A dimly lit bedroom scene. A person is lying in bed, partially covered by a white sheet, with their arms raised. In the foreground, a round analog clock sits on a surface, showing a time around 10:10. The overall atmosphere is dark and quiet, suggesting a nighttime setting.

# Sleep Quality

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Presented by: Dr. Jaime K. Devine

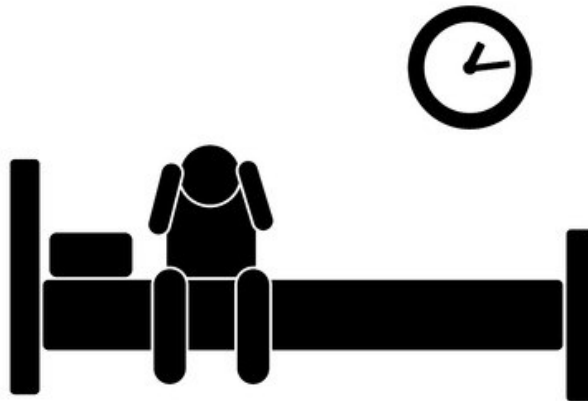
# Overview

1. What is sleep quality?
2. Neuroscience of sleep
3. Sleep fragmentation
  1. Biological sleep disorders
  2. External causes
4. Subjective sleep quality
5. Demographic differences in sleep quality

# What is Sleep Quality?

## General Definition:

- A clinical construct representing a complex phenomenon which includes quantitative aspects of sleep such as latency or number of arousals as well as subjective aspects such as restfulness or satisfaction (Buysse et al. 1989)



# Why is Sleep Quality Important?



## Fatigue Risk Presentations ACAT 2021

March 2, 13:00 Presentation: Fatigue Risk Management

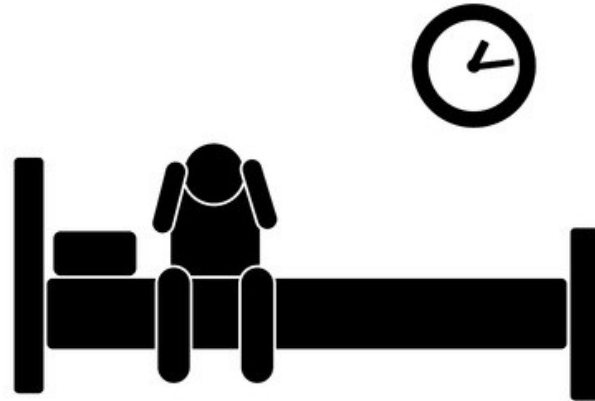
March 3, 14:00 Presentation: Fatigue in Shiftwork Setting



# How do you Measure Sleep Quality?



Brain Activity



Fragmentation



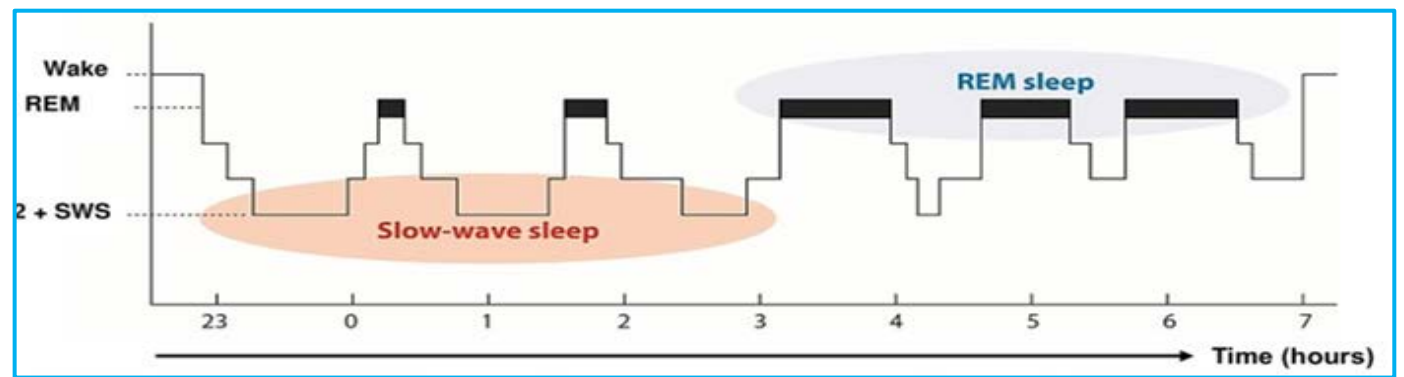
Subjective Satisfaction

# Neuroscience of Sleep

Sleep is divided into stages based on cyclical patterns of electrical activity measured from the brain.

- Light Sleep: Stage 1/N1 and Stage 2/N2
- Deep Sleep: Slow Wave Sleep (SWS)/N3/N4
- Rapid Eye Movement (REM)
- “Sleep architecture” refers to the structure of this pattern

