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Investigation of the Effects of Caffeine Intake on Reaction Time, Acceleration, Speed and Balance in Short Distance Runners

Musab ÇAĞIN[1], Özlem ORHAN[2], Sezen ÇİMEN POLAT[3], Ebru ÇETİN[4] and Halil SAROl[5]

Abstract

The aims of this study is to examine the effects of caffeine intake in sprinters on reaction time, speed, acceleration and balance. A total of 31 sprinters (18 female, 13 male) from the athletics team of university faculty of sports sciences participated in the study. Sprinters were divided into two groups, caffeine and placebo, and their balance, reaction time, 30-meter running time and 15-meter acceleration performances were measured. The Wilcoxon t-Test and the Mann-Whitney U test were applied to the data obtained on the SPSS 23.0 package program. As a result of the study, the number of errors in the balance test decreased significantly in both the experimental group and the control group while a significant decrease was observed in block takeoff reaction time only in the experimental group. In conclusion, it was determined that while caffeine intake did not have a significant effect on acceleration and running times, block take off reaction time created a significant difference in the experimental group and could provide an advantage to the sprinters. Therefore, it can be said that caffeinated gum may be a good ergogenic aid to improve reaction performance in sprinters.

Keywords: *Caffeine Intake, Caffeine Gum, Sprinter, Balance, Reaction*

INTRODUCTION

Caffeine is an ergogenic supplement that is frequently utilized by athletes in almost all branches (Çağın & Çetin, 2022; Çetin et al., 2023; Bostan, 2023). It is observed that athletes refer to these supplements in order to increase their performance capacity and working efficiency. While the type of supplement used differs depending on the needs of the athlete, it can be said that caffeine stands out as the most commonly used substance (Bougrine et al., 2022; Giráldez-Costas et al., 2022; Grgic & Pickering, 2019; Kerksick et al., 2018; Maughan et al., 2018; Merino-Fernández et al., 2022; Murphy et al., 2022; Peeling et al., 2018; Wilk et al., 2019). Caffeine can be consumed in various forms. Following its consumption, high plasma concentrations can be reached in the blood circulation within approximately 1 hour, although this differs depending on individual differences, as well (Desbrow et al., 2009). When consumed in the form of chewing gum, the substance's absorption can be faster as it stimulates the tissues in the mouth that facilitate digestion (Kamimori et al., 2002). With this absorption, certain effects may occur in the organism. When the positive effect induced by caffeine on the organism is examined, it is observed that two main changes that trigger this situation occur. The first of these is the deactivation of central nerve stimulation, i.e., adenosine receptors and the secretion of neurotransmitters such as acetylcholine, catecholamine and dopamine, therefore boosting cognitive processes such as reaction time, learning, control and attention. The second is an increase in muscular contraction as more calcium is secreted from the sarcoplasmic reticulum. Through the use of this substance, it is aimed to improve parameters such as endurance, speed and acceleration (Barcelos et al., 2020; Cornish et al., 2015; Durkalec-Michalski et al., 2019; Ellis et al., 2019; Graham, 2001; Grgic & Del Coso, 2021; Lara et al., 2021; McLellan et al., 2016; Pickering & Kiely, 2019; San Juan et al., 2019; Stecker et al., 2019).

Previous studies investigating the effects of caffeine on the central nervous system and motor skills were reviewed. In order to determine the substance's effects on reaction time, Souissi et al. conducted an experiment with 12 elite judo athletes in the form of the participants drinking coffee containing 5 mg of caffeine per

[1] Gazi University, Sport Science Faculty. E-mail: musabcagin@gazi.edu.tr ; 0000-0001-8882-5506

[2] Gazi University, Sport Science Faculty. E-mail: oarslan@gazi.edu.tr ; 0000-0002-4047-234X

[3] Gazi University, Sport Science Faculty. E-mail: sezencimen@gazi.edu.tr ; 0000-0002-2143-8402

[4] Gazi University, Sport Science Faculty. E-mail: ecetin@gazi.edu.tr ; 0000-0002-1545-0181

