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EFFECT OF CAFFEINE CONSUMPTION PRIOR TO WALKING EXERCISE ON BODY COMPOSITION IN OVERWEIGHT INDIVIDUALS

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Аннотация. *Было показано, что кофеин увеличивает количество доступной энергии в форме циркуляции свободной жирной кислоты через липолиз. Таким образом, потребление кофеина повышает окисление липидов у лиц, выполняющих физические упражнения.* ***Цель исследования*** *- изучить влияние потребления кофеина на состав тела людей с избыточным весом.* ***Методы****: для этого исследования были отобраны тридцать человек с избыточным весом из кампуса университета Малайзии с индексом массы тела (ИМТ) от 25,1 до 29,0 кг/м2. Участники были распределены случайным образом на три группы: контрольная (С) группа (n=10), экспериментальная (Е) группа (n=10) и экспериментальная (СЕ) группа,* *участники которой использовали кофеин (n=10). Группы E и CE участвовали в разработанной программе быстрой ходьбы в течение шести недель. Кроме того, участники группы CE употребляли кофеин (50-100 mg) за один час до начала каждой тренировки. Группе C было предложено не участвовать ни в одной из программ в течение учебного периода.* ***Результаты:*** *достоверных различий в массе тела между 3 группами до и после эксперимента не выявлено. Тем не менее масса тела после эксперимента была значительно ниже (p <0,05) в группах E и CE по сравнению с соответствующими значениями до эксперимента. ИМТ был достоверно ниже (p <0,05) в группе CE по сравнению с группой C после эксперимента. ИМТ также был значительно ниже (p <0,05) после эксперимента в группах E и CE по сравнению с соответствующими значениями до эксперимента. Кроме того, процент жира в организме в группах E и CE были достоверно ниже (p<0,05), чем в группе C после эксперимента.****Заключение:*** *обе экспериментальные программы привели к небольшому снижению массы тела, ИМТ и процента жира в организме участников, но потребление кофеина (50-100 мг) за час до тренировки не привело к дальнейшей потере веса по сравнению с программой быстрой ходьбы.*

Ключевые слова*: кофеин, быстрая ходьба, состав тела, ожирение, ИМТ.*

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INTRODUCTION

Caffeine and 3 dimethylxanthines (theophylline, theobromine, paraxanthine) are biologically active, and the putative impact of methylxantines on metabolism has received considerable attention in sports (Graham *et al.*, 2008). Coffee is certainly the most common mode of caffeine ingestion, and it can also provide caffeine in a more concentrated form than do other foodstuffs (Arnaud, 1993). Caffeine also has many pharmacological effects in humans, including increase in heart rate variability during rest as well as during aerobic exercise (Nishijima *et al.*, 2002). Athletes are among the group of people who are interested in the effects of caffeine on endurance and exercise capacity (Burke, 2008). To date, many research trials have demonstrated caffeine to be an ergogenic aid for exercise of varying intensities, durations and modalities in an athletic population (Bruce *et al.*, 2000; Graham, 2001; Bell and McLellan, 2002; Stuart *et al.*, 2005; Ping *et al.*, 2010). The ability to perform more work after caffeine ingestion, as demonstrated in athletic populations, can result in greater caloric expenditure and the possibility of improved fitness if the exercise is maintained over an extended period of time (Wallman *et al.*, 2010).

Overweight and obesity represent a threat to the health of populations in an increasing number of countries (WHO, 2000). Obesity is the outcome of a prolonged positive energy balance, due to an excess energy intake over energy expenditure. A negative energy balance is needed to produce weight loss and can be achieved by either decreasing intake or increasing energy expenditure. Nutritional agents like caffeine, ephedrine, capsaicin, and green tea have been proposed as strategies for weight loss and weight maintenance, since they may increase energy expenditure and have been proposed to counteract the decrease in metabolic rate that is present during weight loss (Diepvens *et al.*, 2007). Bracco *et al.* (1995) observed that compared with lean women, obese women had increased lipid oxidation the day after caffeine ingestion. There was also increased fat oxidation in obese women who consumed a restricted diet and a mixture of ephedrine and caffeine over an eight weeks period (Astrup *et al.*, 1992). The increase in energy expenditure and changes in plasma substrates after caffeine ingestion resemble those caused by increased activity of the sympathetic nervous system (Acheson *et al.*, 2004).

