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Exploring The Effects Of Caffeine On The Sprint Performance Of University Football Players

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Abstract

Caffeine has a stimulating effect on the central nervous system, which can reduce fatigue and drowsiness. In addition, it has been shown to improve sports performance. In this current study, researchers used a randomized, placebo-controlled single-blind parallel groups trial to investigate the effects of caffeine on the sprint performance of male university football players aged 18 to 25 years in the Multan zone of South Punjab, Pakistan. A total of 120 players were divided into four groups of 30 each, with each group receiving a different dose of caffeine in capsule form. Group A received 3 $mg\text{-}kg^{-1}$, Group B received 6 $mg\text{-}kg^{-1}$ and Group C received 9 $mg\text{-}kg^{-1}$, while Group D was given a placebo 0$mg\text{-}kg^{-1}$. Sprint performance were measured through 20m Sprint test before and after the administration of caffeine and data analysis was conducted using GraphPad Prism version 6.0 software, with statistical tests like paired sample ‘‘t’’-test, ANOVA and Pearson correlation being applied to determine the relationship of each dose of caffeine on sprint performance. In our study, all three study groups 3, 6 and 9 mg/kg^{-1} presented conspicuous effects of caffeine on the 20-m sprint test. Overall results of this study showed that high doses 9 mg/kg^{-1} had prominent effects on the Sprint performance of university football players. Pearson correlation coefficient results showed that there was a positive significant correlation between Group B 6mg Pre and Group C 9mg Post. Moreover, high doses of caffeine do more to improve the sprint performance of university football players.

Keywords: Caffeine, Sprint, Performance, Football, Players.

Introduction

To perform well in various sports, athletes need to have the right information and make choices that align with their goals (Pomportes et al., 2019). Their ability to handle physical and mental stress at the same time affects their performance. Mild to moderate exercise can enhance cognitive function, while intense or prolonged exercise can have the opposite effect (Pomportes et al., 2019). Football is the most popular sport in the world due to its unique features such as field size, number of players and difficulty level, which set it apart from other sports (Schulenkorf et al., 2016). Since different positions require various responsibilities, it is essential to assess each player's physiological and psychological demands (Goksu & Yuksek, 2018). Physical fitness, player methods, cognitive ability, team strategies and psychological factors may affect football players overall performance. With lower scoring than other team sports, the margins of victory are smaller, especially at high levels (Benitez-Sillero et al., 2021).

The word "caffeine" originated from the French and German words for coffee, which reflects the spread of coffee from Arabia and Turkey to Europe (Shadaia, 2020). Caffeine is the most widely used drug globally, with over 90% of adults consuming it daily (Bishop, 2010). In elite sports, 75% of athletes have admitted to using drugs before or during competitions. Although caffeine was previously banned by the World Anti-Doping Agency (WADA), it has been removed from the list of prohibited substances during competition (Wu, 2014). The International Olympic Committee recommends a dosage of 3-6 mg/kg of caffeine before exercise to improve performance and athletes tend to take these doses in competitive environments (Mielgo-Ayuso et al., 2019). Studies have shown that a dosage of 9 mg/kg does not exceed the former IOC threshold concentration of 12 mg/L in post-exercise urine caffeine levels (Magkos & Kavouras, 2005; Beaven et al., 2008). Caffeine is a potent compound that can boost both physical and mental performance (Cappelletti et al., 2015). The body absorbs caffeine quickly and blood levels typically reach their peak within 15 to 120 minutes after consumption. After 3 to 4 hours, caffeine levels start to drop (Grgic et al., 2019). Recent research suggests that dietary supplements like caffeine may help reduce central fatigue caused by changes in brain neurotransmitters and protect cognitive function during exercise (Clark & Mach, 2016; Meeusen & Decroix, 2018). Caffeine is a popular choice among athletes as it can improve sprint performance and enhance cognitive functioning by altering the brain's physiological state (Guest et al., 2021). Caffeine affects all cells in the body, including those in the central nervous system, muscles, and fat, similar to most pharmaceutical and dietary supplements (Sellami et al., 2018). It stimulates the nervous system and brain, which increases alertness and energy while decreasing fatigue (Lima-Silva et al., 2021). Caffeine can increase performance by boosting levels of adrenaline, the hormone that triggers the "fight or flight" response (Barreto et al., 2021). The current research was focus on the sprint performance of the participants. The evaluation of the player's sprint performance was carried out by administering a 20m sprint to determine how effectively football players perform physically after consuming multiple doses of caffeine.

