UNIVERSITEIT GENT

JUDO BELGIUM

University of Hertfordshire UH

EUROPEAN JUDO UNION *Judo – more than sport!*

The Interaction of Sleep, Stress, and training load towards Injury Risk in Elite Judokas

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Research Questions

How does the interaction between training load and stress influence the occurrence of sports injuries?

How can coaches and sport psychologists use stress data to personalize mental training programs for elite judokas?

Which stress measurement methods (subjective and objective) are most reliable, applicable and valid in elite judo athletes?

To assess the impact of the female hormonal cycle on these parameters and their interaction in injury risk, type and impact.

Validity and Reliability of Measurement Tools

What is the relationship between sleep characteristics and injury risk, type and impact in elite judokas?

Can a targeted intervention program focusing on sleep optimization, stress management and training load modulation reduce proneness to injury and improve performance

What are the ethical implications of continuous stress monitoring in elite judo environments?

How does stress (both perceived and physiological) affect the physical and mental performance of elite judokas?

Which stress assessment tools are most valid and reliable for use with elite judokas during training camps and competitive events?

Practical Application

Can a combined approach using both subjective and objective methods provide a more comprehensive understanding of stress in elite judokas?

How do external factors such as audience presence, refereeing decisions, and competition location affect the reliability of stress measurements?

Complexity and Integration

Introduction

- Injuries are a major concern in elite sports, especially in judo
- Multiple factors are involved: sleep, stress, and training load
- Effective monitoring of stress and recovery status offers potential for injury prevention and optimization of training programs in elite-level judo.

Impact of Sleep on Recovery and Injury

Role in Physiological Recovery

- Sleep is essential for tissue repair and muscle recovery through hormone regulation, especially growth hormone release.
- Hormonal imbalance (cortisol↑, growth hormone↓)

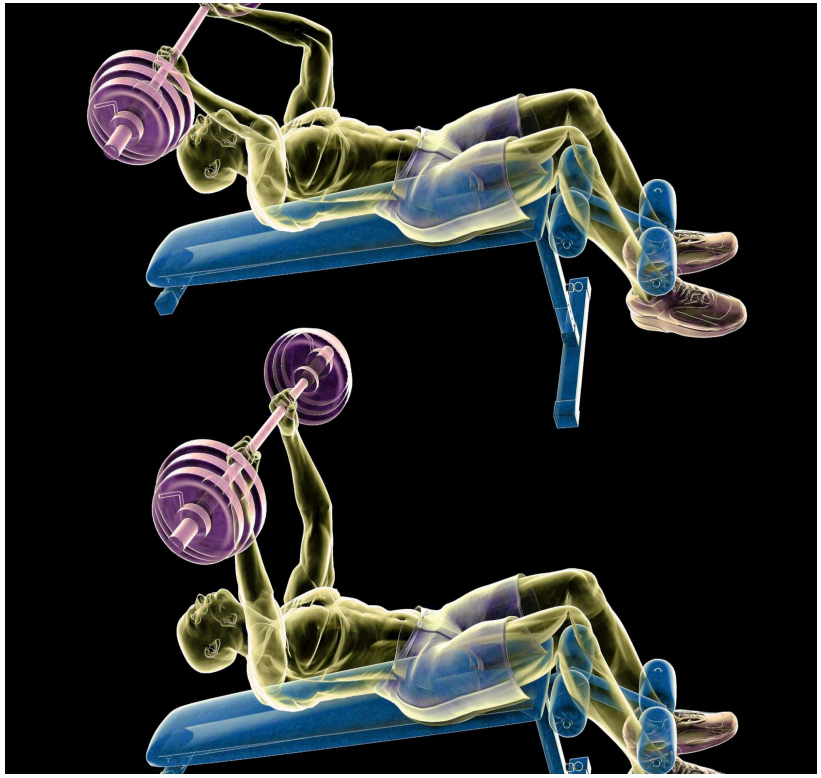
Risk of Injury from Sleep Deprivation

- Athletes sleeping less than six hours face higher injury risks up to 50% in judo up to 78%.
- Impaired motor coordination & slower reaction times
- Critical in sports like judo that require fast decision-making

Impact on Performance and Fatigue

- Poor sleep quality causes cumulative fatigue, decreased performance, and higher vulnerability to overtraining and injuries.

