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Influence of Playing Venue on Testosterone and Cortisol Responses in Male Inter-University Volleyball Players

Abstract

The present study aimed to examine the effect of playing venue on testosterone and cortisol responses in male volleyball players. Ninety-six players from eight different public and private universities were monitored during eight competitive matches playing against each other on a home and opponent's home ground. The matches played at home were also won. Testosterone (ng/mL) and cortisol (µg/dL) levels were analyzed before and after each match. A significantly ($p < 0.0001$) pre-match reduction was seen in the testosterone level of players on the opponent's home ground as evidence which indicates that playing venue affects the players' behavior even, they did not play the match. Whereas, significantly ($p < 0.0001$) higher pre-match cortisol level of players was observed on an opponent's home ground before the commencement of the match. The present study concluded that playing venue strongly influenced the players' hormonal responses, and they perceive more stress while playing on the opponent's ground.

Key Words: Volleyball, Player, Testosterone, Cortisol, Playing Venue

Introduction

The favorable home position is a very much archived wonder in games rivalry, for example, baseball, football, ice hockey, rugby, and basketball ([Bruffvet et al., 2016](#); [Fothergill et al., 2017](#)). Despite the uncertain outcomes, different studies have concluded a positive relationship between the mental and social states' previous competitive events and home advantage (Almeda and Volossovitch, 2017; [Pollard and Armatas, 2017](#)). Several studies have acknowledged that players and teams perform extensively better when they play at home as compared to away from home ([Allen and Jones, 2014](#); [Bruffvet et al., 2016](#); [Aquino et al., 2017](#)). For instance, it can be seen that home ground plays an important role as there are several examples of medals winnings of host countries in the Olympic Games ([Kenyon and Bodet, 2018](#)), and meta-analytical reviews (Jamieson, 2010) have shown that home teams will win roughly 60% of every athletic event.

Even though a home advantage position is more predominant in a few games than in others (Almeda and Volossovitch, 2017), there are no games in which players or teams are more successful away from their home scene. Experts have proposed different factors that might positively effect on home ground ([Pollard and Armatas, 2017](#)). These factors fairly make a favorable playing environment for players affecting players' hormonal responses and anxiety levels during playing at their home ground and away from the home ground ([Bernardi and Steyn, 2020](#)).

Testosterone (T) is an essential steroid hormone; it is serving anabolic capacities, for example, support and developing muscle and bone tissue. This steroid hormone involves in the sexual characteristics of maleness is also linked up with the assertive behavior of the player, which contributes to increased performance of players when he plays at his home ground as well as away grounds ([Massimino et al., 2019](#)). This hormone also has a crucial role in maintaining territoriality in kingdom Animalia. Moreover, it is also associated with aggression and attack during the defence of their territory in animals ([Apfelbeck et al., 2017](#)). Another research has been conducted to study the association between the location of a game and the psychological state of an athlete in the pre-game stage ([Carré et al., 2006](#)). In soccer players, the level of testosterone has been studied in the pre-

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competition stage. In this research, it was found that in a pre-game stage of the level of testosterone hormones was significantly lower in those players who were playing at the opponent's venue as compared to those players who were playing at the home venue. This research gave an important finding that when humans are playing at their home Territory, a high level of testosterone is found in their body. In various rodent and primate studies, this territoriality phenomenon has been observed (Davis and Marler, 2003).

Cortisol (C), a stress hormone produced by the adrenal cortex, also responds to the competitive environment (Jiménez et al., 2020). It has been observed that when an athlete performs at an away competition venue than his ground, his state anxiety level increases due to fear of losing his social status or game victory (Carolina-Paludo et al., 2020). It has been investigated that stress felt by the player before, during and after the match (Filaire et al., 2009).

