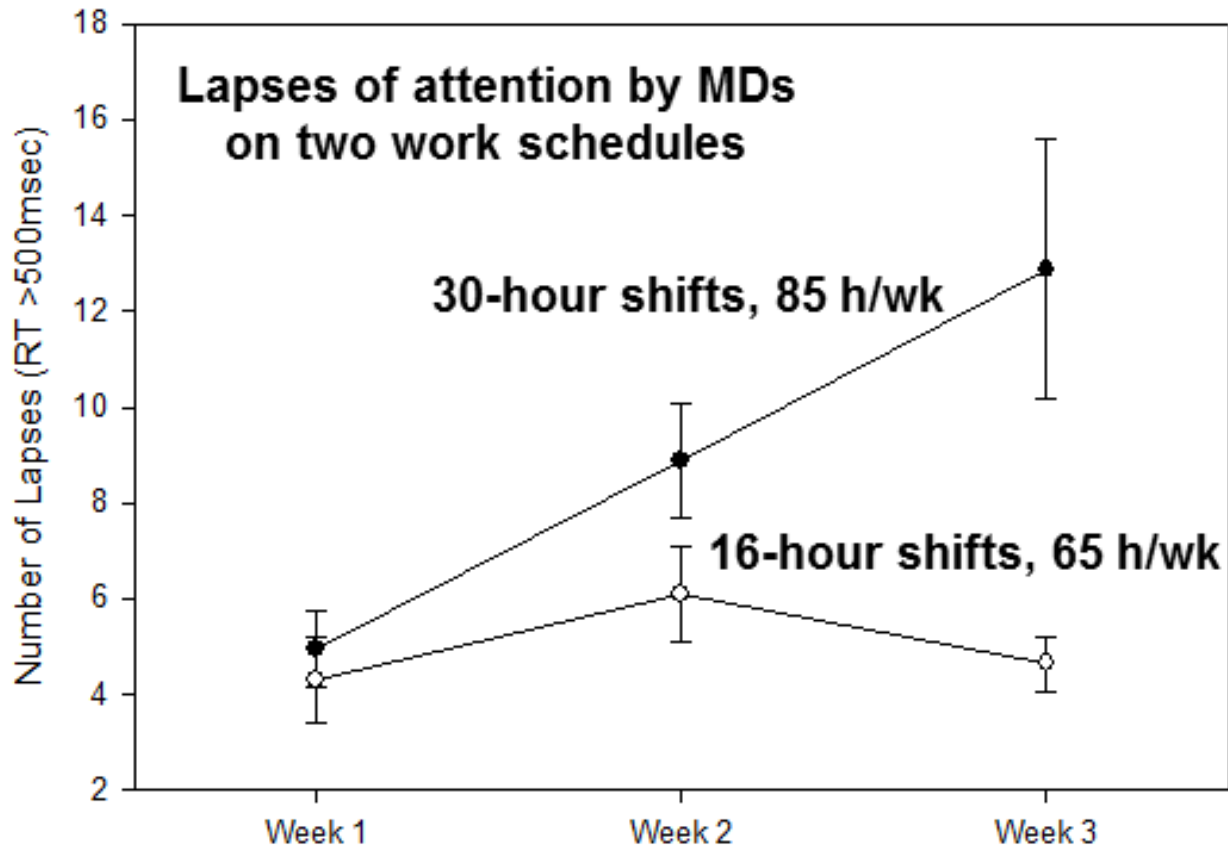
- **109% more attentional failures at night >16 hours**
- **36% more serious medical errors** working 30-h
- **464% more serious diagnostic errors** in the ICU
- **168% more car crashes** commuting after >24-h shifts
- **468% more near-miss car crashes** after >24-h shifts
- **73% greater risk of needle stick or scalpel lacerations** after >20 consecutive hours at work
- **171% more complications** in patients undergoing elective surgery if attending surgeon had <6 h sleep opportunity during prior night on call

Nightly Sleep Duration

Anderson C, Sullivan JP, Flynn-Evans EE, Cade BE, Czeisler CA, Lockley SW. Deterioration of neurobehavioral performance in resident physicians during repeated exposure to extended duration work shifts. Sleep. 2012 Aug 1;35(8):1137-46.