[5] Gazi University, Sport Science Faculty. E-mail: hsarol@gazi.edu.tr ; 0000-0002-1678-3244

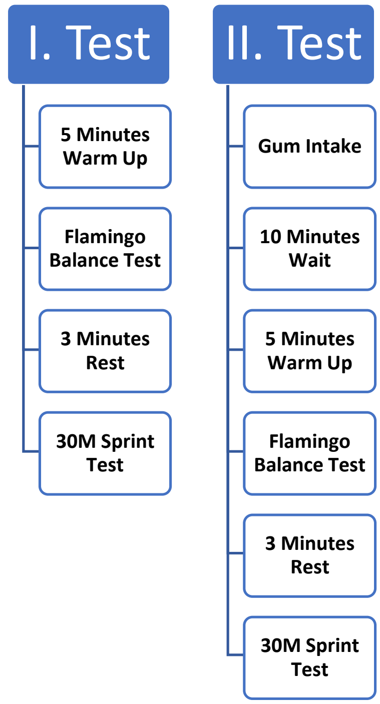
kilogram. It was determined that this intake caused a reduction in basic reaction time (Souissi et al., 2012). Santos et al. used the method of 10 taekwondo athletes taking capsules containing 5 mg of caffeine per kilogram. It was observed that the athletes' fatigue levels in particular were low, meaning that caffeine intake was more effective while resting and that this effect was insufficient in a fatigued state post-training (Santos et al., 2014). Russell et al. investigated the effects of intake through chewing gums containing 400 mg of caffeine on speed performance with 14 professional rugby players. As a result of the study, it was determined that caffeine intake did not have an effect on the speed performances of the athletes (Russell et al., 2020). In another study conducted with middle-distance runners through the intake of capsules containing 6 mg of caffeine per kilogram, it was found that caffeine intake did not have any impact on the 800m performances of the athletes (Ramos-Campo et al., 2019). In a study investigating the impact of caffeine intake on balance performance, Kara conducted an experiment with 15 male subjects taking 6 mg of caffeine per kilogram. As a result of the study, it was found that the balance score of the caffeine group was significantly lower than that of both the placebo group and the control group (Kara, 2014). However, in contrast with these findings, Karaalp & Taşkıran gave 7 mg of caffeine per kilogram mixed with water to 20 male subjects, and no significant difference was observed between the balance scores of the caffeine and the control group (Karaalp & Taşkıran, 2020). When the effects of caffeine intake on acceleration are examined, Puente et al. gave capsules containing 3 mg of caffeine per kilogram to 20 professional basketball players and it was determined that this did not have any impact on the acceleration performances of the athletes (Puente et al., 2017).

There is great variety among different branches, different methods of caffeine intake, and their impacts. Each sports branch, level of athletes, amount of intake, timing, requirements, and goals can constitute the source of this variety. In the studies examined, various forms of caffeine were used while it was observed that there is a limited number of studies conducted with chewing gum as the form of intake (Paton et al., 2010; Russell et al., 2020). Particularly in running performances where the winner is determined by small margins, even split seconds may play a role in setting the winner. It is thought that in order to win, it is necessary to not only train, but also place emphasis on scientific studies. In this context, the present study aims to determine the impact of the chewing gum form of caffeine, which gets digested and mixed with blood faster, on the block takeoff, balance, speed and acceleration of sprinters. In this direction, the effects of caffeinated chewing gum on the said parameters were examined.

METHODS

Study Design

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Gazi University (Code: 2022-938). The balance and 30-meter sprint tests of the students who participated in the study were carried out at Gazi University Indoor Athletics Field. The measurements were performed in September, and it was determined that the weather temperature ranged from 24 to 27 degrees during the first and second measurements. The subjects were notified that they were required not to consume caffeine up to 24 hours or eat anything up to 3 hours before both the first and the second measurements. Before the 30-meter sprint tests, 5-minute jogging warm up, stretching and sprint drills were performed by the subjects. In both measurements, the participants were subjected to first a Flamingo Balance Test and a 30-meter sprint test following 5 minutes of rest. In the second test, the subjects were randomly divided into two groups: caffeine and placebo. The caffeine group was given caffeinated gum (Frêg Caffeinated Gum) at a rate of 5 mg per kilogram, while the placebo group was given the same amount of non-caffeinated gum (First Mint Gum) as the caffeinated gum and asked to chew the gum. 15 minutes after chewing the gum, the subjects participated in Flamingo Balance Test and 30-meter sprint test (Ceylan et al., 2016).



