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PSYCHOMOTORICS

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Are there gender differences in reactive stress tolerance levels of Brazilian judo athletes?

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Key words: reactive stress tolerance, reaction time, Vienna Test System, judo, elite athlete

Abstract

Background. In combat sports, such as judo, reactive stress tolerance is a variable that influences the performance of athletes. This variable plays a crucial role in controlling the movements of body segments and may contribute to sports success.

Problem and aim. Little is known about the behavior of this variable in elite athletes in *judo*. This variable can be influenced by different factors. This study aims to investigate if there are any gender differences in reactive stress tolerance between the athletes in the Junior Brazilian Judo Team.

Methods. The entire population of athletes from the Brazilian team. participated in the study (n=34; 17 male 18.56 ± 3.45 years and 17 female 18.90 ± 3.60 years) Reactive stress tolerance (complex reaction time, number of correct responses, number of incorrect responses, and omitted responses) was measured by the Determination Test (DT/S1; Vienna Test System SPORTS®).

Results. The number of incorrect and omitted answers presented significant differences (ES = 1.07/ 1.01) in the comparison by gender. Female athletes made fewer mistakes and omitted fewer responses than males. There were no significant differences (ES = -0.54 / -0.59) about the time of complex reaction and the number of correct answers.

Conclusion. The elite athletes of the Brazilian judo team do not show different performance levels caused by gender differences. The findings of this study show that at the highest levels of performance this variable is homogeneous.

Introduction

To achieve a high level of athletic performance it is necessary to submit the athlete to rigorous training situations, through a cyclic process of training-fatigue-adaptation [Pinheiro *et al.* 2018; Szmuchrowski *et al.* 2012]. In *judo*, due to the sport's competitive profile of direct combat, elite athletes face a tremendous amount of stress in their sporting lives [Bae *et al.* 2020; Mellalieu, Neil, Hanton, Fletcher 2009]. The ability to manage and react under stressful conditions has a significant impact on their sporting performance [Anshel, Anderson 2002; Craft, Magyar, Becker, Feltz 2003; Jones, Hanton, Connaughton 2007]. More research is needed to understand the complexity of emotional responses of elite athletes to these stressful situations, and the impact on sports performance [Mellalieu *et al.* 2009; Nahum 2017; Wong, Teo, Polman 2015].

Among various psychometric variables for evaluating psychological constructs in judo, it is noticeable that the reactive tolerance of stress can be one of the qualities that distinguish elite athletes from other athletes in different sports modalities. Reactive stress tolerance is defined as the ability of an athlete to react quickly and accurately in a situation where he or she is attacked [Neuwirth, Benesch 2012; Ong 2017]. This construct assesses an individual's ability to maintain focus and respond appropriately when placed in a stressful situation where stress is induced [Ong 2017]. The physical, technical, and tactical actions performed by the athlete and his oppo-

nent depend crucially on their ability to react within the shortest possible time to be effective during the fight [Cojocariu, Abalasel 2014]. Elite athletes have faster and more accurate reactions under stress when compared to athletes from lower competitive levels [Gierczuk *et al.* 2012; Ong 2017; Sadowski *et al.* 2012].

Several studies have been conducted in the field of sports psychology revealing various aspects about the influence of the reactive stress tolerance level in the decision-making process of elite athletes and connecting these data to sports performance [Dogan 2009; Gierczuk *et al.* 2012; Nederhof *et al.* 2008; Ong 2015, 2017; Patocs *et al.* 2016; Sadowski *et al.* 2012; Wilczynska 2016; Witte *et al.* 2015]. One of the main tools used in these studies to evaluate reactive stress tolerance and the decision-making in the sports context is the Determination Test (DT) by the Vienna Test System SPORTS® (VTS). The DT is a test of reactive stress tolerance, which assesses complex reactions to continuous, rapidly changing stimuli and detects a reduction in psychomotor reaction ability [Ong 2015; Wilczynska 2016].

Previous research indicates that there are gender differences in performance level regarding stress-related domains [Anshel, Kang, Miesner 2010; Kaiseler, Polman, Nicholls 2012]. Dogan [2009] verified that the female athletes presented a higher number of incorrect responses under stress compared to male athletes from Turkey. Contrastingly, Ong [2017] found that female athletes had higher reactive stress tolerance than male athletes from Singapore. These differences could be explained also due to the different nationalities, cultures, and religions [Ong 2017]. Thus, further research is needed to investigate differences in reactive stress tolerance performance between men and women.

