

Psycho-physiological symptoms of stress and fatigue in elite male fencers during one-day tournament. A pilot study

Zbigniew Obmiński¹, Helena Mroczkowska², Ryszard Zdanowicz³, Irena Kownacka², Wiesław Błach⁴

¹ Department of Endocrinology, Institute of Sport, Warsaw, Poland

² Department of Psychology, Institute of Sport, Warsaw, Poland

³ Department of Physiology, Institute of Sport, Warsaw, Poland

⁴ Department of Sport Didactics, Academy of Physical Education, Wrocław, Poland

Key words; males, fencing, tournament, hormones, anxiety, fatigue

Summary

Introduction. This study was undertaken in order to revealed the hormonal, metabolic and perceived fatigue among male fencers taking part in a one-day fencing tournament.

Material and methods. Five elite Polish fencers of an international skill level took part in European Fencing Championships. The competition started in the forenoon (10:00 am, eliminatory hits) and ended in the evening (c.a.18:00 pm, final fights) and these two rounds were separated by 2-hour intermission. During the entire tournament each contestants played 7-9 fights and majority of them were won. In capillary blood samples taken four times during the event, pre/post the eliminations and finals, serum cortisol (C) and testosterone (T) and lactate levels were determined. Directly after each sampling state anxiety (SA), mood state (MS) and physical well-being (PW-B).

Results. Based on the final outcome each examined subject was successful. During the whole competition SA and MS scores were unchanged and indicated on a positive psychological status. After the last fight PW-B was markedly decreased, the level of C was the highest, of T and T:C ratio were the lowest, and PW-B showed physical fatigue. CK was significantly elevated next day.

Conclusions. Fencing competition elicited disadvantage shift in the hormonal status indicating high rate of catabolism and induces increased perceived physical fatigue in elite male contestants. Mood state and anxiety state are unchanged over the event, likely due to the successes achieved in the subsequent fights.

Introduction

Each athletic competition consisting of several, repeated bouts performed over one day is severe psycho-physical challenge for an athlete's mind and body. During a competition, especially in the afternoon/evening hours physical and mental abilities decrease due to general fatigue development elicited by prolonged stress. There are several biomedical indices for rating of the whole biological cost of a competition. A part of them are based on determination acute and temporary changes in blood chemistry, especially those indices, which are sensitive to physical exercise and strong emotion. The other one utilize self-reported psycho-emotional state. The most frequently blood indices used for detection biological responses to an athletic competition or the other psycho-physical stimuli are blood levels of steroidal hormones cortisol (C), testosterone (T) and so-called anabolic-catabolic in-

dex C/T ratio which is considered as a marker of equilibrium between the rate of anabolism and catabolism its ratio. The earlier examinations of exercising male wrestles and weightlifters showed that during series of repeated short-lasting maximal efforts their blood T tended to decrease and blood cortisol increased, hence T/C ratio also decreased, although first single efforts caused rise of T [1,2]. That indicated the effect of fatigue accumulation upon suppression of pituitary-gonadal axis. The later studies confirmed, that after few exhaustive competitive bouts T/C indexes were shifted toward lower values as compared to those recorded ones prior to the efforts, and that state may be maintained throughout several hours of the recovery [3-5]. These changes occurred due to very intensive, anaerobic efforts like as wrestling matches, when blood lactate level may reach up to 20 mmol/L, or after less intensive intermitted efforts of mixed, aerobic-anaerobic metabolism like rugby and soccer matches.

Fencing belongs to that sport family, which required from a contestant mostly good special orientation, time response, visual search ability, movement accuracy and explosive strength of lower limbs. Indeed, these fencers' attributes have been examined extensively [6-13], while biological cost of a fencing tournament, which usually lasts the whole day is poorly explored. This study was aimed to explore biological cost of participation in a one-day fencing tournament based on study of the behaviors of blood cortisol, testosterone, lactate (LA) creatine kinase (CK), and state anxiety, mood state and physical well-being throughout the entire competition.