Recurrent Circadian Disruption interacts with Chronic Sleep Deficiency to degrade Performance
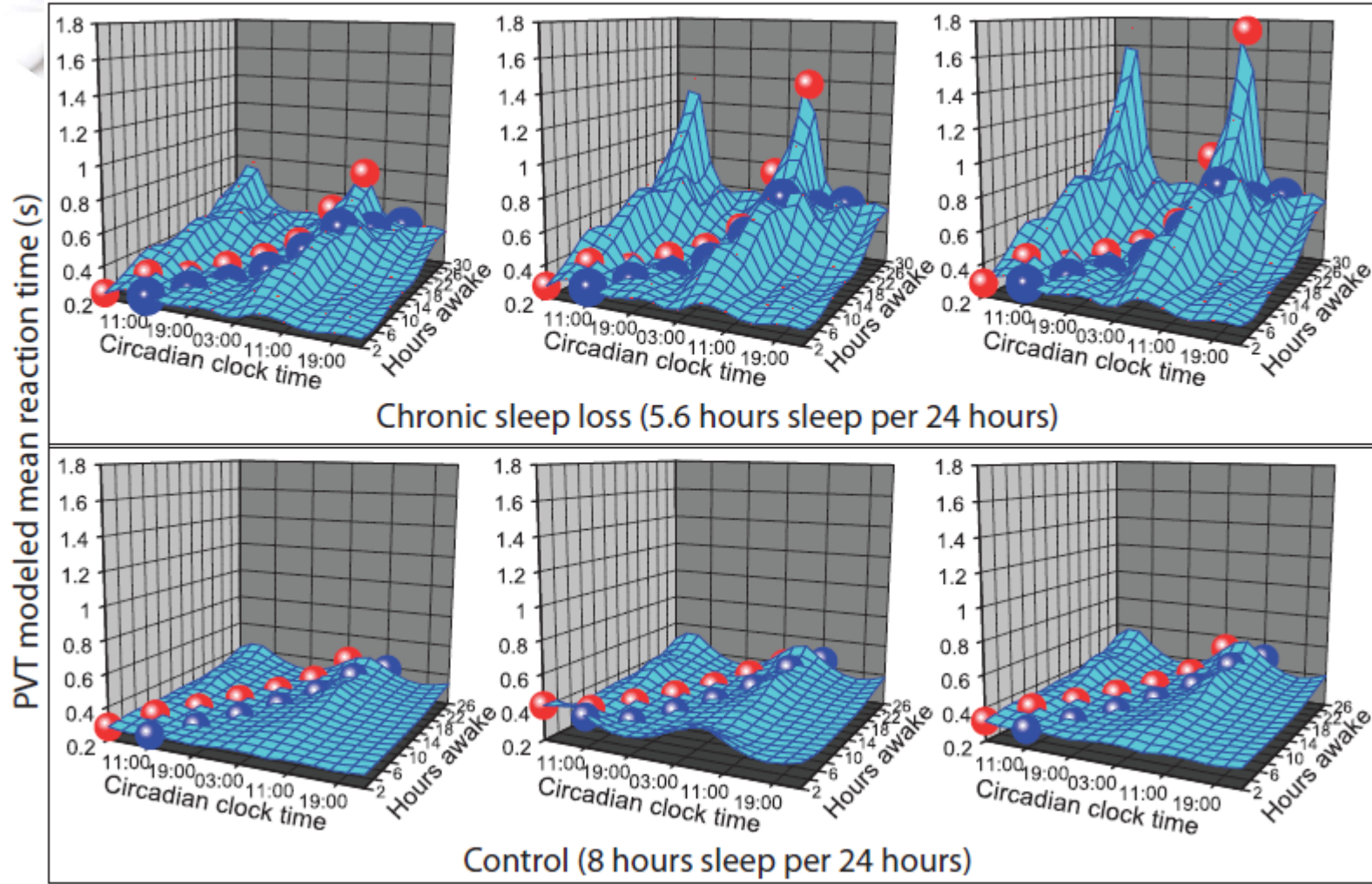
Cohen DA, Wang W, Wyatt JK, Kronauer RE, Dijk D-J, Czeisler CA, Klerman EB. Uncovering residual effects of chronic sleep loss. *ScienceTransl Med 2*: 14ra3, 2010.

8

Sleep Inertia

Fighters

All aircraft

Subjective Alertness — Deviation from Mean (mm)

Cognitive Throughput — Deviation from Mean (# attempted)

