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The effect of pre-exercise caffeine loading on body composition, blood parameters and resting pulse rate in women

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Abstract

The purpose of our study is to determine the impact of caffeine consumption before exercise activities on the body composition, rest pulse^{bpm}, hemoglobin$^{mg/dL}$, glucose$^{mg/dL}$ values of women who have an exercise history of at least 3 years. A total of 28 healthy women willingly participated in our study, consisting of the Step-aerobic group (Group A, N=10); Zumba (Group B, N=9), and the control group (Group C, N=9). In our study, caffeine xanthine was applied to the Step aerobics (6gr) and Zumba groups (3gr) 60 minutes before exercise respectively. On the other hand, no caffeine application was conducted in the control group. In the statistical analysis of our study, the SPSS 24 version program was utilized. The paired sample t-test was utilized for the comparison of inter-group pre-test and post-test averages, while One Way Anova was utilized for group comparisons. When inter-group comparisons were conducted in the study, the data that differences occurred in Group A, BW $^{(kg)}$, BMI $^{(kg/m2)}$**,** glucose$^{(mg/dL)}$**;** Group B**,** glucose$^{(mg/dL)}$, rest pulse$^{(bpm)}$ was reached ($p<0.05$). When the group averages were compared, the finding that the body composition and rest pulse$^{(bpm)}$ measurements demonstrated differences was reached ($p<0.05$). In conclusion, the finding that pre-exercise caffeine intake leads to decreases in body composition measurements and increases in the averages of blood glucose$^{(mg/dL)}$, and rest pulse$^{(bpm)}$ was reached.

Keywords: Blood parameters, body composition, caffeine, resting pulse rate

Egzersiz öncesi kafein yüklemesinin kadınlarda vücut kompozisyonu, kan parametreleri ve dinlenik nabız değerlerine etkisinin araştırılması

Öz

Çalışmamız sağlıklı kadın bireylere aktivite öncesi kafein yüklemesinin vücut kompozisyon, istirahat nabız$^{atım/dk}$, hemoglobinmg/dL, glukozmg/dL, değerlerine etkisini tespit etmek amacıyla yapılmıştır. Araştırmamıza Step-aerobik grubu (Grup A, n=10); Zumba (Grup B, n=9) ve kontrol (Grup C, n=9) olmak üzere toplam 28 sağlıklı kadın gönüllü olarak katılmıştır. Çalışmamızda Step aerobik (Grup A) grubunda yer alan katılımcılara 6gr, Zumba grubundaki (Grup B) bireylere ise 3gr olmak üzere egzersizden egzersiz programından 60 dakika öncesi kafein trimethylxanthine yüklemesi yapılmıştır. Kontrol grubuna ise herhangi bir kafein yüklemesi yapılmamıştır. Araştırmamızın istatiksel analizinde SPSS 24 sürüm programı kullanılmıştır. Verilerin grup içi ön test-son test ortalamalarının karşılaştırılmasında eşleştirilmiş örneklem t test; grup ortalamalarının karşılaştırılmasında ise tek yönlü varyans analizi kullanılmıştır. Araştırmada grup içi ortalamalarının karşılaştırıldığında Grup A, VA (kg), BKI (kg/m2), glukoz(mg/dL); Grup B, glukoz(mg/dL), istirahat nabız(atım/dk) ölçümlerinde anlamlı farklılaşma olduğu bulgusuna ulaşılmıştır($p<0,05$). Grup ortalamalarının karşılaştırıldığında vücut kompozisyonu ve istirahat nabız(atım/dk) ölçümlerinde anlamlı farklılaşma olduğu bulgusuna ulaşılmıştır($p<0,05$). Sonuç olarak; egzersiz öncesi kafein yüklemesinin kadınlarda VA, BKİ ve abdomen ölçümlerinde azalma olduğu, kan glukoz(mg/dL), istirahat nabız(atım/dk) ortalamalarına ise artışa neden olduğu bulgusuna ulaşılmıştır.

Anahtar Kelimeler: *Dinlendik nabız oranları, kafein, kan parametreleri, vücut kompozisyonu*

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Genişletilmiş Türkçe Özet, makalenin sonunda yer almaktadır.

