

**Welcome!**



# Implications of Driving While Sleepy

**DATE: Friday, 5/15/09**

**TIME; 2:00 pm Eastern**

**DURATION: 60 Minutes**

**For Audio Please Call 1.800.704.9804**

**Access code (see registration confirmation email)**

**Host: Brian Johns, DETA WEB & Tech. Officer (Idaho)**

**Moderator: David Huff, DETA Chairman, Montana DE Director**

**Speaker: Allan I. Pack, M.B., Ch.B., Ph.D.**



## Agenda

**Welcome & Introductions (5 Minutes)**

**Dave Huff**

**Presentation (30 Minutes)**

**Dr. Pack**

**Q & A with Presenters (20-25 minutes)**

**Moderated by Dave Huff and  
Brian Johns**

**Conclusion (2-3 minutes)**

**Dr. Pack**

## Courtesy & Dialogue Protocols

- ✓ Participant phones are muted by the system to ensure audio clarity.
- ✓ Submit concise questions electronically using the chat box. As many as possible will be selected for answer following presentation.
- ✓ Limit questions to subject under discussion.

# Implications of Driving While Sleepy

Allan I. Pack, M.B., Ch.B., Ph.D.

John L. Miclott Professor of Medicine

Director, Center for Sleep and Respiratory Neurobiology

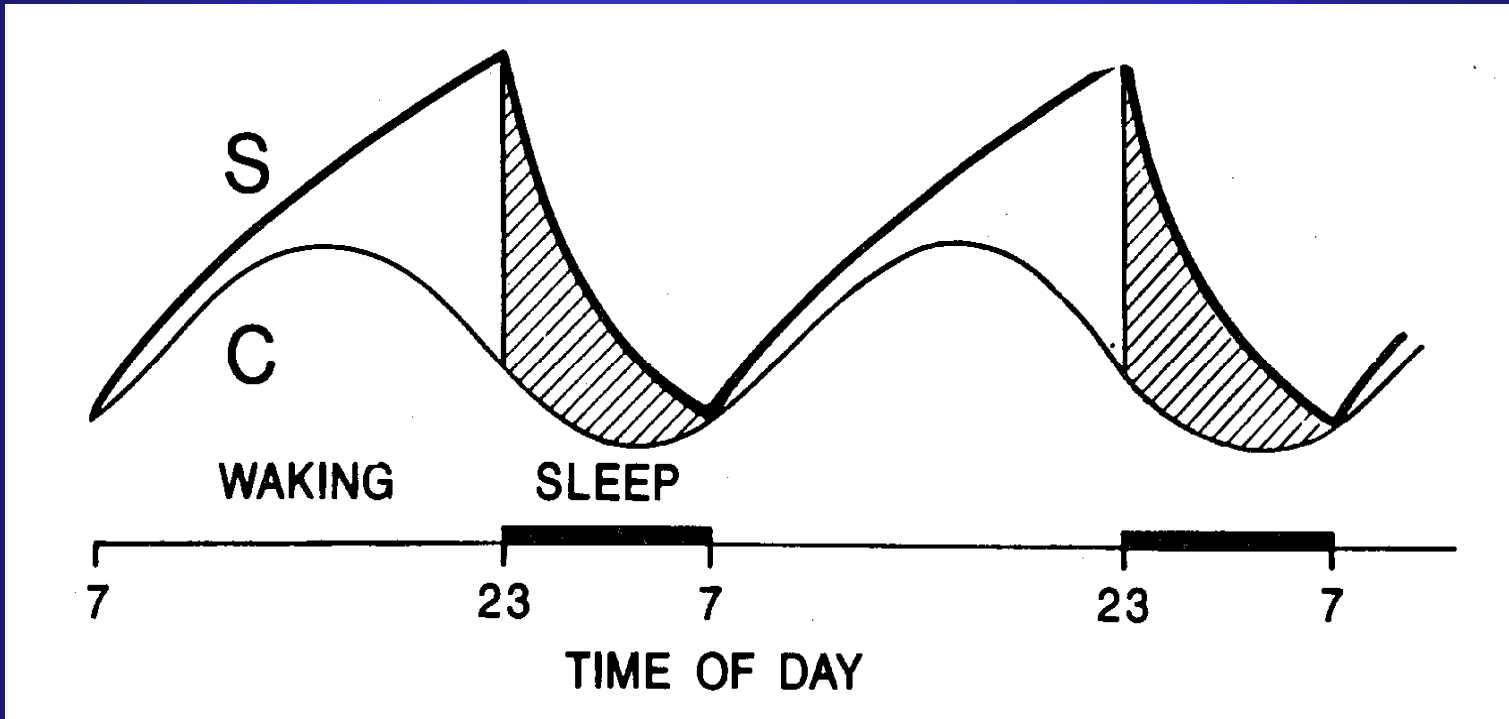
Chief, Division of Sleep Medicine/Department of Medicine

University of Pennsylvania School of Medicine

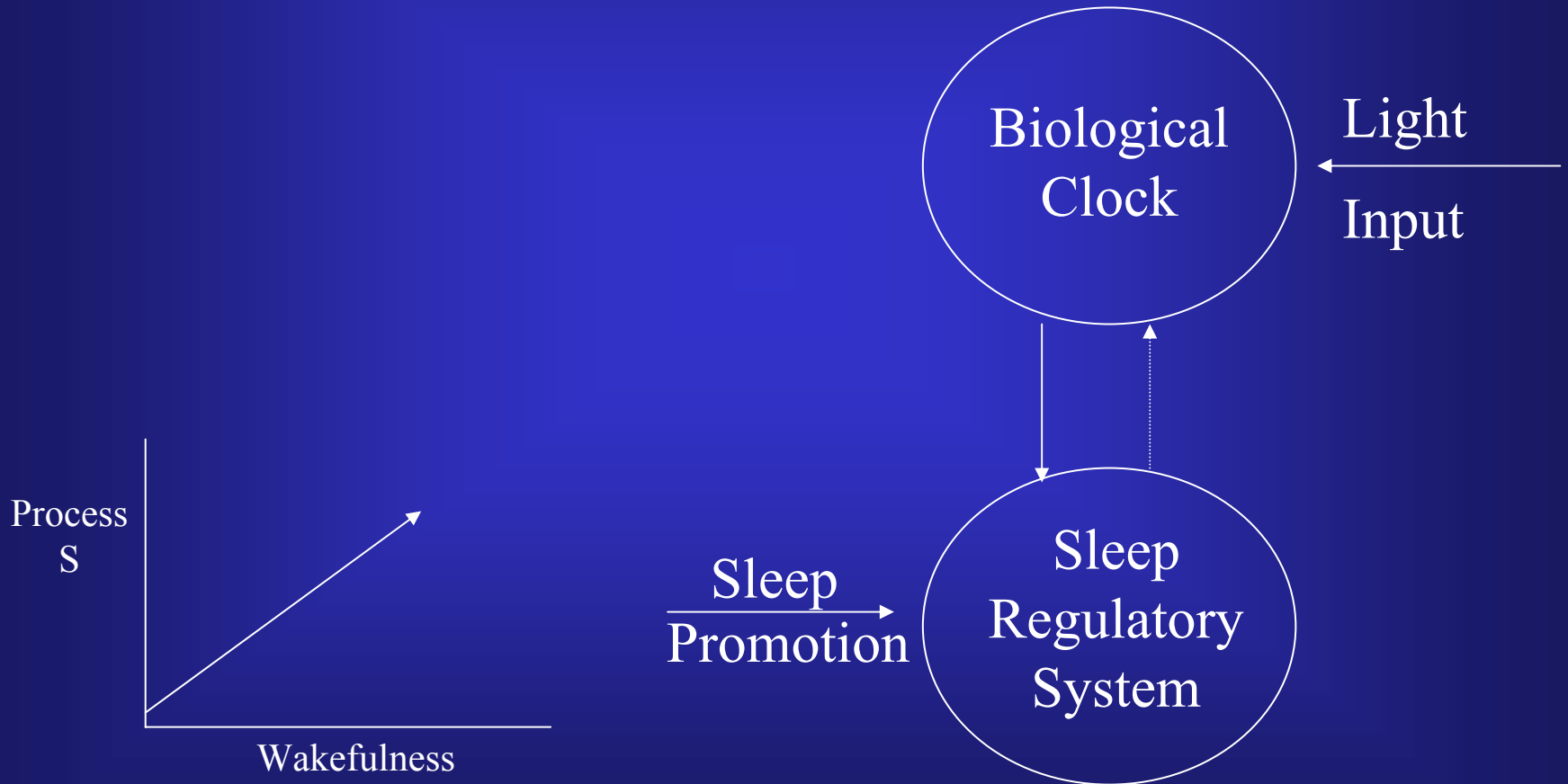
# Outline of Lecture

- Basic biology of sleep and circadian rhythm
- Characteristic and risk factors for fall-asleep crashes
- At-risk groups
- What needs to be done?