↑ Sleep Time → ↓ SWS & ↑ REM



*adapted from Cross et al. 2018*

# Sleep Architecture and Sleep Duration

Each stage of sleep is associated with different benefits



## Stage 1

- Reducing Sleepiness



## Stage 2

- Reducing Sleepiness
- Increasing Vigilance



## Deep Sleep: Slow Wave Sleep (SWS)

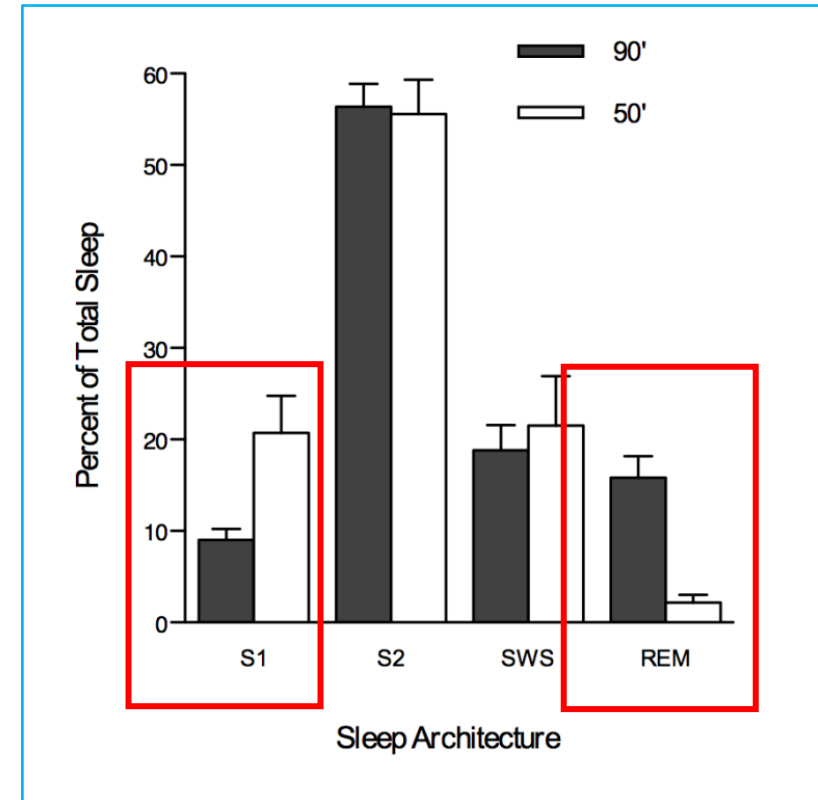
- Reducing Sleepiness
- Increasing Vigilance
- Bodily restoration



## Rapid Eye Movement (REM)

- Improving Learning & Memory
- Improving Cognition

Good Sleep Takes Time!



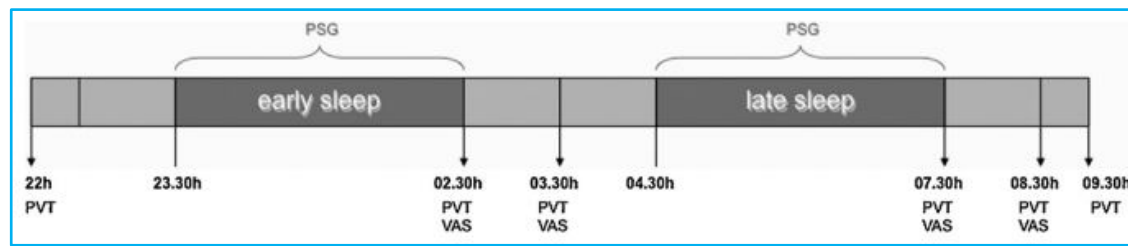
*Devine and Wolf 2016a*



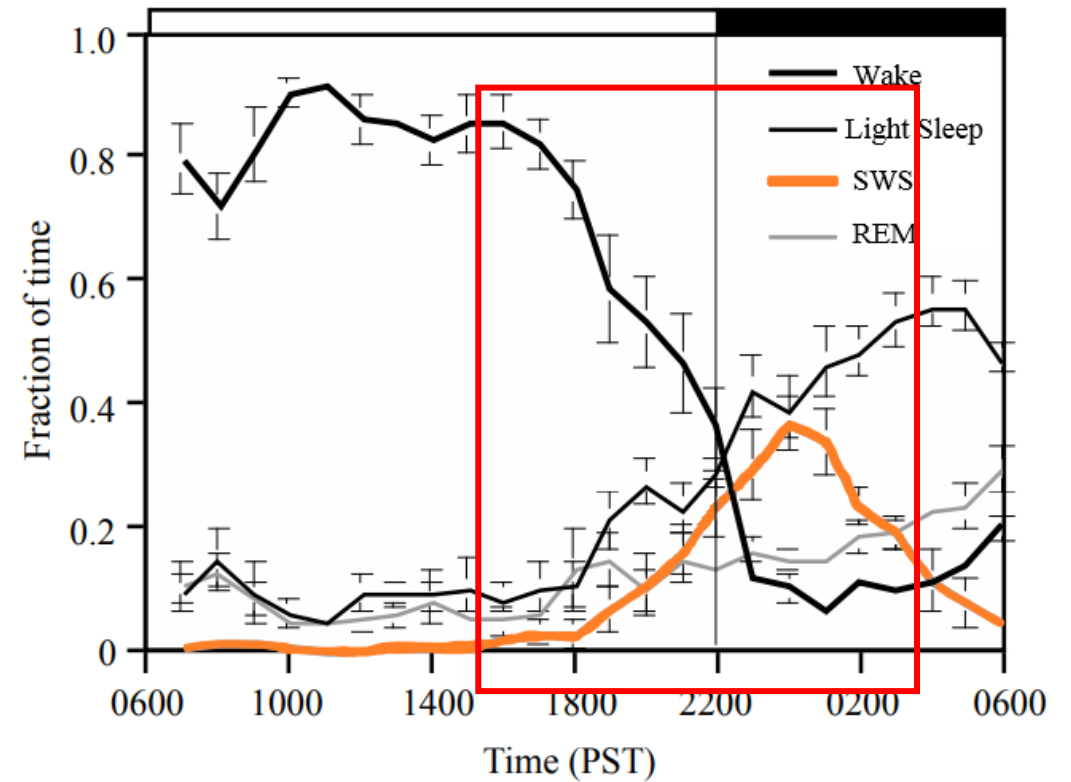
# Sleep Architecture and Time of Day

Time of day affects sleep architecture

- ↑ SWS in the evening
- ↑ REM during morning
- ↓ SWS during daytime hours
- SWS-heavy sleep is more beneficial for vigilance than REM-heavy sleep (Wu et al. 2010; Neu et al. 2015)
  - Early night sleep > Late night sleep







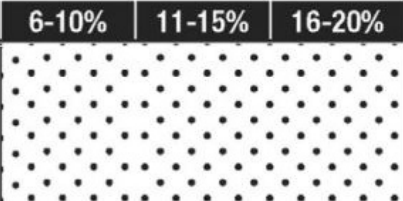


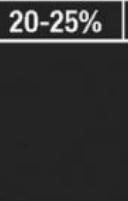

Neu et al. 2015


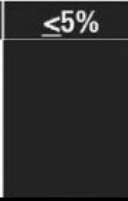
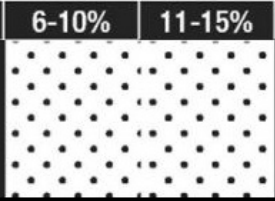
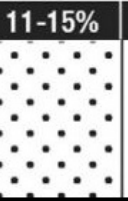