Scheme I. Study design

Sample Group

A total of 31 sprinters (18 female, 13 male) from the athletics team of university faculty of sports sciences participated in the present study. The sample group consists of athletes with a sports age of at least 8 years who compete in the athletics branches of 50-60-100-200 meters. These athletes perform their training programs regularly for 90 minutes 5 times a week (Monday, Tuesday, Thursday, Friday, and Sunday). All of the athletes are physically fit and do not suffer from any recurring injuries. Table 1 contains information about the age, sports age, height and weight of the participants. The participants were informed about the nature of the study and were also informed that participation was voluntary and that they could withdraw at any time.

Table 1. Mean and standard deviation values of the descriptive characteristics of the participants

Parameters	Group	$\bar{x}$±SS
Age	Caffeine Group (n:16)	20.5±0.18
	Placebo Group (n:15)	21.9±0.55
Sport Age	Caffeine Group (n:16)	9.69±0.79
	Placebo Group (n:15)	9.33±0.94
Height (cm)	Caffeine Group (n:16)	167.6±1.66
	Placebo Group (n:15)	182.3±2.17
Weight (kg)	Caffeine Group (n:16)	58.2±1.8
	Placebo Group (n:15)	80.3±4.58

Measurements

Body Weight and Height

The height of the subjects was measured using a stadiometer with an accuracy of 0.01 m (SECA, Germany) while their weight was measured using an electronic scale with an accuracy of 0.1 kg (SECA, Germany).

Flamingo Balance Test

The static balance performance of the subjects was measured using the Flamingo Balance Test (Eurofit Battery). While the subjects were trying to stand in balance on a 15 cm long and 4 cm wide wooden plate using their dominant foot, it was recorded how many times they fell within 1 minute. During this period, the chronometer was stopped each time a subject fell, and it was waited for them to get in position again (Tsigilis et al., 2002).

Dominant Foot Determination Test

The dominant foot of the subjects was identified using the falling start technique, a commonly used method in athletics training as shown in the figure 1. The subjects are positioned on foot with a comfortable stance and the body is slowly leaned forward. The moment the body goes beyond the fulcrum of the center of gravity, one foot strikes forward with the active movement of the arms. This is regarded as the dominant foot of the subject. This process is repeated several times.

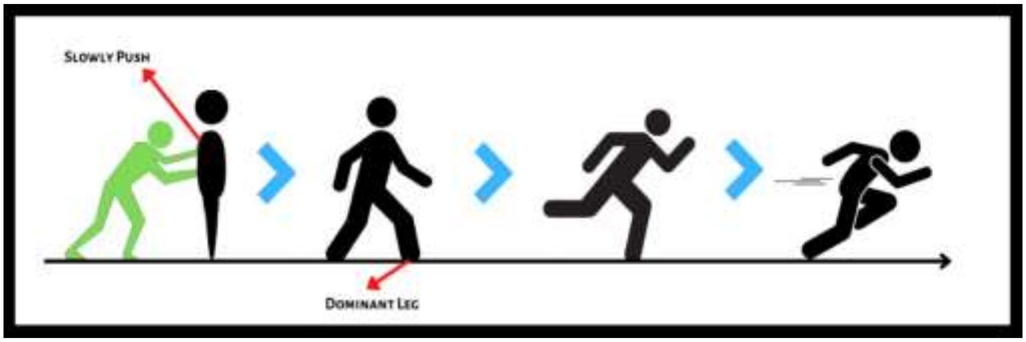


Figure 1. Dominant foot determination test design

30m Sprint Test

In the athletics track, a starting block was placed on the start line as shown in the figure 2.

