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REVIEW ARTICLE

Effect of coffee consumption on the risk of developing arterial hypertension in the general population: a review of systematic reviews of the literature

Efecto del consumo habitual de café sobre el riesgo de desarrollar hipertensión arterial en población general: una revisión de revisiones sistemáticas de la literatura

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Abstract

Introduction: *Coffee is habitually consumed, and its long-term hypertensive effect is uncertain.* **Objective:** *To evaluate the effect of regular coffee consumption on the incidence of arterial hypertension.* **Methods:** *A review of systematic reviews and meta-analyses was conducted in Medline, Embase, Cochrane, and LILACs between January 1966 and September 2019. The search, selection, and extraction were paired, and the quality of the manuscripts was assessed with AMSTAR.* **Results:** *Analyzing the dose-response effect, for each daily cup of coffee consumed, the risk of developing hypertension is reduced by 2% (RR = 0.98; 95% CI: 0.98-0.99) up to a maximum of eight cups. This protective effect is also seen with daily doses of two to eight cups of coffee, compared with no consumption (RR = 0.97; 95% CI: 0.95-0.99 and RR = 0.90; 95% CI: 0.83-0.97, respectively). The analysis by categories (low, moderate, and high consumption vs. abstinence), only produces a protective effect with high consumption (an average of 6.2 cups per day, RR = 0.95; 95% CI: 0.91-0.99).* **Conclusion:** *Moderate and high coffee consumption does not increase the risk of hypertension in the general population and, on the contrary, could be protective.*

Keywords: *Coffee. Hypertension. Cardiovascular system. Incidence.*

Resumen

Introducción: *El café es consumido habitualmente y su efecto hipertensor a largo plazo es incierto.* **Objetivo:** *Valorar el efecto del consumo regular de café en la incidencia de hipertensión arterial.* **Método:** *Se realizó una revisión de revisiones sistemáticas y metaanálisis en Medline, Embase, Cochrane y Lilacs entre enero de 1966 y septiembre de 2019. La búsqueda, selección y extracción fue pareada y la calidad de los artículos se evaluó con AMSTAR.* **Resultados:** *Al analizar el efecto dosis-respuesta, por cada taza diaria de café consumido se reduce un 2% el riesgo de desarrollar hipertensión arterial (RR = 0.98; IC 95%: 0.98-0.99) hasta un máximo de 8 tazas. Este efecto protector también se observa con dosis diarias de café entre 2 y 8 tazas, comparado con el no consumo (RR = 0.97; IC 95%: 0.95-0.99 y RR = 0.90; IC 95%: 0.83-0.97, respectivamente). El análisis por categorías (consumo bajo, moderado y alto vs. abstinencia), solo produce un efecto protector con consumos altos (un promedio de 6.2 tazas al día, RR = 0.95; IC 95%: 0.91-0.99).* **Conclusión:** *El consumo moderado y alto de café no incrementa el riesgo de hipertensión arterial en la población general y, por el contrario, podría ser protector.*

Palabras clave: *Café. Hipertensión. Enfermedades cardiovasculares. Incidencia.*

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Introduction

Coffee is the most widely consumed hot beverage in the world. In Colombia, a consumption of approximately 2 kg/year/person is reported[1], and 10 to 12 kg/year/person in Nordic countries (these being the largest consumers worldwide[2]).

Over the last two decades, habitual coffee consumption has been found to be related to favorable cardiovascular outcomes, like decreased all-cause and cardiovascular mortality, as well as fewer cardiovascular events and reduced cardiovascular risk. However, there is contradictory information on its effect on the incidence of arterial hypertension in the healthy adult population, which has led to many healthcare professionals who are not up to date advising against this beverage, to improve cardiovascular health[3].

Current evidence is unclear regarding the recommendations for consumption in the general population. Overall, it is stipulated that a healthy adult should not consume more than 400 mg of caffeine per day[4]. Most nutritional guidelines agree that habitual coffee consumption should be avoided in children, adolescents and pregnant women, and recommend limiting added sugar in caffeinated beverages[5-9]. However, with regard to cardiovascular health, and particularly the onset of arterial hypertension, the dose that may be safely consumed without increasing the incidence of this condition is uncertain.

