Unlocking athletic performance through optimal recovery: the power of sleep

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Sleep as a key factor in sports performance

- Even a single night of sleep deprivation can significantly impair athletic performance:
  - One night of sleep deprivation reduces sprint performance by 10 %?!

Outline

- **Basic principles of sleep physiology**
- Scientific insights
- Barriers to good sleep in athletes
  - Competition and travel schedules
  - Psychological factors (stress, pressure)
  - Sleep hygiene and environmental factors
  - ….
- Assessment
- Recommendations
  - Personalised sleep strategies
  - Integrate sleep into performance programmes such as nutrition and training
  - Research needs (e.g. women, team sports, youth)
- Conclusion

The importance of sleep

- Primary and vital need
- Active physiological process with various functions:
  - **Memory consolidation**
  - **Cognitive function:**
    - Attention
    - Executive function
    - Problem-solving
    - Decision-making
  - **Emotional regulation:**
    - Mood stability
    - Stress resilience
    - Emotional processing

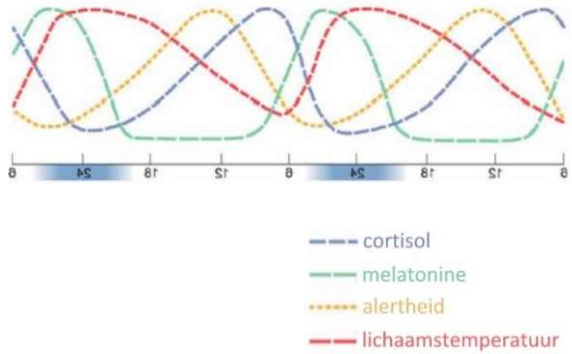
The importance of sleep

- Primary and vital need

- Active physiological process with various functions:
  - Proper functioning of:
    - **Immune system**
    - **Metabolism**
    - **Control of appetite and weight**
    - **Strong connection with cardiovascular system** (blood pressure, sympathetic balance, vascular tone….)

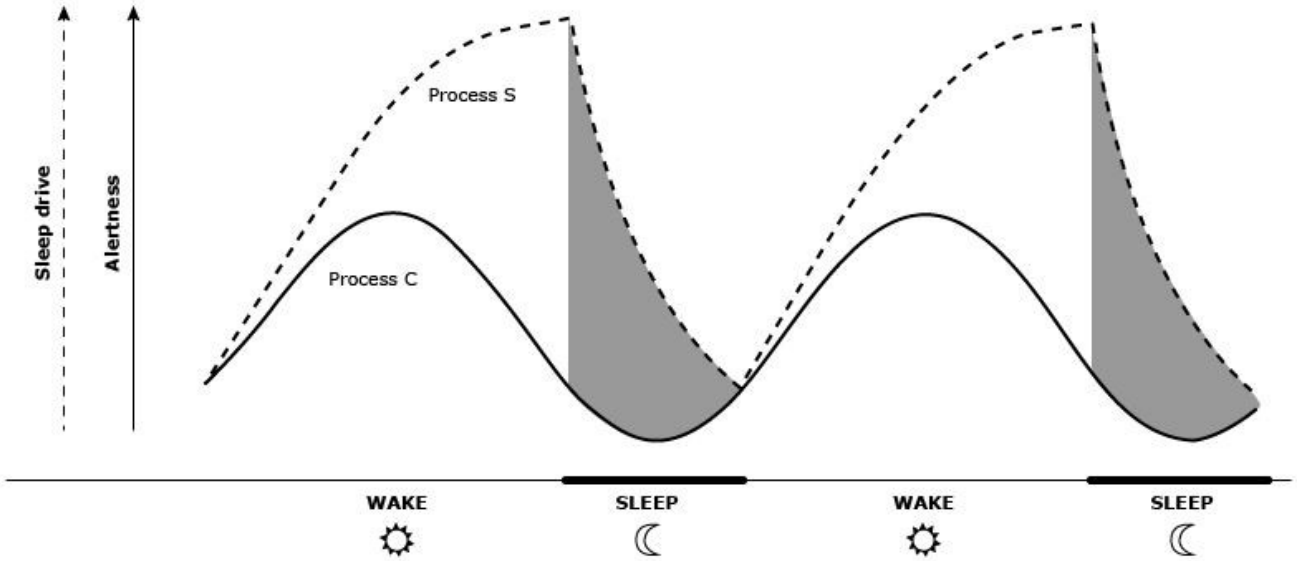
- Sleep is a combination of
  - Learned behavior (conditioning)
  - Biological processes determined by:
    - Genetics
    - Human development stage

Regulation

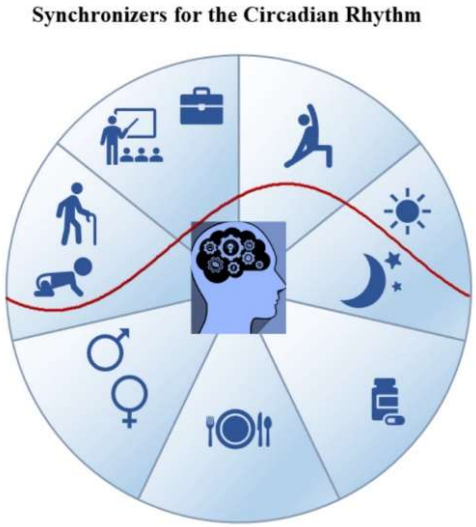


Sleep is determined by 2 rhythms:

- **Process S:** Homeostasis / sleep propensity
- **Process C:** Internal biological clock / circadian rhythm