Psychological Stress and Its Physiological Effects



HPA Axis Activation

- Psychological stress triggers the HPA axis, increasing cortisol levels which negatively affect immune function and muscle repair.

Chronic Stress in Athletes

- Elite judokas face chronic stress from competition, travel, weight management, and expectations increasing injury risk.

Impact on Recovery and Injury

- Stress compounds physical exertion effects, making recovery harder and increasing chances of injury and overtraining.

Stress Management Importance

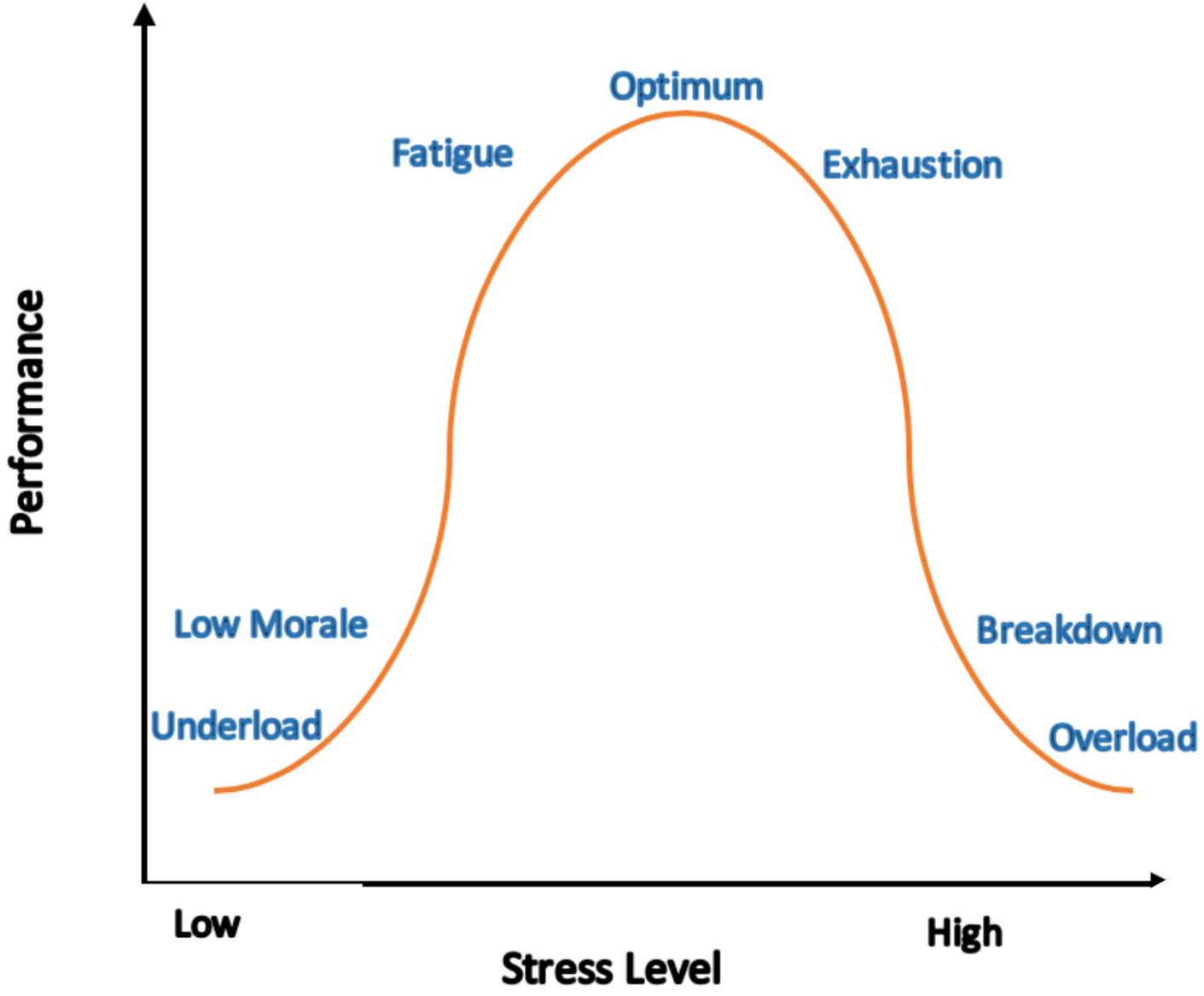
- Managing psychological stress is crucial for athlete health and should complement physical training and recovery plans.