Coffee contains more than 1,000 compounds, usually grouped into minerals and organic substances, like carbohydrates, lipids, proteins and alkaloids (caffeine and trigonelline). It also contains carboxylic and phenolic acids (mainly represented by chlorogenic acid), as well as volatile compounds. Although caffeine has been the most studied compound, due to its stimulant effects, the cardiovascular benefits of coffee are thought to be mainly related to the substances which produce an antioxidant and anti-inflammatory effect (phenolic compounds, trigonelline, magnesium, lignans, and quinides, among others). At the same time, habitually consumed caffeine loses its cardiovascular stimulant effect due to the tolerance phenomenon and related to its genetically determined metabolism and, on the contrary, promotes diuresis, vasodilation (selective inhibition of adenosine receptors A1 and A2, nitric oxide release stimulation) and improves heart rate variability[10]. Due to the above, it is biologically plausible to propose that habitual coffee consumption could lower the risk of developing arterial hypertension despite the existence of contradictory data on the subject.

Given the existing controversy, the objective of this paper is to analyze and summarize the available evidence related to the effect of habitual coffee consumption and the risk of developing arterial hypertension (HTN) in healthy adults. For this review, habitual consumption is defined as drinking one or more cups of coffee a day. Smaller amounts are considered equivalent to nonconsumption.

Methods

A review of systematic reviews of the literature was carried out, with the project approved by consensus on 01/25/2018 by the Research and Ethics Committee at the Pontificia Universidad Javeriana de Bogotá Medical School, Colombia, with record number (01/2018).

The literature search was done in the Medline, Embase, Cochrane and LILACS databases from January 1966 to September 2019 (Table 1). The references of the selected articles were reviewed, and a grey literature search was conducted on Google Scholar.

The inclusion criteria considered studies that were systematic reviews and meta-analyses published in indexed journals studying the effect of habitual coffee drinking and the risk of developing arterial hypertension compared with non-consumption in people of either sex over the age of 18 without an arterial hypertension diagnosis, and which were published in English, Spanish, French or Portuguese.

Studies in pregnant, postpartum or lactating women; studies of patients with psychiatric disorders and psychoactive substance dependence; studies in people with cancer or those whose source of caffeine was medications or beverages like tea, energy drinks, chocolate or sodas; or studies evaluating the effect of caffeine “alone,” that is, not ingested through coffee; and, lastly, studies in animals, were excluded.

The quality of the studies was evaluated with the Assessing the Methodological Quality of Systematic Reviews (AMSTAR) tool, and articles with a score greater than or equal to 7/10 (that is, greater than 60%) were included. After this, data extraction was conducted, considering the title, authors, population, intervention, comparator and outcome of interest (arterial hypertension).

Article selection, both by title and abstract as well as by full text, quality assessment and data extraction were performed independently by a pair of investigators.

Finally, the strength of the evidence was evaluated using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) system, and the

Table 1. Characteristics of the literature search

Terms related to exposure to coffee	Terms related to the outcome of interest	Terms related to the type of publication	Search source
Coffee OR Café OR decaffeinated OR caffeinated OR "Coffee"[Mesh]	"Vascular function" OR vascular AND function OR endothelial AND dysfunction OR cardiovascular AND risk OR hypertension OR "Hypertension" [Mesh] OR High AND Blood AND Pressure	Meta analysis [Publication Type] OR meta-analysis [Title/Abstract] OR meta-analysis [MeSH Terms] OR review [Publication Type] OR search [Title/Abstract] Filters: Review	Medline
'coffee'/exp OR 'decaffeinated coffee'/exp OR 'caffeinated coffee'/exp	'Vascular function'/exp OR 'vascular function' OR 'endothelial dysfunction'/exp OR 'endothelial dysfunction' OR 'cardiovascular risk'/exp OR 'hypertension'/exp OR	'Systematic review'/exp OR 'meta analysis'/exp OR 'review'/exp	Embase
Coffee OR cafe OR Caffeinated OR Decaffeinated"	"Vascular OR Endothelial OR cardiovascular OR hypertension OR Pressure"	"Title Abstract Keyword" in Cochrane Reviews, Cochrane Protocol ls (Word variations have been searched)	LILACS
Coffee OR Café	Vascular OR Endothelial OR cardiovascular OR hypertension	Systematic OR Review	Cochrane

GRADEpro software was used to synthesize the evidence found and thus write a conclusion.