There is a difference in physical abilities between male and female elite athletes. [Franchini, Vecchio, Matsushigue 2011]. However, only few studies aimed to evaluate the differences in performance level of male and female elite athletes, especially regarding the psychological aspects related to success in sports combat [Dogan 2009; Ong 2017]. It is known that both female and male elite judo athletes are required to process and make fast decisions for attack, defense, and counterattack during combat [Marcon *et al.* 2010; Cojocariu, Abalasel 2014]. Thus, the purpose of this study is to investigate if there are any gender differences in reactive stress tolerance between the athletes of the Junior Brazilian Judo Team.

Materials and Methods

Participants

This is a study with a descriptive and cross-sectional cut design in a category in which the entire athlete population was evaluated [Thomas, Nelson, Silverman 2012]. All athletes in the junior category of the Brazilian Judo Team, who participated in competitions in 2016, were evaluated. Thirty-four (34) athletes (n = 17 males and 17 females) participated in the study. The age and experience description of the athletes is presented in table 1.

Table 1. Description of age group, competitive and non-competitive sports experience

Variables	Athletes	
	Male	**Female**
	Means (± SD)	Means (± SD)
Age	18.56 (3.45)	18.90 (3.60)
Initial age of non-competitive experience	8.00 (2.00)	8.00 (3.00)
Initial age at competitive experience	9.00 (2.00)	10.00 (3.00)

Instruments

Determination Test (DT). The DT is a computerized test that was developed by Schuhfried GmbH (Moedling, Austria) as part of the Vienna Test System SPORT® (VTS). It is a complex and multi-stimuli reaction test that seeks to measure reactive stress tolerance in situations that require fast and continuous responses to different stimuli [Schuhrfried 2001; Neuwirth, Benesch 2012]. The stimuli are divided into visual stimuli, with five colored buttons and two-foot pedals (left and right); and acoustic stimuli, with two tones (high and low). The athlete is tasked with responding as quickly and accurately as possible to the stimuli presented. The stimuli are presented continuously in rapid succession, and the athlete should remain focused and react quickly.

The test comprises of four main variables: (a) median reaction time, which measures the speed at which the participant is able to react to complex stimuli; (b) the number of correct responses, which measures the participant's ability to respond quickly and accurately under stress; (c) the number of incorrect responses, which measures the participant's tendency to confuse different responses and respond incorrectly when under stress; (d) the number of omitted responses, which assess the participant's inability to maintain attention or the tendency to give up when placed under stress.

The DT-S1 form was used in this study, which employs the "adaptive" mode. In this mode, the rate of presentation of each stimulus changes according to the level of performance of the participant in the test. The duration of the stimulus presentation is calculated based on the average of the last eight reaction times of the participant. The purpose of the "adaptive" mode is to ensure that the participant is always working at the limit of his/her ability and that reactive stress tolerance is being measured accurately.

Before the start of the first subtest participants were given a practice run to familiarize themselves with the test. If any participant committed too many mistakes during the test, the test result would be made void and an

error message would appear on the screen with instruction to contact the test administrator.

Procedures

The DT-S1 test was applied in the first two days of the athletes' presentation in the evaluation week for the Brazilian judo Team (season 2016), and in these two days of data collection, there were no training or competition sessions. On the first day, the tests were performed with the male judo athletes. All the athletes received explanations regarding the objectives of this research, signed consent, and filled in their demographic information, which included their gender, age, and years of experience. After this, they performed the DT-S1 test between 9:00 and 12:00 in the morning. On the second day, the same procedures were performed for female judo athletes.

During the test, all instructions were administered via the VTS computer program in order to minimize any influence from human factors. At the start of the test, participants were given instructions on how to work the test, and were instructed to work quickly and accurately. All data collection procedures were performed in a reserved room, in an individualized manner, without external interference, and by the same researcher. This study respected all the standards established by the National Council in Health [2012] involving research with human beings. The project was submitted to and approved by the Ethics and Research Committee of the Federal University of Minas Gerais (COEP-UFMG, under the number CAAE- 54593116.4.0000.5149).

