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Effect of Coffee Consumption with Muscle Strength in Male Adolescents Futsal Team

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ABSTRACT

In the realm of sports, caffeine has become a popular choice for athletes seeking to enhance their strength and maintain peak performance levels. Research has demonstrated that caffeine can facilitate the conversion of fat into energy and increase calcium levels within muscle cells, thereby improving muscle performance and reducing fatigue. This study was conducted to examine the impact of coffee consumption on muscle strength in a male high school futsal team. Employing an experimental method involving a one-group pre-post test design, the study included 22 teenagers. This research was conducted at SMA 5 Tambun Selatan, Bekasi. The researchers utilized the vertical jump test to gauge leg muscle strength both before and after administering coffee to participants and analysed use paired t-test. The result is increased muscle strength after giving coffee at a dose of 2mg CAF/kgBW (51.45±8.92) and 3mg CAF/kgBW (54.05±8.81) compared to before giving coffee (46.68±9.99). There is relationship between coffee consumption and increased muscle strength (p=0.00)

INTRODUCTION

Adolescence is a transition from childhood to adulthood which is marked by physical growth and development as well as psychological changes. World Health Organization says adolescents are population with an age range from 10 to 19 years old.(Success Stories South-East Asia Region, 2021) Based on Indonesian Republic Health Rules number 25, 2014, adolescents are citizens in the group of age 10 to 18 years, whereas according to BKKBN, the age range for adolescents is 10 to 24 years old and aren't married.(Kementrian Kesehatan RI, 2014).The transition from childhood to adulthood involves a lot of changes, including in growth and development both physical, sexual, mental, and social. (Mushaddik et al., 2022; Success Stories South-East Asia Region, 2021; Suharyanti & Suharyanti, 2021) Adolescents's growth and development are triggered by several factors, one of which is physical activity. Sport has become an important factor that is expected to improve physical and spiritual fitness in adolescents.(Abdulaziz et al., 2016)

Physical fitness can be improved through physical activity by doing sports. (Nandatama et al., 2017) Alvara Research Center national survey in Jakarta, 2018, said that of 1.200 millennial generation in Indonesia, 72.9% liked sports, of which 44.5% chosed football or futsal followed by running at 18.6%, badminton at 18.1%, cycling at 13.9% and the rest for other sports.(Databoks, 2018)

Futsal is a sport that played in closed field and requires 2 x 20 minutes of game. Because of that, athletes need good physical fitness. Good physical training must include flexibility, strength, power and endurance. It is necessary to be given several training programs to maintain or improve player performance, for example increasing muscle strength. Muscle strength can be built through progressive weight training, such as push-ups, sit-ups, squat jumps .(Tang et al., 2020)

Around 80% of the world's population consumes caffeine every day. Caffeine is easy to find in the market in different forms, such as tea, coffee, cocoa, energy drinks, pills, and many other beverages. Recent research studies showed that caffeine has positive effects on sport performance. The main component of coffee is caffeine, which is an ergogenic substance that can work as stimulant so it can improve several aspects of performance and prevent fatigue.(Burke, 2008; Nandatama et al., 2017; Samoggia & Rezzaghi, 2021)

Based on studies, coffee drinks that contain caffeine with 4.5-5.5 mg/kgBW can help to improve football player's physical performance, including the strength and muscle endurance.(Mielgo-Ayuso et al., 2019) The International Olympic Committee claims that the safe dose for caffeine intake was 3 mg up to 6 mg CAF/kgBW to obtain ergogenic effects.(Maughan et al., 2018) The current study by Tangen DS et al. declared that giving 3 mg/kgBW of caffeine can increase the height of vertical jump at rest state, (Tangen et al., 2020) and according to Nandatama R et al., giving coffee at dose 2 gram/150 ml which consumed one hour before exercise can increase the strength and endurance football athletes.(Nandatama et al., 2017) Contrarily, research conducted by Wilk M et al., administering high doses of caffeine (9 mg/kgBW and 11 mg/kgBW) was unable to provide ergogenic effects on individuals that addicted to coffee, even though the dose was given exceeded the average daily dose.(Wilk et al., 2019) The study that conducted by Desbrow B et al., also declare that caffeine administration did not have a significant effect on endurance.(Desbrow et al., 2012) Based on the variation results above, this study aims to search the effect between coffee consumption and muscle strength in male high school futsal teams.

METHODS

This experimental study is a one-group pre-post-test design which was held in December 2021 in SMA 5 Tambun Selatan, Bekasi. The subjects were 22 male teenagers which was selected by non-random sampling. The inclusion for this study were:1) male teenager who studied in SMA 5 Tambun Selatan, Bekasi. 2) aged 15-18 years. 3) played futsal. 4) have a healthy body with 36.50C-37.50C temperature body, blood pressure ≤120/80 mmHg, pulse 60-100 x/minute, oxygen saturation

95-100% 5) be willing to participate in this study and sign informed consent. Meanwhile, the exclusion criteria were: 1) having a history of gastritis, ulcus pepticum, heart and lung disease 2) taking food or drinks containing caffeine at least 5 days before this study, such as coffee, tea, chocolate, fizzy drinks, and foods that containing coffee, tea, cocoa and so on 3) taking tobacco consumption 4) suffered injury.

