

## An Examination of Psychological and Biochemical Parameters of American Football Players and Volleyball Players: A Discriminate Analysis

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**ABSTRACT** This study was carried out to determine the psychological and biochemical parameters of the American Football players who chose this high-contact sport, and to compare those parameters with those of the players of volleyball, a non-contact sport. Participants were 39 American Football Players, and 21 volleyball players. According to t-test results, there were some statistically significant differences between the average points of conscientiousness, competition anxiety, and intensity of the American football as compared to those of the volleyball players. Discriminate analysis revealed one significant function. According to discriminate function, analysis were correctly placed at 79.5 percent to the American footballers (n=31), and 85.7 percent to the volleyball players (n=18). However, 20.5 percent of the American footballer (n=8) and 14.3 percent of the volleyball players (n=3) were wrongly placed. According to dissociation analysis, the 81.7 percent players were correctly classified. In conclusion, it was revealed that the American Football Players took more self-responsibility; are more prone to worry about failure, and had more intensity and stress levels than the Volleyball Players. Nevertheless, both the American Football Players and volleyball players showed psychological and biochemical differences that obviously discriminated them according to their particular sport.

### INTRODUCTION

There has been a growing interest in analyzing the characteristics of different competitive sports over the last decades. Specific characteristics in many sports have been well described with physical, anthropometric, bio-motor features that indicate what players would be suitable to achieve in a specific sport. The identification of variables from different sports that characterize athletes is of interest to understand what distinguishes them from other athletes or players. An increase in physical activity level is beneficially associated with health. For example, improvement of many health indicators, such as lower blood pressure values, reduced insulin resistance, and normalization of lipid profile is a commonly observed effect among both men and women performing physical exercises (Hashimoto et al. 2013; Haxhi et al. 2013). The impact of muscular performance and its enhancement have been of interest to those who examine it, and its effects on muscles (Cengiz et al. 2015)

It was suggested in this study that the right amount of exercise is evidently essential for the optimal progress and health status of children, while too much or too little exercise may have some unfavorable impacts on the physical development of children. It was also suggested that extra or little exercise might create health risks though there are noticeably more children who could gain advantage by increasing their physical activity (Yuksel et al. 2015). So many studies have centered on the description of anthropometric, physical and bio-motor variables, which distinguish between athletes and their studies (Sovak and Hawes 1987; Thomas et al. 1989; Smith and Thomas 1991; Leone et al. 2002). However, only a few studies have addressed whether the biochemical and psychological variables of different sports athletes can be used to discriminate among them based on the sports participated in.

### Objectives of this Study

Besides the physical and bio-motor characteristics, evaluation of psychological and bio-

chemical characteristics of athletes reveal more objective results than the reason of interest. Therefore, the aim of this study was to identify and quantify the individual contributions of a series of psychological and biochemical variables, which discriminate American football, that has to do with contact and aggressive behaviors, as compared to volleyball that involves players playing in a separated field, with no-contact.

## METHODOLOGY

### Participants

39 American Football Players (Mage= 23.67  $\pm$  2.54), and 21 volleyball players (Mage= 25.14  $\pm$  3.90) totaling 60 athletes (Mage= 24.21  $\pm$  3.16), voluntarily participated in this study. All participants competed at the national leagues; 21.7 percent of them also competed at the international level. The average number of years in competitive sports for these participants was 8.76 years (Mean = 8.02 for American Football; Mean= 9.56 for Volleyball). In addition, the majority of sports participants were training 6 days a week.