Material and methods

The study involved hormonal and psychological observation among five elite (international level) male senior fencers (3 foil, 2 sabre) taking part in an one-day European Fencing Championships. The competition consisted of the eliminatory fights (n=5-6) played from 10:00 am to 12:00-12:30 pm, and afternoon/evening (15:00-17:00) quarter-, semi- and/or Cup fights (n=3-4). 2h intermission separated the morning and evening events. Capillary blood was drawn from earlobe for determination blood lactate (Dr Lange kit, Germany) and serum cortisol (C) and testosterone (T) levels (ELISA kits, DRG-Germany). Directly after the sampling some psychological indices: anxiety state (AS by Spielberger CD: State-Trait Anxiety Inventory), while mood state (MS) and physical well-being (PW-B) were determined with the use of experimental scales. MS scale of scores ranges from 10points (the worst score) to 70 points (the best one) and it is determined using appropriate items for quantitative assessment of intensity of such dichotomous pairs of the feelings as: joy-sadness, calm-jittery, satisfaction-frustration. PW-B score also ranges from 10 to 70 points. This self-reported state shows athlete's readi-

ness to the execution of a physical action of highest energy expenditure, hence, the higher the PW-B score, the lower the state of fatigue. These measurements of the hormones were carried out on four time points: I – 15 minute prior to the first eliminatory fight (forenoon) II – within 3rd minutes after last fight ending elimination, III-prior to the first quarter-final fight (14:30-15:00), IV-after the last fight ending the entire competition (17:00-18:00 pm). Creatine kinase activity (CK) were detected prior to the first eliminatory fight (I time point) and after overnight recovery i.e. next day in the morning. Differences of mean indices recorded on the four time points were compared using one-way analysis of variance with repeated measures (ANOVA) followed by post-hoc Tuckey test, while differences between pre- and post tournament CK activities using Wilcoxon test. The whole experiments was approved by the local Ethical Commission at Institute of Sport.

Results

Time course of blood indices and observed during the competition is given in Table 1.

Mean CK activity increased significantly ($p=0.024$) from 225 ± 92 U/L prior to the event, to 476 ± 159 U/L next morning.

Some of the variables recorded over the entire tournament were correlated each other as is displayed in Table 2.

Considering JFCh as a very high rang competition, each of the examined contestant rated his outcome as a success (three medals, two fourth places). Accumulation of competitive stress derived from subsequent fights which induced progressive rise of C levels and increased of physical fatigue. These changes accompanied with decrease of T/C ratio indicated on a high biological cost of one-day fencing tournament despite the intensity of a single fight was not high as it show relatively low LA levels.

Table 1. Changes in the physiological and psychological variables over the competition

Variable	I	II	III	IV	F (3, 16)	p value
C (nmol/L)	489 ^{IV} ±119	583 ^{IV} ±86	748 ±131	852 ±211	6.22	0.005
T (nmol/L)	12.7 ±4.1	15.5 ±6.0	13.6 ±5.7	10.7 ±3.1	0.80	0.512
T/C*100	2.8 ^{IV} ±1.1	2.6 ±1.0	1.8 ±0.5	1.3 ±0.3	3.73	0.033
LA (mmol/L)	2.1 ±0.7	3.7 ±1.0	3.8 ^I ±0.9	4.0 ^I ±1.1	4.66	0.022
AS	34.0 ±7.2	34.3 ±9.1	34.9 ±6.6	34.4 ±8.4	0.03	0.99
MS	59.6 ±5.1	59.6 ±7.3	58.8 ±6.5	60.2 ±7.6	0.04	0.99
PW-B	63.2 ^{IV} ±5.7	61.4 ^{IV} ±4.2	60.6 ^{IV} ±6.3	45.8 ±8.4	8.03	0.002

Table 2. Significant coefficients of Spearman correlation between the variables (5subjects x 4 time points = 20 cases)

C/LA	T/SA	T/PW-B	T/C*100/ PW-B	LA/ PW-B	SA/ PW-B
0.492	-0.528	0.572	0.666	-0.485	-0.599

Discussion

Mean C level increased significantly during competition reaching the highest value after the last fight. The direction of this change is inversed when comparing to the normal diurnal rhythm occurring at neutral condition. This rhythm is usually expressed as markedly lower C level in the afternoon as compared to the morning value, but this phenomenon may be abolished by competitive stress as was shown among gymnastics [14]. What's more, in our study C levels were rising over the time, that indicated not only increasing physical fatigue and higher demands for energy sources, but also higher psychogenic excitation resulting in the opponents of higher skills at the end of the tournament. Interestingly, the similar progressive increments of C and CK, but decrements of T, and negative correlation between T and state anxiety and physical well-being were observed among elite male players in the morning during five-day international volleyball tournament [15]. The similar pattern of the changes i.e. progressive increase of C and CK decrease of T/C ratio occurred after each of the four volleyball sets [16]. Intensity of a single fencing fight was rather low, because mean end-effort blood LA did not exceed 4.0 mmol/L. Higher mean LA (6.9 mmol) was found following simulated fencing match 3 rounds x 3 minutes with 1-minute intermissions between them [17]. Mean time-duration of the fights in our study was shorted, despite this, after the last fight all the contestants felt physical fatigue (lowered PW-B scores). We suspect, that increased psycho-physical activity over the whole day contributed to that state, but the one environmental factor may have played also the role. Fencing protective uniform inhibits body heat dispersion and the thermoregulation by sweat evaporation. Moreover, it has thermo-insulating properties, that leads to body overheating, that simply enhanced susceptibility to fatigue. That issue exists also in the other sports like ice hockey, kendo, football.