Subjects were interviewed, and after that, a psyhical examination was carried out including body weight, body temperature, blood pressure, oxygen saturation using oxymeter and pulse rate. Body weight is measured using digital scales to determine the amount of coffee consumption. Vertical jump test was used to measure leg muscle strength. This study uses Nescafe Classic®, which contains 100% pure robusta coffee with one caffeine content range from 80 to 90 mg/2gr Nescafe Classic®. (Nestle, 2022)

Subjects will be tested for muscle strength before and after being given coffee. Before being given a coffee drink, subjects will take the vertical jump test 3 times and the highest score will be taken. After that, subjects will be given Nescafe classic® with a dose of 2mg CAF/kgBW on the first day and 3mg CAF/kgBW on the sixth day, which each will be dissolved in 150 ml of water. The two main tests were separated by 6 days and the subjects were not allowed take a food or drinks that containing coffee also no exercise was allowed. Caffeine has an elimination half-life, which is around 2 to 12 hours, with an average of 5 hours in the body, and according to Republic Indonesia Food and Drug Control Agency (BPOM RI), the washout period is usually more than five times of the terminal half-life of the drug, so the researchers carried out washout period for 5 days. (Mandal, 2023; Sampurno, 2005)

After drinking the coffee, the subjects will do the vertical jump test 3 times again at the 30th, 45th and 60th minutes, and the highest score will be taken. The assessment is done by calculating the difference between the subject's hand reach while standing upright and when jumping. In the previous study, there was an increase in leg muscle strength with vertical jump test if the jump height difference before and after drinking coffee was $\geq 2.2 \pm 0.5$ cm. (Wilk et al., 2019)

RESULTS AND DISCUSSION

Table 1. Research Subjects Characteristics (n=22)

Variable	n (%)	Mean ± SD
Age		16.55 ± 1.01
15 years	3 (13.6%)	
16 years	9 (40.9%)	
17 years	5 (22.7%)	
18 years	5 (22.7%)	
Leg muscle strength		
Before drinking coffee		46.68 ± 9.99
After drinking coffee,		
the dose:		
2 mg CAF/kgBW		51.45 ± 8.92
3 mg CAF/kgBW		54.05 ± 8.81

Data table 1 shows the age mean subjects was 16.55 ± 1.01 years with the largest age distribution was 16 years old (40.9%). The averange leg muscle strength before dringking coffee was 46.68±9.99, whereas after drinking coffee with a dose 2mgCAF/kgBW was 51.45±8.92 and at a dose 3mg CAF/kgBW was 54.05±8.81.

Table 2. Relationship Age and Muscle Strength

Age	Leg Muscle Strength		*p-value*
	Increase (n)	Not Increase (n)	
15-16 years	11	1	0.892*
17-18 years	9	1	

*: Chi-square test

Table 3. Relationship Coffee Consumption with Muscle Strength

Caffeine dose	Leg Muscle Strength		*p-value*
	Before	After	
2mg CAF/kgBW	46.68±9.99	51.45±8.92	0.00*
3mg CAF/kgBW	46.68±9.99	54.05±8.81	0.00*

*: Paired t-test

The analysis using paired t-test showed that there was a significant relationship between coffee consumption with muscle strength with a p-value 0.00 ($p<0.05$).

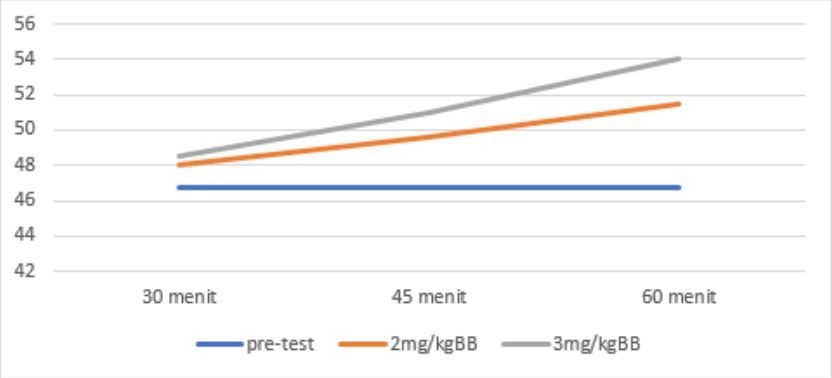

Figure 1. Leg Muscle Strength Before and After Coffee Consumption

Based on figure 1, there was a significant increase in muscle strength after giving coffee at dose 2mg CAF/kgBW or dose 3mg CAF/kgBW which was measured 3 times at the 30th, 45th and 60th minutes. This increase of leg muscle strength can be seen continuing at every minute. At dose 2mg CAF/kgBW, it's shown that the average at the 30th minute was 47.95, at the 45th minute was 49.63 and the 60th minute was 51.45. Meanwhile at dose 3mg CAF/kgBW, the average at the 30th minute was 48.54, at the 45th minute was 50.95 and at the 60th minute was 54.05.