### Instruments

#### Laboratory Methods

- Serum **free testosterone** levels were measured with radioimmunoassay (RIA) (Beckman Coulter, Free Testosterone ACTIVE® RIA)
- Serum **cortisol** analyses were conducted using a chemiluminescent immunoassay (Immulite 2000, Siemens)
- Serum **total antioxidant capacity** levels were examined by colorimetric microplate assay (Antioxidant Assay Kit, Cayman Chemical, USA).
- Serum **AOPP** levels were evaluated with spectrophotometric method as Witko-Sarsat et al. described before (Witko1996)
- Serum **MDA** levels were analyzed as Yoshioka et al. defined. Main principle of the method is; colorimetric measurement of the complex of MDA with thiobarbituric acid TBA after precipitation of serum proteins with trichloroacetic acid (TCA) (Yoshioka et al. 1979)
- Serum **serotonin** levels were performed with High-Performance Liquid Chromatography

(HPLC) by fluorimetric detection (Serotonin or 5-hydroxytryptamine or 5-HT is separated treating the serum/plasma with a suitable precipitant. After addition of a stabilization solution, 50  $\mu$ l of the eluate is directly injected into HPLC)

- Serum **catecholamines** (serotonin, adrenaline, noradrenalin, dopamine) levels were performed with High-Performance Liquid Chromatography (HPLC) by fluorimetric detection (Catecholamines; after purification with clean up columns, are derivatized with 2 specific reagents and incubated at 70 °C for 15 minutes. The derivatized solution, is injected in HPLC)

### Psychological Measures

**Arnett Inventory of Sensation Seeking Scale (AISS), (Arnett 1994):** This scale was used to assess the sensation seeking level of rock climbers. AISS contains 20 items, with the subscales of Intensity and Novelty. Each item is rated on a 4 point Likert scale and anchored as: 1 = “describes me very well” to 4 = “does not describe me at all”, thus, resulting in scores ranging from 4 to 40 for each subscale (Arnett 1994). The Turkish version of AISS comprises of 22 items [19 original items (excluding “I don’t like extremely hot and spicy foods”) and 3 items taken from Persing and Schick’s “Multi dimensional Self-Destructiveness Scale”: “I like an exciting job”, “I make quick decisions”, and “I like to try new things even if they are highly risky”]. Each subscale consists of 11 items and is rated on a 4 point Likert scale. The internal consistencies of the two subscales were 0.84 (Intensity) and 0.75 (Novelty) in a Turkish sample (Sümer and Özkan 2002). For the present sample, the internal consistency was 0.68 for the 22 items.

**Sport Competition Anxiety Test (SCAT) (Martens et al. 1990):** SCAT is trait anxiety inventory designed to measure a predisposition to response with varying degrees of anxiety in competitive sports situations. SCAT has 10 anxiety items and 5 filter statements and each item is rated on a Likert scale, anchored by 1= Hardly Ever to 3= Often. Total score on SCAT ranges from 10 to 30. The reliability and validity evidence of SCAT for Turkish athletes was obtained by (Koruç et al. 2000). The test-retest reliability and internal consistency (Cronbach alpha) of SCAT were .90 and .79, respectively (Koruç et al. 2000 in press)

**Five-Factor Personality Inventory (FFPI)** (Somer et al. 2002): The Five Factor Personality Inventory (short version), developed by Somer et al. (2002) was used to determine personality traits of participants. This scale is based on five-factor model and includes 85 items. The inventory measures five general personality traits of extraversion, conscientiousness, agreeableness, emotional stability and openness. Each item is responded to on five point likert scale in which 1 (completely true for me) to 5 (completely false for me). Internal consistency coefficients of Five Factor Personality Inventory were found for extraversion 0.77, conscientiousness 0.81, and agreeableness 0.68, emotional stability 0.86, and openness 0.73.

**State-Trait Anger Expression Scale (STAXI, Spielberger et al. 1983, 1985):** State-Trait Anger scale assesses the intensity of anger as an emotional state at a particular time. The scale includes 44 items and three subscales of trait, state anger and anger expression. In this study, Turkish version of The Trait Anger scale was used (Özer, 1994). Trait anger subscale measures how often angry feelings are experienced over time. This subscale includes 10 items and individuals rate themselves on 4-point scales.

**Aggression Scale:** The Aggression Scale developed by Tuzgol (1998), was used to assess the aggression characteristics of participants. This scale includes 45 items and measures open, hidden, physical, verbal and indirect behaviors, which are related to aggression in youth. The scale has 30 items, which included aggression, and 15 items, which did not include aggression. Each item is responded to on five point likert scales in which there is 1 (never), to 5 (always). Internal consistency coefficients of Aggression Scale were found to be 0.81 for 45 items.

