

Cardiovascular health

Overview

Cardiovascular disease (CVD) is a collective term used to describe conditions affecting the heart and circulation, including coronary heart disease, heart attack, and stroke. Each of these conditions can be affected by various risk factors including blood pressure, cholesterol, blood vessel dilation and homocysteine levels.

Research into coffee consumption and CVD has suggested that a moderate intake of coffee, of around 3-5 cups per day, may reduce CVD mortality risk¹⁻⁹. Moderate coffee consumption can be defined as 3-5 cups per day, based on the European Food Safety Authority's review of caffeine safety¹⁰.

Specifically in relation to coronary heart disease, many studies suggest a protective effect at intakes of approximately 3-5 cups per day with the association resembling a U-shaped curve^{7,11-12}. Studies reviewing associations between coffee consumption and stroke have suggested that a moderate intake is associated with a reduced risk of stroke, particularly in women¹³⁻¹⁹.

Research considering the effect of coffee consumption on atrial fibrillation suggests that there is no association between coffee consumption and risk of atrial fibrillation, and moderate coffee consumption may be associated with a reduced risk²⁰⁻²⁵. The association between coffee consumption and blood pressure is unclear, with studies reporting conflicting results. The effect appears to be relatively small and not exclusively dependent on caffeine²⁶⁻³⁰.

In relation to cholesterol levels, the method of coffee preparation is the main factor to consider. Trials using filtered coffee demonstrate virtually no effect on serum cholesterol, whilst consumption of unfiltered coffee can increase serum cholesterol levels³¹⁻³⁵. However, the effects on cholesterol levels are transient³¹.

Brachial artery flow-mediated dilation is a measure of endothelial dysfunction, used to evaluate cardiovascular risk. A small number of studies have shown a short-term effect of coffee consumption on reduced flow³⁶⁻³⁸. Additionally, some research has suggested that high coffee intakes increase blood homocysteine³⁹⁻⁴⁹. Further studies are needed before conclusions can be drawn.

Much of the research into coffee consumption and cardiovascular disease has considered the impact in healthy participants, however additional work has considered the effect in patients with specific diseases. Such research provides valuable information on coffee drinking in cases of ill health and may help to explain some of the variation in results from epidemiological studies⁵⁰⁻⁵⁹.

The mechanisms underlying the associations between coffee consumption and reduced risk of stroke, and potential associations with risk factors for coronary heart disease, need further investigation⁶⁰. Caffeine is unlikely to be solely responsible for the observed effects^{13-19,26-49}.

The content in this Topic Overview was last edited in August 2017. Papers in the Latest Research section and further resources are added regularly.

Background information

In Europe, cardiovascular disease – CVD – (principally coronary heart disease and stroke) is the main cause of death, accounting for 45% of all deaths (49% of all deaths in women and 40% of all deaths in men)^{61,62}. Together, coronary heart disease (CHD) and cerebrovascular disease are the most common causes of CVD deaths, accounting for 1.8 million and 1.1 million deaths, respectively².

Overall, CVD is estimated to cost the EU economy €196 billion every year. Of the total cost of CVD in the EU, around 54% are healthcare costs, 24% are productivity losses, and 22% are costs associated with informal care of people with CVD⁶².

Lifestyle and CVD

Lifestyle choices such as poor dietary habits, smoking, significant alcohol consumption and a lack of physical activity have been shown to affect CVD mortality. 28% of CVD deaths may be attributed to smoking, 17% to lack of physical activity, 14% to being overweight, 13% to poor diet quality, and 7% to high alcohol intake⁶³. Such lifestyle choices are associated with long-term adverse conditions such as diabetes, hyperlipidaemia, and hypertension, which in turn can increase the risk of CVD⁶⁴.

