Research Review

Research Review
DOI: https://doi.org/10.52845/RR/5-6-2
Res Rev (Wilmington, N.C.) 5 (6), 2603—2617 (2024)
Received 9 Apr 2024 | **Revised** 27 May 2024 | **Accepted** 12 June 2024 | **Online Available** 20 June 2024

Research Review

OPEN ACCESS

ISSN (O) 2693-5007

RESEARCH ARTICLE

Effects of Caffeine on Blood Pressure

Sarah Abuhamdan[1]* | Kevin Haubrick[1]

Abstract

Caffeine is seen in many different beverages such as coffee, energy drinks, tea, soft drinks, and juices. However, the topic of caffeine and effects on blood pressure has been discussed in multiple studies throughout the years. The purpose of the systematic review was to highlight the effects of caffeine consumption on systolic blood pressure, diastolic blood pressure, and heart rate. The results presented were mixed as some studies showed an elevated systolic blood pressure, diastolic blood pressure, and heart rate after consuming the caffeinated beverages and other studies presented no change in the blood pressure values or heart rate after drinking the caffeinated source.

Key words: Caffeine, energy drinks, diastolic blood pressure, beverage, cardiovascular disease

1 | INTRODUCTION

Caffeine is a stimulant leading to increased activity in both the nervous system and the brain (Department of Health & Human Services, 2022). In the United States, 94% of adults consume caffeinated beverages, and 64% drink caffeinated beverages daily (Peckham, 2023). Caffeine is found in many beverages such as coffee, tea, soft drinks, and energy drinks. Based on a survey conducted through Sleep Foundation results showed the caffeinated drink consumed the most is coffee at 51%, the second most consumed drink is soda at 28%, the third most consumed drink is tea at 10%, and the fourth most consumed beverage is energy drinks at 7% (Peckham, 2023). The consumption of caffeine particularly, energy drinks, is increasing among the young adult population (Akhundova, Tulunay, & Gerede Uludağ, 2021). The concern with the consumption of energy drinks which are known to be high in sugar and caffeine is the effect on arterial blood pressure that then may lead to the cardiovascular disease risk (Nowak et al., 2019). The increased popularity of energy drinks leads to a controversial concept that has been researched for years which is the connection between caffeinated beverages and blood pressure (Chei et al. and Bashir et al., 2018). One caffeinated drink shown to have positive connection to cardiovascular disease is tea, but continuous tea consumption remains unclear as it relates to the risk of hypertension (Chei, Loh, Soh, et al., 2018).

High Blood Pressure, referred to as hypertension, is a common condition found among the adult population, and by the year 2025, approximately 30% of the worldwide population will experience an increase in the condition (Chei, Loh, Soh, et al., 2018). The main health concerns that arise with hypertension are the increased development of renal complications and cardiovascular disease (Chei, Loh, Soh, et al., 2018). The prevention of hypertension focuses on managing different lifestyle factors such as physical activity, diet, sleep, alcohol consumption, and body

[1]The University of Houston.

Address correspondence to: Sarah, Abuhamdan, The University of Houston, *Email: @Sarah Aduhamdan*

Supplementary information The online version of this article (https://doi.org/10.52845/RR/5-6-2) contains supplementary material, which is available to authorized users.

weight.

The mixed studies presented on the topic of hypertension and caffeinated beverages lead to the main purpose of the review. The objective is to examine the effects of different caffeinated beverages such as coffee, tea, and energy drinks on hypertension in adults 18 years and older.

2 | METHODS

The framework of the Preferred Reporting Items for Systematic Reviews and Meta- Analyses (PRISMA) was used to show the effects of caffeine on blood pressure in the systematic review (Page, McKenzie, Bossuyt, et al., 2021).

Protocol and Registration

This systematic review was registered with Prospero: An International Prospective Register of Systematic Reviews (CRD42023443897).

Search Strategy

The research articles used for the systematic review were collected through two primary databases PubMed and CINAHL. The most recent search was performed in January of 2024. The full search strategy used was: (Adults OR Adult OR Men OR Women or Elderly or Aged) AND (Caffeine OR Coffee OR Caffeinated OR Tea or Energy Drinks) AND (Blood pressure OR Hypertension OR Heart Health OR Cardiovascular Outcomes OR High Blood Pressure). The clinical trials selected in the review were limited to full-text availability without a subscription required. See Table 1 for a breakdown of the keywords for each category.

Table 1. Keywords for Population, Intervention, and Outcome

Adults	Caffeine	Blood Pressure
Adult	Coffee	Hypertension
Men	Caffeinated	Heart Health
Women	Tea	Cardiovascular outcomes

Eligibility Criteria

The search for research articles required a step-by-step process for the systematic review to result in the best sources. The first step was inputting the full search strategy in the PubMed and CINAHL databases and limiting the search to clinical trials. The second step was to review the articles based on the titles and abstract. The third step is limiting the search for full text. The full-text articles excluded were based on the established inclusion and exclusion criteria. After completing the research process for articles, it was important to allow the publication year range to be from 10 years because the topic of blood pressure and caffeine has been researched for years. Therefore, the research articles ranged from 2013-2023 to review different mixed studies on the topic. Table 2 outlines a detailed breakdown of the inclusion and exclusion criteria.

Data Extraction and Quality Assessment

The article selection was completed by the primary author, and the process focused on screening the title and abstract of articles. Articles were excluded if they did not meet the established inclusion criteria. Figure 1 presents a breakdown of the selection process for each article. The process of data extraction and synthesis was designed based on the Cochrane Data extraction temple (Ryan et al, 2016). The data extracted from the research articles focused on the title, author, DOI, publication year, study design, number of participants, purpose, age range, gender, methods, outcomes, intervention, and the risk of bias assessment. The Academy of Nutrition and Dietetics Quality Criteria Checklist for primary research was used to complete the quality assessment for each selected article (Academy of Nutrition and Dietetics, 2016). The focus of the Quality Criteria Checklist leads to a total of three ratings which are positive, negative, and neural. A positive rating reports that study addressed different issues of bias, generalizability, inclusion/exclusion, analysis, and data col-

Table 2. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Age	Adults 18 years or older	All studies that involve minors (under the age of 18)
Gender	Males or Females	None
Setting / Country	For the studies there is no restriction on the nationality, ethnicity, or country of origin.	None
Health Status / Problem / Condition	None	Study participants with certain condition such as diabetes and gastroesophageal reflux disease.
Intervention / Exposure	Coffee, caffeine, tea, or energy drinks	Pre-workout supplements
Outcome	The outcomes measured will be focused on hypertension, blood pressure, or hypotension.	The outcomes excluded that mention no effects of blood pressure.
Study Design Preferences	Clinical trials Randomized Controlled Trial Intervention Experimental	Case Studies Systematic Reviews
Size of Study Groups:	A sample size of 10 or more participants.	A sample size of one to nine participant.
Language	All studies published in the English Language.	All studies that are not translated or published in the English language.
Publication Year Range	Ten Years (2013-2023)	All studies published prior to the year 2013
OTHER	For the text-availability it should be full-text.	Full Text availability with subscription required.

lection. The negative rating reports that the study is weak and does not address any relevant issue met in the positive rating. The third rating is neural which shows the article is neither weak nor strong (Academy of Nutrition and Dietetics, 2016).