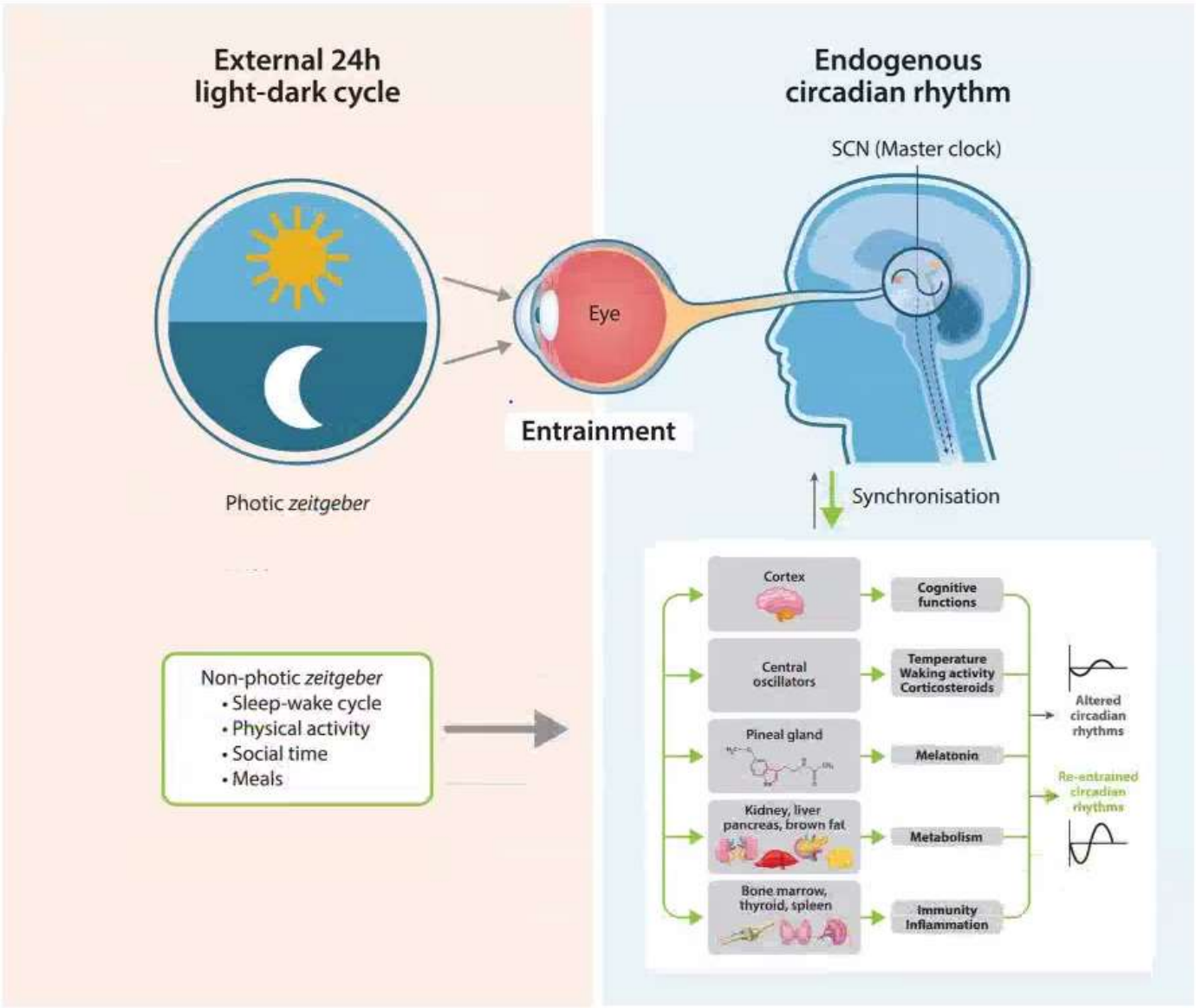
Process S and process C (Cheng & Drake, 2016)

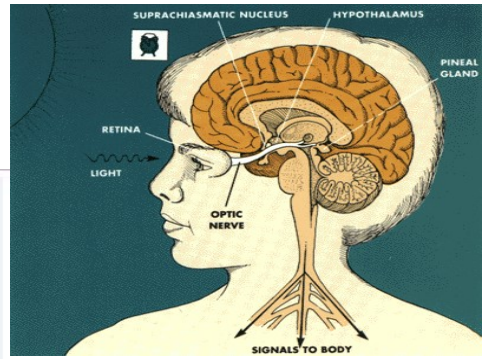


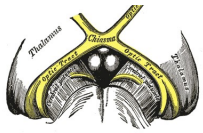
Montaruli et al., Biomolecules 2021

Achermann, & Borbely 2003
(Beersma, 2002)

Circadian rhythm





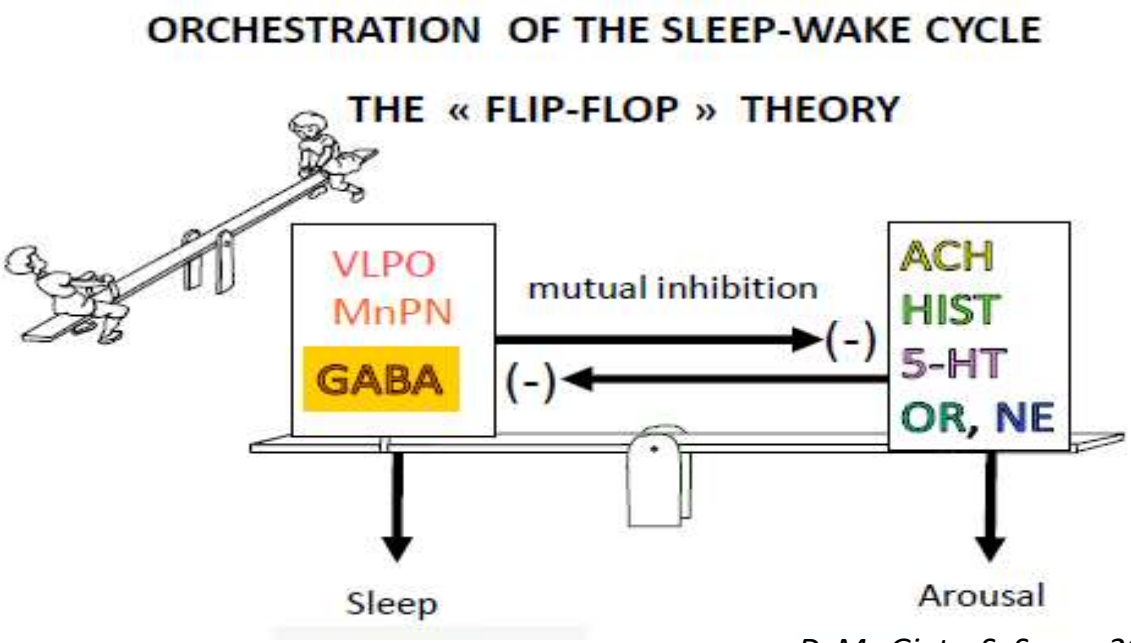


SCN=Nucleus suprachiasmaticus

Fig. 1 Schematic diagram of the circadian clock entrainment pathways. Light directly entrains the suprachiasmatic nucleus (SCN), whereas other non-photic zeitgebers exhibit rhythmic changes and entrain the SCN and peripheral clocks throughout 24 h—adapted with permission from Buttgereit et al. [40] and Hood and Amir [41]

