Overtraining Syndrome: A Multi-faceted Health and Performance Phenomenon

PennWest GLOBAL ONLINE

Presented by Brandon Lee, MS, RD, CSSD, CCRP
Doctor of Health Science Candidate (DHSc(c))
Practitioner | Researcher | Writer | Speaker

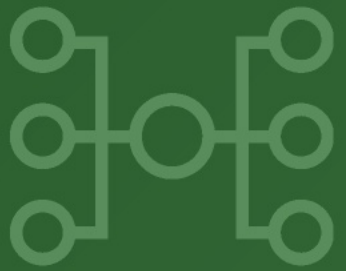
SPT 3000 - Peak Performance in Sport

- Overtraining Syndrome (OTS) Overview
- Assessment Methodologies
- Prevention & Treatment
- The Way Forward

Overtraining Continuum

Proposed Mechanisms

Historical Context



Overtraining Syndrome

Definition

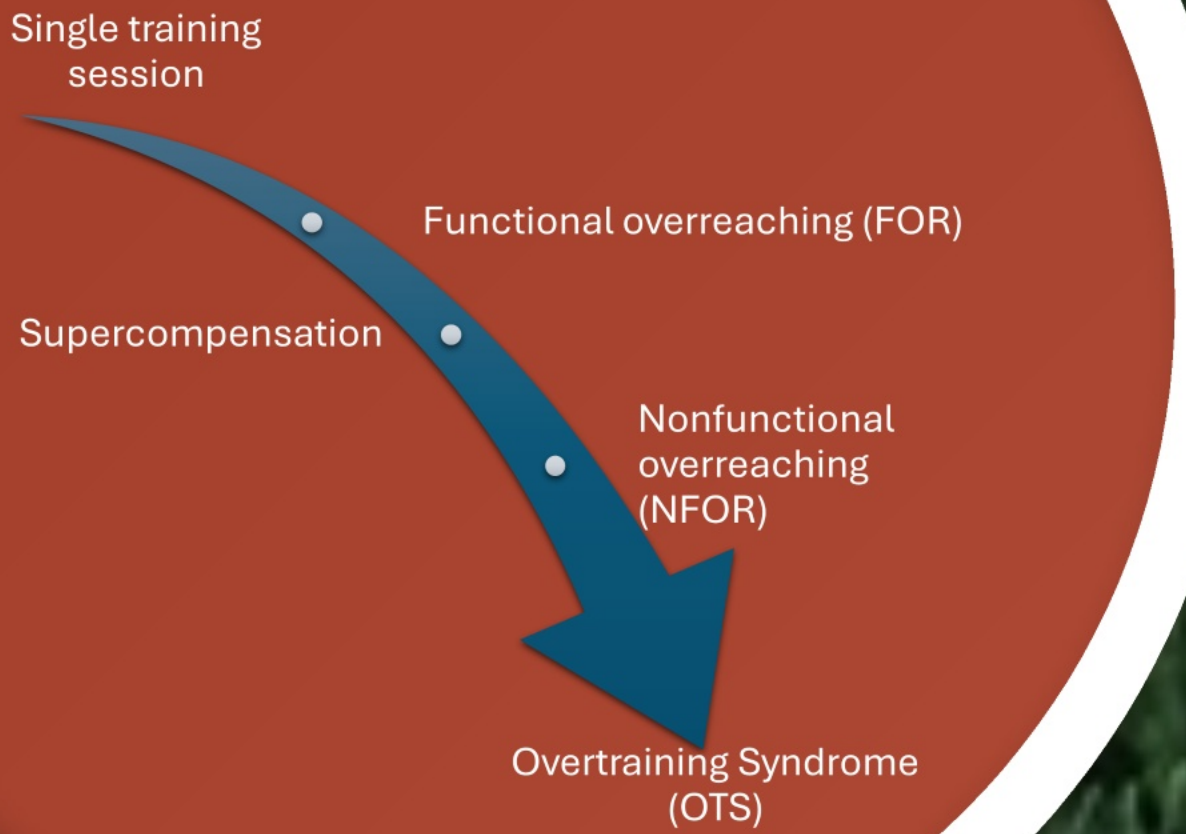
Overtraining syndrome is a sports-specific decrease in performance combined with disturbances in mood state. Underperformance persists despite a period of recovery spanning weeks to months.

