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Hormonal Influences on Mood: Examining Testosterone and Cortisol in University Male Basketball Teams

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Abstract

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Keywords: Testosterone, Cortisol, Competition, Basketball players

Authors:

Rida Qasim: M.Phil Scholar, Department of Sport Sciences & Physical Education, University of the Punjab, Lahore, Punjab, Pakistan.

Yasmeen Tabassum:(Corresponding Author)
Assistant Professor, Department of Sport Sciences & Physical Education, University of the Punjab, Lahore, Punjab, Pakistan.
(Email: yasmeentabassum111@gmail.com)

Badar Mohy ud Din: PhD Scholar, Department of Sport Sciences & Physical Education, University of the Punjab, Lahore, Punjab, Pakistan.

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Title

Hormonal Influences on Mood: Examining Testosterone and Cortisol in University Male Basketball Teams

Authors:

Rida Qasim: M.Phil Scholar, Department of Sport Sciences & Physical Education, University of the Punjab, Lahore, Punjab, Pakistan.

Yasmeen Tabassum:(Corresponding Author)
Assistant Professor, Department of Sport Sciences & Physical Education, University of the Punjab, Lahore, Punjab, Pakistan.
(Email: yasmeentabassum111@gmail.com)

Badar Mohy ud Din: PhD Scholar, Department of Sport Sciences & Physical Education, University of the Punjab, Lahore, Punjab, Pakistan.

Contents

Abstract

This study investigated testosterone and cortisol levels on mood states among university male basketball players who had been preparing themselves for the intervarsity competition 2023-2024. The researcher selected 24 players from the University of the Punjab, Lahore, and Government College University Lahore n=12 each, aged between 19 to 25 years. Psychological states were evaluated using the Profile of Mood States(POMS) after matches, while aerobic fitness was assessed using the Cooper Test, which correlates with testosterone levels and POMS parameters. The results revealed that the winners had a considerably higher level of testosterone, while cortisol levels were diminished. Winners further showed improved POMS scores that indicated better mood states and high VO2 max levels, an indication of better aerobic fitness. Results indicated that high testosterone levels are the cause of high vigor and enhanced psychological resilience and that low cortisol levels reflect a decrease in stress and anxiety after the competition.

Keywords: Testosterone; Cortisol; Competition and Basketball players

Introduction

The strong relationship that has been put together in the triad of psychology, endocrinology, and physical performance regards complex interactions between the mind and body (Ellison, 2020). Psychology is defined as a scientific study of human behavior and mental processes, discovering various aspects of human experience: thoughts, emotions, behavior, and social interactions. In contrast, endocrinology concerns the study of hormones and the endocrine system responsible for managing several functions of the body (Johansen et al., 2020). Regular exercise improves the human body's resilience to various physical demands, showing their interrelationship. The focus of this study is on male university basketball players. The study will

be conducted on the relationship of the levels of testosterone and cortisol to the mood status of the winning and losing players, respectively. In addition, it also determines how VO2 max supports the balance of hormones and the status of mood during contention.

Hormones are chemical messengers synthesized by endocrine glands and are implicated in metabolism, growth, development, reproduction, and the response to stress (Ahrorbek et al., 2023). Stressful hormonal reactions give way to feelings of anxiety. Neurotransmitters, like serotonin, also modulate feelings directly and are under the control of hormones. A good example is cortisol, which deals with regulating mood, as released during games, and has a direct effect on emotions like elation or sadness (Li &Graham, 2017). There is an interaction between hormones and moods during sports competitions at the team level, and knowing how this occurs is relevant for performance, well-being, and success in regard to athletes (Kim et al., 2023).

Testosterone is a steroid hormone, synthesized for the most part in the testes of genetic males and, in much smaller amounts, in the ovaries of genetic females. It is involved in a variety of physiological processes, which include the regulation of muscle mass, maintenance of bone density, and fertility, apart from its role in cognitive function. In relation to athletic contexts, it is putatively associated with competitive behavior and performance (Kraemer et al., 2020). According to research, testosterone levels increase in response to competitive stimuli and appear to signal a drive to win.

