COMPARSION OF MUSCLE DAMAGE IN PROFESSIONAL AND AMATEUR SOCCER PLAYERS FOLLOWING REPEATED SPRINT TEST

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Abstract: *The research aimed to assess the difference in muscle damage between professional and amateur soccer players after a repeated sprint test. Thirty male soccer players (15 amateurs and 15 professionals) underwent a 6x30meter sprint test with 20-second intervals between sprints. The objective was to determine muscle damage based on the concentration of blood enzymes (CK and LDH). Results showed a significant increase in CK and LDH enzyme concentrations after the test, with amateurs exhibiting slightly higher values before the test, but differences decreased after the test. Professional players had similar or slightly lower enzyme values before the test, but post-test levels were comparable or slightly higher compared to amateurs. Analysis also revealed similar trends in CK and LDH enzyme elevation between the two groups, with minimal or insignificant differences. The findings suggest that the repeated sprint test may induce muscle damage in both types of players, but differences between professional and amateur players were not significant. This study provides insight into the potential effects of testing on muscle health in soccer players and indicates the need for further research to better understand the factors influencing muscle damage in this context.*
Key words: *soccer players, muscle damage, repeated sprint, professionals, amateurs*

INTRODUCTION

The repeated sprint test represents a fundamental component in assessing football players' performance, as it simulates intermittent high-intensity efforts characteristic of matches. According to numerous studies, repeated sprints can cause significant muscle tissue damage, with a particular focus on the hamstring muscles, which are among the most frequently injured muscles in football players. Muscle damage caused by repeated sprints is most often evaluated using biochemical markers such as creatine kinase (CK) and lactate dehydrogenase (LDH). The study by Eryılmaz et al. (2019) documented significant increases in CK and LDH levels following a repeated sprint protocol, indicating muscle stress and potential damage. Such damage has implications not only for physical performance but also for players' postural stability, as highlighted in research by Khan et al. (2016). Further evidence confirms that repeated sprints not only cause damage to muscle fibers but also increase the stiffness of the hamstring muscles while simultaneously reducing muscle strength. These factors are critical for recovery and maintaining performance continuity (Freitas et al., 2023). Research also shows that previous injuries significantly impact performance during the repeated sprint test. Football players with a history of hamstring injuries exhibit a more pronounced decline in sprint speed, implying increased neuromuscular fatigue and inadequate recovery, which may further elevate the risk of muscle damage (Røksund et al., 2017). Effective execution of repeated sprints is crucial for competitive success, particularly for players with prior injuries, emphasizing the need for targeted rehabilitation programs to reduce the risk of injuries and optimize physical fitness (Armada-Cortés et al., 2022). Muscle architecture and strength are essential factors in players' responses to the repeated sprint test. According to available data, athletes with a history of hamstring injuries exhibit bilateral strength differences, which can increase the risk of recurrent injuries during high-intensity activities (Méndez-Villanueva et al., 2022). In this context, strength training with an emphasis on eccentric contractions has proven effective in preventing muscle injuries and improving performance, highlighting the importance of evidence-based training methods (Hoyo et al., 2015). Additionally, timely recovery following repeated sprints plays a key role in restoring muscle function. Evidence suggests that up to 120 hours may be required to return to baseline performance levels, underscoring the importance of implementing tailored recovery protocols to facilitate muscle repair and adaptation (Drummond et al., 2021). The consensus in the literature indicates that repeated sprints in football cause significant muscle tissue damage, particularly in the hamstring muscles. The complex interaction between prior injuries, muscle architecture, and recovery strategies plays a crucial role in optimizing performance and reducing the risk of injuries. Therefore, the aim of this study was to determine whether the level of competition influences the degree of muscle damage during the repeated sprint test, i.e., whether players in lower competition levels, due to lower adaptation to training demands, are more susceptible to pronounced muscle fiber damage.