3 | RESULTS

Of the 266 articles retrieved in the search process through PubMed and CINAHL, a total of forty-five studies were used in the systematic review. The participants ages ranged from 18 to 85 years old. Study locations included USA (n= 9), China (6), Turkey (4), Greece (2), Germany (2), Brazil (2), Switzerland (3), Poland (3), Iran (3), Colombia (1), Italy (1), Malaysia (1), Egypt (1), Pakistan (1), Singapore (1), Hungary (1), Mexico (1), Luxembourg (1), Portugal (1), Japan (1), and Spain (1). Due to the variety of caffeine sources used in the studies, a section on different caffeine types is included. The next two sections focus on the caffeine effects on the systolic and diastolic blood pressure numbers. The fourth section focuses on heart rate which was a result presented in many selected studies. The fifth and final section is the quality assessment and risk of bias which presents the quality of the article through the rating.

Sources of Caffeine

Each study had a different source of caffeine used in the intervention, experimental, clinical trials, or randomized controlled trials. Most studies (n=15) selected in the systematic review focused on the consumption of tea. Energy drinks were the most second common caffeine source used in the studies (N=13) followed by coffee (N=12) and caffeinated control beverage (N=7). Four studies focused on the consumption of soda as a form of caffeine source. One study compared energy drinks with Noni and Chokeberry juice. Due to the various source of caffeine presented in the studies, it is important to note that each beverage contained a different amount of caffeine which may led to mixed effects on blood pressure.

Caffeine and Systolic Blood Pressure Outcomes

One of the most common health effects of caffeine consumption is elevated blood pressure along with an increase in heart rate (Caffeine's side effects, n.d.). The systolic blood pressure number represents the measure of pressure in the arteries when the heart beats (Centers for Disease Control and Prevention, 2021). A total of six sources out of the forty-five presented statistically significant results for only systolic blood pressure after the consumption of the caf-

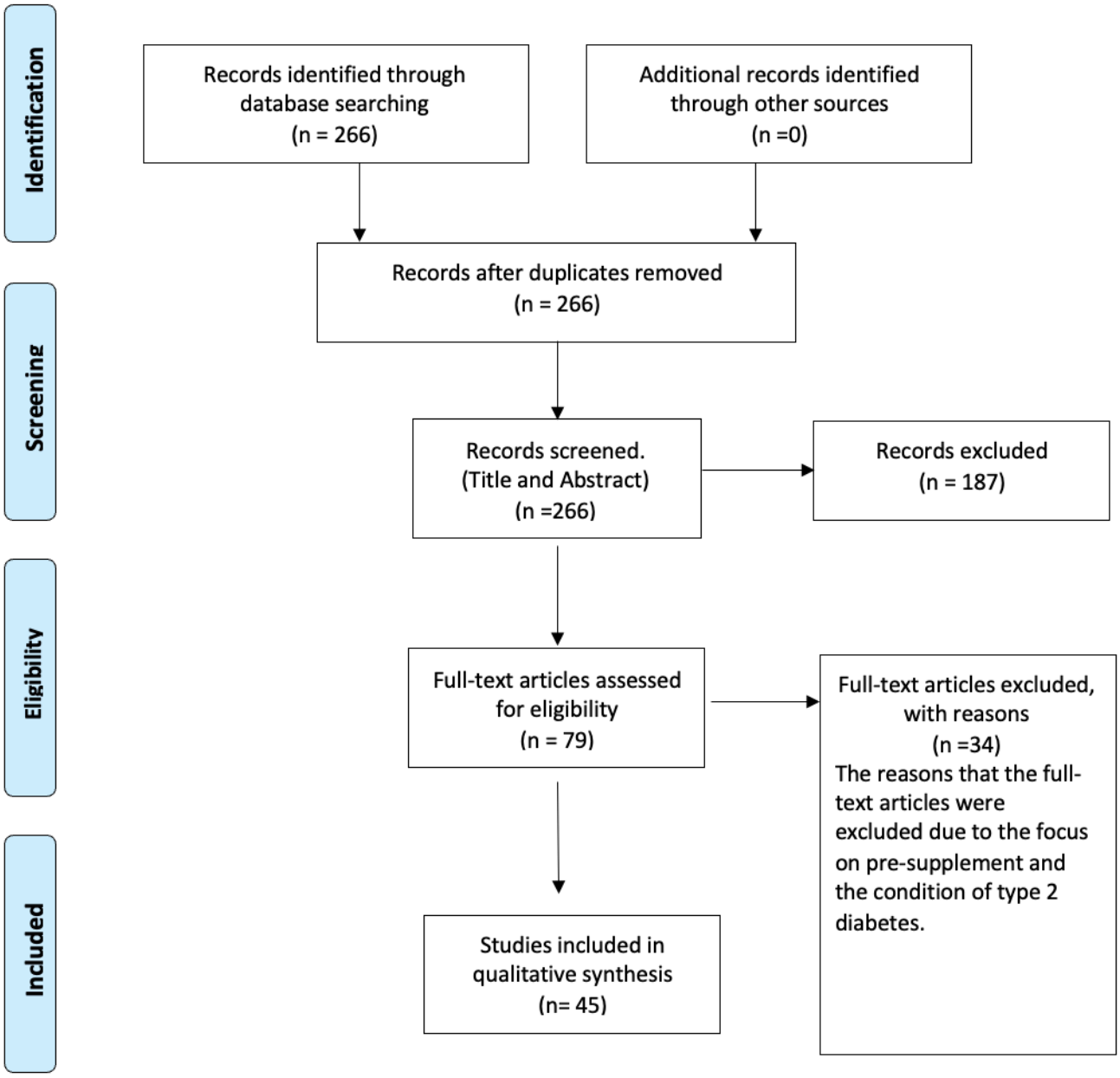

Fig. 1: Article Selection Process

feine source. Studies Garcia et al. (2016), Stopa et al. (2020), and Basrai et al. (2019) noted a significant increase in systolic blood pressure within minutes to one hour and 25 minutes into the study. Garcia et al. (2016) reported an increase in systolic blood pressure after groups A and C consumed the energy drink within 30 minutes but with no clear p-value reported. On the other hand, Stopa et al. (2020) noted an increase in systolic blood pressure after volunteers consumed a single dose of the energy drink within 75 minutes. Basrai et al. (2019) highlighted an increase in systolic blood pressure within an hour of administrating the energy drink ($p < 0.05$) but then returning to the normal range after a total of 3 hours. All three studies focused on the energy drink as the source of caffeine in young adults and noted an increase in sys-

tolic blood pressure within less than two hours when administrating the beverage to participants.