Elevated testosterone is associated with assertiveness, confidence, and risk-taking behavior, traits conducive to athletic performance (Blake et al., 2017). However, the relationship between testosterone and performance is not linear. Excessive fluctuations or imbalances can have detrimental effects. High testosterone levels may increase aggression and impulsivity, compromising decision-making abilities. Conversely, insufficient testosterone levels can lead to fatigue, lethargy, and decreased motivation, impairing performance (Borresen& Lambert, 2009).

Cortisol (C), known as the "stress hormone," is produced by the adrenal glands in response to stress. It mobilizes energy reserves and facilitates adaptive responses to stressors. In sports, cortisol regulates energy metabolism, inflammation, and immune function, impacting performance and recovery (Walsh, 2018). During competitions, cortisol levels rise due to physiological and psychological stressors, enhancing arousal, vigilance, and alertness (Sim et al., 2023). Prolonged activation of the stress response system can impair cognitive function, decrease immune function, and disrupt sleep patterns. Chronic cortisol elevation is linked to burnout, anxiety, and depression, negatively affecting mental health and well-being. Dysregulated cortisol secretion may contribute to overtraining syndrome, characterized by persistent fatigue, decreased performance, and increased injury risk (Armstrong et al., 2022).

The Profile of Mood States (POMS), developed by David McNair, David Lorr, and Richard Droppleman in 1971, measures transient mood states. Unlike personality tests that assess enduring traits, POMS captures current emotional states, providing a structured and objective assessment (Jaggumantri, 2023).

VO2 max (maximal oxygen uptake) measures the maximum amount of oxygen a person can utilize during intense exercise, expressed in ml/kg/min. It indicates cardiovascular fitness and aerobic endurance, reflecting the efficiency of the cardiovascular and respiratory systems in delivering oxygen to muscles. Higher VO2 max values suggest a greater ability to perform sustained aerobic exercise and a higher fitness level (Myers et al., 2017).

Research Methodology

A two-group, pre-test, and post-test experimental design with a quantitative approach was employed, involving the University of the Punjab (PU) and Government College University (GCU) basketball teams. Coaches implemented six-week training programs focusing on skill development and physical fitness before the HEC Intervarsity Men Basketball competition (2023-2024). Matches were held at Lahore University Management Sciences (LUMS) sports complex at 8:00 pm. Blood samples for hormonal analysis were collected 45 minutes before and 15 minutes after each match, following. Mood assessments were conducted 20 minutes post-match, and a VO2 max test was administered at 10:00 am on match day. The study used a convenience sample of 24 male basketball players

aged 19-25 years from PU (n = 12) and GCU (n = 12). All players provided written informed consent. Inclusion criteria were age 18-25, university enrollment, and active participation in the 2023-24 HEC Intervarsity sports competition. The sample mean was 22.42 kg/m² in BMI, 52.13 kg in weight, 20.37 years in age, and 171.79 cm in height Exclusion criteria included current drug or medication use and a history of endocrine disorders. Blood samples (5 ml) were collected by trained phlebotomists 45 minutes before and 15 minutes after matches. Testosterone levels were measured using a BECKMAN COULTER enzyme-linked immunoassay kit (REF: 33560), and cortisol levels using another BECKMAN COULTER kit (REF: 33600). Mood states were assessed using the Profile of Mood States (POMS) inventory, and VO2 max was estimated using the Cooper test. Ethical considerations included informed consent, participant confidentiality, well-being monitoring, and adherence to ethical guidelines. Data were analyzed using SPSS version 25, First, Shapiro-Wilk tests of normality were conducted, followed by parametric tests in the form of two-tailed Paired sample t-tests for hormonal influences on mood, and Independent Sample t-tests to compare hormone levels between winning and losing teams.

