



Dealing with Sleep and Jet Lag

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Disclosures

- NWSL: Chief Medical Officer
- USRowing: Team Physician, Medical and Sports Science Committee
- NFL: Research and Innovations Committee
- AMSSM Foundation: Board Member
- Wu Tsai Human Performance Alliance: Sports Advisory Council
- Korey Stringer Institute: Medical and Science Advisory Board
- Baseline Global: Medical Advisory Board
- Agency for Student Health Research: Medical Advisory Board

The views presented are my own and not reflective of any of the organizations for whom I consult or provide services.

Objectives:

- Describe how sleep can affect mental and physical health
- Discuss the effects of sleep on injury risk and athletic performance
- Identify ways to minimize the adverse effects of jet lag



Mental health issues and psychological factors in athletes: detection, management, effect on performance and prevention: American Medical Society for Sports Medicine Position Statement—Executive Summary

Cindy Chang,¹ Margot Putukian ,^{2,3} Giselle Aerni,⁴ Alex Diamond,⁵ Gene Hong,⁶ Yvette Ingram,⁷ Claudia L Reardon,⁸ Andrew Wolanin⁹



BJSM 2020

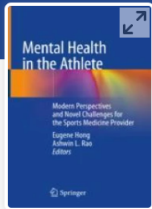


Mental health issues and psychological factors in athletes: detection, management, effect on performance and prevention: American Medical Society for Sports Medicine Position Statement—Executive Summary

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BJSM 2020

- Background and Purpose
- How Teams Work
- Personality Issues and Athletic Culture
 - Personality Issues
 - Sexuality and Gender Issues
 - Hazing
 - Bullying
 - Sexual Misconduct
 - Transition from sport
- The Psychological Response to Injury and Illness
 - Self-medication in response to injury/illness
- Select Psychological Challenges/Issues
 - Eating Disorders/Disordered Eating
 - Depression and Suicide
 - Anxiety and Stress
 - Overtraining
 - Sleep disorders
 - Attention-Deficit/Hyperactivity Deficit (ADHD)
- Summary



Mental Health in the Athlete pp 277–290

The Role of Sleep in Psychological Well-Being in Athletes

[Chad Asplund](#) & [Cindy J. Chang](#) 

Chapter | [First Online: 31 May 2020](#)

- Introduction
- Why Do We Sleep?
- Normal Sleep Architecture
 - Medication Effects on Sleep Architecture
- The Anatomy of Sleep
- Common Sleep Disorders and Their Association/ Effect on Psychological Well-Being in Athletes
 - Insomnia
 - Obstructive Sleep Apnea-Hypopnea (OSA)
- The Specifics of Optimal Sleep for Athletes
 - Sleep and Athletic Performance
 - How Can Athletes Improve Their Sleep?
 - Insomnia
 - Obstructive Sleep Apnea (OSA)
- Summary

Why do we sleep?

- Inactivity theory
 - Protect from danger
- Energy conservation theory
 - Reduce energy demand and expenditure
- Restorative theory
 - Repair and rejuvenate
- Brain plasticity theory
 - Brain organization and structure
- Synaptic pruning theory
 - Strengthen imppt connections w/ other parts of brain; prune non-essential ones

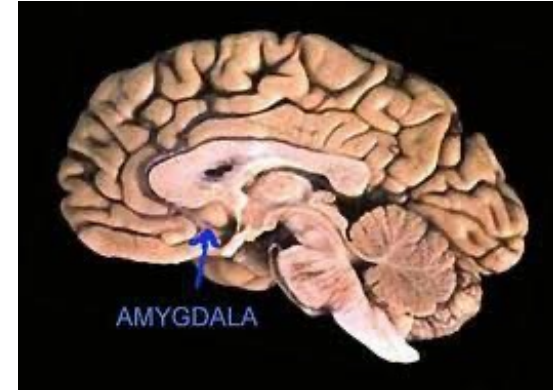


▪ Poor sleep results in:

- Inflammation within brain
- Poor metabolite clearance linked to serotonergic dysfunction, beta-amyloid accumulation

How does sleep affect your patients' mental health?

- Amygdala is main link between sleep and mental health conditions
 - Involved in processing emotions; integrative center for emotions, emotional behavior, motivation and fear
 - Sleep deprivation amplifies emotional reactivity of the amygdala by up to 60%
 - enhances brain's response to negative emotional stimuli
- Decreased sleep of 5 hrs/night for 5 days causes same dysregulation of amygdala as **total** sleep deprivation

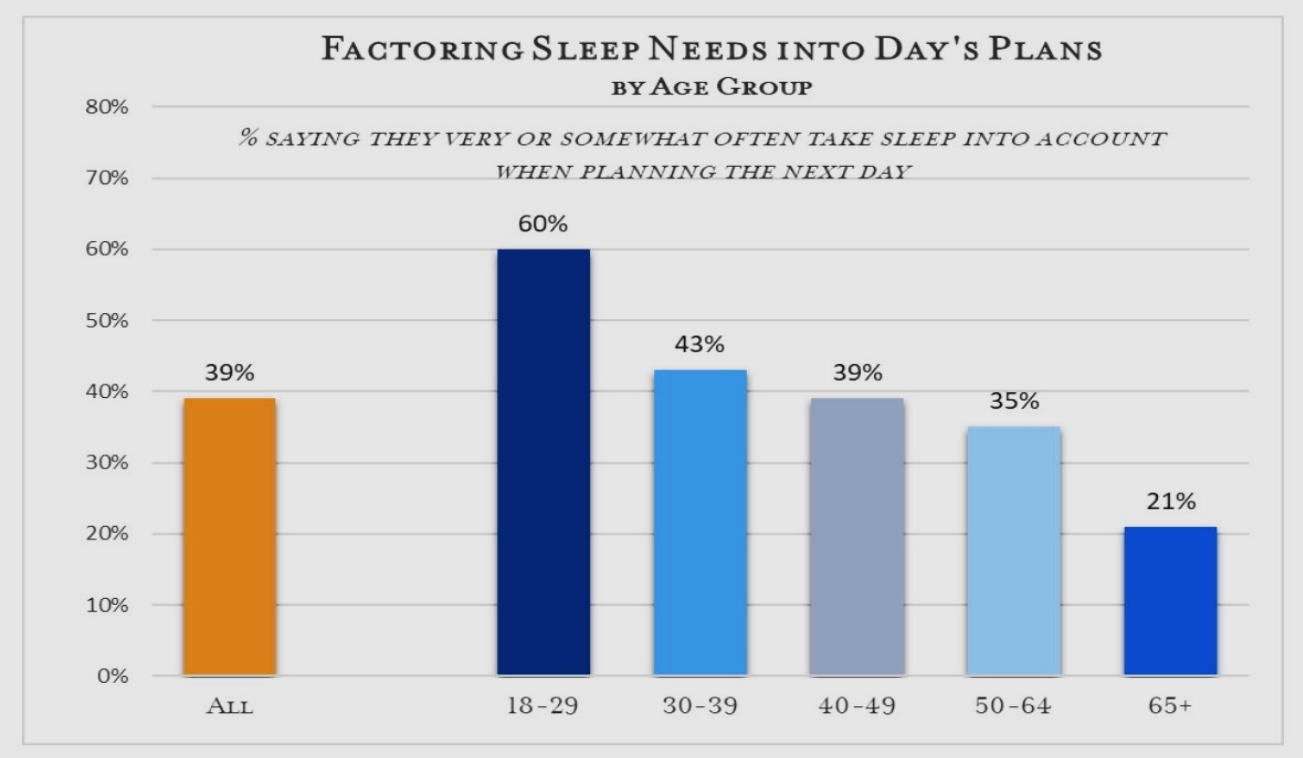


How are we sleeping as adults?