Methodology

This study aimed to investigate the effects of caffeine on the sprint performance of male university football players in Multan zone south Punjab, Pakistan. The study utilized a randomized, placebo-controlled, single-blind parallel groups trial and a total of 120 participants were selected for the study. The Institutional Ethical Review Board of the University of the Punjab, Lahore approved the study (No.D/342/FIMS; Dated: 29-9-2022). During the pre-study screening procedure, participants were told about the Pre-participation Screening Questionnaire, which had been adopted by AHA/ACSM Health/Fitness Facility (Balady et al., 1998). After applying exclusion criteria, a total of 120 players were selected for the study. These players were between 18 and 25 years old, with a mean age of 22.39 ± 1.69 years, a mean height of 172.9 ± 5.85 cm, a mean body mass of 70.12 ± 5.03 kg and a mean body mass index of 23.45 ± 1.43 kg/m^2. The players were divided into four groups of 30 players each to assess the impact of caffeine on their sprint performance. On average, the participants consumed 150.1 ± 39.6 mg of caffeine per day in their normal routine. To ensure accurate testing, the players refrained from intense physical activity and followed a regular diet for 48 hours before the testing began. They were also instructed to avoid caffeine consumption until 24 hours before the experimental session. The 20m sprint test was conducted on participants under specific environmental conditions (Temperature +79°F, Real Feel +79°F, Atmospheric pressure 30_{hg}, Wind speed 1.6 $_{mph}$ (N), Humidity 50%) at the same time of day. Sprint performance time was measured before taking caffeine and then three different doses of caffeine were given to three groups (A, B and C) in capsule form. Group A received a low dose of 3 mg-kg^{-1}, Group B received a medium dose of 6 mg-kg^{-1} and Group C received a high dose of 9 mg-kg^{-1}. Group D served as a placebo control group and received no caffeine. Upon taking an oral dose of caffeine, the players were directed to remain motionless for an hour. Earlier research studies (Beaven et al., 2008; Wu, 2014) have documented the different doses mentioned and it's important to mention that the maximum level of caffeine in the blood is usually achieved an hour after taking it (Graham, 2001). Consequently, the study performed a 20m sprint test on the three experimental groups and the placebo group to determine the impact of caffeine intake on sprint performance after 60 minutes of consumption. Previous researchers have used this 20m sprint test for the football-specific test (Ranchordas et al., 2018; Ellis et al., 2018). In this current research, Participants completed a standard 15-minute warm-up routine before the test, which included activities such as jogging, cradle stretches, heel flicks, squats, lunges, lateral lunges, jumping, landing and sprints. The warm-up was designed to increase heart rate and engage muscles (for 9 minutes), facilitate potentiation (for 2 minutes) and promote mobilization (for 4 minutes).

University football players sprinting speed was measured before (without caffeine) and after (with caffeine) consumption. For this test, the researcher utilized a Stopwatch (ACCUSPLIT Pro Survivor - A601X). Players were allowed one try for practice after the warm-up. Put one foot in front of the other as you start still. No shaking motions are permitted once this starting posture has been maintained for 2 seconds. The best time from two trials was reported to the closest two decimal places. Timing begins with the initial motion and ends when the chest crosses the finish line (Torso). Statistical analysis was carried out using GraphPad Prism version 6.0 software. To examine the impact of each caffeine dose on sprint performance, paired sample 't'-test, ANOVA and Pearson correlation were employed.