# Two Process Model of Sleep Regulation (Borbély)

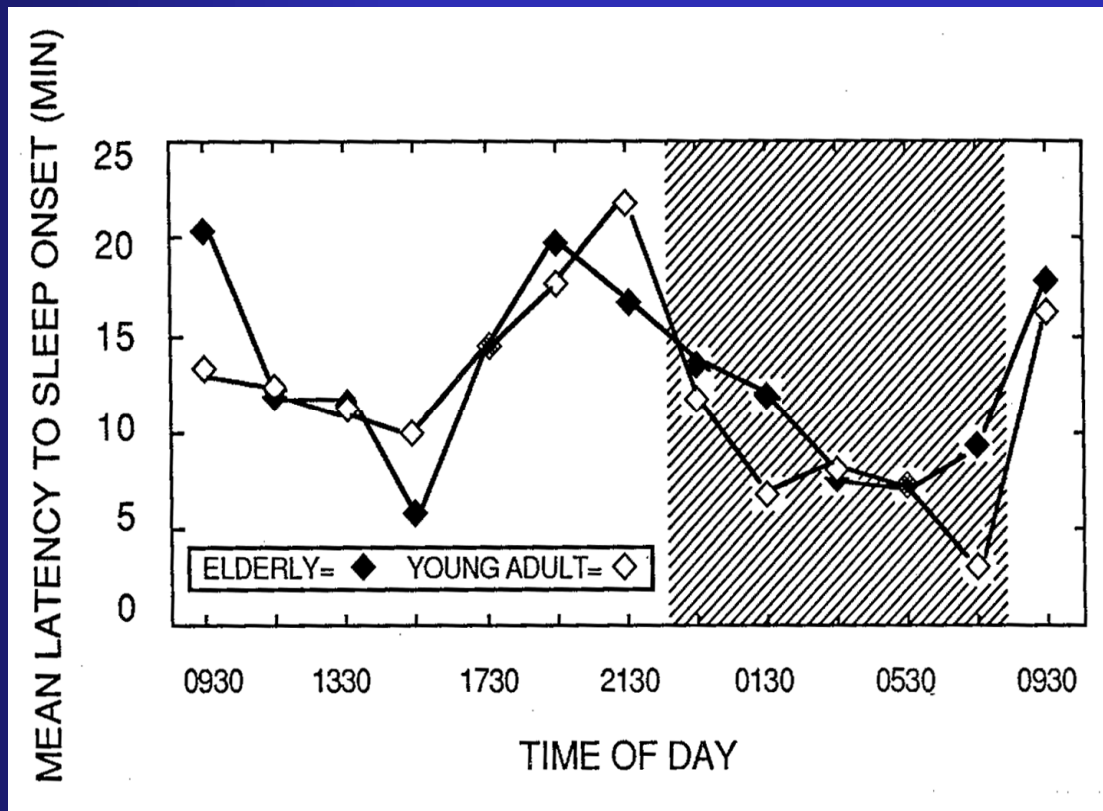


# Interaction of Sleep and Circadian Systems



# Evidence For Circadian Variation In Sleepiness

(Carskadon et al, Neurosci Biobehav Rev 11:307, 1987)



More  
sleepy

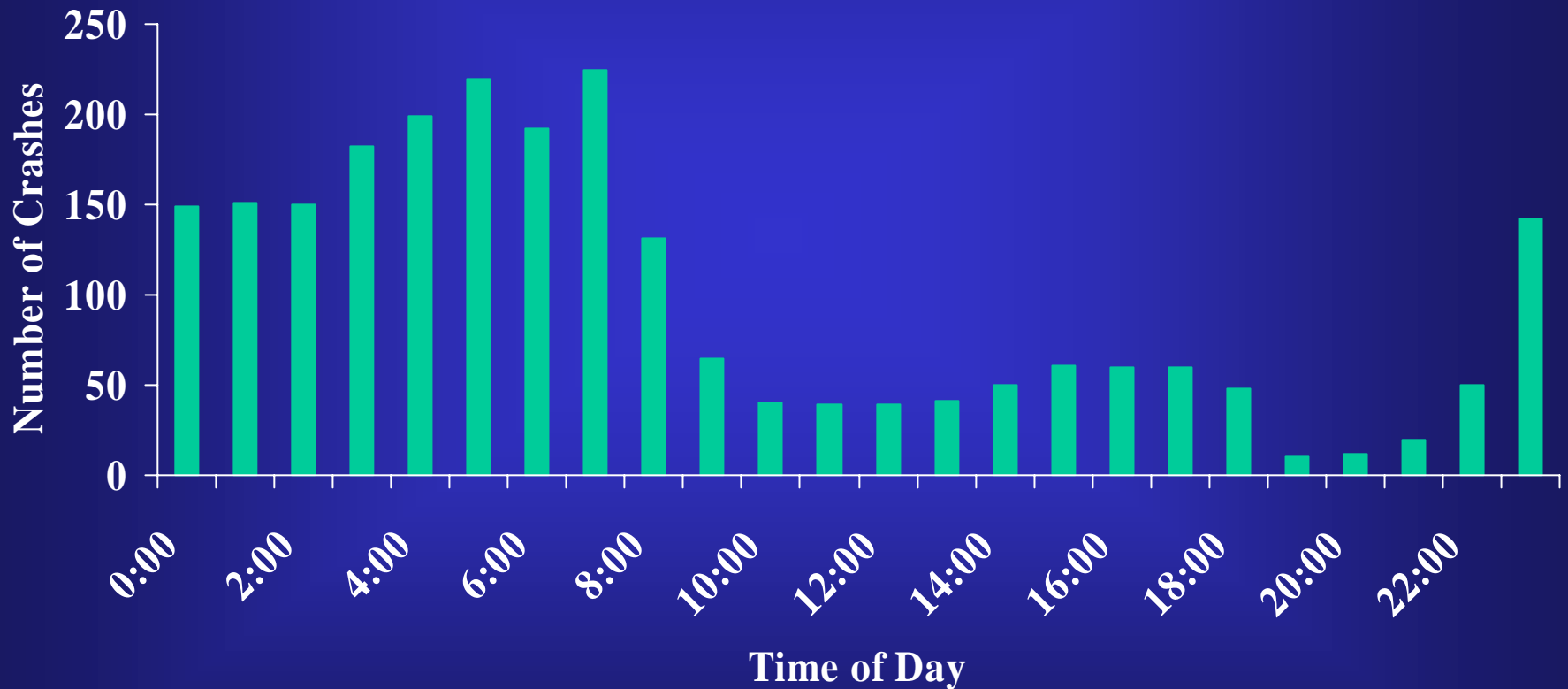
# Consequences of Interaction Between Sleep and Circadian Systems

- Alertness in morning following major sleep episode
- Become “sleepy” after lunch (1:00-3:00 PM)  
(siesta time)
- Alertness then returns even if individual does not sleep
- Early evening becomes forbidden time for sleep
- Sleepy again in late evening
- Sleep efficiency impaired if try to sleep at “alert clock times”



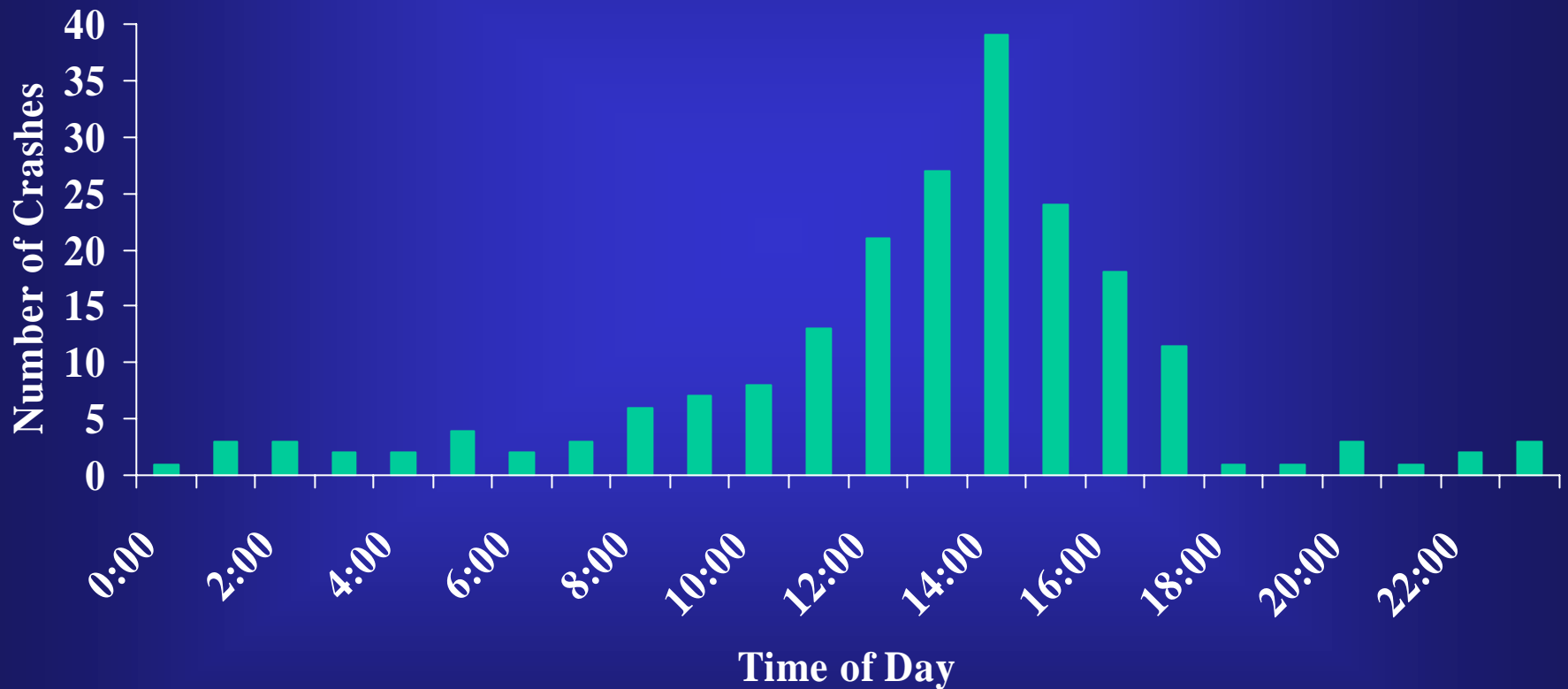
# Time of Occurrence of Fall-Asleep Crashes in Individuals Age 16-25 Years