- 2015 American Academy of Sleep Medicine and Sleep Research Society consensus panel recommended **7 hrs/night minimum for adults** to promote optimal health
- 35.2% of American adults report ≤ 7 hours of sleep/night
- 70 million Americans suffer from chronic sleep problems

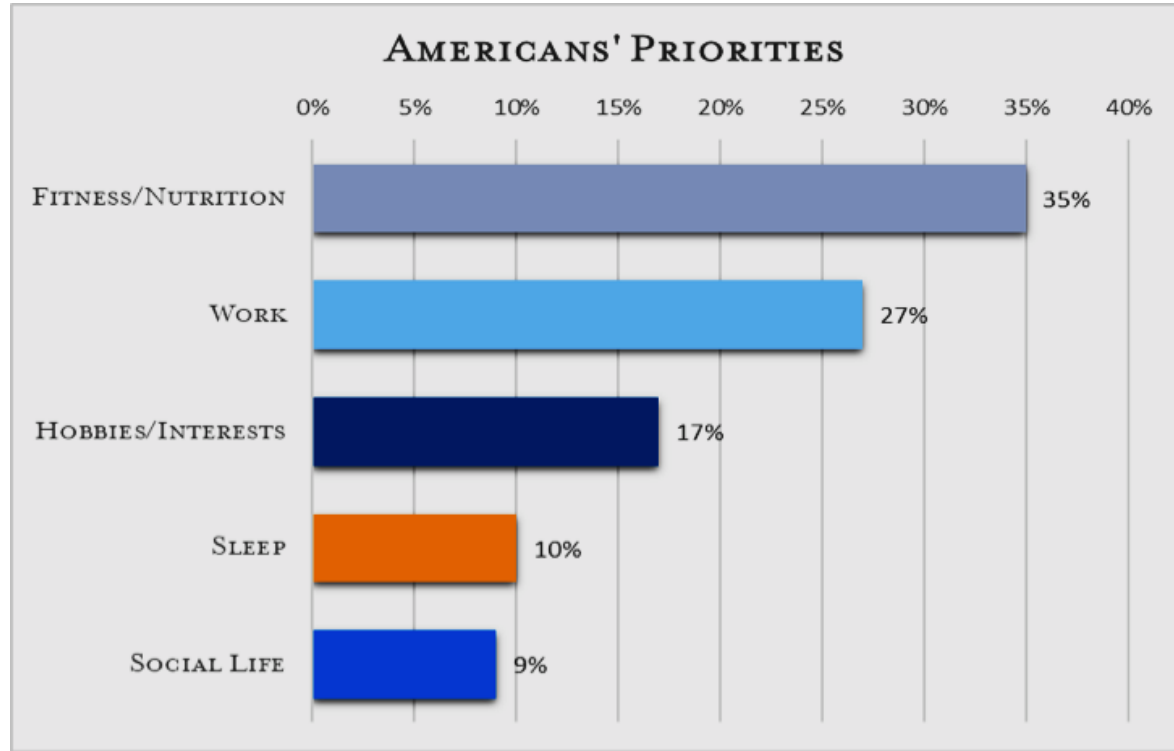


60% of Americans Don't Account for Sleep the Night Before



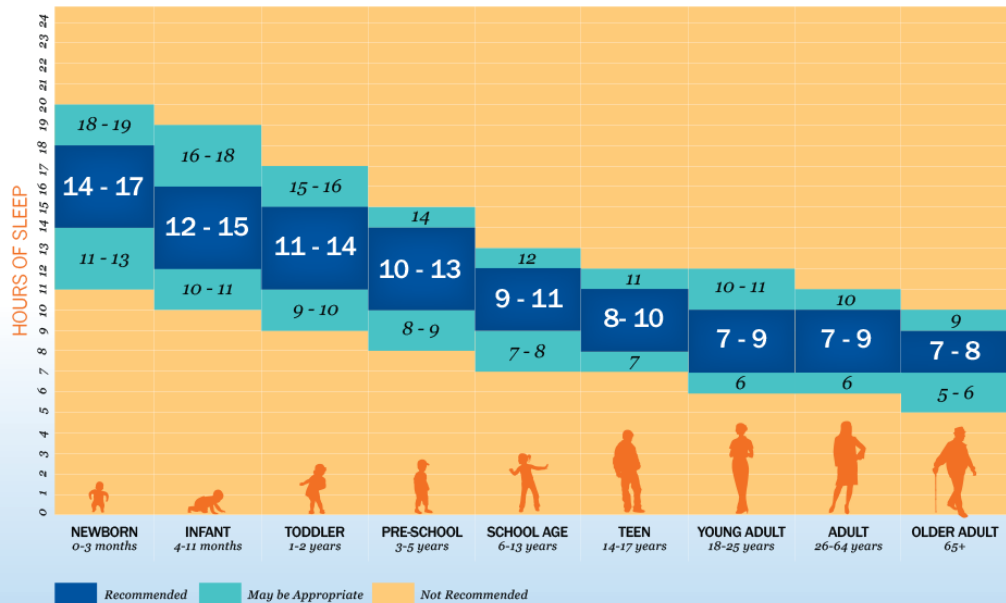
National Sleep Foundation, Sleep In America Poll 2018

35% Americans Chose Fitness/Nutrition vs. 10% Sleep



National Sleep Foundation, Sleep In America Poll 2018

SLEEP DURATION RECOMMENDATIONS



SLEEPFOUNDATION.ORG | SLEEP.ORG

Hirshkowitz M, The National Sleep Foundation's sleep time duration recommendations: methodology and results summary, Sleep Health (2015), <http://dx.doi.org/10.1016/j.sleh.2014.12.010>

87% of parents of 9th-12th graders think they get enough sleep a few nights/week

Only 9% adolescents obtain 9 hours/night

Insufficient and Poor Sleep in College Athlete Population (n=628)

- 39.1% obtain <7 hours on weekdays
- 51% clinically high levels of daytime sleepiness (Epworth)
- 42.4% student-athletes have poor sleep quality (Pittsburgh Sleep Quality Index)



Mah et al. Sleep Health 2018

Self-Reported Sleep Behavior in College Athlete Population (n=14,134)

Table 1 National College Health Assessment: self-reported sleep behaviour among full-time undergraduate students who self-identify as varsity athletes at NCAA member Institutions (n=14 134)^{12(p20)}

| Sleep behaviours | Reported response option | Percent of varsity athletes |
|---|---|-----------------------------|
| Sleep difficulties in the past 12 months. | Traumatic or very difficult to handle. | 24 |
| Falling asleep at night. | Extreme difficulty at least three nights in the last week. | 24 |
| Awaking too early and unable to go back to sleep. | Occurred at least three nights in the last week. | 16 |
| Getting enough sleep to feel rested. | Insufficient sleep more than 3 days out of past 7; | 57 |
| | Insufficient sleep 6–7 days out of past 7. | 23 |
| Daytime tiredness. | Felt tired, dragged out or sleepy at least 3 days during the last week; | 61 |
| | reported that daytime sleepiness has been a big problem in last 7 days. | 17 |
| Negative consequences of sleep difficulties. | Academic performance. | 18 |

Kroshus et al. BJSM 2019

How does sleep affect your patients' mental health?

- In college students, high prevalence of common mental disorders comorbid with sleep disorder
 - Those who experienced poor sleep quality 2.4-fold higher odds of depression, anxiety, and somatoform disorder than those with good sleep quality
- Poor sleep can be sign of a mental health disorder or can exacerbate existing mental health conditions
 - Improved sleep quantity and quality can improve symptoms of depression, anxiety, and bipolar d/o

Byrd KL et al, Health Behav Policy Rev 2014; Harvey A et al, Clin Psychol Rev 2011

How does sleep affect your patients' **mental health**?

