The impact of physical effort on cortisol level: a review of the latest report

Natalia Grzebisz
Faculty of Physical Education, Academy of Physical Education, Katowice, Poland
E-mail address: n.grzebisz@gmail.com

ABSTRACT

The results of the current study demonstrate that exercise interferes with the hormonal balance system. The size and direction of these changes depend on the volume and intensity of a physical effort. Biochemical monitoring can support the process of training and gathered data can assist in countering the effects of overtraining. The article presents the latest reports on the character of the changes in cortisol influenced by various types of physical effort, the impact of the training units, time of their execution and the influence of the supply of carbohydrates on the level of this hormone in the body. This work also presents the advantages of saliva analysis, as a reliable material to measure the level of cortisol in athletes.

Keywords: effort; cortisol; saliva; overtraining; biochemical markers

1. INTRODUCTION

The body strives to maintain the stability of the internal environment. It is called the homeostasis. It will be maintained if appropriate receptors that detect deviations from normal values work well. Incentives stimulating homeostatic systems can be derived from the nervous or hormonal systems. The activation level depends on the type of exercise, age, environmental conditions (e.g., temperature), gender, nutrition or a genetic profile. A different hormonal response to the effort has been noticed due to its length, intensity and character. Homeostasis disorders are also influenced variously in different types of physical exercise:
weight, endurance or high-speed efforts [1]. As far as endurance trainings are concerned, we can distinguish efforts of low intensity (60-80% of HR max) and high intensity ones (85-90% HR max) [2]. High intensity trainings (LHD- long, high distance) are performed at a speed close to that of the competition. Prolonged continuous effort forces all reserves of the body to be activated simultaneously and increases the efficiency of thermoregulation. Thanks to it, an athlete can improve the economics of muscle work and harmonize the motor system. During such efforts there is also a response from the endocrine system. It includes changes in the level of stress hormones: growth hormone, cortisol and testosterone. All of them have a significant impact on the size of homeostasis disorders, the effects of trainings and regeneration [3].

The results of the current study clearly demonstrate that exercise interferes with the hormonal balance system. The size and direction of these changes depends on the secretion of hormones and the character of the effort. For biochemical measurements, saliva came into use as an alternative to serum. It has been observed to show a more accurate measurement compared to serum. The work concerns the review of the latest reports on the changes in cortisol levels in response to exercise.

2. THE IMPACT OF PHYSICAL EFFORT ON CORTISOL LEVEL

Strenuous resistance effort generates large amounts of lactate. It also significantly increases the release of cortisol [4]. The volume of effort is also important in hormonal response, particularly during short intervals. This is confirmed in tests on a group of basketball and tennis players [5,6]. A high concentration of this hormone in the blood correlates with the high maintenance of the activity of CK (creatine kinase), up to 24 hours after the end of the effort. This may be the trigging factor causing immune depression [5]. Moreover, it is time that has a direct impact on the level of cortisol. The largest amount of cortisol is released with a two-hour delay. The values measured after hours of rest are significantly higher than in-workout parameters.

The concentration of cortisol in the blood starts to increase during exercise with an intensity of 50-60% of VO2max. Then, it is observed to gradually increase with the load. It is parallel with the increase in the concentration of adrenocorticotropic hormone (ACTH). During the supramaximal effort, the concentration of the hormone changes only after a few minutes after the end of the exercise. This is connected with the speed of ACTH response. It is clear that endurance training reduces the increase in secretion of cortisol during the exercise. After a few weeks of the output level, the quality of responses is less invasive. It is therefore seen as a positive adaptation to the effort [3]. It also causes an increase in the concentration of free fatty acids and their more efficient use.

Some studies have evidenced adaptive changes in stress tolerance, cortisol concentration and testosterone to cortisol ratio, which may have mediated the post-training improvement in physical performance. The results confirm the effectiveness of a simple periodised training plan (initial overloading and then tapering with a step-wise format) for improving the performance capacity of a sportsman. Hormonal profile could also provide a useful measure of training responses [4].

Yet, the role of cortisol to stimulate proteolysis and gluconeogenesis is still questioned. This may contribute to the use of glucose during exercise. Some reports provide evidence that
the disorder of secretion of cortisol can cause abdominal obesity and insulin resistance [7]. However, it has also been observed that the increase of carbohydrates intake has not lowered the level of stress hormones after the physical effort.

Johnston at all compared the neuromuscular, biochemical, and endocrine responses of a training day consisting of a speed session with an added weight training session on the same day. The study indicated that the addition of a weight training session two hour post a speed session, while increasing the perception of fatigue the following day, does not result in a difference in endocrine response (cortisol levels) or in neuromuscular capability. Likewise creatine kinase, testosterone were unaffected by the addition of a weight training session [9]. This is important information for athletes and their training plan. An additional unit of force after an intense workout will not cause excessive damage to the body.

Some research has also been conducted on the influence of diurnal hormone secretion on physical exertion. It has been proved that intense exercise induces a similar increase in serum-cortisone and corticosterone in the morning and past morning periods. It does not matter whether the cortisol concentration training unit will be carried out in the morning or afternoon. Vigorous exercise increases saliva-cortisone. Saliva-cortisone and cortisol are equally strongly correlated to plasma-cortisol, suggesting a significant role for saliva-cortisone as a novel marker of free cortisol during exercise [10].

The use of saliva as a real alternative to serum in measuring stress hormones could be a future perspective. In the present study, despite high correlation and agreement between cortisol serum and saliva cortisol levels, peak serum levels were attained at 15 min of recovery, whereas peak saliva levels were attained immediately upon exercise cessation in both a maximal treadmill exercise to exhaustion and a 90 min cycle exercise at 55-60% VO2max in the heat (ambient temperature 45 °C, relative humidity 20%) conditions. Furthermore, clearance of serum and saliva cortisol was slower following a maximal treadmill exercise to exhaustion and a 90 min cycle exercise while saliva were still below the peak, end-exercise levels at the end of 60 min recovery. Saliva is a sensitive, reliable method to determine cortisol responses following exercise in addition to its non-invasive, easy-sampling advantages [11,12]. The results in Thomasson study suggest that, even under prolonged exercise conditions, non-invasive saliva samples may offer a practical approach to assessing pituitary–adrenal function, especially when compared with individual basal values [13,14].

3. CONCLUSIONS

The latest reports on changes of cortisol in response to physical effort relate to many issues. They are: the response in a specific sport (such as tennis, basketball), methods for the determinations of this hormone (mainly the analysis of saliva) and the impact of nutrition on the level of this marker (supply of carbohydrates). There were analyzes of the impact of the daily amount of training on the concentration of the stress hormone in the next day. Differences in the post-exercise cortisol performed on fasting and after a meal have also been dealt with (lower concentration of cortisol after a carbohydrate supply). Yet, by increasing the supply of carbohydrates highly above the demand does not decrease the expression of cortisol. Moreover, the time of day has no effect on the level of cortisol. Both the effort in the morning and in the afternoon influence the body at a comparable level. All in all, changes in
cortisol due to physical exertion still leave many unknowns. An example would be its role in stimulating proteolysis and gluconeogenesis or affecting the body's immune response.

References


(Received 06 May 2016; accepted 26 May 2016)