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SELF-PERCEIVED FATIGUE AFTER MOTOR ABILITIES TESTING IN ADOLESCENT ELITE TENNIS PLAYERS

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Summary: The objective of the study was to determine self-perceived fatigue (S-PF) after motor abilities testing (MAT) in adolescent male and female elite tennis players. The research sample comprised of 17 male (mean age of 13.00 ± 1.54 years) and 20 female (mean age of 13.15 ± 1.42 years) adolescent elite tennis players who underwent testing of selected motor abilities in tennis. The level of fatigue in adolescent elite tennis players was measured with the Training Distress Scale (TDS). Both groups of elite tennis players declared the lowest, zero level of S-PF by TDS symptoms as inability to remember things and loose bowels or diarrhoea and significant S-PF during 48 hours after MAT was in both genders felt by lack of energy, feeling of heavy arms and legs, joint stiffness of soreness, and muscle soreness. Boys versus girls experienced significantly higher S-PF in the symptoms as difficulty falling asleep, being unusually tired during the day, joint stiffness of soreness, and ordinary tasks require extra effort. No significant differences were found in overall TDS between males and females adolescent elite tennis players.

Key words: elite tennis players, boys, girls, fatigue, Training Distress Scale, symptoms

Introduction

Several different definitions of fatigue exist, often dependent upon the experimental model employed and/or the conditions under which they occur. Fatigue is a complex and multifaceted phenomenon that has a variety of possible mechanisms (Halson 2014; Bendíková 2017). One of the most common definitions of fatigue was proposed by Edwards (1983) and states that fatigue is a "failure to maintain the required or expected force (or power output)." Fatigue can also be influenced by the type of stimulus (voluntary or electrical), type of

contraction (isometric, isotonic, and intermittent or continual), duration, frequency and intensity of exercise, and type of muscle (Sahlin 1992).

As athletes strive to improve their performance, modifications in training load are required, particularly increases in frequency, duration, and intensity. Training loads are adjusted at various times during the training cycle to either increase or decrease fatigue depending on the phase of training (i.e., baseline or competition phase). Ensuring that fatigue is titrated appropriately is important for both adaptations to training as well as for competition performance (Pyne & Martin 2011). Elite athletes believe mental fatigue negatively impacts sporting performance. Analysis of Russell et al. (2019) revealed perceived associations between mental fatigue and changes in behaviour including, disengagement, decreased motivation and enthusiasm, increased displays of emotion and withdrawal. Changes in concentration, decreased discipline and attention to detail also emerged as descriptors of mental fatigue. Media engagements, study and work commitments were reported to induce mental fatigue (Russell et al. 2019).

The physiological and training status of the elite athlete and the environmental conditions may also significantly influence fatigue. The definitions and caveats mentioned above highlight both the multi-factorial nature of fatigue and the inherent complexities of trying to monitor or measure fatigue in the athlete. For the purpose of this short review, and to reflect a practical perspective, fatigue is defined as "an inability to complete a task that was once achievable within a recent time frame" (Pyne & Martin 2011). Study of Sargent et al. (2014) declares that shorter sleep durations in elite athletes are associated with higher levels of pre-training fatigue. Findings suggest that the amount of sleep an elite athlete obtains is dictated by their training schedule. In particular, early morning starts reducing sleep duration and increase pre-training fatigue levels.

More generically, fatigue is considered the exercise-induced reduction in the force generating capacity of muscle (Gandevia 2001) wherein its manifestations in tennis are presumed to vary. High-intensity, intermittent, skill-based nature of the sport partly challenges definitive classifications of fatigue in tennis. That is, where definitions of fatigue in some field sports reference a reduction of peak speed or power output between multiple efforts (Duffield, Coutts & Quinn 2009; Coutts et al. 2010), the activity profile of tennis does not easily conform to such definitions. Indeed, whether fatigue in tennis manifests in changes to locomotion, technical proficiency or cognitive performance is unclear (Reid & Duffield 2014). Hyperthermia, dehydration and hypoglycaemia have all been identified as common challenges

to sustained performance proficiency in tennis, with emerging evidence suggesting central fatigue may also be a key stressor (Horney et al. 2007).

The objective of the study was to determine self-perceived fatigue during 48 hours after motor abilities testing in adolescent male and female elite tennis players.

Material and methods

Participants

The research sample comprised a total of 37 adolescent elite tennis players. 17 boys (mean age of 13.00 ± 1.54 years) and 20 girls (mean age of 13.15 ± 1.42 years) participated in the questionnaire survey. All tennis players are included in the system support of the Slovak Tennis Association with a ranking up to 10th place in the Slovak national ranking. In this study, informed consent was obtained from all participants. The research was approved by the Ethics Committee of the Faculty of Physical Education and Sports, Comenius University in Bratislava, Slovakia (No. 10/2019).