A model that theoretically explains the relationship between gaining, and losing and also maintaining status, has explained the relationship between the player's condition and hormones during the competition (Kivlighan et al., 2005). Van-der et al. (2010) hypothesized an inversely proportional relationship between the level of the hormone testosterone and willingness to participate, maintain or achieve social status through the competitions. The following contents are proposed to include this feedback loop: in case of the rise in the level of testosterone in an individual's, he or she gets more activated and more willing to compete in an attempt to win also gain or maintain social status. These reciprocal factors of the model find that when an individual wins in the state of competition, this winning of competition causes a rise in the level of testosterone hormones. Whereas defeating causes a decrease in testosterone (Fig. 1).

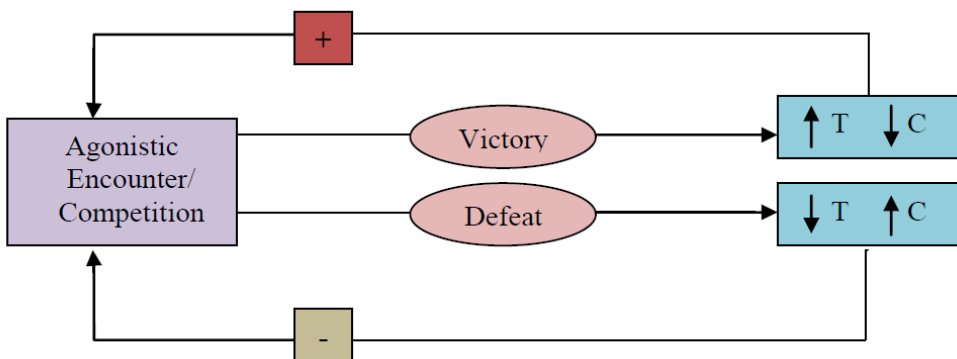


Figure 1: Biosocial Model of Status (Salvador, 2005)

The basic idea of this model is that in a similar competition, individuals who are there for status, an individual tries to 'out stress' his or her opponent through several aggressive and non-aggressive means (Booth et al., 2006). The victories of the status in the competition take a higher rank; on the other hand, the defeated player takes the lower rank (Hsu et al., 2006). Researchers found like degree primate species vary to which they express their speciality and status, whereas primate species that have been studied till now express a consistent rank measuring scale to influence, power, and value generally. Players, being positive and assertive, better able to handle the pressure circumstance are mostly stated the individuals with higher ranks (Gohmet et al., 2005). Nervous, insecure, and submissive and probably succumb to stressful conditions are of those with a lower rank. In complicated that social interactions, calmness, positivity and assertive social nonverbal behavior are vital. Elite athletes regularly engage in ranking competition and get benefits from these trials. Along with testosterone, there are many other hormones, such as the hormone cortisol, which also plays a vital role in responses to competition. Many situations of competition, like athletic events, are stressful, so in response to that condition, cortisol hormone is secreted through HPA-axis activation (Guilliams and Edwards, 2010).

The model demonstrates that players of lower rank experience a bear higher level of stress and, in response to elevated stress, would have more elevated levels of cortisol hormone in the blood

([Sherman et al., 2012](#)). Furthermore, the Cortisol level in a post-competition period of the individual may be impacted when the individual getting defeat in sports would feel greater pressure ([Kivlighan et al., 2005](#)). It can be observed the raised level of testosterone hormone in the winner of the competition after a victorious bout (or a rise in status) and the next competition raise the level of testosterone hormone is hypothesized to be helpful to win the contest create a favorable snowball effect ([Carré et al., 2006](#)). The calm state of mind and confidence, to get engaged in competitive situations with assertiveness, victorious are hypothesized to be more interested, so these changes of hormones lead to another victory with increasing chances ([Archer, 2006](#)). It assumed that the player would experience a decrease in testosterone, which may result in the player being more nervous and insecure before participating in future competitions after facing failure. ([Ritchie and Van-Anders, 2015](#)). For athletic coaches who look way to take the victorious trophy to their home and struggle to stay away from the failure for all of the research related to winning and getting defeat status contests and their relationship with hormone would be vital.