Data Analysis

Data were presented using descriptive statistics: mean and standard deviation (SD). Shapiro Wilk's test was performed to verify the normality of the data. As the data presented normal distribution, parametric tests were adopted for all the study variables. For the comparisons of the variables between the groups was used the Student T-test for independent samples according to the distribution of the data. The effect size was checked with Cohen's d test. Effect size classification was performed with the following values: trivial effect d < 0.25; small effect d 0.25 > 0.50; moderate effect d 0.50 > 1.00 and large effect d > 1.00 [Rhea 2004].

Differences between es were analyzed using independent Student t test and the effect size. The level of significance adopted for all analyses was p<0.05. The data were analyzed using the Statistical software *SPSS* [IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp].

Results

The results of the study are presented in Table 2. Through the results, it was found that there are no significant differences (ES = -0.54 / -0.59) of performance level between es of the athletes of the Brazilian Judo Team of the Junior category about the time of complex reaction (TRC) and the number of correct answers. However, the number of incorrect and omitted answers presented significant differences (ES = 1.07/ 1.01) in the comparison. Female athletes made fewer mistakes and omitted fewer responses than males.

Table 2. Means and standard errors for DT-S1 Test in judo elite athletes

	Gender		*P*
	Males	Females	
Median of complex reaction time (s)	0.75 (0.06)	0.78 (0.05)	0.29
Number of correct responses	218 (23)	233 (25)	0.10
Number of incorrect responses	20 (8)	13 (4)	0.004*
Number of omitted responses	27 (6)	20 (8)	0.008*

*(p< 0,05)

Discussion

This is the first study that aimed to investigate the potential differences in reactive stress tolerance between the athletes of the Junior Brazilian Judo Team. The findings of this study indicate that there were no differences in median reaction time and number of correct responses. However, there were significant differences in the number of incorrect and omitted responses.

Previous research showed that stress contributes to additional demands faced by athletes, and this situation can overburden their resources to cope and respond to environmental stimuli during various competitive situations [Mellalieu *et al.* 2009]. Gorner, Greganova, and Kusnierz [2019] point out that the interaction of athletes with the environment may influence psychological constructs. Brazilian Judo athletes are immersed in an environment that requires them to process a large number of stimuli from their opponents during the fight. The athlete who has the best ability to react quickly and correctly in a stressful situation can make better quality decisions when compared to his or her peers. In this sense, understand how athletes deal with emotional aspects might be determinant for their performance during fights and crucial for winning a championship [Faro *et al.* 2020].

Contrary to the findings of this present study, Dogan [2009] compared the differences in reactive stress tolerance of Turkish collegiate athletes, and found that males performed better than females, having fewer incorrect reactions. In another study by Ong [2017], it was also found that there were differences in reactive stress tolerance between athletes. The results showed that female

athletes had faster median reaction time and more correct responses compared to males. However, the author did not find any significant differences between the es in terms of the number of incorrect answers or number of omitted answers. These findings could be explained due to the different demands of the sports modalities and the level of competitive sports performance. Factors such as cultural habits, including religion, are also mentioned as influencing aspects [Ong 2017]. Nevertheless, the reason for this disparity in reactive stress tolerance by gender is still unclear in the literature.

The absence of significant difference for median reaction time and number of correct responses in this study can be explained by the competitive level of these elite judo athletes. It is known that elite athletes possess faster median reaction time and a greater amount of correct responses than other athletes [Gierczuk *et al.* 2012; Ong 2017; Sadowski *et al.* 2012]. Elite athletes face better quality opposition and experience more intense competition, resulting in them being constantly pushed to the limit. As a result, they need to develop and improve their reactive stress tolerance in order to be successful in their sport. Regarding the differences observed for the number of incorrect and omitted responses, a possible explanation may be associated with the different processes of decision making that males and females employ. Piepiora *et al.* [2019] points out that men and women may have different perceptions of psychological stress. Studies indicate that stressors, coping, and coping effectiveness are influenced by. Nicholls, Polman, Levy, Taylo,r and Cobley [2007] found that females used certain problem-focused coping strategies, such as planning, communication, and technique-orientated coping more frequently than males. Nicholls *et al.* [2007] also showed that males and females presented different stress patterns in sport, where females are more capable of using problem-related strategies such as communication, planning, and coping techniques as compared to men. In this present study, female athletes had a lower number of errors and a lower number of omissions as compared to males, thus demonstrating a better accuracy in situations that require stress control.