Hours Since Scored Waketime

Hourly accident coefficient

Hours since wake time
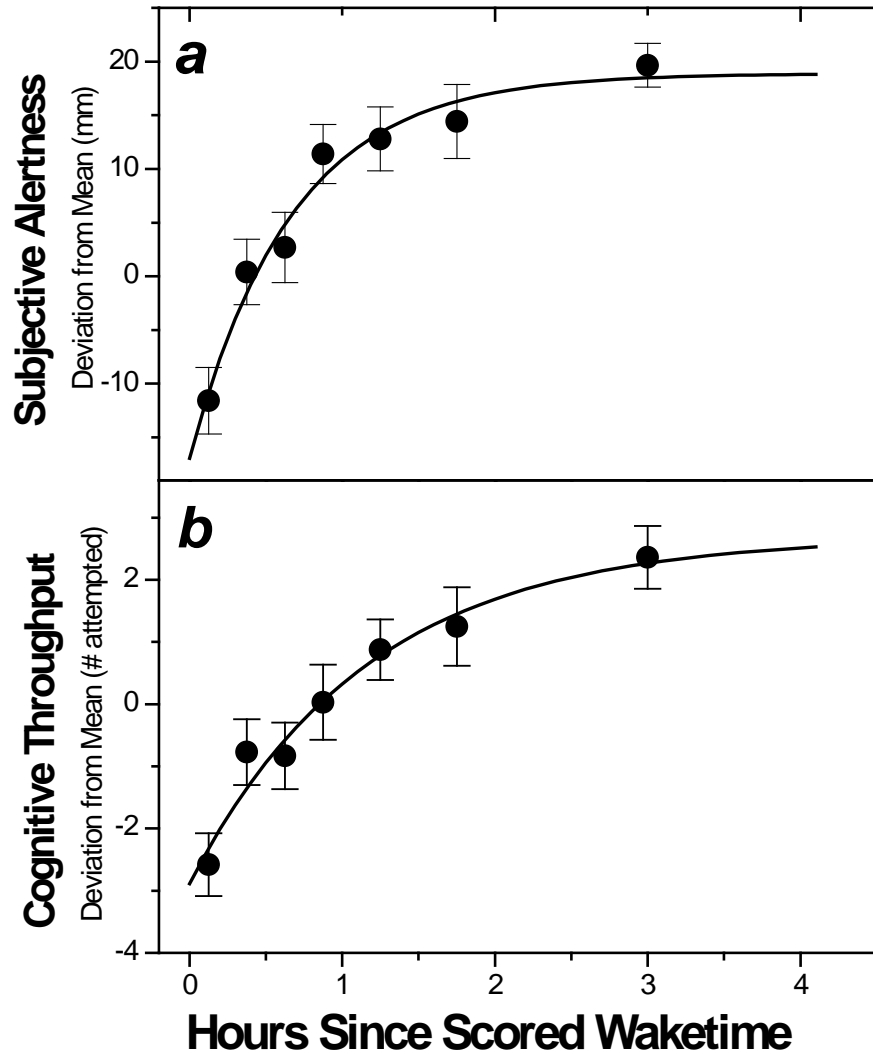
Jewett et al., J. Sleep Res., 1999
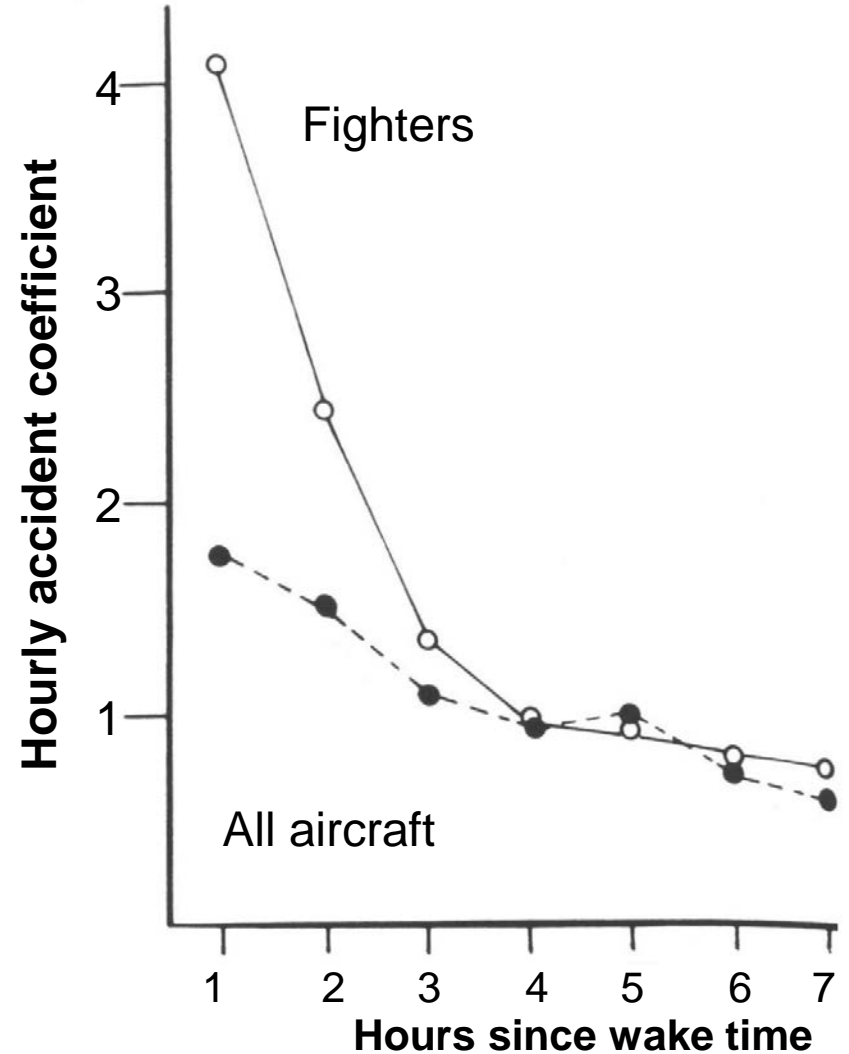
Ribak et al., Aviat. Space Environ. Med., 1983

Sleep Disorders

SLEEP DISORDERS AND SLEEP DEPRIVATION: AN UNMET PUBLIC HEALTH PROBLEM

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SLEEP DISORDERS AND SLEEP DEPRIVATION

AN UNMET PUBLIC HEALTH PROBLEM

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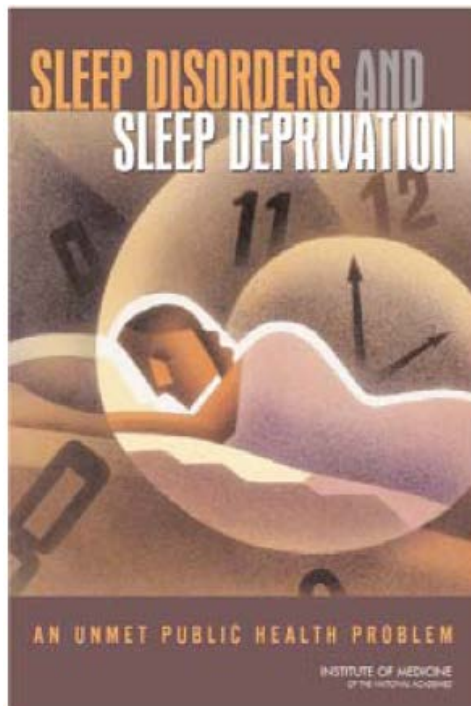
2006

"The cumulative effects of sleep loss and sleep disorders represents an under-recognized public health problem and have been associated with a wide range of health consequences including an increased risk of hypertension, diabetes, obesity, depression, heart attack, and stroke.

Almost 20 percent of all serious car crash injuries in the general population are associated with driver sleepiness."

Fatigue Risk Management Systems

| Determents of Alertness	Fatigue management considerations
Biological time of day	Night shifts, scheduling policies
Consecutive waking hours	Maximum shift lengths, trading shifts
Nightly sleep duration	Mandatory time off between shifts
Sleep inertia	At-work nap policies
Sleep disorders	Occupational screening

Fatigue risk management in police officers

Police Officer Death Rates in the U.S.