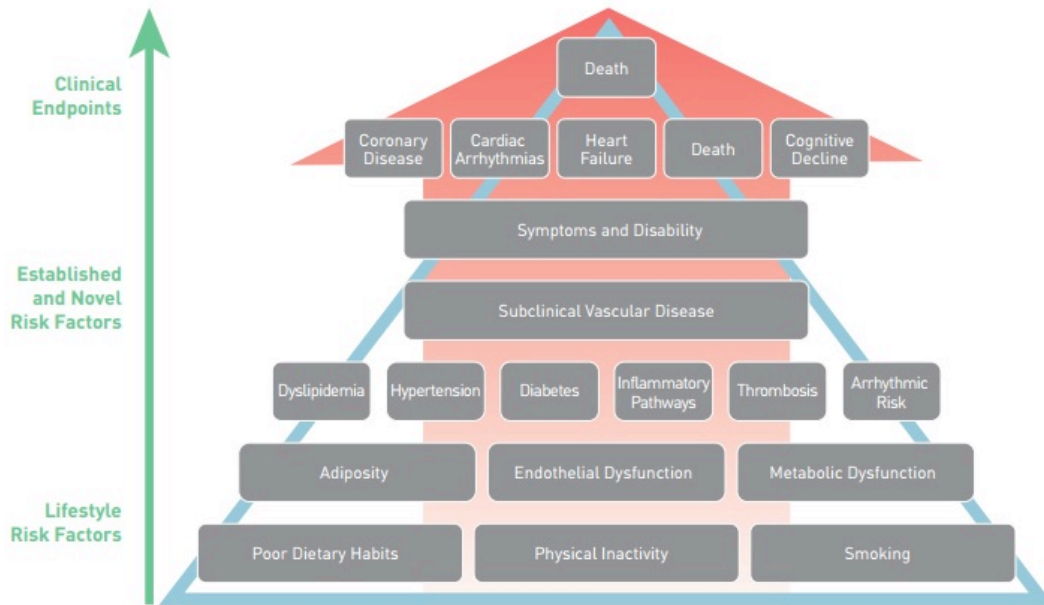


Figure 1: CVD Mortality Pathway – from lifestyle factors to health outcomes [Mozaffarian et al. (2008)]

Coffee consumption and cardiovascular disease risk

A number of meta-analyses have reviewed the associations between coffee consumption and cardiovascular disease (CVD) overall, with many concluding that there is no association between coffee drinking and an increased risk of CVD¹⁻⁶. Some studies have suggested that the association can be illustrated with a ‘U-shaped curve’ with the greatest protection seen at a moderate intake of coffee (3-5 cups per day). The lowest CVD mortality risk is seen at an intake of approximately 3 cups of coffee per day, with a percentage risk reduction of up to 21%⁵⁻⁶.

- A 2012 systematic review and a dose-response meta-analysis of prospective studies observed a statistically significant J-shaped relationship between coffee and heart failure. Compared to those who did not drink coffee, the strongest inverse association was seen at 4 cups per day, with a potentially higher risk reported at higher levels of consumption. There was no indication that the relationship between coffee and heart failure risk varied by sex or by baseline history of myocardial infarction or diabetes¹.
- A 2013 review on coffee consumption and mortality, with over a million participants, suggested a significant inverse association between coffee consumption and CVD mortality risk, especially in women. Intakes of coffee at 3-5 cups per day showed the most significant protective effect, whilst quantities over 5 cups per day were associated with a smaller reduction in total mortality².
- However, a 2013 large American cohort study of over 2,500 CVD deaths suggested a positive association between coffee consumption and all-cause mortality in men, and also in men and women below 55 years of age. The authors advised that

younger people should avoid heavy coffee consumption, cautioning that the finding should be assessed in other populations³.

- A 2013 meta-analysis of well-controlled prospective studies suggested that coffee consumption was not associated with risk of coronary heart disease, weakly associated with a lower risk of stroke and heart failure, and not associated with a higher risk of fatal cardiovascular events. Overall, the authors concluded that for most healthy people, moderate coffee consumption is unlikely to adversely affect cardiovascular health⁴.
- Two 2014 meta-analyses suggest an association between coffee consumption and CVD risk, proposing a 'U-shaped' pattern whereby optimal protective effects were achieved with 3-5 cups of coffee per day. According to these two studies, the greatest risk reduction may be seen at 3 cups of coffee per day, with a reduced CVD mortality risk at 21%^{5,6}.