Results

Table 1

Testosterone, Cortisol, POMS, and VO2 Max Variables for Winning and Losing Teams

Variables	N	Mean	SEM	t	P value
Testosterone					
Winning Team Testosterone Pretest	12	4.00	.35	-3.87	.00
Winning Team Testosterone posttest	12	5.38	.28		
Loser team Testosterone Pretest	12	4.49	.35	2.81	.01
Loser team Testosterone post-test	12	3.80	.31		
Winner team Testosterone post-test	12	5.38	.28	2.45	.01
Loser team Testosterone post-test	12	3.80	.31		
Cortisol					
Winner team cortisol Pretest	12	16.64	3.85	-4.74	.001
Winner team cortisol post-test	12	9.34	3.12		
Loser team cortisol Pretest	12	8.69	2.18	-4.33	.001
Loer team cortisol Pretest	12	14.64	3.20		
Winner team cortisol post-test	12	9.34	3.12	1.45	0.01
Loser team cortisol Pretest	12	14.64	3.20		
POMS					
POMS (winner team)	12	81.57	3.17	8.74	.000
POMS (Loser team)	12	47.76	1.49		
VO2 Max					
Winner team VO2 Max	12	6.21	3.23	2.60	0.01
Loser team VO2 Max	12	5.11	4.19		

Table 1 showed significant changes in the hormonal, psychological, and physical parameters of the winning and losing basketball teams. The winning team showed a high increase in testosterone from the pretest to the post-test with the mean changing from 4.00 to 5.38, SEM = 0.35 and 0.28 respectively, t = -3.87 and p = 0.00. In contrast, the losing team decreased in testosterone from the pretest (Mean = 4.49, SEM = 0.35) to the posttest, with a mean of 3.80 and SEM of 0.31, with t(25) = 2.81, p = 0.01. Moreover, cortisol levels of the winning team decreased from the pretest (Mean = 16.64, SEM = 3.85) to the post-test (Mean = 9.34, SEM = 3.12), given a t-value of -4.74 and a p-value of 0.001. On the other hand, the cortisol levels of the losing team increased from the pretest (Mean = 8.69, SEM = 2.18) to the post-test (Mean = 14.64, SEM = 3.20), at a t-value of -4.33 and a p-value of

0.001. POMS psychological assessments had higher values in the case of the winning team, with mean = 81.57 and SEM = 3.17, compared with the losing team, where the values were mean = 47.76 and SEM = 1.49. The t-value here was 8.74 with a p-value of 0.000. Finally, the values of VO_2 max are higher in the winning team mean of 6.21, SEM 3.23 compared with the losing team, where the mean is 5.11 and SEM is 4.19, t = 2.60, and p = 0.01.

Discussion

The present study aimed to investigate the effect of testosterone and cortisol on the mood status of winners and losers players of the match whereas the second primary aim was to examine the VO_2 max values of players of both teams because VO_2 max helps to manage psychophysiological parameters during sports activity. For this purpose, a total of 24 basketball players from PU n=12 and GCU n=12 who were engaged in the preparation of the HEC Intervarsity Basketball Championship 2023-2024 were selected for this investigation.

Testosterone

The first objective of the study was to measure the value of testosterone before and after the match. Testosterone is one of the most important hormones in the regulation of physiological and psychological processes; it is a major factor in sports team competition.

This research reviews some findings that have emerged from various research studies in establishing the relationship between testosterone levels and mood states of athletes, with views of its implications on performance and competitive outcomes. A study by Cook et al. (2018) assessed testosterone responses in the context of mood state change in professional soccer players across a competitive soccer match.

This was a study where the levels of testosterone before and after matches were measured, and mood assessment used standardized inventories. The results indicated that before matches, testosterone levels were high and parallel to an increased feeling of vigor and confidence. After the match, the testosterone levels had fallen in connection with changed mood states that reflected the outcome of the match. The positive mood changes were associated with victories. This study points to the dynamic interplay among testosterone, mood, and soccer performance.

In the study by Oliver et al. (2013), researchers followed up on the testosterone responses of rugby players over an entire competitive season. What was shown in this study was that there were variations in the levels of testosterone in relation to the outcome of matches and training loads. The findings proved that, against such a background, in cases of victory, the level of testosterone is high, and in cases of defeat, it is low. Thus, the relation between competitive success and hormonal response to exercise is proved. At the same time, mood ratings indicated that a win is related to increased confidence and reduced anxiety, while a loss is related to increased tension and bad states of mood. This might perhaps best epitomize the likely effect of match outcome on testosterone fluctuations and mood states in rugby. In a study by Crewther et al. (2012), changes in the level of a number of hormones, including testosterone, were monitored with emotional responses to exercise through a full competitive season in elite basketball players.