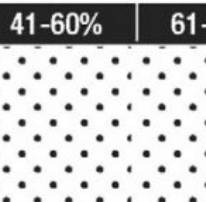
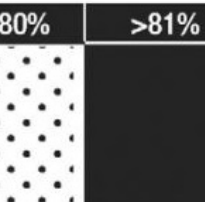

Hsieh et al. 2008


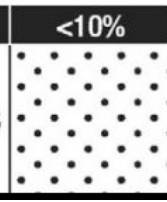
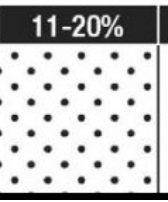
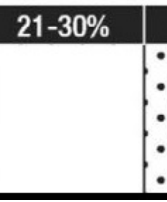
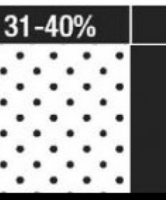

# Sleep Architecture Recommendations

 Inappropriate  
  Uncertain  
  Appropriate

AGE CATEGORY		N1 SLEEP					
		≤5%	6-10%	11-15%	16-20%	20-25%	≥26%
	ADULTS						

AGE CATEGORY		N3 SLEEP					
		≤5%	6-10%	11-15%	16-20%	20-25%	≥26%
	ADULTS						

AGE CATEGORY		N2 SLEEP				
		≤20%	21-40%	41-60%	61-80%	>81%
	ADULTS					

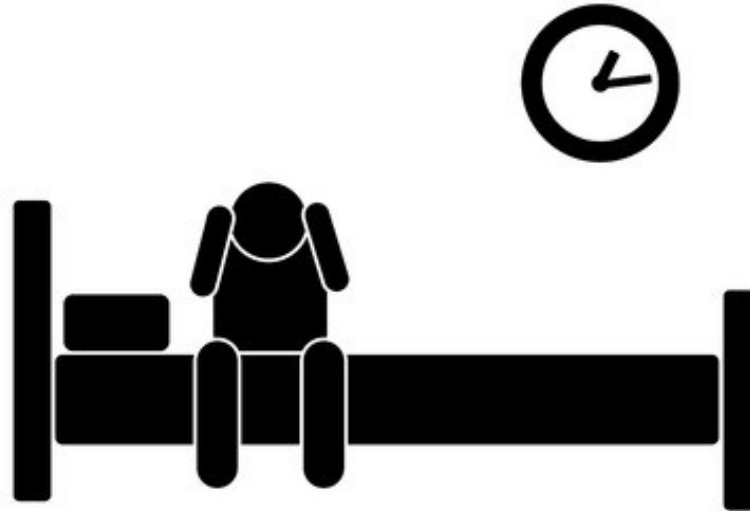
AGE CATEGORY		REM ACTIVITY				
		<10%	11-20%	21-30%	31-40%	≥41%
	ADULTS					

*adapted from Ohayon, et al. "National Sleep Foundation's sleep quality recommendations: first report." Sleep health (2017)*

# Fragmentation of Sleep

**Sleep fragmentation refers to disruptions in sleep continuity**

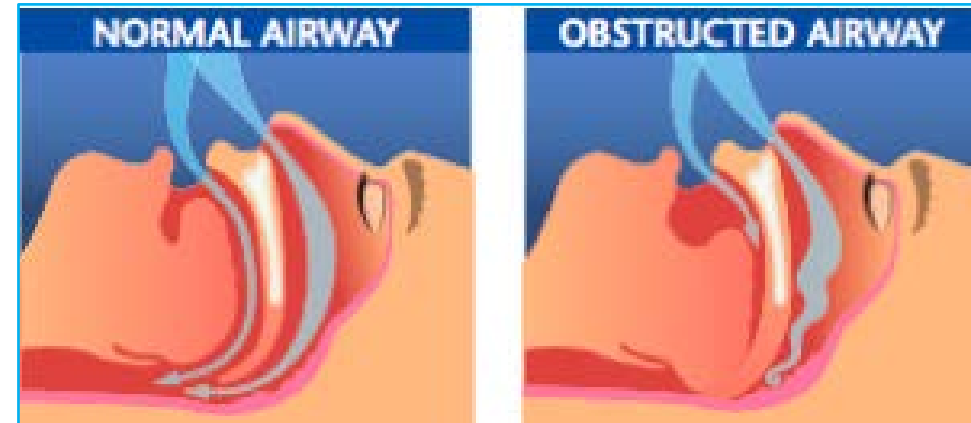
- Fragmentation is measured objectively by counting the number or duration of awakenings.
- ↑ Fragmentation=
  - ↓ total sleep duration
  - ↓ SWS
  - ↓ REM
  - ↓ satisfaction



# Obstructive Sleep Apnea (OSA)

**Sleep is disrupted when airflow is blocked partially (hypopnea) or completely (apnea). The sleeper must wake up to breathe.**

- Severity of OSA is defined by the frequency of these events per hour: Apnea-Hypopnea Index (AHI)
  - $AHI \geq 5$  is criteria for mild sleep apnea
  - $AHI \geq 30$  is criteria for severe sleep apnea
- Risk factors include:
  - Excess weight & large neck circumference
  - Age & gender
  - Family history of OSA
  - Snoring
- 1/4th of adult Canadians are at risk for OSA (Public Health Agency of Canada 2010)