Results

Table 4.1: Participants of the research

Game	Groups	No. of Players	Percentage
	A	30	25%
Football	B	30	25%
	C	30	25%
	D	30	25%
Total		120	100%

The sample size for the study was presented in Table 4.1, which indicated that a total of 120 university-level football players participated in the study. The players were divided into four groups, with each group consisting of 30 university-level football players.

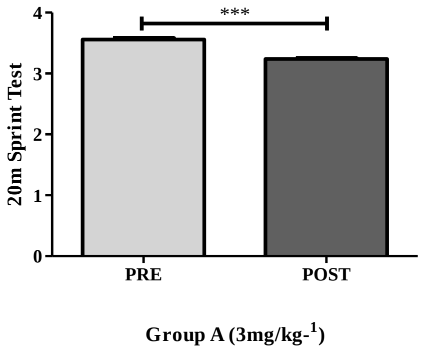
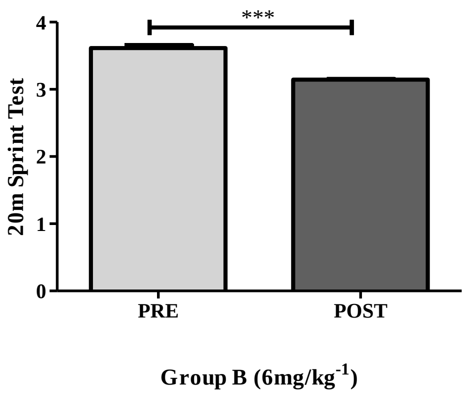


Figure 4.1: Presenting pre vs post-test score of 20m sprints test in Group A Dose (3mg/kg-^{1})

The average time (sec) of the 20m Sprint Test was found to be 3.55± 0.02 before administering 3mg/kg^{-1} dose of caffeine. Whereas, it declined significantly by 9 percent in the post-test condition. The average time (sec) of the 20m Sprint Test was found 3.23± 0.01 in football players, 60 minutes after administering 3mg/kg^{-1} dose of caffeine.



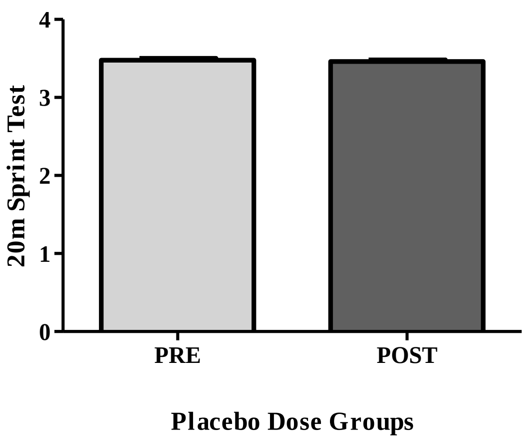


Figure 4.2: Presenting pre vs post-test score of 20m sprints test in Group B Dose (6mg/kg-^{1})

The average time (sec) of the 20m Sprint Test was found to be 3.61± 0.04 before administering 6mg/kg^{-1} dose of caffeine. Whereas, it declined significantly by 13 percent in the post-test condition. The average time (sec) of the 20m Sprint Test was found 3.14± 0.01 in football players, 60 minutes after administering a 6mg/kg^{-1} dose of caffeine.

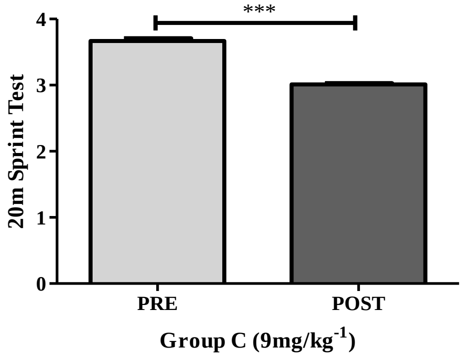


Figure 4.3: Presenting pre vs post-test score of 20m sprints test in Group C Dose (9mg/kg-^{1})

The average time (sec) of the 20m Sprint Test was found to be 3.66± 0.04 before administering 9mg/kg^{-1} dose of caffeine. Whereas, it declined significantly by 18 percent in the post-test condition. The average time (sec) of the 20m Sprint Test was found 3.01± 0.01 in football players, 60 minutes after administering 9mg/kg^{-1} dose of caffeine.