INTRODUCTION

Caffeine (1,3,7 -trimethylxanthine) was first produced in pure form in 1820 and was converted to a synthetic form in 1861. The purine (CSN4H4) derivative, which carries the caffeine methyl group, is an herbal alkaloid (Standen, 1964; Johnson & Peterson, 1974; Keleş, 1985). Caffeine is found in miscellaneous quantities in the beans, leaves, and fruits of almost more than 60 plants (Harpazz et al., 2017). Caffeine was reported to be a banned substance that led to the disqualification and punishment of athletes if more than 12 mcg/ml of it was detected in their urine until the 2004 Olympic Games (Akça et al., 2019). As caffeine is a stimulant to the central nervous system (Astorino & Robenson, 2010), it is commonly known to decrease exhaustion and increase vitality (McLellan et al., 2016). The effects of caffeine usage differ depending on individuals' differences or the research group (Sabol et al., 2019; Dündar,2022). The effect of caffeine intake; has been stated to potentially increase the speed of heartbeat by 5-25% (Sökmen et al., 2008; Bayraktar & Taşkıran, 2019). Due to these effects, athletes tend to take caffeine before competitions or training sessions, and individuals who participate in exercise programs that are popular in modern days tend to take caffeine before the aforementioned activity (Tallis et al., 2015; Southward et al., 2018; Ayhan et al., 2021). The quantity of caffeine in chocolate varies by the rate of cocoa it contains, with 100% cocoa chocolate (unsweetened baking chocolate) containing almost 240 mg caffeine/100gr, 55% bittersweet containing 124 mg caffeine/100gr, and 33% cocoa milk chocolate containing 45 mg caffeine/100gr (Lyngsø et al., 2017). Caffeine can be used top per day with 1 mg in milk chocolate up to >300 mg in dietary supplements (Carvey et al., 2012). Over-excessive caffeine consumerism (1-1.5 g/day) can affect, for instance, anxiety, agitation, insomnia, gastrointestinal disorders, tremors, and mental disorders etc. (Wilson, 2018). The athletic population's high prevalence of caffeine intake because of its positive effect on sports performance the main reason for moving forward performance physically and psychologically (Salinero et al., 2014).

The protocol of caffeine usage in exercising generally suggests that caffeine should be used 60 minutes before the exercise (Glaister et al., 2012). Since it is known that caffeine can remain in the blood for 4 to 6 hours after ingestion and that it can remain in the blood at a high level for a period of 3 to 4 hours, it is recommended to start exercising 1 hour after taking caffeine (Nehlig & Debri, 1994; Bell & Mclehan, 2002; Kara et al., 2019). Caffeine ingestion during long-term exercises, as well as increasing the release of catecholamine, delays the exhaustion of glycogen storage and increases fat breakdown in the body (Karayiğit, 2009). In addition, caffeine reduces relaxed muscle soreness (DOMS) and taking 5mg of caffeine after exercise is recommended (Kim & Lee, 2014). Daily caffeine consumption of more than 2000 mg is known to cause side effects such as nausea, hypertension, and disturbances in heart rhythm (Gurley et al., 2015). Moreover, different statements discussing the impact of caffeine intake on the acute hydration circumstance are present and it is specified that it may cause dehydration (Maughan & Griffin, 2003). The usage of caffeine intake between 3-9 mg/kg before exercise is recommended caffeine taking caffeine at high levels is known to potentially cause side effects (shaking, anxiety, aggressiveness, nausea, headaches, lack of sleep) (Bayraktar & Taşkıran, 2019). When the effect of caffeine intake on athletes (elite or otherwise) is inspected in studies; parameters such as speed, resilience, and perpendicular jumping were inspected, however, studies inspecting the body compositions or blood measurements of non-athlete individuals who participate in active recreational social living centers' exercise programs are limited.

Caffeine consumption is a widely common supplement today. In the literature, there are not many academic studies investigating the effect of caffeine consumption on blood, body composition and pulse rate in women participating in various exercise programs. Our study was conducted to analyze the impact of caffeine ingestion before exercise programs on the blood parameters, resting pulses, and body composition averages of healthy adult women who are fitness members. We were preferring to both a Step-aerobic and Zumba exercise activity in the gym because of there are only these exercise programs. The findings obtained at the end of the research may be a source for similar studies.

MATERIALS AND METHODS

Sample group

The study consisted of women who participated in the exercise programs of a private recreational and social living centre in the GYM whose average ages were step-aerobic (27.7±0. 74^{year}), Zumba (27.22±4.0^{years}), the control group (27±5.6^{years}) and whose average heights were step-aerobic (167.5±6.34^{cm}), Zumba (164±0.25^{cm}), the control group (162.08±3.84^{cm}). For participation in the study, women who participated in the exercise programs of this center for at least 3 years were selected. Women who participated in the study were randomly separated into three groups. Volunteers who chose to participate in our study fully participated in the exercises conducted in this center for three days each week for 8 weeks. It was requested from the volunteers that they would avoid consuming caffeine-containing food items until 24 hours before measurements Our study took willingness into account signed consent forms were taken from the Participants all steps appropriate to the Helsinki Declaration Principles were completed.

Caffeine intake

In our study, the step aerobics group was given $6^{mg/kg}$ of caffeine, whereas the Zumba groups received $3^{mg/kg}$. The caffeine-containing mixture (trimethylxanthine) was to be taken by the participants 60 min before the measurements. Measurements from all groups were taken at the beginning and end of the 8-week exercise program and transferred to an electronic environment.