Two studies noted long-term impact of systolic blood pressure from the consumption of caffeine are Kujawska et al. (2021) and Tian et al. (2020). Kujawska et al. (2021) compared the results of participants who consumed coffee on a daily basis to participants who rarely or never consume the beverage over a period of years. The results highlighted a significant increase in systolic blood pressure ($p = 0.02$). On the other hand, Tian et al. (2020) focused on the consumption of tea and suggested that the consumption of habitual tea is connected to long term systolic blood pressure management in the older adults population. Although each study presented an increase of systolic blood pressure at different time marks it is important to note the results reported were based on variety of caffeinated drinks.

Caffeine and Diastolic Blood Pressure Outcomes

The diastolic blood pressure number represents the measure of pressure in the arteries when the heart rests (Centers for Disease Control and Prevention, 2021). A total of seven out of forty-five studies presented mixed results on the diastolic blood pressure from the consumption of caffeine. Two studies reported no impact on diastolic blood pressure, although the studies presented an increase in systolic blood pressure. Garcia et al. (2016) presented a significant increase in systolic blood pressure but reported no change in diastolic blood pressure. On the other hand, Tian et al. (2020) highlighted no impact on the diastolic blood pressure due to the systolic blood pressure used as a strong predictor for CVD in the older adults population.

Three studies from the seven reported no significant effect on diastolic blood pressure. Kujawka et al. (2021) showed no significant effect on diastolic blood pressure changes after the consumption of coffee when compared to systolic blood pressure ($p = 0.42$). On the other hand, Nogueria et al. (2016) study showed no difference reported for diastolic blood pressure after the consumption of green tea. However, for systolic blood pressure, a decrease was reported after the consumption of the green tea extract for a total of four weeks ($p < 0.05$). However, the study Koksal et al. (2016) noted a positive connection between the consumption of daily total caffeine intake and systolic blood pressure ($p < 0.05$). The study showed no connection between caffeine intake and diastolic blood pressure.

Tong et al. (2014) and Teng et al. (2016) presented findings on diastolic blood pressure and noted no impact on systolic blood pressure. Tong et al. (2014) showed an inverse connection between the consumption of green tea and diastolic blood pressure over a course of five years, but no change reported for systolic blood pressure. On the other hand, Teng et al. (2016) highlighted no statistically significant changes in diastolic blood pressure after the consumption of coffee.

Overall, the studies presented mixed findings reported on diastolic blood pressure after the consumption of caffeine source. There are studies that noted a decrease in diastolic blood pressure and other studies presented no significant impact on the diastolic blood pressure.

Decaffeinated and Caffeinated Coffee Effects on Blood Pressure

A total of five out of the forty-five studies focused on caffeinated and decaffeinated coffee. Moura and colleagues (2022) reported no significant effect on systolic and diastolic blood pressure ($p=0.062$ and $p=.056$, respectively) after consuming caffeinated and decaffeinated coffee. Navarro and authors (2019) focused on the regular consumption of coffee in the group of participants. However, the team reported no significant connection between decaffeinated coffee and the risk of hypertension with no clear p-value. On the other hand, the study by Roshan et al. (2018) showed a significant reduction in systolic blood pressure after the participants consumed the green coffee bean extract ($p =0.01$). A reduction in diastolic blood pressure was observed after the group consumed the green coffee bean extract but with no p-value reported. Yamjj and the team focused on the consumption of regular coffee which presented no effect on blood pressure or the risk of hypertension. The findings present were mixed as some studies showed no significant effect on blood pressure after the consumption of either caffeinated or decaffeinated coffee. While other studies showed a reduction in diastolic blood pressure or systolic blood pressure.

Decrease in both Systolic and Diastolic Blood Pressure

A decrease in systolic and diastolic blood pressure was observed in many studies presented in the review. However, the selected studies noted decrease both systolic and diastolic blood pressure at the same time. Alkerwi et al. (2015) focused on the intake of tea in a group of individuals ranging from the age of eighteen to sixty-nine. One of the major findings presented in the study showed the individuals who consumed at least 1.2 cups of tea had a significantly lower systolic and diastolic blood pressure compared to individuals who do not consume tea or drink less than 1.2 cups ($p < 0.01$). On the other hand, Grassi and authors also focused on the consumption of black tea and presented a decrease in both systolic and diastolic blood pressure. However, there was no clear p-value presented. Although Kujawka and colleagues did not focus on the consumption of the tea in the study, the major findings showed no significant change in both diastolic ($p = .42$) and systolic ($p = 0.13$) blood pressure after the consumption of coffee. The results showed a decrease in both systolic and diastolic blood pressure through a variety of different beverages.

No Increase in Systolic and Diastolic Blood Pressure

Each study presented different findings for both systolic and diastolic blood pressure. With the different findings, it is important to note there are studies that showed no change in the blood pressure value for both systolic and diastolic. Bennett and authors along with Domtor et al. (2015) and Ketelhut et al. (2022) focused on the consumption of caffeine through coffee or caffeinated beverage in healthy adults and noted no significant increase in systolic or diastolic blood pressure. Bennett et al. (2013) showed no increase in blood pressure after the volunteers consumed the caffeine beverage ($p > 0.05$). On the other hand, Domotor et al. (2015) noted no significant increase after the group of healthy individuals consumed coffee and presented no clear p-value. While Ketelhut and colleagues (2022) noted no significant difference between diastolic and systolic blood pressure ($p = .187$ and $p = .236$) after the group of nineteen healthy adults consumed caffeine. All three studies focused on group of young, healthy adults along with the consumption of a caffeinated beverage and noted no significant change in both systolic and diastolic blood pressure.

Increase in both Systolic and Diastolic Blood Pressure

The increase in systolic and diastolic blood pressure was noted in separate studies and the results were presented in the Caffeine Outcomes section for both systolic and diastolic blood pressure. However, there are a total of eleven studies out of the forty-five that presented increase in systolic and diastolic blood pressure in the same study. Four studies focused on the consumption of energy drinks in young, healthy volunteers. Martyn et al. (2016), Kozik et al. (2018), and Bashir et al. (2019) all presented findings on systolic and diastolic blood pressure after administrating the beverage during a period of an hour or after resting the volunteers from exercise. Martyn and team (2016) showed that after the consumption of energy drinks, a higher systolic and diastolic blood pressure value reported compared to the individuals who do not consume the energy drink beverage ($p < 0.0001$). While Bashir and authors highlighted an increase in blood pressure after administrating the energy drink to the group of adults ($p < 0.05$). Kozik et al. (2018) showed an increase in systolic and diastolic blood pressure after the consumption of the energy drink ($p \leq 0.001$). On the other hand, Shah and colleagues (2016) noted a significant increase in both systolic and diastolic blood pressure after the consumption of energy drinks at different hours of the study. The systolic blood pressure increased after the administration of one single energy shot at 3 and 5 hours ($p=0.050$ and $p=0.038$). On the other hand, diastolic blood pressure increased after a single dose of energy drink in 1 and 5 hours on consuming the beverage ($p=0.019$ and $p=0.043$).