To our knowledge, information about effect of caffeine consumption prior to exercise on body composition in overweight individuals in Malaysia is scarce. Thus the present study was carried out to investigate the effect of caffeine consumption prior to walking exercise for six weeks on body composition in overweight individuals.

METHODS

Participants

Thirty healthy individuals from the campus in Universiti Sains Malaysia were recruited as participants for this study. They were age-matched and randomly assigned into two interventions groups and a control group. Intervention groups were named exercise group (E) and combined exercise plus caffeine group (CE). Each group consisted of ten participants. All the participants had body mass index (BMI) between 25.1 kg/m^2 to 29.9 kg/m^2 and were classified as overweight according to World Health Organization (WHO). They were instructed not to be involved in any other exercise program during the study period. The nature and risk of the experimental procedures were explained to them and a written informed consent was obtained from each of the participants. This study was approved by the Human Research Ethics Committee, Universiti Sains Malaysia.

Research Design

All participants in both interventions group were requested to participate in a prescribed exercise program three times per week for six weeks. The walking exercise program was the intervention brisk walk suggested by the National Heart, Lung, and Blood Institute (NHLB). For the first week, participants were requested to complete three sessions of 15 minutes of brisk walking exercise. The 15 minutes sessions consisted of warm up for five minutes, walk briskly for five minutes and cool down for five minutes. For next five weeks, the duration of brisk walking was increased two minutes each week. The prescribed exercise is shown in Table 1.

	Warm-up	Exercising	Cool down	Total time
Week 1	Walk 5 min.	Then walk briskly 5 min	Then walk more slowly 5 min	15 min
Session A	Repeat pattern above			
Session B	Repeat pattern above			
Session C	Repeat pattern above			
Continue at least three exercise sessions during each week of the program.				
Week 2	Walk 5 min.	Walk briskly 7 min	Walk 5 min.	17 min.
Week 3	Walk 5 min.	Walk briskly 9 min	Walk 5 min.	19 min.
Week 4	Walk 5 min.	Walk briskly 11 min	Walk 5 min.	21 min.
Week 5	Walk 5 min.	Walk briskly 13 min	Walk 5 min.	23 min.
Week 6	Walk 5 min.	Walk briskly 15 min	Walk 5 min.	25 min

(Adapted from walking program by National Heart, Lung and Blood Institute, USA, 2006)

Table 1: Intervention Brisk Walking Program

In addition, participants in the caffeine + exercise group were required to consume caffeine an hour before the exercise sessions. Caffeine was consumed in the form of a Nescafe® drink (3 in 1, Rich). Amount of caffeine in each sachet (20g) was between 50–100mg. Participants in the control group were requested not to participate or involve in any exercise program for six weeks. Anthropometric, body composition and waist-to-hip ratio assessment were carried out on the control group at the same interval as for the intervention groups which were done before and after six weeks of the prescribed exercise program.

Procedures

A stadiometer (Seca Corporation, Germany) was used to measure standing height of each participant to the nearest 0.1 centimeter (cm). Participants were requested to stand with foot together and with their shoes removed. A weighing scale (Seca Corporation, Germany) was used to measure body mass of each participant to the nearest 0.1 kilogram (kg). A body composition analyzer (Omron Healthcare Corporation, Japan) was used to measure the body composition of the participants. After keying in the data of the participants such as height, gender and age, they were requested to step onto the body composition analyzer until the measurements were recorded. For measurement of the waist to hip ratio, a non-elastic measuring tape was used to measure the circumference of the waist and hip of the participants. The circumference of hip was measured at the widest part of the buttocks and the circumference of waist was measured at the narrowest point of the natural waist, just above the belly button. To determine the ratio, waist measurement was divided by the hip measurement.