Exercise schedule

Step-Aerobic Group (Group A)

- Duration: 8 weeks
- Exercise Duration: 70min.
- Exercise density: 3 days per week (Monday-Wednesday-Friday)
- Exercise Intensity: 50-70%
- Exercise time: between 13:00-14:00

Zumba Group (Group B)

- Duration: 8 weeks
- Exercise Duration: 70min
- Exercise Density: 3 Days per week (Monday-Wednesday-Friday)
- Exercise Intensity: 50-70%
- Exercise Time: between 13:00-14:00

Control Group (Group C)

For the control group, no caffeine intake was conducted, and they were requested to continue their Exercise programs for 8 weeks.

Test protocol

Body composition measurements: Body Weight (kg), Body Fat Ratios (kg), and Body Mass Index (kg/m^2) measurements were obtained through the use of a Tanita Compacto brand smart scale. This device is able to analyze not only all of the body but also some parts of the body. For the participants, it was requested for them to step onto the scale without any metal objects on their person with bare feet and for them to hold the paddles at the sides. At the end of the measurements, findings were automatically recorded in the GYMPRO application. In this study, expert sports trainers accompanied the participants all of the practice while body composition measurements were performed by a dietitian.

Blood measurements: in our study, blood measurements were conducted upon the circular cleaning and drying of the inner side of the right arm (using a 10-15cm upper side turnstile) by transferring the blood to 4^{ml} Edta bran tubes and the samples were analyzed by the laborants in the Erciyes University Medical Faculty laboratory.

Resting pulse measurements: The resting blood pulses of the participants were measured with a Microlife BP 3As1-2 brand with a digital indicator, a hand pump, and an arm wrap tension tool at a resting condition. The measurements were taken from the left arms of the participants with the help of a professional medical worker. The results were recorded in two different periods, those being systolic and diastolic blood pulses (mmHg) and pulses (bpm).

The exercise programs were applied at 12:00 p.m. and 5:00 p.m. Pre-test and post-test were conducted at the 13.00 pm.

Statistical analysis

Data obtained from the participants from the licensed SPSS 24 (Statistical Package for the Social Sciences, USA) statistical program was utilized. They were statistically shown with arithmetic averages and standard deviation. The normal variance test of the data was tested with the Shapiro-Wilk method and the finding that they demonstrated normal distribution was reached. The comparison of the averages of double variables in our study was conducted with Paired Sample T-tests, while the One-Way ANOVA analysis was used to compare groups. The differentiation direction of the group averages was determined through the use of the Tukey method.

FINDINGS

The study was conducted to determine the effect of caffeine loading for 8 weeks on body composition, blood parameters and resting heart rate values in women. The findings are given in tables and the information is explained bellow figure.

Table 1. Descriptive information

Variables	Group	N	Minimum	Maximum	Mean+S.d
Age(year)	Group A	10	21.00	33.00	27.70±3.74
	Group B	9	21.00	36.00	27.22±4.14
	Group C	9	20.00	34.00	27.00±5.36
Height(cm)	Group A	10	157.30	176.50	167.50±6.34
	Group B	9	151.40	171.10	164.00±0.25
	Group C	9	156.10	166.00	162.08±3.84

The table reveals that of the participants, the age and height average of the Group A (Step-aerobic, N=10; age:27.70±3.74$^{years\text{-}old}$, height:167.5^{cm}); while for the Group B (Zumba group, N=9, age:167.5±6.34$^{years\text{-}old}$, height:164±4.25^{cm}).

Table 2. Group (A) body composition measurements (N=10)

Variables	Measurement	Min.	Max.	Mean+S.d	t	p
BW (kg)	Pre-test	58.70	81.50	72.07±6.74	4.096	**0.003***
	Post-test	57.90	79.40	71.0±5.72		
BMI (kg/m2)	Pre-test	20.10	29.40	25.57±3.34	3.196	**0.011***
	Post-test	20.00	28.90	25.11±3.20		
BFR (kg)	Pre-test	15.50	26.70	26.84±3.15	-0.813	0.437
	Post-test	15.10	28.40	27.36±1.95		
Right arm(kg)	Pre-test	1.05	1.90	1.42±0.34	1.071	0.312
	Post-test	1.05	1.88	1.41±0.33		
Left arm(kg)	Pre-test	1.01	1.96	1.42±0.34	0.499	0.670
	Post-test	1.95	1.88	1.47±0.36		
Abdomen(kg)	Pre-test	11.40	18.55	15.31±2.10	4.497	**0.001***
	Post-test	11.10	18.49	15.18±2.13		
Right leg (kg)	Pre-test	4.40	5.40	4.77±0.33	1.652	0.133
	Post-test	4.30	5.50	4.74±0.36		
Left leg(kg)	Pre-test	4.35	5.30	4.71±0.34	2.461	**0.036***
	Post-test	4.35	5.30	4.66±0.30		

*=p<0.05 (BW: Body Weight, BMI: Body Mass Index, BFR= Body Fat Ratios)

The body fat ratios, right and left arm, and right leg fat ratios of the participants (Experimental group, N=10) were found to demonstrate no significant differences (p>0.05); the body weight, body mass indices, abdomen and left leg ratios were found to demonstrate significant differences (p<0.005).