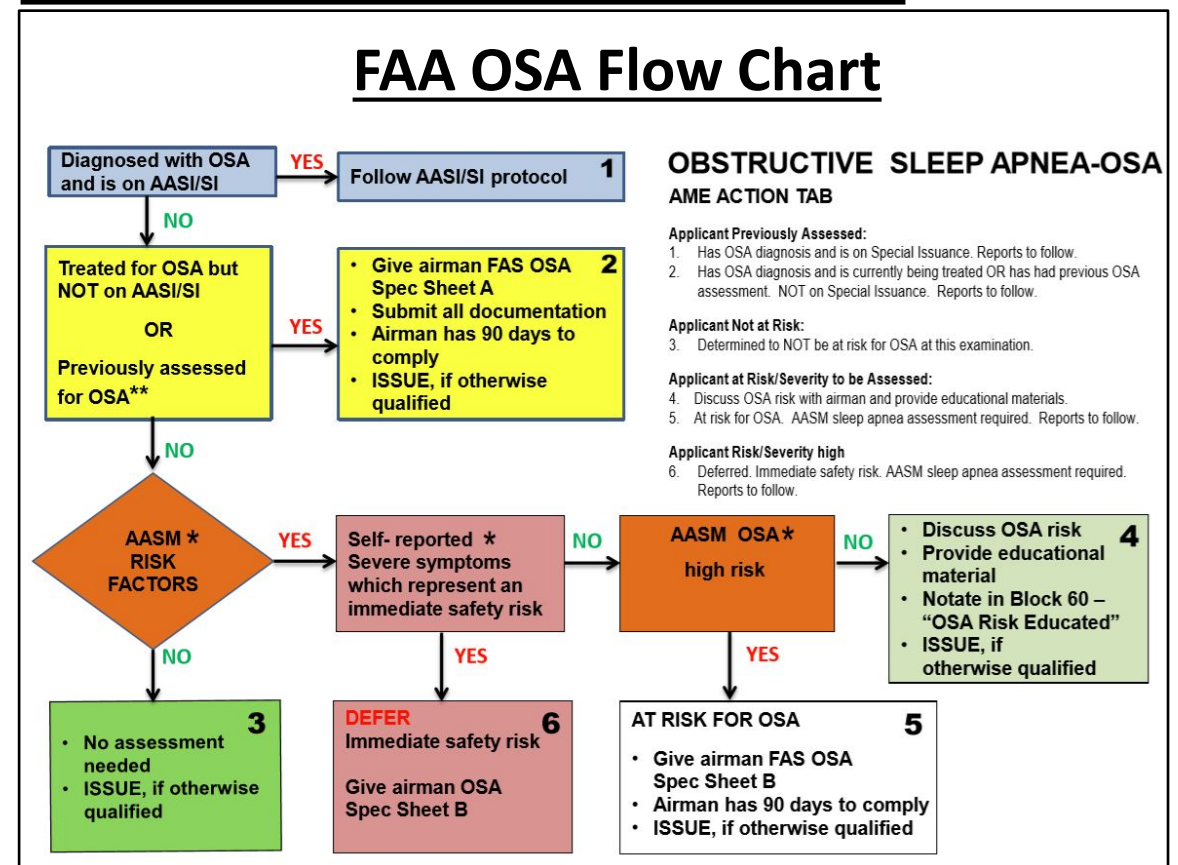


# Obstructed Sleep Apnea (OSA)

## Untreated Sleep Apnea is a safety risk



## Consider an OSA Policy



# Primary Insomnia Disorder

**Sleep is disrupted because of difficulty falling asleep or staying asleep. Sleep does not feel restorative and causes substantial distress and impairments of daytime functioning.**

- Primary insomnia disorder is related to a biological inability to sleep, but many lifestyle factors can cause or contribute to insomnia.
- Risk factors include:
  - Mental health
  - Stress
  - Age
  - Gender
- Roughly 24% of adult Canadians report insomnia symptoms. Report of insomnia symptom in Canada has increased by upward of 40% over the past decade (*Garland et al. Sleep Health 2018, Statistics Canada 2018*)



# Primary Insomnia vs. Secondary Insomnia

## Primary Insomnia

- Primary insomnia cannot be attributed to any other cause.



## Secondary Insomnia

- Secondary insomnia is when symptoms of insomnia arise from some other problem.



# Shift Work Sleep Disorder

- Shift work sleep disorder is characterized by trouble sleeping and excessive sleepiness affecting people whose work hours overlap with the typical sleep period.



# Narcolepsy

**Sleep and awakenings occur suddenly (attacks), along with overwhelming daytime drowsiness, hallucinations, and loss of muscle tone (cataplexy).**

- Narcolepsy is caused by a neurological inability to maintain sleep-wake cycles.
- Risk factors include:
  - Genetic predisposition/family history
  - Age
- Roughly 1 in 2,000 people (0.05%) have narcolepsy, but receiving an official diagnosis takes about 10 years.  
*(Canadian Sleep Society, Wake Up Narcolepsy)*
- Chronic sleep deprivation can mimic the symptoms of narcolepsy.
- Narcolepsy is likely to be a disqualifying condition.

# Restless Leg Syndrome

## Periodic Limb Movement Disorder

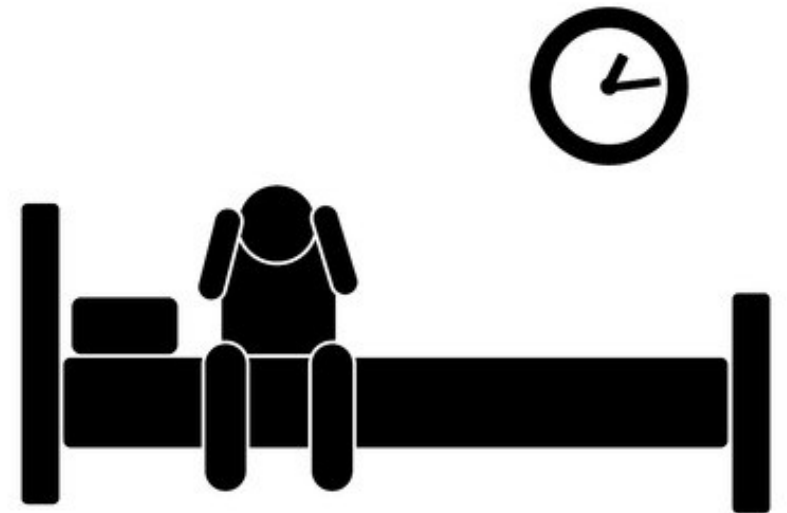
**Sleep is disrupted because of a neurological disfunction resulting in uncontrollable limb movement, tingling, or urge to move.**

- Risk factors include:
  - Age
  - Stress
  - Narcolepsy or other neurological sleep disorder
  - Shift work or circadian misalignment
- Roughly 15% of adult Canadians report symptoms of sleep movement disorders (*Lavigne et al. 1994*).