The study found increases in pre-game testosterone levels, which were taken to be a sign of increased arousal and readiness to compete. Measures of mood states varied with emotional states; with the higher levels of testosterone going into the game correlating with increased vigor and assertiveness. Following exercise, post-game testosterone levels decreased, often paralleling changes in the mood state influenced by game performance and team success. The present study shows how testosterone might relate to emotional responses and psychological readiness in basketball athletes.

Crewther et al. (2008) conducted research into testosterone responses and stress-related markers of cricket players during match preparations. The design measured pre-match testosterone with cortisol responses and mood states using validated inventories. The findings indicated that increasing testosterone is associated with psychological preparedness and competitive arousal, and provides the optimal platform for performance readiness. For example, cortisol fluctuations as a stress response mirrored changes in testosterone, again with improved mood and performance outcomes under higher states of arousal. The

present study underlines complex interactions in testosterone, stress responses, and mood dynamics within cricket.

A study by Salvador et al. (2003) assessed the relationship between testosterone levels and state anxiety during tournament competition in tennis players. The research investigated the changes in testosterone before and after the matches and measured anxiety using standard rating scales.

Results from the study indicated that high testosterone levels are associated with low anxiety and high confidence, both of which facilitate focused performance through tactical decisions before the match. It proves that testosterone also modulates the state of anxiety response and increases psychological resilience in the competitive context of tennis.

Cortisol

The second objective was to assess the cortisol levels among winners and losers before and after the match. An important area of study in this context is how the cortisol level would interplay with the mood in sports team competitions. Cortisol is often referred to as the "stress hormone" and is a glucocorticoid hormone. The athlete, coach, and sports psychologist must understand how cortisol fluctuations relate to variations in mood and performance.

In a study by Filaire et al. (2001), the authors assessed the relationship between cortisol and state of mood in professional soccer players. The study measured cortisol and state of mood before and after the match. The results indicated that the cortisol levels before competition were significantly high, and related positively with anxiety, and tension. Cortisol levels and mood states decreased in post-match measurements; the best mood state improvements were found in the winning teams.

This research underscores the anticipatory increase in cortisol related to pre-competition anxiety and the affect-improving consequences of successful performance.

In a study carried out during a competitive season, Elloumi et al. (2012) assessed cortisol responses to, and mood changes experienced by, rugby players during this period. Their results indicated that the cortisol concentration at match time was significantly higher than at training time, thus indicating increased stress in competition. Mood state assessments revealed increased feelings of vigor and a reduced state of fatigue after winning, but high depression and anger after losing. The current study provides insight into the changeability of cortisol and mood during the course of a competitive season, as well as the effects of match outcomes on these psychological states.

A study by Moreira et al. (2012) assessed hormonal changes and mood states throughout a basketball tournament at the elite level. It indicated an increase in cortisol prior to the games, and this increase was associated with tension and anxiety. The marked drop in cortisol after playing (games they had won) had positive effects on their mood state by reducing tension and improving vigor. These results suggest that successful performance reduces the stress response and improves mood, whereas losses accentuate stress and negative emotions.

Goymann and Wingfield (2004) examined the stress hormone responses in terms of the mood of female handball players. In this study, the state of cortisol level was measured at different phases of competition. The results indicated peak cortisol levels during high-stakes competition with increased anxiety and tension. However, as the tournament proceeded, the players acclimatized to the playing environment, and their cortisol levels and anxiety decreased. This study shows how the stress response changes during the course of competition and that it is related to changes in mood state.

A study by Suay et al. (1999) evaluated the changes in cortisol responses and state anxiety in competitive ice hockey players during a playing season. This research group reported that cortisol concentrations were greatly shifted during the most stressful matches since this increase in cortisol output paralleled an increase in anxiety and tension levels. Post-match measurements indicated a decrease in cortisol with an improvement in mood, more so in teams that emerged victorious. It was noted that, in the case of chronic exposure to high competition stress with low recovery possibility, baseline cortisol levels were high and state anxiety and major mood disturbances were prevalent, thus underpinning the potential role of recovery strategies in the management of stress and mood among athletes.