Table 3. Group (A) blood parameter and resting pulse measurements (N=10)

Variables	Test	Min.	Max.	Mean+S.d	t	p
Glucose(mg/dL)	Pre-test	75.00	100.00	88.1±8.26	-1.998	**0.047***
	Post-test	76.00	103.00	89.4±9.10		
Hemoglobin(mg/dL)	Pre-test	5.10	14.10	8.51±3.20	-0.822	0.430
	Post-test	5.10	15.70	8.95±3.24		
Resting pulse rate (bpm)	Pre-test	65.00	82.00	73.70±4.54	-1.655	0.132
	Post-test	66.00	83.00	74.40±4.69		

*=p<0.05

Measurements throughout the Step-Aerobic group (N=10) of the participants led to the finding that the haemoglobin and resting pulses demonstrated no differences (p>0.05) while the Glucose levels demonstrated significant differences (p<0.005).

Table 4. Group (B) body composition measurements (N=9)

Variables	Measurement	Min.	Max.	Mean+S.d	t	p
BW$^{(kg)}$	Pre-test	69.30	89.40	79.14±6.19	0.080	0.938
	Post-test	68.90	88.70	79.07±5.96		
BMI$^{(kg/m2)}$	Pre-test	24.10	31.90	29.07±2.43	-0.437	0.666
	Post-test	24.50	31.80	29.11±2.27		
BFR$^{(kg)}$	Pre-test	20.60	30.30	26.84±2.43	-0.516	0.620
	Post-test	20.50	30.00	27.36±1.95		
Right arm$^{(kg)}$	Pre-test	1.90	2.17	2.01±0.09	0.400	0.700
	Post-test	1.80	2.20	2.00±0.13		
Left arm$^{(kg)}$	Pre-test	1.80	2.20	1.96±0.09	0.874	0.407
	Post-test	1.85	2.10	1.94±0.10		
Abdomen$^{(kg)}$	Pre-test	18.00	21.0	19.92±1.05	-0.750	0.475
	Post-test	18.50	21.0	20.02±0.82		
Right leg$^{(kg)}$	Pre-test	4.90	5.10	5.14±0.26	0.894	0.392
	Post-test	4.87	5.15	5.12±0.27		
Left leg$^{(kg)}$	Pre-test	4.00	5.00	4.90±0.37	0.567	0.584
	Post-test	4.00	4.95	4.80±0.40		

*=p<0.05 (BW: Body Weight, BMI: Body Mass Index, BFR= Body Fat Ratios)

In the participants' zumba (N=9) the finding that no significant difference was observed in any body composition measurements was reached (p>0.005).

Table 5. Group (B) blood parameter and resting pulse measurements (N=9)

Variables	Measurement	Min.	Max.	Mean+S.d	t	p
Glucose$^{(mg/dL)}$	Pre-test	80.00	108.00	91.22±8.37	-2.449	**0.040***
	Post-test	85.00	109.00	94.20±7.49		
Hemoglobin$^{(mg/dL)}$	Pre-test	6.60	18.60	12.18±4.46	0.913	0.380
	Post-test	5.90	16.65	11.91±4.61		
Resting pulse rate$^{(bpm)}$	Pre-test	68.00	82.00	77.66±4.38	1.941	**0.048***
	Post-test	72.00	86.00	79.22±4.73		

*=p<0.05

The Zumba group of the participants (N=9) was found to demonstrate no significant differences in the hemoglobin and resting pulse findings (p>0.05) while the Glucose values were found to demonstrate significant differences (p<0.005).

Table 6. Group (C) body composition measurements (N=9)

Variables	Measurement	Min.	Max.	Mean+S.d	t	p
BW$^{(kg)}$	Pre-test	44.70	87.20	63.62±14.47	0.614	0.556
	Post-test	44.80	85.60	63.41±14.00		
BMI$^{(kg/m2)}$	Pre-test	17.30	32.40	23.47±4.95	2.001	0.080
	Post-test	17.00	32.00	23.35±4.90		
BFR$^{(kg)}$	Pre-test	5.40	31.30	21.27±9.21	1.423	0.193
	Post-test	5.40	31.00	20.69±9.39		
Right arm$^{(kg)}$	Pre-test	0.20	2.10	1.15±0.66	0.000	0.121
	Post-test	0.20	2.10	1.15±0.67		
Left arm$^{(kg)}$	Pre-test	0.10	2.00	1.11±0.66	1.000	0.347
	Post-test	0.10	2.00	1.10±0.61		
Abdomen$^{(kg)}$	Pre-test	1.20	30.70	15.40±9.45	-0.047	0.964
	Post-test	1.20	30.80	15.10±9.45		
Right leg$^{(kg)}$	Pre-test	2.20	6.70	4.11±1.59	-1.512	0.169
	Post-test	2.20	6.70	4.13±1.63		
Left leg$^{(kg)}$	Pre-test	1.90	6.70	4.05±1.67	0.050	0.961
	Post-test	1.90	6.80	4.05±1.70		

*=p<0.05 (BW: Body Weight, BMI: Body Mass Index, BFR= Body Fat Ratios)

Throughout the participants' control group measurements (N=9) led to no significant differences being found in the body composition measurements (p>0.005).