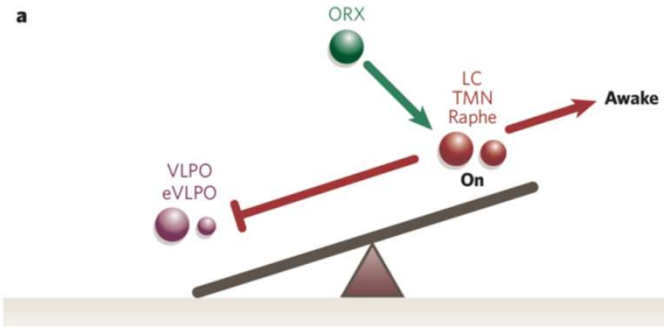
Jande van Rensburg, 2021

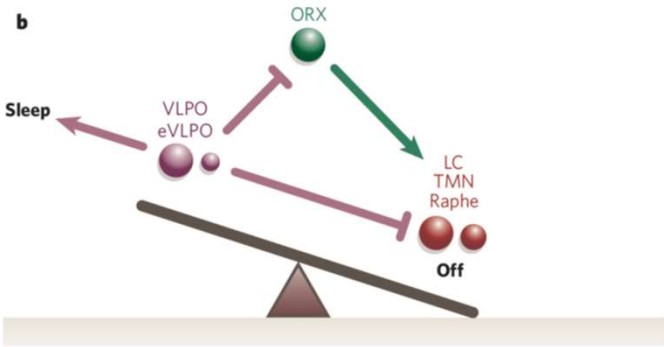
Regulation of sleep



D. Mc Ginty, S. Saper, 2006

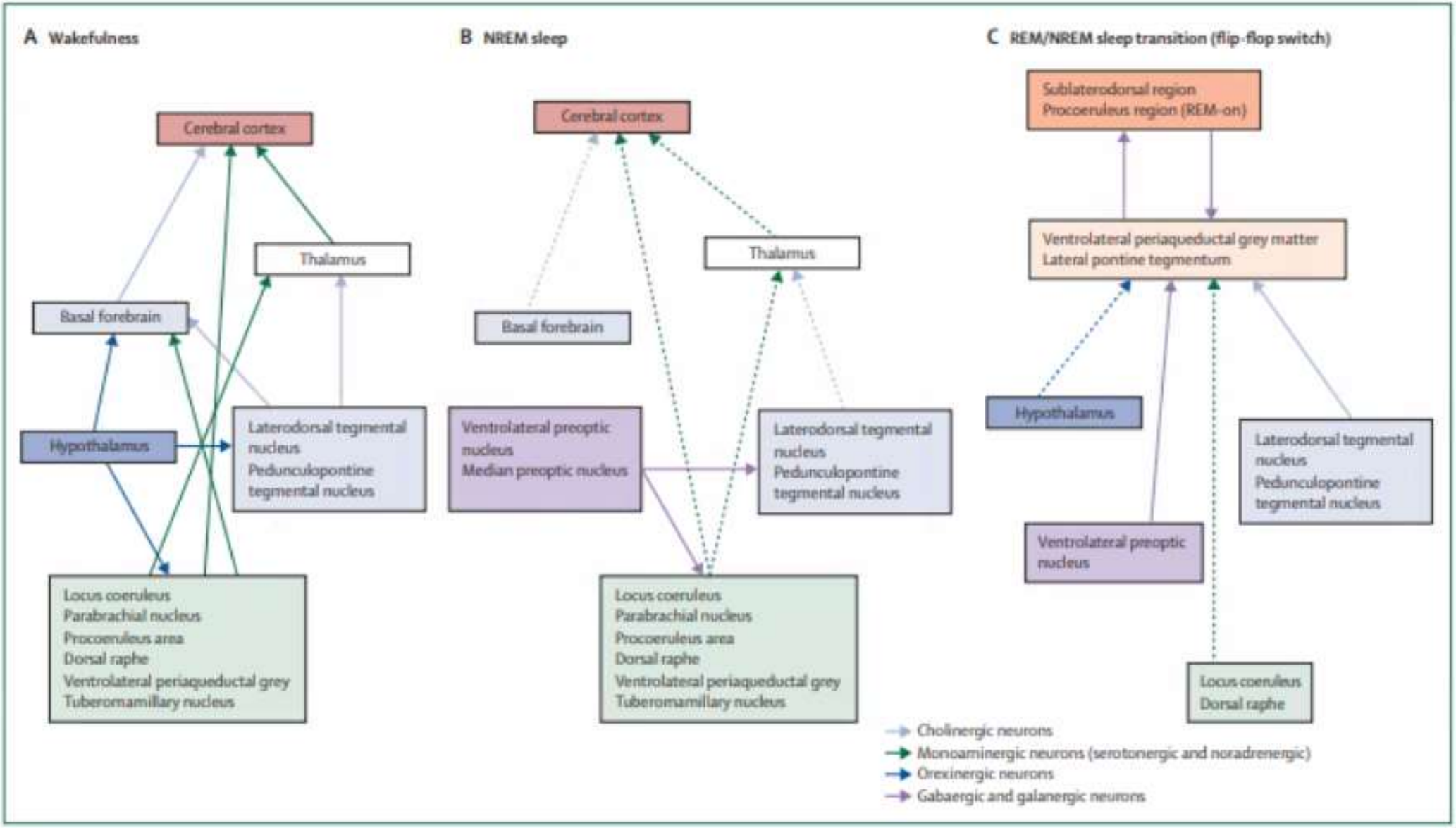
S. Saper et al., 2005





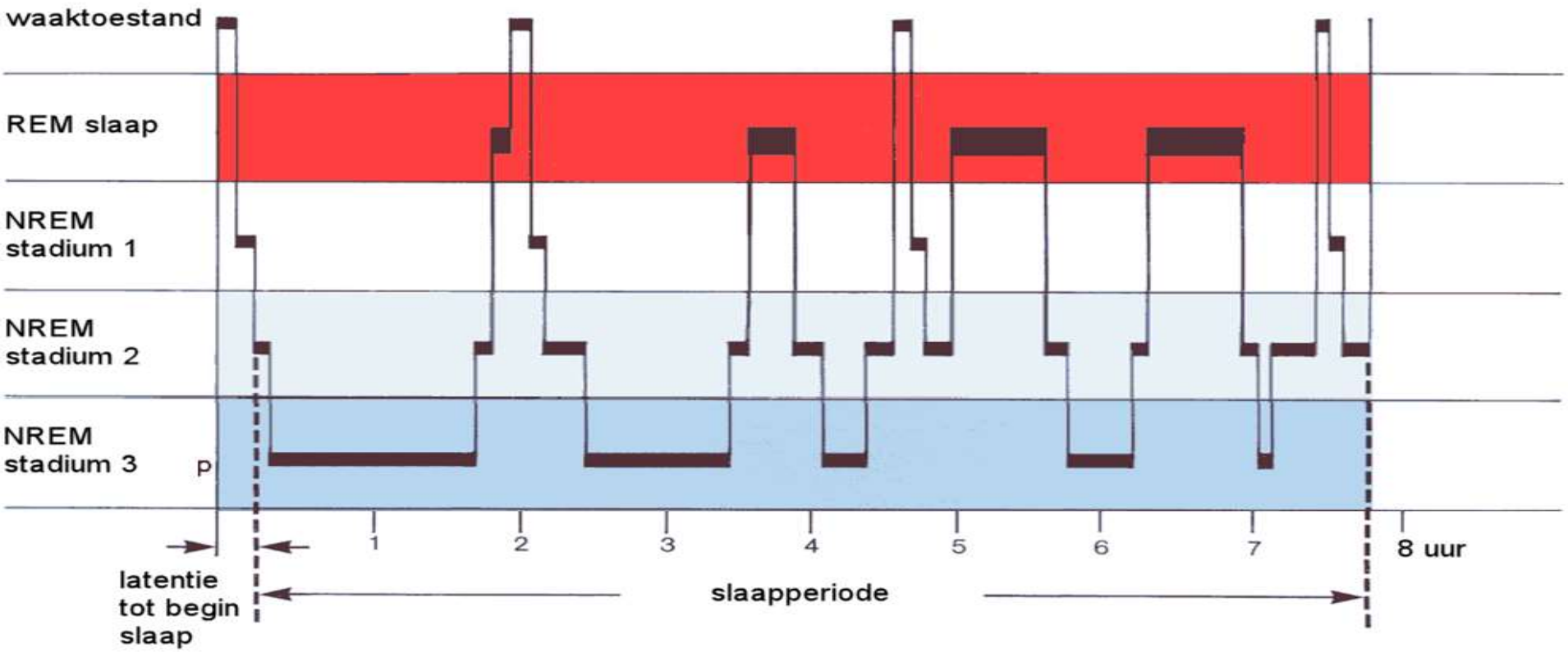
Promote wakefulness	Promote sleep
Serotonin	GABA
Noradrenalin	Adenosin
Acetylcholine	Melatonin
Histamine	
Dopamine	
Glutamate	
Orexin/hypocretin	