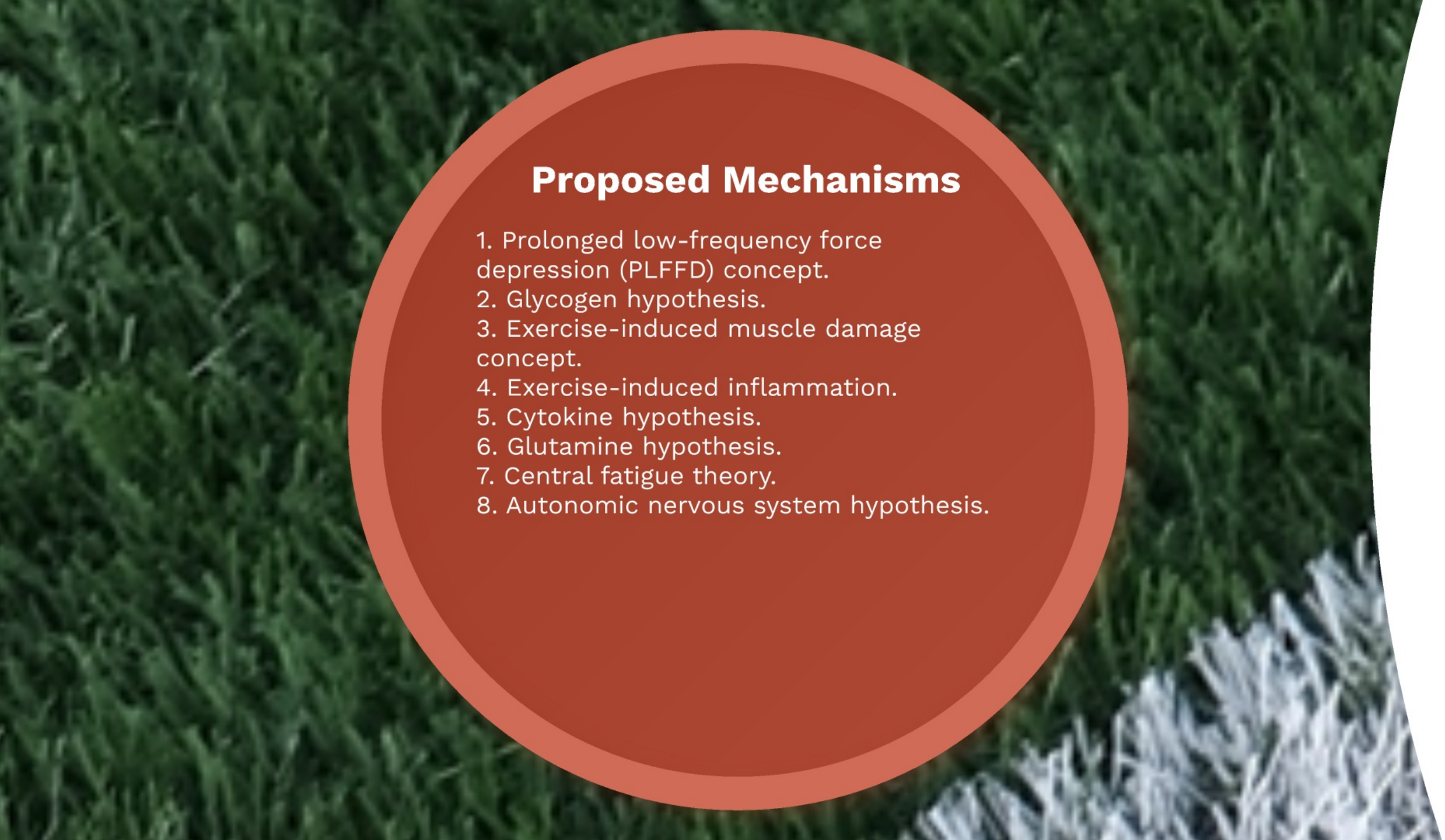
Also called "unexplained underperformance syndrome", "staleness", or "fatigue syndrome".