Table 7. Group (C) blood parameters and resting pulse measurements (N=9)

Variables	Measurement	Min.	Max.	Mean+S.d	t	p
Glucose$^{(mg/dL)}$	Pre-test	70.00	109.00	87.52±13.61	-0.188	0.855
	Post-test	71.00	110.00	87.61±13.87		
Hemoglobin$^{(mg/dL)}$	Pre-test	7.50	13.50	19.08±2.05	-0.363	0.726
	Post-test	7.60	13.10	19.12±1.94		
Resting pulse rate$^{(bpm)}$	Pre-test	75.00	91.00	80.55±5.74	0.883	0.403
	Post-test	71.00	95.00	79.66±7.34		

*=p<0.05

Throughout the participants' control group (N=9) measurements, it was found that no changes in the blood parameters and resting pulse measurements were observed (p>0.005).

Table 8. Comparison of participants' BW, BMI, BFR averages (Anova)

Variables	Group	N	Mean+S.d	df	f	p	Tukey
BW$^{(kg)}$	Group A	10	71.00±6.08	2	5.160	**0.014***	A-C B-C
	Group B	9	79.07±5.96				
	Group C	9	65.74±12.90				
BMI$^{(kg)}$	Group A	10	25.11±3.20	2	5.380	**0.014***	A-C B-C
	Group B	9	29.11±2.27				
	Group C	9	24.03±4.76				
BFR$^{(kg)}$	Group A	10	22.60±4.12	2	2.502	0.103	-
	Group B	9	27.36±1.95				
	Group C	9	20.69±9.39				

*=p<0.05 (BW: Body Weight, BMI: Body Mass Index, BFR= Body Fat Ratios)

In the significance analyses of the body composition measurements depicted in the table, it was determined that BW and BMI averages demonstrated differences (p<0.005) and that this difference was caused due to the differences between the averages of the step-aerobic group and the control group, as well as those between the averages of the zumba group and the control group.

Table 9. Comparison of participants' arm, abdomen region and leg fat ratio averages (Anova)

Variables	Group	N	Mean+S.d	df	f	p	Tukey
Right Arm$^{(kg)}$	Group A	10	1.41±0.33	2	1.329	**0.002***	A-B B-C C-B
	Group B	9	2.00±0.11				
	Group C	9	1.26±0.63				
Left Arm$^{(kg)}$	Group A	10	1.47±0.38	2	1.202	**0.004***	A-B B-C C-B
	Group B	9	1.94±0.10				
	Group C	9	1.21±0.60				
Abdomen$^{(kg)}$	Group A	10	15.18±0.21	2	2.394	0.113	-
	Group B	9	20.02±0.82				
	Group C	9	17.10±0.85				
Right Leg$^{(kg)}$	Group A	10	4.74±0.36	2	1.203	0.240	-
	Group B	9	5.12±0.27				
	Group C	9	4.37±0.56				
Left Leg$^{(kg)}$	Group A	10	4.66±0.30	2	0.993	0.585	-
	Group B	9	4.94±0.43				
	Group C	9	4.31±0.63				

*=p<0.05

When the table is inspected, in the body composition measurements significance analyses, right and left arm averages demonstrated differences (p<0.005) the finding that this difference was caused due to the differences between the averages of the step-aerobic group and the control group, as well as those between the averages of the zumba group and the control group was reached.

Table 10. Comparison of participants' blood parameters and resting pulse measurement averages (Anova)

Variables	Group	N	Mean+S.d	df	f	p	Tukey
Glucose$^{(mg/dL)}$	Group A	10	89.40±9.10	2	0.702	0.505	-
	Group B	9	94.20±7.40				
	Group C	9	88.90±14.20				
Hemoglobin$^{(mg/dL)}$	Group A	10	8.95±9.10	2	1.707	0.203	-
	Group B	9	11.91±4.61				
	Group C	9	13.10±2.07				
Resting pulse rate$^{(bpm)}$	Group A	10	74.40±4.69	2	2.574	**0.005***	A-C
	Group B	9	79.20±4.73				
	Group C	9	80.00±7.78				

*=p<0.05

When the table is inspected, the findings that significant differences occurred in the resting pulse measurements (p<0.005) and that this difference is caused by the step-aerobic group alongside the control group were reached.