Sleep-wake regulation according to the flip-flop switch model



Riemann D. et al. Lancet Neurology 2015

Normal sleep: as evidenced by the hypnogram



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Prevalence

- Insufficient sleep/sleep quantity: about 40% TST < 7 hours

  (Leeder et al. 2012, Lastella et al. 2015, Sargent et al. 2014, Mah et al. 2018)

- **Sleep quality/sleep disturbance: 13-70% poor sleep quality *(mostly PSQI >5)***

  (Gupta Morgan & Gilchrist (2017)

- Daytime sleepiness/tiredness: 30-60 %

  (Turner et al. 2019, Mah et al. 2018)

Table 4 Sleep assessments in elite athletes using the Pittsburgh Sleep Quality Index (PSQI)

Study	Sport	Level of performance	*n*	Sex	Mean age, y (SD)	Mean global score (SD)[a]	Prevalence, %		
							≥5	>5	>8
Dekker et al. [70]	Gymnastics	National	12	M + F	22.9 (3.5)	6 (NR)	NR	NR	NR
Samuels [1]	Bobsleigh	Elite	24	M + F	27.0 (NR)	6 (1)	78	57	26
Tsunoda et al. [62]	WCB	Elite	14	M	29.5 (5.2)	6 (3)	NR	43	NR
Swinbourne et al. [63]	Team sports	National	175	M + F	21.9 (2.6)	6 (3)	65	50	22
Bleyer et al. [64]	Multi-sports	Elite	452	M + F	21.2 (5.8)	5 (3)	NR	38	NR
Durán et al. [65]	Multi-sports (Paralympic)	Elite	33	M + F	26.4 (9.8)	11 (8)	79	NR	NR
Mean					24.8 (5.4)	7 (4)	74	47	24

F female, *M* male, *NR* not reported, *SD* standard deviation, *WCB* wheelchair basketball

[a] Scores of >5 are indicative of clinical sleep disturbance

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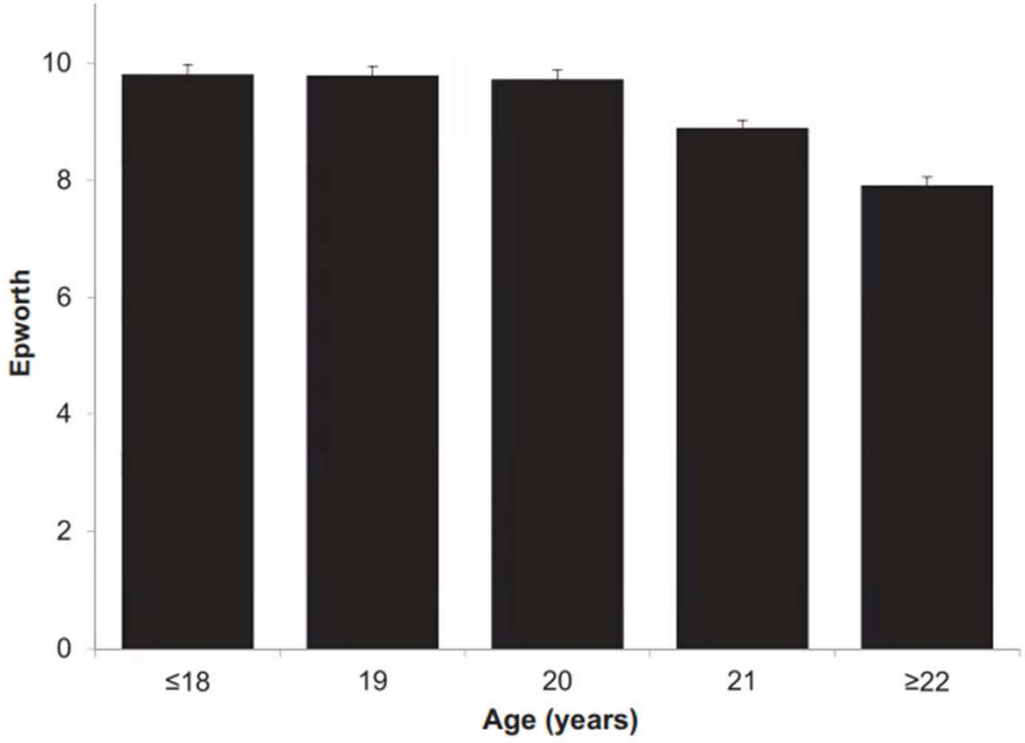

Fig. 3. Epworth Sleepiness Scale in collegiate athletes by age. Data provided as mean with standard error.

Scientific insights

- **Retrospective study:**
  - **N =** 479 athletes (371 female and 108 male) across 20 Olympic team and individual sports
  - **Results:**
    - 52% PSQI ≥ 5 = 'poor sleepers'
    - Female athletes longer Sleep onset latency (SOL) compared with male athletes
    - Team sport vs individual sport athletes:
      - ↓ SOL
      - ↑ TST
      - Later wake times
      - Spent more time in bed
      - ↓ Sleep Efficiency (SE)
      - High global PSQI most important components :
      - SOL & Sleep quality
  - Individual items may be useful for specific sleep interventions

Key Points

In the present study, 52% of elite athletes were categorised as 'poor sleepers' on the Pittsburgh Sleep Quality Index (PSQI).

Longer sleep onset latencies and greater daytime dysfunction were observed in female athletes compared with male athletes.

Team sport athletes reported shorter sleep onset latencies, longer sleep durations, later wake times and spent significantly more time in bed than individual sport athletes but reported lower sleep efficiency compared with individual sport athletes.