Line of Duty, by Cause, 1974-2004

Felonious vs. Accidental
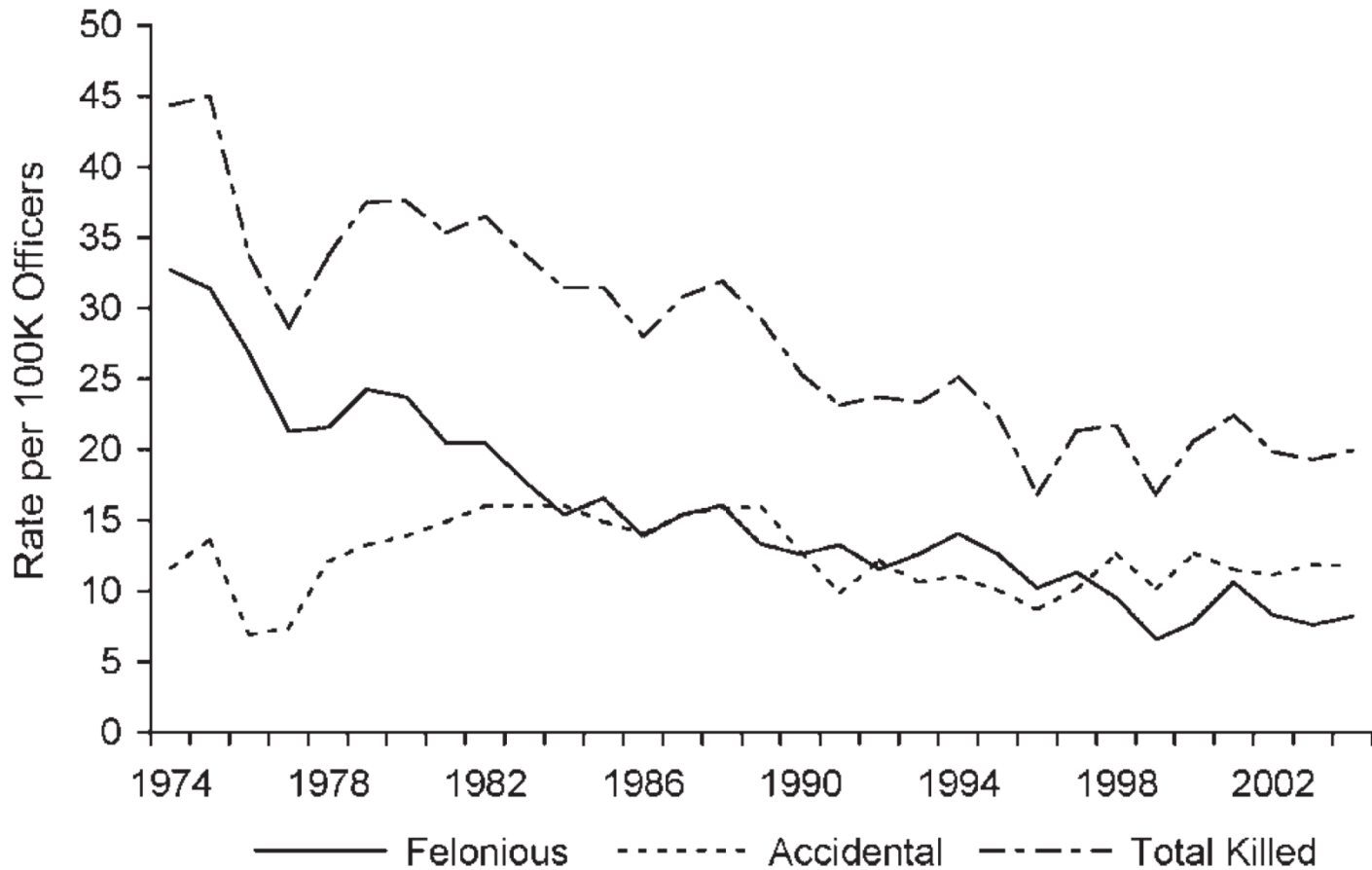
RESEARCH BULLETIN

Law Enforcement Fatalities Spike Dangerously in 2010

Following a two year decline, law enforcement fatalities in 2010 spiked to 162. This was an increase of nearly 40 percent compared to last year, when 117 officers were killed in the line of duty.

Preliminary data from the National Law Enforcement Officers Memorial Fund show that for the 13th year in a row, traffic fatalities were the leading cause of officer fatalities, with 73 officers killed in the line of duty—an increase of 43 percent from 2009.

Of the 73 traffic-related fatalities in 2010, 50 officers died in automobile crashes, 16 were struck and killed by automobiles while outside of their vehicles, 1 died in a bicycle accident, and 6 died in motorcycle crashes.