DISCUSSION AND CONCLUSION

Due to their stimulating effects, caffeine and its derivatives are commonly preferred, especially by athletes and those who exercise for health purposes. Studies conducted on the performance parameters of numerous athletes are present, moreover, studies on individuals who exercise for health purposes are low in quantity. Our study was conducted to determine the effects of pre-exercise caffeine intake (trimethylxanthine,3-6$^{mg/kg}$, liquid) on the blood (glucose, haemoglobin), body composition (BW, BMI, BFR), and resting pulse levels of participants of exercise groups for health purposes (step-aerobic, zumba). In our study, healthy women participants were randomly selected as control groups (N=9), and measurements were taken in the same social living centre and the same timeframe.

Astorino et al. (2008) 6$^{mg/kg}$ caffeine intake 'Efficacy of acute caffeine ingestion for short-term high-intensity exercise performance' in the conducted study, participants reported an increased feeling of energy, heart palpitation, unrest, and shaking. Throughout our study, no harmful health conditions were reported to the application team.

In our study, the conclusion was that throughout the caffeine-applied groups, the step-aerobic group (N=10) demonstrated significant changes in BW, BMI, the abdomen, the left leg, and glucose values while the Zumba group (N=9) demonstrated significant changes in glucose and resting pulse values were reached ($p<0.005$). The control group, on the other hand, was observed to not demonstrate any meaningful differences ($p>0.005$). Hursel and Patenga (2009) in the 'Green tea catechin plus caffeine supplementation to a high-protein diet has no additional effect on body weight maintenance after weight loss' study they conducted (N=80), concluded that the participants demonstrated significant differences in blood glucose levels compared to the placebo group after 4 weeks. Crowe et al. (2006) in their study titled Physiological and Cognitive Responses to Caffeine During Repeated', reported that blood parameter (glucose, hemoglobin$^{mg/dL}$) values did not demonstrate significant changes. Studies in which similar and different conclusions were reached can be found in the literature. Personal differences, exercise types, caffeine intake durations and doses, nutrition habits, and exercise intensities are believed to have possibly been impactful in these differences.

Due to the anti-angiogenic effects of caffeine consumption, it has been reported to have a preventative effect against increases in changes such as body weight and obesity (Westerterp et al., 2006). Kobayashi et al. (2005) reported that regular caffeine intake has a decreasing effect on body weight, body mass ratio, and body fat ratio. Listiarini et al. (2022) in their 'The Caffeine Supplementation in a Moderate-Intensity Aerobic Exercise in Obese Asian Women' study (N=9), determined that throughout an 8-week exercise program, caffeine intake before exercising reduced BMI and BFR. Lorino et al. (2006) in their study titled the effects of caffeine on athletic agility, concluded that caffeine consumption before exercise led to significant changes in the participants' physical parameters (BW, BMI, BFR) and performance measurements ($p<0.005$). On the other hand, in their study titled 'Effects of catechin enriched green tea on body composition', Wang et al. (2010) concluded that caffeine consumption had no significant difference in body composition measurements ($p<0.05$). Findings in Table 2 also support this statement. In the Averages in Tables 4 and 6, it was concluded that although differences were observed, they were not statistically meaningful. Alongside the fact that studies reaching different and similar conclusions can be found in the literature, it is believed that this difference may be caused by factors such as the sample group, age, body composition values, and exercise day numbers.

Studies stating that daily caffeine consumption at an overly high level can lead to increases in pulse^{bpm} levels can be found in the literature (Turnbull et al., 2017). Additionally, caffeine consumption at an optimal dose was determined to increase resting pulses in middle-aged men who participated in aerobic exercises (N=10) (Harber et al., 2020). On the other hand, another similar study in which blood plasma levels and resting pulses were measured, concluded that $5^{mg/kg}$ of caffeine given to subjects 60 minutes before exercise led to significant changes ($p<0.005$) (Köse, 2005). Notarius et al. (2006) in the 'Caffeine prolongs exercise duration in heart failure' study (N=10), on the other hand, concluded that blood pressure and resting pulse increased.

Alongside the fact that caffeine is an alternative option for the prevention of caffeine, they are also considered to be an option for the preservation of body mass (Diepwens et al., 2007). In the findings in Tables 8 and 9, when inter-group averages are compared, it was demonstrated that BW and BMI measurements were altered in this difference's direction (Tukey) between the step-aerobic and Zumba groups and the control group; in the right and left arm measurements, on the other hand, occurred between the step-aerobic and Zumba, the Zumba and control, the control and step-aerobic groups. In the study conducted with the participation of obese women, it was spotted that there were no significant changes ($p>0.005$) in BW and BMI levels (Bracale et al., 2014). In another similar study, 'Caffeine Treatment Prevented from Weight Regain after Calorie Shifting Diet Induced Weight Loss' it was concluded that a significant difference ($p<0.005$) occurred (Davodi et al., 2014). Alongside the fact that our study and the literature contain similar and contradictory findings; it is believed that caffeine intake, alongside proper planning, and the proper dose of the exercise prescription, can positively impact the changes in individuals' body weight and BMI values.

