

Probiotics and Sleep in Athletes Improve Recovery from Gut- Brain-Axis

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Disclaimer

- This presentation is based on current available evidence, which remains emerging and evolving, particularly in the area of probiotics and sleep. The findings discussed should be considered preliminary, and the effects of probiotics are strain-specific and may vary depending on individual response and context. The purpose of this presentation is to share insights and stimulate professional discussion rather than provide definitive clinical recommendations



Overview

- Introduction
- Sleep 101
- Prevalence of sleep disturbances in Hong Kong and athletes
- Factors contributing to sleep disturbances among athletes
- Impact of poor sleep on exercise performance
- Gut-brain axis overview and mechanisms linking gut microbiota to sleep
- Scientific evidence on probiotics and sleep in athletes

Introduction

- Sleep is not just “Rest”
- During sleep, anabolic metabolism is upregulated, procedural memory are consolidated and immune responses are augmented
- Essential for recovery, immunity, and performance of athletes
- The National Sleep Foundation recommends 7 – 9 hours of sleep for adults



Walsh NP et al. Sleep and the athlete: narrative review and 2021 expert consensus recommendations. *British Journal of Sports Medicine*. 2021;55:356 – 368.

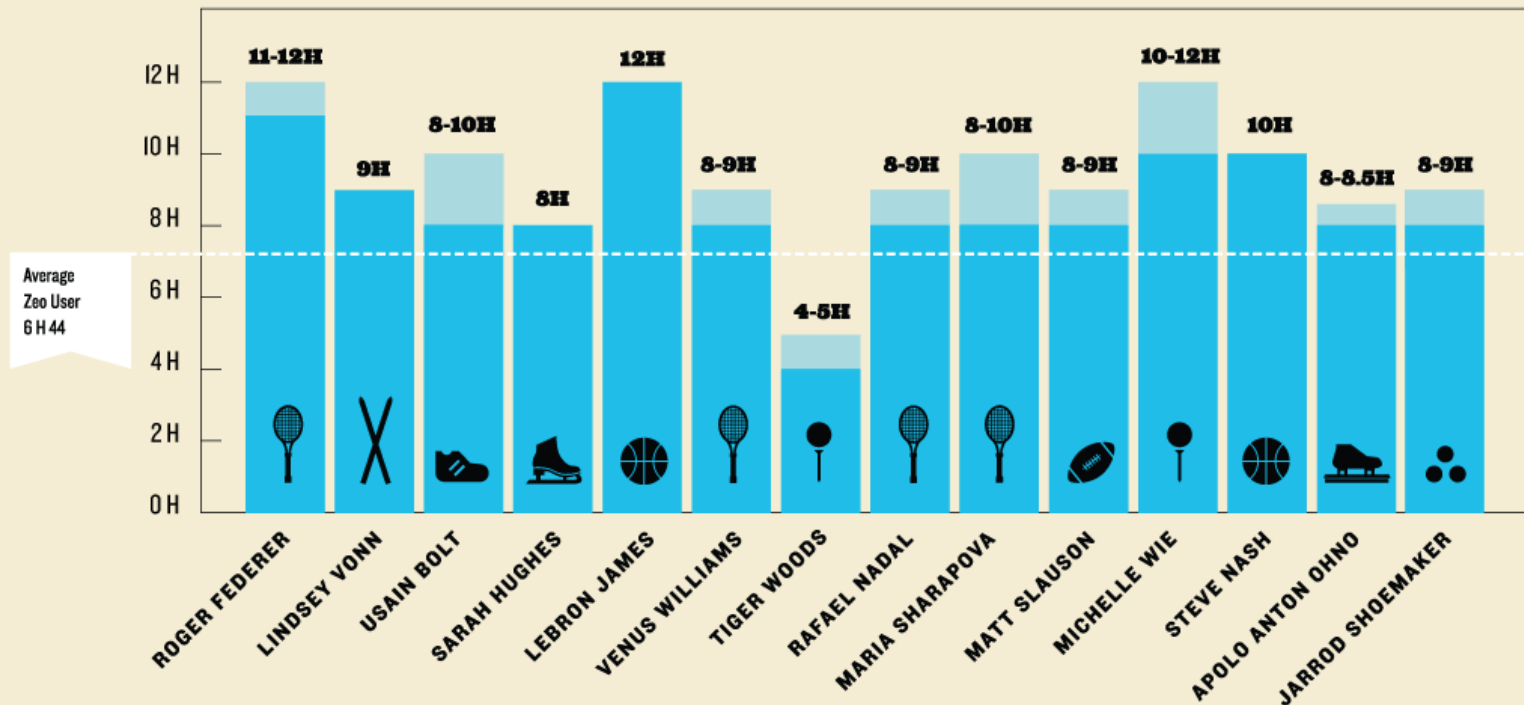
Roberts SSH, et al. Effects of training and competition on the sleep of elite athletes: a systematic review and meta-analysis. *British Journal of Sports Medicine*. 2020;54:1188 – 1199.

Watson NF et al. Recommended amount of sleep for a healthy adult: A joint consensus statement of the American Academy of Sleep Medicine and Sleep Research Society.

American Academy of Sleep Medicine: Darien, IL, USA, 2015;11:591- 592.