Thus, prolonged psychical tension and successive fencing bouts against more and more stronger opponents resulted in development of physical and mental fatigue that indicate significantly lowered PW-B score after the last fights, while mood and anxiety states (MS, AS) did not change despite development of physical fatigue. It seems, that those well psycho-mental features were maintained likely due to winning of subsequent fights. Although mean AS scores were almost the same at four time points, individual values slightly fluctuated (on average by 10%). Unfortunately, basal AS scores and the resting hormonal status are lacking in our study, therefore, it is hard to evaluate, whether mean AS scores recorded during competition was mild, high or low. Among male volleyball players mean morning, precompetitive AS scores ranged from 34.1 to 40.0 depending on the opponent skills [15], but among male rowers their pre and post rowing regatta AS were clear-

ly higher and unchanged, 41.9 and 41.8 respectively [18]. Because of small sample and small between-subject dispersion in outcomes of subsequent fights we omitted seeking of relationships between anxiety and final standing position. This issue was explored by Doron J [19]. He showed, that some psychological features fluctuated within a fencing match, and the only variables which facilitate successful actions and winnings were high perceived control and task-oriented coping but low negative affectivity.

Mean T level showed biphasic, U-converted shape of the curve, i.e. slightly rise followed by slightly fall. Somewhat of lower end-competition T as compared to the initial level (by 15.7%) together with elevated C value is responsible for significantly decreased anabolic-catabolic index (T:C ratio). The change of this variable showed general biological cost of the tournament, i.e. shift of proteins metabolism toward their catabolism (degradation). This change was paralleled to PW-B ($r=0.666$) and it confirms close association between the post-competition chemistry status in blood with self-reported physical fatigue revealed earlier also during volleyball tournament [15].

Study limitation

It is noted, that a more thorough analysis of the changes in the T should take into account the natural daily rhythm of T level, which is higher in the morning and lower in the evening. In sedentary man, at neutral non-stressful condition the forenoon T (10.00 am) was almost two-fold higher than that the evening (18:40 pm), but a competition may mask that physiological difference [20]. Another methodological shortcoming is lack of recorded basal state anxiety at neutral condition. It is well known that each competition strongly elevates psychological arousal among contestants. However, Sterkowicz and co-authors revealed ten various specific circumstances, which modulate intensity of psychological stress [21]. Taking all of them into account in our study, we may note, that only high rank of the competition (EFCh) was that situation which fostered to higher stress, while relatively lower number of spectators, so-called home advantage (EFCh was held in Warsaw) and comparable skill levels examined contestants and their opponents were rather favorable for psychical comfort.

Conclusions

1. One day fencing tournament reduces T/C index and suggests shift of proteins metabolism towards predominance of catabolism.
2. Successful fencers, who played their last final fights in the late afternoon showed unchanged, relative low state anxiety and high mood state, but felt physical fatigue.

References

1. Passelergue P, Robert J, Lac G. Salivary cortisol and testosterone variation during an official and simulated weight-lifting competition. *Int J Sports Med.* 1995; 16: 289-303.