Mood Status

The third objective of this study was to establish the mood status of players of winners and losers after the match. Mood status is one of the factors that drive competition of sports teams, hence impacting positively or negatively on sports performance, team dynamics, and the general well-being of athletes. A number of studies have been done regarding the effects of competitive environments on mood states in athletes, hence providing insights into the psychological aspects of sports performance. A study conducted by Lane and Terry (2000) traced the mood states of professional soccer players during the playing season. The POMS was administered on several occasions prior to, as well as following, the matches of the study. Results indicated that players experienced a significant increase in tension, depression, and anger prior to high-stakes matches, while a win would be followed by increased vigor and decreased fatigue.

The present study demonstrated that there is a high influence of match outcome on the mood status of soccer players, thus, it indicated that psychological interventions can be pertinent in managing the mood before and after the competition. A further recent study by Robazza and Bortoli (2007) measured the status of mood among rugby players over the period of one competitive season with the help of POMS and showed that there were significant changes in mood states across the season. In particular, periods of high competition were associated with increased tension, depression, and fatigue. Wins were associated with higher vigor and lower tension, and losses with higher depression and anger. The present research thus exemplifies the fluidity of mood based on the demands of a competitive season and also underlines a need for psychological services to be delivered to athletes. Hall et al. (1998) focused on another study about the emotional responses of basketball players during a tournament.

Competitive State Anxiety Inventory-2 was used to evaluate competitive anxiety, and POMS evaluated mood state. Results showed that high anxiety and tension were found among players, with general improvements in mood higher vigor, and less depression after victories. Indeed, losses were associated with large increases in anger and depression. The findings from this study reflect emotional volatility in athletes due to high-pressure tournaments and the need for effective coping strategies. In a study targeting to find the relationship between mood and performance in female handball players, Rohlfs et al. (2005) found that with the use of POMs, positive mood states, such as vigor and excitement, were positively related to better performance outcomes. Additionally, negative mood states, including tension and depression, were related to poorer performance.

This research thus suggests that performance in team sports could be enhanced through interventions aiming at enhancing positive mood states. Other research by Zeni et al. (2011) explored mood states in volleyball players during a competitive season. The assessment of change in mood before and after the match was done using the POMS. This indicated that pre-match tension and anxiety were very common, and following a victory, post-match improvement in mood, characterized by increased vigor, may be noted. Losses were associated with increased feelings of depression and anger. This study points to the competitive results on the mood state and how important mood management strategies are in maintaining psychological well-being for athletes.

VO_2 Max

The fourth objective of the study was to examine the VO_2 max score of players of both teams before the match. VO_2 max is one of the most important physiological variables related to sporting activity, especially in team sports, where aerobic capacity has been reported to have important implications for performance. This discussion reviews literature reporting VO_2 max values in different team sport contexts and its relationship with athletic performance and training implications.

In a study by Castagna et al. (2010), VO_2 max values for professional soccer players were analyzed according to the position played. The conclusion they reached was that midfielders and forwards usually record a higher level of VO_2 max compared with defenders and goalkeepers. The larger the VO_2 max, the greater the endurance and aerobic capacity of the player, thus helping them perform at a high level throughout the whole game.

The current research emphasizes aerobic fitness in relation to soccer and position-specific training that will allow for the maximum expression of VO2 max. Gabbett et al. (2008) investigated the relationship between VO2 max and rugby league performance. VO2 max was recorded during the preseason, while game statistics were compiled for the entirety of the in-season phase. Higher VO2 max players were more involved in the game since they made more tackles and ran more meters. This evidences that good aerobic fitness helps in the maintenance of Rugby match performance. This underlines the role of VO2 max for endurance and active participation during a game.

In a different study, Foster et al. (2001) measured the level of VO2 max in elite basketball players. They realized that the better the level of VO2 max, the better the game performance in that players recovered faster between high-intensity efforts hence allowing more playing time and efficiency.

It also found that aerobic capacity improved through appropriate training, enables superior levels of performance to be attained and sustained throughout basketball games.

