

The Effect of Increasing Lactic Acid Levels on Psychological Changes in Female Futsal Athletes in Malang City

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ABSTRACT: This study aims to analyze the effect of increased lactic acid levels on changes in the psychological conditions of female futsal athletes in Malang City, including stress levels, somatic anxiety, and cognitive anxiety. The research method used a quantitative approach with a one-group pretest–posttest design, with 18 athletes as research subjects. Lactic acid levels were measured using The Edge Blood Lactate, while psychological aspects were measured using the Athlete Recovery Stress Scale (ARSS) for stress and the Competitive State Anxiety Inventory-2 Revised (CSAI-2R) for somatic anxiety and cognitive anxiety. Data collection was carried out before and after the match intervention. The validity and reliability of The Edge Blood Lactate were 0.96, ARSS 0.84, and CSAI-2R 0.79. The results showed a significant increase in lactic acid levels from 1.27 mmol/L to 9.33 mmol/L after the match, reflecting a high metabolic load. Psychologically, levels of stress, somatic anxiety, and cognitive anxiety also increased significantly. The correlation between variables shows that an increase in lactic acid levels is positively related to an increase in these three psychological aspects.

KEYWORDS: Lactic acid, Fatigue, Anxiety, Stress

INTRODUCTION

During matches, futsal athletes often face intense competitive situations. These situations not only drain physical energy but also affect their psychological well-being. Futsal is an intermittent sport that places high demands on the physical, technical, and tactical aspects of its players (Arifin & Kusuma, 2023). Futsal itself is a very high-intensity sport, thus demanding optimal physical abilities. In addition to requiring good physical abilities, futsal also requires technique and tactics for the game. Futsal players spend more than 50% of their playing time at an intensity of 80-90% of their maximum heart rate, and post-match lactic acid levels reach an average of 5.3 mmol/L (Juniarsyah, et al., 2017). Fatigue can affect an athlete's performance. One physiological aspect that often arises in the context of intense sports activities is an increase in blood lactic acid levels due to fatigue.

Fatigue encompasses physical and psychological aspects, as well as subjective fatigue, which is characterized by physical decline, feelings of tiredness, decreased motivation, and decreased work efficiency. Fatigue, both physical and psychological, is essentially a response mechanism in the body to prevent further injury after high-intensity activity and allow for recovery after rest (Iwandana et al., 2022). The average heart rate of futsal players approaches its maximum in the first 10 minutes of the match, namely the first half. Research by Nybo et al. (2014) explains that physical fatigue is influenced not only by metabolic factors but also by neurological factors, such as reduced nerve signals to the muscles.

In high-intensity futsal matches, stress and anxiety often arise in response to performance pressure, coach expectations, and the uncertainty of the match situation. Unmanaged stress and anxiety can negatively impact an athlete's decision-making ability, motor coordination, and performance consistency (Fadilah & Priambodo, 2024). Anxiety and stress are psychological responses often experienced by athletes during competition or intense training (Fadilah et al., 2024, p. 34). Stress can arise in response to external pressures such as coach demands, team expectations, or tense match situations. Anxiety, whether trait anxiety or state anxiety, is often related to athletes' perceptions of their ability to face challenges (Fransisco et al., 2016).

Several studies have shown that women, influenced by the hormone estrogen, tend to have a higher lactate oxidation capacity and utilize fat more efficiently during moderate-intensity exercise. This theoretically facilitates faster post-exercise lactate clearance than men, but this depends on the individual's fitness status and training history (Brooks, G.A., 2018). High lactic acid levels can negatively impact performance and accelerate fatigue. This is measured using the Borg Scale (Rating of Perceived

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Exertion/RPE). The RPE scale is a psychophysiological indicator that is highly correlated with lactate and is a component of subjective stress. This implies that high lactic acid levels can trigger the perception of severe fatigue (Chandra A. et al., 2018).

During matches and experiencing defeat, some female futsal athletes often become overwhelmed. This is evident in their handling of the situation, such as losing control of their emotions, leading to overthinking, which can lead to high levels of anxiety and stress.

Research Design

This research is a quantitative quasi-experimental study with a one-group pretest and post-test design. This study uses a quantitative approach because it focuses on collecting and analyzing numerical data to test previously formulated hypotheses.

Participant

In this study, there was only one subject group without a control group. This study used a total sampling technique, namely using the entire population of 18 athletes.