# Fragmentation of Sleep

**Sleep fragmentation refers to disruptions in sleep continuity.**

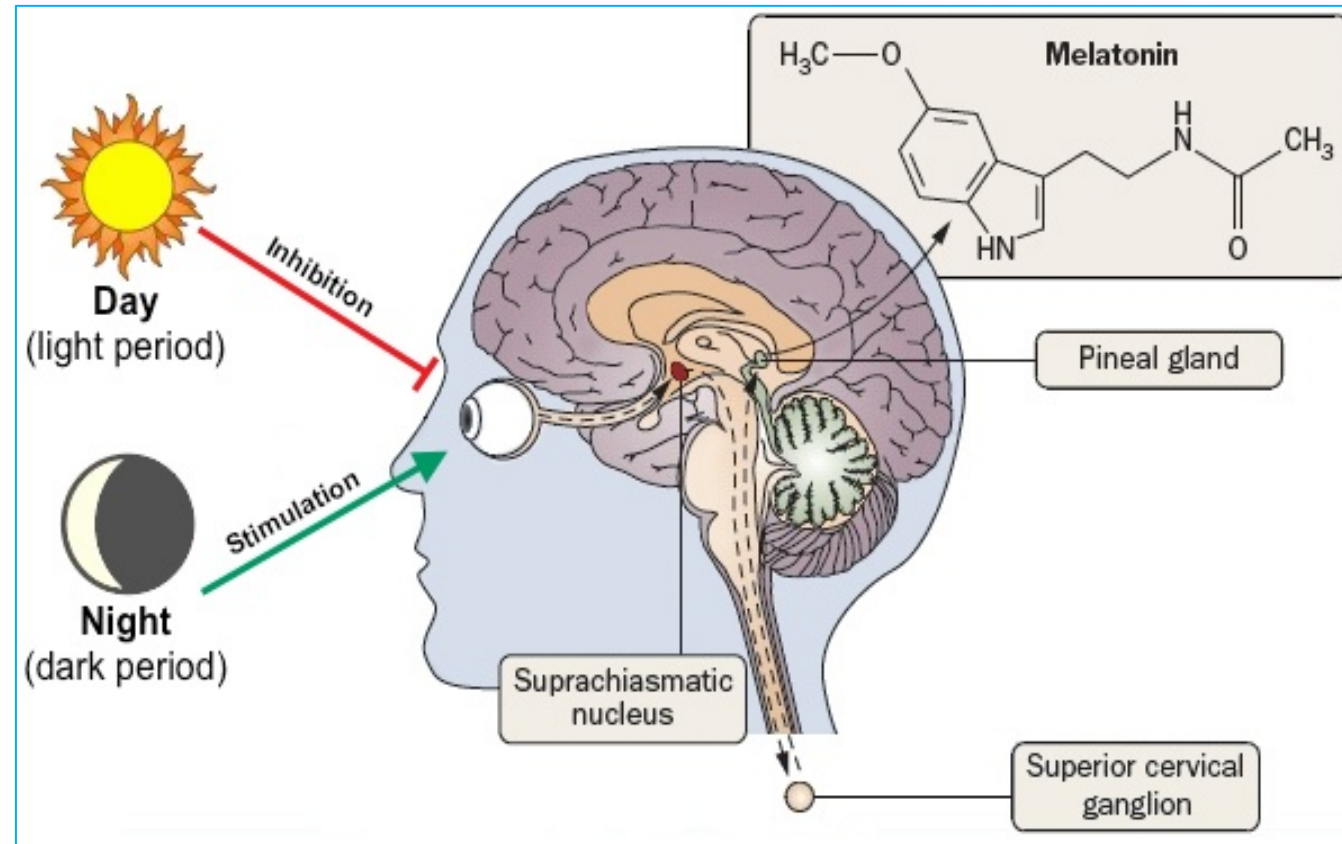
- Awakenings due to:
  - Biological sleep disorders
    - Obstructive Sleep Apnea (OSA)
    - Primary Insomnia Disorder
    - Narcolepsy
    - Periodic Limb Movement Disorder (PLMD)/Restless Leg Syndrome (RLS)
  - External sources
    - Circadian factors
    - Environment
    - Work schedule
    - Stress



# Circadian Factors: Light

The circadian rhythm is a biological process that regulates the sleep-wake cycle based on information about time of day (zeitgebers).

- Day = wake; Night = sleep.
- Light is the major zeitgeber.
  - Time of day
  - Time of year
  - Location
  - Artificial light and devices
- Darkness encourages melatonin production.
  - Melatonin is not a sleeping pill.





