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INVESTIGATING THE EFFECT OF PHYSICAL TRAINING ON CORTISOL LEVELS OF PLAYERS

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ABSTRACT:
Background: Cortisol, also known as the stress hormone, plays a crucial role in the body's response to stress.
Method: This study determines the effect of an eight-week physical training program on cortisol in male university athletes in the sports disciplines of ergo rowing, middle-distance running and long-distance running. Ninety participants were recruited from three universities in Lahore and divided into sport categories. The design was short-term longitudinal; cortisol levels were measured at three stages: pre-training, mid-training, and post-training. Baseline cortisol was measured through real competitions and serum cortisol sampling was done by blood tests analyzed by ELISA.
Results: The results indicated that there was a significant decrease in cortisol levels among all exercising groups; the greatest decrease noted was in the long-distance runners.
Conclusion: These current findings give evidence on the basis of efficacy of regular aerobic exercise in decreasing stress by modulating the hypothalamic-pituitary-adrenal axis and underline the importance of structured training with adequate recovery for both optimal stress management and players performance. It underpins a role for aerobic exercise in promoting well-being and decreasing physiological stress markers within competitive settings.

Key words: Cortisol, Ergo-Rowing, Middle Distance, Long Distance

INTRODUCTION:

Aerobic activities can modulate cortisol levels by improving stress resilience (1). This modulation effectively manages the physiological reactions to stress, averting the harmful consequences of prolonged elevation in cortisol levels (2). In contrast, anaerobic training, particularly when it involves excessive training or insufficient recovery, may increase cortisol levels, indicating the presence of stress and the necessity for improved recovery protocols (3). Cortisol, also known as the stress hormone, plays a crucial role in the body's response to stress (4). Produced by the adrenal glands, this hormone is essential for maintaining homeostasis in the body, being involved in numerous physiological processes such as metabolism and immune function (5). The significance of cortisol in the stress response has been a focal point of research, with Hans Selye's concept of the "General Adaptation Syndrome" laying the groundwork for understanding cortisol's role in managing stress (6-7).

The hypothalamus and pituitary gland (HPA axis) in the brain primarily mediate cortisol's activity during stress (8). Activation of the HPA axis triggers cortisol release, leading to increased blood sugar levels, enhanced glucose utilization in the brain, and the availability of substrates for tissue repair (9). The HPA axis regulates various body processes such as digestion, the immune system, emotions, and sexuality (10). The type and intensity of stress influence cortisol release, with physical stress, such as exercise or injury, eliciting different patterns compared to psychological stress, such as anxiety or fear (11). Understanding the critical role of cortisol as a stress marker requires examining these fundamental and distinct responses (12-13).

Cortisol levels follow a diurnal pattern, peaking in the morning and declining throughout the day, which is vital for various physiological processes and can be disrupted by factors like sleep deprivation and chronic stress (14- 15).

The body's response to physical stress through cortisol is essential for understanding how it adapts and manages physical challenges, influenced by exercise intensity, duration, individual physiology, and environmental conditions (16). High-intensity and long-duration physical activity is perceived as a stressor, activating the HPA axis and increasing cortisol production to mobilize energy through gluconeogenesis and lipolysis, ensuring adequate fuel supply for muscle activity (11-17). However, excessive acute stress can impair muscle recovery and adaptation due to cortisol's catabolic effects (11). Chronic physical stress, such as prolonged intensive training without adequate recovery, can lead to overtraining and sustained cortisol elevation, compromising immune function and increasing injury and illness risk (18-19).

Balancing training stress with recovery is crucial to prevent these adverse effects (20). Cortisol responses to physical stress vary among individuals, with endurance athletes showing a less pronounced response compared to less trained individuals, suggesting adaptation to rigorous training (21). Age, sex, nutritional status, and environmental factors also influence cortisol responses (22- 11-23).

Nutritional choices significantly impact cortisol response to physical stress, with adequate intake of carbohydrates and proteins helping mitigate excessive cortisol levels during and after exercise, thereby optimizing performance, supporting recovery, and preserving muscle mass (24). Environmental stressors, such as extreme temperatures and high altitudes, can exacerbate physical stress responses (23). Additionally, psychological stress can amplify cortisol release, highlighting the importance of comprehensive stress management strategies for physically active individuals (25). Cortisol is increasingly recognized as a biomarker for stress-related diseases, influencing various bodily functions and being sensitive to stress (12). Elevated cortisol levels are associated with stress-related disorders, such as Cushing's syndrome and Addison’s disease, which can be diagnosed and managed by understanding cortisol dynamics (26-11-27-28).