How Much Sleep “GOATs” Get

HOW MUCH SLEEP THE PROS GET



Coach Mah's Game Plan

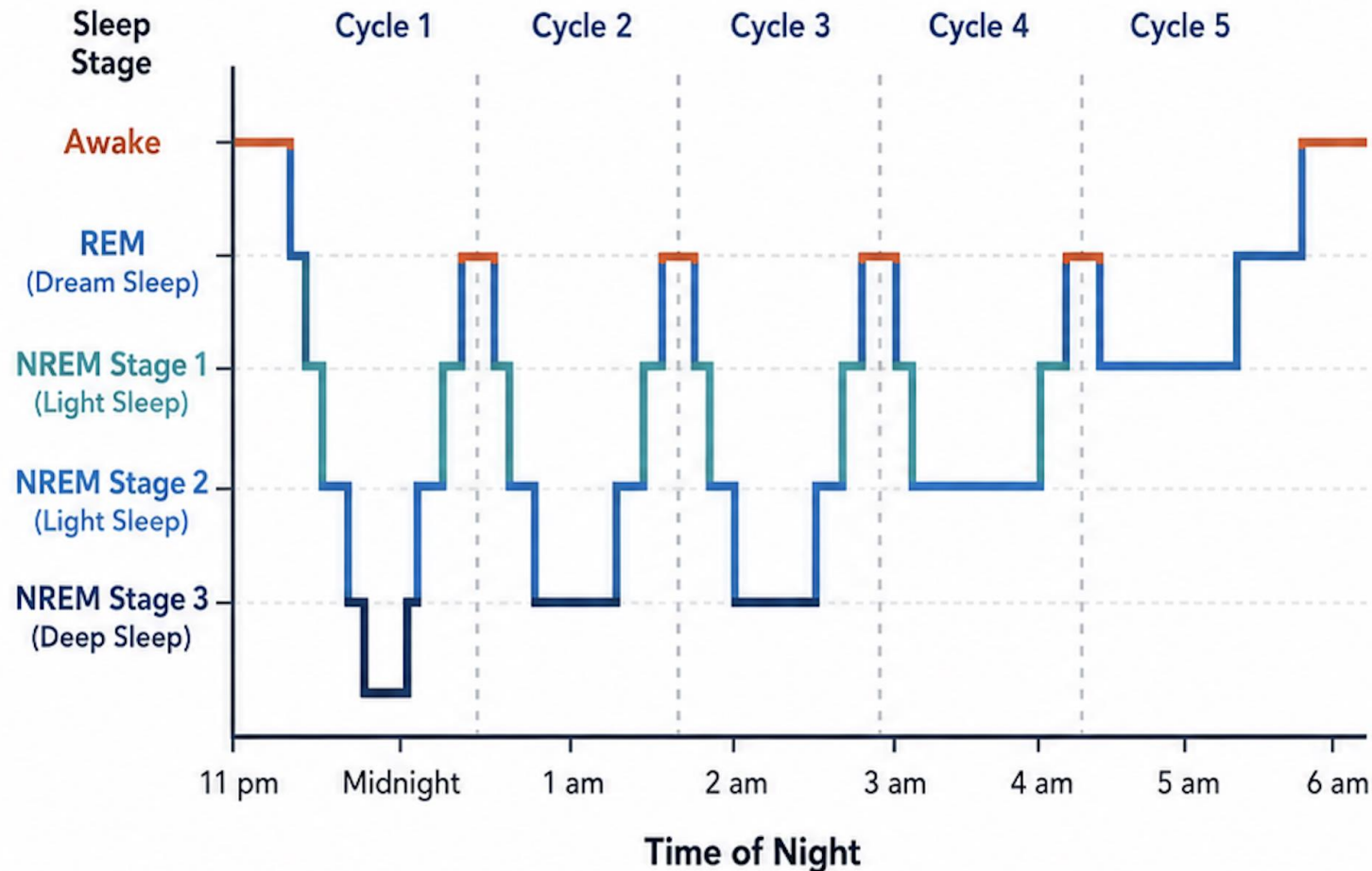
Sleep is extremely important to me — I need to rest and recover in order for the training I do to be absorbed by my body.

USAIN BOLT

Sleep 101

How Your Sleep Cycles Through the Night

Your body moves through different stages of sleep in repeating cycles.



REM Sleep

- Dreaming & memory consolidation
- Emotional regulation



NREM Stages 3 & 4 (Deep Sleep)

- Physical restoration
- Immune function & growth



NREM Stage 2

- Memory processing
- Motor skills learning



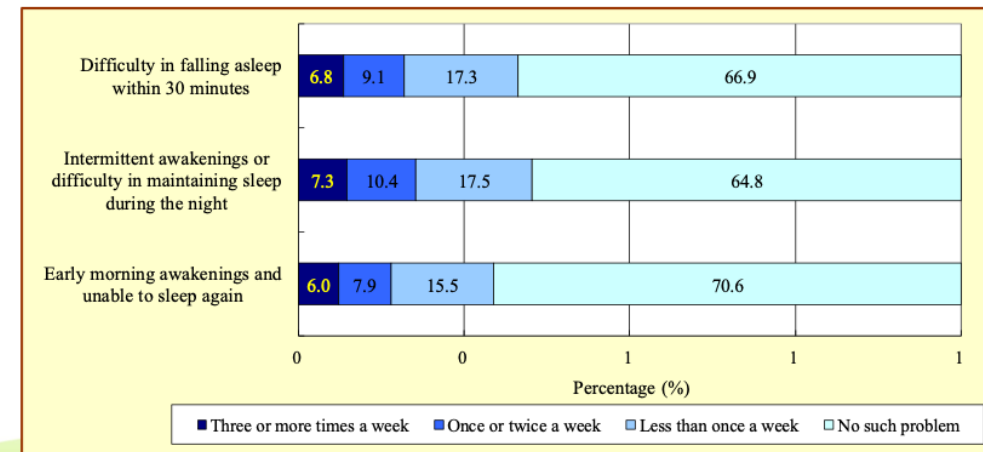
NREM Stage 1

- Light sleep
- Transition to sleep

Prevalence of Sleep Disturbance in Hong Kong

- The Population Health Survey 2014/2015 interviewed 12000 aged 15 years old and above and found close to half (48%) experiencing sleep disturbance
 - Difficulty in falling asleep within 30 minutes: 6.8%
 - Intermittent awakenings: 7.3%
 - Early morning awakening and unable to sleep again: 6.0%
- Wong and Fielding (2011)
 - 5001 Chinese adults completed a phone interview
 - 39.4% (2.2 million) adults in Hong Kong reported insomnia

Figure 3: Frequency of sleep disturbances in the 30 days preceding the survey among non-institutionalised persons aged 15 and above



Base: All respondents.

Note: Figures may not add up to the total due to rounding.

Source: Population Health Survey 2014/15, Department of Health.