Research design

Adolescent elite tennis players underwent testing of selected motor abilities in tennis over the course of one day. They completed the following tests: (1) Bend and reach test, (2) Standing long jump test, (3) Pick up tennis balls test (fan), (4) 20-m sprint test (with 5 and 10 m split times), (5) 2 kg medicine ball throw test, (6) Serve speed and accuracy test, (7) Hit and turn tennis-specific endurance test (Ferrauti, Ulbricht & Pfannkoch 2013). For 48 hours after motor abilities testing (MAT), they were asked to observe symptoms of fatigue on themselves (S-PF; self-perceived fatigue). After 48 hours, they completed a questionnaire where they mediated the level of fatigue symptoms experienced.

The level of fatigue in adolescent elite tennis players was measured with the Training Distress Scale (TDS; Grove et al. 2014), a 19-item measure assessing the distress symptoms previously identified by Fry et al. (1994). These symptoms include a variety of complaints related to emotionality, general fatigue, concentration difficulties, physical discomfort, sleep disturbance, and appetite changes. Example items are “lack of energy,” “quick tempered,” “unable to maintain attention,” “muscle soreness,” “trouble falling asleep,” and “loss of appetite.” Adolescent elite tennis players responded to these items by indicating the extent to which they had experienced each of the symptoms during the past 48 h. All responses were made on a 5-point bipolar scale anchored by the phrases not at all (0) and extreme amount (4).

A higher mean point score meant higher experience of TDS symptom as well as higher levels of self-reported fatigue.

Statistical analysis

The program IBM SPSS Statistics version 23.0 was used for data processing. The data were described using absolute and relative frequencies, including the mean ($\overline{x}$) and standard deviation (±SD). The Non-parametric Mann-Whitney U-test was used to assess differences in S-PF between two independent samples according to gender (boys versus girls). Wilcoxon Signed Rank Test was used to assess the differences between two related samples – TDS symptoms inside boys' and girls' groups. The significance level was set at $\alpha \leq 0.05$ (*) and $\alpha \leq 0.01$ (**). The rate of dependence (effect size) between the two samples of features was conveyed by means of the coefficient *r* ($r > 0.90$ - very large effect size, $r = 0.70 – 0.90$ - large effect size, $r = 0.50$-0.70 - medium effect size, $r = 0.30 – 0.50$ - small effect size, $r < 0.29$ – very small effect size) proposed by Pett (1997). In the current study, only one measurement has been made and two main groups of adolescent elite tennis players according to the gender formed the study.

Results

In the group of male elite tennis players, absolutely no S-PF during 48 hours after MAT was manifested by TDS symptoms such as not being able to remember things, loss of appetite, not being able to eat well, and mental confusion, as these symptoms scored 0.000 points of the mean score (Table 1).

Table 1

Differences in TDS symptoms between boys' and girls' elite tennis players

TDS symptoms	Boys (n = 17)	Girls (n = 20)	Mann-Whitney U-Test		
	$\bar{x}$/ ± SD		*U*	*p*	*abs (r)*
Muscle soreness	1.294 ± 1.104	0.850 ± 0.988	128	0.182	0.207
Lack of energy	0.294 ± 0.469	0.350 ± 0.670	167	0.922	0.048
A quick temper	0.117 ± 0.485	0.100 ± 0.447	168	0.907	0.018
Not being able to remember things	0.000 ± 0.000	0.000 ± 0.000	170	1.000	----
Difficulty falling asleep	0.176 ± 0.392	0.000 ± 0.000	140*	0.050	0.302
Loss of appetite	0.000 ± 0.000	0.150 ± 0.489	153	0.186	0.212
Lack of interest in normal daily activities	0.294 ± 0.469	0.150 ± 0.366	145	0.295	0.168
Snappiness with family or teammates	0.058 ± 0.242	0.000 ± 0.000	160	0.278	0.167
Not being able to focus	0.117 ± 0.332	0.050 ± 0.223	158	0.459	0.117
Heavy feelings in your arms or legs	0.471 ± 0.717	0.500 ± 0.607	159	0.713	0.022
Restless sleep	0.058 ± 0.242	0.000 ± 0.000	160	0.278	0.167
Not being able to eat well	0.000 ± 0.000	0.100 ± 0.447	161	0.357	0.156
Being unusually tired during the day	0.588 ± 0.712	0.150 ± 0.366	112*	0.028	0.361
General irritability	0.235 ± 0.562	0.100 ± 0.308	156	0.472	0.147
Mental confusion	0.000 ± 0.000	0.100 ± 0.308	153	0.186	0.224
Joint stiffness of soreness	0.588 ± 0.712	0.200 ± 0.410	120*	0.049	0.316
Loose bowels or diarrhoea	0.000 ± 0.000	0.000 ± 0.000	170	1.000	----
Insomnia	0.058 ± 0.242	0.000 ± 0.000	160	0.278	0.167
Ordinary tasks require extra effort	0.353 ± 0.492	0.100 ± 0.308	121*	0.049	0.294
Overall TDS	**0.248 ± 0.231**	**0.153 ± 0.132**	**320**	**0.318**	**0.245**