To athletic mentors who are continually searching for an approach to proceed with their triumphant ways for them impact of winning and losing is vital and their relationship with hormone too ([Etzel, 2006](#)). Rat, Bird and Non-Human Primate Studies, in evaluating. Inside a serious setting biosocial model of status, it is critical to research hormonal reactions to both winning and getting defeat from someone; because of ([Chichinadze et al. \(2012\)](#) biosocial model of status, one would anticipate that testosterone should ascend in victors and drop in failures while cortisol should ascend in failures and drop in champs). Concentrates on rodents, feathered creatures, and primates have given general help to the biosocial model of status. For instance, Generally, a decrease in testosterone following the challenge found that male mice on the losing end of an agonistic experience.

Moreover, the winner's impact on the California mouse is examined by [Oyegbile and Marler \(2005\)](#). Winning future agonistic is improved by the free of the improved battling method, victors exhibited a huge rise in testosterone. (Notwithstanding rat considers, it has been discovered that fruitful agonistic experiences increment testosterone in winged creatures. For instance, [Fessler et al. \(2001\)](#) took a glance at the connection between rivalry results and testosterone levels in hostage male red wilderness fowl. The researchers report that the champs are those people who attacked first, and the victory can be related to the best rise in testosterone ([Salvador, 2005](#)). One another research by the researchers with primates gave fractional help to the biosocial model of status.

Nonetheless, the key distinction is that dominants have lower corticosterone levels, essentially as compared to subordinates. Accordingly, the rat contemplates proposing that competition is related to raised degrees of corticosterone in the two champs (dominants) and failures (subordinates), yet subjection is related to the most significant levels of corticosterone ([Williamson et al., 2017](#)). With dominants in many different competitions having higher cortisol while subordinates giving higher Cortisol levels in some primate competitions, research on cortisol and primates has been progressively element. [Novaco and Gonzalez \(2009\)](#) proposed that subordinates will have the most noteworthy Cortisol levels on the off chance that they live in a stressors' domain loaded up with physical and mental stressors and come up short on a social, emotionally supportive network. Moreover, [Kudielka et al. \(2009\)](#) contend that the general guideline is that subordinates present with constantly elevated cortisol levels due to the most physical and mental stressors; however, there are exemptions according to their social venue wherein rank is assigned.

The main objective of the study is to check the effect of playing venue on testosterone and cortisol responses of volleyball players that how testosterone and cortisol concentrations vary on home as well as away grounds.

Material and Methods

In this study ninety-six, university volleyball players having an age range between 18 to 25 years from eight public and private universities situated in Lahore city were recruited. All physically fit players who had participated in the Higher Education Commission (HEC) inter-university sports competition 2016-17 representing their university were recruited for the present analysis. Players were involved in their routine training schedule. Consent was taken from each of the players as well as their directors and team management before the commencement of the study.

To collect the data of both home venue and away venue competition, volleyball matches were organized in such a way that every team got a chance to play one match on her home ground and one match on away venue with the same team.

Blood sampling was conducted before sixty minutes of the commencement of match time. A registered medical technician from a patent pathology laboratory, under the supervision of a qualified medical practitioner, was hired for the blood samples of recruited players for pre-test analysis, keeping in view all the ethical aspects. Then, players were allowed to play the match, and fifteen minutes after the match, again, medical staff took a blood sample for the post-test analysis (Arr5uda *et al.*, 2014). The same practice was repeated in all eight basketball matches with the time-lapse of one match after every three days early in the morning after getting an eight-hour normal sleep on average and a standard local breakfast having basic macro and micronutrients. Every time after taking the blood samples, medical staff shifts those samples to the pathological laboratory for assessment of Testosterone and Cortisol level in the blood, before and after matches. Testosterone and Cortisol assessment was done by Enzyme-Linked Immunosorbent Assay (ELISA).

Statistical Analysis

Results were analyzed, statistically, by paired sample “t” test (Carré *et al.*, 2006) to work out the significant variations amongst the parameters of the study in comparable groups.