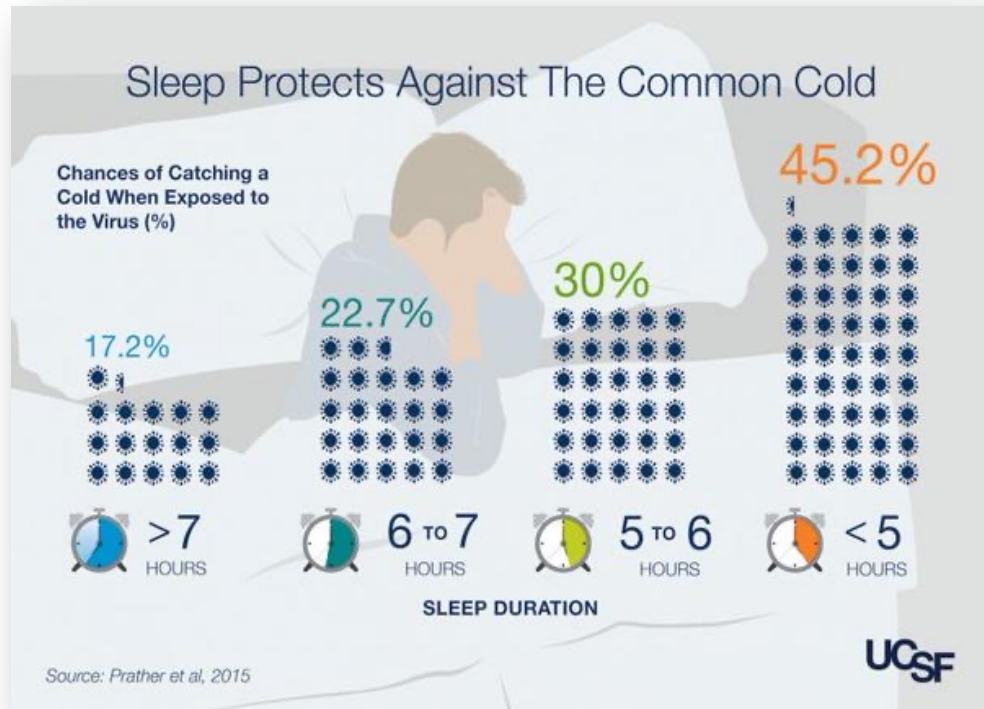
- Decreases in both quality and duration of sleep linked to:
 - Impaired cognitive functioning/judgment, mood problems, somatic symptoms
 - Increase in perceived physical exertion and decrease in pain tolerance
- Sleep loss increases both sympathetic activity and catecholamine levels
 - Lead to altered stress system responsiveness, similar to that seen in mood d/o
- Sleep's role in pain perception and mental and physical recovery after injury or surgery can mean that deprivation is a risk factor for:
 - Substance and alcohol misuse, violence-related behaviors, and MVC

Meerlo et al, Sleep Med Rev 2008; Paiva et al Sleep Sci 2016; Hildenbrand et al, J Sch Health 2013; Taylor and Bramoweth J Adol Health 2010

How does sleep affect your patients' physical health?

- **Shorter sleep duration associated with increased susceptibility to common cold**

Catching a cold is 4x more likely with ≤ 6 hours of sleep vs. 7 hours



Prather AA et al, Sleep 2015

Graphic courtesy of C. Mah

How does sleep affect your patients' **physical health**?

▪ **Sleep loss increases injury risk**

NBA male athletes playing back-to-back games:

- 3.5x ↑ risk of injuries in Away games
- 3.3x ↑ risk of injuries if played 3-4 games vs 1-2 games in the 5 days before an injury

In adolescent athletes:

- Fatigue-related injuries associated with sleeping ≤ 6 hrs
- 1.7x ↑ risk of injury with < 8 hrs of sleep

Teramoto M et al, J Sci Med in Sport 2017; Luke A et al, CJSM 2011
Milewski MD, et al, J Pediatr Orthop 2014

How does sleep affect your patients' health—and academic performance?

- Avg adolescent 6.8 hr sleep (optimal 9.25 hr)
 - ↑ risk MH disorders
 - ↑ risk-taking behaviors and accidental injury

A/B students ≥ 8.25 hr; D/F < 6.75 hr

A students 15 min more sleep than B

B students 11 min more sleep than C



Wahlstrom and Owens Curr Opin Psych 2017

How does sleep affect your patients' **health—and academic performance?**

- School start times shifted one hour later resulted in 66% of students obtaining 8 hrs of sleep (up from 33%)

Grades and national achievement scores improved

70% reduction in teen car crashes



Wahlstrom and Owens, *Curr Opin Psych* 2017

What about different *combinations* of sleep duration, physical activity and sedentary behavior on physical, psychological, and educational outcomes?

- Systematic review of 41 studies of children 5-17 yoa
 - Physical outcomes: adiposity, cardiometabolic risk factors, cardiorespiratory and muscular fitness
 - Psychological outcomes: well-being and socioemotional, health-related QOL, mental health
 - Education-related outcomes: academic performance, cognitive/executive function
- If more active, less sedentary, and slept longer than peers: most favorable outcomes
- Shorter sleep duration negatively affected all types of outcomes

Does sleep mediate the association between school pressure, physical activity, screen time, and psychological symptoms?

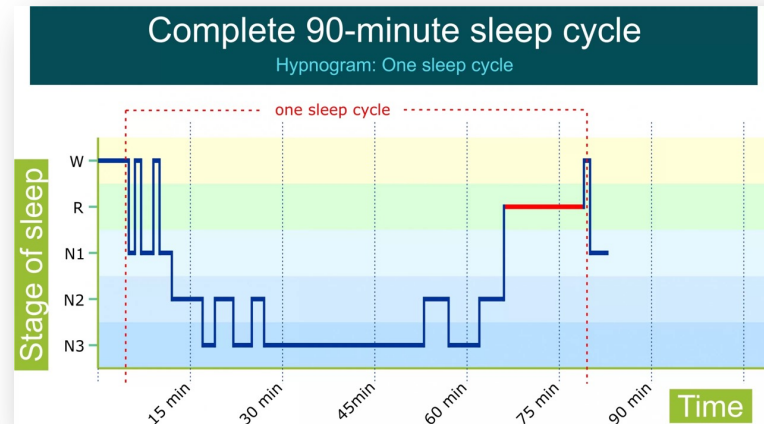
- 49,403 adolescents (11-15 yoa) from 12 countries in WHO “Health Behaviour in School-aged Children” (2013/2014) study
 - More school pressure, fewer days engaging in sufficient physical activity, and higher levels of screen time associated with more psychological symptoms
 - Adolescents experiencing a lot of school pressure slept 15 min less on weekdays and 12 min less on weekend days
 - Better sleep quantity and quality related to a better mental health status

Vandendriessch A et al, Int. J. Environ. Res. Public Health 2019

How does sleep affect your patients' athletic performance?