Procedure

Measurements were taken before and after treatment or intervention. This approach was used to identify the influence of one variable on another. This approach was used to determine the effect or influence of the independent variable (changes in lactic acid levels) on the dependent variable (changes in psychological conditions in the form of stress and anxiety levels) in the context of futsal training or matches in female athletes. The treatment consisted of high-intensity futsal matches designed to resemble official competition conditions (2 x 20 minutes) with a 10-minute break between halves. This design allowed for observation of changes in lactic acid levels (a physiological variable) and psychological conditions (stress and anxiety) before and after the activity.

Research Instrument

The research instruments used were the Edge Blood Lactate Monitoring System (Lactate Meter) to measure lactic acid levels in the blood and a questionnaire (ARSS - Stress Subscale (Acute Recovery And Stress Scale) and anxiety levels were measured using the CSAI-2R (Competitive State Anxiety Inventory-2 Revised)).

Data Analysis Techniques

The data analysis used in this study used prerequisite tests in the form of normality tests and descriptive tests. To test for differences in variables, paired sample t-tests (for normally distributed data) and Wilcoxon tests (for non-normally distributed data) were used. Hypothesis testing used correlation tests, using SPSS 27 data analysis.

RESULT

This study explains that high-intensity physical activity can cause excessive fatigue and trigger stress and anxiety in the sample.

Descriptive Statistic

The research results are presented in the form of descriptive statistics, difference tests, and correlation tests to describe changes in the physiological and psychological responses of female futsal athletes before and after the match.

Table 1. Descriptive Statistics of Research Variables

Variable	N	Mean Pre-test	Mean Post-test	SD Pre	SD Post	Change
Lactic acid (mmol/L)	18	1,27	9,33	0,30875	1,01235	+8,06
Stres (ARSS)	18	0,3861	5,3576	0,24596	0,20202	+4,97
Somatic Anxiety (CSAI-2R)	18	10,94	18,39	0,802	1,290	+7,44
Cognitive Anxiety (CSAI-2R)	18	7,44	12,39	1,042	1,037	+4,94

Based on Table 1, all study variables increased from pre-test to post-test. The descriptive analysis results showed that all study variables increased from pretest to posttest. Lactic acid levels increased sharply from 1.27 mmol/L to 9.33 mmol/L, with a change of +8.06, indicating a high physiological burden after the match. The stress variable also increased from 0.3861 to 5.3576 (+4.97). Furthermore, somatic anxiety increased from 10.94 to 18.39 (+7.44), while cognitive anxiety increased from 7.44 to 12.39 (+4.94). Overall, the data indicate that match activity triggers increased physiological and psychological responses in female futsal athletes. The largest increase occurred in lactic acid levels, followed by increases in somatic and cognitive stress and anxiety. These results

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indicate that high-intensity futsal matches trigger simultaneous physiological and psychological responses in female futsal athletes.

Difference Test. Pre-test and Post-test

The results of the test of the differences between conditions before and after the futsal match are presented in the following table.

Table 2. Results of the Pre-test and Post-test Difference Test

Variable	t / Z	Sig. (p)	Information
Lactic Acid	-30,106	0,001	Significant
Stres	-3,726	0,001	Significant
Somatic Anxiety	-3,755	0,001	Significant
Cognitive Anxiety	-3,768	0,001	Significant

Based on Table 2, all variables showed significant differences between before and after the match ($p < 0.05$). The very high statistical value for the lactic acid variable indicates that the futsal match had a very strong physiological impact, which was then followed by a significant increase in stress and anxiety in athletes.

Corelation Test

The relationship between increased lactic acid levels and changes in psychological state was analyzed using Pearson correlation. The results of the analysis are presented in Table 3.

Table 3. Correlation Test Results

Variable Relationship	r	Sig. (p)	Interpretasi
Lactic acid Difference - Stress Difference	0,504	0,033	Moderate, Significant
Lactic Acid Difference – Somatic Anxiety Difference	0,546	0,019	Moderate, Significant
Lactic Acid Difference – Cognitive Anxiety Difference	0,487	0,040	Moderate, Significant

The correlation results showed a positive and significant relationship between increased lactic acid levels and stress and anxiety, both somatic and cognitive. This suggests that the greater the increase in post-match metabolic stress, the greater the psychological distress experienced by athletes.

DISCUSSION

Increased Lactic Acid Levels After a Match

The results showed a significant increase in lactic acid levels, from 1.27 mmol/L before the match to 9.33 mmol/L after the match (+8.06 mmol/L), which exceeds the anaerobic threshold and indicates very high metabolic stress. This finding aligns with the characteristics of futsal as a high-intensity, intermittent sport that predominantly utilizes the glycolytic anaerobic energy system, resulting from activities such as repeated sprints, rapid changes of direction, and explosive game transitions.