2. Kraemer WJ, Fry AC, Rubin MR, et al. Physiological and performance responses to tournament wrestling. *Med Sci Sports Exerc.* 2001; 33(8): 1367-78.
3. Silva JR, Ascensão A, Marques F, Seabra A, Rebelo A, Magalhães J. Neuromuscular function, hormonal and redox status and muscle damage of professional soccer players after a high-level competitive match. *Eur J Appl Physiol.* 2013; 113(9): 2193-201.
4. Elloumi M, Maso F, Michaux O, Robert A, Lac G. Behavior of saliva cortisol [C], testosterone [T] and the T/C ratio during a rugby match and during the post-competition recovery days. *Eur J Appl Physiol.* 2003; 90(1-2): 23-8.
5. Passelergue P, Lac G. Saliva cortisol, testosterone and T/C ratio variations during a wrestling competition and during the post-competitive recovery period. *Int J Sports Med.* 1999; 20(2): 109-13.
6. Hagemann N, Schorer J, Cañal-Bruland R, Lotz S, Strauss B. Visual perception in fencing: do the eye movements of fencers represent their information pickup? *Atten Percept. Psychophys.* 2010; 72(8):2204-14.
7. Gutiérrez-Dávila M, Javier Rojas F, Antonio R, Navarro E. Effect of uncertainty on the reaction response in fencing. *Res Q Exerc Sport.* 2013; 84(1): 16-23.
8. Gutiérrez-Dávila M, Zingsem C, Gutiérrez-Cruz C, Giles FJ, Rojas FJ. Effect of uncertainty during the lunge in fencing. *J Sports Sci Med.* 2014; 13(1): 66-72.
9. Hijazi MM. Attention, Visual Perception and their Relationship to Sport Performance in Fencing. *J Hum Kinet.* 2013; 39: 195-201.
10. Gutiérrez-Dávila M, Rojas FJ, Caletti M, Antonio R, Navarro E. Effect of target change during the simple attack in fencing. *J Sports Sci.* 2013; 31(10): 1100-7.
11. Gutierrez-Davila M, Rojas FJ, Antonio R, Navarro E. Response timing in the lunge and target change in elite versus medium-level fencers. *Eur J Sport Sci.* 2013; 13(4): 364-71.
12. Mouelhi Guizani S, Bouzaouach I, Tenenbaum G, Ben Kheder A, Feki Y, Bouaziz M. Simple and choice reaction times under varying levels of physical load in high skilled fencers. *J Sports Med Phys Fitness* 2006; 46(2): 344-51.
13. Taddei F, Bultrini A, Spinelli D, Di Russo F. Neural correlates of attentional and executive processing in middle-age fencers. *Med Sci Sports Exerc.* 2012; 44(6): 1057-66.
14. Georgopoulos NA, Rottstein L, Tsekouras A, et al. Abolished circadian rhythm of salivary cortisol in elite artistic gymnasts. *Steroids.* 2011; 76(4): 353-7.
15. Obmiński Z, Lerczak K, Mroczkowska H, Witek K. Changes in psycho-physiological indices in male volleyball players during 5-day international tournament. *Medycyna Sportowa* 2012; 28: 67-73.
16. Obmiński Z, Lerczak K, Witek K, Borkowski L, Starczewska-Czapowska J. Study on blood chemistry changes induced by various exertions in male volleyball player who suffers from episodic muscle cramps. A case study. *Medycyna Sportowa* 2009; 25: 200-6.
17. Milia R, Roberto S, Pinna M, et al. Physiological responses and energy expenditure during competitive fencing. *Appl Physiol Nutr Metab.* 2014; 39(3): 324-8.
18. Obmiński Z, Mroczkowska H, Kownacka I. State anxiety and perception of fatigue following rowing regatta. *Medycyna Sportowa* 2010; 26: 260-6.
19. Doron J, Gaudreau P. A point-by-point analysis of performance in a fencing match: psychological processes associated with winning and losing streaks. *J Sport Exerc Psychol.* 2014; 36(1): 3-13.
20. Obmiński Z, Hübner-Woźniak E. The change of the anabolic-catabolic equilibrium following 3-round sparing contests in boxers. *Medycyna Sportowa* 2009; 25: 176-82.
21. Sterkowicz S, Blecharz J, Sterkowicz-Przybycień K. Stress and sport situations experienced by people who practice karate. *Archives of Budo* 2012; 8(2): 65-77.
22. Oliveira T, Gómez M, Sampaio JE. Effects of game location, period, and quality of opposition in elite handball performances. *Percept Mot Skills* 2012; 114(3): 783-94.
23. Prieto J, Gómez MÁ, Pollard R. Home advantage in men's and women's Spanish first and second division water polo leagues. *J Hum Kinet.* 2013; 37: 137-43.

Address for correspondence:

Zbigniew Obmiński

Zakład Endokrynologii, Instytut Sportu

ul. Trylogii 2/16, 01-982 Warszawa, Poland

tel. +48 (22) 834-08-12, cell. 508-545-831, e-mail: zbigniew.obminski@insp.waw.pl

Received: 11.07.2014

Accepted: 16.10.2014