Three studies focused on the consumption of tea and shined the light on the increase in both systolic and diastolic blood pressure. Yin et al. (2017) presented results on both systolic and diastolic blood pressure after the consumption of tea. The higher consumption of tea was connected with a lower systolic blood pressure ($p=0.0003$). However, there was an opposite significant connection reported for diastolic blood pressure and the consumption of tea ($p=0.003$). While Yu and team (2023) reported an increase in systolic and diastolic blood pressure after tea consumption with no clear p-value reported. Feng and colleagues noted an increase in diastolic and systolic blood pressure for participants who con-

sumed tea consistently when compared to participants who had never consumed the beverage However, no clear p-value was reported on the finding.

Three studies focused on the consumption of a caffeinated beverage or coffee and the connection with systolic and diastolic blood pressure. Chrysant and authors (2015) highlighted a significant increase in both systolic and diastolic blood pressure after the caffeine administration ($p < 0.05$). While Chei and colleagues (2018) presented results that showed a statistically significant connection between the intake of caffeine and hypertension but with no reported p-value. However, the team also suggested that there are other ingredients in the coffee that may affect the caffeine which may then benefit the blood pressure. Papakonstantinou et al. (2016) presented findings on both systolic blood pressure and diastolic blood but on different points in the study. The systolic blood pressure reported an effect on gender and time after the consumption of the coffee ($p <0.001$). On the other hand, diastolic blood pressure only presented a significant finding on the time interaction with the consumption of coffee ($p=0.010$).

The study Hernandez-Lopez et al. (2022) is from a few studies in the systematic review that shined the light on soft drinks. The study presented an increase in systolic and diastolic blood pressure after the consumption of beverages ($p< 0.001$ and $p <0.001$). There are studies that presented an increase in the blood pressure values, other studies presented a decrease in the values, and studies particularly focusing on the consumption of caffeinated and decaffeinated beverages. Table 3

Caffeine and Heart Rate Outcomes

Of the forty-five studies includes in the review, eight assessed heart rate or heart variability as an outcome after the consumption of a caffeine source. Table 4 outlines the studies along with information on author, study design, number of participants, major findings, and bias rating. Four studies reported no significant differences in heart rate after the consumption of the caffeine source. Arazi and colleagues (2014) highlighted participants who consumed green tea extract for a total of three weeks with no changes in the heart rate and no clear p-value reported. While Fletcher et al. (2017) showed no impact on the heart rate during any time point in the study for the 18 young, healthy volunteers participating in consuming the 946 mL which is equivalent to 32 ounces of the energy drink or 320 mg of caffeinated control drink. Although Arazi et al. (2014) used green tea extract as the caffeine source and Fletcher et al. (2017) focused on the use of energy drinks or caffeinated control drinks, both studies highlighted no impact on the heart rate. On the other hand, Chapman et al. (2021) noted a significant heart rate increase ($p < 0.02$) after the consumption of high fructose corn syrup and sucrose soft drink compared to the consumption of water and diet. Chapman and researchers (2021) also focused on the outcome of heart rate variability and noted no significant ($p > 0.07$) changes after the consumption of the pre-drink. The findings of Flueck et al. (2016) showed no significant ($p < 0.75$) change in most parameters of the heart rate variability outcome after the consumption of caffeine compared to the placebo group.

Of the eight studies, only two presented findings on a decrease in heart rate after the consumption of the caffeine source. Nowak et al. (2019) and Costa et al. (2023) highlighted a decrease in heart rate after the consumption of the caffeinated drink. Nowak et al. (2019) and team focused on the effects on the heart after the consumption of noni and chokeberry juice vs energy drinks. The major finding highlighted was that Nowak and team observed the heart rate after the consumption of energy drink which led to a non-significant increase ($p = 0.243$) after all portions were consumed by the participants. On the other hand, Costa et al. (2023) showed a decrease in heart rate, but the results were non-significant but with no clear p-value reported after volunteers consumed 250 mL of Red Bull energy drink. However, although the authors showed a decrease in heart rate, over a period of time results showed significant ($p < 0.01$) results in heart rate (Costa et al. 2023).

Two studies from the selected eight focused on an increase in heart rate after consuming the caffeinated beverages. Shah et al. (2019) and Zimmermann-Viehoff et al. (2016) both noted either a significant increase in heart rate or heart variability. Zimmermann-Viehoff and colleagues (2016)

Table 3. outlines the studies along with information on author, study design, number of participants, major findings, and bias rating. Part A

Author and Year	Study Design & Participants	Major Findings	Bias Rating
Acar-Tek et al., 2018	Study: Pilot Study Total Participants: 24 Women Ages: 20 to 30 years BMI: 18.5 and 24.9 kg/m^2 The research study took place at Gazi University located in Turkey. The blood pressure was measured at different time marks after the consumption of coffee. The time marks were 30, 60, 120, and 180 minutes.	Based on the evaluation completed for the study it showed that the systolic blood pressure was not statistically significant after the consumption of the green coffee. All these measurements were reported after the consumption of the green coffee. The changes were not statistically significant, and the p-value was greater than 0.05. The diastolic blood pressure observed changes in the evaluation process after each mark. All the results marked at each time frame were almost statically significant and p value equaled to 0.06.	R/+;V/+
Akhun-dova et al., 2021	Study: Open Label Study Participants: 15 Men 15 Women Age: 19 to 46 years BMI: <18.5 or obese individuals BMI>30 was excluded from the study.	The values of systolic and diastolic blood pressure were similar before and after the energy drink consumption. One of the important parts in the results was that the low caffeine energy drinks had no significant effect on blood pressure.	R/+; V/+
Alk-erwi et al., 2015	Total Participants: 1352 *The total participants were finalized for the study based on collected data and dietary questionaries.	The coffee consumption had a p-value of <.0001. The blood pressure was measured through the OMROM (the blood pressure monitor) 3 times.	R/+;V/+
Al-Shafei et al., 2019	Study: Randomized Controlled Participants: 200 Total Participants (Divided into 2 groups) Female and Male Average Age: 53 +/ 4 years The study took a total of 8-month period.	The diastolic blood pressure was insignificantly reported, and the p-values breakdown are posted below. 1.9 (p<0.05) 3.2 (p>0.05) 3.9 (p<0.05) 5.2 (p<0.01) Based on the first group in the study, the green tea treatment for the systolic blood pressure it was significantly lower from the values of baseline. The p-Values are posted below are based on 1- 4 months. 3.3 (P<0.05) 5.4 (p<0.01) 8.4 (p<0.001)	R/+; V/+

focused on the outcome of heart rate variability through the consumption of expresso coffee. The study reported a significant increase in heart rate variability after the consumption of different beverages caffeinated expresso, decaffeinated expresso, and water in the 3 groups but with no clear reporting of the p-value. Shah et al. (2019) reported statistically significant ($p < 0.001$) heart rate results after participants consumed 32 ounces of the energy drink. Each study presented a different source of caffeine and reported a mix of results on the heart rate outcomes. Some studies showed an increase in heart rate after consuming the caffeine beverage while some studies presented a decrease in heart rate after consuming the beverage. Overall, it is important to note that although similar beverages may have been used in trials, each study presented a different major finding on the heart rate outcome.