- Sleep single most important factor for recovery from sport
 - Average sleep cycle 90 min; most need 5 sleep cycles/night
 - Natural increase in growth hormone occurs at 0100; to maximize, must be in deep sleep at time of secretion
 - 11:30 pm is latest bedtime for best opportunity for recovery, with 7:30 am alarm

With natural circadian rhythm disrupted, cortisol levels also increase inducing a catabolic state



Littlehale N, Sleep 2016

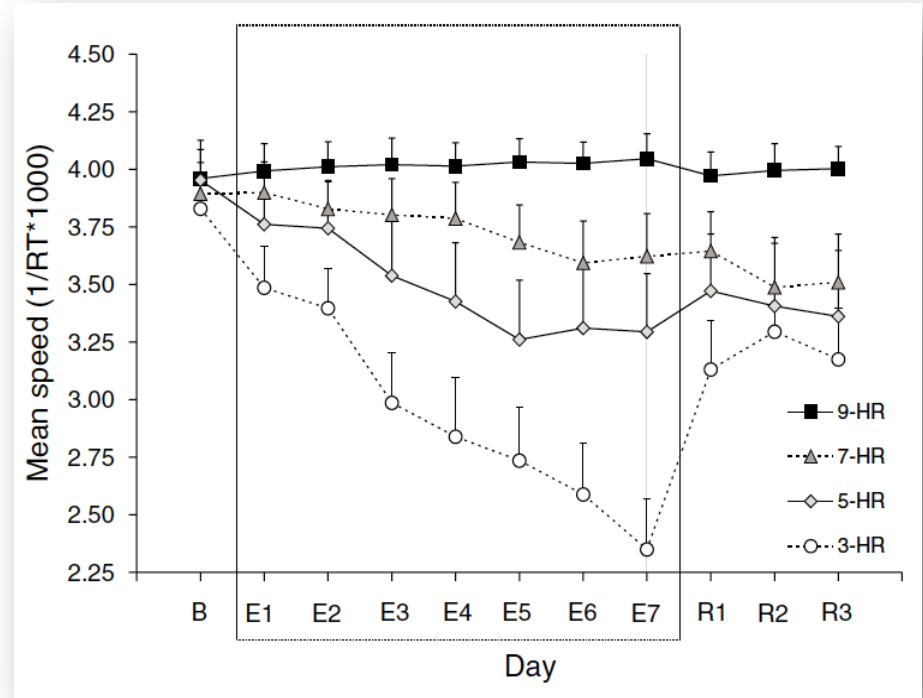
How does sleep affect your patients' athletic performance?

■ Psychomotor vigilance task speed

Slower reaction time

Even with recovery sleep, speed still impaired

In other studies, cognitive functions of judgement and decision-making also impaired



Vitale et al, Int J Sports Med 2019; Belenky G et al J Sleep Res 2003

How does sleep affect your patients' athletic performance?

- 25% decrease in serving accuracy after 1 night of 5 hrs of sleep
 - **Caffeine did not correct impairment**

- Performance of both submaximal and maximal weight-lifting tasks altered after 2nd day of sleep loss (3 hr/night)



Reyner LA and Horne JA, Phys & Behav 2013; Reilly T and Piercy M, Ergonomics 1994

How does sleep affect your patients' athletic performance?

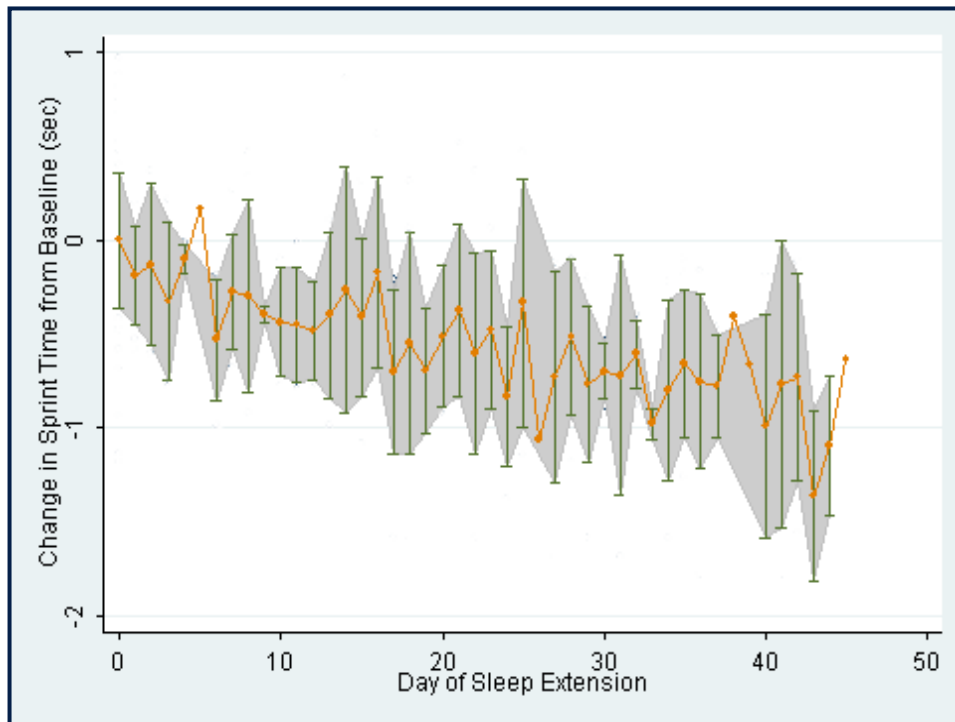
- 6 wks sleep extension in collegiate men's basketball program
 - Increased sleep extension compared to baseline by 110.9 ± 79.7 min
 - Minimum goal of 10 hrs in bed/night