(Pack A, et al, *Accid Anal Prev* 27:769, 1995)



# Time of Occurrence of Fall-Asleep Crashes in Individuals Over 65 Years

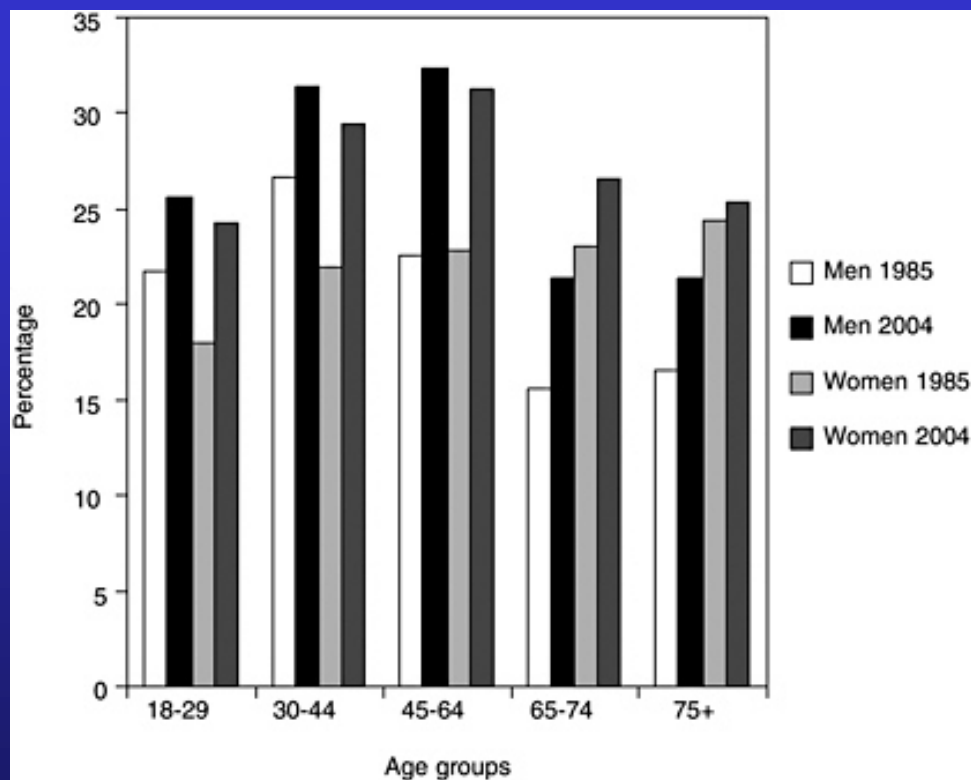
(Pack A, et al, *Accid Anal Prev* 27:769, 1995)



# What About Sleep Loss?

- Total sleep deprivation (one long episode of extended wakefulness)
- Chronic partial sleep loss
  - ↓ sleep, over many days

# Higher Percentage of Our Society Sleep Less Than 6 Hours/Day Than Did So Twenty Years Ago (Now 25-30%)

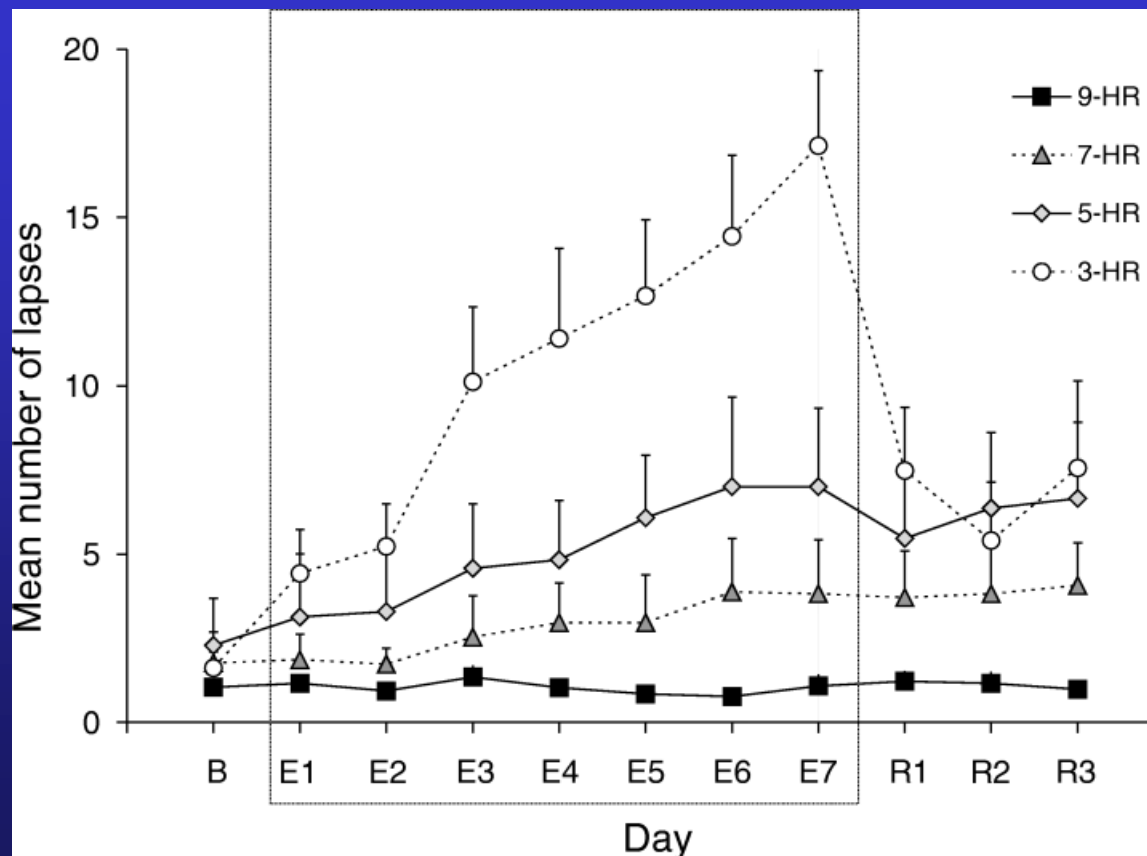


Percent of adults in the United States who usually slept 6 hours or less a night.  
Source: CDC, 2005