Table 4. tudies examining heart rate as an outcome after consumption of caffeine

Author and Year	Study Design & Participants	Major Findings	Bias Rating
Arazi et al., 2014	**Study:** Randomized controlled trial **Participants:** Hypertensive Women ● 24 middle-aged women ● Three groups which contains 8 people. **Average of Age, Height, and Weight** -Age: 46.4 -Weight: 66.6 kg -Height: 166.3 cm Green Tea Extract (~75 mg EGCG) was consumed by groups T and R. Placebo Group- ~490 mg Maltodextrin Capsule (twice a day for a total of three weeks) Control Group- Only Ingested PL Blood pressure and Heart Rate measured before and after exercise at 0, 15, 30, 45, and 60 minutes.	-At three weeks, the green tea extract did not affect the results of systolic blood pressure, diastolic blood pressure, and heart rate. -No significant differences reported for heart rate between the three groups (79.5- T Group, 78- R Group, and 74- C Group)	R/+;V/⊘
Chapman et al., 2021	Study: Randomized, double-blinded crossovers experimental trials. Total Participants: 12 healthy, nonobese adults 10 Males 2 Females ● Age: 24 years ● Body Mass Index: 24.1 +/ 3.1 kg/m^2 ● Weight: 76 +/ 9 kg ● Height: 177 +/ 8 cm	At baseline, no difference was observed at the consumption of the pre-drink for heart rate.	R/+;V/+
Costa et al., 2023	Study: Prospective Study Participants: 30 young healthy adults ● Age:18 and 22 years old	After the consumption of the energy drink Red Bull, a decrease in heart rate was observed. However, the results were not significant.	R/+; V/+
Fletcher et al., 2017	Study: Double blind, randomized, crossover, and controlled. Participants: 18 Healthy adults from ages 18 and 40 years. ● 12 Men ● 6 Women	One of the parameters that showed no difference between the groups at any time of the study was heart rate.	R/+;V/+
Flueck et al., 2016	Study: Double blind, placebo controlled, and randomized. Participants: healthy, non-smoking men. ● Age range: 18 and 60 years old ● Physically active for at least three times per week. ● The participants suffering from diabetes were excluded from the study.	Heart Rate Variability did not change significantly after the ingestion of caffeine compared to the placebo group. All the trials observed a decrease in heart rate, but the results were non-significant.	R/+; V/+
Nowak et al., 2019	Study: Research Article Total participants: 88 49 Females 39 Males 15 individuals- overweight. 3 individuals- underweight. Healthy volunteers (over the age of 18) Average Age: 25 The participants were divided into total of 4 groups. All the participants had their blood pressure (SBP and DBP), heart rate (HR), and blood glucose measured and recorded.	Heart rate significantly decreased after the consumption of noni juice. The decrease in heart rate was observed after the consumption for the third part of the noni juice and results were statistically significant (p=0.030).	R/+;V/+
Shah et al., 2019	Study: Randomized, double-masked, crossover, and placebo controlled Total Participants: 34 Average Age: 22.1 (Ages 18-40 years) Location: University Campus setting	Heart rate was statistically significant (P<0.001) after energy drink consumption.	R/+;V/+
Zimmerman Viehoff et al., 2016	Study: Randomized Crossover Participants: 77 healthy individuals (38 habitual and 39 non-habitual coffee consumers) There were three groups for the study, and each consumed a different beverage. The beverages were warm eater, decaffeinated expresso, and expresso.	Heart Rate Variability increased after the consumption of decaffeinated or caffeinated expresso. Also, Heart Rate Variability increased after the consumption of water.	R/+; V/+

Quality/Risk Assessment

The quality assurance of the literature review was completed using the Quality Criteria Checklist published by the Academy of Nutrition and Dietetics Evidence Analysis Library (Academy of Nutrition and Dietetics, 2016). A total of 36 articles were given a "+" rating, which indicates a strong article. On the other hand, nine studies received a rating of "neutral" which indicates that publications are not exceptionally strong. None of the selected articles in the systematic review received a negative rating. Table 3 and 4 above outline the selected studies presented in the systematic review and bias rating given to each study.

4 | DISCUSSION

The topic of caffeine consumption and blood pressure has been discussed in multiple studies throughout the years. The results of the systematic review were mixed as each selected study presented different data after consumption of the caffeinated beverages. The most reviewed studies focused on the increase in systolic and diastolic blood pressure (N=11), heart rate outcomes (N=8), impact on diastolic blood pressure (N=7), impact on systolic blood pressure (N=7), decaffeinated and caffeinated coffee effects on blood pressure (N=5), decrease in both diastolic and systolic blood pressure (N=3), and no change reported in diastolic and systolic blood pressure (N=3).

The increase in systolic and diastolic blood pressure reported mixed p-values however observed an increase in the blood pressure within hours of administrating the caffeinated beverages to the selected participants. The beverages presented in the studies were a variety with energy drinks tested the most followed by tea, coffee/caffeinated beverage, and soft drink. On the other hand, there are a total of five studies that showed a decrease in both systolic and diastolic blood pressure after participants consumed the caffeinated beverage of coffee or tea. There are total of five studies that focused on the intake of caffeinated or decaffeinated coffee which results in mixed results as some studies focused on a reduction in blood pressure while other studies showed no significant effect after consuming the beverage.

There are a total of three studies that noted no significant difference between systolic and diastolic blood pressure after healthy participants consumed the caffeinated beverage. On the other hand, the impact on systolic and diastolic blood pressure outcomes presented in the beginning of the results section focused on the studies that also highlighted no impact on the blood pressure value after consuming the beverage. A total of eight sources focused on the heart rate or heart rate variability after consuming the caffeinated beverages. Of the selected eight sources, two highlighted increases in heart rate, followed by two studies focused on the decrease in heart rate, and four studies noted no significant difference. Table 3 and 4 outline the selected studies along with study design, participants, major findings, and the rating.

Overall, the final findings from each study presented in the systematic review were mixed due to the different data reported after the caffeinated beverages were consumed from the participants who varied in age. Therefore, it is important for individuals to follow the set health guidelines in order to understand the recommended caffeine consumption intake.