Shift re-scheduling program

TABLE I. Self-Reported Results of Philadelphia Police Shift Rescheduling Program Participants [Adapted from Czeisler, 1988]

Percent respondents reporting	Control sample		Treatment precinct	
	% Pre-test (n = 198)	% Post-test (n = 177)	% Pre-test (N = 145)	% Post-test (N = 114)
Falling asleep at work	72	75	70	51
Poor quality sleep	16	24	22	7
Insufficient sleep	59	69	52	39
No problem with daytime fatigue	12	14	17	31
Always or frequently tired	46	47	40	21
Sleeping pill use	11	8	8	4
Daily alcohol use	14	13	17	8
Family work-schedule satisfaction	10	10	9	48

Fatigue Risk Management Systems

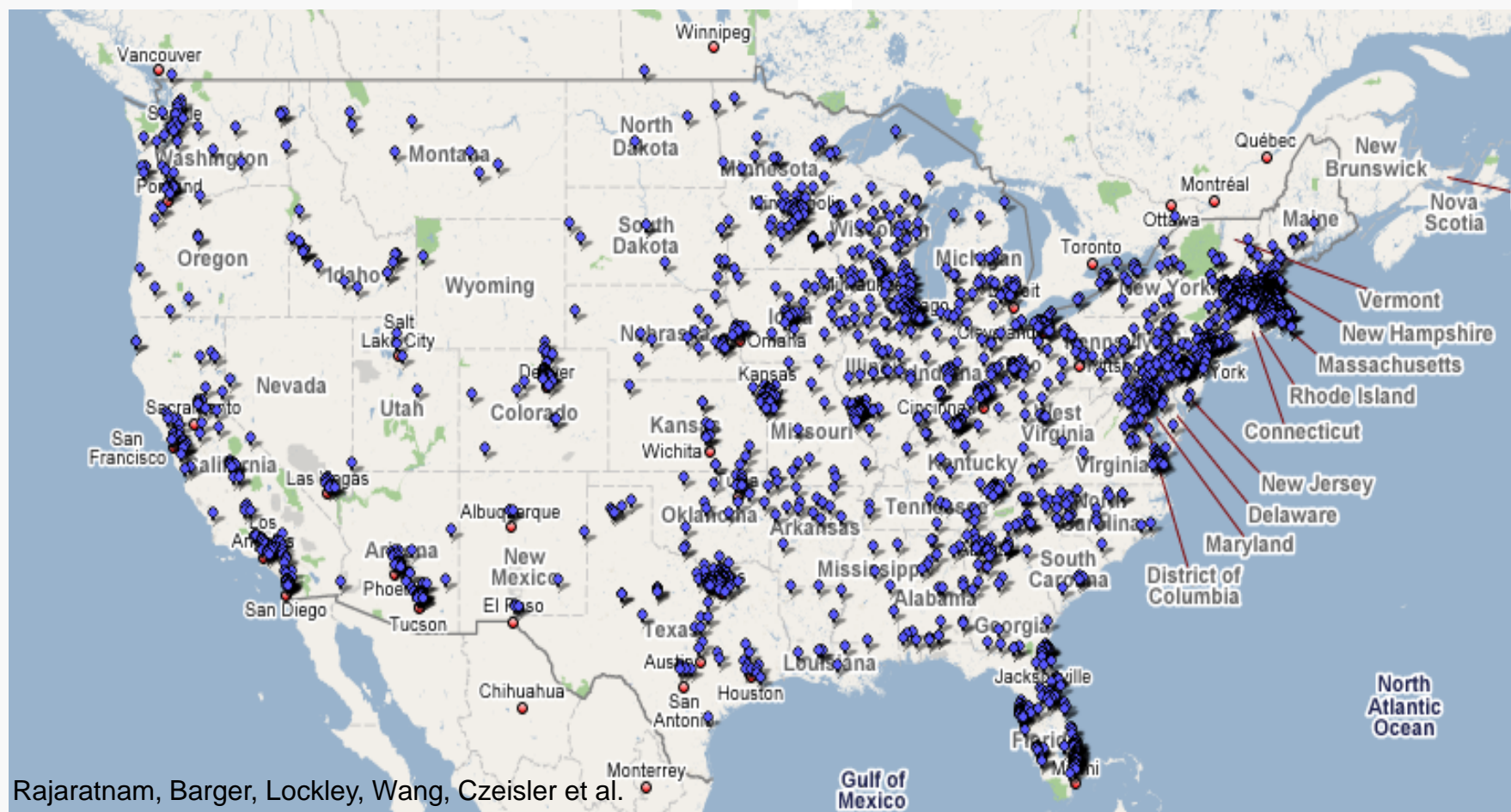- Hours of service
- Scheduling practices
- Education
- Sleep disorders screening
- Policies
- Reporting
- Monitoring

Harvard Work Hours, Health and Safety Group
OPERATION HEALTHY SLEEP POLICE STUDY

4,957 North American Police Officers

Rajaratnam, Barger, Lockley, Wang, Czeisler et al.

Police Sleep Disorder Screening

	All participants	Subgroups			Participant with current sleep disorder diagnosis
		Online	State Police	Municipal Police	
Obstructive sleep apnea, %	33.6 %	36.0 %	20.3 %	32.2 %	15.1 %
Insomnia (moderate to severe) , %	6.5 %	7.0 %	3.8 %	-	21.7 %
Shift work disorder, %	14.5 %	15.3 %	7.0 %	-	7.6 %
Restless legs syndrome, %	1.6 %	1.7 %	1.0 %	-	34.3 %
Narcolepsy with cataplexy, %	0.4 %	0.4 %	0	-	0

Rajaratnam SMW, Barger LK, Lockley SW, Shea SA, Wang W, Landrigan CP, O'Brien C, Qadri S, Sullivan JP, Cade BE, Epstein LJ, White DP, Czeisler CA. JAMA 2011 306: 2567-78

