Biomarkers of Cardiac, Musculoskeletal Stress and Inflammation in Extreme Endurance Athletes: Insights from a Mountain Ultramarathon

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Introduction

Extreme physical exertion, such as ultramarathons, places considerable physiological demands on the cardiovascular and musculoskeletal systems. Biomarkers like high-sensitivity Troponin I (hs-TnI), NT-proBNP, high-sensitivity C-Reactive Protein (hs-CRP), creatine kinase-MB (CKMB), Interleukin-6 (IL-6), and soluble ST2 (sST2) offer insights into myocardial stress, systemic inflammation, and skeletal muscle damage. This study assessed these biomarkers in athletes completing a 330 km mountain ultramarathon with a 24,000 m elevation gain to differentiate physiological adaptation from pathological risks.

Methods

Blood samples were collected from 48 participants at three time points: pre-, mid- (148 km), and post- (330 km) race. Biomarker levels were measured using MAGLUMI X3 (Snibe®) and Alinity immunoassay systems (Abbott®). Pre-concentrations were compared with mid- and post- to evaluate the impact of extreme exertion.

Results and Discussion

All biomarkers showed significant increases during the race. hs-TnI levels rose from <5 ng/L at pre- to peaks of 12 ng/L at post-, indicating mild, transient myocardial strain without permanent damage. NT-proBNP increased from 50 pg/mL at pre- to >600 pg/mL at post-, reflecting acute cardiac volume overload. Inflammatory markers displayed marked responses: hs-CRP levels surged from <1 mg/L at baseline to 30 mg/L at post-, while IL-6 spiked to >200 pg/mL at mid-, indicating early systemic inflammation.

sST2 showed notable elevations, with baseline levels (~30 ng/mL) near thresholds indicating subclinical cardiac stress, rising to >100 ng/mL at post-, suggesting baseline myocardial strain exacerbated by exertion. CK levels increased to 5,000 U/L at post-, indicating acute severe skeletal muscle damage, while CKMB peaked at 60 U/L, requiring careful contextual analysis to rule out cardiac involvement.

Conclusions

Extreme endurance events cause substantial physiological stress, as reflected in biomarker fluctuations. The alarming baseline and peak levels of sST2 highlight its utility in detecting early cardiac strain. Tailored monitoring and recovery strategies are vital to safeguarding the long-term health of athletes exposed to such challenges. Additionally, the significant rise in IL-6 and hs-CRP underscores the pronounced inflammatory response induced by extreme exertion, which may contribute to prolonged recovery and systemic stress.