### Data Collection Procedure

Psychological measures which includes, "Five Factor Personality Inventory", "Aggressive Scale", "State-Trait Anger Scale" "Arnett Sensation Seeking Scale" and "Sport Competition Anxiety Test" were administered to all participants in classroom setting. Researchers provided verbal and visual information on how to respond to items from each questionnaire. Participation in the study was voluntary and self-report questionnaire responses were anonymous. The participants spent about 20-25 minutes to

fill in the questionnaires. In Addition to Biochemical Measures, Fasting venous blood samples of the players were collected, sera were obtained after centrifugation and stored at (-) 80°C until the assay. The samples were analyzed at Gazi University School of Medicine, Core Biochemistry-Hormone Laboratory and Research Laboratory.

### Data Analysis

Independent t-test was used to examine the differences in psychological biochemical parameters between American Football players and Volleyball players. In addition, the discriminate analysis was used to examine the most important biochemical and psychological variables in the type of sports and to examine the ability of these variables PSPP in discrimination of American Football players and Volleyball players. The psychological and biochemical parameter scores were used to discriminate between American Football players and Volleyball players, and were entered directly as predictors, with comparative predictive power assessed by size of the respective structure coefficients. The assumption of discriminate analysis was analyzed before conducting it. The normality, directionality and multicollinearity were investigated. The normality analysis indicated that there is no skewness and kurtosis. The results showed that there was no skewness value higher than 3, and there was no Kurtosis value higher than 10.

The scatter plot of directionality also did not reveal any deviation from normality. The univariate multicollinearity was examined with Pearson Product Moment Correlation and the correlation coefficient was found to be between -0.62 and 0.45. There are no tolerance values approaches to 0, which indicated no multicollinearity. At the third step, the homogeneity of variance-covariance was tested. Box M statistic revealed no significant result (Box M = 354.929  $F_{(190, 5376)} = 1.12$ ;  $p > 0.05$ ).

## RESULTS

### Comparison of Biochemical Parameters between American Football Players and Volleyball Players

Independent t-test results showed significant differences only in Mda.mg [ $t(58) 2.76, p < 0.01$ ]

**Table 1: Comparison of biochemical parameters**

	Parameters	Type of Sport	M	SD	t	p
Biochemical Parameters	Aopp.Mg	American Football	229.43	106.24	-.21	.832
		Volleyball	235.93	123.16		
	Testosterone	American Football	12.76	4.02	-.14	.890
		Volleyball	12.90	3.13		
	Cortisol	American Football	15.06	4.37	.98	.330
		Volleyball	13.90	4.41		
	Mda.Mg	American Football	4.28	0.65	2.76	.008**
		Volleyball	3.78	0.68		
	Total antioxidant	American Football	2.35	0.31	-.84	.407
		Volleyball	2.42	0.31		
	Serotonin	American Football	119.74	31.66	1.96	.055
		Volleyball	104.59	21.46		
	Adrenalin	American Football	83.82	42.89	.60	.548
		Volleyball	77.29	33.85		
	Noradrenalin	American Football	196.90	107.03	.58	.567
		Volleyball	180.24	107.05		
	Dopamine	American Football	17.97	9.54	.67	.509
		Volleyball	16.33	8.25		

**Table 2: Comparison of psychological parameters**

	Parameters	Type of Sport	M	SD	t	p
Personality	Extroversion	American Football	2.29	0.50	-.066	.948

score between American Football and Volleyball players. The mean value of Mda.mg was higher in American Football players than volleyball players (Table 1).

**Comparison of Psychological Parameters between American Football Players and Volleyball Players**

Independent t-test results indicated statistically significant differences in conscientiousness subscale of personality [t (58) = 2.82, p < 0.01], competitive anxiety [t (58) = 2.92, p < 0.01] and intensity subscales of sensation seeking [t (58) = 2.05, p < 0.05] between American football and volleyball players (Table 2).