# Consequences of Sleep Loss

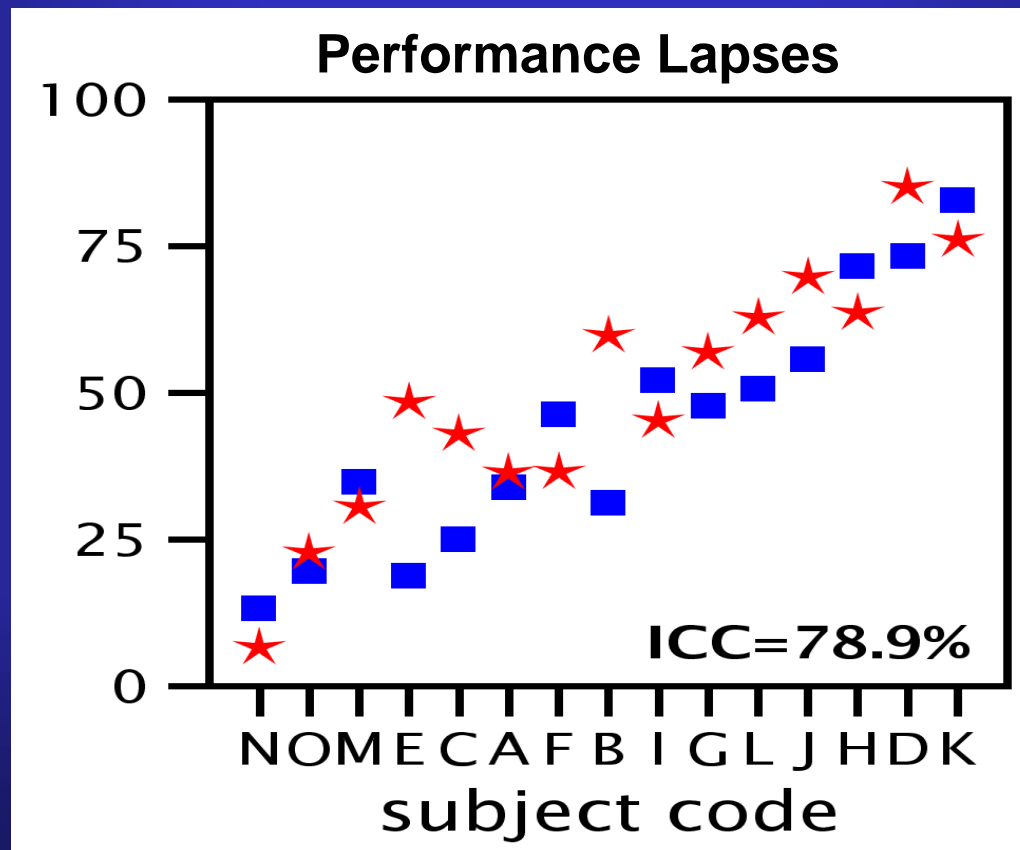
- Behavior
  - Wake state instability → performance lapses

# Cumulative Partial Sleep Deprivation Performance Lapses Accumulate Over Days If Sleep Duration is Reduced (Belenky et al, J Sleep Res 12:1, 2003)



# Response to Sleep Deprivation is A Subject-Specific Trait

(Van Dongen et al, Sleep 27:423, 2004)



# Consequences of Sleep Loss

- Behavior
  - Wake state instability → performance lapses
  - Altered cognitive processing
  - Increased risk of crashes



# Consequences of Sleep Deprivation on Cognitive Performance

(Durmer & Dinges, Sem Neurol 25:117, 2005)

- Involuntary micro-sleeps
- Attention-intensive performance is unstable
- Cognitive slowing
- Response time slows
- Decline in short-term recall and working memory

# Characteristics of Fall-asleep Crashes (Passenger Cars)

(Pack et al, *Accid Anal Prev* 27:769, 1995)

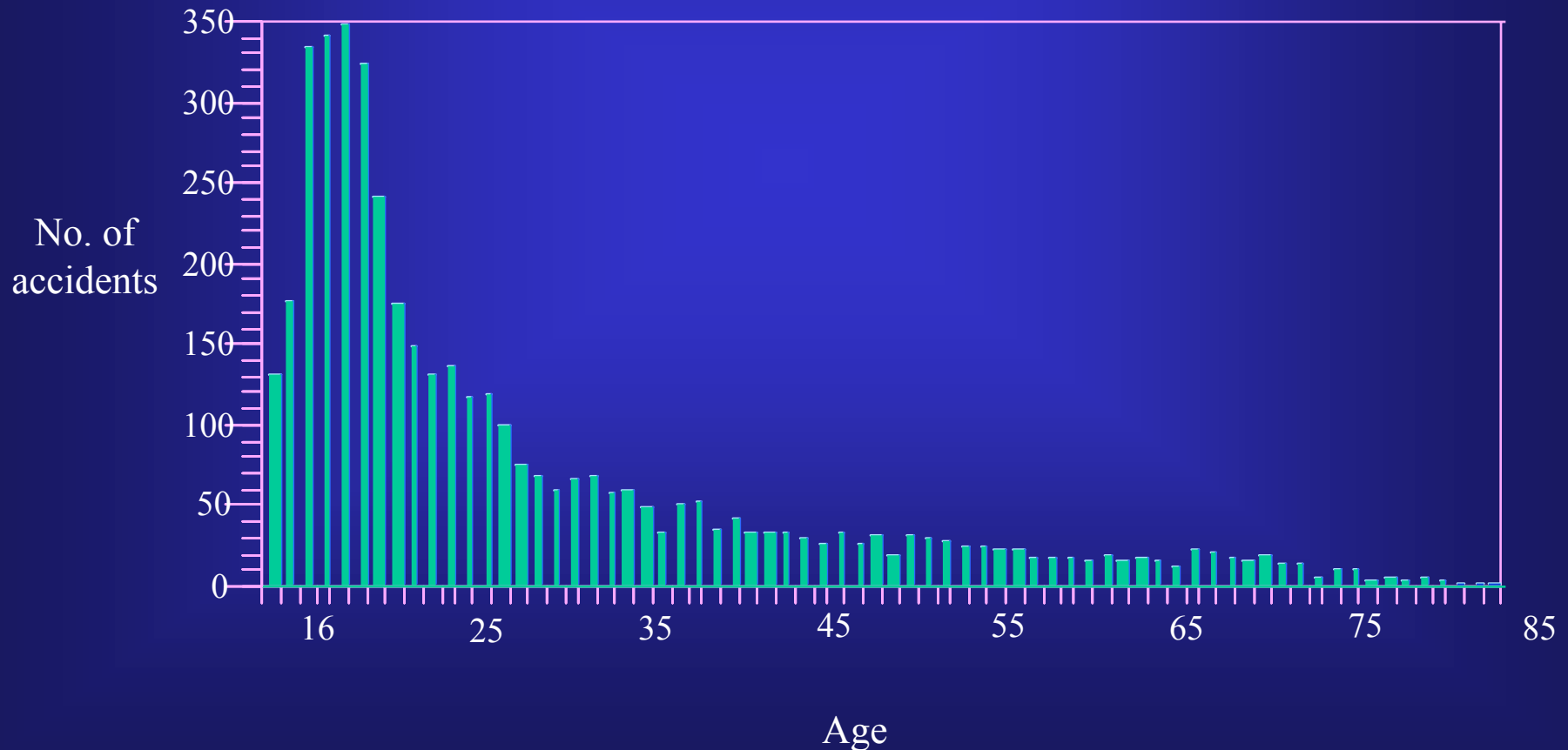
<u>Crash</u>	<u>% of Crashes</u>
Drive off the road	78.5
Single vehicle	77.5
<u>Injury</u> (as severe as alcohol-related crashes)	
No injury	40.6
Severe injury (level A)	13.5
Fatality	1.4
<u>Driver</u>	
Male	74.5
≤ 25 years	55

# Comparison of Seriousness of Fall-Asleep, Alcohol-Related and Other Crashes (Pack A, et al, *Accid Anal Prev* 27:769, 1995)

Type of Crash	Percentage				
	No Personal Injury	Level C Injury	Level B Injury	Level A Injury	Fatality
Fall-asleep	40.6	21.7	22.8	13.5	1.4
Alcohol-related	35.2	20.6	24.3	17.8	2.1
All others	59.2	25.4	9.9	5.1	0.5

# Distribution of Age of Driver In Fall-Asleep Crashes

(Pack et al, *Accid Anal Prev* 27:769, 1995)