Statistical Analysis

Statistical Package for Social Sciences (SPSS) version 20.0 was used for the analytical procedure. All the data were expressed as means ± standard deviation (SD). ANOVA with repeated-measures was used to analyze and compare differences of body weight, BMI, WHR, and percentage of body fat between groups. Statistical significance was accepted at $p < 0.05$.

RESULTS

The participants' physical characteristics are presented in Table 2.

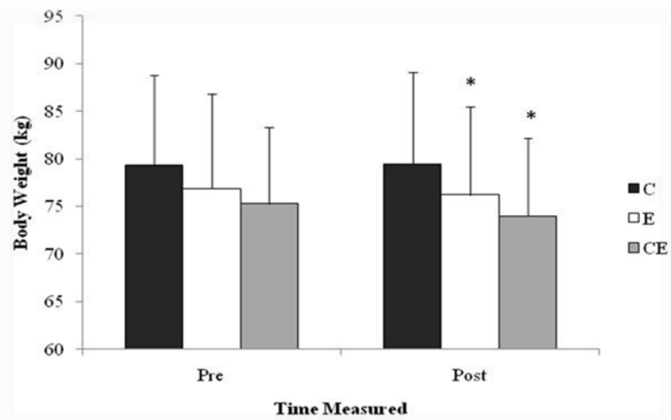
N = 30	Control(C)	Exercise(E)	Caffeine + Exercise(C+E)
N	10	10	10
Age (years)	21.6 ± 1.3	21.6 ± 1.4	21.5 ± 1.2
Height (cm)	168.3 ± 6.9	168.2 ± 7.0	166.2 ± 6.3
Weight (kg)	79.3 ± 9.5	76.9 ± 9.9	75.3 ± 8.0

Values shown as means ± standard deviation (SD)

Table 2: Physical characteristics of the participants.

Body Weight

Body weight of the participants in all three groups during pre and post intervention is shown in Fig. 1. ANOVA with repeated measures revealed that there was no interaction between all groups and time on body weight. However, there was a significant difference ($p<0.05$) in body weight between pre and post for both intervention groups. Body weight was significantly lower in the Exercise and Caffeine + Exercise groups compared to their respective baseline values after the 6 weeks walking program.



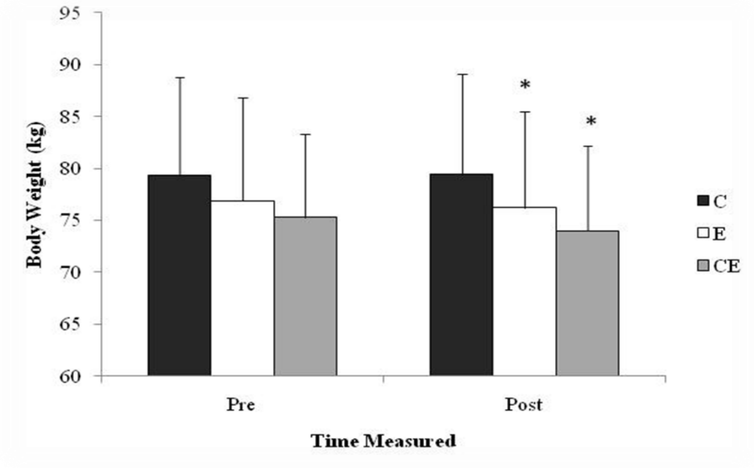


Figure 1: Mean body weight at pre and post intervention.
* Significantly different from respective pre intervention values (p<0.05)

Body Mass Index (BMI)

BMI of participants in all three groups at pre and post intervention is shown in Fig. 2. At post intervention, BMI of CE and E groups were significantly lower than the control C group. Body mass index was significantly (p<0.05) lower in the Exercise and Caffeine + Exercise groups compared to their respective pre-intervention values after the 6 weeks walking program. BMI was also significantly (p<0.05) lower in the Exercise and Caffeine group compared to the control group at post-test.