Types of OTS

Prevalance of OTS

The Overtraining Continuum





Proposed Mechanisms

1. Prolonged low-frequency force depression (PLFFD) concept.
2. Glycogen hypothesis.
3. Exercise-induced muscle damage concept.
4. Exercise-induced inflammation.
5. Cytokine hypothesis.
6. Glutamine hypothesis.
7. Central fatigue theory.
8. Autonomic nervous system hypothesis.

OTS History

- **First reported in the 1930s**.
  - Characterized by performance decline, fatigue, and mood disturbances.

- **Gained traction in the mid-1980s.**
  - Definitions remained focused solely on training program's impact on recovery.

Prevalence of OTS

- An estimated 30% of young (<18 y/o) and adult (>18 y/o) athletes have experienced NFOR/OTS at least once.
- Proposed prevalence: 20-60% of all athletes throughout their careers.
- Up to 60% of male and female elite runners have had OTS.
- Overall, OTS is rare in most athletes and difficult to diagnose.

Types

Sympathetic and Parasympathetic

Intensity- and Volume- Induced

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OTS Risk Factors

Signs & Symptoms

Assessment Methodologies

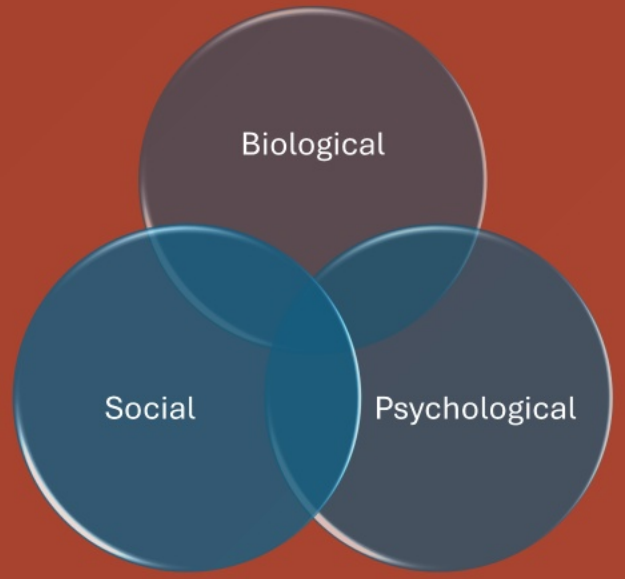
Complex Systems Model of OTS

Evaluation Methods

Risk Factors

- High duration and intensity training periodization without adequate transition periods, tapering, or general recovery considerations.
- Inadequate rest/recovery due to personal matters, family, work and health stressors, meal skipping, and poor sleep.
- Unhealthy sporting/organization culture.

Biopsychosocial Model



Physiological Signs and Symptoms

- Chronic fatigue ("washed-out")
- Performance decline (athlete specific)
- Frequent or prolonged illnesses (e.g., cold or flu)
- Prolonged muscle soreness, stiffness, or damage
- Disordered sleep patterns
- Anorexia (loss of appetite)
- Unintentional body composition changes (e.g., unplanned weight loss)
- Altered blood pressure
- Low glycogen stores (i.e., frequent bonking)
- Decreased maximal oxygen consumption
- Altered resting heart rate (e.g., tachycardia)
- Decreased heart rate variability
- Bowel movement changes
- Amenorrhea

Psychological Signs and Symptoms

- Depressive symptoms
- Decreased mental concentration and restlessness
- Increased irritability
- Loss of vigor

Complex Systems Model of OTS

Overtraining syndrome...
1. Is highly individualized.

2. Features physiological and psychological symptoms constantly shifting based on daily training, activities and stressors.

3. Can only be diagnosed by exclusion.

4. Doesn't have a single known biomarker.

5. Doesn't have an identified physiological mechanism.

6. Is theoretically infinite in duration.

7. Impacts endocrine, nervous, muscular, circulatory, and metabolic responses complicating diagnostics.

8. Is influenced by life stressors.


BLOOD BIOMARKERS OF OVERTRAINING SYNDROME

BRANDON LEE, MS, RD, CSSD

Effective physical training programs induce functional overreaching to improve athlete performance. However, athletes may develop overtraining syndrome (OTS) when an athlete's training is chronically intense, long, or frequent without cessation or adequate recovery. This article will discuss the importance of blood biomarker monitoring as a vital tool in OTS diagnostics and recovery.