Self-reported sleepiness

Rajaratnam SMW, Barger LK, Lockley SW, Shea SA, Wang W, Landrigan CP, O'Brien C, Qadri S, Sullivan JP, Cade BE, Epstein LJ, White DP, Czeisler CA. JAMA 2011 306: 2567-78
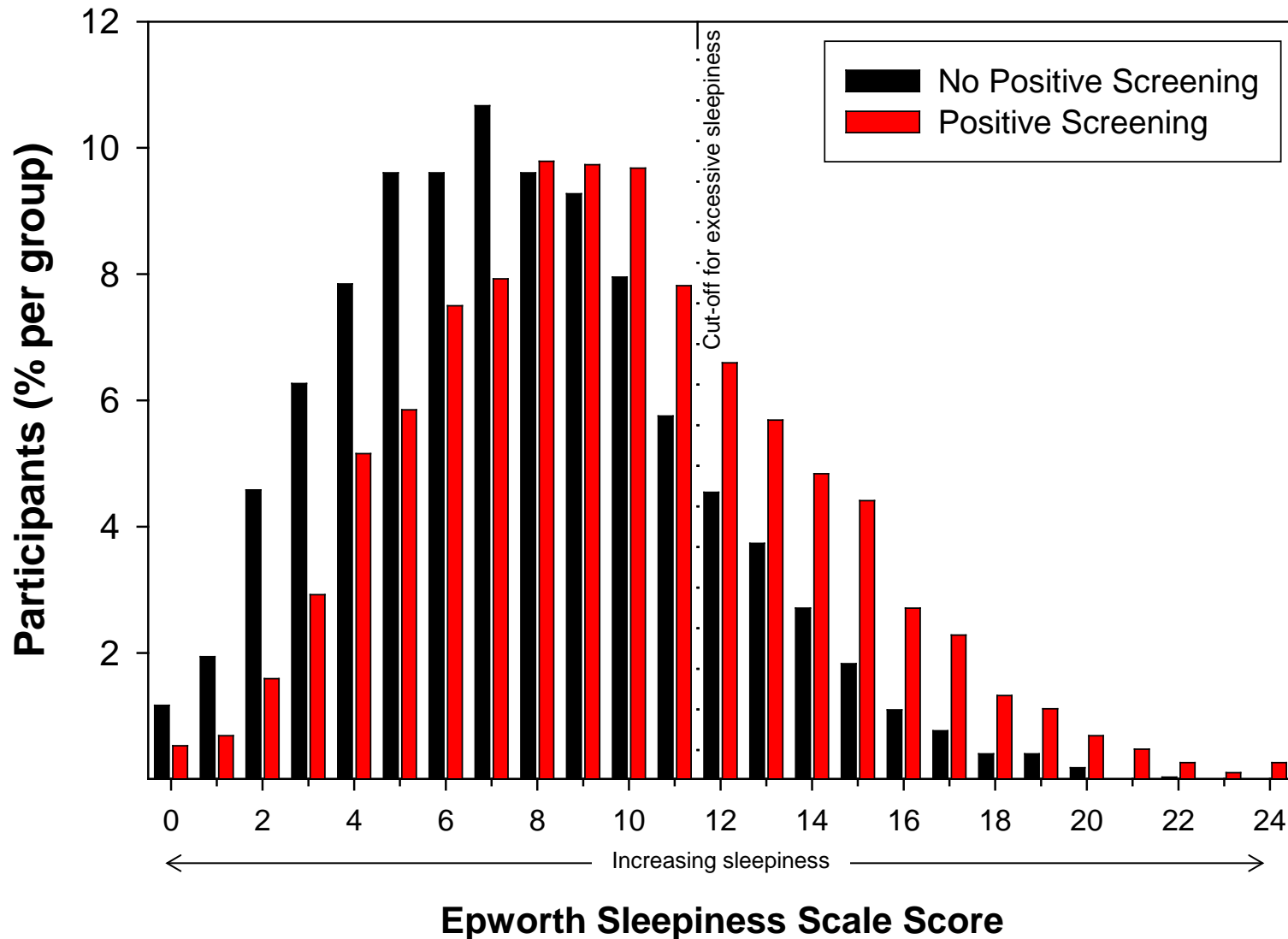
Police Officers

- Excessive sleepiness is common in police officers.

  - Almost half reporting having fallen asleep while driving
  - One-quarter reporting that this occurs 1 to 2 times per month.

- This is despite police officers apparently recognizing the dangers associated with drowsy driving; in a survey of North American police officers, almost 90% regarded drowsy driving to be as dangerous as drunk driving.

Rajaratnam SMW, Barger LK, Lockley SW, Shea SA, Wang W, Landrigan CP, O'Brien C, Qadri S, Sullivan JP, Cade BE, Epstein LJ, White DP, Czeisler CA. JAMA 2011 306: 2567-78

Self-reported characteristics of participants screening positive vs. those screening negative for sleep disorders

	Any sleep disorder		
	Positive screening	**Negative screening**	**P[a]**
N (%)	2,003 (40.4)	2,954 (59.6)	
Age, *y* Mean ± SD *(range)*	39.9 ± 8.3 *(20 – 66)*	37.5 ± 8.3 *(20 – 77)*	<0.001
Employed in police work, *y* Mean ± SD *(range)*	14.2 ± 8.2 *(0 – 40)*	11.6 ± 8.0 *(0 – 41)*	<0.001
Sex, *n (%) (95% CI)* Women Men Not known	 250 (12.5) (11.0-13.9) 1,753 (87.5) (86.1-89.0) 0 (0)	 611 (20.7) (19.2-22.1) 2,326 (78.7) (77.3-80.2) 17 (0.6)	<0.001
Body mass index, *n (%) (95% CI)*[†] < 25 kg/m^2 ≥ 25 and < 30 kg/m^2 ≥ 30 and < 35 kg/m^2 ≥ 35 kg/m^2 Not known	 209 (10.4) (9.1-11.8) 603 (30.1) (28.1-32.1) 827 (41.3) (39.1-43.4) 359 (17.9) (16.2-19.6) 5 (0.2) (0.0-0.5)	 785 (26.6) (25.0-28.2) 1,664 (56.3) (54.5-58.1) 392 (13.3) (12.0-14.5) 85 (2.9) (2.3-3.5) 28 (0.9)	<0.001
< 30 kg/m^2 ≥ 30 kg/m^2 Not known	812 (40.5) (38.4-42.7) 1,186 (59.2) (57.1-61.4) 5 (0.2) (0.0-0.5)	2,449 (82.9) (81.5-84.3) 477 (16.1) (14.8-17.5) 28 (0.9)	<0.001
Body mass index, *kg/m^2* Mean ± SD *(range)*	30.9 ± 4.9 *(15.8 – 56.5)*	27.1 ± 3.7 *(17.0 – 49.4)*	<0.001