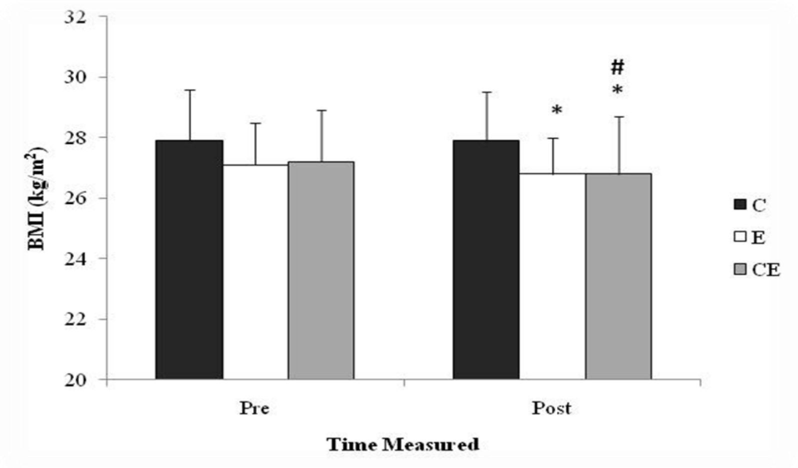


Figure 2: Mean Body Mass Index at pre and post intervention.
* Significantly different from respective pre intervention values (p<0.05)
# Significantly different from control group (p< 0.05)

Percent Body Fat

Percent of body fat of participants in all three groups during pre and post is shown in Fig. 3. ANOVA with repeated measures revealed that there was an interaction (p<0.05) between both intervention groups and time on percent body fat. At post intervention, BMI of E group and CE group were significantly lower than C group. Furthermore, paired-sample T tests revealed a lower percent body fat between pre and post intervention values in both CE and E groups.

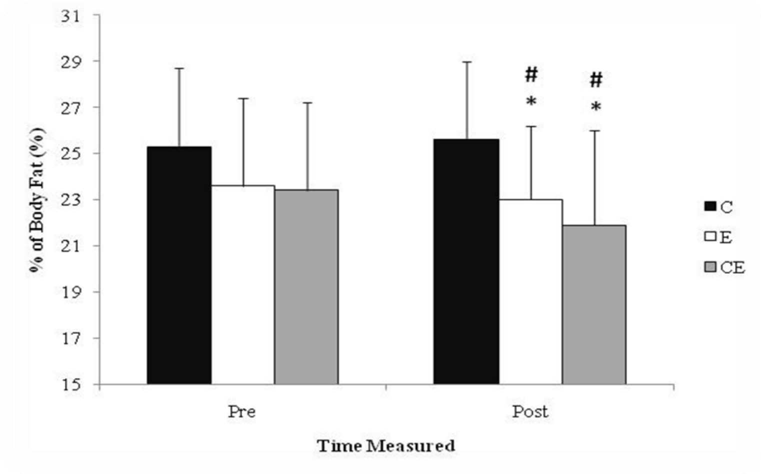


Figure 3: Mean percent body fat at pre and post intervention.
* Significantly different from respective pre intervention values (p<0.05)
# Significantly different from control group (p< 0.05)

Waist-to-Hip Ratio (WHR)

WHR of participants in all three groups during pre and post intervention is shown in Fig. 4. ANOVA with repeated measures revealed that there was no interaction between all groups and time on WHR. Furthermore, there was also no significant main effect of time on WHR. A paired-sample T test revealed that there were no differences between pre and post WHR for all the 3 groups.