METHODS

Study Design

This cross-sectional study was conducted with the results obtained from testing two groups of football players on the repeated sprint test. The repeated sprint test consisted of performing six consecutive sprints over a distance of 30 meters, with 20 seconds of active recovery between sprints. Sprint times were measured using a photocell system (Globus Ergotester, Italy). Testing was conducted in the morning hours in an indoor facility on an artificial surface (tartan). Participants started the test from a high standing position behind the start line of the 30-meter distance and began their maximum sprint upon an auditory signal. Participants were instructed to maintain maximum running speed throughout the entire track and decelerate only after passing through the photocells at the 30-meter mark. After each sprint, participants had 20 seconds to jog lightly back to the start line and prepare for the next auditory signal and subsequent sprint. All biochemical blood analyses were performed in the Biochemistry Laboratory of the Clinical Center in Banja Luka following the laboratory's established protocols. Blood sampling was conducted on-site in the sports hall where the measurements took place. After sampling, the blood samples were transported to the laboratory in coolers with appropriate temperature control to ensure sample integrity. Venous blood samples were taken from the medial antecubital vein both immediately before and after the test to determine enzyme levels. The samples were analyzed using an automated biochemistry analyzer, Dimension RXL Max, which operates based on spectrophotometric measurement. The concentrations of creatine kinase (CK) and lactate dehydrogenase (LDH), as markers of muscle damage, were determined.

Participants

Thirty male football players (15 amateurs and 15 professionals) participated in this study. Amateur football players were selected from a team competing in the 3rd League of Bosnia and Herzegovina (average age 23.3±3.2 years), while professional football players were selected from a team competing in the 1st (Premier) League of Bosnia and Herzegovina (average age 22.4±3.4 years). Participants were fully informed about any potential risks and discomfort associated with testing before providing written consent to participate in the study. Players from the 1st League trained six times per week and played official matches, while players from the 3rd League trained three times per week and participated in official matches. Participants were instructed to avoid intense physical activity and refrain from consuming caffeinated beverages the day before testing.

Statistical Analysis

Data analysis was performed using the SPSS 20 software for Windows. The first step in data analysis was to determine the normality of the distribution of the results. The Wilks-Shapiro test was applied to assess whether the test results significantly deviated from a normal distribution. Normality was tested at a significance level of 0.05. Measures of central tendency and dispersion were presented as arithmetic means and standard deviations. The significance of differences in the arithmetic means of muscle damage indicators (enzymes) before and after the test was analyzed using the paired t-test. Statistical significance was tested at an error level of 5%. An independent samples t-test was used to determine the statistical significance of differences in enzyme concentrations (muscle damage markers) before and after the repeated sprint test between the two groups of football players. The effect size of the difference determined by the independent t-test was presented as Cohen's d. For interpreting the magnitude of the differences, Hopkins' (2004) criteria were used. According to the proposed criteria, the differences were interpreted as follows: <0.2 – trivial difference; 0.2-0.6 – small difference; 0.6-1.2 – moderate difference; 1.2-2.0 – large difference; >2.0 – very large difference.

RESULTS

This section presents the results of the study, which include changes in creatine kinase (CK) and lactate dehydrogenase (LDH) levels in football players from the 1st and 3rd leagues, analyzed before and after the repeated sprint test. The results shown in Table 1 indicate significant differences in CK and LDH values before and after the repeated sprint test for players from both leagues.

For 3rd league players, CK increased from an average value of 317.93±121.06 to 380.6±140.19, which was statistically significant (t=8.27, p=0.0001). A similar trend was observed among 1st league players, where CK rose from 305.87±141.06 to 365.53±174.82 (t=6.621, p=0.0001). The effect sizes (Cohen's d) were high for both groups (d=4.42 for the 3rd league and d=3.54 for the 1st league). Similarly, LDH values for 3rd league players increased from 197.33±19.42 to 231.13±24.94 (t=6.449, p=0.0001), while for 1st league players, the values rose from 184.87±22.77 to 215.13±24.55 (t=9.795, p=0.0001). The effect sizes for LDH were also significant (d=3.45 for the 3rd league and d=5.23 for the 1st league).

Table 1 Difference in mean concentrations of creatine kinase (CK) and lactate dehydrogenase (LDH) before and after the test, with t-test results for dependent samples and effect size estimation, presented separately for the subsample of 3rd league football players (amateurs) and the subsample of 1st league football players (professionals)

	M_{before} (SD)	M_{after} (SD)	Cohen d	t	p value
CK (3rd league)	317.93 (121.06)	380.6 (140.19)	4.42	8.27	0.0001**
CK (1st league)	305.87 (141.06)	365.53 (174.82)	3.54	6.621	0.0001**
LDH (3rd league)	197.33 (19.42)	231.13 (24.94)	3.45	6.449	0.0001**
LDH (1st league)	184.87 (22.77)	215.13 (24.55)	5.23	9.795	0.0001**

Legend. M_{before} (SD) - arithmetic means and standard deviations of enzyme concentration before the test, M_{after} (SD) - arithmetic means and standard deviations of enzyme concentration after the test, Cohen's d - effect size parameter (<0.2 - trivial difference; 0.2 - 0.6 - small difference; 0.6 - 1.2 - moderate difference; 1.2 - 2.0 - large difference; 2.0 - 4.0 - very large difference; >4.0 - extremely large difference; according to Hopkins, 2004), t - t statistic, p - level of significance, ** - statistically significant at a significance level of 0.01.