Summary table of meta-analyses

AUTHOR	INCLUDED STUDIES	RESULTS
Mostofsky E. et al. (2012) Habitual coffee consumption and risk of heart failure: a dose-response meta-analysis	Five independent prospective studies of coffee consumption and heart failure risk, including 6,522 heart failure events and 140,220 participants	Moderate coffee consumption is inversely associated with risk of heart failure, with the largest inverse association observed for consumption of 4 servings per day.
Malerba S. et al. (2013) A meta-analysis of prospective studies of coffee consumption and mortality for all causes, cancers and cardiovascular disease	Seventeen prospective studies (smoking adjusted)	Combined risk reductions (RRs) for CVD mortality were 0.89 for the highest versus low drinking and 0.98 for the increment of 1 cup/day. Compared with low drinking, RRs for the highest consumption of coffee were 0.95 for CHD/IHD, 0.95 for stroke.
Liu J. et al. (2013) Association of Coffee Consumption with All-Cause and Cardiovascular Disease Mortality	43,727 participants with 699,632 person-years of follow-up (Aerobics Center Longitudinal Study)	A positive association between coffee consumption and all-cause mortality was observed in men and in men and women younger than 55 years.
Rebello S.A. & van Dam R.M. (2013) Coffee Consumption and Cardiovascular Health: Getting to the Heart of the Matter	Review of eight meta-analyses providing data on 99 studies with >1.6million adult participants	Coffee consumption was not associated with risk of CHD and weakly associated with a lower risk of stroke and heart failure. Evidence largely suggests that coffee-consumption is not associated with a higher risk of fatal cardiovascular events. In randomized trials coffee-consumption resulted in small increases in blood pressure. Unfiltered coffee increased circulating LDL cholesterol and triglycerides concentrations, but filtered coffee had no substantial effects on blood lipids.
Ding M. et al. (2013) Long-Term Coffee Consumption and Risk of Cardiovascular Disease: A Systematic Review and a Dose-Response Meta-Analysis of Prospective Cohort Studies	Thirty-six studies included with 1,279,804 participants and 36,352 CVD cases	Compared with the lowest category of coffee consumption [median: 0 cups/d], the RR of CVD was 0.95 for the highest [median: 5 cups/day] category, 0.85 for the second highest [median: 3.5 cups/day], and 0.89 for the third highest category [median: 1.5 cups/day]. Coffee consumption was non-linearly associated with both CHD and stroke risks.
Crippa A. et al. (2014) Coffee Consumption and Mortality from All Causes, Cardiovascular Disease, and Cancer: A Dose-Response Meta-Analysis	Twenty-one prospective studies, with 121,915 deaths and 997,464 participants	Strong evidence of nonlinear associations between coffee consumption and mortality for all causes and CVD. The largest risk reductions were observed for 4 cups/day for all-cause mortality and 3 cups/day for CVD mortality.

Coffee consumption and coronary heart disease risk

The majority of studies on coffee and coronary heart disease (CHD) found no association between coffee consumption and coronary heart disease. However, there is considerable variation between the studies, for both statistically significant inverse and positive associations. Some studies observed statistically significant inverse associations, particularly for women^{7,8}. A U-shaped association has also been reported⁹.

Meta-analyses have suggested there is either no association between CHD and coffee intake; or a potential protective effect:

- A 2009 meta-analysis of 21 prospective cohort studies on coffee consumption and coronary heart disease showed variation between the results of the individual cohort studies, with two studies reporting a positive correlation, and two a negative correlation both for the group who drank 4-6 cups of coffee per day and for those who drank more than 6 cups per day⁷. However, the overall evaluation did not show a statistically significant association between coffee drinking and long-term risk of coronary heart disease. In addition, habitual moderate coffee consumption was associated with a lower risk in women.
- A meta-analysis published in 2013 suggested a small protective effect (5% risk reduction) of coffee consumption on CHD².
- A 2014 meta-analysis of 36 studies with 1,279,804 participants and 36,352 CVD cases concluded that coffee consumption was associated with small reduction in CHD risk. The authors suggested an 11% risk reduction at lower coffee intakes (1.5 cups per day) and a 7% risk reduction at higher coffee intakes (5 cups per day)⁵.