Results

Testosterone level (ng/mL) of Volleyball Players

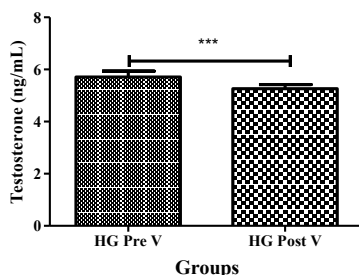


Figure 2 (a): Average Level of Testosterone (ng/mL) in HG Pre-V vs HG Post V analysis

HG Pre-V: Home Ground Pre-test Volleyball

HG Post V: Home Ground Post-test Volleyball

***Significance at $P < 0.001$

Figure 2 (a) reveals that there is a significant difference in pre-test vs post-test testosterone level of volleyball players while playing on their home ground. The average testosterone level (ng/mL) before the match was 5.71 ± 0.22 ng/mL, at home ground, which declined by 8 % after the test. The post-test level on the home ground was estimated to be 5.26 ± 0.16 ng/mL (Table 1).

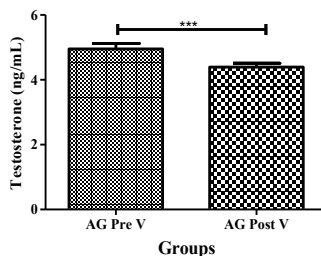


Figure 2 (b): Average Level of Testosterone (ng/mL) in AG Pre V vs AG Post V analysis

AG Pre V: Away Ground Pre-test Volleyball

AG Post V: Away Ground Post-test Volleyball

***Significance at $P < 0.001$

Figure 2 (b) illustrates pre-test and post-test comparison of testosterone level of volleyball players while playing in on away venue. Testosterone pre-test away venue was estimated as 4.95 ± 0.17 ng/mL, which reduced significantly by 11 % in post-test estimation. The average post-test level of testosterone at away ground was 4.39 ± 0.11 ng/mL (Table 1).

Table 1. Average Levels of Testosterone (ng/mL) in Comparable Groups

Game	#	Venue comparison	Test type	Testosterone level (ng/mL)		%age Difference	P-value
				Pre	Post		
Volleyball n=96	a	Home vs Home	Pre	05.71 ± 0.22	8↓***	< 0.0001	
			Post	05.26 ± 0.16			
	b	Away vs Away	Pre	04.95 ± 0.17	11↓***		
			Post	04.39 ± 0.11			

Cortisol level (µg/dL) of Volleyball Players

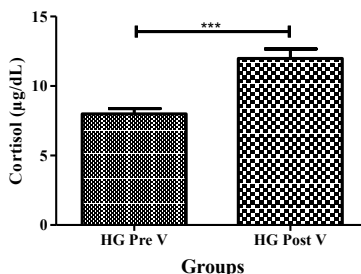


Figure 3 (a): Average Level of Cortisol (µg/dL) in HG Pre V vs HG Post V analysis

HG Pre-V: Home Ground Pre-test Volleyball

HG Post V: Home Ground Post-test Volleyball

***Significance at $P < 0.001$

Figure 3 (a) reveals that there is a significant difference in pre-test and post-test cortisol levels of volleyball players while playing in their home ground. The average cortisol level before the match was 7.99 ± 0.38 µg/dL at home ground, which increased by 50 % in the post-test. The level of cortisol in the home ground post-test estimation was 11.98 ± 0.68 µg/dL (Table 2).

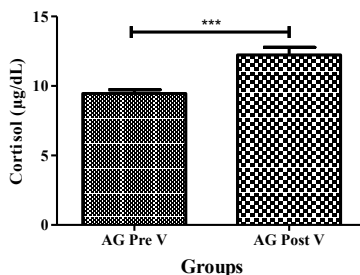


Figure 3 (b): Average Level of Cortisol (µg/dL) in AG Pre V vs AG Post analysis

AG Pre V: Away Ground Pre-test Volleyball

AG Post V: Away Ground Post-test Volleyball

***Significance at $P < 0.001$

Figure 3 (b) illustrates a pre-test vs post-test comparison of cortisol level of volleyball players while playing in an away venue. Cortisol pre-test away venue was estimated at $9.45 \pm 0.27 \mu\text{g/dL}$, which increased by 29% in post-test estimation. The level of cortisol in away ground post-test analysis was $12.23 \pm 0.55 \mu\text{g/dL}$ (Table 2).