Figure 4.4: Presenting pre vs post-test score of 20m sprints test in placebo dose Group

The average time (sec) of the 20m Sprint Test was found to be 3.47 ± 0.02 before administering a placebo dose of caffeine. Whereas, it declined non-significantly in the post-test condition. The average time (sec) of the 20m Sprint Test was found 3.46± 0.02 in football players, 60 minutes after

Game	Group	n	Dose	Test type	20m Sprint (Sec) Test Mean ± SEM	%age Difference	P-Value
Football n=120	A	30	Low Dose (LD) 3mg /kg^{-1}	Pre	3.55± 0.02	9↓***	< 0.0001
				Post	3.23± 0.01		
	B		Medium Dose (MD) 6mg /kg^{-1}	Pre	3.61± 0.04	13↓***	< 0.0001
				Post	3.14± 0.01		
	C		High Dose (HD) 9mg /kg^{-1}	Pre	3.66± 0.04	18↓***	< 0.0001
				Post	3.01± 0.01		
	D		Placebo Control 0mg /kg^{-1}	Pre	3.47 ± 0.02	-	0.6
				Post	3.46± 0.02		

administering a placebo dose of caffeine.

Table 4.2: Indicating mean score of 20m Sprint Test in football players in pre vs post-test conditions

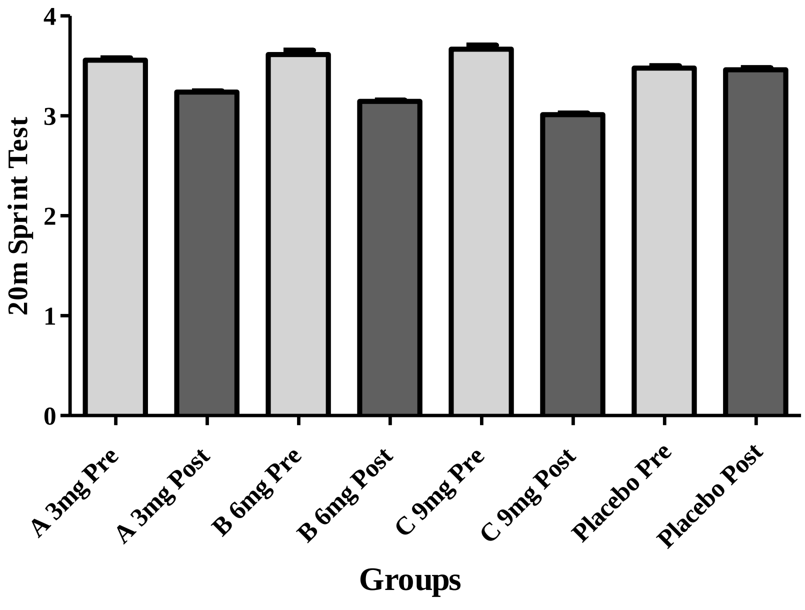


Figure 4.5: Presenting overall comparison of 20m Sprint Test analyzed by ANOVA in different dose groups

In Table 4.3: A comprehensive presentation of different 20m Sprint Test levels analyzed by ANOVA is presented.