Results

A total of 558 articles were obtained, and 501 after removing the duplicates. Thirty-three were selected by title and abstract, and 15 by the full text. Four systematic reviews were selected in accordance with their quality (Fig. 1).

These reviews include a total of 33 studies (23 cohort studies and 10 clinical experiments) conducted in different parts of the world, with follow up ranging from six weeks to 33 years, for a total of 2,085,809 participants (Table 2).

The four reviews included evaluate the risk of developing arterial hypertension as a result of habitual coffee consumption (Table 3).

After conducting a parametric analysis to determine the linear dose-response relationship between coffee drinking and the risk of arterial hypertension, Xie et al.[11] found that, for each cup of coffee drunk per day, this risk is reduced by 2% (RR = 0.98; 95% CI: 0.98-0.99). This has a cumulative effect as the number of cups increases, up to a maximum of eight. Additionally, these authors found an inverse dose-response relationship between consuming different doses of coffee per day, compared with non-consumption, such that two cups had an RR = 0.97; 95% CI: 0.95-0.99, four cups had an RR = 0.95; 95% CI: 0.91-0.99, six cups had an RR = 0.92; 95% CI: 0.87-0.98 and eight cups had an RR = 0.90; 95% CI: 0.83-0.97.

Similarly, in a dose-response analysis, D'Elia et al.[12] reported a protective effect with a consumption of three to seven cups of coffee per day, compared with non-consumption, with a 3-14% risk reduction (RR = 0.97; 95% CI: 0.94-0.99 for three to four cups per day, RR = 0.94; 95% CI: 0.91-0.97 for more than four to five cups per day, RR = 0.90; 95% CI: 0.86-0.93 for more than five to six cups per day, and RR = 0.86; 95% CI: 0.82-0.91 for six to seven cups per day) (Fig. 2A).

That said, the analyzed publications also evaluate the effect of coffee consumption on the incidence of arterial hypertension according to its amount, classifying it as low, moderate or high; low consumption ranges from one to three cups a day, moderate from three to six cups a day, and high is more than six cups a day. In the comparison between low consumption and non-consumption, there are discrepancies. For example, Zhang et al.[13] found a slight increase in the risk of developing arterial hypertension (RR = 1.09; 95% CI: 1.01-1.18), while Steffen et al.[14] did not report a risk of developing this disease (RR = 1.05; 95% CI: 1.0-1.1) at the stated doses. Both studies agree that moderate and high coffee consumption compared with non-consumption have a neutral effect on the risk of developing arterial hypertension (Fig. 2B).

On the other hand, after analyzing Xie's[11] 10 cohorts, comparing the highest consumption vs. non-consumption