# Why Do People Have Drowsy Driving Crashes?

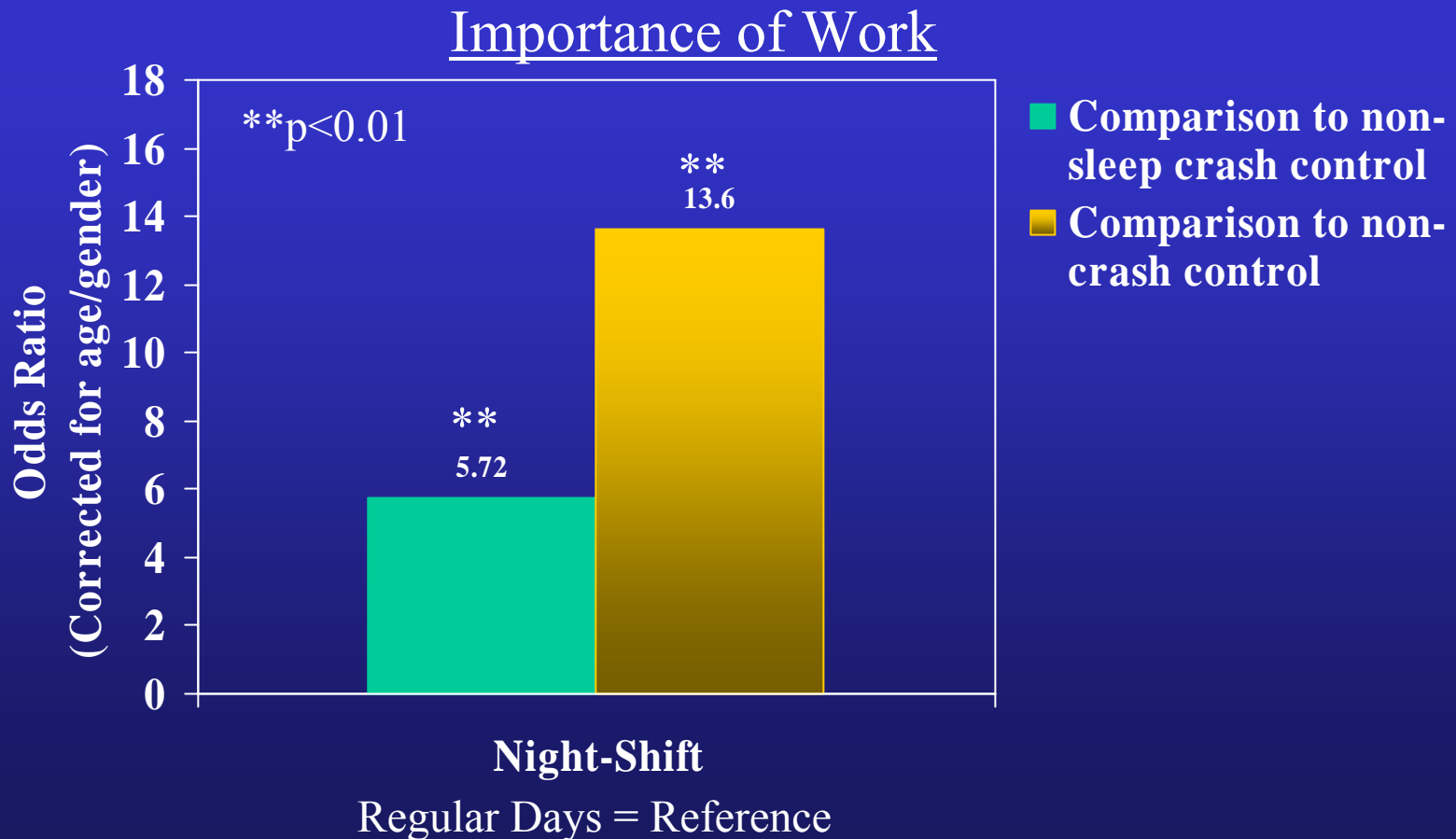
(Stutts et al, *Accid Anal Prev* 35:321, 2003)

## 3 Groups Studied (North Carolina)

- Fall asleep crashes (police reported fall-asleep or fatigue)
- Non-sleep crashes (5th crash report following, not fall-asleep)
- Non-crash controls (sample from people renewing license, no crash for 3 years)

# Why Do People Have Drowsy Driving Crashes?

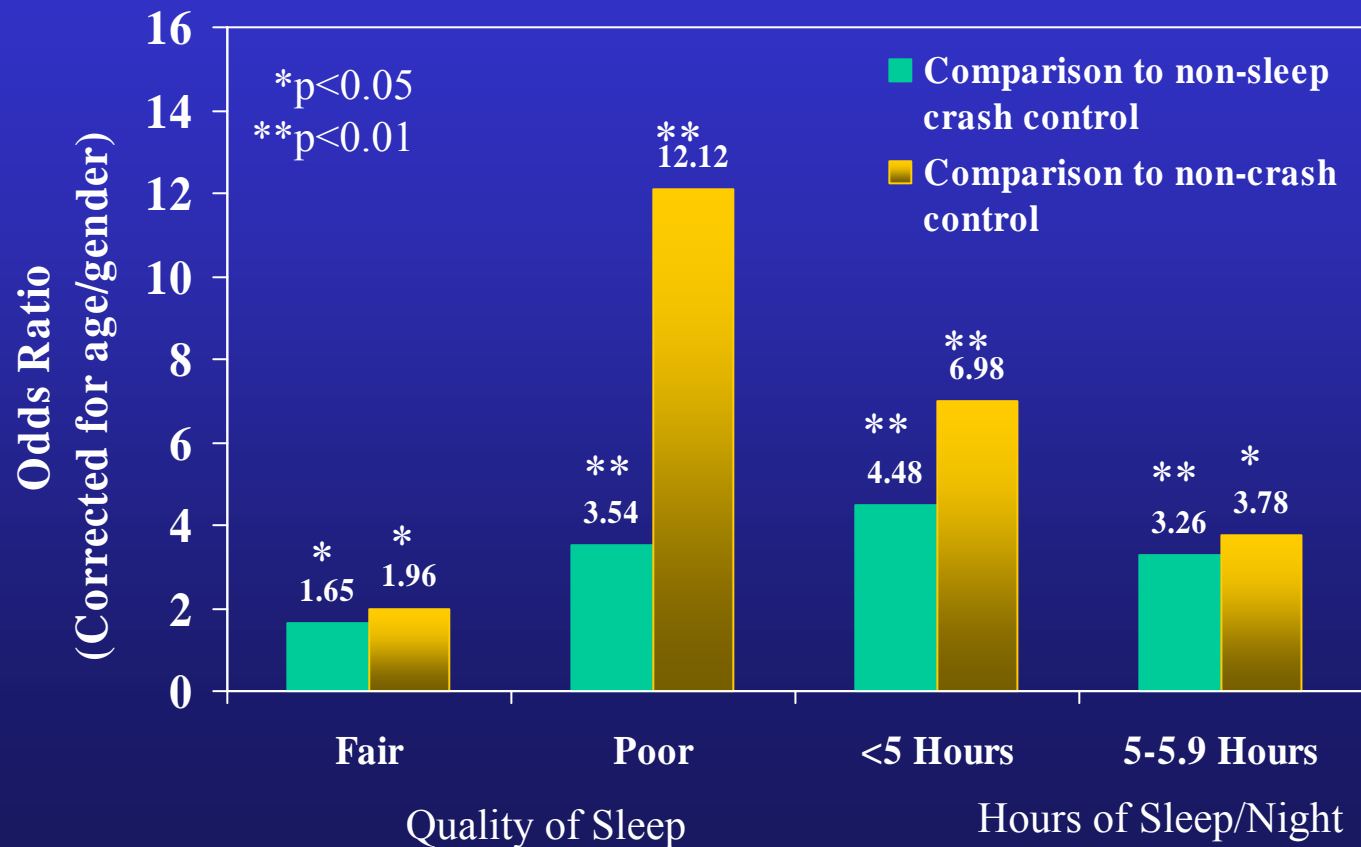
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# Why Do People Have Drowsy Driving Crashes?