Group Comparison	20m Sprint Test (sec)	Percentage Difference

	Means ± SEM		
A 3mg Pre vs A 3mg Post	3.55±0.02	3.23±0.01	**9↓***
A 3mg Pre vs B 6mg Post	3.55±0.02	3.14±0.01	**11↓***
A 3mg Pre vs C 9mg Post	3.55±0.02	3.01±0.01	**15↓***
A 3mg Post vs B 6mg Pre	3.23±0.01	3.61±0.04	**11↓***
A 3mg Post vs C 9mg Pre	3.23±0.01	3.66±0.04	**13↓***
A 3mg Post vs C 9mg Post	3.23±0.01	3.01±0.01	**7↓***
A 3mg Post vs Placebo Pre	3.23±0.01	3.47±0.02	**7↓***
A 3mg Post vs Placebo Post	3.23±0.01	3.46±0.02	**6↓***
B 6mg Pre vs B 6mg Post	3.61±0.04	3.14±0.01	**12↓***
B 6mg Pre vs C 9mg Post	3.61±0.04	3.01±0.01	**16↓***
B 6mg Pre vs Placebo Pre	3.61±0.04	3.47±0.02	**3↓**
B 6mg Pre vs Placebo Post	3.61±0.04	3.46±0.02	**4↓**
B 6mg Post vs C 9mg Pre	3.14±0.01	3.66±0.04	**16↓***
B 6mg Post vs C 9mg Post	3.14±0.01	3.01±0.01	**4↓*
B 6mg Post vs Placebo Pre	3.14±0.01	3.47±0.02	**10↓***
B 6mg Post vs Placebo Post	3.14±0.01	3.46±0.02	**10↓***
C 9mg Pre vs C 9mg Post	3.66±0.04	3.01±0.01	**17↓***
C 9mg Pre vs Placebo Pre	3.66±0.04	3.47±0.02	**5↓***
C 9mg Pre vs Placebo Post	3.66±0.04	3.46±0.02	**5↓***
C 9mg Post vs Placebo Pre	3.01±0.01	3.47±0.02	**15↓***
C 9mg Post vs Placebo Post	3.01±0.01	3.46±0.02	**14↓***

***** indicate significance at P ≤0.001**

Significant reduction (P < 0.001) of time was documented of 20m Sprint Test in 3mg post-test caffeine administered condition vs 3mg pre-test caffeine administered condition. Moreover, a 9 % reduction of time was found in the 3mg post caffeine administered group as compared to the 3mg pre-test administered group.

Prominent reduction (P< 0.001) of 20m Sprint Test time was evidenced in the 6mg post-test caffeine administered conditions when compared with the 3 mg pre-test administered condition. Moreover, an 11% reduction of time was found in the 6mg post caffeine administered group as compared to the 3mg pre-test administered group.

Marked reduction ($P < 0.001$) was noticed in the time of 20m Sprint Test in 9mg post-test caffeine administered conditions when compared with 3 mg pre-test caffeine administered conditions. Moreover, a 15% reduction of time was found in the 9mg post-test caffeine administered group as compared to the 3mg pre-test administered group.

In a comparison of 3mg post-test caffeine administered condition vs 6mg pre-test caffeine administered condition, there was a marked ($P < 0.001$) decrease of 20m Sprint Test time in 3mg post-test. Moreover, an 11% reduction was found in the 3mg post-test caffeine administered group as compared to the 6mg pre-test administered group.

Prominent reduction ($P < 0.001$) was noticed in the time of 20m Sprint Test in 3mg post-test caffeine administered condition vs 9mg pre-test caffeine administered condition. Moreover, a 13% reduction was found in the time of 3mg post caffeine administered group as compared to the 9mg pre-test administered group.

Meanwhile, the same significantly ($P < 0.001$) decreasing trend of 20m Sprint Test time was evidenced in the 9mg post-test caffeine administered condition vs 3mg post-test caffeine administered condition. Moreover, a 7% reduction was found in the time of 9mg post caffeine administered group as compared to the 3mg post-test administered group.

Marked reduction ($P < 0.001$) was noticed in the time of 20m Sprint Test in 3mg post-test administered vs Placebo pre-test caffeine administered condition. Moreover, a 7% reduction was found in the 3mg post-test caffeine administered group as compared to the Placebo pre-test test administered group.

In a comparison of the 3mg post-test caffeine administered condition vs placebo post-test caffeine administered condition, there was a marked ($P < 0.001$) decrease of 20m Sprint Test time in the 3mg post-test conditions. Moreover, a 6% reduction was found in the time of the 3mg post-test caffeine administered group as compared to the placebo post-test administered group.

Prominent reduction ($P < 0.001$) was noticed in the time of 20m Sprint Test in 6mg post-test caffeine administered condition vs 6mg pre-test caffeine administered condition. Moreover, a 12% reduction was found in the time of the 6mg post-test caffeine administered group as compared to the 6mg pre-test administered group.