Rajaratnam SMW, Barger LK, Lockley SW, Shea SA, Wang W, Landrigan CP, O'Brien C, Qadri S, Sullivan JP, Cade BE, Epstein LJ, White DP, Czeisler CA. JAMA 2011 306: 2567-78

Performance, safety outcomes and attentional failures associated with positive sleep disorder screening

	Odds ratio[†]	% increased risk
Serious administrative error – actual	1.43 (1.23-1.67)	41
Fall asleep while driving	1.51 (1.20-1.90)	57
Error or safety violation – attributed to fatigue	1.63 (1.43-1.85)	53
Occupational Injury	1.22 (1.01-1.49)	26
Uncontrolled anger towards suspect/citizen	1.25 (1.09-1.43)	20
Citizen complaints	1.35 (1.13-1.61)	19
Serious administrative error – near-miss	1.55 (1.32-1.80)	41
Absenteeism (all cause sickness absence)	1.23 (1.08-1.40)	24
Fall asleep during meetings at the police department	1.95 (1.52-2.52)	101
Fall asleep on the telephone	1.86 (1.20-2.89)	94
Fall asleep while stopped in traffic	1.38 (1.08-1.76)	51

[†]Adjusted for age, sex, BMI, primary police activity, second job, mean total work hours per week, number of night shifts worked, monthly sleep and shift rotation. Only those variables that were significant were included in the final model. *Rajaratnam, et al. JAMA 2011*

Comorbidities and adverse health outcomes associated with sleep disorders

	Positive vs. negative sleep disorder screening result Adjusted OR† (95% CI)	Positive vs. negative OSA screening result Adjusted OR† (95% CI)
Diabetes	ns	2.10 (1.26, 3.50)
Cardiovascular disease	ns	1.96 (1.07, 3.59)
Gastrointestinal disorder	1.48 (1.12, 1.97)	1.74 (1.42, 2.13)
Depression	2.75 (1.66, 4.56)	2.76 (2.00, 3.82)
Anxiety disorder	3.07 (1.78, 5.31)	2.22 (1.53, 3.23)
Health status	1.70 (1.35, 2.14)	1.89 (1.53, 2.33)
Pharmacotherapy for insomnia	1.87 (1.37, 2.55)	2.19 (1.71, 2.81)
Caffeine consumption	ns	2.35 (1.66, 3.32)
Fall asleep while driving after work	4.40 (2.81, 6.89)	2.21 (1.70, 2.87)
Burnout – emotional exhaustion	3.15 (2.28, 4.37)	2.55 (2.01, 3.23)
Burnout – depersonalization	1.62 (1.30, 2.02)	1.50 (1.25, 1.79)

†Adjusted for age, sex, BMI, hypertension, cigarette smoking, alcohol consumption, primary police activity, second job, mean total work hours per week, night shift work, and shift rotation. Only those variables that were significant were included in the final model.

Rajaratnam, et al. JAMA 2011

Firefighter Research Program

Phase 1 – Nationwide study of prevalence of sleep disorders and association with health and safety outcomes

Phase 2 – Effectiveness of a sleep health program in urban department

Phase 3 – Comparison of different methods of implementing sleep health programs

Phase 4 – Sleep health program plus policy intervention and improved sleep quarters in urban department – feasibility, acceptability and effectiveness

67 fire departments participated

*881 fire stations, 19,581 firefighters

Barger, et al. JCSM 2015

Firefighter Sleep Disorder Screening

- 37.2% screened positive for a sleep disorder

  - 28.4% Obstructive Sleep Apnea

  - 6.0% Insomnia

  - 9.1% Shift Work Disorder

  - 9.1% Restless Legs Syndrome

    n= 6,933 firefighters in 66 departments

Barger, et al. JCSM 2015

Self-reported safety outcomes, comorbidities and adverse health outcomes associated with positive sleep disorder screening

	Positive outcome with Positive sleep disorder screening n (%)	Positive outcome with Negative sleep disorder screening n (%)	Unadjusted OR (95% CI)	Adjusted OR[e] (95% CI)
Motor Vehicle Crash[a]	48(2.0)	46(1.2)	1.71 (1.14-2.57) P=0.0101	**2.00 (1.29-3.12) p=0.0021**
Near Crashes[b]	451(18.5)	345(8.7)	2.38 (2.04-2.76) P<0.0001	**2.49 (2.13-2.91) P<0.0001**
Nodding off or falling asleep while driving[b]	498(20.7)	418(10.7)	2.17 (1.89-2.50) P<0.0001	**2.41 (2.06-2.82) P<0.0001**
Cardiovascular disease[c]	60 (2.4)	36(0.9)	2.78 (1.83-4.22) P<0.0001	**2.37 (1.54-3.66) P<0.0001**
Diabetes[c]	98 (3.9)	55(1.3)	3.01 (2.15-4.20) P<0.0001	**1.91 (1.31-2.81) P=0.0009**
Depression[c]	266 (10.5)	143(3.5)	3.29 (2.66,4.05) P<0.0001	**3.10 (2.49-3.85) P<0.0001**
Anxiety[c]	165 (6.6)	78(1.9)	3.66 (2.78-4.82) P<0.0001	**3.81 (2.87-5.05) P<0.0001**

