

The Effect of Coffee Consumption on Acute Increased Blood Pressure in Normotensive Teens

Eunike Jennifer Tandiono¹, Ecie Budiyaniti^{2*}

¹School of Medicine and Health Sciences, Atma Jaya Catholic University of Indonesia, North Jakarta, Indonesia

²Department of Histology, School of Medicine and Health Sciences, Atma Jaya Catholic University of Indonesia, North Jakarta, Indonesia

*Corresponding author: Ecie Budiyaniti, ecie.budiyaniti@atmajaya.ac.id

Abstract

Introduction: Caffeine has been known to elevate blood pressure. However, the effect of drinking coffee on blood pressure varied among studies. This study examines the impact of coffee on the acute response of blood pressure in a late adolescent with normal blood pressure.

Methods: This cross-sectional study with a cross-over design involving 16 male and late female adolescents. The intervention group subjects drank a glass of 200 ml of Robusta coffee (commercial brand), while the control group drank plain water. After a 7-day washout, the intervention group became the control group and vice versa. A paired t-test was applied to evaluate systolic blood pressure (SBP) and diastolic blood pressure (DBP) before and after the intervention. The significance was set at $p < 0.05$.

Results: SBP and DBP in the control group were unchanged ($\Delta 0.8$ and 0.6 mmHg, $p = 0.237$ and 0.584 , respectively). SBP and DBP in the intervention group were significantly elevated ($\Delta 8.4$ and 8.1 mmHg, $p < 0.01$ and < 0.01 , respectively).

Discussion: Our findings demonstrated that coffee increases SBP and DBP significantly in the late adolescent with normal BP. Increased sympathetic tones and blocking adenosine receptors are suggested to increase BP. However, some limitations were also found, so the results should be interpreted carefully.

Conclusion: A 200 ml coffee (Robusta) increased SBP and DBP in late adolescents with normal blood pressure.

Keywords: Caffeine - Blood Pressure - Sympathetic Activity - Adenosine Receptor - Phosphodiesterase

INTRODUCTION

Drinking coffee now is recognized as not only elderly behavior only. Young people have been enjoying drinking coffee for decades. Thousands of cafés have sprung up and offered various coffee-based drinks in great demand by young people in Indonesia's cities.

Drinking coffee in a café has become a new lifestyle for young people today. A study showed increased caffeine consumption among late teens, especially high school and college students. This usually occurs when academic challenges increase.¹

Coffee comes from the coffee bean plant in the Rubiaceae family with the genus *Coffea*.² Caffeine in coffee is classified as a stimulant that can speed up messages from the brain to the body and cause physical dependence if consumed every day. Adenosine's endogenous antagonistic properties of caffeine can cause vasoconstriction and increased peripheral vascular resistance.^{3,4} The caffeine content in each cup of coffee is 60.4 - 80.1 mg. The caffeine in one cup of coffee can take as little as 20 minutes to reach the bloodstream and about an hour to achieve full effectiveness.⁵ The coffee beans primarily consumed in Indonesia are Arabica and Robusta coffee. Arabica coffee has a 1-1.3% caffeine content, while Robusta coffee has a 2-3% caffeine content.⁶

Some people believe caffeine can increase blood pressure, while others do not. Several previous studies also gave different results. One study stated an increase, but another found no significant increase in blood pressure. As increased hypertension in youth⁷, drinking coffee may become a risk factor for increased blood pressure. This study aimed to examine the effect of drinking coffee on acute elevated blood pressure in late adolescents.

METHODS

This study was a cross-sectional intervention study with a cross-over design conducted in January-February 2020. The inclusion criteria

were late adolescents aged 17-25. Exclusion criteria were those with systolic blood pressure ≥ 120 mmHg or diastolic ≥ 80 mmHg, anti-hypertensive drugs, BMI ≥ 23 kg/m², smoking, and drinking alcohol. Based on Federer's method with two treatments, a sample size of 16 subjects was obtained. Subjects were divided into two groups (8 people each), control and intervention. After a 7 day-wash out, the two subject groups switched roles, and the control group became the intervention group and vice versa. Switching the role of the subject was to minimize differences in individual responses to coffee consumption. In fact, the effect of caffeine will last within hours.⁹ However, 7 days was to ensure that the effect of caffeine was completely disappeared.

Height was measured using a stature meter, and body weight with a digital scale (Seca Robusta 813, Germany). Body mass index (BMI) was obtained by dividing body weight (kg) by the square of height (m). In a sitting position, systolic and diastolic blood pressures were taken using an aneroid sphygmomanometer (ABN Spectrum, Indonesia). Blood pressure measurements were taken twice in the afternoon, just before and 20 minutes after drinking coffee. Every measurement was taken twice, the average value was taken. All measuring instruments was calibrated. Participants remained in a

state of no physical activity during the observation of blood pressure response.