Prevalence of Sleep Disturbance in Athletes

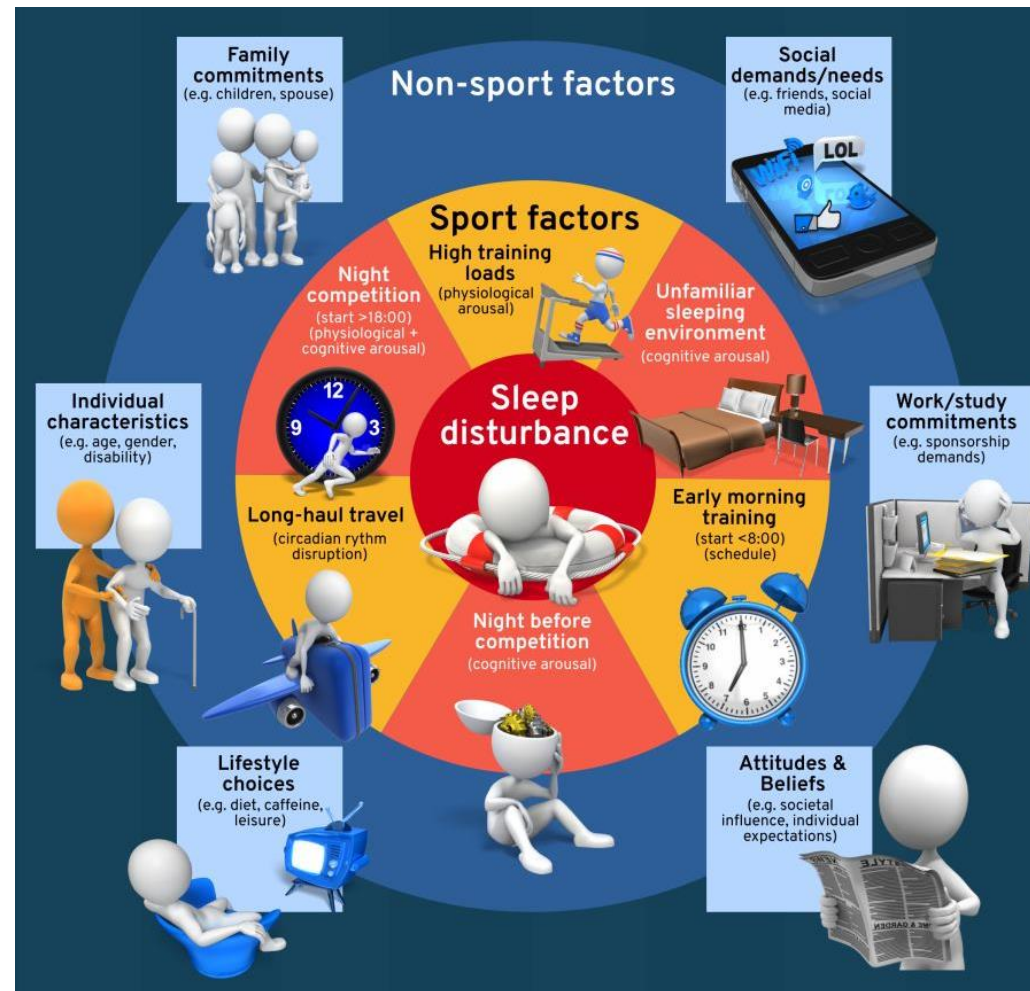
- Elite athletes have significantly higher prevalence of sleep disturbance than general population
- Erlacher et al (2011)
 - 632 German athletes
 - 65.8% reported poor sleep in the night(s) before the competition
- Juliff et al (2015)
 - 283 elite Australian athletes
 - 64% reported at least one episode of worse sleep on the night before important competition
- Tuomilehto et al (2016)
 - 107 professional ice hockey players
 - 46% reported sleep problems during competition season
 - Total sleep time less than 7 hours

Juliff LE et al. Understanding sleep disturbance in athletes prior to important competitions. *Journal of Science and Medicine in Sport*. 2015;18:13 – 18.

Erlacher D et al. Sleep habits in German athletes before important competitions or games. *Journal of Sports Sciences*. 2011;29:859 – 866.

Tuomilehto H et al. Sleep of professional athletes: Underexploited potential to improve health and performance. *Journal of Sports Sciences*. 2017; 35:704 – 710.

Factors Contributing to Poor Sleep in Athletes

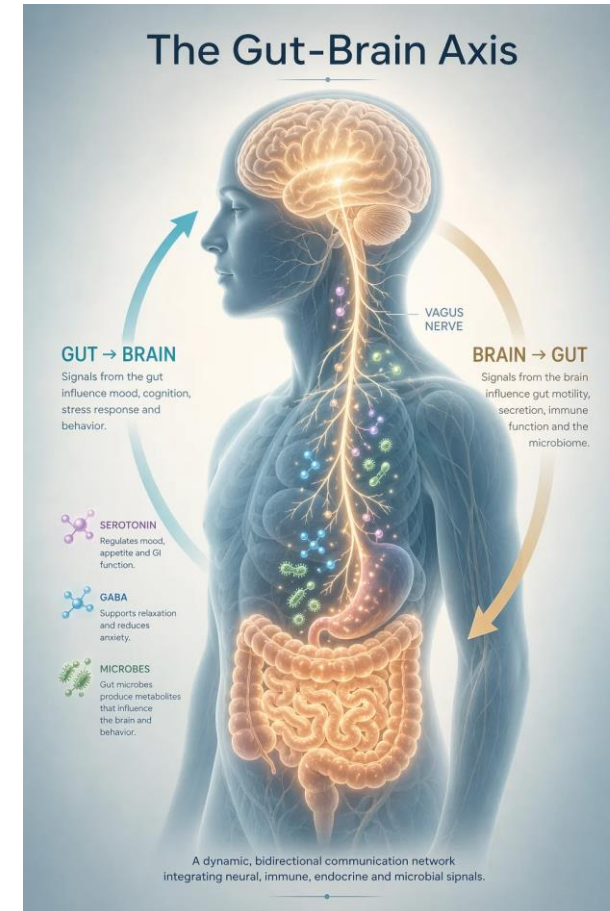


Impact of Sleep Disturbances

- 1 or 2 nights of total sleep deprivation or 1 or 2 weeks of partial sleep restriction can cause
 - Impairs cognition
 - Impairs learning and memory consolidation
 - Impairs mental well-being
 - Disrupts growth and repair cells
 - Disrupts metabolism of glucose
 - Lowers the protective immune response
 - Increases perceived effort
 - Reduces power