Note. *U* = Mann-Whitney U-test statistics; *p* = statistical significance (*p*-values *≤.05, **≤.01); abs(r) = absolute value of *r* = effect size

Table 2

The level of S-PF in adolescent elite tennis players

Without S-PF symptoms		With S-PF symptoms	
Boys	**Girls**	**Boys**	**Girls**
Not being able to remember things	Not being able to remember things	Lack of energy	Joint stiffness of soreness
Loss of appetite	Difficulty falling asleep	Lack of interest in normal daily activities	Lack of energy
Not being able to eat well	Snappiness with family or teammates	Ordinary tasks require extra effort	Heavy feelings in your arms or legs
Mental confusion	Restless sleep	Heavy feelings in your arms or legs	Muscle soreness
Loose bowels or diarrhoea	Loose bowels or diarrhoea	Being unusually tired during the day	
Snappiness with family or teammates	Insomnia	Joint stiffness of soreness	
Restless sleep	Not being able to focus	Muscle soreness	
Insomnia	A quick temper		
A quick temper	Not being able to eat well		
Not being able to focus	General irritability		
Difficulty falling asleep	Mental confusion		
General irritability	Ordinary tasks require extra effort		
	Loss of appetite		
	Lack of interest in normal daily activities		
	Being unusually tired during the day		

Note. Wilcoxon Signed Rank Test was used to assess the differences between two related samples – TDS symptoms, inside boys' and girls' groups.

Along with these TDS symptoms, male elite tennis players did not show S-PF during 48 hours after MAT in following symptoms: loose bowels or diarrhoea, snappiness with family or teammates, restless sleep, insomnia, a quick temper, not being able to focus and maintain attention, difficulty falling asleep, general irritability (total 63.2 % of TDS symptoms). On the other hand, significant S-PF during 48 hours after MAT was in male elite tennis players felt by lack of energy, lack of interest in normal daily activities, extra effort in carrying out ordinary tasks, feeling of heavy arms and legs, unusual tiredness during the day, joint stiffness of soreness, and muscle soreness (Table 2).

In the group of female elite tennis players, absolutely no S-PF during 48 hours after MAT was manifested by TDS symptoms such as not being able to remember things, difficulty falling asleep, snappiness with family or teammates, restless sleep, loose bowels or diarrhoea, and insomnia as these symptoms scored 0.000 points of the mean score (Table 1). Along with these TDS symptoms, female elite tennis players did not show S-PF during 48 hours after MAT in symptoms listed in Table 2 (total 78.9 % of TDS symptoms). On the other hand, significant S-PF during 48 hours after MAT was in female elite tennis players felt by joint stiffness of soreness, lack of energy, feeling of heavy arms and legs and muscle soreness (Table 2).

Furthermore, we found that girls (21.1 %), compared to boys (36.8 %), experienced S-PF to a lesser extent after MAT, as they declared the fatigue in fewer TDS symptoms (Table 2). Together, boys and girls elite tennis players did not experience S-PF within 48 hours after MAT in the following twelve symptoms out of nineteen (63.1 %): not being able to remember things, loss of appetite, not being able to eat well, and mental confusion loose bowels or diarrhoea, snappiness with family or teammates, restless sleep, insomnia, a quick temper, not being able to focus and maintain attention, difficulty falling asleep, general irritability (Table 2). Interestingly, it was found that both groups of elite tennis players declared the lowest, zero level of S-PF by inability to remember things and loose bowels or diarrhoea, and on the other hand, the highest level of S-PF was declared by both groups of elite tennis players by the symptom of muscle soreness (Table 1).

Comparing differences in S-PF during 48 hours after MAT, we found significant differences between boys and girls elite tennis players in four TDS symptoms. Boys versus girls experienced significantly higher S-PF in the symptoms “difficulty falling asleep” ($U = 140$, $p = 0.050$, $r = 0.302$), “being unusually tired during the day” ($U = 112$, $p = 0.028$, $r = 0.361$), “joint stiffness of soreness” ($U = 120$, $p = 0.049$, $r = 0.316$), and “ordinary tasks require extra effort” ($U = 121$, $p = 0.049$, $r = 0.294$). No significant differences in overall TDS between male and female adolescent elite tennis players were found (Table 1).