Mah CD et al, Sleep 2011

0.7 Sec Faster Sprint Time ($P < 0.001$)

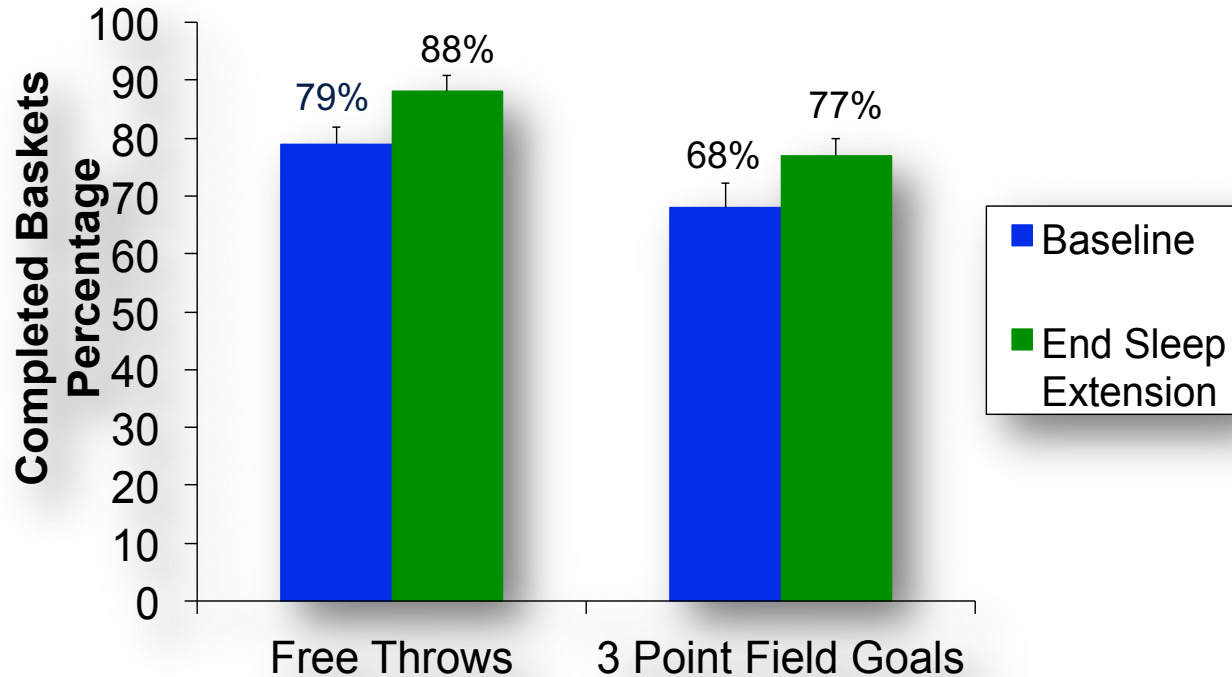
Baseline
16.2 Sec



End Sleep Extension
15.5 Sec

Mah CD et al, Sleep 2011; Graphic courtesy of C. Mah

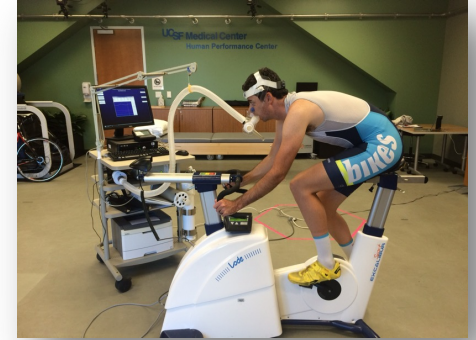
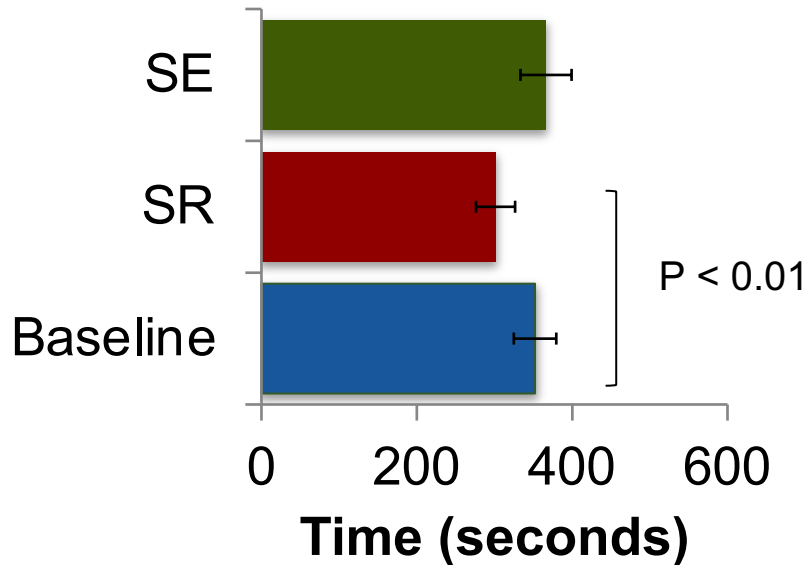
9% ↑ in Free Throw % and 3 Pt Field Goal % ($P < 0.001$)



Mah CD et al, Sleep 2011; Graphic courtesy of C. Mah

How does sleep affect your patients' athletic performance?

Time to Exhaustion in Elite Cyclists



- ↓ 51 secs (14.4%) following sleep restriction
- ↑ 14 secs following sleep extension

Mah CD unpublished data; Graphic courtesy of C. Mah

How does sleep affect your patients' **athletic performance**?

- Sleep Duration Correlates with Performance in Ultra-Endurance Triathlon
 - Stage 1 – 10 km swim, 146 km cycle
 - Stage 2 – 276 km cycle
 - Stage 3 – 84.4 km run
 - Total sleep time (TST) and quality measured using actigraphy wristband
- Reduction in TST had significant negative correlation to exercise performance
- Latency, wake episodes, and efficiency did not change

Kisiolek et al Int J Sports Phys Perf 2021

How does sleep affect your patients' athletic performance?

- Elite male cyclists restricted sleep to 4 hr/night x 3 nights
 - Maximal vertical jump height ↓
 - LE coordination variability ↑ and associated with ↑ slowing of psychomotor response time



Altered joint coordination variability may be linked to overuse injury and increased risk of ACL injury

Mah CD et al, J Sports Sci 2019

How does sleep affect your patients' athletic performance?

- Systemic review and meta-analysis (n=227)
 - Performance tasks were classified into different exercise categories: anaerobic power, speed/power endurance, high-intensity interval exercise (HIIE), strength, endurance, strength-endurance, and skill
 - Control (>6 hr) vs Intervention (<6 hr)

~0.4% decline in performance for every hour spent awake after acute sleep loss

Exercise tasks performed in PM consistently negatively affected by sleep loss; tasks performed in AM largely unaffected

Craven J et al, J Sports Medicine 2022

Project REST (Recovery Enhancement and Sleep Training)

- Baseline survey (n=289) with questionnaires on sleep, health, mental well-being, stress, social functioning, and other factors.
- Sleep problems are highly prevalent
 - 68% “poor sleep” on PSQI
 - 43% get < 7 hrs of sleep (87% ≤ 8 hrs)
 - 12% moderate-severe insomnia
 - 23% excessive fatigue
 - 17% drowsy driving in past month

https://www.ncaa.org/sites/default/files/2017RES_InnoGrant_Grandner_Slides_2017_20170206.pdf

Project REST (Recovery Enhancement and Sleep Training)

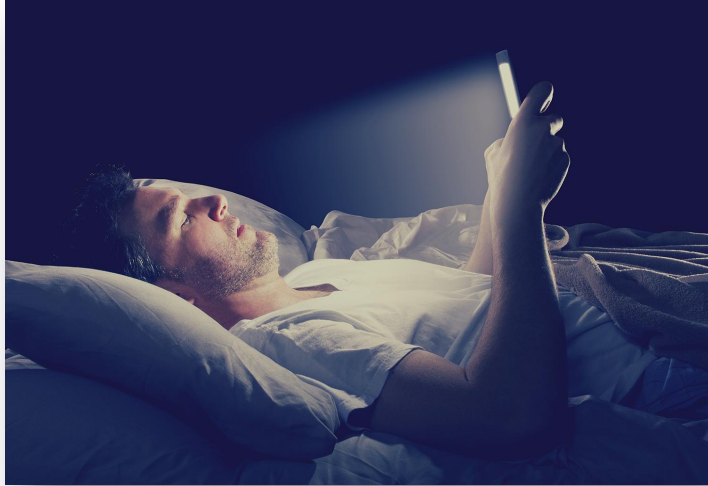
- 2 hr sleep education (n=40) with sleep strategies
- 10 wk intervention with objective sleep monitoring and online sleep logs
- Received daily text messages (tips, reminders, sleep facts)

83% reported better sleep, 89% reported athletic performance positively affected



https://www.ncaa.org/sites/default/files/2017RES_InnoGrant_Grandner_Slides_2017_20170206.pdf

How does cell phone use affect your patients' sleep?



- Young adults that checked social media within 30 min of sleeping were 1.5x more likely to have disturbed sleep
- Blue light emitted from devices 1 hr before bed can prevent sleep, ↓ melatonin release, ↓ REM

Levenson et al Sleep 2017; Chang et al PNAS 2015

Does exercise volume and timing affect your patients' **sleep**?