**Discriminant Analysis**

The results of the discriminant analysis, using the biochemical and psychological parameter scores to discriminate American Football and Volleyball player is presented in (Table 3).

The structure coefficient revealed that the conscientiousness personality characteristic, competitive anxiety and biochemical parameter of Mda.Mg were the important variables in the prediction of American Football and Volleyball

**Table 3: Statistical significance and standardized coefficients and function and predictors of relationships for the one discriminate functions (DF1)**

Predictor Variables	Standardized Coefficients	Function and Predictors of Relationships
Psychological		
1. Extroversion	.00	-.01
2. Agreeableness	-.01	.26
3. Conscientiousness	.82	.34
4. Emotional Stability	1.02	-.03
5. Openness to Experience	-.36	.07
6. Aggressiveness	.27	.16
7. Novelty	-.16	.07
8. Intensity	.27	.23
9. Trait Anger	.17	.11
10. Competitive Anxiety	.95	.35
Biochemical		
11. Aopp.Mg	.27	-.03
12. Testosterone	-.59	-.02
13. Cortisol	.41	.12
14. Mda.Mg	.60	.34
15. Total antioxidant	.11	-.10
16. Serotonin	.39	.24
17. Adrenalin	.15	.07
18. Noradrenalin	-.06	.07

players. The canonical correlation between two data sets were  $R_c = .0.74$  ( $\chi^2 = 37.635$ ,  $p < .01$ ).

The mean discriminant scores (group centroids) were 0.78 for American Football players and -1.45 for volleyball players. The group centroid values for Volleyball players are lower than American Football players and also have opposite signs. This indicated that the dominant contributors of conscientiousness personality characteristic, competitive anxiety and biochemical parameter of Mda. Mg equally separated the American Football players from volleyball players. The results showed that discriminate function reflected differences between American Football players and Volleyball players (Table 4).

**Table 4: Classification for all significant discriminant function after validation**

Groups	Predicted group memberships, n (%)		
	n	American Football	Volleyball
American Football	39	35 (89.7)	4 (10.3)
Volleyball	21	2 (9.5)	19 (90.5)

The results of discriminate analysis indicated that that biochemical and psychological characteristic could correctly classify 79.5 percent of the American footballers and 85.7 percent of the volleyball players (Table 5).

### DISCUSSION

Volleyball is characterized as an intermittent sport, with frequent high-intensity actions, involving explosive bursts, short body displacements and numerous jumps. The sensitivity of the aforementioned performance, psychological and biochemical markers in monitoring the overload effects of training in athletes of various sports, leads us to the hypothesis that these markers will present the same sensitivity for monitoring the effects of training load intensification during a pre-competitive period in volleyball (Freitas et al. 2014).

On the other hand, many football players believed themselves to be suffering from cognitive deficits which they acquired during the