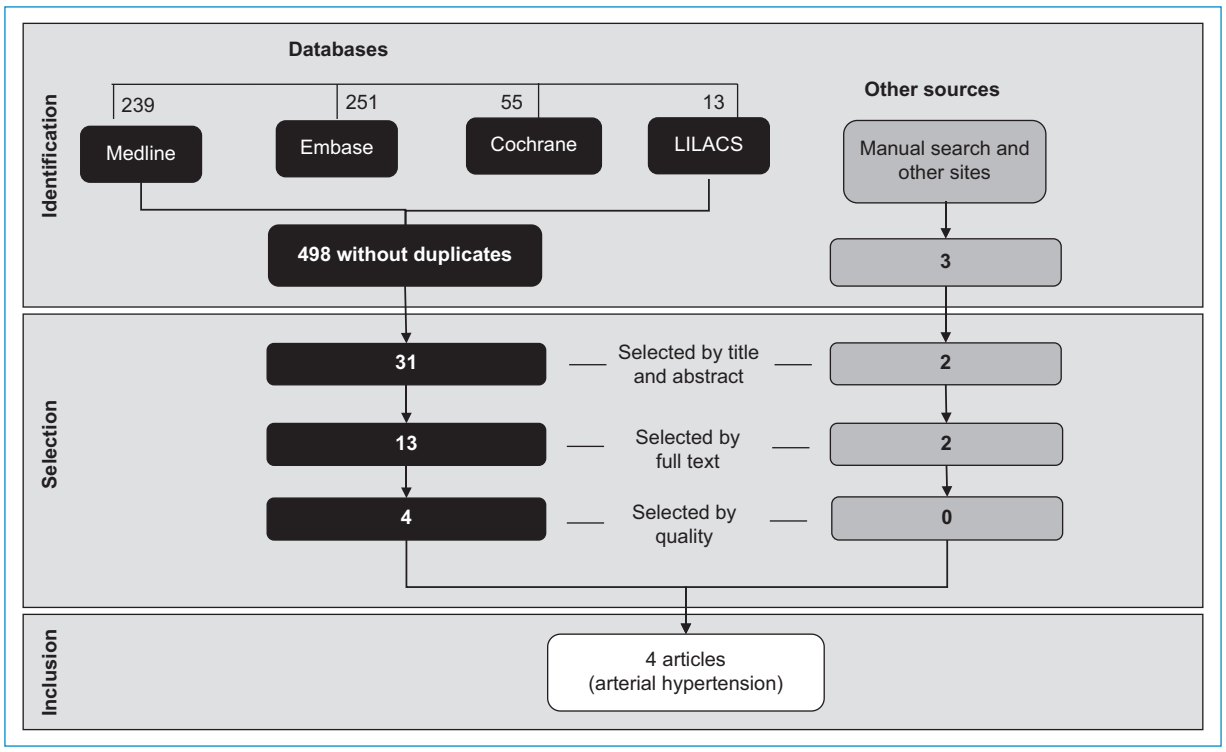

Figure 1. Article identification, selection and inclusion process.

Table 2. Characteristics of the included studies

Author and journal	AMSTAR	Countries	Follow up	Studies	Participants	Population	Outcomes
D'Elia. 2019. Eur J Nutr	9/11	USA., Finland	3-33 years	4 cohort studies	196,256 people, 41,184 cases of HTN	Adults	Consumption of 1-2 and 3-7 cups of coffee (1 cup = 200 ml) and the risk of HTN
Xie C. 2018. J Hum Hypertens	9/11	USA, Singapore, Poland, Holland, Finland, Italy	3-33 years	10 cohort studies	243,869 people, 58,094 cases of HTN	Healthy	Coffee consumption by categories (low, third and second highest and highest) and risk of HTN
Steffen M. 2012. J Hypertens	9/11	Finland, Netherlands	6 weeks-33 years	15 studies (10 RCTs and 5 cohort studies)	1,473,117 people	> 18 years (≤ 1 cup of coffee)	Coffee consumption and the effect on AP and the risk of developing HTN
Zhang Z. 2011. Am J Clin Nutr	7/11	USA, Finland, Italy, Holland	6.4-33 years	6 cohort studies	172,567 people, 37,135 cases of HTN	Healthy and hypertensive	Habitual coffee consumption (> 6 months) and the risk of HTN or changes in AP

HTN: arterial hypertension; AP: arterial pressure.

(low: 0 cups) and using the categories of highest consumption: 6.2 cups per day; second highest: 4.5 cups; and third highest: 1.5 cups, no association was found between the onset of arterial hypertension and the average consumption of 1.5 and 4.5 cups a day (RR = 1.02; 95% CI: 0.97-1.06 and RR = 0.96; 95% CI: 0.89-1.03,

Table 3. Risk of developing hypertension with habitual coffee consumption at different doses