Table 2 presents the analysis of differences between 1st and 3rd league football players in changes in CK and LDH values. Before the repeated sprint test, the mean CK and LDH values were similar in both groups (p>0.05), indicating sample homogeneity. After the test, the differences between the groups were also not statistically significant (p>0.05), although CK and LDH values were slightly higher in 3rd league players. The analysis of CK and LDH value increases showed slight differences between the leagues, with CK increasing by 20.13±6.25% in 3rd league players and 18.86±3.30% in 1st league players (p=0.49). Similarly, LDH increased by 17.47±10.80% in 3rd league players compared to 16.66±6.83% in 1st league players (p=0.81). The study results indicate a significant impact of the repeated sprint test on CK and LDH values in players from both leagues, with the differences between leagues not being statistically significant. These changes may reflect specific physiological adaptations of football players to varying levels of training intensity and competition.

Table 2 Differences in the mean concentrations of creatine kinase (CK) and lactate dehydrogenase (LDH) in blood between 3rd league players (amateurs) and 1st league players (professionals), including t-test results for independent samples and effect size estimation

	3rd league		1st league			
	M	SD	M	SD	*Cohen d*	*p value*
CK_{before}	317.93	121.06	305.87	141.06	0.09	0.803
CK_{after}	380.6	140.19	365.53	174.82	0.09	0.796
LDH_{before}	197.33	19.42	184.87	22.77	0.59	0.11
LDH_{after}	231.13	24.94	215.13	24.55	0.65	0.09
CK increase (%)	20.1267	6.2549	18.864	3.2976	0.25	0.49
LDH increase (%)	17.4707	10.8012	16.6553	6.8297	0.09	0.81

Legend: M1±SD1 - arithmetic means and standard deviations of CK and LDH concentrations (amateurs), M2±SD2 - arithmetic means and standard deviations of CK and LDH concentrations (professionals), Cohen's d - parameter of effect size (<0.2 - trivial difference; 0.2 - 0.6 small difference; 0.6 - 1.2 moderate difference; 1.2 - 2.0 large difference; 2.0 - 4.0 very large difference; >4.0 extremely large difference; according to Hopkins, 2004), Increase in CK (%) - percentage increase in creatine kinase concentration relative to the pre-test value, Increase in LDH (%) - percentage increase in lactate dehydrogenase concentration relative to the pre-test value.

