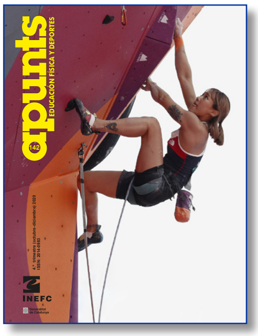
apunts
EDUCACIÓN FÍSICA Y DEPORTES
ISSUE 142

Published 01 October 2020
https://doi.org/10.5672/apunts.2014-0983.es.(2020/4).142.09



OPEN ACCESS

The potential influence of Cortisol and Testosterone on psychobiological aspects in Paralympic athletes

João Paulo-Pereira-Rosa[1,2*], Andressa Silva [1,2], Dayane Ferreira-Rodrigues[1,2], Eduardo Stieler[1] & Marco Tulio-de-Mello[1,2]

[1] Departamento de Esportes, Escola de Educação Física, Fisioterapia e Terapia Ocupacional, Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil.
[2] Academia Paralímpica Brasileira, Comitê Paralímpico Brasileiro, Brasília/ DF, Brazil.

Cite this article:
Paulo-Pereira-Rosa, J., Silva, A., Ferreira-Rodrigues, D., Stieler, E., & Tulio-de-Mello, M. (2020). The potential influence of Cortisol and Testosterone on psychobiological aspects in Paralympic athletesa. *Apunts. Educación Física y Deportes*, *142*, 76-79. https://doi.org/10.5672/apunts.2014-0983.es.(2020/4).142.09

Editor:
© Generalitat de Catalunya
Departament de la Presidència
Institut Nacional d'Educació
Física de Catalunya (INEFC)

ISSN: 2014-0983

***Corresponding author:**
João Paulo-Pereira-Rosa
jpseipai@hotmail.com

Section:
Scientific Notes

Original language:
English

Received:
15 November 2019

Accepted:
19 March 2020

Published:
1 October 2020

Cover:
New Olimpic Sports for Tokyo 2020. Climbing. Photo: Climbing. Asian Games 2018. Women's combined final. Competes Kim Ja-in from South Korea. Climbing leader. JSC Sport Climbing. Palembang, Indonesia. REUTERS / Edgar Su.

Abstract

Paralympic sport is based on performance and requires the planning of physical, technical and psychological training. Factors such as structure, duration and intensity of specific training and disability type might influence hormone levels of blood-free testosterone and cortisol. Few studies have examined the psychobiological aspects in elite athletes with disabilities and their associations with hormonal status. Although there are similarities between the training of elite athletes with and without disabilities, there are certain important variations that take the relationship between hormones and behaviour in Paralympic athletes into account. This article will provide information expanding the level of analysis of close and reciprocal variables involved in the influence of the endocrine system in the psychobiological domains of Paralympic athletes.

Keywords: Para-athletics, Hormones, Sports for Persons with Disabilities.

Introduction

Athletes reach their full physical, technical and psychological potential during routine and systematic training. The interface between psychological and biological factors and their impact on sports performance is an essential factor in preparing an elite athlete.

More specifically in Paralympic athletes, these factors are associated with understanding the nature and extent of the athlete's disability in order to make possible adaptations to the training program (Vanlandewijck, 2006). The Paralympic movement offers a range of sports opportunities for people with disabilities, considering neuroanatomical differences according to the types of functional diversity present in different athletes, such as impaired muscle power or passive range of movement, limb deficiency, short stature, visual and/or intellectual impairments (IPC, 2015).

Despite the growth of the Paralympic movement in recent years, research has focused primarily on the preparation of elite athletes and their peak athletic performance. One emerging area of research includes the interactions between biomarkers and behavioural factors.

This question can generate new knowledge regarding the use of this information in training. In this scientific note, perspectives will be presented to encourage researchers to further our understanding of the interaction between behavioural and physiological factors in the Paralympic athlete.

1.*Factors influencing sports performance in Paralympic athletes*

Paralympic athletes depend on factors such as the equipment used (prosthetic devices, wheelchair, etc.) and the interface between the athlete and their gear (Vanlandewijck et al., 1999). Additionally, the athlete's biological and psychological state and the modality (Paralympic categories and functional classifications) are also essential in improving sports performance.

Usually, the interaction between biological and psychological factors influences any improvement in sports performance. The study of biological factors seeks to understand the morpho-functional characteristics (physiological functionality, metabolic and/or neuromuscular) resulting from impairment (acquired or congenital) which directly influence the athlete's motor behaviour (Vanlandewijck, 2006).