Gut-Brain Axis

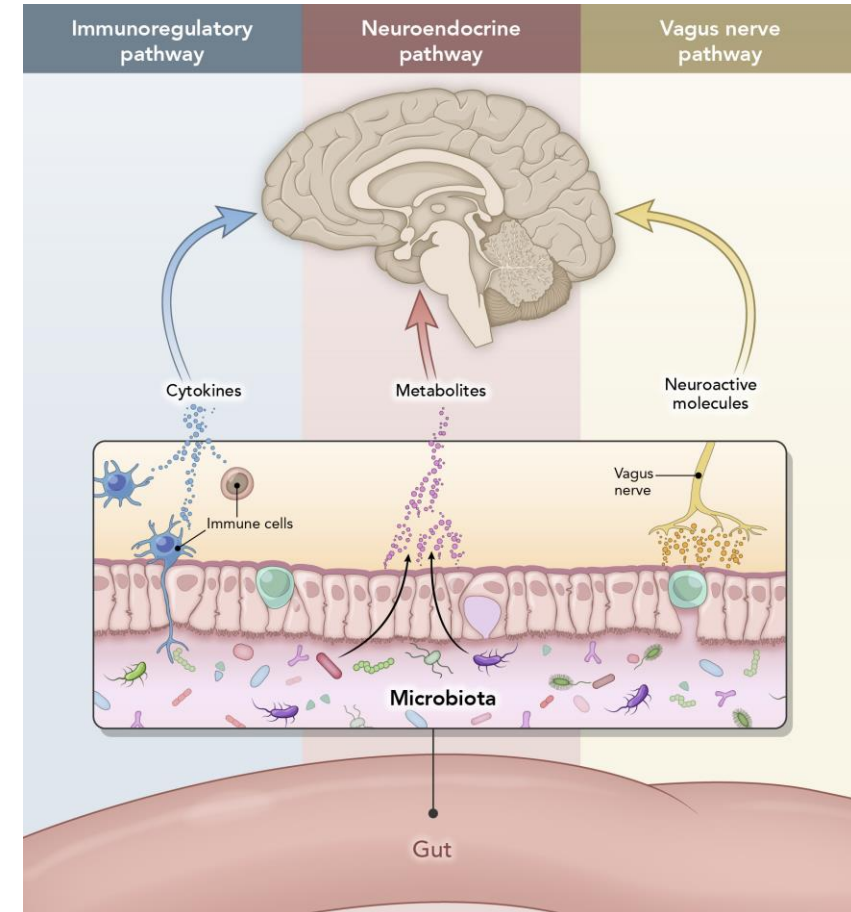
- The gut = The second brain
- Bi-directional interplay between the brain and the gut
 - Neural pathway (vagus nerve)
 - Endocrine pathway (HPA)
 - Immune and microbial pathway



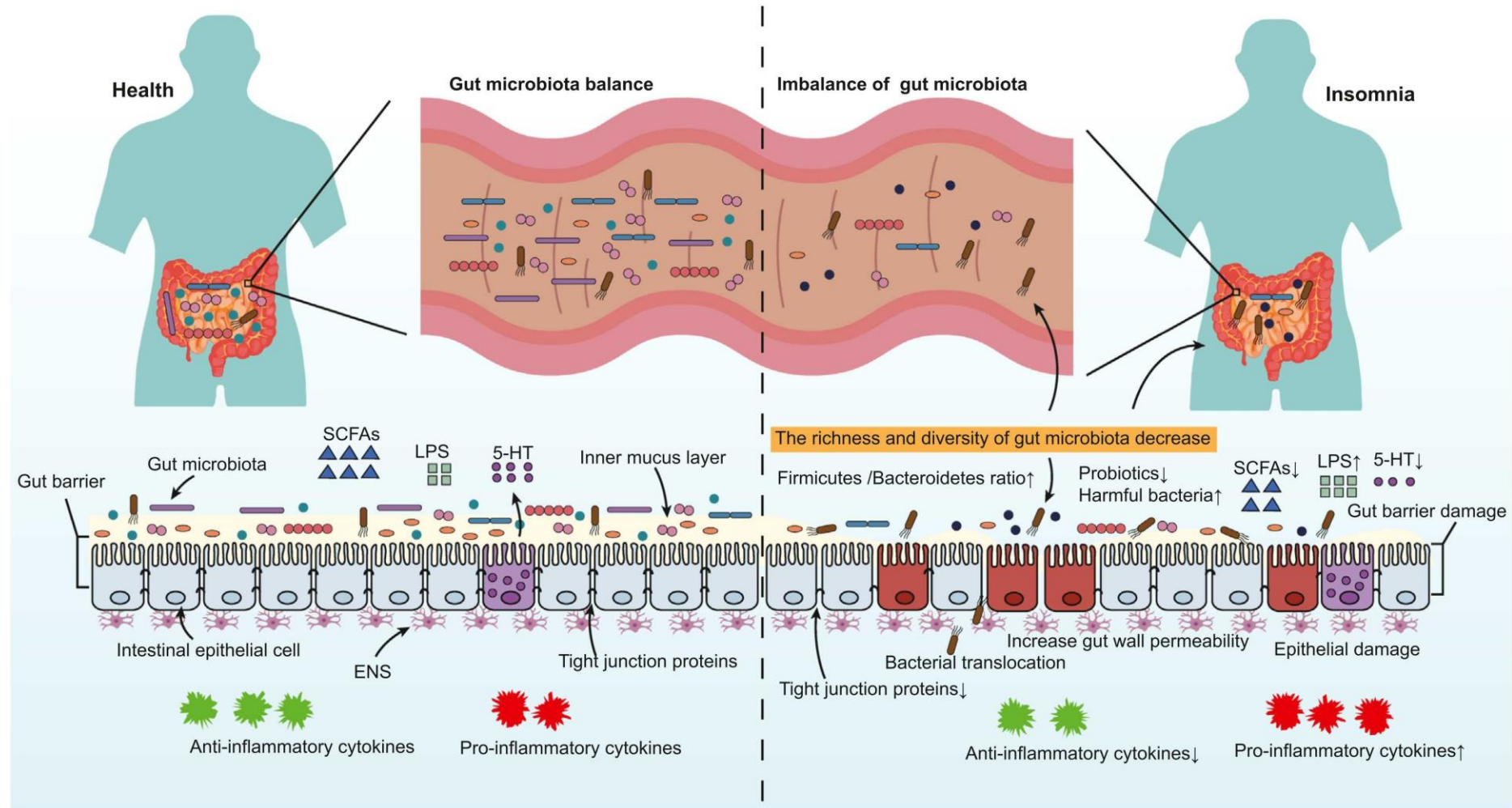
Gut health may affect brain. Brain can also affect the gut!!