Psychological Stress and Its Physiological Effects

- Activates the HPA axis (Hypothamic-pituitary-adrenal) ⟶ increased cortisol
- Chronic stress = suppressed immunity, muscle breakdown, delayed recovery
- Stress alters motor patterns ⟶ higher injury risk

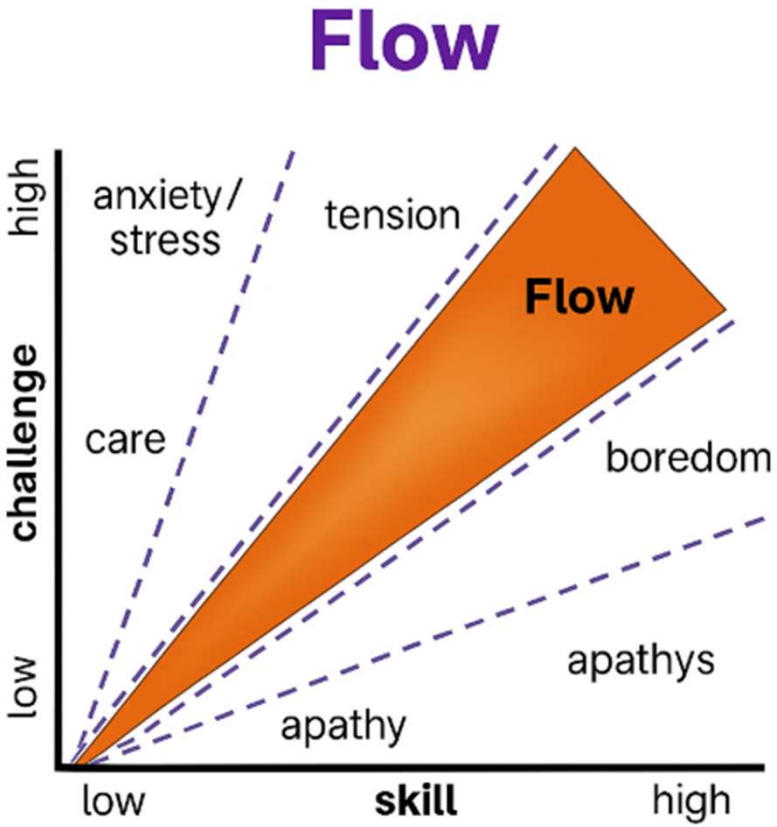
Allostatic Load

Cumulative damage to the body, both physically an mentally



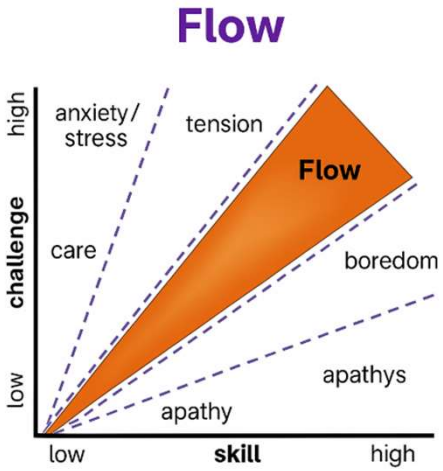
The Yerkes-Dodson Law: performance vs. stress level

- **Too little stress** → Underperformance (lack of focus)
- **Optimal stress** → Peak performance (flow, sharpness)
- **Too much stress** → Overload and errors



Application in Elite Sports and Key Insights

- Elite judokas constantly balance on this curve
- **Mental training** and **stress management** are key
- Staying in the **optimal zone** is essential for consistent high performance



- Stress is **not inherently negative** — it's a powerful mechanism
- It is **neurobiologically anchored** and **trainable** through mental techniques
- Stress has a **direct impact on performance**
- Therefore, it is a **crucial element** in coaching and guidance