Application for Practitioner

Although there are numerous studies presented in the systematic review that showed a statistically significant elevated blood pressure effect on the participants whether on the systolic or diastolic numbers. However, with the different caffeine sources presented in the systematic review, it is recommended individuals follow the set guidelines published by the Food and Drug Administration and peer-reviewed journals to understand the appropriate amount of caffeine to consume. The FDA recommends healthy adults consume a maximum amount of 400 milligrams of caffeine per day which is equivalent to around 4 to 5 cups of coffee (Food and Drug Administration, 2020). However, for individuals who may have a family history of high blood pressure or are currently diagnosed with hypertension, it is important to continue monitoring any blood pressure changes, limit caffeine intake, and discuss the health issues with a healthcare professional (National Library of Medicine, 2021).

Strengths/Limitations

The systematic review presented both strengths and limitations. One of the strengths was the number of

sources found aligning to the established inclusion criteria. Another strength was the mixed age groups presented in each study. All the selected articles went through the PRISMA guidelines which helped to determine sources that met the criteria of the systematic review and sources excluded from the process. The multiple caffeine sources that focused on a particular population in each study, led to limitations due to limiting the generalizability. Most studies used questionnaires or self-reported data from the participants as a tool to gather health information The self-reported data may affect the accuracy of the results. Another limitation presented in the study is the limited availability of English-free, full-text sources.

5 | CONCLUSION

This systematic review aimed to examine the consumption of caffeine and negative health effects on blood pressure. However, the blood pressure effects from the different caffeine sources demonstrated mixed results as some studies presented significantly elevated blood pressure and other studies presented non-significant results for both diastolic and systolic blood pressure. The systematic review presented the effects of blood pressure through the consumption of caffeine sources such as tea, coffee, energy drinks, soda, and other caffeine intake. The studies focused on the effects of caffeine on diverse groups of individuals ranging from ages 18 to 84. Further research is needed to address the long-term and short-term health effects of the consumption of one type of caffeine source to better understand the impact on blood pressure.

Academy of Nutrition and Dietetics. Evidence analysis manual: Steps in the Academy Evidence Analysis Process. (2016, April). https://www.andeal.org/vault/2440/web/files/2016_April_EA_Manual.pdf

Acar-Tek, N., A□agündüz, D., & Ayhan, B. (2018). Effect of Green Coffee Consumption on Resting Energy Expenditure, Blood Pressure, and Body Temperature in Healthy Women: A Pilot Study. Journal of the American College of Nutrition, 37(8), 691–700. https://doi-org.ezproxy.lib.uh.edu/10.1080/07315724.2018.1461147

Akhundova, J., Tulunay Kaya, C., & Gerede Uludağ, D. M. (2021). Acute effects of consumption of low-caffeine energy drinks on endothelial functions in healthy volunteers. Anatolian Journal of Cardiology / Anadolu Kardiyoloji Dergisi, 25(10), 678–683. https://doi-org.ezproxy.lib.uh.edu/10.5152/AnatolJCardiol.2021.144

Alkerwi, A., Sauvageot, N., Crichton, G. E., & Elias, M. F. (2015). Tea, but not coffee consumption, is associated with components of arterial pressure. The Observation of Cardiovascular Risk Factors study in Luxembourg. Nutrition Research, 35(7), 557–565. https://doi-org.ezproxy.lib.uh.edu/10.1016/j.nutres.2015.05.004

Al-Shafei, A. I. M., & El-Gendy, O. A. A. (2019). Regular consumption of green tea improves pulse pressure and induces regression of left ventricular hypertrophy in hypertensive patients. Physiological reports, 7(6), e14030. https://doi.org/10.14814/phy2.14030

Arazi, H., Samami, N., Kheirkhah, J., & Taati, B. (2014). The effect of three weeks green tea extract consumption on blood pressure, heart rate responses to a single bout resistance exercise in hypertensive women. High blood pressure & cardiovascular prevention : the official journal of the Italian Society of Hypertension, 21(3), 213–219. https://doi.org/10.1007/s40292-014-0048-1

Bashir, M. U., Imran, M., & Ali, A. (2018). Energy Drinks on Cardiovascular System; Short Term Effects of Energy Drinks on Cardiovascular System and Physical Performance of Male Medical Students. Professional Medical Journal, 25(11), 1717–1722. https://doi-org.ezproxy.lib.uh.edu/10.29309/TPMJ/18.4496

Basrai, M., Schweinlin, A., Bischoff, S. C., Menzel, J., Weikert, C., Dusemund, B., Lampen, A., Mielke, H., Putze, K., & Watzl, B. (2019). Energy Drinks Induce Acute Cardiovascular and Metabolic Changes Pointing to Potential Risks for Young Adults: A Randomized Controlled Trial. Journal of Nutrition, 149(3), 441–450. https://doi-org.ezproxy.lib.uh.edu/10.1093/jn/nxy303

Bennett, J. M., Rodrigues, I. M., & Klein, L. C. (2013). Effects of Caffeine and Stress on Biomarkers of Cardiovascular Disease in Healthy Men and Women with a Family History of Hyper-

tension. Stress & Health: Journal of the International Society for the Investigation of Stress, 29(5), 401–409. https://doi-org.ezproxy.lib.uh.edu/10.1002/smi.2486

Centers for Disease Control and Prevention. (2021, May 18). High blood pressure symptoms and causes. Centers for Disease Control and Prevention. https://www.cdc.gov/bloodpressure/about.htm#:~:text=Blood%20pressure%20is%20measured%20using,your%20heart%20rests%20between%20beats.

Caffeine's side effects. Aurora Health Care. (n.d.). https://www.aurorahealthcare.org/services/gastroenterology-colorectal-surgery/caffeine-side-effects

Chapman, C. L., Reed, E. L., Worley, M. L., Pietrafesa, L. D., Kueck, P. J., Bloomfield, A. C., Schlader, Z. J., & Johnson, B. D. (2021). Sugar-sweetened soft drink consumption acutely decreases spontaneous baroreflex sensitivity and heart rate variability. American journal of physiology. Regulatory, integrative and comparative physiology, 320(5), R641–R652. https://doi.org/10.1152/ajpregu.00310.2020

Chei, C.-L., Loh, J. K., Soh, A., Yuan, J.-M., & Koh, W.-P. (2018). Coffee, tea, caffeine, and risk of hypertension: The Singapore Chinese Health Study. European Journal of Nutrition, 57(4), 1333–1342. https://doi-org.ezproxy.lib.uh.edu/10.1007/s00394-017-1412-4

Chrysant, S. G., & Chrysant, G. S. (2015). Cardiovascular complications from consumption of high energy drinks: recent evidence. Journal of Human Hypertension, 29(2), 71–76. https://doi-org.ezproxy.lib.uh.edu/10.1038/jhh.2014.47

Costa, R., Rocha, C., & Santos, H. (2023, January 27). Cardiovascular and cerebrovascular response to Redbull® energy drink intake in young adults. Anatolian journal of cardiology. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9893714/