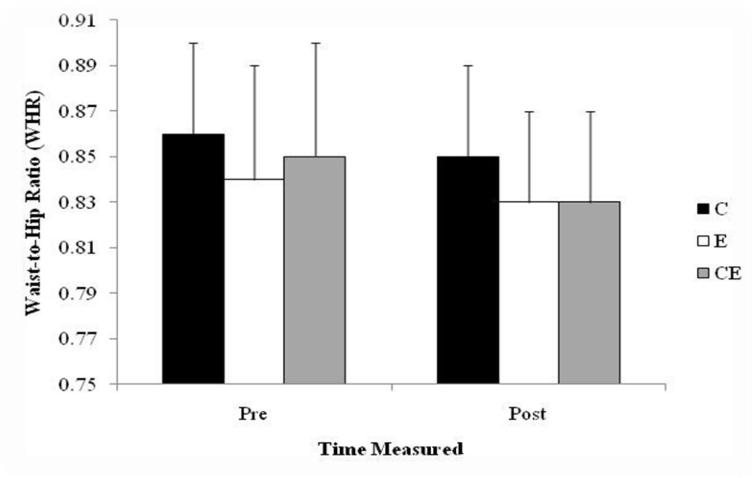


Figure 4: Mean waist-to-hip at pre and post intervention.

Heart Rate of Participants at the End of Brisk Walking Exercise

Mean heart rate of the participants in both intervention groups at the end of brisk walking sessions are shown in Table 3. These data indicated that the participants involved in the intervention program were walking at the prescribed intensity during these brisk walking sessions.

DISCUSSION

The 6-week brisk walking exercise program resulted in a significant (p<0.05) 0.7 kg mean weight loss in E group and 1.3 kg in CE group compared to the respective pre intervention body weights. This finding of weight reduction following a walking program has also been reported in other studies. For example, brisk walking exercise for 16 weeks without caffeine consumption has reported a mean weight loss of 5.7 kg (Leon et al., 1979). Bergman et al. (1996) reported that body weight decreased significantly during an 8-week walking program without caffeine consumption. In a study by Racette el al. (1995), 12-weeks of aerobic exercise program, resulted in a higher mean weight losses in the exercise group (10.8 ± 3.2 kg) compared to non-exercise group (8.1 ± 2.3 kg).

Table 3: Mean heart rate of the participants in intervention groups at the end of brisk walking sessions

	Exercise (E)	Caffeine + Exercise (C+E)
Mean Heart Rate (beats.min^{-1})	149	144

There were no significant differences between body weight in both intervention groups and these data indicated that caffeine consumption did not have any addictive effect when compared to the weight loss by just brisk walking alone. This finding was in agreement with another study by Astrup *et al.* (1992) who reported that caffeine had no effect on body weight loss after participants were treated by diet (4.2 MJ/day) and caffeine (200 mg) three times a day for 24 weeks. Pasman *et al.* (1997) also reported that supplementation of caffeine has no beneficial effect on body weight loss and weight maintenance in the long-term. One of possible explanations for these results is the development of insensitivity to caffeine effects (Diepvens et al., 2007).

In the present study, six weeks of prescribed intervention brisk walking training resulted in significant changes in BMI for both intervention groups compared to pre intervention values, (27.1 ± 1.4 kg/m^2 vs. 26.8 ± 1.2 kg/m^2, p<0.05) in the E group and (27.9 ± 1.7 kg/m^2 vs. 27.5 ± 1.6 kg/m^2, p<0.05) in the CE group. Thus, BMI of E and CE groups reduced 0.3 kg/m^2 and 0.4 kg/m^2 after the prescribed intervention. CE group also had a significantly lower in BMI when compared to Control group at post intervention (26.8 ± 1.9 kg/m^2 vs. 27.9 ± 1.6 kg/m^2, p<0.05).