One example is the condition of autonomic dysreflexia associated with spinal cord injury (SCI), characterized by an exacerbated response of the sympathetic system and a lack of control over the parasympathetic system (Krassioukov, 2009). As a rule, autonomic dysreflexia occurs when a spinal cord injury occurs above the thoracic vertebrae T5-T6 (Krassioukov, 2009) and it can be induced by stimuli such as bladder distention or the application of tight leg straps (such as in rugby wheelchair athletes and wheelchair distance racing).

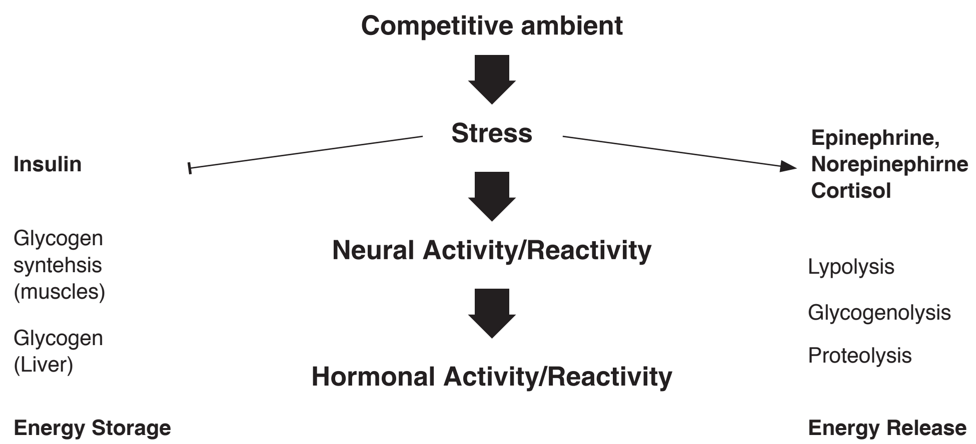
Regarding psychological factors, disabled persons with acquired disabilities tend to develop sports expectations with a stronger connotation of overcoming their impediment compared to their peers with congenital disabilities (Samulski et al., 2011). Indeed, knowledge of the psychological factors related to impairment offers a major contribution to the beginning and continuation of the sports training process.

The impacts caused by disability could lead these individuals to have higher levels of anxiety and insecurity in the face of certain situations, arising both from the conditions of daily life and the demands of the sport (Samulski et al., 2011). For this reason, an interdisciplinary intervention (coach and sports psychologist) may be positive for the development of the athlete's skills.(Riera et al., 2017).

2. *Interaction between the cortisol and testosterone biomarkers and psychobiological aspects*

The human body is dynamic, and the biological system is influenced by environmental factors that inhibit or stimulate hormone production and release (figure 1).

Figure 1
Interaction between the cortisol and testosterone biomarkers and psychobiological aspects.



Certain metabolic and hormonal changes have been described in persons with congenital or acquired disability. For example, in SCI conditions, plasma noradrenaline and adrenaline levels may be increased during autonomic dysreflexia episodes (Leman et al., 2000). Other important hormones may be changed in disabled people.

Cortisol (CORT) is an essential primary human glucocorticoid hormone in the regulation of glucose and is produced due to stress, depending on the circumstances and on the psychological status of the individual. The activation of the hypothalamic pituitary adrenal (HPA) axis, with the release of CORT, reflects the affective component of the individual's experience (Frankenhaeuser, 1991).

From the endocrine standpoint, in competitive situations (sporting events) the stress response is triggered before the start of the competitive activity. This sharp increase performs a particular function in preparing for competitive adjustment (Kivlighan et al., 2005). However, research into the link between the concentrations of CORT and psychobiological aspects in athletes with disabilities is lacking.

In addition to CORT, another potent steroid hormone with psychobiological effects is testosterone (TEST). The motivation of competition can be related to the impact of endogenous TEST in the central nervous system, and some studies show different levels of TEST in winners and losers during and after competition (Fry et al., 2011) and in athletes competing at home compared to those competing away (Carré, 2009).

3. *Resting hormonal changes in people with disabilities*

Some studies have suggested a high prevalence of TEST deficiency in men with acute SCI (less than four months since injury) (Schopp et al., 2006). Low TEST rates have been reported in men with chronic SCI when compared to age-matched non-disabled men (Bauman et al., 2014).