DISCUSSION

The results of this study revealed a significant increase in CK and LDH enzyme concentrations following the repeated sprint test in both groups of football players, confirming findings from previous studies that highlight the ability of this test to induce acute muscle damage (Eryılmaz et al., 2019; Freitas et al., 2023). Despite initial differences in these enzyme concentrations, professional and amateur football players achieved similar post-test values. This conclusion aligns with research emphasizing the importance of adaptation to high-intensity training in reducing muscle damage (Hoyo et al., 2015). However, the lack of significant differences between groups suggests that the intensity of the repeated sprint test exceeds the adaptive capacity of even professional players. This is further supported by findings indicating that specific efforts, such as repeated sprints, can cause muscle damage even in well-trained athletes (Freitas et al., 2023). Greater consistency in training processes among professional players may contribute to more efficient muscle fiber regeneration and more stable physiological responses to exertion. Professional players, exposed to higher training loads, are likely to develop better adaptations compared to amateurs, even though differences in this study were not statistically significant. The increase in CK and LDH was slightly more pronounced in amateurs, indicating lower adaptation to the specific demands of repeated sprint testing. This discrepancy could be associated with the lower training frequency of amateurs (three times per week) compared to professionals (six times per week), which is consistent with findings emphasizing the importance of training continuity and intensity in reducing muscle damage (Røksund et al., 2017). Additionally, biomechanical differences in running, sprint intensity, and neuromuscular control between amateurs and professionals may contribute to varying degrees of muscle damage. Professionals, due to better running techniques and optimized neuromuscular patterns, may distribute the load more evenly during sprints, potentially reducing the risk of microtrauma to muscle fibers. Nevertheless, accumulated fatigue during the test remains a key factor contributing to increased CK and LDH concentrations. The rise in these enzymes, as markers of muscle damage, indicates not only structural damage to muscle fibers but also potential functional consequences. Reduced strength and increased muscle stiffness following the test may negatively impact football performance, particularly in a competitive context. In the long term, repeated muscle damage without adequate recovery can increase the risk of injuries and affect the continuity of training and sports performance (Armada-Cortés et al., 2022). Effective recovery after intense exertion is crucial for minimizing muscle damage and optimizing training adaptations. Studies indicate that full recovery can take up to 120 hours following a repeated sprint test (Drummond et al., 2021). Individualized recovery protocols, including proper hydration, protein-rich nutrition, massage, and cold therapy, may play a key role in minimizing muscle stress. These results highlight the need for a strategic approach to designing training programs that balance high intensity with adequate recovery. For amateur players, special attention should be given to gradually increasing training intensity to reduce the risk of overload and injury. For professionals, the priority should be maintaining optimal condition through regular recovery programs and monitoring biochemical markers of muscle stress. The minimal differences in the increase of CK and LDH between professionals and amateurs (CK: 20.13% vs. 18.86%; LDH: 17.47% vs. 16.66%) indicate similar physiological responses to the test. This suggests that the level of competition is not a determining factor in the intensity of muscle damage induced by this test, and similar recovery and regeneration protocols can be applied to both competition levels. One limitation of this study is the relatively small sample size, which may affect the generalizability of the findings. Future studies should include larger samples and consider additional variables such as individual differences in muscle architecture, injury history, and recovery strategies. Longitudinal studies tracking changes in biochemical markers throughout the season could also provide deeper insights into the cumulative effects of training and competition on the muscular health of football players. In conclusion, this study contributes to a better understanding of the physiological responses of football players to intense exertion and opens the door for further research aimed at improving sports performance and reducing injury risks.

CONCLUSION

This study provides significant insights into the effects of the repeated sprint test on muscle damage in football players of different competition levels. Although no statistically significant differences were observed between professional and amateur players, the results highlight the importance of applying individualized training and recovery protocols. Such an approach could significantly contribute to minimizing muscle damage and optimizing the physical fitness of athletes.

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POREĐENJE MIŠIĆNIH OŠTEĆENJA KOD PROFESIONALNIH I AMATERSKIH FUDBALERA NAKON TESTA PONAVLJANJA SPRINTA

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Sažetak: *Istraživanje je provedeno s ciljem procjene razlike u mišićnom oštećenju između profesionalnih i amaterskih fudbalera nakon testa ponavljanja sprinta. Istraživanje je uključivalo je 30 muških fudbalera (15 amatera i 15 profesionalaca) koji su podvrgnuti testu sprinta 6x30 metara sa 20 sekundi pauze između svakog sprinta. Cilj je bio utvrditi mišićno oštećenje na osnovu koncentracije enzima u krvi (CK i LDH). Rezultati su pokazali značajno povećanje koncentracije enzima CK i LDH nakon testa, pri čemu su amateri imali nešto više vrijednosti prije testa, ali su se razlike smanjile nakon testa. Profesionalni fudbaleri su imali slične ili nešto niže vrijednosti enzima prije testa, ali su nakon testa imali slične ili nešto više vrijednosti u poređenju sa amaterima. Analiza je takođe pokazala slične trendove u porastu enzima CK i LDH između dviju grupa, sa minimalnim ili beznačajnim razlikama. Rezultati su sugerisali da test ponavljanja sprinta može uzrokovati mišićno oštećenje kod oba tipa fudbalera, ali razlike između profesionalnih i amaterskih igrača nisu bile značajne. Ovo istraživanje pruža uvid u potencijalne učinke testiranja na mišićno zdravlje fudbalera te ukazuje na potrebu daljeg istraživanja kako bi se bolje razumjeli faktori koji utiču na mišićno oštećenje u ovom kontekstu.*

Ključne riječi: *fudbaleri, mišićno oštećenje, ponavljanje sprinta, profesionalci, amateri*