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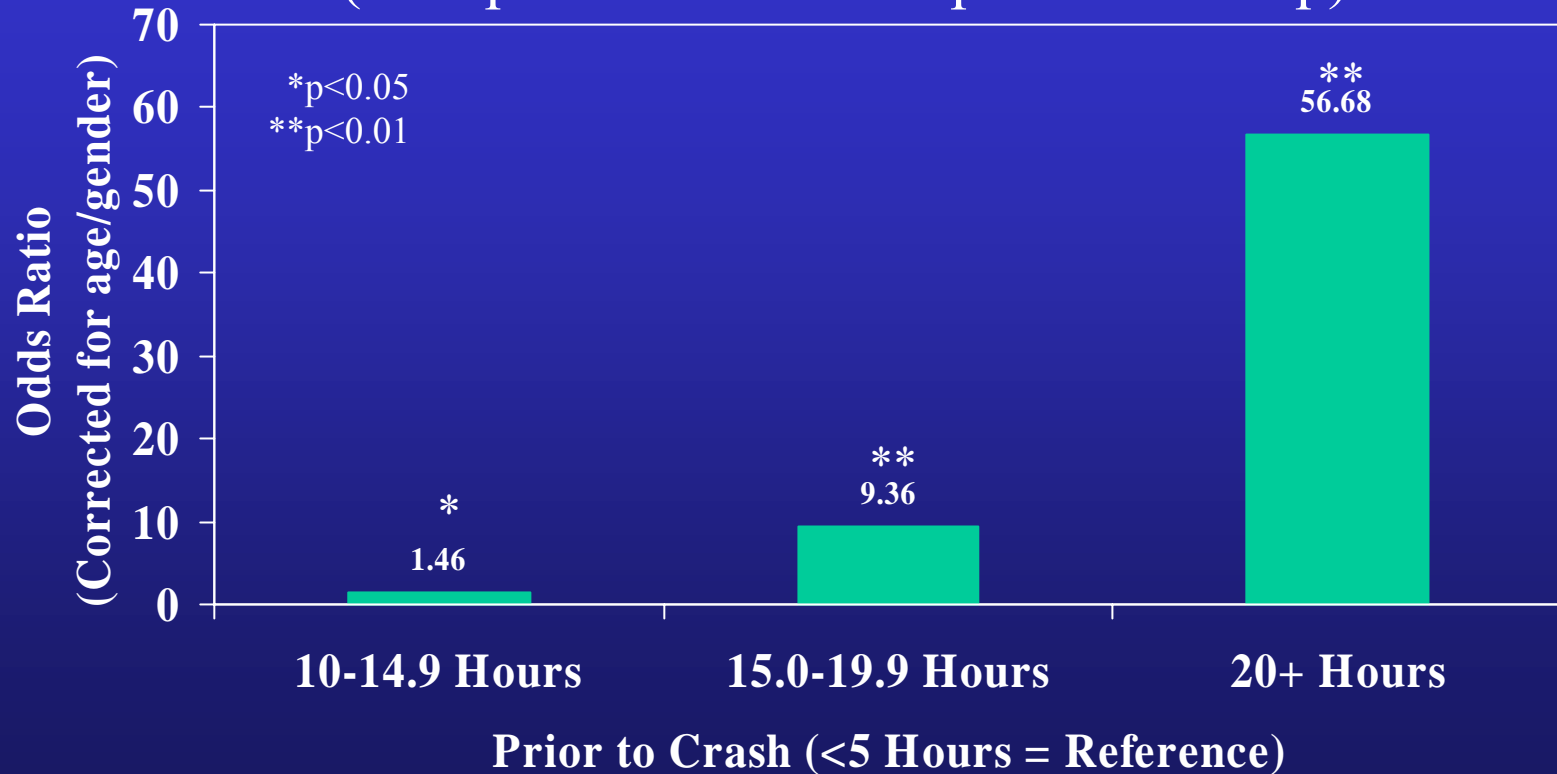
## Quality and Quantity of Sleep



# Why Do People Have Drowsy Driving Crashes?

(Stutts et al, *Accid Anal Prev* 35:321, 2003)

Hours Awake Before Crash  
(Compared to Non-Sleep Crash Group)

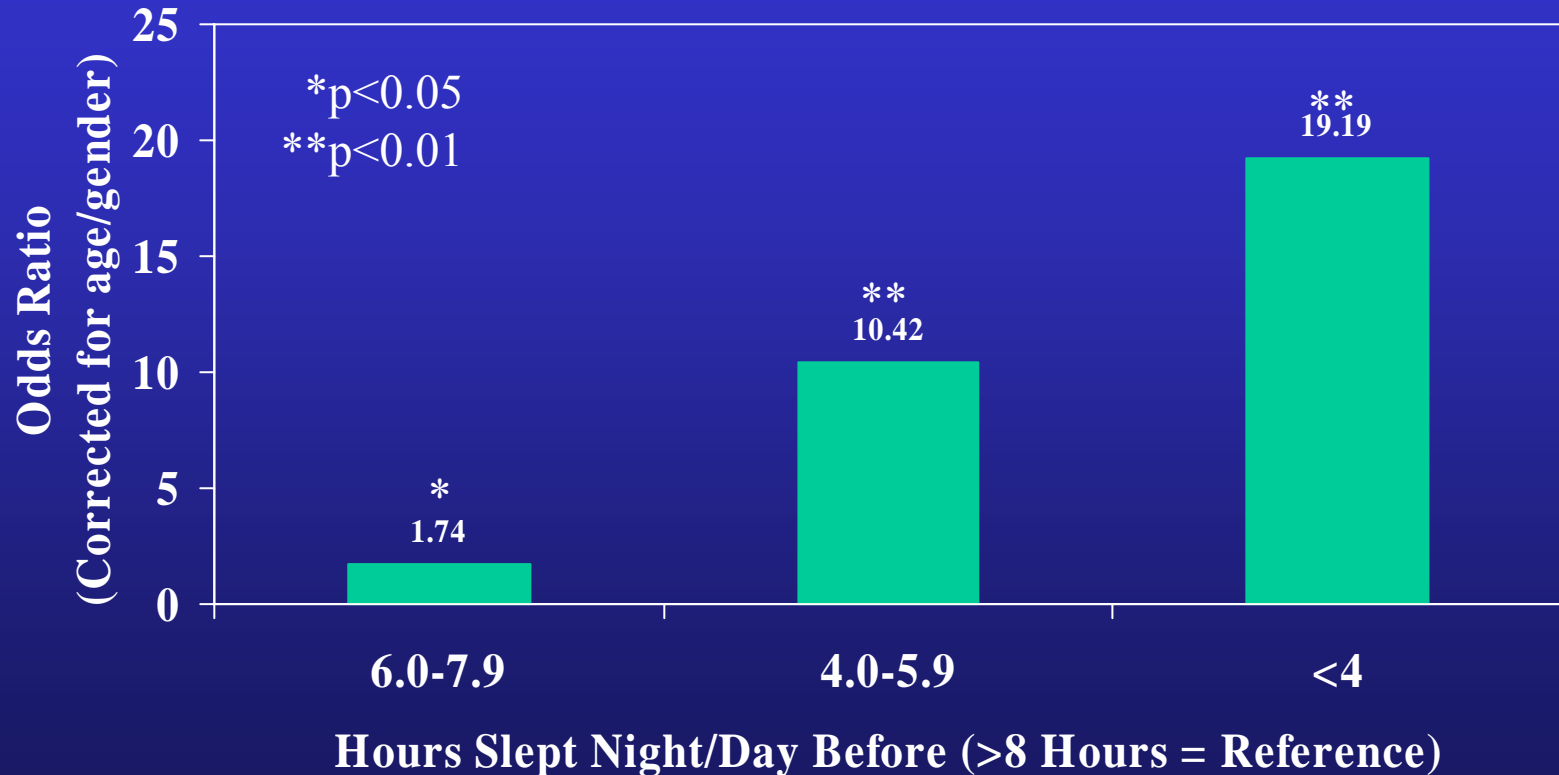




# Why Do People Have Drowsy Driving Crashes?

(Stutts et al, *Accid Anal Prev* 35:321, 2003)

## Hours of Sleep Preceding Crash



# Why Do People Have Drowsy Driving Crashes?

(Stutts et al, *Accid Anal Prev* 35:321, 2003)

<u>Factors identified</u>	<u>Increased Risk</u>
Night-shift work	(5.7-12.6)
Sleep duration (<5 hours/day)	(4.5-7.0)
Hours awake before crash	
15-19.9 hours	(9.4)
20+ hours	(56.7)

# Sleep Loss Augments Effect of Low Level Alcohol

(Horne JA, et al, Occup Environ Med 60:689, 2003)

4 Conditions (same individual, different treatment order;  
weekly intervals, all included drivers started at 2:00 PM)

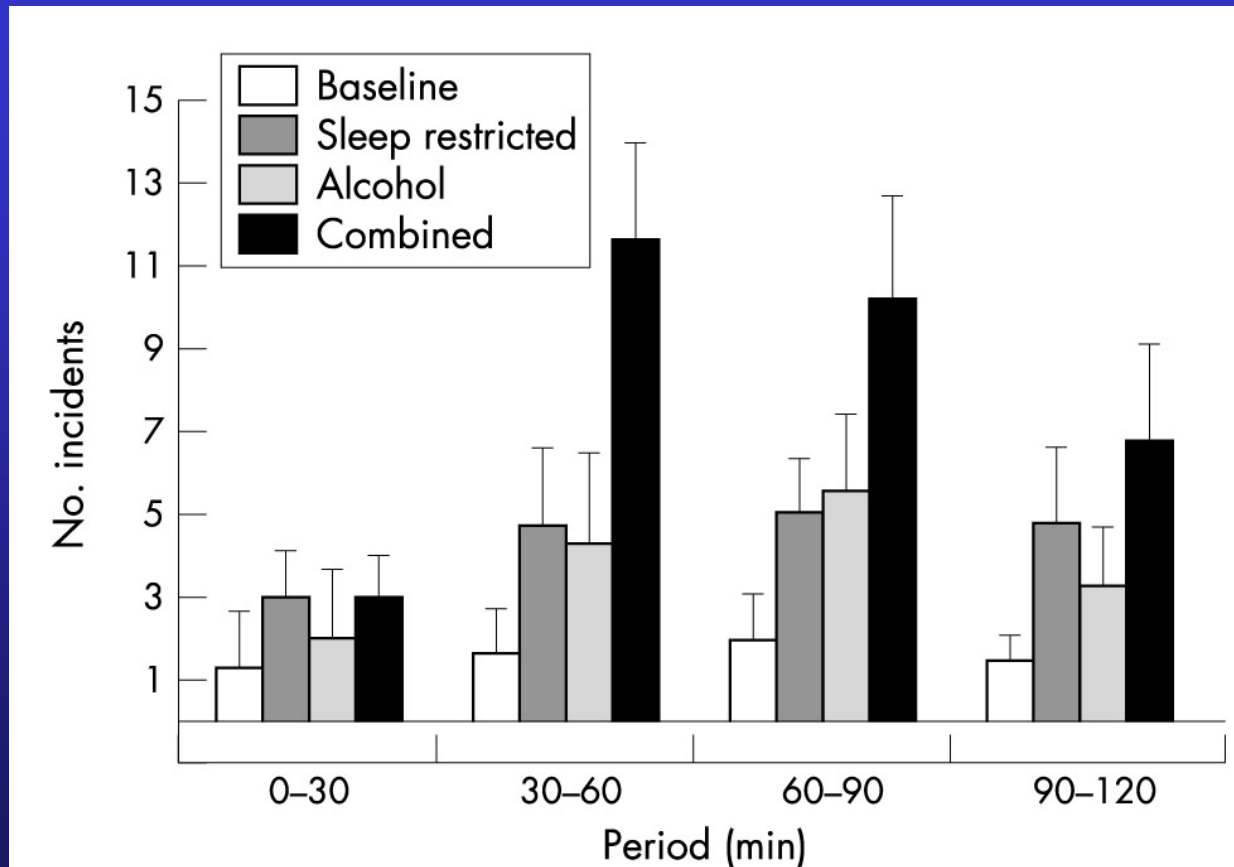
- Normal night sleep + lunchtime alcohol (Alcohol)
- Normal night sleep + no alcohol (Baseline)
- Normal sleep reduced to 5 hours + alcohol (Combined)
- Normal sleep reduced to 5 hours + no alcohol (Sleep restriction)