Study	Percentage reduction in the risk of HTN	Relative risk (RR) according to daily consumption in cups	# of studies
D'Elia, 2019	3-14%	Compared with non-consumption (dose-response analysis) RR = 0.97; 95% CI: 0.94-0.99 for 3-4 cups RR = 0.94; 95% CI: 0.91-0.97 for > 4-5 cups RR = 0.90; 95% CI: 0.86-0.93 for > 5-6 cups RR = 0.86; 95% CI: 0.82-0.91 for > 6-7 cups	4 studies
Xie, 2018	2%	RR = 0.98; 95% CI: 0.98-0.99 for each daily cup of coffee vs. non-consumption	8 studies
	3-10%	Compared with non-consumption (dose-response analysis) RR = 0.97; 95% CI: 0.95-0.99 for 2 cups RR = 0.95; 95% CI: 0.91-0.99 for 4 cups RR = 0.92; 95% CI: 0.87-0.98 for 6 cups RR = 0.90; 95% CI: 0.83-0.97 for 8 cups	
	0-5%	Each category compared with non-consumption RR = 1.02; 95% CI: 0.97-1.06 for 1.5 cups per day (third highest) RR = 0.96; 95% CI: 0.89-1.03 for 4.5 cups per day (second highest) RR = 0.95; 95% CI: 0.91-0.99 for 6.2 cups per day (highest consumption)	
Steffen, 2012	-	Each category compared with non-consumption RR = 1.05; 95% CI: 1.0-1.1 for the consumption of 1-3 cups/day (low) RR = 1.05; 95% CI: 0.93-1.2 for the consumption of 4-6 cups/day (moderate) RR = 1.0; 95% CI: 0.87-1.15 for the consumption of > 6 cups/day (high)	10 RCTs. 5 cohort studies
Zhang, 2012	-	Each category compared with non-consumption RR = 1.09; 95% CI: 1.01-1.18 for the consumption of 1-3 cups/day (low) RR = 1.07; 95% CI: 0.96-1.20 for the consumption of 3-5 cups/day (moderate) RR = 1.08; 95% CI: 0.96-1.21 for the consumption of more than 5 cups/day (high)	6 studies

respectively). However, a protective effect was seen with an average consumption of 6.2 cups per day (RR = 0.95; 95% CI: 0.91-0.99) (Fig. 3).

Discussion

There is a 2% dose-response reduction in the risk of developing arterial hypertension per cup of coffee consumed per day, with a cumulative effect directly proportional to the number of cups drunk per day, up to a maximum of eight cups. When two to eight cups are drunk per day (compared with non-consumption), this risk is reduced by 3 to 10%. When consumption categories are compared, low or moderate coffee consumption (one to five cups a day) has a neutral effect on the incidence of arterial hypertension. However, the protective effect persists for high consumption (an average of six cups of coffee per day).

As previously mentioned, coffee contains different compounds with antioxidant, anti-inflammatory, vasodilatory and diuretic effects, which explain the protective effect against developing arterial hypertension. In addition, evidence from observational studies supports the theoretical benefits regarding a reduced risk of developing arterial hypertension. In this regard, the results of this review are similar to the analyses by other authors, who show an inverse association between habitual coffee consumption at moderate or high doses and the risk of developing hypertension[15]. Furthermore, this protective effect seems to be related to habituation to regular consumption. In this regard, in 2021, Surma and Oparil found an increased risk of arterial hypertension in individuals with non-habitual or occasional coffee consumption[16]. On the other hand, the relationship between habitual coffee consumption and the risk of hypertension in population subgroups continues to be controversial. For example, the protective effect is not as clear in older adults[17,18], as opposed to what occurs in women, in whom this effect increases up to 12%. Moreover, individuals with CYP1A2 enzyme polymorphisms who habitually drink coffee have been reported to have a lower probability of developing hypertension[19].

Given the high burden of disease related to arterial hypertension (close to 10 million deaths per year)[20,21], the U.S. Preventive Services Task Force recommends yearly screening for this condition in asymptomatic adults[22]. In contrast, local guidelines for the prevention and treatment of hypertension[23] do not refer to the potential effects of coffee consumption, despite the high