[a] Yes vs. no, [b] At least once vs. zero, [c] Yes vs. never or not now, [d] Poor, fair, good vs. very good, excellent, [e] Adjusted for age, gender, BMI, cigarette smoking, and alcohol consumption

Barger, et al. JCSM 2015

Comparison of Methodologies for Implementing a Sleep Health Program

	Expert-Led	Train-the-Trainer	Online	Total	p-value
Number of departments	2	2	4	8	
Number of stations	38	87	119	244	
Area covered (square miles)	441.1	8780	1136	10357.1	
Number of firefighters	1630	1519	2952	6101	
Number of training sessions	110	142	-	-	
Training participation rate, n (%)	1368 (83.9)	1345 (88.5)	1890 (64.0)	4603 (75.4)	<0.0001
Baseline survey participation rate †, n (%)	1002 (61.5)	892 (58.7)	751 (25.4)	2645 (43.4)	<0.0001
Baseline survey co-operation rate †, n (%)	1002 (73.2)	892 (66.3)	751 (39.7)	2645 (57.5)	<0.0001
End-of-program questionnaire co-operation rate †, n (%)	214 (21.4)	149 (16.7)	323 (43.0)	686 (25.9)	<0.0001
Training knowledge assessment (n pre/ n post training)	750 / 749	1252 / 1249	1381 / 910	3383 / 2908	
Training - Mandatory or with Continuing Education (CE) credit	Mandatory	Mandatory	Mixed	Mixed	

Comparison of Methodologies

End-of-program questionnaire participation, diagnosis and treatment compliance					
	Expert Led	'Train-the-Trainer'	Online	Total	χ2 p-value
Total participants in end-of-program questionnaire	214	149	323	686	-
Screened at high risk for a sleep disorder, n (%)	87 (40.7)	60 (40.3)	138 (42.7)	285 (41.5)	0.84
Reported in the end-of-program questionnaire that they screened at high risk for a sleep disorder, n (%)	61 (70.1)	37 (61.7)	83 (60.1)	181 (63.5)	0.30
Sought clinical evaluation as a result of the program, n (%)*	36 (41.4*)	15 (25.0*)	27 (19.6*)	78 (27.4*)	0.0015
Recommended treatment, n (%) **	30 (83.3)	8 (53.3)	17 (63.0*)	55 (70.5*)	0.057
Compliant with treatment, n (%)**	23 (76.7)	7 (87.5)	14 (82.4*)	44 (80.0*)	0.81

42% of focus group participants reported changing their sleep behavior.

Barger, LK, O'Brien, CS, Rajaratnam, SM, Qadri, S, Sullivan, JP, Wang, W, Czeisler, CA, Lockley, SW. Implementing a sleep health education and sleep disorders screening program in fire departments: a comparison of methodology. *JOEM.* 2016.

Fatigue Risk Management Systems

- Hours of service
- Scheduling practices
- Education
- Sleep disorders screening
- Policies
- Reporting
- Monitoring

Operation Fight Fatigue

Proposed Rest Policy in Intervention Fire Stations

- Firefighters were encouraged to take a 2-3 hour rest break during each 24-hour shift
    - This rest time was encouraged to be normally taken between 4pm and 8pm.
    - If operationally feasible, the rest time could be taken before 4pm.

- Randomized clinical trial
- Sleep health education
- Screening for common sleep disorders
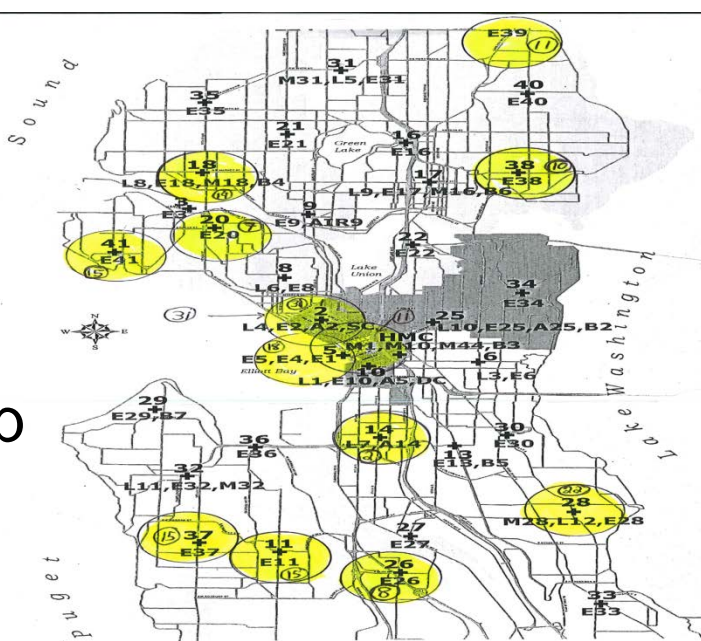
- 17 stations assigned to intervention group
- 184 black out panels were installed in 105 windows across 13 fire stations

Conclusions

- Fatigue risk management is important to implement in first responders

- Along with hours of service rules, good scheduling practices, education, sleep-friendly policies, reporting and monitoring

- Sleep disorder screening and treatment programs should be implemented as part of a comprehensive fatigue risk management program

Harvard Work Hours, Health and Safety Group

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