The PSQI components of sleep onset latency and sleep quality made the greatest contribution to the high global PSQI scores. Strategies targeting sleep onset latency may be particularly important in elite athletes.

Individual questionnaire items or components may be useful for practitioners to guide decision making and recommendations for specific sleep interventions in athletes.

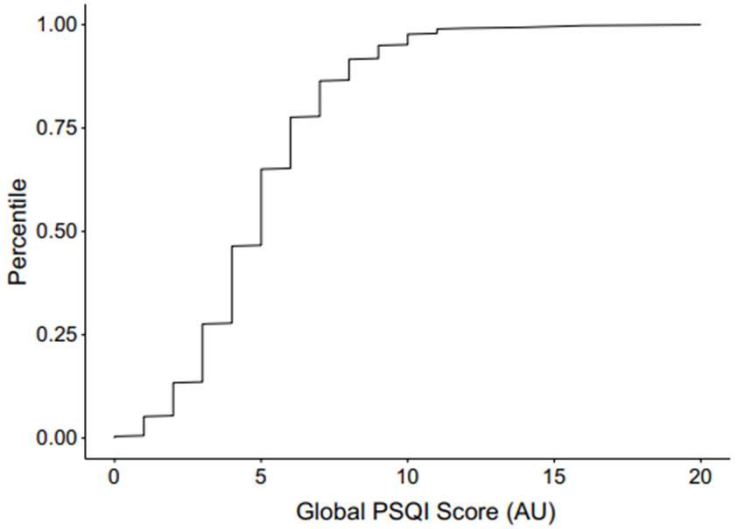

Fig. 1 Percentile distribution of global Pittsburgh Sleep Quality Index (PSQI) score across all athletes

Halson et al. 2022 Sleep Quality in elite athletes

Effects of Sleep Deprivation on Athletic Performance

Poor sleep health	Impaired athletic performance
Overall Performance	↓ overall performance
Speed, Accuracy, Endurance	↓ speed, ↓ precision, ↓ endurance capacity
Cognitive Function	↓ concentration, impaired learning, ↓ reaction times, ↑ poor decision-making
Strength Performance	Inconsistent effect; strength may ↓ or **=** under sleep deprivation
Injury and Health Risks	↑ risk of injury, ↓ pain threshold, ↑ susceptibility to illness
Physiological Strain	↑ heart rate, ↑ oxygen consumption, ↑ blood lactate during exercise
Recovery limitations	↓ secretion of growth hormone, impaired muscle repair
Psychological impact	↑ fatigue, ↓ motivation, ↑ perceived exertion

Simpson et al. 2017, Vitale et al. 2019, Huang et al. 2021, Walsh et al. 2021

Scientific insights: sleep extension

- **Objective**: review systematically effects of sleep extension on sports performance
- **Method**:
  - November 2020
  - Articles in English
  - Databases: PubMed, Virtual Health Library, SPORTDiscus, Web of Science, Scopus databases
- **Results:** 5 out of 74 articles were eligible + 2 studies subsequently included
  - 15 sports measured:
    - 6 studies presented a large effect size
    - Others ranged from trivial to medium.
    - Overall, a high of bias
    - Quality of evidence: ranged from very low to moderate quality
- **Conclusions**: limited evidence suggests that sleep extension interventions may be beneficial to improve sports performance in athletes. Conclusions are tentative because of the low quality of the evidence and risk of bias.

Coelho et al. 2021. Sleep extension in athletes: what we know so far: a systematic review

Scientific insights: sleep extension via naps

- Daytime naps can partially counteract the negative consequences of sleep deprivation:
  - **Short naps (20–30 minutes)**: improve alertness, vigilance, and reaction time without causing sleep inertia
  - **Longer naps (60–90 minutes)**: provide deeper recovery through slow-wave and REM sleep, though they may induce post-nap grogginess
  - **Optimal timing**: early afternoon (13:00–15:00) aligns with circadian dips in alertness and minimizes interference with nocturnal sleep