- High volumes of exercise related to improved sleep and psychological functioning
 - Adolescent athletes training 18hr vs. 4.5hr/wk had higher sleep quality, shorter sleep-onset latency, and fewer awakenings
 - Less tiredness and increased concentration during day; significantly lower anxiety and depressive symptoms
- Exercise (2-4h before bed) may not be associated with worse sleep
- Evening exercise 7-10 pm can induce *phase delay*; 7 am/1-4 PM exercise can induce *phase advance*

Myllymaki et al J Sleep Res 2011; Buman et al Am J Epid 2014, Brand et al J Adol Health 2010; Thomas JM et al JCI Insight 2020

Sleep Optimization

- **9 hours sleep per night** should be daily goal for athletes
- If inadequate night's sleep, a nap the following day may be beneficial
 - Naps in mid-afternoon (13:00–16:00) have greater recuperative value
- If aware that sleep will be impaired (e.g. long travel day before competition), “banking sleep” to get more extended sleep prior to sleep deprivation may improve performance
- *Physical performance benefits* of napping greater in sleep-restricted athletes compared to well-rested athletes
- Napping improves *cognitive performance* (visual reaction time, attention and mental rotation tasks)
- Napping *improves sleepiness and alertness*; results in *improved mood states*

Treatment for Insomnia

- Cognitive Behavioral Therapy (CBT) first-line treatment
- Diet - Manipulation of precursor amino acid L-tryptophan can affect CNS by regulating production of serotonin and melatonin
 - Foods high in CHO – shorter sleep latency
 - Foods high in protein – improved sleep quality
 - Foods high in fat – decrease total sleep time
- Non-BZD hypnotics improve sleep latency/maintenance of sleep (only eszopiclone)
- Melatonin inconclusive but safe for short-term use
 - ↓ sleep–onset latency but did not improve sleep quality; not regulated by FDA

Anderson KN J Thorac Dis 2018; Taylor DJ Int Rev Psych 2014; Halson SL Sports Med 2014



How does **travel** affect your patients' **health—and athletic performance?**

- **NBA male athletes** playing back-to-back games:
 - 3.5x ↑ risk of injuries in Away games
 - 3.3x ↑ risk of injuries if played 3-4 games vs 1-2 games in the 5 days before injury

- **NFL football players** playing close to circadian peak in performance demonstrate significant athletic advantage over those playing at other times.

Teramoto M et al, J Sci Med in Sport 2017; Smith RS et al, Sleep 2013

How does **travel** affect your patients' **athletic performance**?

- West Coast vs East Coast *night* games x 25 NFL seasons:
 - West Coast teams win 63.5% of games
 - West Coast team beats Las Vegas point spread 67.9%
- Circadian advantage for West Coast teams regardless of location of game (peak performance late afternoon)
- Follow up study
 - 40 NFL seasons (1970-2011) demonstrated West coast teams beat point spread 2x more than East Coast teams



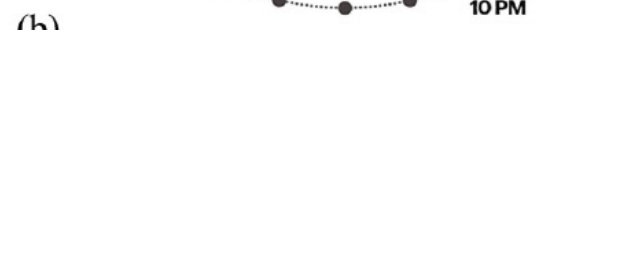
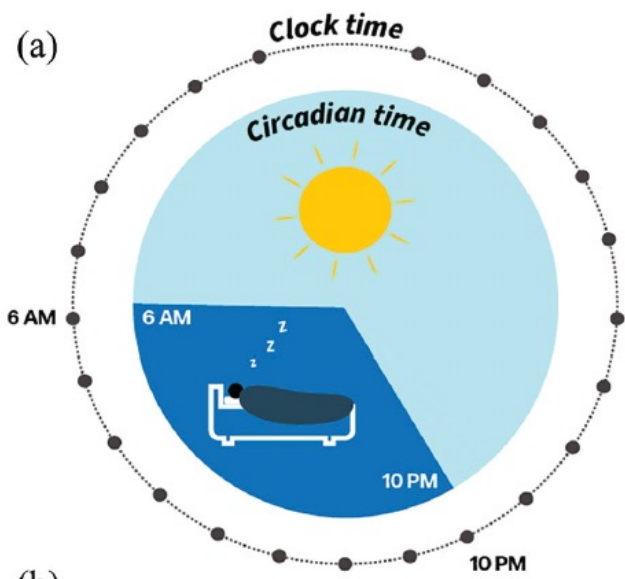
Smith RS et al, Sleep 1997, 2013

Jet Lag

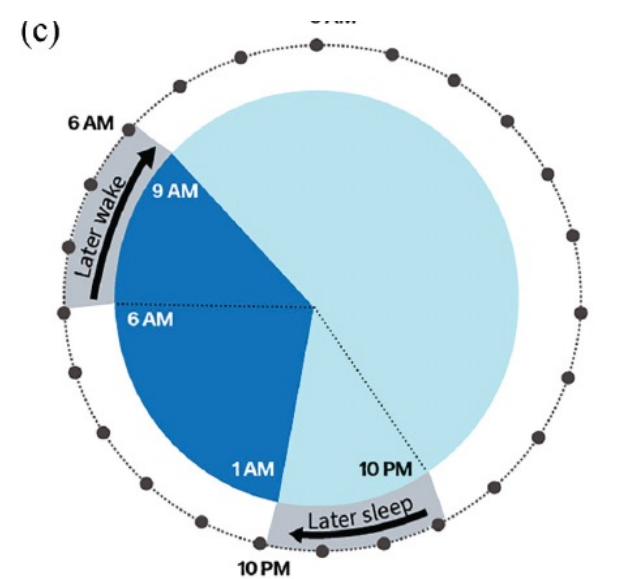
- Jet lag is consequence of circadian desynchronization
 - Resolves with resynchronization at rate of **1 day per time zone (1h/d) when traveling East, and ½ day per time zone (2h/d) when traveling West**
 - Episodic and characterized by GI disturbance (heartburn, indigestion, diarrhea), sleep disturbance, intermittent fatigue, impaired concentration
- Incidence and severity of jet lag increase with # of time zones crossed



Herxheimer A BMJ Clin Evid 2014; Forbes-Robertson et al, Sports Med 2012; Samuels CH, CJSM 2012