OVERREACHING VS. OVERTRAINING

Athletes consistently strive for excellence, especially at the collegiate, professional, and Olympic levels. Ideally, strength and conditioning coaches and personal trainers develop training programs that help athletes achieve functional overreaching (FOR), which is an adaptive state that leads to acute fatigue based on deliberately planned training, followed by specific adaptations to imposed demands (SAID).

In other words, training programs should introduce stimuli that challenge the athlete physiologically and mentally, resulting in temporary performance reductions but ultimately leading to enhanced performance (also known as "supercompensation"). However, an imbalance between adaptation and recovery can lead to nonfunctional overreaching (NFOR). NFOR is a physiological state of consistent fatigue, stagnation, and noticeable reductions in performance (13). Beyond NFOR is OTS, which is a plateau or decrease in physical or psychological performance due to excessive training duration, intensity, and frequency or insufficient recovery practices (4). OTS, previously called "unexplained underperformance syndrome," is the culmination of a prolonged, elevated state of fatigue, continuously intense physical training, and inadequate recovery (5,12). It is often the result of prolonged maladaptation for months to a year, and recovery can take just as long (4,13). Mismanaged training programs place athletes at greater risk for OTS.

SIGNS AND SYMPTOMS OF OVERTRAINING

While a complete list of documented signs and symptoms of OTS is beyond the scope of this article, sports professionals must be aware of these indicators. Notable signs include chronic fatigue, performance declines, frequent or prolonged illnesses (e.g., cold or flu), depressive symptoms, and overall poor physical and mental wellness. Other indicators of OTS include prolonged muscle soreness or damage, disordered sleep patterns, anorexia (loss of appetite), unintentional body composition changes (e.g., unplanned weight loss), altered blood pressure, low glycogen stores (i.e., frequent bonking), decreased maximal oxygen consumption, altered resting heart rate, and decreased heart rate variability (13,18). Physical signs such as tiredness or the desire to rest are often noticed and indicate poor training adaptation (4). However, blood biomarkers could also be a valid measure to determine the presence of OTS.

BLOOD BIOMARKERS

Blood biomarkers are objectively measured characteristics of normal biological processes and can be diagnostic, predictive, or monitoring tools. They can also be used for risk assessment, safety, surrogate or endpoint data, and pharmacodynamics. In the context of OTS, blood biomarkers can indicate a correlational and potentially causal relationship with OTS. This article proposes that an athlete's comprehensive health and performance assessment include blood biomarker monitoring as a vital tool in OTS diagnostics and recovery.

The most common OTS blood biomarkers include testosterone (males), adrenocorticotropic hormone, cortisol, growth hormone, insulin-like growth factor-1 (IGF-1), creatine kinase, catecholamines, and C-reactive protein. Testosterone and cortisol appear to be the most sensitive to OTS, but these blood biomarkers have limitations. All blood biomarkers must be evaluated and considered within the framework of timely and comprehensive health and performance evaluation to accurately understand an athlete's performance, adaptation to imposed demands, and health.

TESTOSTERONE

Testosterone levels are one of the primary indicators of OTS in male athletes. Testosterone promotes protein synthesis, red blood cell production, glycogen replenishment, and reduces protein breakdown (12). Healthy total testosterone levels are unique to each individual and can vary based on age, sleep quality, weight, genes, and overall health status. A reference range between 280 – 1080 ng/dL in men is considered normal (19).

Some research studies have found that intense and prolonged physical training sessions can reduce testosterone levels and other associated hormones such as cortisol (4,12,18). In a cross-sectional study, 14 OTS athletes, 25 healthy athletes, and 12 healthy sedentary participants had their total testosterone, testosterone to estradiol ratio, and testosterone to cortisol ratio levels examined. The results showed that the healthy athletes had higher levels of total testosterone that the OTS athletes and sedentary participants. The OTS athlete's testosterone to estradiol ratio was about 50% lower compared to healthy athletes and sedentary individuals. There was no difference in the testosterone to cortisol ratio between the OTS athletes and the healthy athletes. Interestingly, researchers theorize that reductions in testosterone occur due to the conversion of androgen precursors into estrogens (7).