BAC (mg/100 ml)

	Before Drive	After Drive
With sleep restriction	38.3 (4.0)	0.0
Without sleep restriction	32.4 (4.0)	0.0

# Sleep Loss Augments Effect of Low Level Alcohol

(Horne JA et al, Occup Environ Med 60:689, 2003)



# Some At-Risk Groups

- Teens
- Shift-workers
- Individuals with a sleep disorder

# Associations with Teen Crash Risk

(Hutchens et al, *Accid Anal Prev* 40:869, 2008)

Variable	OR	95% CI for OR	
		Lower	Upper
Ethnicity – non-Hispanic	2.856	1.040	7.839
Length licensure	1.304	1.158	1.469
Drives drowsy alone	1.798	1.079	2.998
Current smoker	2.078	1.268	3.404

# Restriction of Nighttime Driving in Teens As Countermeasure for Crashes

- 15% of miles driven in teens between 9:00 PM and 6:00 AM but 50% of fatal crashes (Williams AF et al, J Public Health Policy 18:334, 1997)
- “A nighttime curfew is an essential component of a graduated licensing” (same article)
- Value of nighttime curfew (10:00 PM to 5:00 AM (New Zealand))
  - Pre-post restricted license
  - Nighttime crashes 2252 → 980
  - Odds ratio 0.66 (95% CI 0.50-0.86; p=0.003)
  - (Adjusted for age, gender, year of crashes)(Begg et al, Inj Prev 9:292, 2001)

# Differential Diagnosis of Excessive Sleepiness

- Insufficient sleep syndrome
- Obstructive sleep apnea
- Restless legs syndrome
- Narcolepsy
- Delayed sleep phase syndrome
- Conditions interrupting sleep, e.g., chronic pain
- Medications with sleepiness as a side effect



# Some Key Features of Human Narcolepsy

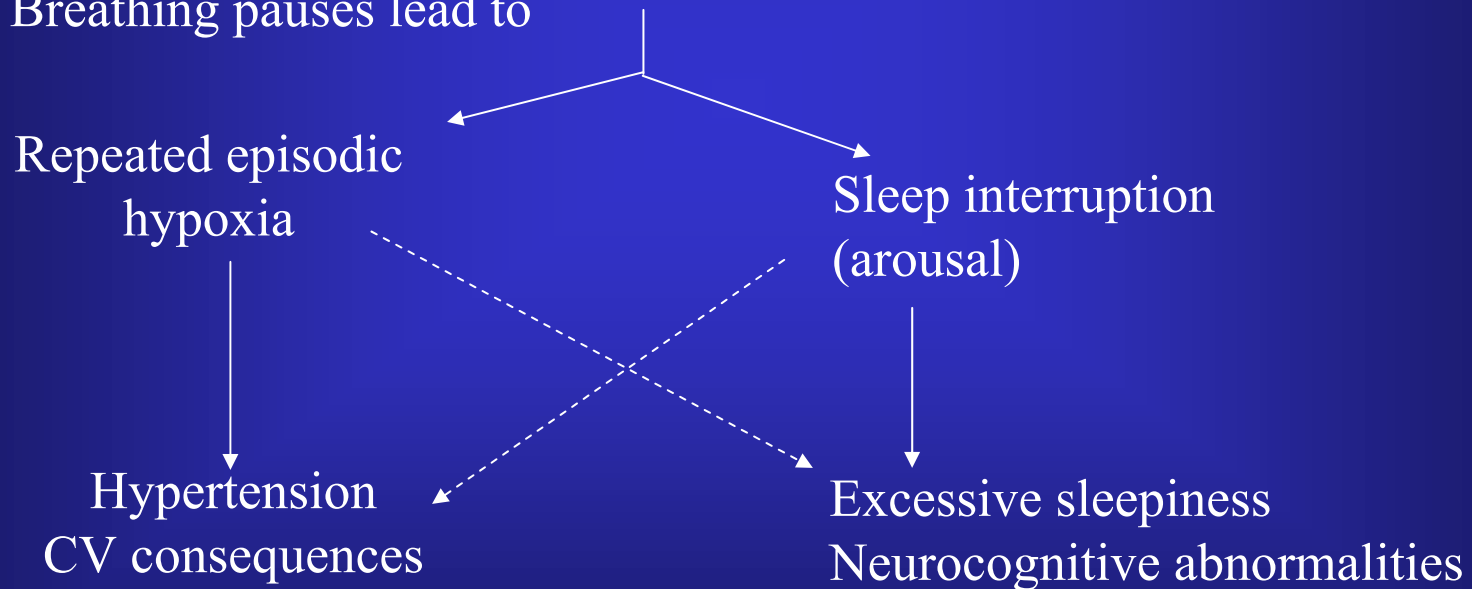
## An example of a “dissociated state”

- Age of onset is typically post-puberty (late teens)
- Key clinical features:
  - Excessive daytime sleepiness
  - Cataplexy (emotion-->brief paralysis)
  - Hypnagogic hallucinations (dreams in wakefulness)
  - Sleep paralysis
- Have REM sleep during daytime naps