Gut-Brain Axis Pathways

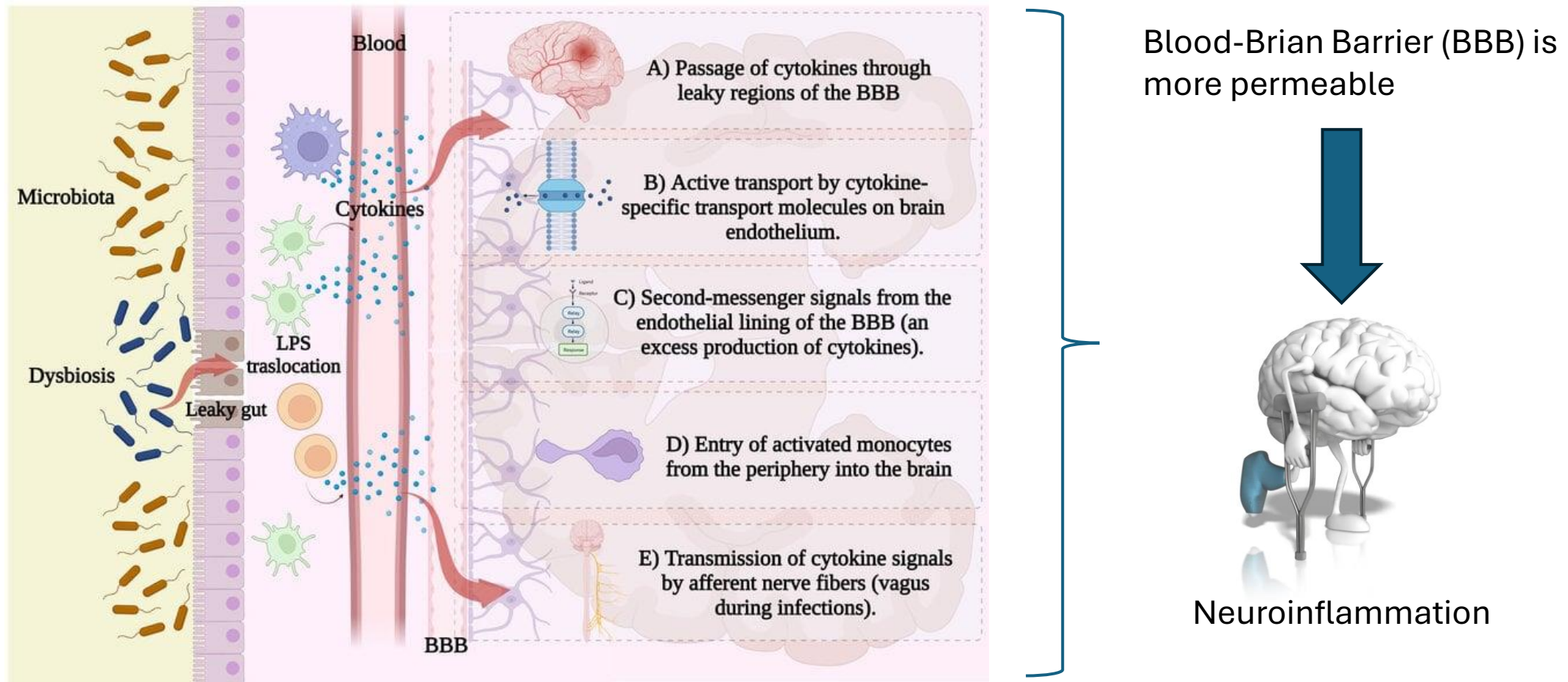
- Vagus nerve pathway
 - 80 – 90% of the neural connection in gut-brain axis is through the vagus afferent nerve fibers (gut to the brain)
 - Sleep and mood regulation
- Neuroendocrine pathway
 - Gut microbiota produces neurotransmitters (GABA, serotonin, melatonin, histamine, acetylcholine) and short chain fatty acids (butyrate, propionate and acetate)
- Immunoregulatory pathway
 - Microbiota contributes to host defense by inhibiting the growth of pathogens
 - Signals to the brain indirectly via cytokines



Gut-Microbiota and Sleep Disorder



Dysbiosis Leads to Neuroinflammation



Probiotics Supplements and Sleep



Lactobacillus paracasei Lpc-37



Lactiplantibacillus plantarum LP01
Lactocaseibacillus rhamnosus LR06
Limosilactobacillus fermentum LF16
Bifidobacterium longum 04
Lactocaseibacillus casei IDCC3451



Lactobacillus acidophilus LA-G80
Bifidobacterium longum subsp. longum (B. longum) BL-G301
Lactobacillus plantarum Lp-G18
Lactobacillus gasseri LG-G12
Lactobacillus rhamnosus LGG

Probiotics Beverages and Sleep



Lactobacillus gasseri CP2305



Lactococcus lactis JCM5805 & GABA



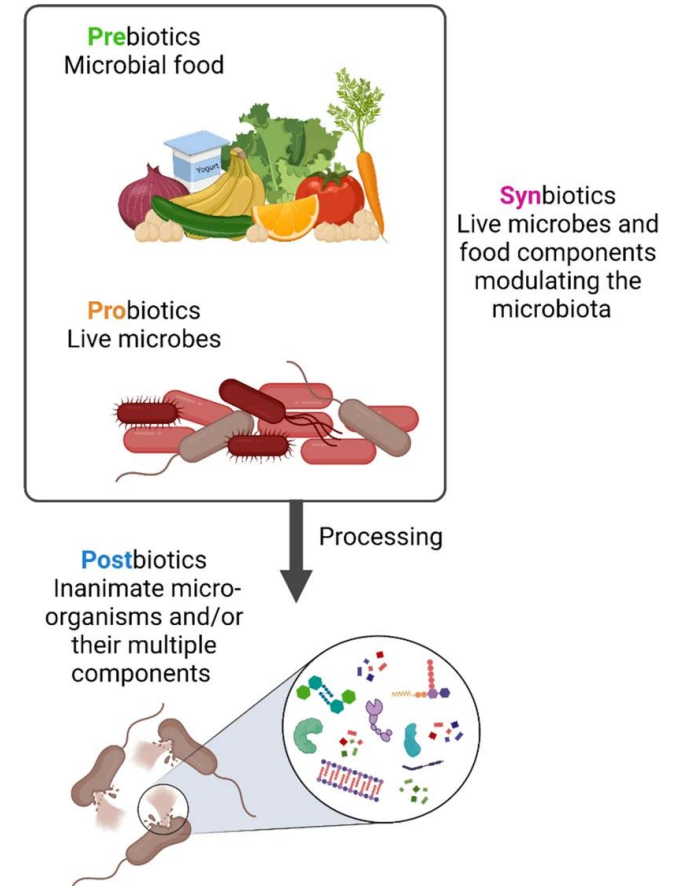
Lactobacillus casei YIT 9029

What is Probiotics?

- Derived from the Latin preposition “Pro” = for and the Greek word “biotic” = life
- FAO and WHO defines probiotics as “living microorganism that when administered in adequate amount confer a health benefit on the host
- IOC defines probiotics are “live micro-organisms that when administered orally for several weeks can increase the numbers of beneficial bacteria in the gut. These have been associated with a range of potential benefits to gut health, as well as modulation of immune function
- 2 major strains
 - Lactobacillus
 - Bifidobacterium