Reduction of BMI after a prescribed exercise program was supported by the suggestion of Okita *et al.* (2004), who found that after two months of aerobic exercise program (60% to 80% of the maximum heart rate) without caffeine supplementation resulted in a significant reduction of BMI (-1.2 kg/m^2). Another study demonstrated that BMI decreased significantly (from 28.7 ± 6.4 kg/m^2 to 28.2 ± 6.4 kg/m^2) after the participants participated in eight weeks of walking exercise program (Bergman *et al.*, 1996). A change in BMI is directly proportionate with changes in body weight, i. e., a decrease in body weight will result in a reduction in BMI.

There were no significant differences in percent body fat between the 3 groups at pre intervention but after 6 weeks of the prescribed intervention brisk walking program, percent of body fat in the E and CE groups were significantly lower (p<0.05) than the control group (23.0 ± 3.2 % vs 25.6 ± 3.4 %, p<0.05 and 21.9 ± 4.1 % vs. 25.6 ± 3.4 %, p<0.05) respectively. At post intervention, there was also a significant reduction (p<0.05) of 0.6 % and 1.5 % of percent body fat in the E and CE groups compared to their respective pre intervention values. These data indicated that the brisk walking program may have resulted in increased mobilization of fat stores to supply activity energy requirements which resulted in reduction of fat stores with the continuous lipolysis demanded. A previuos study also revealed that percent body fat decreased significantly during the 8 weeks walking program (Bergman *et al.*, 1996). Lewis *et al.* (1976) combined a walk-jog program with moderate calorie restriction in obese adult women and showed 5% decreased of percentage of body fat in 17 weeks.

Caffeine is commonly proposed to enhance exercise capacity by promoting fat oxidation and inhibiting carbohydrate oxidation via feedback mechanisms in the active muscle (Graham *et al.*, 2008; Ping *et al.*, 2010). It also act as a thermogenic agent that in combination with slimming regimens could be use in promoting the loss of body energy (Miller *et al.*, 1974). Caffeine alone has several important metabolic effects. Caffeine stimulates fat utilization in muscle tissue during exercise (Spriet *et al.*, 1992). Van Soeren and Graham (1998) suggested that caffeine is an adenosine-receptor antagonist and all tissues with adenosine receptors can be affected by caffeine exposure. This will increase the lipolysis process and result in a higher amount of free fatty acids in the blood that will be available as a substrate for continuous muscular contractions during prolonged exercise. However, there was no significant effect of caffeine consumption on extra weight loss when compared to the E group in the present study. Although CE group showed a higher percentage of body fat loss, it was not statistically significant. The probable reason for this finding was that the dosage of caffeine given to the participants was not adequate to elicit a more discernable effect on percent body fat loss.

After 6 weeks of intervention, the results showed that there were no significant differences in WHR between groups at pre and post intervention and no significant changes after the intervention programme in all three groups. Bergman *et al.* (1996) also failed to demonstrate any significant changes in hip circumference after an 8-week of exercise. Both findings might be partially explained by a possible increase of lean tissue in the measured areas although there was a decrease in body weight and percent of body fat. Walking could increase the strength and muscle size, masking any reduction in fat stores when circumference measures are taken (Bergman *et al.*, 1996).

CONCLUSIONS

Both intervention program (brisk walking and brisk walking + caffeine consumption) resulted in a small but significantly lower body weight, BMI and percent of body fat among the overweight male participants. Our results also indicated that consuming caffeine (50-100mg) one hour prior to exercise did not result in any further weight loss compared to exercise alone. In addition, the prescribed brisk walking program did not have any effect on the waist to hip ratio among the participants.

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АЭРОБНЫЕ И АНАЭРОБНЫЕ СПОСОБНОСТИ, ГИБКОСТЬ И МЫШЕЧНАЯ ПРОИЗВОДИТЕЛЬНОСТЬ МАЛАЗИЙСКИХ МОЛОДЫХ ЖЕНЩИН, ВЕДУЩИХ СИДЯЧИЙ ОБРАЗ ЖИЗНИ, А ТАКЖЕ ЛИЦ, ЗАНИМАЮЩИХСЯ СИЛАТ И ТХЭКВОНДО

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