The coffee provided was commercial, Robusta gold, in sachets. Other ingredients were carbohydrate, fat, and protein in very small amounts. The intervention group consumed a cup of 200 ml of coffee, while the control group drank a glass of plain water.

Data were presented as the mean and standard deviation for numerical value and frequency and percentage for categorical value. A paired t-test was used to compare numerical data between groups as well as pre-post intervention. Significance was set at $p < 0.05$. The statistical test was computed using IBM SPSS Statistics 19 (Chicago, Illinois, USA).

RESULTS

Subjects' characteristics are described in Table 1. The mean BMI, SBP, and DBP of the subjects were normal

Table 1. The subjects' characteristics

	Mean±SD
Age (years)	21.5±1.9
Weight (kg)	55.4±11.5
Height (cm)	164.9±0.9
BMI (kg/m ²)	20.3±3.3
SBP (mmHg)	102.3±10.0
DBP (mmHg)	65.9±6.1

Table 2 compares mean SBP and DBP between pre-post intervention in the control group. There were no significant differences in mean

SBP and DBP after the intervention ($p=0.237$ and 0.584 , respectively).

Table 2. The comparison of SBP and DBP between pre-post intervention in the control group

	Pre	Post	Δ	p
SBP	102.3±10.0	103.0±10.3	0.8±2.4	0.237
DBP	65.9±6.1	66.4±7.0	0.6±4.0	0.584

Table 3 compares mean SBP and DBP between pre-post intervention in the intervention group. Post-SBP and DBP significantly increased after the intervention ($p < 0.01$).

Table 3. The comparison of SBP and DBP between pre-post intervention in the control group

	Pre	Post	Δ	p
SBP	101.9±10.0	110.4±10.4	8.4±5.8	<0.01
DBP	67.5±7.1	75.6±7.8	8.1±6.2	<0.01

DISCUSSION

The effect of coffee on blood pressure has been investigated. However, the results between studies needed to be more consistent. However, study on teens is lacking. The different findings might be caused by other subjects' characteristics, including age, habitual or non-habitual coffee consumers, also type and dose of coffee. Our study showed that drinking coffee raised blood pressure acutely. Systolic and diastolic blood pressure increased significantly after drinking a cup of coffee.

The effect of coffee on blood pressure varied among studies. Some studies reported that coffee enhances blood pressure. A randomized controlled trial study by Hara et al. in young normotensive indicated that a single cup of coffee increased BP in non-habitual coffee drinkers but not in habitual coffee drinkers.⁸ A systematic review and meta-analysis by Mesas et al. found that caffeine increased 8.1 mmHg in SBP and 5.7 mmHg in DBP.⁹ They also reported that increased BP lasted ≥ 3 hours.⁹ A study by Geethavani et al. demonstrated that coffee consumption increased BP significantly.¹⁰ It was indicated that elevated blood pressure was more significant in hypertensive individuals.⁹ These previous studies supported our findings that coffee elevated blood pressure in late normotensive adolescents.

However, studies reported that coffee consumption had no effect on blood pressure also exist. Rhee et al. examined the impact of coffee consumption in postmenopausal women.¹¹ They found that coffee consumption did not increase the risk of hypertension.¹¹ Study by Zimmermann-Viehoff et al. showed that drinking coffee did not induce vagal activity, which may elevate blood pressure.¹²

Some factors could influence the different findings on the effect of coffee on blood pressure between studies. A non-habitual coffee consumer might be more sensitive to

elevated blood pressure than a habitual coffee consumer.^{8,13} Also, elevated blood pressure is perhaps more significant in hypertensive people.^{9,14} The dose of coffee intake may also determine the effect on blood pressure.¹⁵ However, our study demonstrated that even blood pressure increased in normotensive subjects. As mentioned above, we had no specific explanation but might associate it with habitual or non-habitual.

The mechanism for increasing blood pressure after drinking coffee is in several ways. First, increasing blood pressure may be associated with increased sympathetic activity.¹³ The sympathetic activity has the effect of increasing blood pressure. Increasing blood pressure is also related to the blocking of adenosine receptors and the inhibition of phosphodiesterases.¹⁶ It has already been known that adenosine decreases blood pressure. Blocking the adenosine receptor will automatically inhibit adenosine and induce blood pressure elevation.¹⁷ phosphodiesterase is an enzyme that affects vascular relaxation or dilatation.¹⁸ Thus, inhibiting this enzyme will increase blood pressure.

Limitations of this study were also noted. First, this study did not differentiate between habitant and non-habitan coffee consumers, which could bias the results. Second, the effect of coffee consumption on blood pressure was

observed later to determine how long increased blood pressure lasted.