# Environment: Bedroom

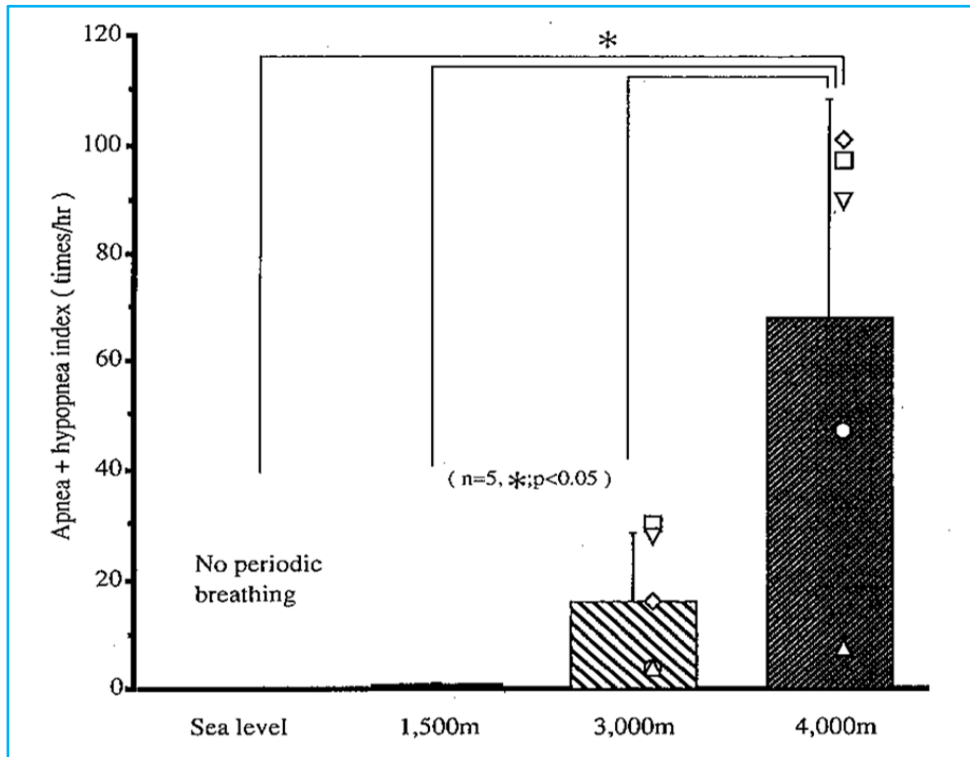
Where you sleep affects how you sleep



# Environment: Altitude

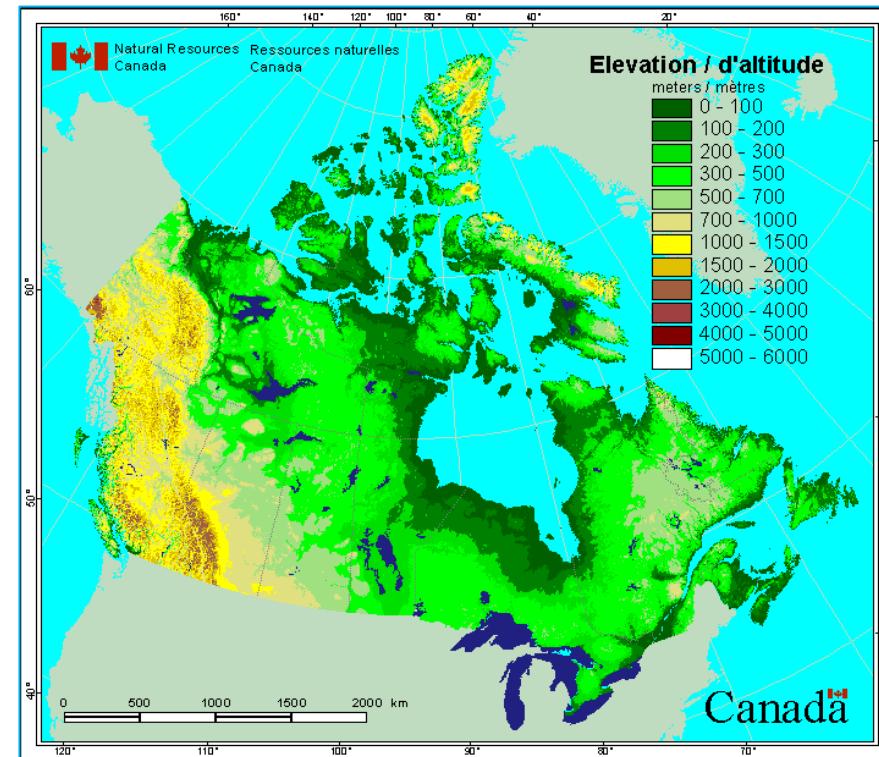
Sleeping at High Altitude Mimics Obstructed Sleep Apnea (OSA)

## >4000m ASL mimics OSA



Mizuno et al. 1993

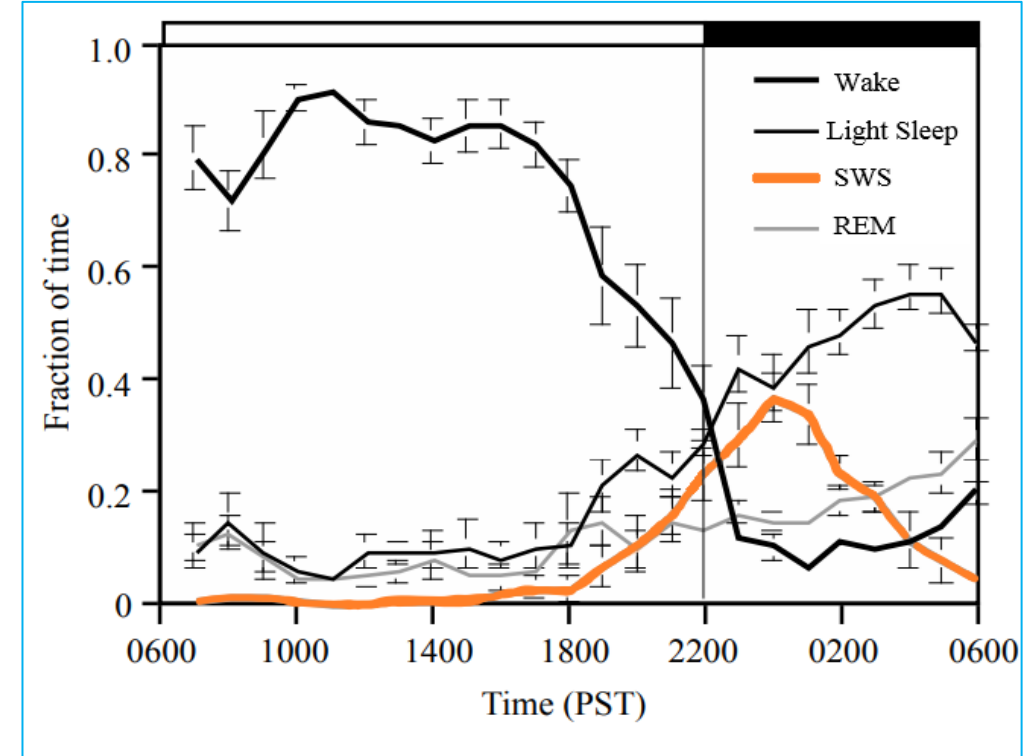
## Acclimated people not affected



# Work Schedule

Work schedules which overlap with typical sleep period can make it difficult to get consistently good quality sleep.

- Humans are not biologically disposed to sleeping during the day.
  - Harder to fall asleep
  - Harder to stay asleep
  - Circadian misalignment
  - Shift work sleep disorder
- Sleep architecture fluctuates by time of day.
- Social distractions compound circadian misalignment.