In the resting pulse measurements in Table 10, it was concluded that inter-group differences ($p<0.005$) occurred. Harber et al. (2021), in their study titled 'Caffeine ingestion alters central hemodynamics following aerobic exercise in middle-aged men', observed that pre-exercise caffeine intake increased both resting pulse and mid-exercise pulse values. In our study, the direction of the changes in resting pulse levels between groups A and C group A pulse averages increasing and group C averages decreasing is believed to potentially be caused by caffeine intake.

This study was conducted to determine the impact of $6\text{-}3^{mg/kg}$ of caffeine intake pre-exercise on the physical (BW, BMI, BMR, abdomen, right, left hand and leg fat ratios) blood parameters (glucose and haemoglobin) and resting pulse levels of women. After the study; it was concluded that in inter-group comparisons in the step-aerobic group (N=10) demonstrated significant differences in body $mass^{kg}$, body mass $index^{kg/m2}$ $abdomen^{kg}$ left leg^{kg} $glucose^{mg/dL}$ values while the zumba group demonstrated significant differences in $glucose^{mg/dL}$ and resting $pulse^{bpm}$ values ($p<0.05$). When the averages of the groups are compared (N=28), BW, BMI, right-left arm fat ratios, and resting pulse values were found to demonstrate significant differences ($p<0.005$). It has been concluded that the consumption of caffeine before exercising positively affects the body fat ratios of active healthy women, that especially depending on the type of exercise, the body fat ratios might regionally decrease and that it causes increases in pulse^{bpm} and blood glucose$^{mg/dL}$ values.

In conclusion, it was determined that the consumption of caffeine at an optimal dose (3-6$^{mg/kg}$) leads to decreases in body composition (BW^{kg}, BMI$^{kg/m2}$, the abdomen region^{kg}, left leg^{kg}) values, and leads to increases in blood glucose$^{mg/dL}$ and resting pulse^{bpm} measurement averages. The conclusion that these differences were caused by pre-exercise caffeine intake was reached considering the findings that were obtained.

Recommendations

Based on these results, the number of samples can be increased, and male participants can be included in future studies.

GENİŞLETİLMİŞ ÖZET

GİRİŞ

Kafein (1,3,7 -Trimethylxanthine) ilk defa 1820'de saf hale getirilmiş ve 1861 yılında ise sentetik hale getirilmiştir. Kafein metil grubu taşıyan pürin (CSN4H4) türevi bir bitkisel alkaloiddir (Standen, 1964; Johnson & Peterson,1974; Keleş, 2011). Kafein 2004 olimpiyatları öncesine kadar sporcuların idrarında 12 mcg/ml'nin üzerinde kafein tespit edilmesi durumunda müsabakalardan men ve ceza almasına neden olan bir yasaklı madde olduğu belirtilmektedir (Akça ve ark., 2019). Kafein merkezi sinir sisteminin uyaranı olduğu için (Astorino & Robenson., 2010) yaygın olarak yorgunluğu azaltmada ve zindeliği artırmada etkili olduğu bilinmektedir (McLellan ve ark., 2016). Kafein kullanımının etkisi akut ve kronik olarak bireysel farklılıklar veya araştırma grubu özelliklerine göre farklılık göstermektedir (Sabol ve ark., 2019; Dündar,2022) Kafein kullanımın etkisi; karaciğer ve plazma glukoz değerlerinde, kan basıncında, kalp atım hızında %5-25 oranında artış olabileceği belirtilmektedir (Sökmen ve ark., 2008; Bayraktar &Taşkıran,2019). Bu etkilerinden dolayı sporcular müsabaka veya antrenman öncesi kafein tüketimi yaparak günümüzde popüler olarak egzersiz programlarına katılan bireyler aktivite öncesi kafein kullanmaktadır (Tallis ve ark., 2015; Southward ve ark., 2018; Ayhan ve ark., 2021).

Egzersizde kafein kullanımı protokolü genellikle egzersizden 60 dakika öncesi kullanımı önerilmektedir (Glaister ve ark., 2012). Kafeinin vücuda alımında 4 ile 6 saat arasında kanda kalabileceği ve 3 ile 4 saatlik zaman dilimde yüksek düzeyde kanda bulunabileceği belirtilmekte olup kafein yüklemesinden 1 saat sonra egzersize başlanılması önerilmektedir (Nehlig & Debri, 1994; Bell & Mclehan, 2002; Kara ve ark., 2019).