Figure 2. Activation phase of the sensor measuring the reaction time at the chock outlet

Each subject adjusted the starting block individually. The times were recorded in seconds through sensors placed in the rear block where the block and the foot meet, at 15m and 30m (FitLight Trainer, Canada) as shown in the figure 3.

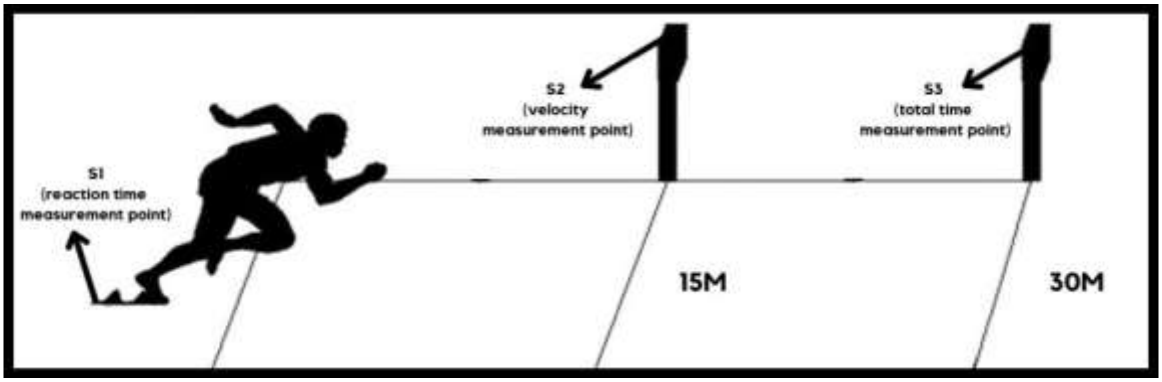


Figure 3. 30m sprint test design

Data Analysis

Data analysis was performed on the SPSS 23.0 package program. The Wilcoxon t-Test was applied in order to determine whether there were any differences between the intragroup pre-tests. The Mann-Whitney U test was used to determine whether there were any differences between the two groups. The level of statistical significance was accepted as p<0.05.

RESULTS

At the end of the experiments table 2 shows the number of balance errors, reaction times, acceleration and total time values of the caffeine and placebo groups in the first and second tests. In the first test, the caffeine group's mean number of balance errors was found as 7.31±1.31 while this value was 0.32±0.02 s for reaction time, 3.53±0.11 s for acceleration, and 5.82±0.13 s for total time and the placebo group's mean number of balance errors was found as 5.93±1.17 s while this value was 0.2±0.03 s for reaction time, 2.93±0.08 s for acceleration and 5.02±0.08 s for total time. In the second test, the caffeine group's mean number of balance errors was found as 3.38±0.76 while this value was 0.17±0.02 s for reaction time, 3.36±0.06 s for acceleration, and 5.83±0.09 s for total time as the placebo group's mean number of balance errors was found as 2.87±0.66 while this value was 0.19±0.02 s for reaction time, 2.89±0.05 s for acceleration and 5.06±0.09 s for total time. When the results of the first and second tests were examined, a significant difference was found in terms of the number of balance errors in both the caffeine and the placebo group while a significant difference was found in terms of reaction time only in the caffeine group (p<0.05). No significant difference was determined in either group in terms of the parameters of acceleration and total time as shown in the table 2.

Table 2. Comparison of Caffeine and Placebo groups

Parameters	Group	First-Test	Second-Test	In-group	Between Groups
		x̄±SS	x̄±SS	*p*	*p*
Balance (number of errors)	Caffeine Group (n:16)	7.31±1.31	3.38±0.76	*0.00**	*0.62*
	Placebo Group (n:15)	5.93±1.17	2.87±0.66	*0.01**	
Reaction Time (s)	Caffeine Group (n:16)	0.32±0.02	0.17±0.02	*0.00**	*0.02**
	Placebo Group (n:15)	0.2±0.03	0.19±0.02	*0.75*	
Acceleration (s)	Caffeine Group (n:16)	3.53±0.11	3.36±0.06	*0.11*	*0.69*
	Placebo Group (n:15)	2.93±0.08	2.89±0.05	*0.43*	
Total Time (s)	Caffeine Group (n:16)	5.82±0.13	5.83±0.09	*0.37*	*0.43*
	Placebo Group (n:15)	5.02±0.08	5.06±0.09	*0.96*	