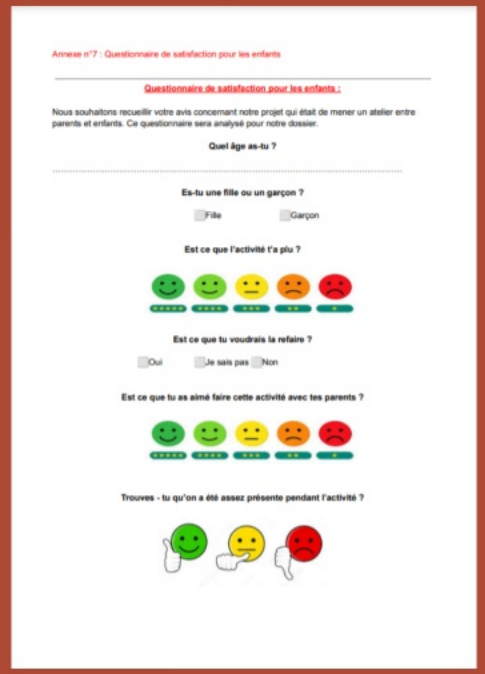
On the other hand, OTS researchers found that a 12-week recovery period that included increased energy intake, physical training cessation, emphasis on sleep quality, and stress management can mildly improve total testosterone and significantly improve

Blood Biomarkers

- Testosterone levels: Total testosterone, total testosterone:sex hormone-binding globulin (SHBG) ratio, and total and free testosterone:cortisol ratio, testosterone:estradiol ratio.
- Estradiol and prolactin.
- Adrenocorticotropic hormone (ATCH).
- Cortisol (plasma and salivary).
- Growth hormone (aka somatotrophin) and Insulin-like growth factor (IGF-1).
- Creatine kinase.
- Catecholamines (i.e., epinephrine, norepinephrine, and dopamine).
- C-reactive protein (CRP).
- Lymphoctes (elevated).
- IL-1B, IL-6, and TNF (elevated following exercise).

Psychological Questionnaires

- Profile of Mood States (POMS)
- French Society of Sport Medicine (SFMS)
- Hamilton Depression Scale (HAMD)
- Montgomery-Asberg Depression Rating Scale (MADRS)
- Recovery Stress Questionnaire for Athletes (RESTQ-Sport)



Annexe n°7 : Questionnaire de satisfaction pour les enfants

Questionnaire de satisfaction pour les enfants :

Nous souhaitons recueillir votre avis concernant notre projet qui était de mener un atelier entre parents et enfants. Ce questionnaire sera analysé pour notre dossier.

Quel âge as-tu ?

Es-tu une fille ou un garçon ?

Fille Garçon

Est ce que l'activité t'a plu ?

Est ce que tu voudrais la refaire ?

Oui Je sais pas Non

Est ce que tu as aimé faire cette activité avec tes parents ?

Trouves - tu qu'on a été assez présente pendant l'activité ?

Body Composition & Metabolic Alterations

- Increased body fat.
- Change in steroid hormone quantity and ratios.
- Blunted hormonal response to exercise.
- Blunted cortisol awakening response.

Emerging Methods

- Heart rate variability (HRV)
- Metabolites
- 2-bout exercise test (TBE) and cardiopulmonary exercise test (CPX)
- Neurotransmitters
- Immunological and REDOX parameters
- Telomere length
- Electroencephalography (EEG)

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Prevention & Treatment

"An ounce of prevention is worth a pound of cure."
- Benjamin Franklin

An ounce of prevention...