Meanwhile, the same significantly ($P < 0.001$) decreasing trend of 20m Sprint Test was evidenced in the time of 9mg post-test caffeine administered condition vs 6mg pre-test caffeine administered condition. Moreover, a 16% reduction was found in the time of the 9mg post-test caffeine administered group as compared to the 6mg pre-test administered group.

Significant reduction ($P < 0.001$) was documented in the time of 20m Sprint Test in placebo pre-test caffeine administered condition vs 6mg pre-test caffeine administered condition. Moreover, a 3% reduction was found in the time of placebo pre-test caffeine administered group as compared to the 6mg pre-test administered group.

In a comparison of 6mg pre-test caffeine administered condition vs placebo post caffeine administered condition; there was a marked ($P < 0.001$) decrease of 20m Sprint Test time in placebo post conditions. Moreover, a 4% reduction was found in the time of placebo post caffeine administered group as compared to the 6mg pre-test administered group.

Prominent reduction ($P < 0.001$) was noticed in the time of 20m Sprint Test in 6mg post-test caffeine administered condition vs 9mg pre-test caffeine administered condition. Moreover, a 16% reduction was found in the time 6mg post-test caffeine administered group as compared to the 9mg pre-test administered group.

Marked reduction (P < 0.001) was noticed in the time of 20m Sprint Test in 9mg post administered vs 6mg post-caffeine-administered condition. Moreover, a 4% reduction was found in the time 9mg post-test caffeine administered group as compared to the 6mg post-test caffeine administered group.

Significant reduction (P < 0.001) was documented in the time of 20m Sprint Test in 6mg post-test caffeine administered condition vs placebo pre-test caffeine administered condition. Moreover, a 10% reduction was found in the time 6mg post-test caffeine administered group as compared to the 6mg post-test administered group.

Prominent reduction (P < 0.001) was noticed in the levels of 20m Sprint Test in 6mg post-test caffeine administered condition vs placebo post-test caffeine administered condition. Moreover, a 10% reduction was found in the 6mg post-test caffeine administered group as compared placebo post-test administered group.

Prominent reduction (P < 0.001) was noticed in the time of 20m Sprint Test in 9mg post-test caffeine administered condition vs 9mg pre-test caffeine administered condition. Moreover, a 17% reduction was found in the time 9mg post-test caffeine administered group as compared to the 9mg pre-test administered group.

Marked reduction (P < 0.001) was noticed in the time of 20m Sprint Test in placebo pre-administered vs 9mg pre caffeine administered condition. Moreover, a 5% reduction was found in the time placebo pre-test caffeine administered group as compared to the 9mg pre-test caffeine administered group.

Significant reduction (P < 0.001) was documented in the time of 20m Sprint Test in placebo post-test caffeine administered condition vs 9mg pre-test caffeine administered condition. Moreover, a 5% reduction was found in the time placebo post-test caffeine administered group as compared to the 9mg pre-test administered group.

Prominent reduction (P < 0.001) was noticed in the time of 20m Sprint Test in 9mg post-test caffeine administered condition vs placebo pre-test caffeine administered condition. Moreover, a 15% reduction was found in the time 9mg post-test caffeine administered group as compared to the placebo pre-test administered group.

Prominent reduction (P < 0.001) was noticed in the time of 20m Sprint Test in 9mg post-test caffeine administered condition vs placebo post-test caffeine administered condition. Moreover, a 14% reduction was found in the time 9mg post-test caffeine administered group as compared to the placebo post-test administered group.

