



Editorial overview: Sports endocrinology

Fabio Lanfranco

Current Opinion in Endocrine and Metabolic Research xxxx, xxx:xxx

This review comes from a themed issue on **Sports Endocrinology**

Edited by **Fabio Lanfranco**

<https://doi.org/10.1016/j.coemr.2019.10.001>

2451-9650/© 2019 Elsevier Ltd. All rights reserved.

Fabio Lanfranco

Division of Endocrinology and Metabolism, Department of Medical Sciences, University of Turin, Italy
e-mail: fabio.lanfranco@unito.it



Dr. Fabio Lanfranco is an assistant professor of Endocrinology at the University of Turin, Italy. His research interests include sports medicine, effects of physical activity on endocrine and metabolic functions, andrology, and reproductive medicine. He has authored more than 80 publications in indexed peer-reviewed international journals and more than 150 communications at national and international meetings.

Physical activity exerts an important influence on the endocrine system, modulating synthesis and secretion of several hormones. Mode, intensity, duration of the exercise bout, gender, age, and fitness level of the individual, as well as environmental and psychological factors, may affect the endocrine response to physical activity. In the last decades, the effects of physical activity on the endocrine system have gained growing interest in the scientific world and not only among endocrinologists.

This compendium of mini-reviews explores the newest and most innovative topics in sports endocrinology, providing an authoritative overview of the effects of physical activity on the endocrine and metabolic functions. A substantial part of this issue is devoted to the ‘hot topic’ of hormonal doping in sports. Hormone abuse has become a widespread habit among professional and recreational athletes. The properties of androgens, erythropoietin, as well as dietary supplements and their use and misuse in sports are described. Specific methods to detect hormone abuse are presented and discussed.

This focused issue is divided into three sections.

The first section is dedicated to the *effects of physical activity on the endocrine function*.

Vita Birzniece examines the effect of exercise on the **GH-IGF axis**, and the effect of the growth hormone (GH) on physical performance in health and disease. It is well known that exercise stimulates GH secretion, suggesting a physiological role of GH in the regulation of physical health. GH deficiency presents with low muscle mass and impaired exercise capacity, while GH excess in acromegaly associates with functionally weaker muscles and low aerobic exercise capacity. This indicates that GH has to be just right to exert its positive effects on muscle mass and function.

A close inter-relation between GH and cortisol responses to acute exercise exists. The **hypothalamic-pituitary-adrenal axis** (HPA axis) is stimulated by acute exercise and initiates numerous neuroendocrine cascades. **Travis Anderson and colleagues** revise the effects of physical activity on the HPA and GH axes, describing the different actions of acute and prolonged aerobic and resistance exercise on cortisol and GH responses. The authors

2 Sports Endocrinology

highlight the importance of future investigations that should consider the synchronicity between HPA and GH axes response and their interaction with other physiological systems.

In their review, **Anthony C. Hackney and Ayoub Saedi** provide an overview of contemporary literature that addresses how the ‘physical stress’ of exercise impacts on aspects of the thyroid and anterior pituitary glands, with a focus on **thyroid hormones and prolactin**.

Bryan Holtzman and Kathryn E. Ackerman describe the physiology of the **female hypothalamus-pituitary-gonadal (HPG) axis** in women’s sport, discuss the implications of the HPG axis in differential injury risk in sexes, pharmacologic manipulation of the menstrual cycle, and causes and effects of HPG axis dysfunction. The effects of physical activity on the **male HPG axis** hormones are discussed by **Paolo Sgrò**, who reviews the different effects of acute and chronic exercise along with the possible mechanisms involved in hormonal changes and the consequences of such modifications on sexual and spermatogenetic functions.

Paolo Moghetti and colleagues revise the metabolic effect of regular physical activity providing a detailed overview on the recommendations for aerobic and resistance exercise in type 2 diabetes. The authors focus on the adverse effect of sedentary behavior on metabolic aspects and mortality and describe the benefits of breaks in sedentary time in diabetic and nondiabetic subjects. The latest American Diabetes Association guidelines on lifestyle management are reported.