Tools for monitoring stress and recovery

Biomarker Category	Specific Biomarkers	Relevance to Chronic Fatigue	Typical Measurement Method
Muscle anabolic/catabolic hormones	Testosterone, Cortisol, Testosterone/Cortisol ratio	Reflect metabolic strain and stress responses to training/competition loads	Blood or saliva samples; ELISA or radioimmunoassay
Muscle damage markers	Creatine Kinase (CK), Lactate Dehydrogenase (LDH)	Quantify extent of exercise-induced muscle damage	Blood samples; Spectrophotometry
Immunological markers	Salivary Immunoglobulin A (s-IgA), Immune cell function	Indicate mucosal immunity status and potential vulnerability to upper respiratory tract infections	Saliva samples; ELISA
Oxidative stress markers	Reactive Oxygen Species, Antioxidant Capacity, TBARS, Protein Carbonyls	Assess cellular stress and redox balance	Blood samples; Spectrophotometry, ELISA
Inflammatory markers	C-Reactive Protein (CRP), Cytokines (e.g., IL-6, TNF-α)	Indicate systemic inflammatory responses to prolonged intense training	Blood samples; ELISA, Flow cytometry

Tools for Monitoring Stress and Recovery

Subjective Stress Assessments

Questionnaires like RESTQ-Sport[1], POMS[2], and DALDA[3] evaluate perceived stress and recovery through athlete self-reporting.

Physiological Stress Measures

Objective tools measure heart rate variability, salivary or hair cortisol as markers of physiological stress response. Sleep via wearables (actigrafie)

Combining Assessment Methods

Integrating subjective and objective methods provides a comprehensive view of stress and recovery for better training decisions.

[1] The Recovery-Stress Questionnaire [2] POMS (Profile of Mood States) [3] DALDA (Daily Analyses of Life Demands for Athletes)

Introduction to Salivary Cortisol

Non-invasive Stress Biomarker

- Salivary cortisol is a practical, non-invasive biomarker used to assess psychological stress through HPAA activity.

Use in Vulnerable Populations

- It enables stress-free sampling in vulnerable populations like children or medical patients without needing medical staff.

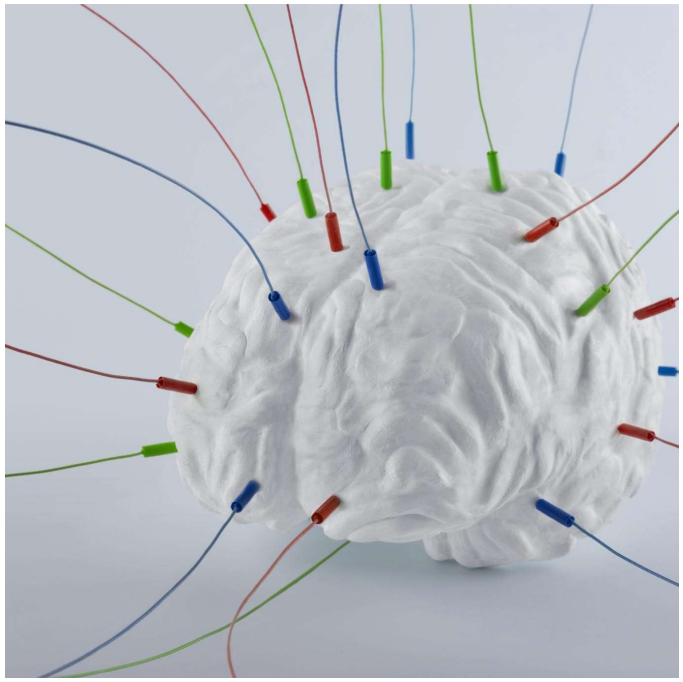
Complex Interpretation Factors

- Interpreting cortisol levels requires considering sex hormones, binding proteins, and individual stress responses.

Research Limitations

- Salivary cortisol may not directly reflect central HPAA activity and has limitations in correlating with other biomarkers.

CRF/AVP and HPAA Regulation



CRF and AVP Activation

- Psychological stress activates CRF and AVP neurons, triggering cortisol release through the hypothalamic-pituitary-adrenal axis.

Variability in Cortisol Levels

- Salivary cortisol levels vary due to individual differences and situational factors like unpredictability and habituation.