In a general context, 80% of people with SCI are male, justifying the higher output of scientific research focusing on the demands of this biological sex (NSCIA, 2016). However, there are few studies investigating the effects and consequences of SCI in hormone levels in women. A study conducted by Dirlikov et al. (2019) presents thyroid function and testosterone levels in women with SCI. The results showed that low total TEST was associated with depressive symptomology after accounting for time since injury. The same study highlights the need for further research in order to elucidate the concerns of women after SCI.

A combination of comorbidities, medication, and obesity could be partly accounted for by the decline in serum TEST, amplifying the age-related changes in the secretion of this hormone (Bauman et al., 2014) or associated to the stress and comorbid trauma associated with SCI (Schopp et al., 2006).

Visual impairment also changes hormonal status, because ocular light exposure is a powerful environmental circadian synchronizer. The studies conducted by Bodenheimer, et al. (1973) reported some abnormalities in TEST and CORT production in a majority of blind men.

Changes in TEST and CORT hormone levels can modulate psychobiological responses. Low levels of TEST are associated with lack of energy, lack of motivation and reduced libido (Kelleher et al., 2004). Besides hormonal changes in resting conditions, exercise may influence catecholamine concentration and the secretion of blood-free hormones in individuals with disability (Rosety-Rodriguez et al., 2014).

4. *Exercise responses in cortisol and testosterone levels in disabled athletes*

In elite sport, there are certain similarities between the training of elite athletes with and without disabilities. It has been documented that hormonal changes (mainly TEST and CORT) during a challenge in non-disabled athletes could interact with their personality traits to improve their competitive performance (Parmigiani et al., 2009). However, there are significant differences that should be considered in the hormonal patterns of Paralympic athletes.

Catecholamine release is affected in people in whom the high-cervical and thoracic nerves are disabled (C1- T1) due to the suppression of neural pathways for sympathetic pathways and adrenal gland dysfunction (Leicht et al., 2013). Thus, some evidence of a hormonal variation altered by hormonal axis function which directly influences hormone concentration during and after physical exercise has been observed.

Conclusion and Outlook

Fluctuations in behavioural factors during the competitive season are likely to occur due to training, performance and expected results. The use of questionnaires is practical, and large amounts of information can be collected at a relatively low cost. However, the information provided by surveys might not suffice to understand some forms of variables - i.e. changes of emotions, behaviour, feelings, etc.

Monitoring hormonal status (TEST/CORT) might allow psychologists, sports scientists and sports coaches to gain more extensive and more precise knowledge of the psychobiological responses of athletes with disabilities and to understand behaviour regulation better. For example, these biomarkers could guide both training (affective responses) and motivational strategies (coping). However, certain limitations inherent to Paralympic sport (diversity and heterogeneity of the athletes with regard to disabilities and functional classifications), biological sex and specific physiological characteristics resulting from impairment (acquired or congenital) must be considered in order to achieve a better understanding of this link between these biomarkers in psychobiological variables.

Some studies have investigated the use of the TEST/CORT ratio, utilizing plasma or serum levels, to monitor athletic performance. The use of saliva as a collection tool is reported to be advantageous as it is safe and non-invasive and has a close correlation with serum levels (Papacosta & Nassis, 2011)

In other words, the practical implications of monitoring TEST and CORT might allow a multi-parameter evaluation (psychological and biological) of variables that determine the athlete's performance during the training or competition period. Thus, we hope to stimulate a discussion that could lead to a greater understanding of the different aspects involved in behaviour and the influence of hormones (TEST/CORT) in the physical and psychological domains of Paralympic athletes.

Acknowledgements

The authors express their gratitude to the Universidade Federal de Minas Gerais (UFMG), Centro de Estudos em Psicobiologia e Exercício (CEPE), the Comitê Paralímpico Brasileiro (CPB), the Academia Paralímpica Brasileira (APB), Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES, Fundação de Amparo à Pesquisa do Estado de Minas Gerais - FAPEMIG and the Conselho Nacional de Desenvolvimento Científico e Tecnológico-CNPq.

References

Bauman, W. A., Fountaine, M. F., & Spungen, A. M. (2014). Age-related prevalence of low testosterone in men with spinal cord injury. *Journal of Spinal Cord Medicine, 37*, 32–39.

Bodenheimer, S., Winter, J. S. D., & Faiman, C. (1973). Diurnal rhythms of serum gonadotropins, testosterone, estradiol and cortisol in blind men. *Journal of Clinical Endocrinology & Metabolism, 37*, 472-475.