Post-match lactate levels exceeding 9 mmol/L indicate that the female futsal athletes from Malang City competed at a high intensity. Physiologically, this increase in lactate contributes to peripheral and central fatigue by decreasing muscle pH and disrupting central nervous system function, including brain areas involved in emotion and decision-making. Blood samples taken one minute after the match were taken during the peak lactate phase, thus reflecting a heavy metabolic load.

Furthermore, the more complex physiological and hormonal responses of female athletes allow for a more rapid accumulation of metabolic fatigue, so that lactate spikes not only reflect high physical loads but also serve as a physiological basis for increased stress, somatic anxiety, and cognitive anxiety. Thus, this study confirms that high post-match metabolic stress is potentially associated with changes in the psychological state of female futsal athletes.

Increased Stress After the Match

Descriptive analysis results showed that the stress levels of female futsal athletes in Malang City increased significantly after the match. The average stress score based on the ARSS increased from 0.3861 in the pre-test to 5.3576 in the post-test (+4.97 points), indicating the emergence of acute stress due to the high match load.

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Normality tests showed that the pre-test stress data were normally distributed, while the post-test data were not, but the pre-post difference was normally distributed. Based on this, a parametric test of the difference in the data indicated that the increase in stress was statistically significant, thus accepting the alternative hypothesis (H_1), confirming a change in the athletes' psychological state after the match.

This increase in stress is a psychological response to the combination of heavy physical demands, competitive pressure, and metabolic and mental fatigue during high-intensity futsal matches. These activities trigger activation of the HPA axis and the sympathetic nervous system, which leads to various physical and psychological stress symptoms. In addition to physiological factors, the intermittent nature of futsal play, as well as gender and social dynamics in female athletes, also contribute to the heightened stress response. Thus, the competition load not only affects physiological responses such as increased lactic acid, but also has a significant impact on the psychological aspects of athletes.

Increased Anxiety After the Match

The results showed that somatic anxiety in female futsal athletes significantly increased after the match, with the average score rising from 10.94 (pre-test) to 18.39 (post-test) (+7.44 points). This increase reflects a worsening of physical symptoms of anxiety, such as heart palpitations, muscle tension, and restlessness. Although the pre-test data were not normally distributed, and the post-test data were not normally distributed, the distribution of the pre-post difference was normal, allowing for a t-test to demonstrate a statistically significant change, supporting the alternative hypothesis (H_1). The increase in somatic anxiety is influenced by the emotional and hormonal response characteristics of female athletes, who are more sensitive to physiological stress in competitive situations. Somatic anxiety develops progressively with increasing physical load, activation of the sympathetic nervous system, and accumulation of lactic acid, particularly from the early minutes of the match through the second half. These findings confirm that somatic anxiety results from a combination of high physical load, metabolic fatigue, and competitive pressure, necessitating post-match physiological and psychological monitoring and intervention.

The results also showed an increase in cognitive anxiety after the match, with the average score increasing from 7.44 to 12.39 (+4.94 points). Although the pre- and post-test data were not normally distributed, the normal distribution of the differences allowed for valid analysis and proved significant, supporting the alternative hypothesis (H_1). This increase was characterized by the emergence of negative thoughts, excessive worry, self-doubt, and decreased concentration. Cognitive anxiety is understood as a response to competitive pressure, performance demands, and physiological fatigue during a match. In the context of a simulated match that resembles an official competition, athletes experience increased performance pressure and post-match self-evaluation, which amplifies cognitive anxiety. This anxiety develops progressively from the start of the match and tends to increase in the second half due to accumulated physical and mental fatigue. Gender and social context factors also contribute to the amplification of cognitive anxiety responses in female athletes. Thus, this study confirms that physiological changes due to a match are closely related to psychological changes, particularly cognitive anxiety. Therefore, psychological interventions such as managing negative thoughts and strengthening self-confidence are important in the management of female futsal athletes.

CONCLUSION

Based on the results of the study and discussion regarding the effect of increased lactic acid levels on changes in the psychological condition of female futsal athletes in Malang City, it can be concluded that high-intensity futsal matches cause a very significant increase in lactic acid levels from 1.27 mmol/L to 9.33 mmol/L ($p < 0.05$), which indicates a high metabolic load during the match. The increase in lactic acid levels is positively and significantly related to increased stress levels in athletes, as well as to increased anxiety, both somatic anxiety and cognitive anxiety. These findings confirm that the physiological response due to intense anaerobic activity is closely related to changes in the psychological condition of female futsal athletes after the match.

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