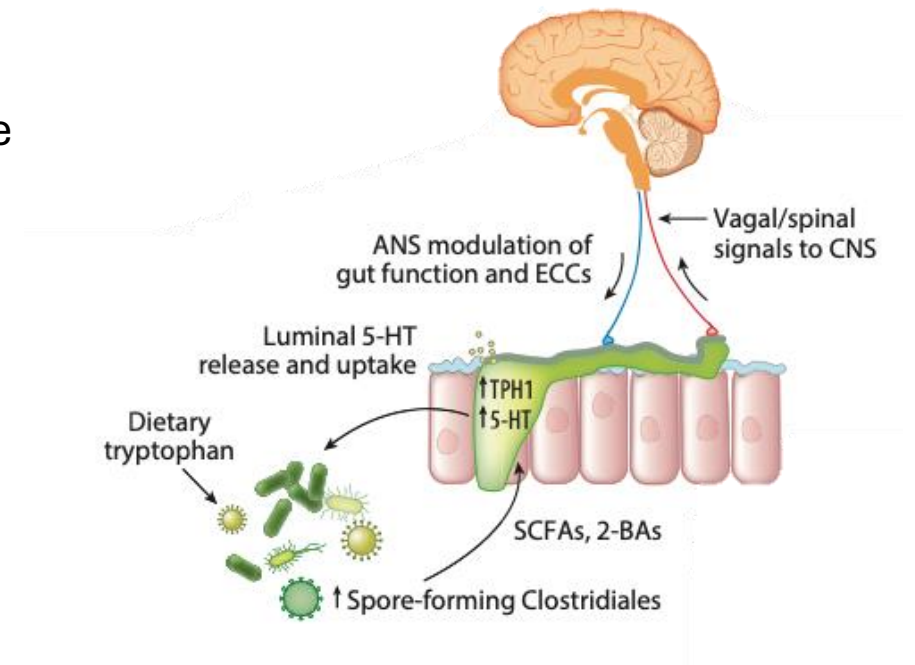
What are Prebiotics, Synbiotics, Postbiotics and Parabiotics?

- Prebiotics
 - A substrate found in food that specifically support the growth and development of probiotics
 - Examples: fructooligosaccharides (FOS), galactooligosaccharides (GOS), inulin, resistant starch
- Synbiotics
 - A mixture of probiotics and prebiotics synergistically promote the survival and proliferation of probiotics
- Postbiotics
 - Preparation of inanimate microorganism and/or their components that confers a health benefits on the host
- Parabiotics
 - Non-viable microbial cells (intact or broken) or cell fractions which, when administered in adequate amounts, confer a benefit on the consumer



How Probiotics Improve Sleep

- Alter gut microbiota composition and diversity
 - Dysbiosis has been associated with increased inflammation and altered neurochemical signaling
 - Probiotics may help to restore or maintain more balance gut microbiota
- Influence tryptophan-serotonin-melatonin pathway
 - More than 90% of serotonin is synthesized in the gut by spore-forming bacteria from tryptophan in enterochromaffin cells
 - Serotonin is precursor of melatonin, regulates circadian rhythm and sleep
 - Gut serotonin $\neq$ Brain serotonin
 - Gut microbiota are more likely to influence sleep indirectly through neural, metabolic, and immune signaling



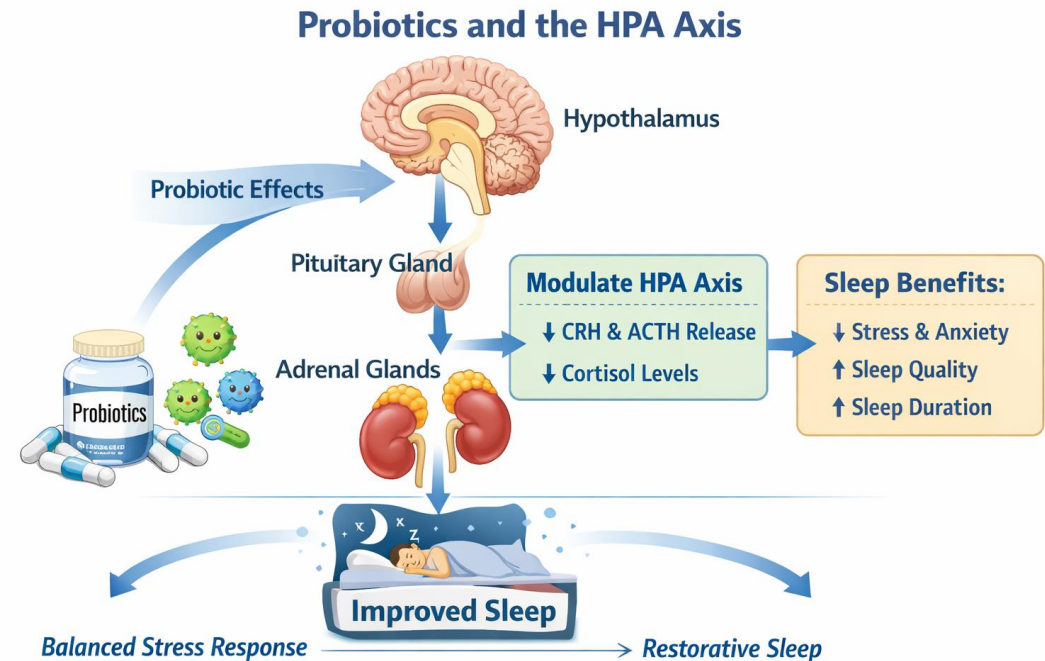
Tegals T & Radak Z. Probiotic supplementation for optimizing athletic performance: current evidence and future perspectives for microbiome-based strategies. *Frontiers in Nutrition*. 2025;12:1572687.

Wosinska L et al. The potential impact of probiotics on the gut microbiome of athletes. *Nutrients*. 2019;11:2270.

Yano JM et al. Indigenous bacteria from the gut microbiota regulate host serotonin biosynthesis. *Cell*. 2015;161:264 – 276.

How Probiotics Improve Sleep

- Modulate hypothalamic-pituitary-adrenal (HPA) axis
 - HPA axis is the central neuroendocrine system for regulating body's response to stress
 - Under stress (like high training load, competition anxiety), it leads to activation of the HPA axis → elevated or dysregulated cortisol secretion → affect sleep-wake circadian rhythm



How Probiotics Improve Sleep

- Reduce pro-inflammatory cytokines
 - Dysbiosis initiate neuroinflammation and may disrupt sleep architecture
 - People with sleep disorder may have been found to have elevated levels of pro-inflammatory cytokines (IL-1, IL-1 β , IL-2, IL-6, IL12), and tumor necrosis factor alpha (TNF- α) and reduced levels of anti-inflammatory cytokines (IL-10)
 - Probiotics potentially upregulates genes associated with immune activation and decrease inflammatory biomarkers

Wang Z et al. Brain-gut-microbiota interactions in sleep disorders. *Brain Medicine*. 2025;1:31 – 52.

Sempach L et al. Examining immune-inflammatory mechanisms of probiotic supplementation in depression: Secondary findings from a randomized clinical trial. *Translational Psychiatry*. 2024;14:305.