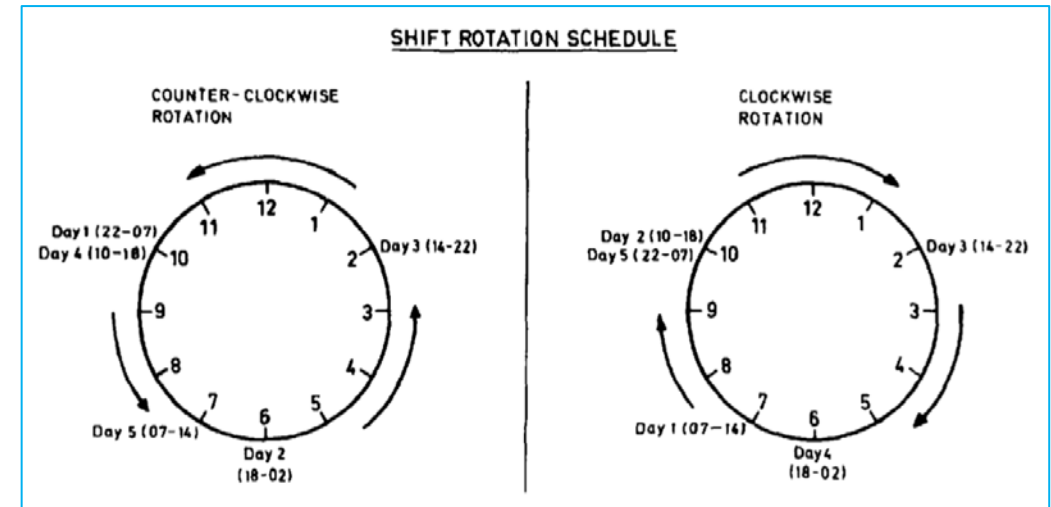


*Hsieh et al. 2008*

# Work Schedule

**Rotating work schedules or work schedules which change frequently can make it difficult to get consistently good quality sleep.**

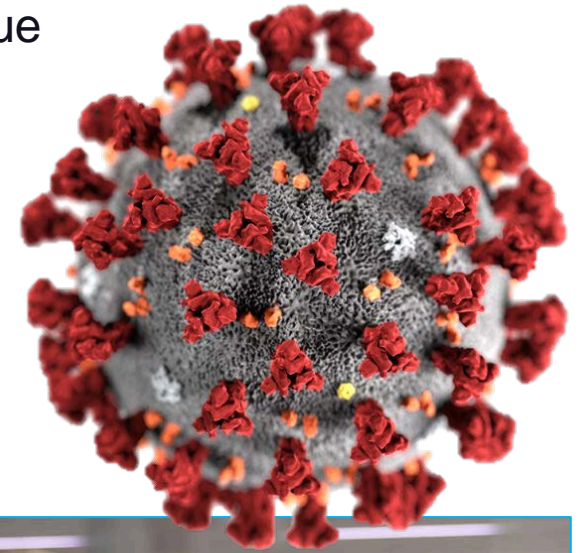
- Shorter rotation intervals make it hard to establish a functional sleep routine.
- It is harder to re-adjust when schedules follow a counter-clockwise/backward rotation (night to evening to morning).





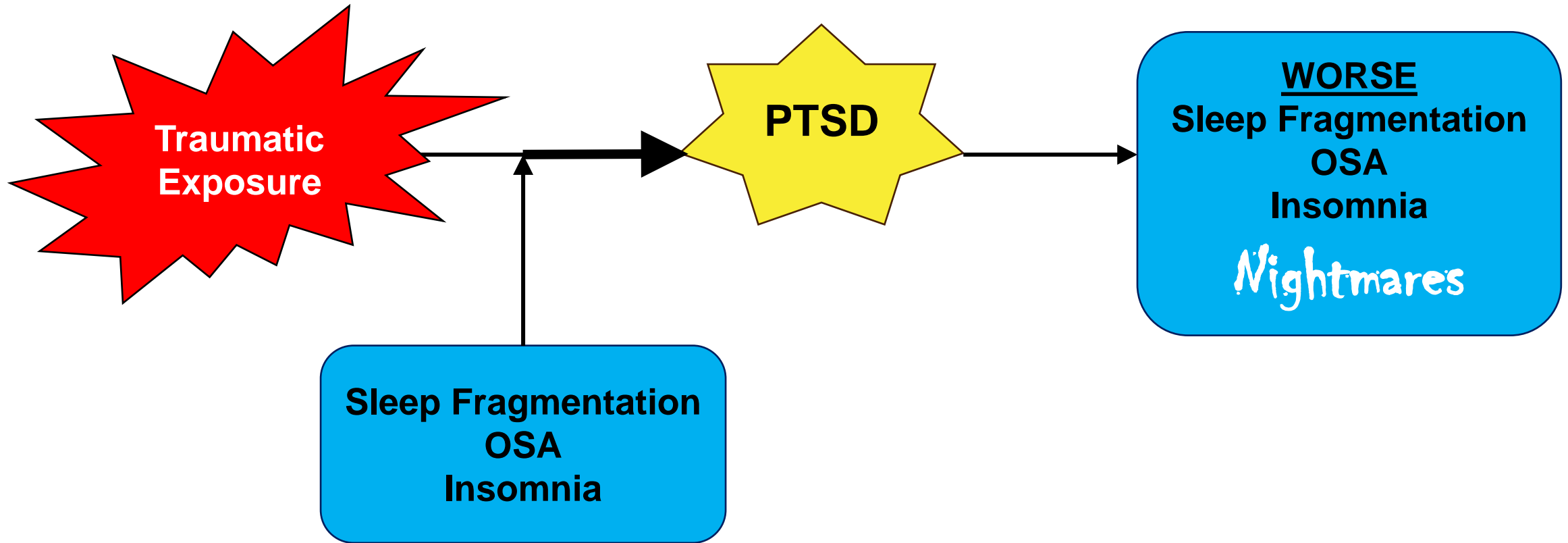
# Stress

Stress and mental health issues can result in insomnia symptoms or chronic fatigue



# Sleep and Post Traumatic Stress Disorder

Stress and mental health issues can result in insomnia symptoms or chronic fatigue





# Personal Satisfaction and Sleep Quality

**Satisfaction with the recuperative value of one's own sleep is important.**

- Easy to self-monitor
- Important for mood
- Correlates with other measures of sleep quality
- Frequently examined in context of fatigue
  - Self report sleep quality is related to performance