CONCLUSION

In conclusion, this study's findings indicated that drinking a glass of 200 ml coffee (Robusta) significantly elevated systolic and diastolic blood pressure in late adolescents with normal blood pressure. We recommend the following study involve a larger sample size, habitant and non-habitanant, and blood pressure observation until it reaches normal.

ACKNOWLEDGMENT

The authors would like to thank all subjects.

REFERENCES

1. Tannous M, Kalash YA. Prevalence of Caffeinated-beverage Consumption by University Students in North Lebanon. *Pub Health Res* 2014;4(5):173-8.
2. American Heart Association. Understanding Blood Pressure Readings. American Heart Association. 2017
3. Alcohol and Drug Foundation. Caffeine. Australia: Alcohol and Drug Foundation. 2019
4. Beware of These Effects of Caffeine on the Body. Center for Science in the Public Interest.
5. Heckman MA, Weil J, Gonzales E. Caffeine (1, 3, 7-trimethylxanthine) in Foods: A comprehensive review on consumption, functionality, safety, and regulatory matters. *J Food Sci* 2010;75 (3): R77-R87
6. Sridevi V, Giridhar P. Changes in caffeine content during fruit development in *Coffea canephora* P. Ex. Fr. Grown at different elevations. *J Biol Earth Sci* 2014;4 (2): B168-B175
7. De Venecia T, Lu M, Figueredo VM. Hypertension in young adults. *Postgrad Med*, 2016;128(2):201-207. doi: 10.1080/00325481.2016.1147927.
8. Hara A, White H, Miyagawa K, Takeuchi T, Nakatani Y, Yokoyama H, et al. Acute effects of caffeine on blood pressure and heart rate in habitual and non-habitual coffee consumers: a randomized, double-blind, placebo-controlled study. *Jpn J Pharm Health Care Sci* 2014; 40(7): 383-388
9. Mesas AE, Leon-Muñoz LM, Rodriguez-Artalejo F, Lopez-Garcia E. The effect of coffee on blood pressure and cardiovascular disease in hypertensive individuals: a systematic review and meta-analysis. *Am J Clin Nutr* 2011; 94(4): 1113-26. doi: 10.3945/ajcn.111.016667
10. Geethavani G, Rameswarudu M, Reddy RR. Effect of caffeine on heart rate and blood pressure. *Int J Sci Res Pub* 2014;4 (2): 1-2
11. Rhee JJ, Qin F, Hedlin HK, Chang TI, Bird CE, Zaslavsky O, et al. Coffee and caffeine consumption and the risk of hypertension in postmenopausal women. *Am J Clin Nutr* 2016;103(1), 210-217. doi: 10.3945/sajcn.

12. Zimmermann-Viehoff F, Thayer J, Koenig J, Herrmann C, Weber CS, Deter HC. Short-term effects of espresso coffee on heart rate variability and blood pressure in habitual and non-habitual coffee consumers--a randomized cross-over study. *Nutr Neurosci* 2016;19(4): 169-75. doi: 10.1179/1476830515Y.0000000018.
13. Corti R, Binggeli C, Sudano I, Spieker L, Hänseler E, Ruschitzka F, et al. Coffee acutely increases sympathetic nerve activity and blood pressure independently of caffeine content. Role of habitual versus non-habitual drinking. *Circulation* 2002; 106 (23): 2935-40. <https://doi.org/10.1161/01.CIR.0000046228.97025.3A>.
14. Green PJ, Kirby R, Suls J. The effects of caffeine on blood pressure and heart rate: A review. *Ann Behav Med* 1996;18(3): 201-216. doi: 10.1007/BF02883398.
15. Zhang Z, Hu G, Caballero B, Appel L, Chen L. Habitual coffee consumption and risk of hypertension: a systematic review and meta-analysis of prospective observational studies. *Am J Clin Nutr* 2011;93(6): 1212-9. doi: 10.3945/ajcn.110.004044.
16. Nurminen ML, Niittynen L, Korpela R, Vapaatalo H. Coffee, caffeine and blood pressure: a critical review. *Euro J Clin Nutr* 1999;53: 831-9.
17. Shen FM, Su DF. The effect of adenosine on blood pressure variability in sinoaortic denervated rats is mediated by adenosine A2a-Receptor. *J Cardiovasc Pharmacol* 2000; 36(5): 681-6. doi: 10.1097/00005344-200011000-00019.
18. Ghiadoni L, Versari D, Taddei S. Phosphodiesterase 5 inhibition in essential hypertension. *Curr Hypertens Rep* 2008;10(1): 52-7. doi: 10.1007/s11906-008-0011-4.