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Barriers

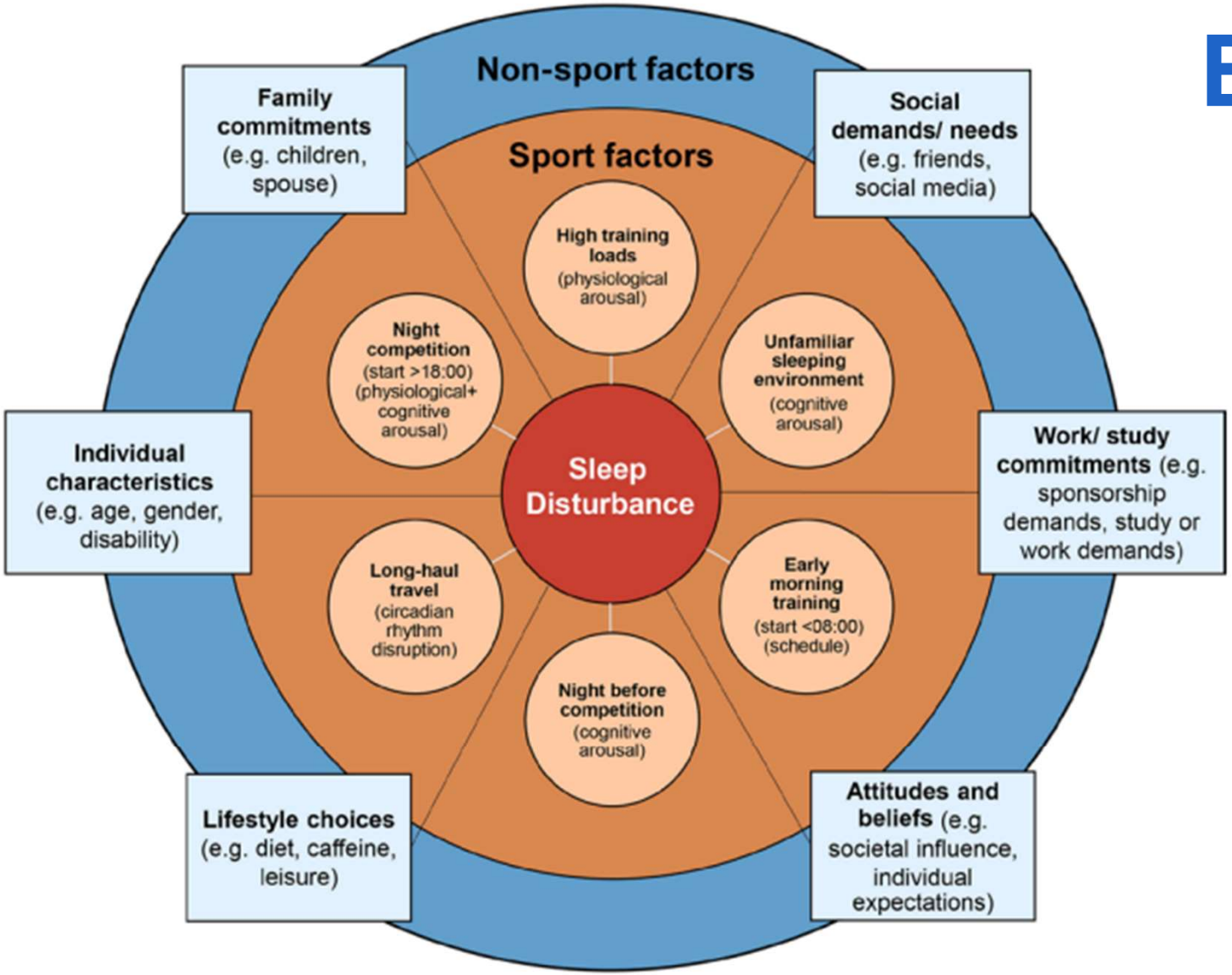


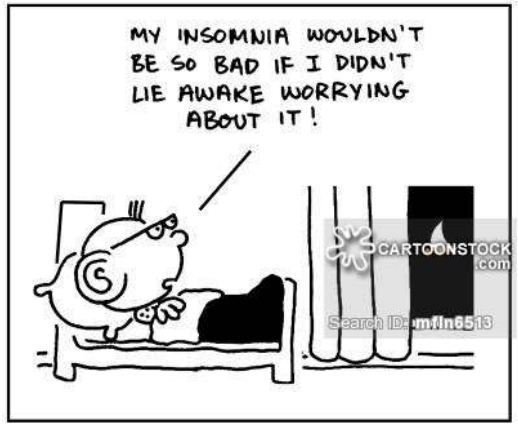
Figure 1 Contributory factors for sleep disturbance in athletes; including sport-specific factors (orange shading) and non-sport factors (blue shading).

Walsh et al. Br J Sports Med 2021;55:356-368

Additional barriers

- **Pre-competition anxiety and stress**
- **Mental health problems with mood disorder:**
  - approximately 90% of individuals with mood disorders experience sleep problems
- Injury-related discomfort
- **Primary sleep disorders** (e.g., insomnia, sleep apnea, RLS and PLMS)

Barriers primary sleep disorders



- **Insomnia:**
  - **Risk factors:**
    - The multifaceted demands of elite sports:
      - Intensity and volume of training, scheduling challenges

        (Collette, Kellmann, Ferrauti, Meyer & Pfeiffer, 2018; Sargent, Halson & Roach, 2014 , Sargent, Lastella, Halson & Roach, 2014; Sargent, Halson & Roach, 2014)
      - Pre-competition anxiety

        (Erlacher, Ehrlenspiel, Adegbesan & Galal El-Din, 2011; Lastella & al., 2015)
      - Circadian challenges (jet lag)

        (Samuels, 2012, Fowler et al. 2015, Fowler et al. 2016)
    - Personality traits with a focus on success (e.g., perfectionism) may predispose an elite athlete to insomnia

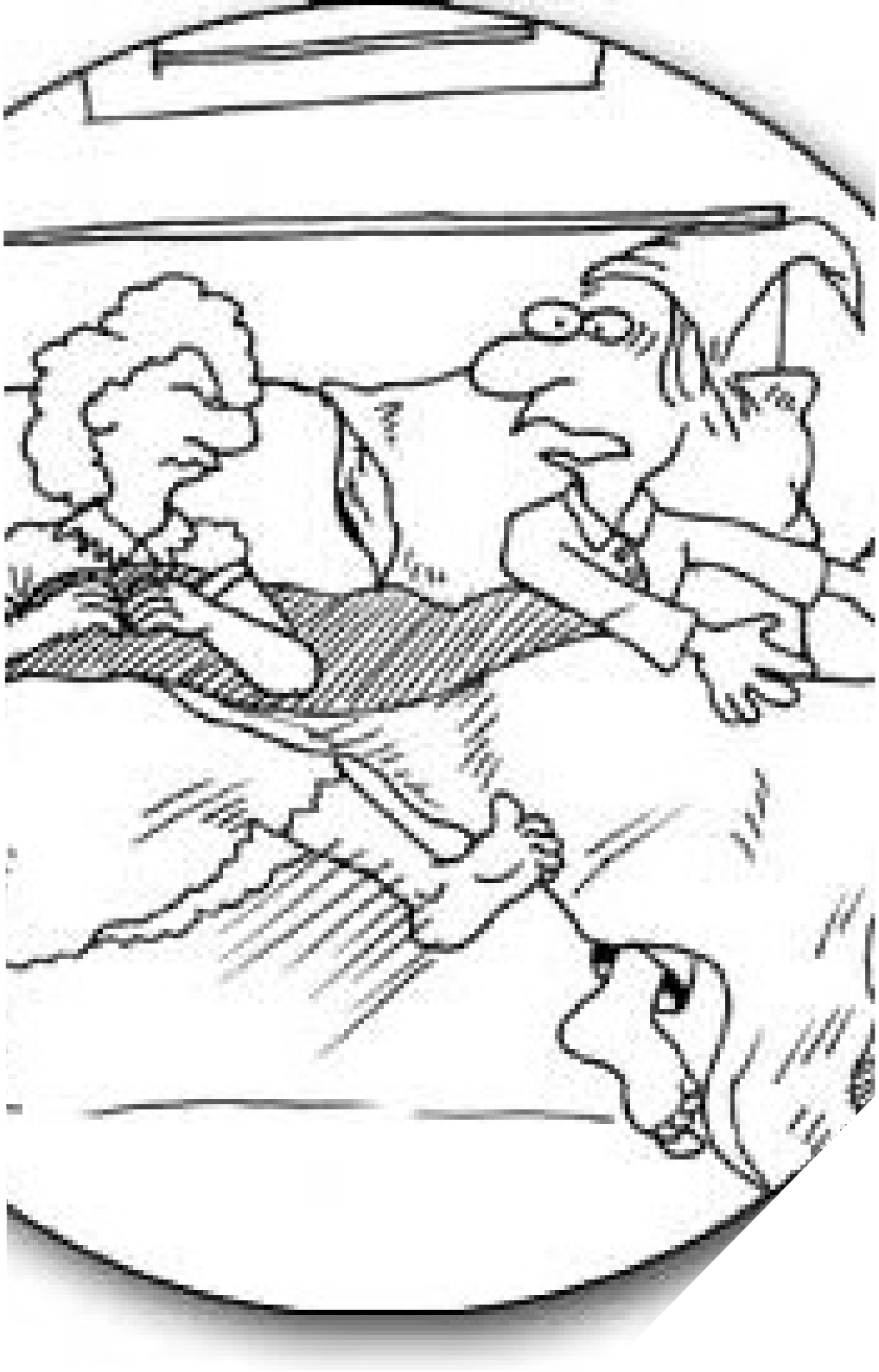
      (Harvey, Gehrman & Espie, 2014)
  - 26% of the athletes significantly scored for insomnia symptoms using the Insomnia Severity Index (ISI) and Pittsburgh Sleep Questionnaire Index (PSQI) *(Gupta et al. 2017)*