**However...**

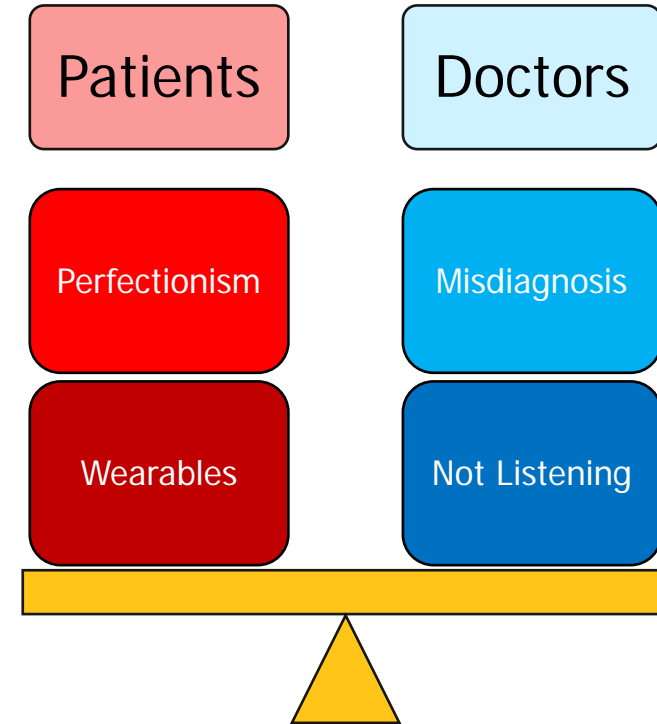
- Potentially unreliable
- Knowing is half the battle
- Don't obsess



# Orthosomnia

**Orthosomnia is the “perfectionist quest to achieve perfect sleep”.**

- Wearables/sleep trackers may “reinforce sleep-related anxiety or perfectionism for some patients”
- 2017 case report of 3 patients
- Popularized by the media
- Use best judgement



# Demographics Differences in Sleep Quality

## Age

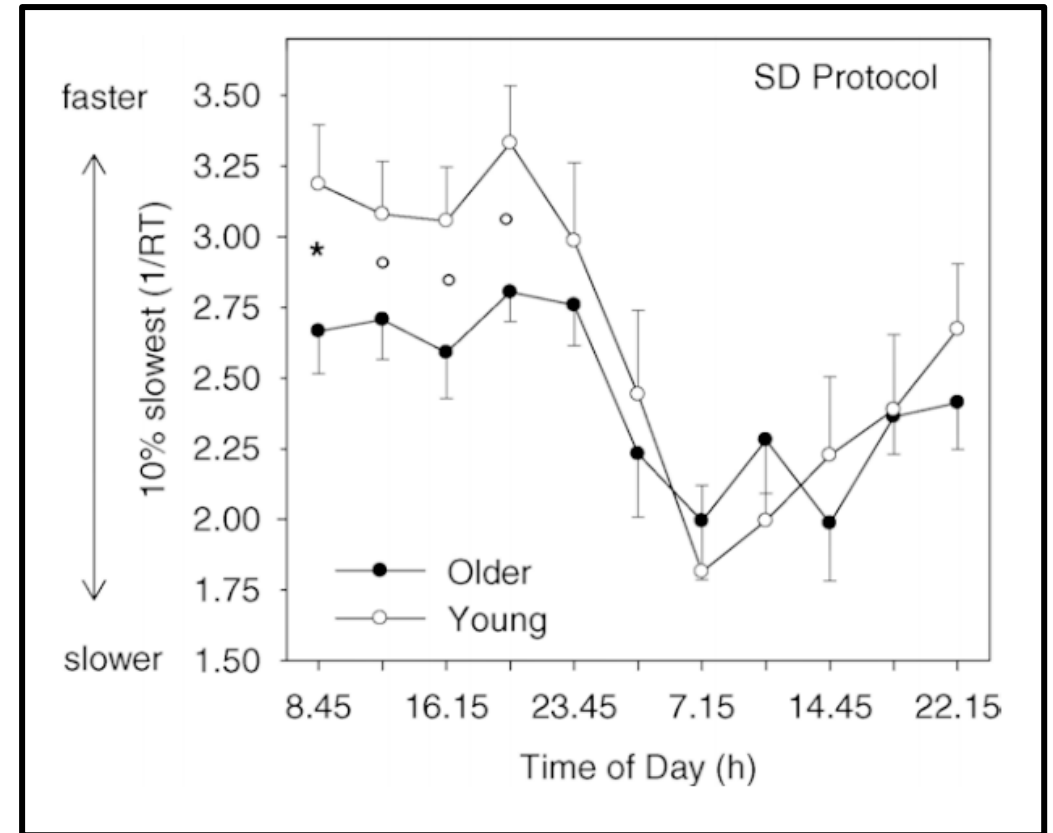
- Sleep quality gets worse with age
  - No influence on performance

## Gender

- Women report worse sleep quality than men
  - No influence on performance

## Race and Ethnicity

- Disparities contribute to sleep problems
- Circumstances > biology

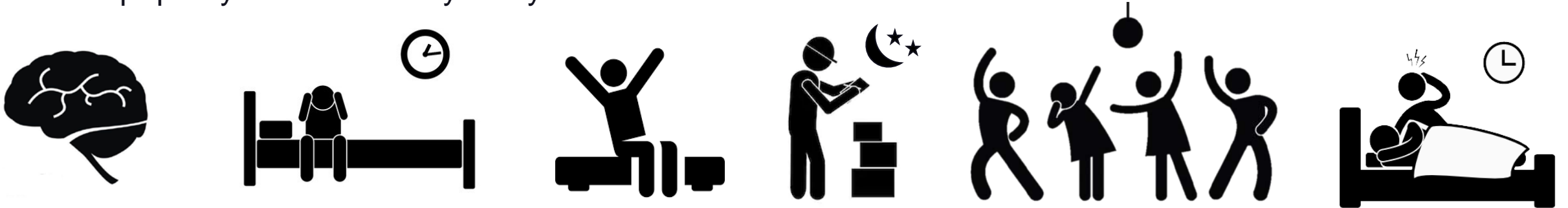


*Blatter et al. 2006*

**Demographics do not provide any irrefutable information about sleep quality**

# Take-Aways

1. Sleep quality is important for safety.
2. Sleep quality is influenced by many factors.



3. Sleep quality can be improved by making behavioral changes to your environment and lifestyle, but biological sleep disorders require treatment.



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# Thank You



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