Carré, J. M. (2009). No place like home: testosterone responses to victory depend on game location. *American Journal of Human Biology, 21*(3), 392-394.

Dirlikov, B., Lavoie, S., & Shem, K. (2019). Correlation between thyroid function, testosterone levels, and depressive symptoms in females with spinal cord injury. *Spinal Cord Series and Cases, 5*(1), 1-7.

Frankenhaeuser, M. (1991). The psychophysiology of workload, stress, and health: comparison between sexes. *Annals of Behavioral Medicine, 13*, 197-204.

Fry, A. C., Schilling, B. K., Fleck, S. J., & Kraemer, W. J. (2011). Relationships between competitive wrestling success and neuroendocrine responses. *Journal of Strength & Conditioning Research, 25*(1), 40-45.

IPC, I. P. C.-. (2015). Explanatory guide to Paralympic classification. *What is classification*.

Kelleher, S., Conway, A. J., & Handelsman, D. J. (2004). Blood testosterone threshold for androgen deficiency symptoms. *Journal of Clinical Endocrinology & Metabolism, 89*(8), 3813-3817.

Kivlighan, K. T., Granger, D. A., & Booth, A. (2005). Gender differences in testosterone and cortisol response to competition. *Psychoneuroendocrinology, 30*(1), 58-71.

Krassioukov, A. (2009). Autonomic function following cervical spinal cord injury. *Respir Physiol Neurobiol, 169*(2), 157-164.

Leicht, C. A., Goosey-Tolfrey, V. L., & Bishop, N. C. (2013). Spinal cord injury: Known and possible influences on the immune response to exercise. *Exercise immunology review, 19*, 144-163.

Leman, S., Bernet, F., & Sequeira, H. (2000). Autonomic dysreflexia increases plasma adrenaline level in the chronic spinal cord-injured rat. *Neuroscience letters, 286*(3), 159-162.

NSCIA, N. S. C. I. S. C.-. (2016). Facts and Figures at a Glance. *Birmingham, AL: University of Alabama at Birmingham*, 1-2.

Papacosta, E., & Nassis, G. P. (2011). Saliva as a tool for monitoring steroid, peptide and immune markers in sport and exercise science. *J. Sci. Med. Sport, 14*(5), 424-434.

Parmigiani, S., Dadomo, H., Bartolomucci, A., Brain, P.F., Carbucicchio, A., Costantino, C., Ferrari, P.F., Palanza, P. and Volpi, R. (2009). Personality traits and endocrine response as possible asymmetry factors of agonistic outcome in karate athletes. *Aggressive Behavior, 35*(4), 324-333.

Riera, J., Caracuel, J. C., Palmi, J., & Daza, G. (2017). Psychology and Sport: The athlete's self-skills. *Apunts. Educación Física y Deportes, 1*(127), 82-93. https://doi.org/10.5672/apunts.2014-0983.es.(2017/1).127.09

Rosety-Rodriguez, M., Rosety, I., Fornieles, G., Rosety, J. M., Elosegui, S., Rosety, M. R., & Ordoñez, F. J. (2014). A short-term arm-crank exercise program improved testosterone deficiency in adults with chronic spinal cord injury. *International Brazilian journal of urology, 40*(3), 367-372.

Samulski, D. M., Noce, F., & Costa, V. T. (2011). Mental preparation. In Y. Vanlandewijck, & W. Thompson (Eds.), *Handbook of Sports Medicine and Science - The Paralympic Athlete* (pp. 198-213): Wiley-Blackwell.

Schopp, L. H., Clark, M., Mazurek, M. O., Hagglund, K. J., Acuff, M. E., Sherman, A. K., & Childers, M. K. (2006). Testosterone levels among men with spinal cord injury admitted to inpatient rehabilitation. *American journal of physical medicine and rehabilitation, 85*(6), 678-684.

Vanlandewijck, Y. (2006). Sport science in the Paralympic movement. *Journal of rehabilitation research and development, 43*(7), XVII - XXIV (Guest Editorial).

Vanlandewijck, Y., Theisen, D. M., & Daly, D. J. (1999). Field test evaluation of aerobic, anaerobic and wheelchair basketball skills performances. *International Journal of Sports Medicine, 20*(8), 548-554.

Conflict of Interests: No conflict of interest was reported by the authors.