Barriers :
primary sleep disorders

- **Sleep apnea**
  - High prevalence in certain type of sports:
    - Strength, power and high contact sports (large BMI and neck circumference)
      (Dunican & Eastwood, 2017; Emsellem & Murtagh, 2005; Swinbourne, Gill, Vaile & Smart, 2016)
    - Less injury-prone
      (Swinbourne, Gill, Vaile & Smart, 2016)
    - However, these specific body traits, unfortunately, also predispose these athletes to an increased risk of obstructive sleep apnea (OSA)
      (Ahbab & al., 2013; Emsellem & Murtagh, 2005; Mihaere & al., 2009) (George, Kab, Kab, Vila & Levy, 2003; Rice & al., 2010, Dobrosielski & al. 2016, Tuomilehto & al., 2017)

Barriers : primary sleep disorders

- **Restless legs (RLS) and periodic limb movements (PLMs)**
  - Very few studies have been conducted on RLS among athletes
  - Findings:
    - Runners 13% RLS
      (Fagundes & al., 2010)
    - Hockey players 5% RLS
      (Tuomilehto & al., 2017)
    - Rugby players 12% PLMs
      (Dunican & al., 2019)
  - RLS and PLMs are relatively common among elite athletes from a variety of sports



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Assessment

Subjective tools			
Sleep diaries	Non-intrusive and cost effective. Affords long-term monitoring and provides information on routine, subjective information.	Burdensome and may be influenced by recall bias. Overestimates sleep duration and efficiency relative to polysomnography.	Affords long-term monitoring in a realistic setting but takes effort from the athlete and the practitioner to collect the data. For example, Consensus Sleep Diary.
Sleep questionnaires	Cost and time effective, can provide behaviour information.	May be influenced by response bias, lack of standardised data for athletes.	Questionable utility without validation in athletes. For example, PSQI, ISI, KSS, SSS, ESS, SHI, LSEQ, VAS, MEQ, subjective ratings.
Athlete-specific sleep questionnaires	Cost and time effective, can identify athletes who need further sleep assessment, can provide behaviour information, validated in athletes.	May be influenced by response bias, lack of validation with polysomnography.	Can be used as an initial clinical tool (ASSQ), and a way to identify maladaptive sleep behaviours (ASBQ). See figure 2 for specifics. Additional questionnaires needed to be developed for athlete specific assessment.

ASBQ, Athlete Sleep Behaviour Questionnaire; ASSQ, Athlete Sleep Screening Questionnaire; ESS, Epworth Sleepiness Scale; ISS, Insomnia Severity Index; KSS, Karolinska Sleepiness Scale; LSEQ, Leeds Sleep Evaluation Questionnaire; MEQ, Morningness and Eveningness Questionnaire; PSQI, Pittsburgh Sleep Quality Index; SHI, Sleep Hygiene Index; SSS, Stanford Sleepiness Scale; VAS, Visual Analogue Scale.

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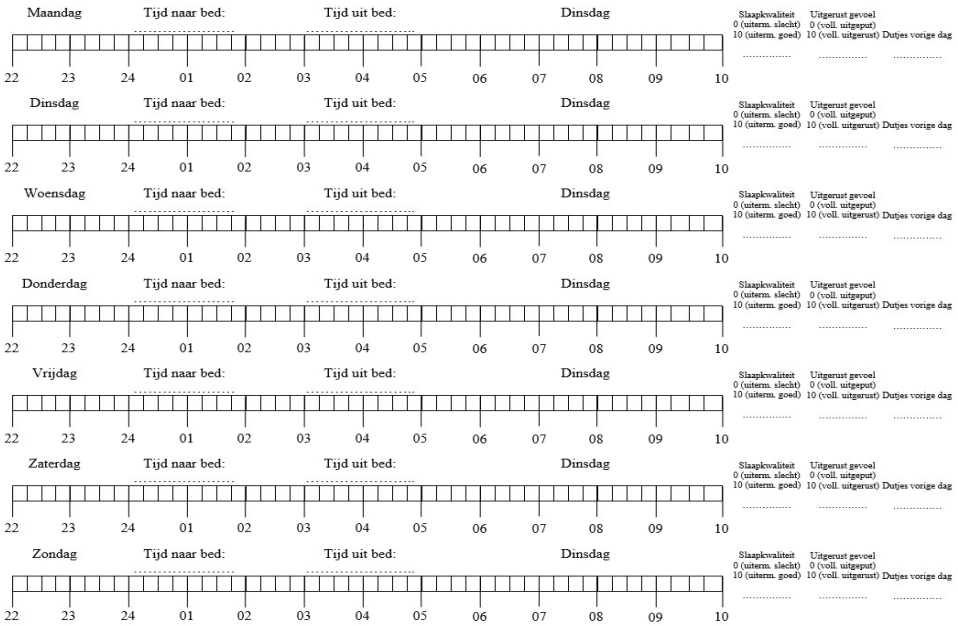
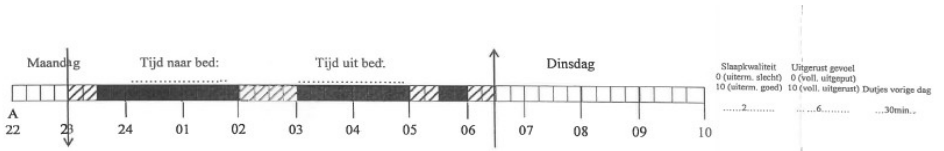
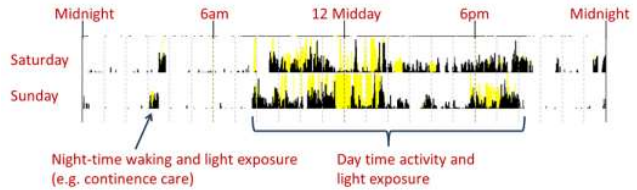




Assessment

Table 1 Evaluation of tools for sleep assessment in athletes

Tool	Strengths	Weaknesses	Practicality of use
Objective tools			
Polysomnography	Gold standard for sleep assessment. Determination of sleep stages and spectral power. Diagnosis for sleep disorders.	Expensive, intrusive and typically one-time assessment. Typically performed in laboratory in an unnatural sleep environment. Expertise required for interpretation.	Laboratory or home-based systems. Mainly used for sleep disorders diagnosis and research.
Research-grade actigraphy devices	Current standard for sleep assessment in the athletic field setting. Non-intrusive and less expensive than polysomnography. Provides long-term monitoring, provides data on routine. Validated against polysomnography.	Does not measure sleep stages accurately. Not suitable for diagnosis of sleep apnoea. Device is easily removed. Requires expertise for analysis. More expensive than commercial devices. Difficulties with assessing insomnia. Typically overestimate total sleep time and sleep efficiency relative to polysomnography. Some devices do not disclose algorithms.	Affords long-term monitoring in a realistic setting but requires some sleep expertise.
Commercial wearable devices	Non-intrusive and less expensive than polysomnography and research-grade Actigraphs. Provides long-term monitoring and data on routine. Increases sleep awareness, promotes athlete-staff interaction and provides immediate feedback. May prompt further evaluation.	Does not measure sleep stages accurately, unless validation supports this function. Not suitable for diagnosis of most sleep disorders under normal conditions. Device is easily removed. May cause increase in anxiety/worry around sleep. Immediate feedback could influence/be detrimental to performance. Typically overestimate total sleep time and sleep efficiency relative to polysomnography. Most devices do not disclose algorithms or provide access to raw data. Many devices have limited validation.	Affords long-term monitoring in a realistic setting but device must be validated. Ability to adjust feedback important, when required.