Sex and Hormonal Modulation

- Sex differences and hormonal changes influence HPAA responses, affecting cortisol regulation during menstrual cycles and contraceptive use.

Research Implications

- Understanding HPAA regulation complexity is vital for accurate stress assessment and study design considering confounding variables.

Dissociations with ACTH

ACTH-Independent Cortisol Release

- Cortisol can be released independently of ACTH via sympathetic nervous system activation and other neuropeptides.

Stress Type Effects

- Physical stress tends to increase adrenal cortisol release, whereas psychological stress may reduce it.

Cortisol Awakening Response

- CAR shows a sharp rise in cortisol upon waking that is not fully explained by ACTH activity.

Individual Variability

- Individual differences and chronic factors modulate adrenal sensitivity and complicate cortisol measurement.

Blood vs. Salivary Cortisol

Salivary Cortisol as Proxy

- Salivary cortisol is an easy-to-collect proxy for free cortisol in blood with strong correlation under many conditions.

Impact of CBG Saturation

- High cortisol levels saturate cortisol-binding globulin, causing nonlinear relationships between blood and salivary cortisol.

Physiological Influences

- Factors like oral contraceptives, menstrual cycle, and pregnancy alter CBG levels, affecting cortisol measurements.

Enzymatic Conversion and Binding

- Conversion of cortisol to cortisone in saliva and partial CBG binding create variability in salivary cortisol levels.

Urinary Cortisol and Metabolites

Urinary Cortisol Overview

- Urinary cortisol reflects HPAA activity by measuring cortisol production and clearance over time.

Metabolism and Excretion

- Most cortisol is metabolized in the liver, excreted via stool or skin, with only a small fraction in urine.

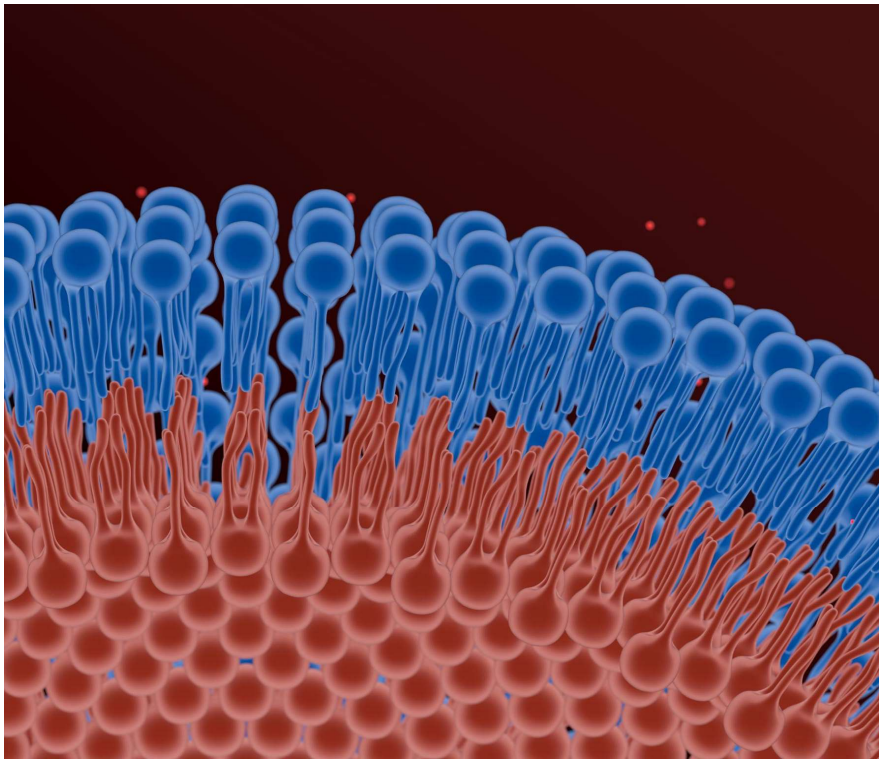
Analytical Techniques

- Gas chromatography/mass spectrometry enables precise measurement of cortisol metabolites in urine samples.

Practical Considerations

- Urinary cortisol is less feasible for large studies; salivary cortisol offers ease but less comprehensiveness.