Akkasheh G et al. Clinical and metabolic response to probiotic administration in patients with major depressive disorder: A randomized, double-blind, placebo-controlled trial. *Nutrient*. 2016;32:315 – 320.

How Probiotics Improve Sleep

- Increase short-chain fatty acid (SCFA) production
 - SCFAs, including butyrate, acetate, and propionate, are metabolites produced primarily by gut microbiota fermentation of dietary fibers
 - SCFAs strengthen intestinal barrier integrity and promote mucus production which decrease permeability
 - SCFAs influence serotonin production and other neurotransmitter-related pathways involved in mood and sleep regulation
 - Some animal studies showed probiotic administration has increased acetate and butyrate levels reducing anxiety or depressive symptoms

Dhaliwal J et al. Lactobacillus plantarum mtcc 9510 supplementation protects from chronic unpredictable and sleep deprivation-induced behavior, biochemical and selected gut microbial aberrations in mice. *Journal of Applied Microbiology*. 2018;125:257 – 269.

Han S-K and Kim DH. Lactobacillus mucosae and bifidobacterium longum synergistically alleviate immobilization stress-induced anxiety/depression in mice by suppressing gut dysbiosis. *Journal of Microbiology Biotechnology*. 2019;29:1369 – 1374.

Tian P et al. Bifidobacterium with the role of 5-hydroxytryptophan synthesis regulation alleviates the symptom of depression and related microbiota dysbiosis. *Journal of Nutritional Biochemistry*. 2019;66:43 – 51.

Probiotics and Athletes' Sleep

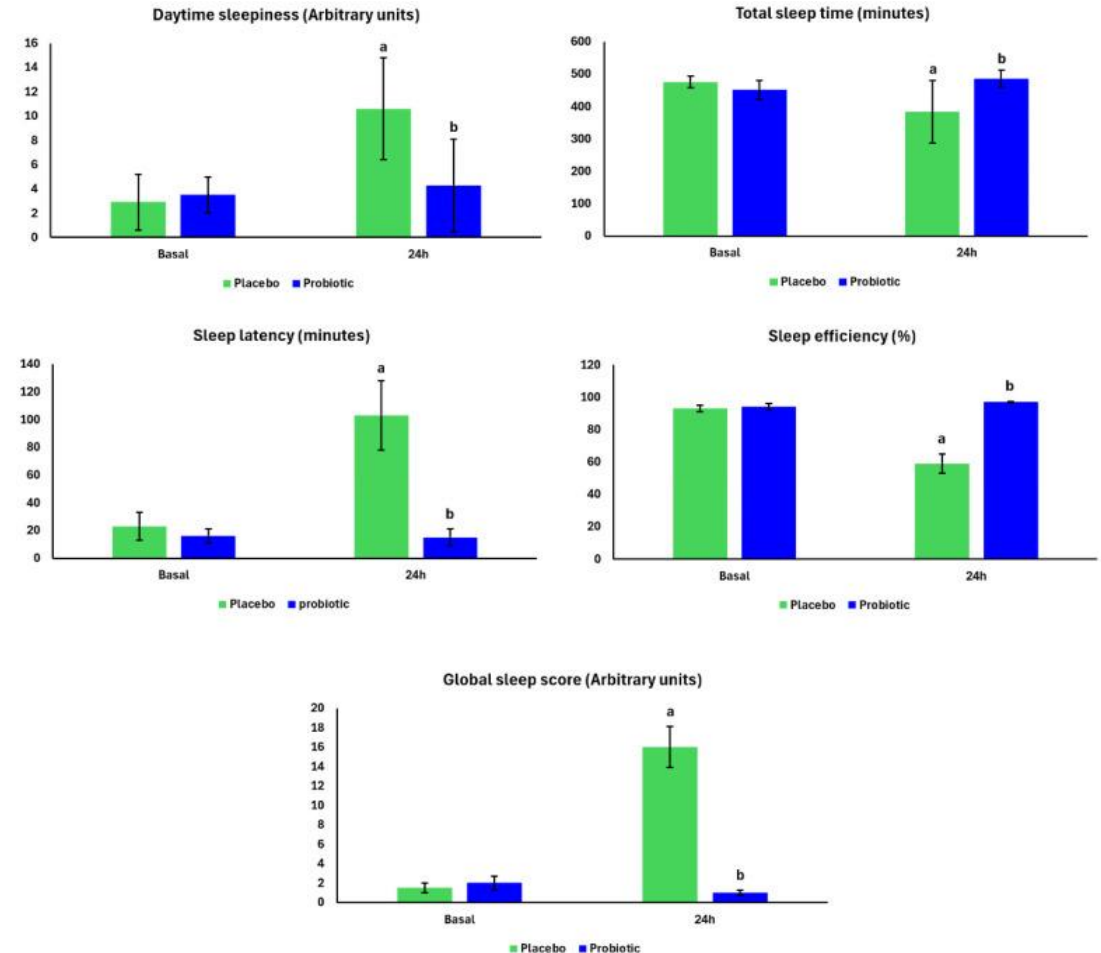
- Harnett et al (2021)
 - 19 elite male rugby athletes (9 probiotic, 10 placebo)
 - 17 weeks intervention encompassing both international and local competition
 - Probiotic group reported sleep quantity and sleep quality improved
- Quero et al (2021)
 - 27 subjects (14 sedentary individuals vs 13 professional soccer players)
 - Randomly assigned into 2 groups
 - Synbiotics (7 sedentary individuals and 7 soccer players) and placebo (7 sedentary individuals and 6 soccer players) for 30 days
 - Soccer players who took synbiotics increased sleep efficiency and decreased sleep latency

Harnett JE et al. Probiotic supplementation elicits favourable changes in muscle soreness and sleep quality in rugby players. *Journal of Science and Medicine in Sport*. 2021;24:195 – 199.

Quero CD et al. Differential health effects on inflammatory, immunological and stress parameters in professional soccer players and sedentary individuals after consuming a synbiotic. A triple-blinded, randomized, placebo-controlled pilot study. *Nutrients*. 2021;13:1321.