Marco Minetto and collaborators examine the **responses of skeletal muscles and tendons to exercise** and their possible implications for the development of positive and negative effects associated with acute and chronic exercise such as muscle function changes, muscle soreness, and muscle and tendon hypertrophy. The authors emphasize that the understanding of these effects is essential to guide clinical recommendations for exercise prescription in healthy and pathological subjects.

The **second section** of ‘Sports Endocrinology’ is dedicated to the use of performance-enhancing endocrine drugs in competitive and recreational sports activities.

In the world of competition and sports, **androgen abuse** is the most potent and prevalent form of doping detected. **Thiago Gagliano-Jucá and Shehzad Basaria** extensively revise the effectiveness of androgens in increasing muscle mass, muscle strength, and athletic performance, along with the numerous adverse effects associated with such abuse.

Alan D. Rogol and colleagues review the current state and future directions of GH testing. The

authors use rhGH and analytes of the GH/IGF-1 system as examples related to doping for sports performance, review the legitimate use of banned pharmaceutical agents when medically necessary (therapeutic use exemption), and the concept of ‘personalized’ medicine with the use of the athlete’s biological passport.

Wolfgang Jelkmann focuses on discoveries regarding doping with recombinant human erythropoietin (rhEpo) and other erythropoiesis-stimulating agents (ESAs), reported since 2017. Detection methods, which have undergone improvements in the last years, are described. The mini-review is completed by a paragraph on the WADA’s biological passport in the first 10 years after its implementation.

Apart from hormone abuse to purportedly increase physical performance, in the last decade, there has been a remarkable rise in the popularity of herbal and botanical supplements, because of increased mindfulness toward health and wellbeing. **Ina Garthe** evaluates whether the increased consumption of supplements *per se* leads to increased use of high-risk supplements in athletic populations and whether more precautions need to be taken to reduce the risk of inadvertent doping in the future.

Mario Thevis and colleagues present new pharmacological interventions that possess the potential to enhance mitochondrial biogenesis or muscle size and function, and that represent important aspects for sports drug testing programs. New drug candidates are described, doping control test methods are reviewed, and current and future testing strategies for low and higher molecular mass drugs are presented in the light of newly available analytical approaches and biological matrices.

The ‘Steroidal Module of the Athlete Biological Passport’ is the topic developed by **Federico Ponzetto and colleagues**. The authors describe the concept of an Athlete Biological Passport (ABP) and review the research work on the steroidal module carried out since the introduction of the ABP, with a particular emphasis on the discussion of confounding factors altering urinary steroid profiles, as well as newly discovered promising biomarkers.

In the third section of this compendium, a focus on physical activity in particular conditions is presented.

A specific mini-review is dedicated to the endocrine and metabolic repercussions of Relative energy deficiency in sport (RED-S). **Lauren M. McCall and Kathryn E. Ackerman** discuss how low energy availability (EA) is detrimental to performance and long-term health both in male and female athletes.

A complete overview of exercise-associated **disorders of sodium and potassium balance**, as well as other electrolyte disorders, is provided by **Tamara Hew-Butler and colleagues**. The authors emphasize the growing incidence of dysnatremia in sport and point out that exercise-associated electrolyte disorders are uncommon, generally resulting from improper hydration advice, improper training advice, profuse gastrointestinal losses, malnutrition, or supplement abuse.

The last, but not least, topic of this section is sarcopenia, that is, the combination of low muscle mass and poor muscle function in the elderly. **Alexis McKee and John E. Morley** describe the pathogenesis of this condition, which is multifactorial and includes both endocrine and non-endocrine factors. Understanding the molecular biology of the muscle along with the endocrine causes of sarcopenia has led, in part, to our current treatment of sarcopenia.

I am proud to present this issue of the series *Current Opinion in Endocrine and Metabolic Research* entitled ‘Sports

Endocrinology’: it represents a state-of-the-art overview of the complex interplay between physical activity and training on the endocrine function and of the use and abuse of performance-enhancing endocrine drugs in competitive and recreational sports activities, highlighting its negative consequences for long-term health.

The contributors to this compendium are well-known experts in the fields of sports medicine and endocrinology, endocrine physiology, pharmacology, and doping detection. I am profoundly grateful to all of them, who have made this issue what it is.

I would also like to acknowledge the Editorial Manager, Stacy King, whose expertise and constant support was indispensable.

Conflict of interest statement

Nothing declared.