In a study by Patel et al. (2011), VO2 max levels of field hockey players were investigated in relation to positional roles and match demands. It was found that midfielders and forwards, who usually cover more distance and frequently have high-intensity bursts, showed higher VO2 max values compared to defenders. Higher VO2 max levels were related to better endurance and the capability of maintenance of performance in games, which contributes to team success. The current study, therefore, substantiates the position-related difference in aerobic demands and forms the basis for specific training programs on the optimization of VO2 max in this team sport: field hockey. Kara et al. (2008) examined the VO2 max values of professional volleyball players and their relationship with game performance. VO2 max was measured during preseason testing and related to match statistics in jump height and agility. Thus, higher VO2 max players would be able to continue pounding the ball over the net for a longer period of time in the case of long-lasting rallies and recover more quickly between the points. This clearly shows the role played by aerobic capacity in sustaining the level of performance throughout volleyball matches.

Conclusion

As a result, from the detailed review of studies involving university basketball male players, complex interactions of testosterone, cortisol, mood status, and VO2 max in competition in sports teams were shown. It is possible that the elevated levels of testosterone associated with heightened vigor, confidence, and readiness to compete might have contributed to improved performance and favorable mood state experienced by the players after their success. On the other hand, alterations in testosterone and mood may be the result of the stress of competing and of events occurring during the match, which impacts the athlete's psychological state and readiness to perform. The marked effects of cortisol level changes on mood status underline the contribution to states of anxiety and tension building up to competition; successful performances are usually associated with a decrease in cortisol and an improvement in mood, while losses are associated with continued high cortisol and negative mood states. The higher the VO2 max levels, the better this parameter improves resistance, recovery, and generally all performance indicators of diverse sports disciplines, therefore requiring personalized training methods to maximize aerobic capacity and ensure team success. In particular, the question requires further dynamic interactions in future research in order to more precisely refine protocols of training and psychological support aimed at the optimization of athletic performance and well-being in competitive sports. Future studies can be done on interventions that would optimize hormonal responses and improve athletic performance in university basketball players.

Recommendations

Based on the findings from the study on university basketball male players examining the impacts of testosterone, cortisol, mood status, and VO2 max on winning and losing statuses in the sports team competition, the following recommendations are proposed:

Optimizing Testosterone Regulation: With testosterone playing such a key role in vigor, confidence, and readiness to compete, the future

really involves optimizing testosterone in as natural a manner as possible. This is best done through individualized training, nutritional interventions, and psychological techniques that will support a positive hormonal environment for peak performance.

Development of mood management strategies: Contingent upon the evidence accrued regarding the performance outcome effect of mood states, strategies for the effective management of mood should be developed and implemented. Such psychological interventions as cognitive-behavioral techniques and mindfulness training should be introduced into the athletes' preparation routines to manage less desirable mood states like anxiety, depression, and anger, and promote a more stable emotional base from which to perform.

Development of stress management techniques: The effect of cortisol levels on anxiety levels before performance underlines the need for integrated stress management techniques. Coaches and sports psychologists should be collaborating in programs designed to reduce stress through relaxation techniques, biofeedback training, and inoculation programs to better equip athletes to handle pressures and maintain optimal cortisol levels.

Individualized Training Programs for Aerobic Capacity: Since VO_2 max has been indicated to be a constant predictor of endurance performance in the majority of sporting disciplines, future research should aim at further refining any training regime individually tailored towards improving aerobic capacity. Position-specific training regimes, interval training methods, and periodized conditioning programs need to be designed to ensure maximum VO_2 max levels so that teams may achieve more success when competing.

Continued Interdisciplinary Research: Interdisciplinary research collaboration is highly encouraged to take the understanding of hormonal responses, mood dynamics, and performance outcomes of sports competitions by teams to new heights. Holistic approaches toward athlete preparation and performance enhancement can be derived from insights taken from Physiology, Psychology, Nutrition, and Sports Medicine.

In summary, applying these suggestions in case the results are anything to go by can help optimize athletes' preparation, improve performance outcomes, and promote general well-being during sports competition among teams. Future research on this area needs to replicate itself across a myriad of sports and competitive environments so as to finally come up with strategies that target the maximization of athletic potential to attain lasting success.

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