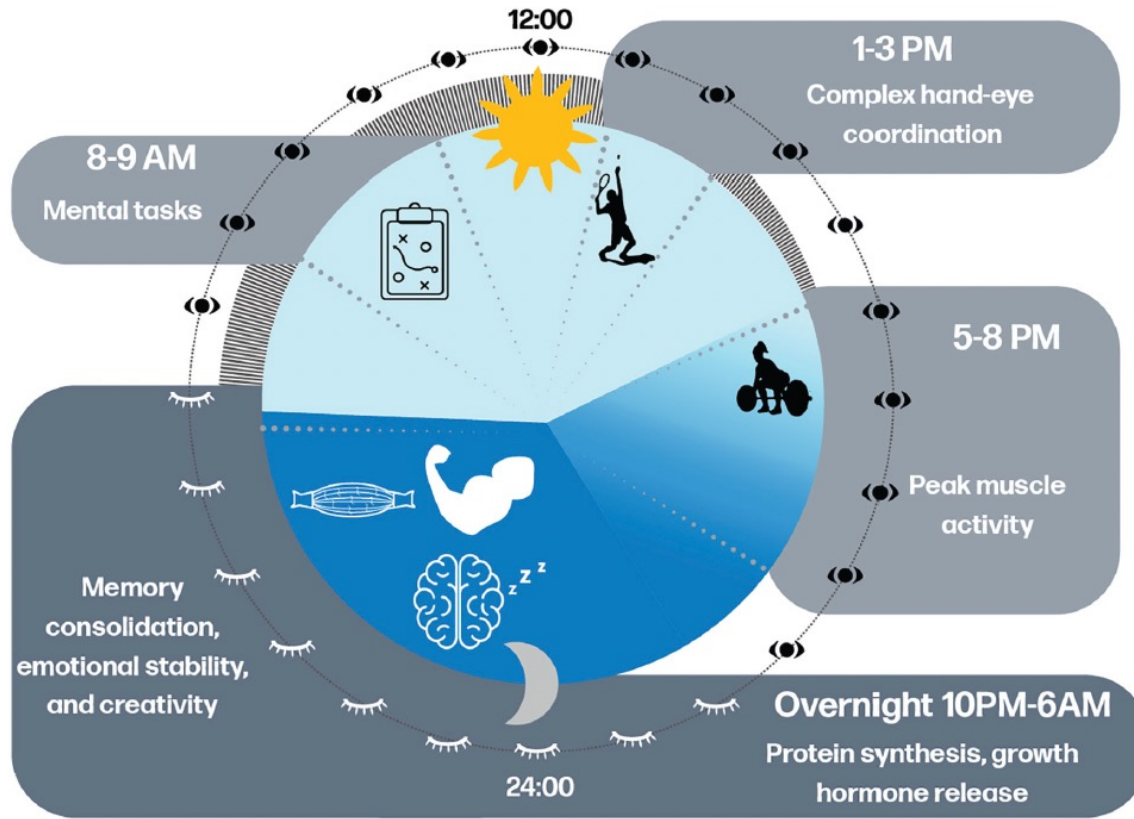


Traveling 3 time zones East



Traveling 3 time zones West

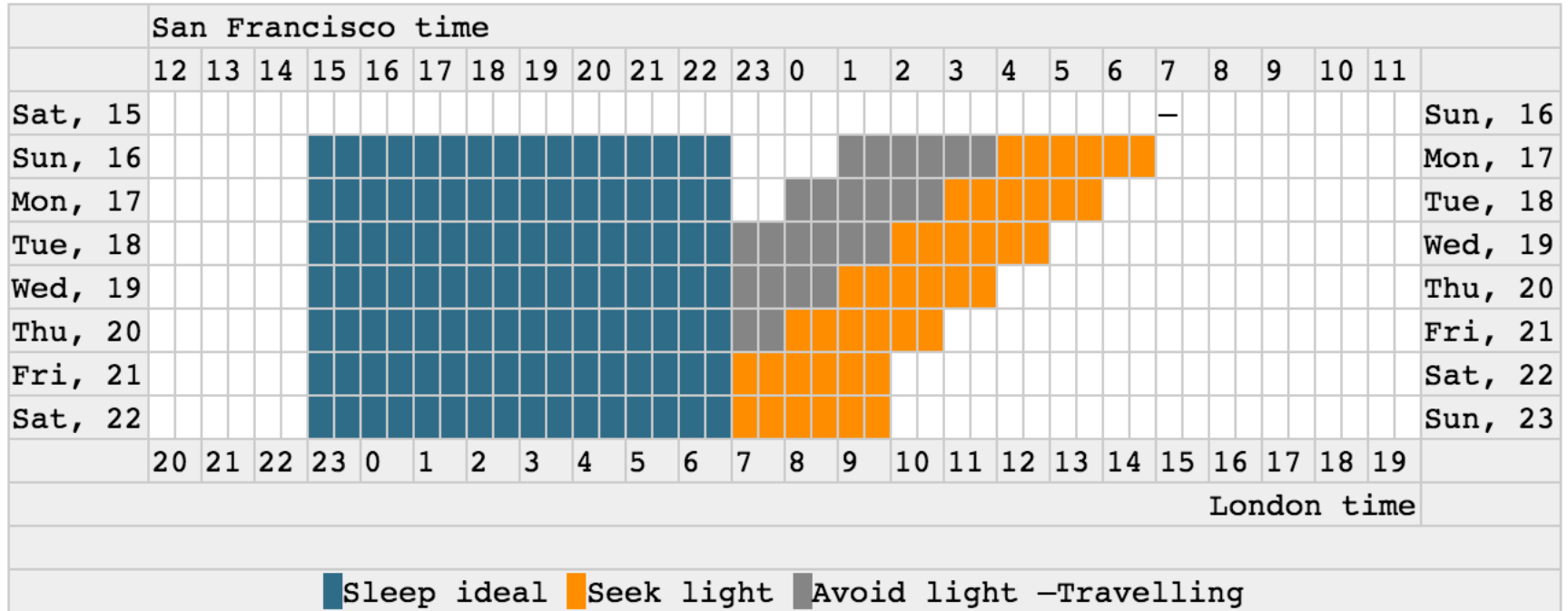
Heller HC et al, J Biolog Rhythms 2024



Heller HC et al, J Biol Rhythms 2024

Jet Lag Calculator

- Shift sleep schedules pre- and post- flight; when to seek and avoid sunlight



Departing on...

04/01/2024



08:45 AM



Arriving on...

04/01/2024



11:35 AM



Usually go to sleep at...

11:45 PM



And wake up at...

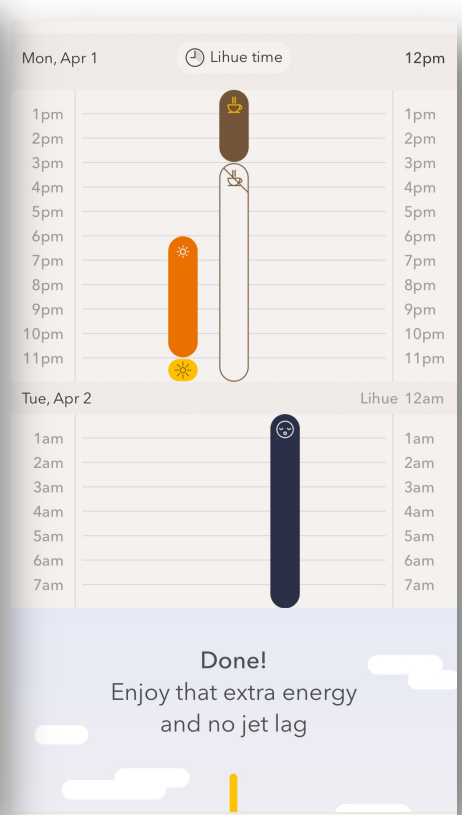
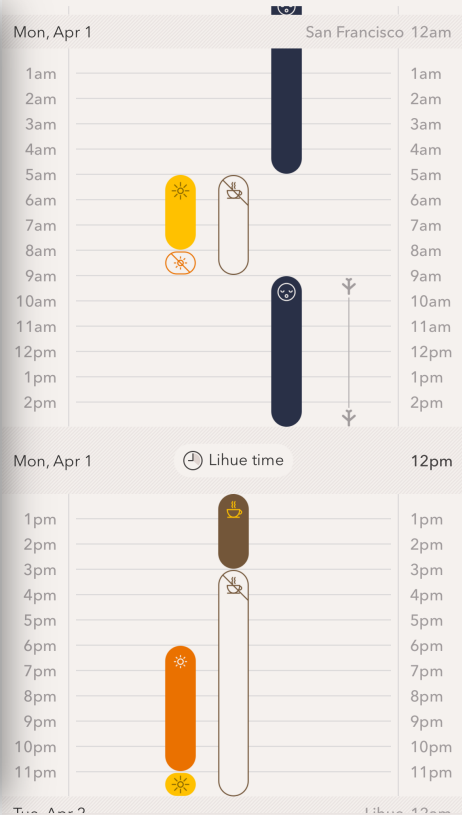
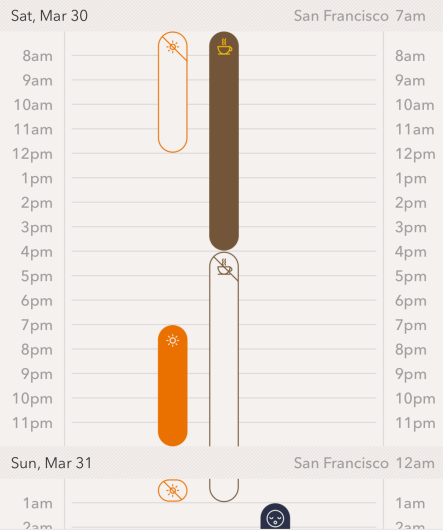
07:00 AM



Start shifting sleep schedule to new time zone:

- after arriving.
- after departing on the plane.
- up to 2 days before departing.