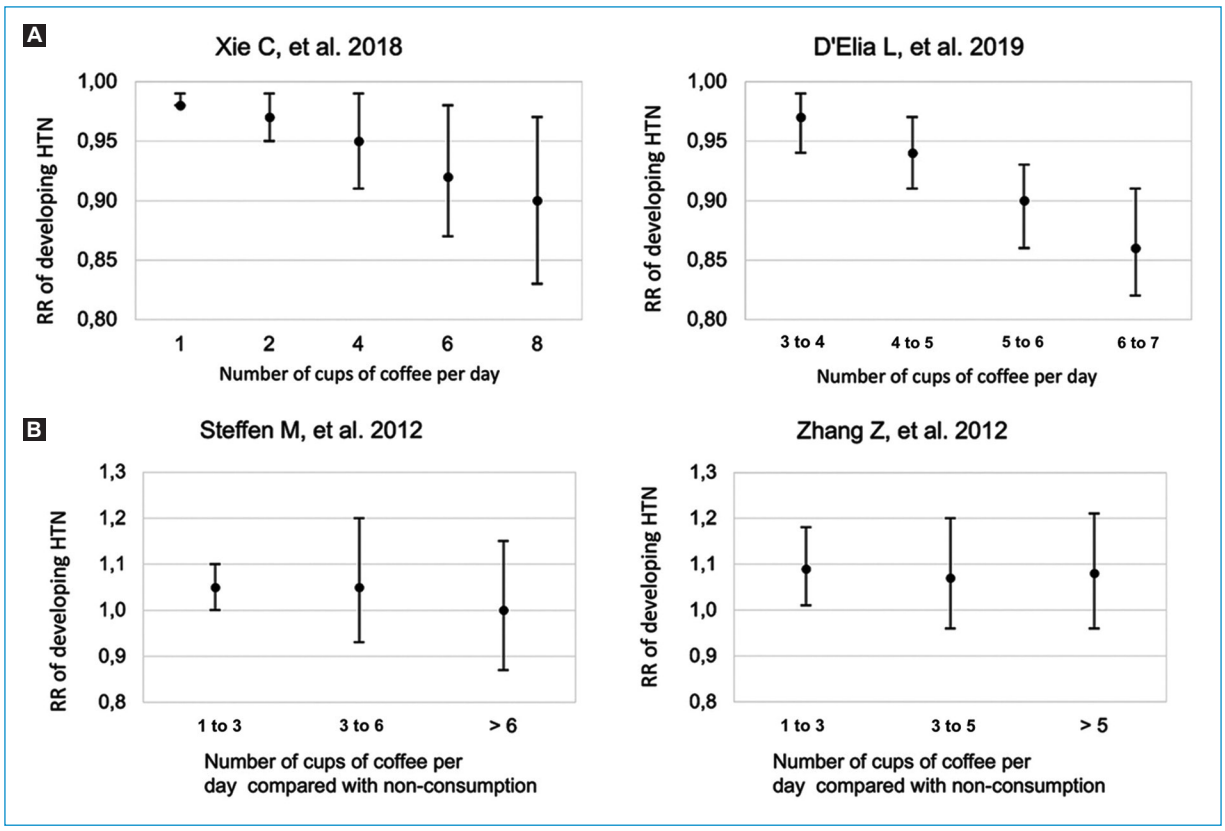

Figure 2. **A:** relationship between the number of cups consumed per day and the risk of developing arterial hypertension (dose-response analysis) **B:** relationship between categories of coffee consumption (low, moderate, high) and the risk of developing arterial hypertension.

