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Biochemical Changes In Athletes' Bodies During Physical Exercise

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ABSTRACT

This study explores the general patterns and characteristics of enzyme activity changes in athletes' bodies during physical exercise. Increased enzyme activity results from biochemical changes in cells triggered by intense or prolonged muscle activity. Short-term physical exertion typically leads to a rapid return of enzyme activity to normal levels during rest. However, a sustained increase in enzyme activity may indicate excessive training intensity. In sports practice, the activity levels of creatine phosphokinase (CPK), aspartate aminotransferase (AST), and alanine aminotransferase (ALT) are commonly measured to evaluate athletes' functional states and the effects of training.

KEYWORDS

Exercise, physical activity, creatine phosphokinase, aspartate aminotransferase, alanine aminotransferase.

INTRODUCTION

Creatine phosphokinase (CPK) is an intracellular enzyme that facilitates the formation and breakdown of creatine phosphate, transferring a phosphate group from creatine phosphate to ADP (adenosine diphosphate). This process supplies muscles with significant energy for short bursts of activity [1]. Research indicates that creatine kinase levels are notably higher in athletes participating in strength-based sports. The rise in CPK activity in these athletes is linked to the dominance of the creatine phosphokinase pathway in ATP resynthesis, which supports energy demands during exercise [2; 3; 4]. CPK plays a vital role in the energy metabolism of muscle and nervous tissues. Typically, CPK activity in blood serum ranges from 40–200 U/L. During anaerobic exercises, such as sprints up to 400 meters, peak CPK activity is observed approximately 5 minutes after muscle activity ends. CPK activity levels during short, high-intensity workouts are used to assess training intensity or identify signs of overtraining [2; 5; 6; 3]. For athletes engaging in prolonged, high-oxidative exercises (e.g., marathons, 30–50 km cross-country skiing, multi-day cycling races, or triathlons), CPK activity in the blood increases 24–28 hours post-exercise and may remain elevated for 3–6 days [5; 6; 3]. Studies on CPK dynamics following strength training with weights [7] show that CPK activity can increase by about 100% within 8 hours, reaching peak levels between 24 and 96 hours, depending on the exercise type and the athlete's individual physiology [8; 7; 9]. Short-term cooling methods, such as cold water immersion [10], contrast therapy [11], and cryotherapy [12], can help reduce the risk of elevated CPK activity after exercise. The intensity of physical loads influences various biochemical changes in muscles, blood, and internal organs.

Aspartate aminotransferase (AST) and alanine aminotransferase (ALT) are intracellular enzymes found in the liver, skeletal muscles, heart, and kidneys. Elevated levels of AST and ALT in blood plasma indicate cell damage. These enzymes play a key role in amino acid metabolism: AST catalyzes the reversible transfer of an amino group from L-aspartic acid to ketoglutaric acid, while ALT facilitates the same process from L-alanine to ketoglutaric acid. Found exclusively in organ tissue cells, these enzymes enter the bloodstream only due to injury or pathological conditions [5; 6; 3; 13]. Under normal conditions, blood levels are 3–26 U/L for ALT and 6–25 U/L for AST. AST activity is highest in the heart, liver, muscles, and kidneys, while ALT is predominantly found in the liver, with smaller amounts in other organs.

In heart and skeletal muscle disorders, AST levels typically rise, whereas ALT levels increase in cases of acute hepatitis. Thus, AST serves as a marker of heart muscle damage, and ALT indicates acute liver or biliary tract conditions. In angina, AST and ALT levels remain within normal ranges. In infants, elevated ALT and AST levels may occur without being pathological. In athletes, increased activity of these enzymes enables early detection of metabolic changes in the liver, heart, and muscles, while also supporting the evaluation of exercise endurance and the use of pharmacological agents.

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