Araştırmalarda kafein alımının sporcular (elit veya elit olmayan) üzerindeki etkileri incelendiğinde; sürat, dayanıklılık, dikey sıçrama, kuvvet gibi parametreler test edilmiş fakat sporcu olmayan fakat aktif rekreaktif sosyal yaşam merkezlerinde egzersiz programlarına katılan bireylerin vücut kompozisyonu veya kan ölçümleri üzerine yapılmış çalışmalar sınırlıdır. Çalışmamız egzersiz programı öncesi kafein yüklemesinin yetişkin sağlıklı kadın fitness üyelerinde kan parametreleri, istirahat nabız ve vücut kompozisyonu ortalamalarına etkisini tespit etmek amacıyla yapılmıştır.

YÖNTEM

Çalışmamızda step-aerobik grubuna 6 mg/kg ve zumba gruplarına 3 mg/kg olmak üzere kafein yüklemesi yapılmıştır. Kafein yüklemesi (trimethylxanthine) içeren karışım egzersizlerden 60 dk önce içmeleri istenmiştir. Kontrol grubuna ise kafein yüklemesi yapılmamış ve sadece egzersizlere katılmaları istenmiştir. Tüm grupların ölçümü 8 haftalık egzersiz programı öncesinde ve sonrasında Vücut Kompozisyonu, kan parametreleri ve dinlendik nabız ölçümleri alınıp elektronik ortama aktarılmıştır.

TARTIŞMA VE SONUÇ

Kafein ve türevleri uyarıcı etkileri nedeniyle özellikle sporcular ve sağlık amaçlı egzersiz katılımcılarında tercih edilmektedir. Çeşitli sporcularda performans parametrelerine etkisi üzerine yapılmış çalışmalar mevcut olmakla birlikte sağlık amaçlı egzersiz yapan bireylerdeki çalışmaların sayısı nicelik bakımından azdır. Çalışmamızda egzersiz öncesi kafein yüklemesinin (trimethylxanthine,3-6$^{mg/kg}$, sıvı) sağlık amaçlı egzersiz grupları (step-aerobik, zumba) katılımcılarının kan (glukoz, hemoglobin), vücut kompozisyonu (VA, BKI, VYO) ve istirahat nabız ölçüm değerlerine etkisinin tespit edilmesi amacıyla yapılmıştır. Araştırmamızda sağlıklı kadın üyeler kontrol grubu (n=9) olarak rasgele seçilmiş aynı sosyal yaşam merkezinde bulunan ve aynı zaman dilimi içerisinde ölçümler alınmıştır. Astorino ve arkadaşları., (2008) 6$^{mg/kg}$ kafein yüklemesi yaptıkları çalışmada katılımcılarda artmış bir enerji hissi, kalp çarpıntısı, huzursuzluk ve titreme rapor etmişlerdir. Çalışmamız sürecinde katılımcılardan uygulama ekibine herhangi rahatsızlık durumu rapor edilmemiştir. Araştırmamızda kafein kullanan gruplarda step-aerobik (n=10) VA, BKI, karın bölgesi, sol bacak ve glukoz değerlerinde zumba grubunda ise(n=9); glukoz ve istirahat nabız değerlerinde anlamlı farklılaşma olduğu bulgusuna ulaşılmıştır ($p<0,005$). Kontrol grubunda ise ölçümlerde herhangi bir anlamlı farklılaşma olmadığı bulgusuna ulaşılmıştır ($p>0,005$). Hursel ve Patenga (2009) yaptıkları çalışmada 4 hafta sonunda katılımcıların kan glukoz değerlerinde plasebo grubuna göre anlamlı farklılaşma olduğu bulgusuna ulaşılmıştır. Crowe ve arkadaşları. 2006 yaptıkları çalışmada kan parametreleri (glukoz, hemoglobin$^{mg/dL}$) değerlerinde farklılaşmanın anlamlı olmadığı bulgusuna ulaşılmıştır ($p>0,005$). Literatürde farklı ve benzer sonuçlara ulaşıldığı çalışmalar mevcuttur. Bireysel farklılıklar, egzersiz türü, kafein alımının süresi ve dozu, beslenme alışkanlıkları, egzersiz şiddeti bu sonuçların farklı olmasında etkili olabileceği düşünülmektedir.

Sonuç olarak; egzersiz öncesi planlanmış optimal dozda kafein tüketiminin (3-6$^{mg/kg}$) vücut kompozisyon (VA^{kg}, BKI$^{kg/m2}$, karın bölgesi^{kg}, sol bacak^{kg}) değerlerinde azalma, kan glukoz$^{mg/dL}$ ve istirahat nabız$^{atım/dk}$ ölçümleri ortalamalarında ise artışa sebep olduğu bulgusuna tespit edilmiştir. Bu farklılaşmaların egzersiz öncesi kafein tüketiminden kaynaklandığı sonucuna elde edilen bulgular ışığında yorumlanmaktadır.

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