**Table 5: Coefficient correlations between psychological biochemical parameters**

Variables	Aopp Mg	Testosterone	Cortisol	Mda. mg	Total antioxidant	Serotonin	Adrenalin	Noradrenalin	Dopamine	Extroversion	Agreeableness	Conscientiousness	Emotional stability	Upenness to Experience	Aggressiveness	Novelty	Variables	Trait anger	
AOPP.MG	1.00																		
Testosterone	-.06	1.00																	
Cortisol	-.05	.23	1.00																
Mda.mg	.11	.16	-.16	1.00															
Total antioxidant	-.27	.13	.06	.07	1.00														
Serotonin	-.02	.24	.20	.17	.00	1.00													
Adrenalin	-.01	-.06	-.18	-.08	-.15	.16	1.00												
Noradrenalin	.21	-.13	.06	.03	-.27	.11	.03	1.00											
Dopamine	-.06	-.14	-.11	.15	-.10	.20	-.09	.16	1.00										
Extroversion	-.11	-.10	-.16	.09	-.06	-.02	.20	.16	.06	1.00									
Agreeableness	.02	.11	-.01	.16	.13	-.16	-.05	-.08	-.06	-.22	1.00								
Conscientiousness	-.16	-.10	-.01	.08	-.06	-.06	-.19	.03	.22	.02	.12	1.00							
Emotional stability	.00	.10	.02	-.16	.00	.08	.06	.07	-.09	-.17	-.02	-.38	1.00						
Openness to experience	.14	.12	-.07	.33	.05	-.09	-.05	-.10	-.11	.17	.14	.34	-.46	1.00					
Aggressiveness	.02	.15	-.05	.24	.02	-.12	-.05	-.02	.02	-.05	.46	.25	-.47	.45	1.00				
Novelty	.03	.03	.01	.07	-.11	.29	-.05	.24	.19	-.16	.19	.14	-.24	.05	.16	1.00			
Intensity	.06	.26	.22	.07	-.26	.18	.12	.01	-.17	-.25	.19	.00	-.12	.10	.35	.38	1.00		
Trait Anger	.00	.12	.23	-.06	-.06	-.04	.01	.01	.01	-.10	.15	.08	-.37	.26	.57	.10	.26	1.00	
Competitive anxiety	-.18	.11	-.12	.30	-.14	.06	.10	-.03	.14	.25	.14	.30	-.62	.36	.34	.19	.22	.28	1.00

course of their careers (Hampshire et al. 2013). It is believed that superior athletic performance has enabled them to benefit from knowledge that relates to physiology of human motor activity. Nevertheless, many coaches and psychologists throughout the world believe that future records will be broken primarily because of the increase in attention that is given to the psychological parameters of human (Singh and Kerketta 2015).

Therefore, this study aims at determining the psychological and biochemical parameters of American football that is based upon one to one physical combat and non-contact sport such as volleyball, where there is a net between the competing teams. The first question of the study is, whether there is a significant difference in the psychological and biochemical parameters that exist between the players of American football and volleyball. The parameters, which affect the selection of these sports, have also been elucidated. The results of the t-test used to determine these parameters showed significant differences as regards to self-control/responsibility, competing anxiety, feeling density and MDA in favor of the American footballers. The result recorded for self-control and responsibility in favor of American footballers can be attributed to the fact that they take higher personal responsibility during the match and that they have stringent criteria of success.

The fact that American footballers scored higher marks in competition anxiety and feeling density than the volleyball players may be due to their higher fear of being unsuccessful. In other words, since the American footballers have man-to-man combat during the game, any personal mistake may cause the team very dearly and may be very hard to compensate for, which increases the competition anxiety and the feeling of density among the players. The MDA levels of the American footballers were found to significantly higher than those found in volleyball players ( $\bar{X}=4.28$  to  $\bar{X}=3.78$ ). This reveals that the aggressive nature of the game increases the stress of the players, and promotes the MDA levels. However there are many studies showing that regular exercise decreased the MDA levels (Souza et al. 2006). It was reported that the regular exercises decreased the MDA levels of swimmers (Gonne et al. 1995), soccer players (Çelik et al. 2007), and football players (Valodo et al. 2007) also, depending on their frequency. Since the frequency of training of the volleyball players

was twice that of the American footballers, their MDA levels were found to be lower than the American footballers. This supports the data reported in the literature. Similarly, frequent exercise strengthens the antioxidant defense mechanism of the body and decreases the free radicals. In this study, the T. antioxidant levels of the volleyball players were found to be higher than those of American footballers (volleyball players =2.42, American footballers =2.35). Based on these data, one can easily conclude that the frequency of the exercises increased the level of antioxidants and decreased the level of stress.