Dömötör, Z., Szemerszky, R., & Köteles, F. (2015). Subjective and objective effects of coffee consumption - caffeine or expectations? Acta physiologica Hungarica, 102(1), 77–85. https://doi.org/10.1556/APhysiol.101.2014.012

Feng, C., Cao, Y., Su, Y., Cai, H., Shu, X.-O., Zheng, W., Yu, D., & Zong, G. (2021). Association between Tea Consumption and Hypertension Risk among Middle-Aged and Older Chinese Adults. Journal of Nutrition, 151(12), 3773–3780. https://doi-org.ezproxy.lib.uh.edu/10.1093/jn/nxab293

Fletcher, E. A., Lacey, C. S., Aaron, M., Kolasa, M., Occiano, A., & Shah, S. A. (2017, April 26). Randomized controlled trial of high-volume energy drink versus caffeine consumption on ECG and hemodynamic parameters. Journal of the American Heart Association. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5524057/

Flueck, J. L., Schaufelberger, F., Lienert, M., Schäfer Olstad, D., Wilhelm, M., & Perret, C. (2016). Acute Effects of Caffeine on Heart Rate Variability, Blood Pressure and Tidal Volume in Paraplegic and Tetraplegic Compared to Able-Bodied Individuals: A Randomized, Blinded Trial. PloS one, 11(10), e0165034. https://doi.org/10.1371/journal.pone.0165034

Food and Drug Administration. (2020). Spilling the Beans: How Much Caffeine is Too Much? FDA. https://www.fda.gov/consumers/consumer-updates/spilling-beans-how-much-caffeine-too-much#:~:text=For%20healthy%20adults%2C%20the%20FDA

Freemas, J. A., Greenshields, J. T., Baker, T., Carter, S. J., Johnson, B. D., & Schlader, Z. J. (2021). Arterial stiffness is not acutely modified by consumption of a caffeinated soft drink sweetened with high-fructose corn syrup in young healthy adults. Physiological reports, 9(7), e14777. https://doi.org/10.14814/phy2.14777

Gaeini, Z., Bahadoran, Z., Mirmiran, P., & Azizi, F. (2019). Tea, coffee, caffeine intake and the risk of cardio-metabolic outcomes: findings from a population with low coffee and high tea consumption. Nutrition & Metabolism, 16(1), N.PAG. https://doi-org.ezproxy.lib.uh.edu/10.1186/s12986-019-0355-6

Garcia, A., Romero, C., Arroyave, C., Giraldo, F., Sanchez, L., & Sanchez, J. (2016, June 16). Acute effects of energy drinks in medical students - european journal of nutrition. SpringerLink. https://link.springer.com/article/10.1007/s00394-016-1246-5

Grasser, E., Yepuri, G., Dulloo, A., & Montani, J.-P. (2014). Cardio- and cerebrovascular responses to the energy drink Red Bull in young adults: a randomized cross-over study. European Journal of Nutrition, 53(7), 1561–1571. https://doi-org.ezproxy.lib

.uh.edu/10.1007/s00394-014-0661-8

Grassi , D., Draijer, R., Desideri , G., Mulder , T., & Ferri , C. (2015, February 4). Black tea lowers blood pressure and wave reflections in fasted and postprandial conditions in hypertensive patients: A randomised study. Nutrients. https://pubmed.ncbi.nlm.nih.gov/25658240/

Hernández-López, R., Canto-Osorio, F., Vidaña-Pérez, D., Torres-Ibarra, L., Rivera-Paredez, B., Gallegos-Carrillo, K., Velazquez, R., Ramírez, P., Barrientos-Gutiérrez, T., Salmerón, J., & López-Olmedo, N. (2022). Soft drink and non-caloric soft drink intake and their association with blood pressure: the Health Workers Cohort Study. Nutrition Journal, 21(1), 1–10. https://doi-org.ezproxy.lib.uh.edu/10.1186/s12937-022-00792-y

Köksal, E., Yardımcı, H., Kocaadam, B., Deniz Güneş, B., Yılmaz, B., & Karabudak, E. (2017). Relationship between dietary caffeine intake and blood pressure in adults. International Journal of Food Sciences & Nutrition, 68(2), 227–233. https://doi-org.ezproxy.lib.uh.edu/10.1080/09637486.2016.1226276

Kozik, T. M., Carey, M. G., Bhattacharyya, M., Chien, W., Charos, G. S., Connolly, T. F., Hickman, M. C., Schmidt, S., & Pelter, M. M. (2018). Cardiovascular responses to ENERGY drinks in a healthy population during eXercise: The C-Energy-X Study. Journal of Electrocardiology, 51(6), S1–S5. https://doi-org.ezproxy.lib.uh.edu/10.1016/j.jelectrocard.2018.07.025

Kujawska, A., Kujawski, S., Hajec, W., Skierkowska, N., Kwiatkowska, M., Husejko, J., Newton, J. L., Simoes, J. A., Zalewski, P., & Kędziora-Kornatowska, K. (2021). Coffee Consumption and Blood Pressure: Results of the Second Wave of the Cognition of Older People, Education, Recreational Activities, Nutrition, Comorbidities, and Functional Capacity Studies (COPERNICUS). Nutrients, 13(10), 3372. https://doi.org/10.3390/nu13103372

Martyn, J., & Chmiel, Z. (2019). Consumption of energy drinks and assessment of blood pressure values among young adults. Family Medicine & Primary Care Review, 21(4), 335–342. https://doi-org.ezproxy.lib.uh.edu/10.5114/fmpcr.2019.90162

Moura de Araújo, M. F., Gueiros Gaspar, M. W., Saraiva Veras, V., Freire de Freitas, R. W. J., de Paula, M. do L., Alves de Oliveira Serra, M. A., Garcia Lira Neto, J. C., Coelho Damasceno, M. M., Bandeira Moreira, A. V., & Derenji de Mello, V. (2022). Consumption of caffeinated and decaffeinated coffee enriched with cocoa and fructo-oligosaccharides among non-diabetic persons: Double blind randomized clinical trial. Journal of Food Biochemistry, 46(5), 1–12. https://doi-org.ezproxy.lib.uh.edu/10.1111/jfbc.14081

National Library of Medicine. (2021, September 8). Caffeine. Medlineplus.gov. https://medlineplus.gov/caffeine.html

Navarro, A. M., Martinez-Gonzalez, M. A., Gea, A., Ramallal, R., Ruiz-Canela, M., & Toledo, E. (2019). Coffee consumption and risk of hypertension in the SUN Project. Clinical Nutrition, 38(1), 389–397. https://doi-org.ezproxy.lib.uh.edu/10.1016/j.clnu.2017.12.009

Nogueira, L. P., Nogueira Neto, J. F., Klein, M. R., & Sanjuliani, A. F. (2017). Short-term Effects of Green Tea on Blood Pressure, Endothelial Function, and Metabolic Profile in Obese Prehypertensive Women: A Crossover Randomized Clinical Trial. Journal of the American College of Nutrition, 36(2), 108–115. https://doi.org/10.1080/07315724.2016.1194236