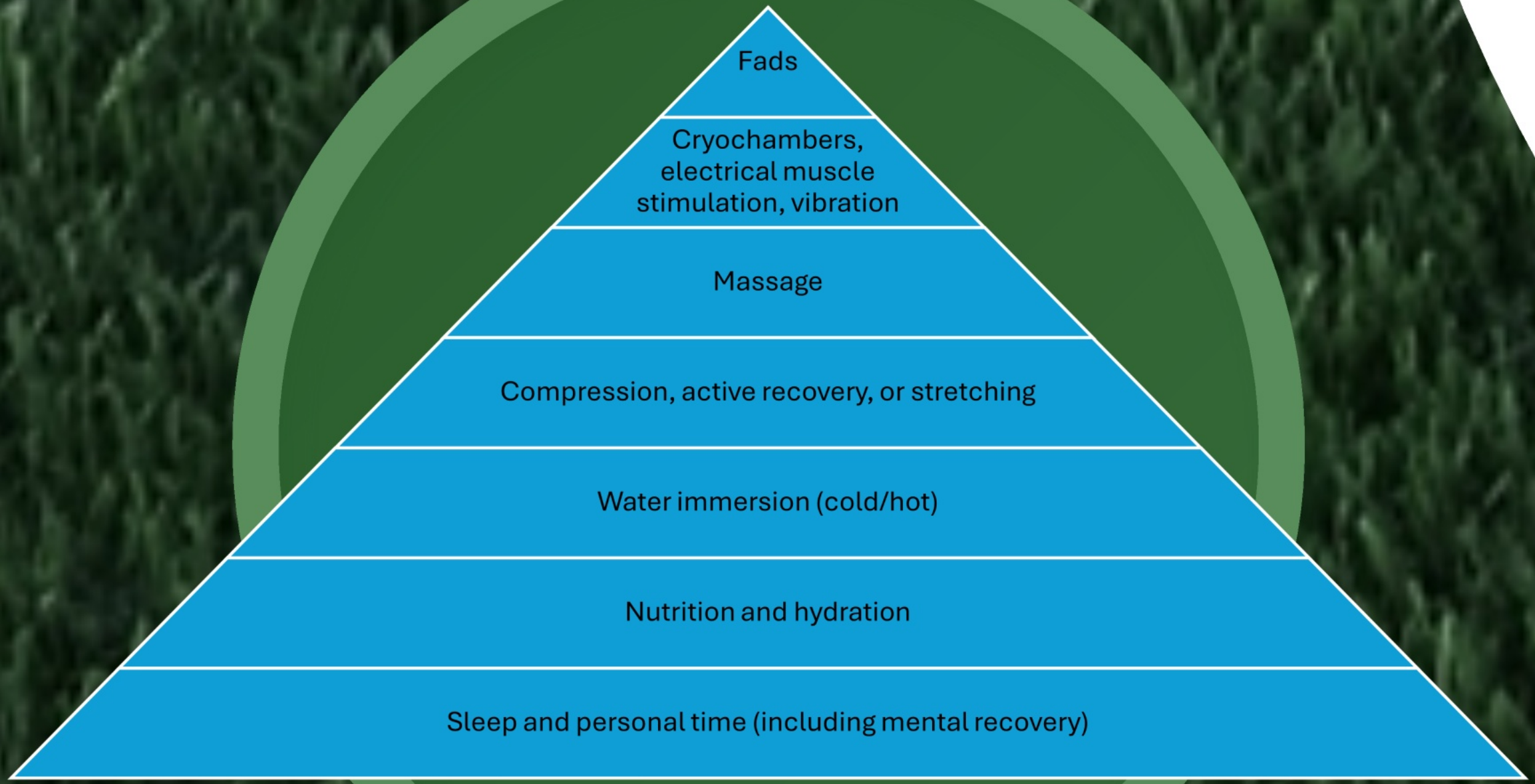
Physical & Psychological Considerations

Nutrition Considerations

Preventative Measures

- Athlete reporting (e.g., bodily awareness).
- 10% volume/intensity rule.
- Periodization is key.
- 24-72 hour recovery for muscle groups.
- Quality nutrition and sleep practices.
- Training variety (e.g., exercise types, location)

Recovery Pyramid



Adapted from French, D., & Ronda, L. T. (Eds.). (2021). NSCA's essentials of sport science. Human Kinetics.

Physical and Psychological Considerations

Physical Therapist
Athletic Trainers
Massage Therapists
Strength and Conditioning Specialist
Exercise Physiologist
Sports Coaches

Sports Psychologists
Mental Performance Coaches

Nutrition Considerations

Macronutrients:

- CHO: 8-10g/kg BW
- PRO: 1.2-1.4g/kg BW
- FAT: 30% of total kcal

Micronutrients:

- Vit A, C, E & zinc and magnesium

The Way Forward

Research

Awareness

Culture Change

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