Another aim of this study was to examine the comparison between a highly physical one to one combat game such as American football and a non-contact game such as volleyball, and determine the reasons why the American footballers chose that game, despite the high risks involved. In his study entitled, '*The relation of aggressive behavior with environmental and biological factors*,' Palermo (2010) defined testosterone and cortisol as the hormones that trigger the aggressive behavior. Thus, it was expected that the testosterone levels of the American football players would be higher, and that their cortisol level would be lower than those of the volleyball players. However, the study revealed that the cortisone levels of the American footballers were higher and the testosterone levels were a little bit lower than those of the volleyball players. A lot of researchers have stated that serotonin hormone could mediate between the testosterone hormone and aggressive behavior (Raine 1993; Soler et al. 2000; Sanchez-Martin 2000; Giotakos et al. 2003). Therefore in his study, serotonin levels were taken in place of testosterone and the serotonin levels of the American football players were found to be significantly higher than those of the volleyball players ( $p<0.05$ ). This result thereby proves that the competitive and aggressive nature of American football increases serotonin not testosterone.

The indirect effect of serotonin hormone on anxiety may be attributed to the double effects which serotonin has both on increasing and decreasing of anxiety. In disorders such as panic attack, the anxiety increases with the serotonin levels. The patient may always think that something will happen to him, and this increases the serotonin levels. The increased serotonin level is expected to increase the anxiety. The increased serotonin levels of American football players may

be related to their higher levels of expectancy. The American football players are expected to display the aggressive behaviors due to the nature of the game. Therefore, it is safe to conclude that the footballers try to overcome the fears they have which is related to this expectancy by choosing this branch of sport. The increased serotonin levels may be due to the fact that the players may need to be aggressive in order to be able to fight their fears, and to motivate themselves to go against it (Isik and Taner 2006). It has also been observed, that the parents of the American football players are worried about the health of their children, and this may result in a situation whereby the players may also need to worry about their own health. Therefore, they may try to eliminate these fears by going out rightly against it. This is similar to counter phobic response of the people who have high anxiety to overcome, and who do so by doing bungee jumping. The counter phobic attitude of the American football players, who were constantly filled with adverse effects from internalizing messages about getting, injured, may be very effective in their choice of sport.

The second question to be answered is, whether the psychological and biochemical parameters are the determining factors in their choice. The separation analysis which resulted in a single function regarding to this, showed that psychological and biochemical parameters can be taken together ( $\lambda=46$ ;  $\chi^2_{19}=37.64$ ;  $p<0.001$ ). Also, the canonical correlation coefficient of the variables taken in this model was found to be .74. Also, when the loads and the standardized coefficients of the variables in the partition function are taken into account issues such as competition anxiety, self-control/responsibility and the MDA parameters appear to be important variables that explain the differences between the American football and volleyball players. The much higher level of physical combat in American football is the biggest reason behind these differences. Also, the fact that the players may have the failure anxiety which often emanate from thinking that any mistake made may be very hard to compensate for, and which often results to the player blaming himself for any loss of points and thereby losing his self-confidence because of that, are some of the important reasons for choosing American football over the volleyball as a sport which is highly influenced by both the psychological and biochemical parameters.

Judging by the findings of this research study, it is hereby justified in its prediction of players' choice of sport branch to be 89.7 percent in the case of American football and 90.5 percent in the case of volleyball. Among the psychological variables, the competition anxiety and self-confidence/responsibility and biochemical parameters of MDA showed that it was possible to classify both players correctly by 90 percent and to show the branch of the player right with a very good accuracy. This data shows that the research model functions well in the explanation of the reasons behind the choice of American football or volleyball.

### CONCLUSION

There were some significant differences between the self-confidence/responsibility, competition anxiety, feeling intensity and MDA levels of the American football players and those of the volleyball players. It was observed that the psychological and biochemical parameters of players have been 55 percent effective in their selection of either American football, or the volleyball. The most effective parameters in the selection were competition anxiety, self-control and MDA. These values were much higher in American football players. According to a discriminate analysis, the study correctly grouped the choice of American football to be 89.7 percent and volleyball to be 90.5 percent. The total correct estimation was 90 percent.

### RECOMMENDATIONS

When we consider these data, it becomes evident that the psychological and biochemical selection parameters did change according to the contact which is experienced in much more aggressive sports such as American football, over a non-contact sport such as volleyball.

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