# Obstructive Sleep Apnea

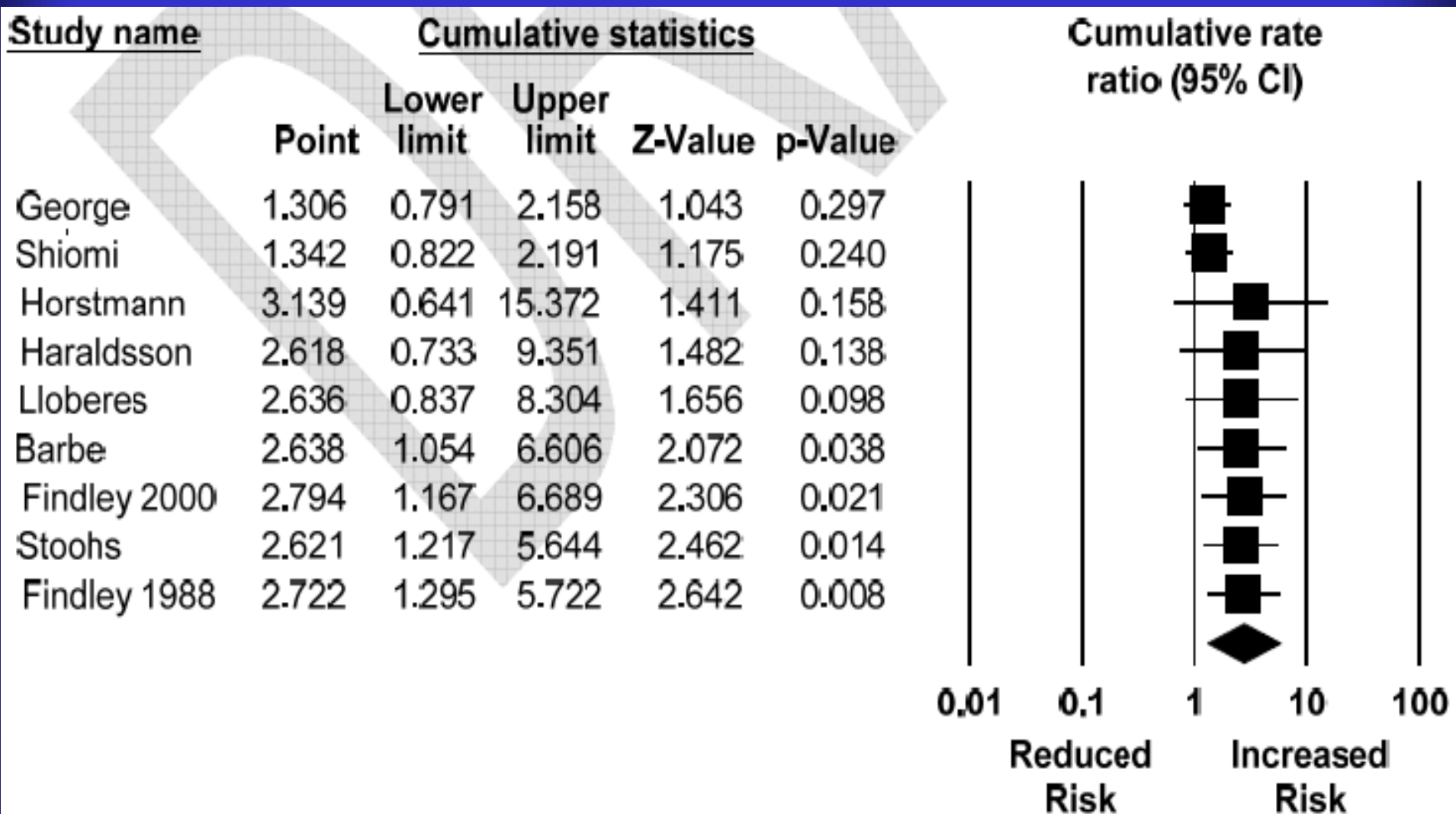
## Major Facts

- Symptomatic sleep apnea with excessive sleepiness - 4% of middle-aged males, 2% of middle-aged females
- Recurrent pauses (apnea) or decrements in breathing (hypopneas)
- Breathing pauses lead to



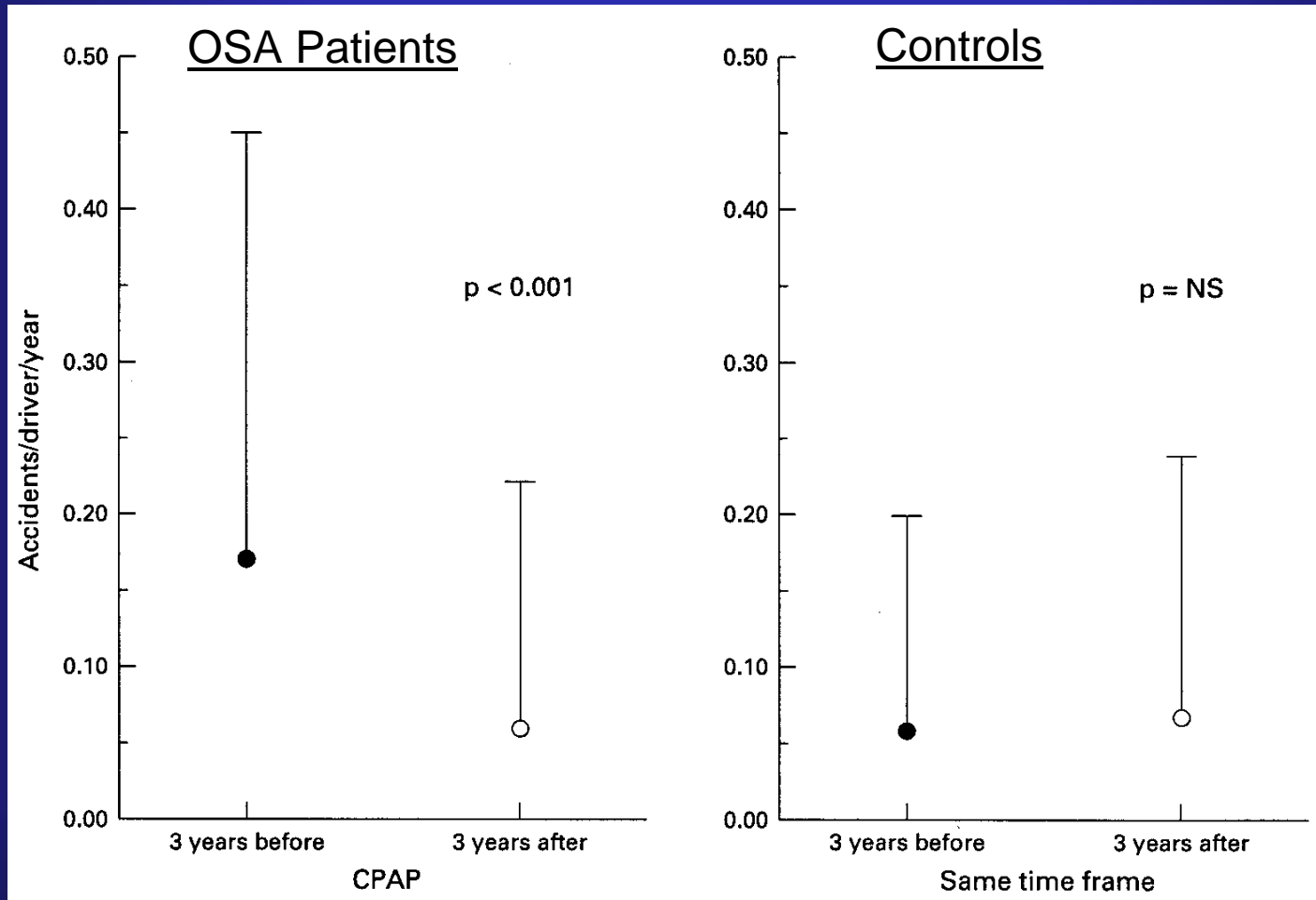
- Safe, effective treatment available (nasal CPAP)

# Increased Risk of Crash with OSA (FMCSA, 2007)



# Most Definitive Study - Crash Rates Before and After CPAP and In Controls

(George, Thorax 56:508, 2001)



# What About Drowsy Driving Crash Statistics

- Often not captured in police reports – no space
- Current data focused on known risks
  - Alcohol/speeding, etc.

# Fall-Asleep/Drowsy Driver Crashes

## What Needs To Be Done?

- Education
  - Public
  - Police
  - Legal communities
  - Traffic safety professionals
  - Etc.

# Fall-Asleep/Drowsy Driver Crashes

## What Needs To Be Done?

- Improved recognition
  - Acceptance of criteria for fall-asleep crashes
  - Incorporation into accident report forms
  - Understanding interaction with low level alcohol
  - National statistics

# Characteristics of Fall-Asleep Crashes

(Horne JA, Reyner L. Br Med J 310:565, 1995)

- Breathalyzer alcohol levels below the legal driving limit
- The vehicle either ran off the road or into the back of another vehicle
- No signs of the brakes being applied beforehand (i.e., no skid marks)
- No mechanical defect in the vehicle, no tire blow-out
- Good weather and clear visibility
- Elimination of speeding and driving too close to the vehicle in front



# Fall-Asleep/Drowsy Driver Crashes

## What Needs To Be Done?

- Sensible/implementable public policy for specific at-risk groups:
  - Teens
  - Shift-workers (Naps, Transportation Home)
  - Commercial drivers (screening for OSA)

# Fall Asleep/Drowsy Driver Crashes

## What Needs To Be Done?

- What about specific legislation?
  - Currently has very limited role

# Maggie's Law

- 20 year old woman (Maggie McDonnell) killed in a head on collision in 1997 in Clementon, NJ
- Man who caused accident had fallen asleep at wheel and told police that he had not slept in 30 hours
  - Jury acquitted him of vehicular homicide and he walked away with a \$200 fine for reckless driving
- 2/15/01 - NJ Assemblyman George Geist introduces a bill establishing driving while fatigued as recklessness under vehicular homicide statute

# Maggie's Law

- Bill signed into NJ law, August 5, 2003
- It is now possible to charge a motorist with vehicular homicide (up to 10 years in prison; \$100,000 fine) if driver falls asleep and kills another driver
- Driver fatigue is defined as driving after being up for 24 hours
- First conviction (8/20/05); 26 year old man who caused a fatal crash in NJ after not having sleep for >24 hours sentenced to 5 years in prison

# Conclusions

- There is an understandable underlying biology
- All evidence points to fall-asleep/drowsy driving crashes being much more common than is realized by traffic safety professionals
- Need for national approach to improved recognition and improved statistics
- There are obvious steps that could, and should, be taken
- Requires collaboration between traffic safety and sleep experts

# QUESTIONS?

- Please type any questions you may have into the chat/text box on the left side of your screen.
- Only the moderators can see these questions and they will select as many as possible to pass on to the presenter.