In this study, all subjects were male, because there were no females in the futsal extracurricular at SMA 5 Tambun, Bekasi. The same results were also obtained according to another study. It was said that female participation is low because of the stigma that futsal is an activity that has violent and courageous characteristics that are identical to the male's characteristics. (Akurat & Maksum, 2021)

In our results, there was no relationship between age and muscle strength because all of the subjects were in the teenage age category. One of the risk factors that can influence muscle strength is age. Physicologically, peak mass growth and muscle

strength are gained in late adolescence. Meanwhile, muscle mass decreases around 3 to 8% at the age of 30 years and this decreases even higher above the age of 60 years old. (Ng et al., 2019; Volpi et al., 2004)

There was a relationship between coffee consumption and leg muscle strength in both doses of caffeine p=0.00 (p<0.05). This study results showed an increase in the total leg muscle strength average before consuming coffee (46.68±9.66) and after consuming coffee with a dose of 2mg CAF/kgBW and 3mg CAF/kgBW (54.05±8.81) using vertical jump test. Coffee contains purine alkaloids called caffeine (1,3,7-trimethylxanthine) which bind and regulate several protein that has physiological effects and stimulates sympathetic nervous system as an adenosine receptor antagonist.(Ludwig et al., 2014; Wishart et al., 2017)

Caffeine is one of the ergogenic substances that can increase muscle strength. Caffeine also can help improve sport performance, and muscle performance especially to increase aerobic activity endurance as well as increasing the ability to repetitions or repeat movements in muscle training. This is due to the effects of caffeine which can inhibit the muscle Ca2+ reuptake by sarcoplasmic reticulum thus reducing excitability threshold value and making muscle contraction last longer. Caffeine increases C-AMP by inhibiting the activity of cyclic nucleotide phosphodiesterase, so the result is increasing free fatty acids (FFA) that can be used as energy and causes glycogen saving effects for endurance performance in the long term. Caffeine has a structure similar to adenosine, acting as a competitive antagonist at the adenosine receptor causing low adenosine concentrations in the body, resulting in increased motor activity and lipolysis inhibition to increases FFA production so it can be used as energy for muscle contraction. In addition, caffeine causes the epinephrine release from the adrenal gland causing lipolysis in muscle and fat tissues as an energy sources. As a results of the increasing FFA, the use of glycogen at the beginning of exercise decreases. (Hayati, 2012; Samoggia & Rezzaghi, 2021; Spriet, 2014)

Caffeine as an adenosine receptor antagonist (A1 and A2) on the skeletal muscle membrane make increases exicitation-contraction coupling through the release of Ca2+ from the sarcoplasma reticulum and improves Na+-K+ATPase pump activity which helps increase muscle performance. Adenosine has the effect to inhibiting lipolysis and stimulating insulin to glucose uptake which causes skeletal muscle contraction. In addition, because it is accompanied by an increase in adenosine consentration during exercise, it can increase glycogenolysis in both working and non working tissue also skeletal adipose tissue during physical activity. Futhermore, caffeine has been proven to improve the force velocity relationship and the fibre's muscle conduction velocity. (Hodgson et al., 2013; Tangen et al., 2020)

In this study, it was found that muscle power performance increased every minutes in both doses, 2mg CAF/kgBW and 3mg CAF/kgBW, which the height occurring at the 60th minute. Recently, some studies said the low caffeine dose administration (3mg/kgBW) also can produce an ergogenic effect, with no changes in heart rate, catecholamines level, lactate, FFA and glycerol during exercise. Every minute the muscle strength increases because of the associated caffeine absorption by the small intestine. Approximately 0.5-2% of the caffeine is excreted by urine and the rest will be absorbed by the body through the small intestine. After oral caffeine consumption, the working time will be reached within 45-60 minutes, where the maximum concentration in plasma will be reached between 30-120 minutes. The increase in muscle strength for each respondent was different due to each individual's physiological digestive system differences which depended on the time of gastric emptying and food consumption. The elimination of caffeine half-life was around 2 to 12 hours, with an average 5 hours. It's been reported that women had shorter half-life compared to men. (Grzegorzewski et al., 2022; Mandal, 2023; Spriet, 2014; Wishart et al., 2017)

Studies conducted by Nandatama R et al. and Tangen DS et al. had the same results with this study, which showed that there was an increase in muscle strength after giving coffee, even though it was said that it could increase athlete's endurance.(Nandatama et al., 2017; Tangen et al., 2020)

CONCLUSION

There was a significant relationship between coffee consumption and muscle strength in both doses. The increasing muscle strength reached to the maximum at the 60th minutes in both doses.

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