Table 2. Average Levels of Cortisol ($\mu\text{g/dL}$) in Comparable Groups

Game	#	Venue comparison	Test type	Cortisol level ($\mu\text{g/dL}$) Mean \pm SEM	%age Difference	P-value
Volleyball n=96	a	Home vs Home	Pre	07.99 ± 0.38	50 \uparrow ***	< 0.0001
			Post	11.98 ± 0.68		
	b	Away vs Away	Pre	09.45 ± 0.27	29 \uparrow ***	< 0.0001
			Post	12.23 ± 0.55		

Discussion

There are several key findings of this study conducted on male inter-university volleyball players. It was observed that when players performed at their home playing venue, their level of testosterone was raised, and they also won the matches. Further, it was also documented in the current study that the cortisol level of players was elevated on the opponent's home ground because of fear of losing the victory status.

Testosterone (T) is an anabolic hormone that mediates sports competition by increasing motivation to compete and physical ability, particularly among males (Vermeer *et al.*, 2016). In our findings, the testosterone level was significantly elevated on the home ground and decreased on the away ground. The trend of reduced testosterone levels in players was seen on away playing ground situations in comparison to the testosterone level of the same players on their home ground; it was declined just because of the changing the playing venue (Arruda *et al.*, 2014).

Some studies found no alteration in the hormonal profile of playing at the home venue or away (Gray *et al.*, 2017; Casto and Edwards, 2016). Whereas, some researchers found a significant difference in the hormonal profile of players who are participating in the competition, played at home venue as compared to those players who are playing away from the home ground. It has been reported earlier that the concentration of testosterone hormone increases after winning the competition, either it is in the home ground or away from the home ground (Fothergill *et al.*, 2017).

Cortisol (C) is another catabolic hormone belonging to the steroid category, which has an association with uncontrolled and unstable conditions (Casto and Edwards, 2016). It is also called the stress hormone. When any emergency and a competitive situation are encountered, it prepares the human body to respond to the stressor stimulus. The challenging conditions and appraisal of threatening are associated with increased cortisol level that might be due to the hypothalamic-pituitary-adrenal axis (HPA) responses to both psychological and physical stress from the external environment (Popma *et al.*, 2017).

Whenever any sign of disturbance is observed, the hypothalamus-pituitary-adrenal (HPA) response through cortisol biosynthesis acts as an indicator of stress condition (van Dalfsen and Markus, 2018). In response to the unstable and stressful conditions, C begins to rise. For example, in a competitive state, a player encounters several psychological stimulators and stressors, perpetuating the rising of C that results in altered glucose level, cardiovascular activation and anti-inflammatory responses to tackle the overwhelming stress (Wright *et al.*, 2010).

It was observed, in the current study, that level of cortisol also increased on the home ground due to an increased level of the crowd expectations, though this psychological parameter was not evaluated in the current study.

Whereas, in another research, a positive relation was observed between pre- and post-fight Cortisol levels in Judaists and somatic anxiety (Moreira *et al.*, 2012). Somatic anxiety, testosterone and pre-round C in the competition of golf also expressed the same similar trends (Filaire *et al.*, 2009).

In sports competitions, variations in behavior and physical expressions are caused by hormonal changes, which are due to the triggering of HPA to respond to the externally stimulating factors. The relationship between cognitive anxiety and salivary testosterone is negative; when the player is

performing away from his home venue, he feels worried, apprehension and nervousness; this condition occurs when the player is unfamiliar with the playing venue in the presence of moderate testosterone.

Research has revealed that playing location also influences hormonal responses due to psychological factors such as the level of state anxiety ([Arruda et al., 2017](#)).

Conclusion

In conclusion, playing at home ground in favorable conditions elevate testosterone level while playing in away ground testosterone level gone down due to unfavourable conditions. In opposition to that, the cortisol level of players goes higher on the opponent's home ground due to the opposed situations. Playing venue influences players' hormonal responses at home and away from the ground, due to which players' performance and match outcomes are affected.

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