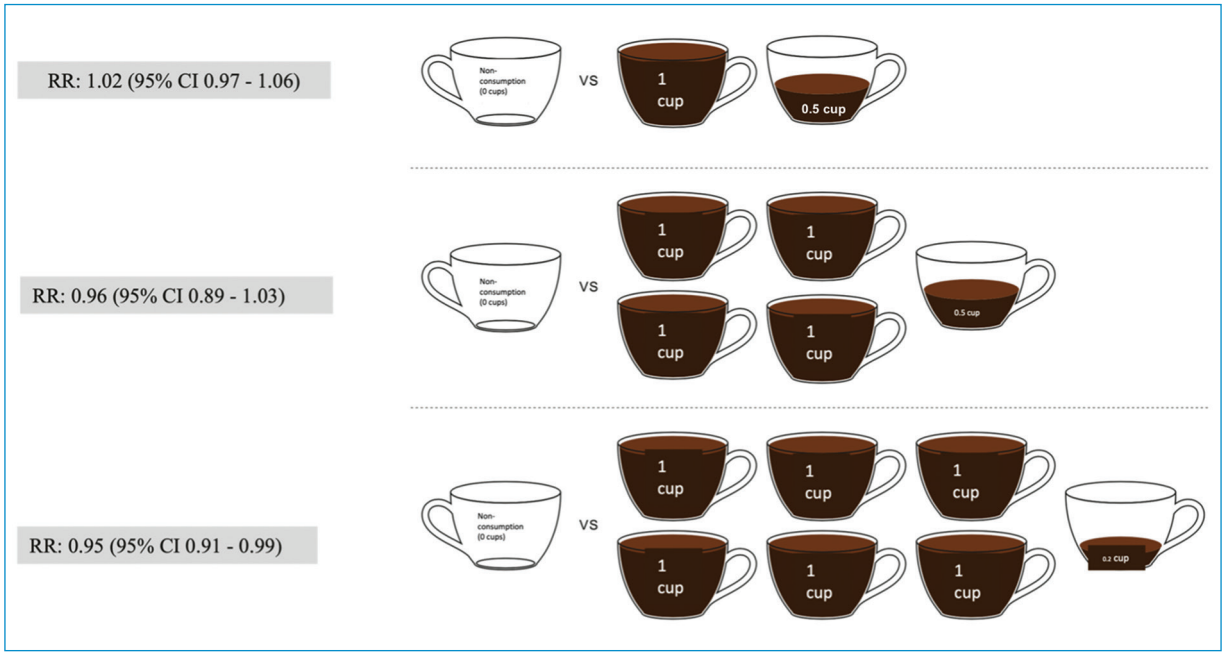

Figure 3. Effect of coffee consumption by categories according to the average number of cups/day compared with non-consumption.

consumption reported in Colombia[24]. What is more, this beverage is not mentioned as part of the nutritional plan for either prevention or treatment of this disease.

Comparing the analyzed evidence with similar studies in which other cardiovascular outcomes are evaluated in relation to habitual coffee consumption, a neutral or risk reducing effect for developing cardiovascular events is reported when three to four cups are drunk per day. Regarding the risk of cerebrovascular events, there is a protective effect if the consumption does not exceed four cups per day, and for all-cause mortality, the risk is lowered if the dose is between three and four cups a day[25,26]. In contrast, the current results suggest that the protective dose for preventing arterial hypertension is slightly higher (an average of 6.2 cups per day and no more than 8).

The limitations of this study include the fact that the coffee doses are not standardized in the primary studies, and therefore neither the size of each cup nor the classification of low, moderate or high consumption is homogenous in the included cohorts, which limits their comparison. Furthermore, the different articles do not analyze factors like the type of preparation or coffee concentration in each cup. Likewise, they do not take into account other substances which are often added to coffee, like sugar, milk, cream, etc., whose health effects are not negligible.

In addition, the consumption recorded in most articles is self-reported, which could introduce error and subjectivity to the measurements. Finally, while most of the primary studies included in the reviews controlled confounding variables (smoking status, sex, age), the influence of other factors related to developing hypertension cannot be eliminated, like overweight, sedentarism or sodium consumption, for example. Therefore, new studies must be designed to more accurately determine the influence of the mentioned variables on the incidence of arterial hypertension.

As strengths, we highlight that, of the four reviews included in this article, three have high quality and one has moderate quality. In addition, we emphasize the fact that the included studies gather a considerable number of participants with diverse characteristics with regard to sex, age and race, and although a Latin American population is not included, the diversity of regions allows us to infer that the effect is not related to a specific genotype. Likewise, the length of follow up in most of the included studies was sufficient to observe the evaluated outcome.

Conclusion

In light of the current evidence, the habitual consumption of moderate and high doses of coffee (from two to eight cups per day) has a neutral or risk reduction effect on the possibility of a healthy person developing arterial hypertension. The average consumption of 6.2 cups of coffee a day, compared with non-consumption, has a protective effect against the onset of arterial hypertension.

This information is relevant for guiding current clinical practice, given the high prevalence of regular coffee consumption in the Colombian population, and considering the lack of concrete recommendations in this regard in the current nutritional guidelines. *Level of certainty: very low; importance: critical* (GRADE).

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Conflicts of interest

The authors have no conflicts of interest.

Ethical disclosures

Human and animal protection. The authors declare that no human or animal experiments were performed for this study.

Data confidentiality. The authors declare that no patient data are included in this article.

Right to privacy and informed consent. The authors declare that no patient data are included in this article.

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