p<0.05

DISCUSSION AND CONCLUSION

In the present study, the effects of caffeine intake in sprinters on reaction time, acceleration, speed and balance performances were evaluated. When the results of the study are examined, a negative and statistically significant difference was detected in both groups in terms of the number of errors in the balance test. When the literature is reviewed, it can be said that although the number of studies examining the relationship between caffeine intake and balance is limited, there are disputable results in the existing studies (Kara, 2014; Karaalp & Taşkıran, 2020). While some of the studies reported effects, others found no change. In this context, when the results of the present study are examined, the increase observed in both groups in terms of balance performance can be attributed to the use of balance measurement methods different from other studies and the experience resulting from the presence of a second measurement. Additionally, it is thought that the presence of two tests and the implementation of these measurements one day apart caused the participants to exhibit an improved balance performance in the second test with the help of the experience they acquired in the first test.

In terms of the reaction time values, a negative and significant difference was determined in the caffeine group. It was observed that, in previous studies examining the effect of caffeine intake on reaction time, reaction time values are generally measured in a computer environment using hands, and no study investigating reaction time with starting blocks was found in the literature (Kahathuduwa et al., 2017; Souissi et al., 2012; Souissi et al., 2014). In this context, it is thought that the present study will contribute to the literature in terms of the method used to measure reaction time. The measurement of the runners' reaction times using a sensor placed in the rear block during the time of takeoff as demonstrated in the present study is thought to be the most effective method in the evaluation of the real-time reaction performance of sprinters. In line with the developing and changing regulations in recent years, errors in block takeoff by sprinters are considered as a cause for disqualification. Therefore, the reaction time detected in this stage is the most striking point of the study in terms of reflecting the competitive environment and performance level of athletes. The obtainment of the reaction, acceleration, and speed parameters in the athletics field, the natural environment of runners, with the help of sensors enabled the measurement of the effects of caffeine to be performed in a more efficient environment and in a more goal-oriented manner. According to the results obtained, a positive reduction was determined in the block takeoff reaction times of the sprinters who took 3 mg of caffeine per kg through the chewing gum method. This reduction can enable athletes to minimize their error rate, therefore reducing the possibility of disqualification, and it can impact total time if combined with other factors.

When the results of the first and second tests are examined in terms of acceleration and total time performances, no statistically significant difference was found in either group. When the literature is reviewed, in different studies, no significant development or change was observed in the acceleration and speed of athletes regardless of the method of caffeine intake (Puente et al., 2017; Ramos-Campo et al., 2019; Russell et al., 2020). In the present study, it was observed that caffeine produced no effect on the acceleration and speed parameters of the sprinters. It can be said that speed and acceleration performances constitute the most important part of competitions for runners. All runners design a large part of their training around improving these two parameters. These designs include large-scale training programs such as conditional loads and exercises towards long-term muscular development. The development of these parameters in the short term is very difficult and, furthermore, it is known that speed is the most time-consuming and difficult parameter to develop (Bompa et al., 2012). Therefore, it is not surprising that no significant increase was observed in the parameters of either acceleration or speed following caffeine intake.

In conclusion, the present study aimed to determine the effects of caffeinated chewing gum by establishing the simulation closest to the competitive environment of athletes. With the help of sensors, the reaction, acceleration, and speed parameters of sprinters identical to those in the moment of competing were determined. According to the results obtained, although no effect was found in acceleration and total time, it was observed that caffeine intake was effective in reaction time during starting block take off. Considering that starting block take off reaction can impact the outcome for a sprinter, it is thought that the result obtained is significant. The use of caffeine in the form of chewing gum can be recommended for sprinters.

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