Lihue timeshift
will start
Sat, Mar 30



Done!
Enjoy that extra energy
and no jet lag

Pre-Flight Strategies to Minimize Jet Lag

- Obtain adequate sleep to reduce sleep debt prior to flight (sleep banking)
- Shift body clock gradually by 1 hr/day before flight
 - e.g., for 3 d before West to East coast flight bedtime and wake time shifts 1h *earlier* each day
- Select best flight times that allow proper sleep *prior* to flight; consider layovers for crossing 10+ time zones
 - Choose flight with arrival time to coincide w/ optimal light exposure/avoidance
- Well-planned nutrition and hydration program may have impact on jet lag

There is insufficient high-quality evidence about effectiveness of lifestyle and environmental adaptations

Herxheimer A BMJ Clin Evid 2014; Forbes-Robertson et al, Sports Med 2012; Samuels CH, CJSM 2012

In-Flight Strategies to Minimize Jet Lag

- Prioritize good hydration on flight. Avoid alcohol; no caffeine 6hr before sleep
- Eat smaller lighter meals before and during flight timed with destination location
- Wear layered, loose fitting clothing
- Plan to sleep according with destination location (*reset watch to destination time*)
- Don't stay awake to watch movies
- Ensure that ambient temperature on plane not too warm (67° F)
 - Core body temp (CBT) also has 24hr circadian rhythm of 0.8-1.0° C
 - minimum b/w 0300-0700 during lowest level of alertness
- Utilize Travel Recovery Bag to optimize sleep environment

Obradovich N et al, Sci Adv 2017; Forbes-Robertson S et al, Sports Med 2012; Samuels CH, CJSM 2012

Essential Items for Travel Recovery Bag

- Eyemask (contoured)
- Earplugs (silicone)
- Noise-canceling headphones
- Travel pillow (memory-foam)
- Sunglasses or blue-blocking glasses
- Pre-sleep snack/pack enough food
- Electrolytes for hydration
- Familiar sleep item from home
- Other recovery modalities...



Post-Flight Strategies to Minimize Jet Lag

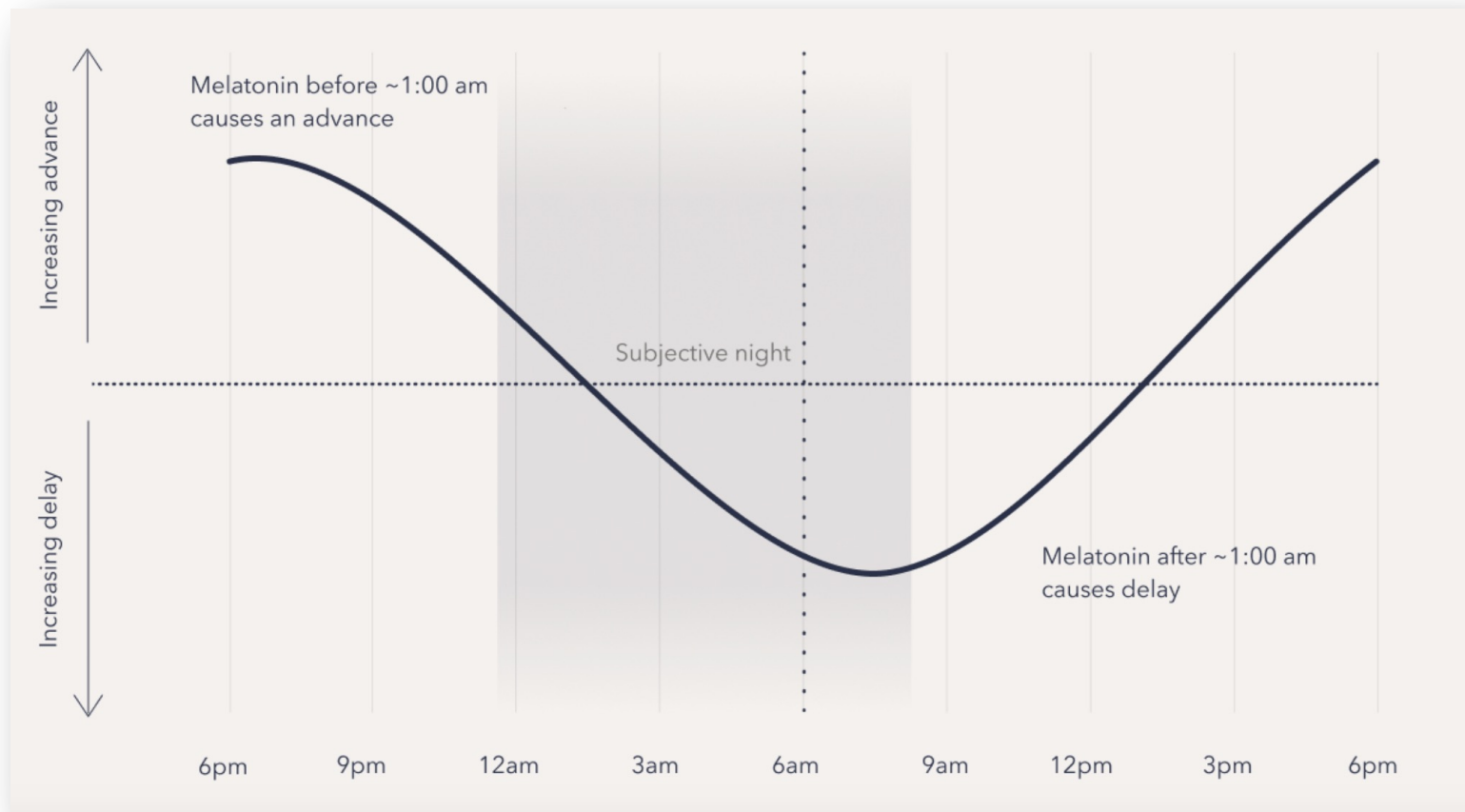
- Leverage sunlight exposure/avoidance to resynchronize body clock
 - After Westward flight: Stay awake while daylight and sleep once dark
 - *Phase Delay* = body has to delay or move backward to earlier time to be in synch
 - After Eastward flight: Stay awake (unless you arrive in early AM, then nap) and be outdoors as much as possible in afternoon and evening
 - *Phase Advance* = body has to advance or move forward to later time to be in synch
 - If > 8h East, Phase Delay as easier for body clock to adjust to extensive delays easier than extensive advances

Janse van Rensburg et al Sports Med 2021; Herxheimer A BMJ Clin Evid 2014; Forbes-Robertson et al, Sports Med 2012; Samuels CH, CJSM 2012

Post-Flight Strategies to Minimize Jet Lag

- Melatonin (start low at 1-3 mg) can help shift body clock
- Non-BZD hypnotics (zolpidem, zopiclone) on first few nights may improve sleep duration to reduce some effects of jet lag
- Use strategic short 20-30 min power naps and caffeine (1 mg/kg) to mitigate sleep inertia during circadian nadir to ↓ cumulative sleep debt and fatigue
- Adjust timing of meals to speed adaptation

Janse van Rensburg et al Sports Med 2021; Herxheimer A BMJ Clin Evid 2014; Forbes-Robertson et al, Sports Med 2012; Samuels CH, CJSM 2012



Questions?

(and thank you for not falling asleep during my presentation!)