Target Tissue Sensitivity



Glucocorticoid Receptor Variability

- Differences in glucocorticoid receptor isoforms and gene polymorphisms affect tissue sensitivity to cortisol, causing varied responsiveness.

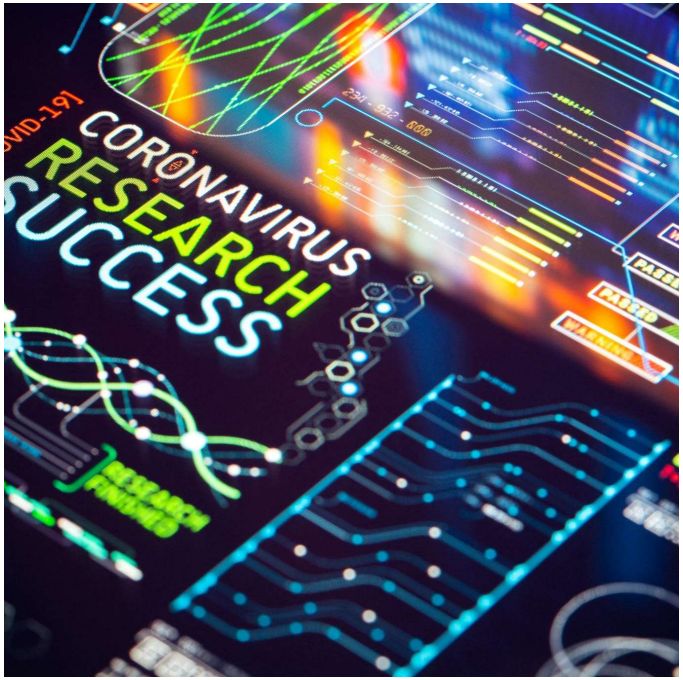
Enzymatic Activation by 11β-HSD1

- The enzyme 11β-HSD1 converts inactive cortisone into active cortisol, enhancing glucocorticoid effects in specific tissues.

Impact on Cortisol Data Interpretation

- Tissue-specific sensitivity and receptor variation complicate the uniform interpretation of salivary cortisol levels across individuals.

Considerations



Salivary Cortisol Utility

- Salivary cortisol is a non-invasive biomarker widely used in stress research with good correlation to free blood cortisol.

Interpretation Challenges

- Interpreting salivary cortisol requires considering hormonal influences, binding globulin levels, and individual sensitivity variations.

Comprehensive Stress Assessment

- Measuring multiple HPAA parameters like salivary cortisol, ACTH, and blood cortisol offers more complete insights into stress responses.

Research Implications

- Understanding cortisol regulation mechanisms is essential for designing robust stress research and drawing accurate conclusions.

Training Load and Injury Risk

ACWR and Injury Prediction

- The acute: chronic workload ratio is a key metric used to predict injury risk based on training load balances.

Impact of Sleep and Stress

- Sleep quality and stress levels critically influence how training loads affect injury risk and recovery.

Individualized Load Management

- Personalized training adjustments based on recovery capacity optimize injury prevention and performance.

Integrated Monitoring Systems

- Combining data on workload, sleep, and stress helps detect early injury risks and guides training modifications.

Conclusion and Practical Implications

Dynamic Interaction of Factors

- Sleep, psychological stress, and training load dynamically influence injury risk in elite athletes.

Comprehensive Monitoring Systems

- Integrating monitoring systems into daily training allows individualized load management and early injury risk detection.

Prioritizing Health Practices

- Focusing on sleep hygiene, stress management, and contextual training data improves athlete performance and health.

Sustainable Athletic Development

- Evidence-based approaches reduce injury likelihood, supporting sustainable training and peak competition performance.

Research agenda

- Find an answer to all the research questions with focus on elite judokas
- Research collaboration between the University of Hertfordshire, University Ghent, Judo Belgium
- Research group
  - Prof. Dr. Mike Callan, University of Hertfordshire
  - Dr. Daniel Muniz, University of Hertfordshire
  - Prof. Dr. An Mariman, University of Ghent
  - Prof. Dr. Dirk Vogelaers, University of Ghent
  - Dr. Peter Smolders, Judo Belgium
  - Prof. dr. Peter Vermeir, University of Ghent, PhD candidate University of Hertfordshire.