Stress management techniques, including mindfulness, relaxation, and exercise, can effectively regulate cortisol levels (29). Mindfulness practices have shown varying effects on cortisol levels, necessitating well-designed future studies to understand their impact (30). Relaxation techniques, such as deep breathing, meditation, and yoga, can lower cortisol levels and reduce stress (31). Physical activity is a well-established method for stress management, linked to effective regulation of the HPA axis and cortisol levels (32-33). However, the cortisol response to varying physical activity levels requires further investigation to confirm these findings (34). Cortisol's role in health conditions, such as cardiovascular diseases, and its potential as a biomarker, remains a subject of debate, emphasizing the need for comprehensive research to understand these complex relationships (11).

MATERIALS AND METHODS:

Participants: ninety male university athletes aged 19-25 years from three universities in Lahore participated in this study: University of the Punjab (PU, n = 60, 20 per sport category), Government College University, Lahore (GCU, n = 15 per sport category) and University of Central Punjab, Lahore (UCP, n = 15 per sport category). Participants were recruited through a purposive sampling technique based on their involvement in ergo rowing, middle-distance running, or long-distance running events.

Design: a short-term longitudinal design with both experimental was employed to investigate the effects of an eight-week physical training program on cortisol level in athletes of Ergo rowers, middle-distance runners and long-distance runners at different stages: pre-training, mid-training (after 04 weeks), and post-training/pre-competition. The study comprised two distinct phases: a training phase and a competition phase.

Measures:

Baseline cortisol was assessed prior to the training program by organizing actual competitions: Ergo rowing: 2000 meters on indoor rowing ergometers at the University of the Punjab gymnasium, Lahore. Middle-Distance and Long-Distance Running: Competition held at Punjab Athletics Stadium, Lahore.

Serum Cortisol Sampling

A blood sampling procedure was conducted in 10 minutes within the players' dressing room to assess the players' concentration levels of free cortisol. Highly skilled and registered pathologists conducted this process from an accredited pathology laboratory, all operating under the vigilant supervision of a qualified medical practitioner. Stringent ethical guidelines were diligently observed throughout the procedure.

After blood collection (5ml), serum was isolated via centrifugation at 3000rpm. A fully automated chemiluminescent analyzer and Beckman coulter kits USA measured the serum cortisol level. The resulting serum samples were preserved at -80°C for further hormonal analysis. The serum samples were inspected for free cortisol levels using the ELISA method.

Statistical Analysis

The analysis of the data was conducted on GraphPad Prism version 6.0 software. Data from each research parameter was given as Mean ± SEM and statistically assessed using a two-tailed Paired sample t-test to check the effect of the physical training program on cortisol level.

The researcher used Analysis of Variance (ANOVA) to explore the effect of physical training on cortisol level. This study employed Pearson correlation to check the relationship between physical training cortisol level of male university players of ergo rowing, middle and long distance.

RESULTS:

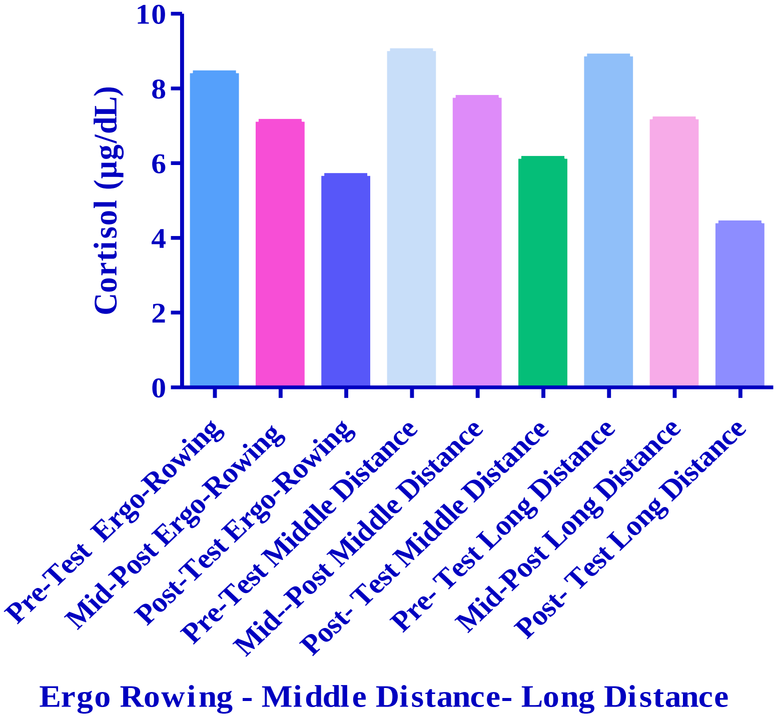

Figure 1: Group Comparison of Cortisol in Ergo Rowing, Middle Distance and Long Distance

Figure 1 indicates a significant reduction in cortisol levels (ug/dL) across different stages of testing (Pre-Test, Mid-Post, and Post-Test) for participants engaged in ergo-rowing, middle-distance, and long-distance exercises. In ergo-rowing, cortisol levels decreased by 15% from Pre-Test to Mid-Post, by 33% from Pre-Test to Post-Test, and by 20% from Mid-Post to Post-Test, all marked by *** to indicate high statistical significance. Similarly, in the middle-distance group, cortisol levels dropped by 14% from Pre-Test to Mid-Post, by 32% from Pre-Test to Post-Test and by 21% from Mid-Post to Post-Test, also highly significant. The long-distance group showed the most dramatic decreases, with cortisol levels reducing by 19% from Pre-Test to Mid-Post, by 50% from Pre-Test to Post-Test, and by 39% from Mid-Post to Post-Test, reflecting a substantial and highly significant reduction in stress hormone levels through the stages of testing. These results suggest that all forms of exercise tested effectively reduce cortisol levels, with long-distance exercise showing the most pronounced effect.

Table 1: Group Comparison of Cortisol in Ergo Rowing, Middle Distance and Long Distance

Group Comparison			
Cortisol (ug/dL) in Ergo-rowing			
Group Comparison	**Means ± SEM**	**Means ± SEM**	**Percentage difference**
Pre-Test vs Mid-Post	8.41 ± 0.15	7.11 ± 0.09	15↓***
Pre-Test vs Post-Test	8.41 ± 0.15	5.65 ± 0.14	33↓***
Mid-Post vs Post-Test	7.11 ± 0.09	5.65 ± 0.14	20↓***
Cortisol (ug/dL) in Middle distance			
Pre-test vs Mid-Post	9.006 ± 0.1	7.75 ± 0.11	14↓***
Pre-test vs Post-test	9.006 ± 0.1	6.11 ± 0.17	32↓***
Mid-Post vs Post-Test	7.75 ± 0.1	6.11 ± 0.17	21↓***
Cortisol(ug/dL) in long distance			
Pre-Test vs Mid-Post	8.86 ± 0.12	7.18± 0.13	19↓***
Pre-Test vs Post-Test	8.86 ± 0.12	4.39± 0.15	50↓***
Mid-Post vs Post-Test	7.18 ± 0.13	4.39± 0.15	39↓***

Table 2 Presenting Coefficient of correlation of Cortisol level (µg/dL) among all groups, Ergo Rowing, Middle- and Long-Distance players.

	Cortisol Ergo Rowing pretest	Cortisol Ergo Rowing mid-test	Cortisol Ergo Rowing post-test	Cortisol middle distance pretest	Cortisol middle-distance mid-test	Cortisol middle distance post-test	Cortisol long-distance pretest	Cortisol long-distance mid-test	Cortisol long-distance post-test
Cortisol Ergo Rowing pretest	1	.099	.031	.014	-.186	.146	.146	.006	.128
Cortisol Ergo Rowing mid-test		1	.104	.228	.174	-.055	.119	-.062	-.301
Cortisol Ergo Rowing post-test			1	-.114	-.266	.212	-.175	**-.440***	.030
Cortisol middle distance pretest				1	.084	-.034	-.074	-.151	-.064
Cortisol middle-distance mid-test					1	.277	.040	.028	.030
Cortisol middle distance post-test						1	**-.377***	-.353	.181
Cortisol long-distance pretest							1	.257	-.132
Cortisol long-distance mid-test								1	.000
Cortisol long-distance post-test									1

*. Correlation is significant at the P>0.05 level (2-tailed).