Nowak, D., Gośliński, M., Wesołowska, A., Berenda, K., & Popławski, C. (2019). Effects of Acute Consumption of Noni and Chokeberry Juices vs. Energy Drinks on Blood Pressure, Heart Rate, and Blood Glucose in Young Adults. Evidence-Based Complementary & Alternative Medicine (ECAM), 1–9. https://doi.org/10.1155/2019/6076751

Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. (2021, March 29). The Prisma 2020 statement: An updated guideline for reporting systematic reviews. The BMJ. https://www.bmj.com/content/372/bmj.n71

Papakonstantinou, E., Kechribari, I., Sotirakoglou, *K*., Tarantilis, P., Gourdomichali, T., Michas, G., Kravvariti, V., Voumvourakis, K., & Zampelas, A. (2016, March 15). Acute effects of coffee consumption on self-reported gastrointestinal symptoms, blood pressure and stress indices in healthy individuals. Nutrition journal. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4791892/

Peckham, T. S. (2023, September 26). 94% of US drink caffeinated beverages. Sleep Foundation. https://www.sleepfoundation.org/sleep-news/94-percent-of-us-drink-caffeinated-beverages

Peng, X., Zhang, M., Wang, X., Wu, K., Li, Y., Li, L., Yang, J., Ruan, Y., Bai, R., Ma, C., & Liu, N. (2021). Sex differences in the association between green tea consumption and hypertension in elderly Chinese adults. BMC Geriatrics, 21(1), 1–7. https://doi-org.ezproxy.lib.uh.edu/10.1186/s12877-021-02431-3

Rhee, J. J., Qin, F., Hedlin, H. K., Chang, T. I., Bird, C. E., Zaslavsky, O., Manson, J. E., Stefanick, M. L., & Winkelmayer, W. C. (2016). Coffee and caffeine consumption and the risk of hypertension in postmenopausal women. The American journal of clinical nutrition, 103(1), 210–217. https://doi.org/10.3945/ajcn.115.120147

Roshan, H., Nikpayam, O., Sedaghat, M., & Sohrab, G. (2018). Effects of green coffee extract supplementation on anthropometric indices, glycaemic control, blood pressure, lipid profile, insulin resistance and appetite in patients with the metabolic syndrome: a randomised clinical trial. The British journal of nutrition, 119(3), 250–258. https://doi.org/10.1017/S0007114517003439

Ryan R, Synnot A, Prictor M, Hill S. Cochrane Consumers and Communication Group Data extraction template for included studies. CCCG http://cccrg.cochrane.org/author-resources. La Trobe University, Melbourne. Published November 2016. Approved (S. Hill) November 29th, 2016.

Shah, S. A., Dargush, A. E., Potts, V., Lee, M., Millard-Hasting, B. M., Williams, B., & Lacey, C. S. (2016). Effects of Single and Multiple Energy Shots on Blood Pressure and Electrocardiographic Parameters. The American journal of cardiology, 117(3), 465–468. https://doi.org/10.1016/j.amjcard.2015.11.017

Shah, S. A., Szeto, A. H., Farewell, R., Shek, A., Fan, D., Quach, K. N., Bhattacharyya, M., Elmiari, J., Chan, W., O'Dell, K., Nguyen, N., McGaughey, T. J., Nasir, J. M., & Kaul, S. (2019). Impact of High-Volume Energy Drink Consumption on Electrocardiographic and Blood Pressure Parameters: A Randomized Trial. Journal of the American Heart Association, 8(11), e011318. https://doi.org/10.1161/JAHA.118.011318

Stopa, M., Łobacz, M., Niemczyk, M., Rudowska, K., Radko, A., Mikunda, A., Czarnecka, D., & Olszanecka, A. (2020). Influence of energy drinks on acute hemodynamic parameters in young healthy adults: a randomized double-blind placebo-controlled crossover pilot study. Kardiologia polska, 78(4), 335–337. https://doi.org/10.33963/KP.15231

Teng , C. L., Lim, W. Y., Chua, C. Z., Teo, R. S. K., Lin, K. T. H., & Yeo, J. C. (2016 ,Jan-Feb). Does a single cup of caffeinated drink significantly increase blood pressure in young adults? A randomised controlled trial. Australian family physician. https://pubmed.ncbi.nlm.nih.gov/27051992/

Tian, S., Zhang, Y. J., Ma, Q. H., Xu, Y., Sun, H. P., & Pan, C. W. (2020). Associations between habitual tea consumption and 5-year longitudinal changes of systolic blood pressure in older Chinese. Archives of gerontology and geriatrics, 91, 104245. Advance online publication. https://doi.org/10.1016/j.archger.2020.104245

Tong, X., Taylor, A. W., Giles, L., Wittert, G. A., & Shi, Z. (2014). Tea consumption is inversely related to 5-year blood pressure change among adults in Jiangsu, China: a cross-sectional study. Nutrition Journal, 13, 98. https://doi-org.ezproxy.lib.uh.edu/10.1186/1475-2891-13-98

Yamaji, T., Harada, T., Hashimoto, Y., Nakano, Y., Kajikawa, M., Yoshimura, K., Goto, C., Mizobuchi, A., Tanigawa, S., Yusoff, F. M., Kishimoto, S., Maruhashi, T., Nakashima, A., & Higashi, Y. (2022). Relationship of Daily Coffee Intake with Vascular Function in Patients with Hypertension. Nutrients, 14(13), 2719–N.PAG. https://doi-org.ezproxy.lib.uh.edu/10.3390/nu14132719

Yin, J., Xu, Y., Pan, C.-W., Duan, S., Liu, F.-C., Yao, Q.-K., & Tu, S. (2017). Blood pressure is associated with tea consumption: A cross-sectional study in a rural, elderly population of Jiangsu China. Journal of Nutrition, Health & Aging, 21(10), 1151–1159. https://doi-org.ezproxy.lib.uh.edu/10.1007/s12603-016-0829-4

Yu, S., Wang, B., Li, G., Guo, X., Yang, H., & Sun, Y. (2023). Habitual Tea Consumption Increases the Incidence of Metabolic Syndrome in Middle-Aged and Older Individuals. Nutrients, 15(6), 1448. https:

//doi-org.ezproxy.lib.uh.edu/10.3390/nu15061448

Zimmermann-Viehoff, F., Thayer , J., Koenig , J., Herrmann, C., Weber, C. S., & Deter , H. C. (2016, May 19). Short-term effects of espresso coffee on heart rate variability and blood pressure in habitual and non-habitual coffee consumers–a randomized crossover study. Nutritional neuroscience. https://pubmed.ncbi.nlm.nih.gov/25850440/

How to cite this article: Abuhamdan S., Haubrick K. Effects of Caffeine on Blood Pressure. Research Review. 2024;2603−2617. https://doi.org/10.52845/RR/5-6-2