Probiotics and Athletes' Sleep

- 27 marathon runners (14 probiotics, 13 placebo)
- 30 days prior to the marathon
- Sleep was assessed before supplementation, before marathon, and 1- and 24-hour after marathon
- Probiotic group, daytime sleepiness, sleep latency, and global sleep score were lower 24-hour after the marathon compared to the placebo
- Total sleep time and sleep efficiency were higher in the probiotic group 24-hour after the marathon compared to the placebo



Probiotics and Athletes' Sleep

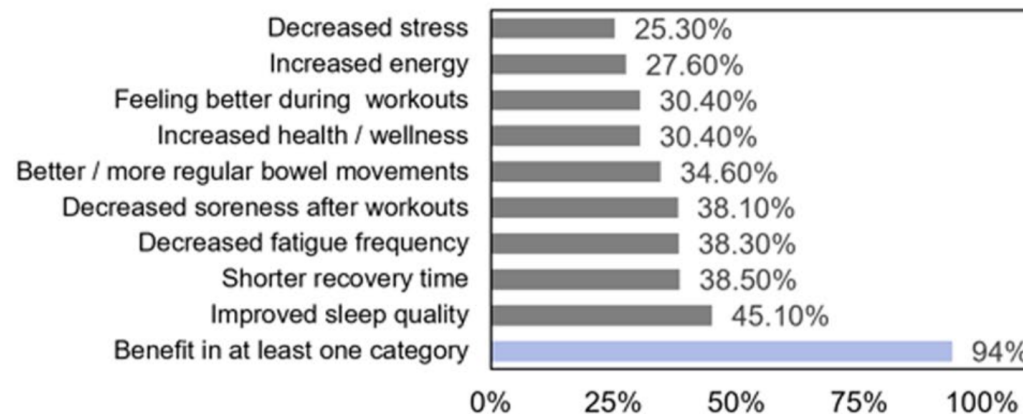
- 257 healthy adults (40.9±14.9 years old)
- Exercise 5.6 days per week
- 10 billion or 35 billion cfu multi-strain *Lactobacillus* (*L. acidophilus* FB0012, *L. plantarum* FB0015, and *L. rhamnosus* FB0047) for 2 weeks
- Online survey before intervention, day 7 and day 14
- 11 male elite soccer (26.5±2.0 years old)
- 12 weeks of placebo followed by 12 week of probiotics
- 40 billion cfu multi-strain *Lactobacillus* (*L. acidophilus* FB0012, *L. plantarum* FB0015, and *L. rhamnosus* FB0047)
- Online survey collected at post-placebo and post-probiotics
- Stool, blood and urine collected at baseline, post-placebo and post-probiotics

Probiotics and Athletes' Sleep

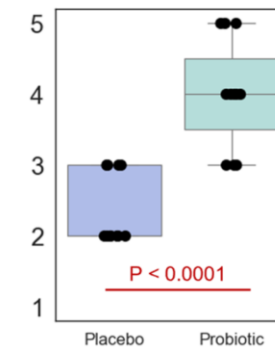
Healthy adult (n = 257)

Elite male soccer (n = 11)

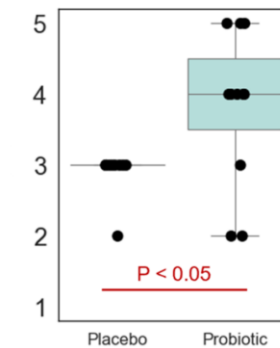
Percent participants who reported the following
after two weeks of probiotic use



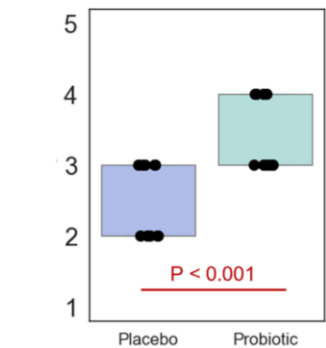
Change in Sleep Quality



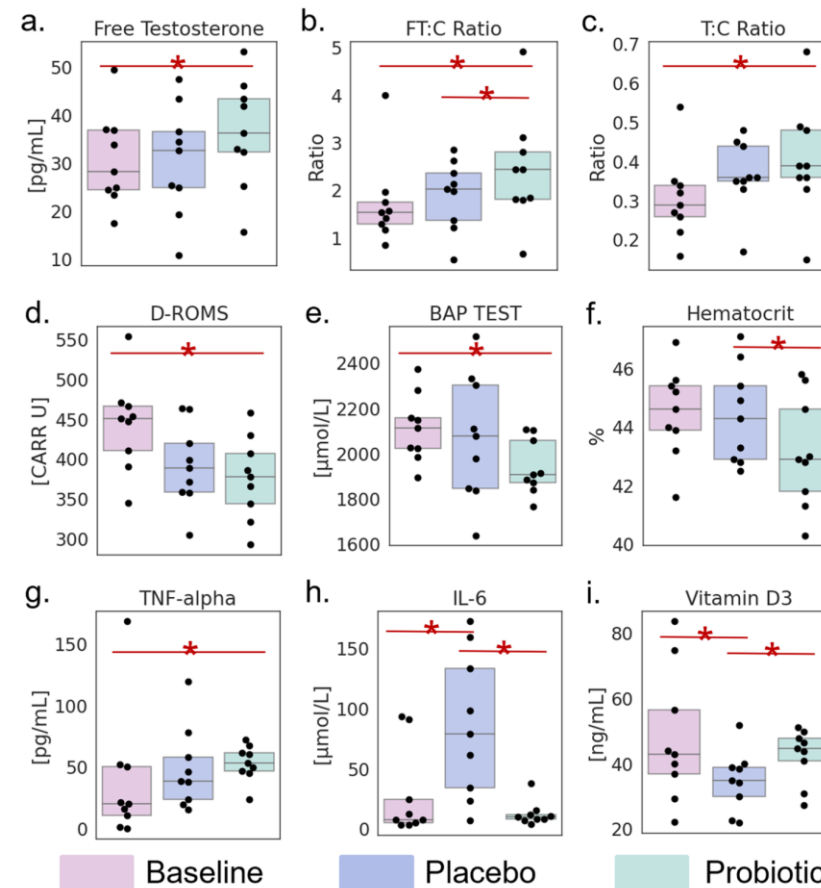
Change in Energy Level



Change in Bowel Movements



Probiotics and Athletes' Sleep



Bongiovanni T et al. A *Lactobacillus* consortium provides insights into the sleep-exercise-microbes nexus in proof of concept studies of elite athletes and in the general population. *Microbiome*. 2025;13:1.

Are Probiotics the Solution?

- Existing evidence is small studies
- Mostly subjective sleep evaluation
- Not performance outcomes

Conclusion

- Sleep is a key pillar of athletic performance, supporting recovery, cognition, and hormonal balance
- Sleep disturbances are common in athletes, driven by training load, competition stress, and travel
- Poor sleep impairs performance and physiology, including reduced endurance, slower reaction time, and hormonal disruption
- The gut–brain axis may influence sleep regulation through neurotransmitters, immune pathways, and neural signaling
- Probiotics show emerging potential to improve sleep quality and stress response, but evidence in athletes remains limited and strain-specific
- Future research is needed to identify effective probiotic strains, dosage, and long-term impact in elite athlete