Discussion

The objective of the present study was to determine self-perceived fatigue during 48 hours after motor abilities testing in adolescent male and female elite tennis players. The present study show, that male elite tennis players did not show S-PF during 48 hours after MAT in 63.2 % of TDS symptoms, and female tennis players in 78.9 % of TDS symptoms. On the other hand, significant S-PF during 48 hours after MAT was in both genders felt by lack of energy, feeling of heavy arms and legs, joint stiffness of soreness, and muscle soreness. Elite athletes in general, show TDS symptoms like "difficulty concentrating" and "fatigue or lack of energy" as an increased risk of poor athletic performance (Takeda et al. 2015). Repetitive exercises involving eccentric actions of high intensity or duration, which adolescent elite tennis players have undergone to test their level of motor abilities, can lead to muscle damage (Byrne et al. 2004). Exercise induced muscle damage is associated with a protective inflammatory response (Peake et al. 2005) and changes in the afferent inputs from the muscle spindle, Golgi tendon organ and groups III and IV afferent nerve endings (Komi 2000). A painful sensation when contracting, stretching, or putting pressure onto the exercised muscle (Weerakkody et al. 2001) is experienced within the first 24 h and last for 1 – 3 days after eccentric exercise (Proske et al. 2004), which was also evident in a group of our elite tennis players during the 48 hours after MAT.

In the current study, boys versus girls experienced significantly higher S-PF. It was shown in TDS symptoms as difficulty falling asleep, being unusually tired during the day, joint stiffness of soreness, and ordinary tasks require extra effort. The research of Wolbeek et al. (2006) shows opposite results, when girls are much more fatigued than boys. This gender difference was because of higher scores on the subscale's severity of fatigue, motivation, and concentration. In girls, medication use, higher age, and lower age at menarche were associated with higher levels of fatigue. In boys, fatigue was associated with symptoms of unrefreshing sleep, muscle pain, and memory and concentration problems. In girls, fatigue severity was also related to unrefreshing sleep, muscle pain, and concentration problems. In addition, headaches and tender lymph nodes were significantly related to fatigue scores in girls only (Wolbeek et al. 2006). Another research corresponds with the results of the previous research when female adolescents with self-reported health disorders declared significantly higher occurrence of self-perceived fatigue compared to male peers (Olekšák & Nemček 2021). Related to sport participation, the study of Nemček & Nemček (2021) revealed significant differences in problems with sleep, and unusual fatigue among three samples of elite junior racket sports

players, when elite junior tennis and table tennis players declare significantly higher problems with sleep compared to badminton players and elite junior table tennis players can feel significantly more unusually tired compared to tennis and badminton players.

In the present study no significant differences in overall TDS between male and female adolescent elite tennis players were found. According to level of fatigue in other racket sports, the results of the Nemček & Nemček's (2021) study revealed, that elite junior table tennis players can feel significantly more unusually tired compared to elite tennis and badminton players. It has been reported that high intense training may affect mood states, leading to anxiety, depression, feelings of fatigue and low self-esteem (Fry et al. 1994). In the study of Millet et al. (2005), the relationship between the training loads and perceived fatigue was significant. Linear mixed model analyses of Sargent et al. (2014) study revealed that on nights prior to training days, time spent in bed was significantly shorter, sleep onset and offset times were significantly earlier, and the amount of sleep obtained was significantly less, than on nights prior to rest days. Moreover, there was a significant effect of sleep duration on pre-training fatigue levels. Specifically, the authors found, that shorter sleep duration is associated with higher levels of pre-training fatigue. Taken together, these findings suggest that the amount of sleep an elite athlete obtains is dictated by their training schedule. In particular, early morning starts reducing sleep duration and increase pre-training fatigue levels (Sargent et al. 2014).

Conclusion

By both genders of elite tennis players, self-perceived fatigue during 48 hours after MAT was declared by the symptoms of "lack of energy", join stiffness of soreness", "heavy feelings in arms or legs", and "muscle soreness". In addition, the male elite tennis players also showed S-PF with symptoms of "lack of interest in normal daily activities", "ordinary tasks require extra effort", and "being unusually tired during the day". Boys versus girls experienced significantly higher S-PF in the symptoms "difficulty falling asleep", "being unusually tired during the day", "joint stiffness of soreness", and "ordinary tasks require extra effort". No significant differences in overall TDS between male and female adolescent elite tennis players were found.

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