Table 2 there is a correlation of cortisol(µg/dL) levels that were measured during different phases: pre-test (before training), mid-test (after four weeks training), and post-test (prior competition) of ergo rowing, middle-distance running, and long-running distance players. Many of the correlations here are weak. However, some notable significant correlations at 0.05 include a negative relationship between cortisol levels of post-ergo rowing and levels of post-middle distance running with a -0.440* and between post-middle distance running and pretest levels of long-distance running with a -0.377*. This point would show some interaction in cortisol response between the activities at certain testing phases.

DISCUSSION:

The effect of eight weeks of physical training on cortisol levels of ergo rowing, middle-distance distance and long-distance players before training, after four weeks of training and before the competition. The activation of the hypothalamic-pituitary-adrenal (HPA) axis in response to psychosocial stressors is a well-documented phenomenon by (35). This activation results in elevated cortisol secretion from the adrenal cortex, which plays a crucial role in both the regulation and utilization of energy derived from proteins and carbohydrates, as well as in the synthesis of reserve substances for metabolic adaptation to physical stress (36- 10). In adolescents, athletic performance can be significantly impacted by stress rather than optimal training, as stress hormones exhibit considerable variability during puberty.

In addition to secreting adrenaline, the adrenal gland stimulates testosterone levels from the testes, a hormone associated with masculinization whose principal functions vary according to the individual's age (37). Regarding these hormones, exercise and competitive activities elicit distinct responses; notably, competitive scenarios are marked by diverse variables that are not consistently observed during training sessions (38).

Cortisol is an endocrine indicator of stress situations in different competitive environments. In our investigation, the pronounced reduction was evidenced after performing one month of ergo-rowing training and competition. Moreover, in the mid-post condition of training, there was a prominent decline in cortisol levels in the serum of players. The trend of this reduction in the cortisol level depicts that training positively influences the participant's mind; thus, players would feel better in challenging competitive environments. Moreover, a similar trend of reducing cortisol was evidenced in the middle-distance and long-distance players, indicating that training in all three games can reduce the level of stress in these players, thus resulting in better overall performance.

An investigation by (39) observed that the cortisol level was reduced before the competition. In an investigation by (40), 21 rowers were included. In that investigation, a two-month camp was established for ergo rowers. Low-intensity water rowing training was opted for. Levels of testosterone and cortisol remained unchanged in their research.

Moreover, in another investigation by (41), the relative significance of exercise intensity, duration, and performance capacity was recorded in the 16 male rowers. These two experiments were separated by a gap of 12 months. In that research, cortisol and growth hormone response to the 40 min was pronounced at an anaerobic threshold level compared to the 7-minute supramaximal intensity. Hence, it was documented that strenuous exercise, cortisol, and somatotropin levels were triggered.

In another investigation by (42), eight ergo-rowing players of college levels were engaged. In that investigation, it was observed that the cortisol level did not change after 6 min of the "all-out" test.

In another research by (43), 14 male and 8 female participants were recruited. That study documented that urinary cortisol (UC) was significantly elevated at eight weeks of training. However, UC decreased significantly later in the investigation. Moreover, VO_2 max increased at 16 weeks of concurrent training. The prime reason for reduced cortisol of ergo-rowing is that the participants were given a rest period after every week of training. This rest period can be a cardinal reason for reduced cortisol in the mid-post and post-test analysis.

CONCLUSION:

This current study results a significant decline in cortisol levels over various testing stages (Pre-Test, Mid-Post, and Post-Test) for the participants who participated in exercises involving ergo-rowing, middle-distance and long-distance exercises. The strong decrease in cortisol, especially for the long-distance group, demonstrates that such physical activities are highly efficient in controlling stress. The findings support with literature showing the ability of regular aerobic exercise to enhance positively resilience against stressful episodes through down regulation of the hypothalamic-pituitary-adrenal axis response. It suggests that structured training intervention with adequate recovery periods is very important for optimal stress and performance management for players. These results indicates, in a very accumulative sense, the importance of regular aerobic exercise during training regimens to attenuate physiological stress markers within competitor environments while promoting well-being.

Statement of conflict of interest

The authors have declared no conflict of interest.

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