Table 4.4: Presenting Coefficient of correlation of 20m Sprint Test in different dose groups

	Group A 3mg Pre	**Group A 3mg Post**	**Group B 6mg Pre**	**Group B 6mg Post**	**Group C 9mg Pre**	**Group C 9mg Post**	**Placebo Pre**	**Placebo Post**
G A 3mg Pre	1	.066	-.125	-.102	-.024	.187	.003	-.054
GA 3mg Post		1	-.141	.289	.141	-.110	.139	-.271
G B 6mg Pre			1	.180	.045	.361*	.175	-.082
G B 6mg Post				1	.267	-.001	.201	.046
G C 9mg Pre					1	.144	.332	-.235
G C 9mg Post						1	.060	-.138
Placebo Pre							1	-.242

Placebo Post	1

*** indicate significant at P ≤0.05 (2-tailed).**

Correlation coefficients of the 20m Sprint Test in different dose groups were shown in Table 4.4 There was a positive significant correlation (P<0.05) between Group B 6mg Pre and Group C 9mg Post. Whereas it was also noted that the correlation among Group A 3mg Pre and Group B 6mg Pre, Group A 3mg Pre and Group B 6mg Post, Group A 3mg Pre and Group C 9mg Pre, Group A 3mg Pre and placebo post, Group A 3mg Post and Group B 6mg Pre, Group A 3mg Post and Group C 9mg Post, Group A 3mg Post and placebo post, Group B 6mg Pre and placebo post, Group B 6mg Post and Group C 9mg Post, Group C 9mg Pre and placebo post, Group C 9mg Post and placebo post, placebo pre and placebo post had become an inverse sign.

Discussion

In our study, all three caffeine administered groups i.e. 3, 6 and 9mg-kg^{-1} presented a prominent decline in the completion of 20m sprint time. In all three groups, caffeine high dose of 9mg-kg^{-1} had a highly substantial effect in reducing completion time of university football players. The current study results are consistent with the findings made by (Ellis et al. 2018; Ranchordas et al. 2018; Glaister et al. 2008). The mechanism of speed in humans refers to the physiological and biomechanical processes that allow individuals to move quickly. These processes involve the coordination of multiple body systems, including the muscular, skeletal and nervous systems. Muscles produce the force needed to move the body and their contraction is controlled by the nervous system, specifically the motor neurons. The skeletal system provides the framework and support necessary for movement, while joints and ligaments allow for smooth movement and prevent injury. In addition to these systems, other factors can also affect the speed of humans, including cardiovascular fitness, the ability to generate power and body composition. Improving these factors through training and conditioning can lead to improved speed and performance in activities such as sprinting and running (Roupa et al., 2022). The findings of our investigation validate the outcome presented by several scientific researchers exploring the effect of caffeine doses on sprint performance.

One such study was conducted by Ellis et al. (2018) who found that consuming 3 mg/kg of caffeine capsules resulted in a significant enhancement in sprint performance 20m sprint compared to a placebo. In an investigation by Ranchordas et al (2018) documented that consuming 200 mg of caffeine resulted in improved sprint performance. Similarly, Glaister et al. (2008) discovered that a caffeine intake of 5 mg/kg significantly enhanced sprint performance when compared to a placebo. Overall, scientific evidence suggests that consuming caffeine in appropriate doses can improve sprint performance.

However, the optimal dosage of caffeine may vary depending on factors such as the individual's body weight, tolerance to caffeine and the specific sprinting activity being performed. As far as our region is concerned the best performance was evidenced after oral administration of caffeine at a dose of 9 mg-kg^{-1}. The significant reason of this is that muscular performance is enhanced due to elevated release of calcium and increases contractile characteristics.

Conclusion

In our study, all three groups 3, 6, and 9 mg/kg^{-1} presented prominent effects of caffeine on the 20m sprint time. Overall results of this study showed that high doses 9 mg/kg^{-1} had prominent effects on the sprint performance of university football players. Pearson correlation coefficient results showed that there was a positive significant correlation between Group B 6mg Pre and Group C 9mg Post. Moreover, these high doses of caffeine do improve the performance of university football players.

Practical Application

Football players can take caffeine capsules 15 minutes before a game. It takes 15-120 minutes for the caffeine to have its full effect in their body, it's mostly absorbed. However, FIFA says halftime breaks can't be longer than 15 minutes. During the second half, players may feel tired and want more energy. If they take caffeine in this way, it can help them play better.

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