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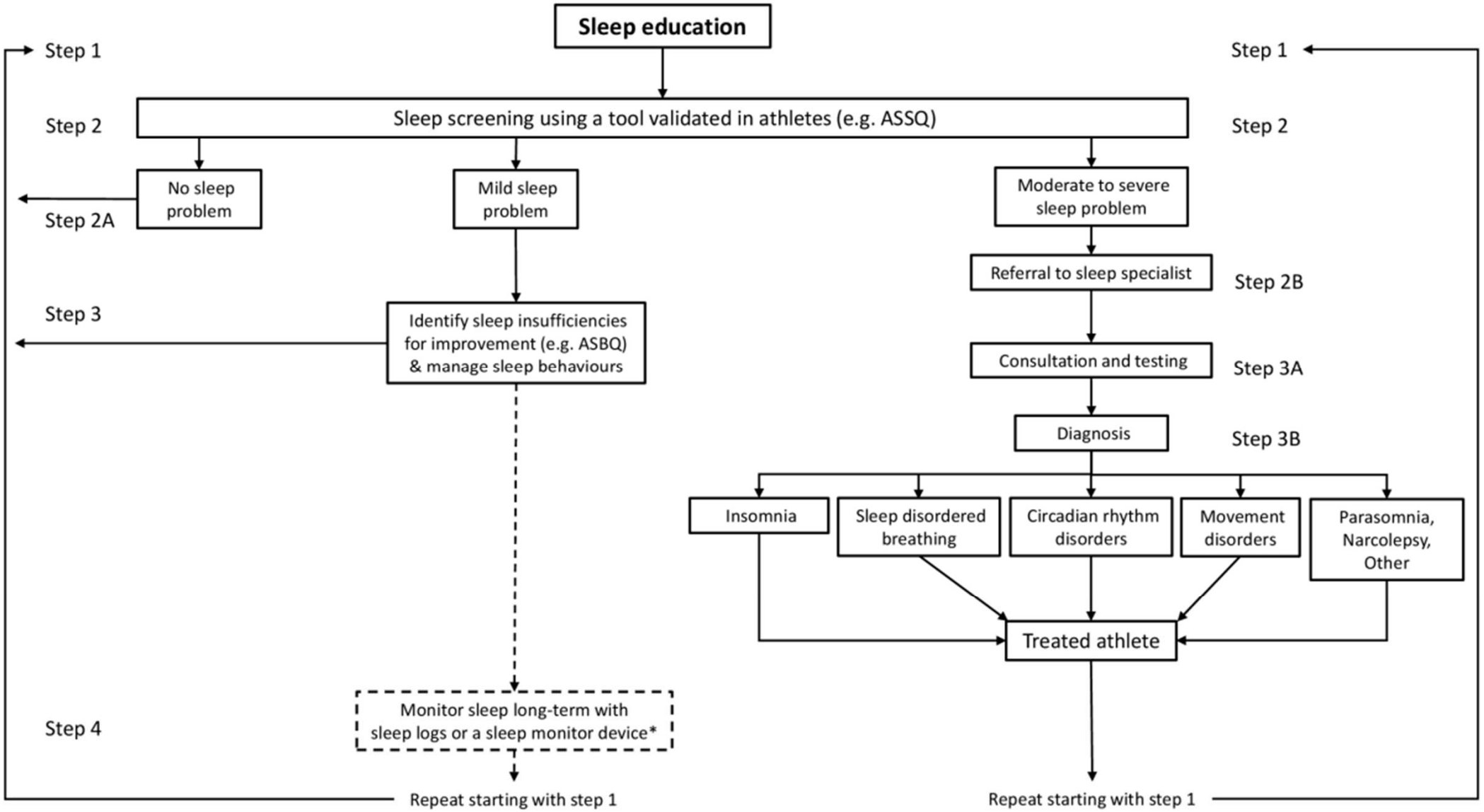
Recommendations for Optimal Sleep in Athletes

Recommendation	Rationale
Sleep Duration	Most adults need 7–9 hours; athletes likely require more due to physical and mental demands
Sleep Education	Awareness of sleep's impact on performance promotes behavioral change
Training Schedule & Chronotype	Align training times with chronotype, avoid late-evening and early-morning sessions
Sleep Environment	Cool (~18°C), dark, quiet, and comfortable environment improves sleep quality
Nutrition & Stimulants	Avoid caffeine after lunch, limit alcohol and nicotine
Light Exposure	Bright light in the morning, dim lights and reduce screen use before bedtime
Consistent Sleep-Wake Rhythm	Regular bedtimes and wake times, relaxing pre-sleep routines aid sleep onset
Napping	Short naps (<30 min) or full-cycle naps (90–120 min) when night sleep is insufficient
Sleep Extension	Longer sleep may enhance performance but should be applied cautiously

Fox et al. 2020, Silva et al., 2021, Simpson et al., 2017, Souabni et al., 2021, Vitale et al. 2019, Vitale & Weydahl, 2017, Walsh et al., 2019

Recommendations

- Following a night of restricted sleep, a **20–30 minute nap in the early afternoon** is the most effective strategy to restore mental sharpness and physical readiness
- Prior to demanding training sessions or competitions, a **longer nap of 60–90 minutes** may provide additional recovery benefits, provided sufficient time is allowed for full arousal afterward
- Napping should be considered a **supplementary strategy**, not a substitute for consistent, high-quality nocturnal sleep



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Conclusion

- Healthy sleep is essential for athletic performance and overall well-being
- Inadequate sleep duration, poor sleep quality, and irregular schedules negatively impact physical, cognitive, and mental health domains, increasing injury risk and impairing recovery
- Prioritizing sleep through education, structured routines, and evidence-based interventions should be a fundamental component of athlete care and performance optimization
- **Take-Home Message:**

  “Prioritize sleep as a key performance factor—optimal recovery, injury prevention, and mental resilience start with healthy sleep.”

Think sleep!