Another explanation for these findings is based on differences in the structural connection of the human brain [Ingalhalikar *et al.* 2014]. Extensive research has established the presence of differences in brain structure and function [Kaczkurkin *et al.* 2018; Ruigrok *et al.* 2014; Sowell *et al.* 2007; Cosgrove *et al.* 2007]. Ingalhalikar *et al.* [2014] analyzed a group of young adults aged between 17 and 22 years and verified that there exist differences in relation to the interhemispheric and intrahemispheric connectivity in females and males, respectively. Female brains displayed higher interhemispheric connectivity. The authors suggest that male brains are structured to facilitate connectivity between perception and coordinated action, whereas female brains are designed to facilitate communication between analytical and intuitive processing modes. Thus, males exhibit greater connectivity in the motor, sensory and executive sub-networks, while females have better connectivity in reward and memory subnetworks. Female brains are designed to facilitate communication between analytical and intuitive processing modes [Ingalhalikar et al. 2014]. This unique difference in brain connectivity may allow less influence of reactive stress tolerance in the decision making of females.

Piepiora and Petecka [2020] indicated that the differences between women and men in social behavior and cognitive skills are low. Kajtna and Doupona [2017] analyzed psychological aspects that vary between males and females, but the sample of this study was composed by coaches. In relation to stress research in sport psychology, it is still necessary to explore more homogeneous samples of professional athletes according to their professional levels [Nahum 2017]. Therefore, this study contributes to a better understanding of how reactive stress tolerance can affect and influence the decision-making process of elite judo athletes. The limitation of the study was that reactive stress tolerance was only evaluated in one competitive judo category, making it necessary to verify if the results can be applied to other competitive categories as well. It is important to highlight the difficulty of accessing athletes who compete at a higher sporting level and also take into account the athletes' training routine, which prevented the implementation of a longer battery of tests related to reactive stress tolerance. However, the results of this study may contribute to establishing parameters in relation to the variable of reactive stress tolerance, and can guide coaches that work with elite athletes, as well as coaches that have athletes who wish to represent the national team of their country.

Conclusion

The male and female Junior Brazilian Judo athletes did not differ in median reaction time of reactive stress tolerance and number of correct responses, but female judo athletes had fewer incorrect and omitted responses than male judo athletes. This shows that in this level of sports performance this variable is homogeneous, based on the high qualification of these athletes and the competitive levels of sports requirements in which they are.

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Czy istnieją różnice płciowe w reaktywnej tolerancji stresu u brazylijskich zawodników judo?

Słowa kluczowe: reaktywna tolerancja stresu, czas reakcji, Wiedeński System Testowy (VTS), judo, sportowiec elitarny

Streszczenie

Tło. W sportach walki, takich jak judo, reaktywna tolerancja stresu jest zmienną, która wpływa na wyniki sportowe. Zmienna ta odgrywa kluczową rolę w kontroli ruchów segmentów ciała i może przyczynić się do osiągnięcia sukcesu sportowego. Problem i cel. Niewiele wiadomo na temat zachowania się tej zmiennej u elitarnych sportowców uprawiających judo. Na zmienną tę mogą wpływać różne czynniki. Celem pracy było zbadanie, czy istnieją różnice między płciami w zakresie reaktywnej tolerancji stresu u zawodników brazylijskiej drużyny juniorów judo.

Metody. W badaniu wzięła udział cała drużyna (n=34; 17 mężczyzn 18,56 ± 3,45 lat i 17 kobiet 18,90 ± 3,60 lat) reprezentacji Brazylii. Reaktywną tolerancję na stres (złożony czas reakcji, liczbę prawidłowych odpowiedzi, liczbę nieprawidłowych odpowiedzi i pominiętych odpowiedzi) mierzono Testem Determinacji (DT/S1; Vienna Test System SPORTS®).

Wyniki. Liczba odpowiedzi błędnych i pominiętych wykazywała istotne różnice (ES = 1,07/ 1,01) w porównaniu między płciami. Zawodniczki popełniały mniej błędów i pomijały mniej odpowiedzi niż mężczyźni. Nie stwierdzono istotnych różnic (ES = -0,54 / -0,59) dotyczących czasu reakcji złożonej i liczby poprawnych odpowiedzi.

Wniosek. Elitarni zawodnicy brazylijskiej drużyny judo nie wykazują odmiennych wyników ze względu na płeć. Wyniki niniejszego badania pokazują, że przy wysokim poziomie wydajności zmienna ta jest jednorodna.