A number of studies have considered coffee and coronary heart disease, also suggesting overall that there is no association with CHD, and indeed in some cases a protective benefit was observed at moderate coffee intakes:

- A Japanese study followed 37,742 participants over 10 years, with 426 deaths from cardiovascular disease and 2,454 deaths from all causes. The study observed statistically significant inverse associations between coffee consumption and both mortality from all causes as well as mortality from coronary heart disease in women. In men, no association with coronary heart disease was seen⁸.
- A Dutch study followed 37,514 participants over 13 years with 1,387 cases of coronary heart disease. For coffee consumption, a U-shaped association with slightly reduced risk for coronary heart disease was observed, with the lowest risk in the group seen at 2-3 cups per day⁹.
- A Swedish study assessed 37,315 male participants over 9 years with 784 cases of heart failure. In this study, coffee consumption was not associated with incidence of heart failure, including those consuming more than 5 cups per day¹¹.
- A further Swedish study, using case-control instead of the prospective cohort design and smaller in size (375 cases of first myocardial infarction), observed a statistically significant positive association but only for filtered coffee in men. In women, no association reached statistical significance¹².

Coffee consumption and risk of stroke

Most of the studies reviewing the association between coffee consumption and stroke have suggested that drinking coffee is associated with a reduced stroke risk^{13-15,18,19}, although some have shown contradictory results^{8,16,17}. Of the factors associated with an

increased risk of stroke, smoking is considered to be one of the most significant, therefore many studies consider smoking status alongside coffee consumption.

Meta-analyses have considered the associations between coffee consumption and stroke with similar results.

- Data from a 2011 meta-analysis of 11 prospective studies, with 10,003 cases of stroke and 479,689 participants, concluded that moderate coffee consumption may be weakly inversely associated with risk of stroke. Compared with no coffee consumption, consumption of 2 cups of coffee per day was associated with a 14% reduction and 3 cups per day with a 17% reduction in risk of stroke. The reduction in risk was reduced at higher intakes of coffee¹³.
- A further meta-analysis of 9 cohort studies published in 2012 concluded that coffee consumption of 4 cups or more per day showed a preventive effect on stroke. In the European subgroup, increased coffee drinking showed an 18% reduction in risk of stroke¹⁴.

A number of studies have considered coffee consumption and the incidence of stroke, concluding that there is no indication of an association and some suggestion of a protective effect:

- A large prospective cohort study from the US Nurses' Health Study of 83,076 female participants, followed over 24 years with 2,280 cases of stroke, observed a significant inverse association for coffee consumption and incidence of stroke. This association was even stronger in the subgroup of past and non-smokers. The authors concluded that coffee consumption may modestly reduce the risk of stroke in women¹⁵.
- 2 further studies, one prospective cohort study from Japan⁸, and a case-cohort study from the Netherlands¹⁶, included male and female participants. Both studies were smaller in total number of participants, number of years of follow up, and number of cases. Neither of these studies observed any association between coffee consumption and stroke.
- In a study on thromboembolism in women with 37,393 participants, followed over 19 years with 1,950 incident cases, no statistically significant association with coffee was seen¹⁷.
- A further study in 33,994 adults, where daily coffee consumption ranged from 0 to 20 cups, concluded that heavier daily coffee consumption is associated with decreased stroke prevalence, despite a smoking tendency in heavy coffee drinkers. Interestingly, heart failure, diabetes, and hypertension were less frequent, and high cholesterol more frequent in those consuming more than 3 cups of coffee per day¹⁸.
- A Japanese study of 82,369 Japanese adults aged 45-74 years without cardiovascular disease also concluded that coffee consumption was associated with an inverse risk of CVD and cerebral infarction¹⁹.

Caffeine consumption from coffee and atrial fibrillation

Atrial fibrillation (AF) is the most common cardiac arrhythmia and involves the two upper chambers (atria) of the heart. People with atrial fibrillation usually have a significantly increased risk of stroke.

To date, research has not demonstrated an association between coffee consumption and risk of atrial fibrillation, although some studies have suggested that coffee consumption may have a protective effect²⁰⁻²³:

- A meta-analysis with 228,465 participants concluded that caffeine exposure was weakly associated with a reduced risk of AF. A dose response analysis suggested that the incidence of AF decreased by 6% for every 300 mg per day increment in habitual caffeine intake. The authors concluded that it is unlikely that caffeine consumption causes or contributes to AF and that habitual caffeine consumption might reduce AF risk²⁰.
- 3 further meta-analyses have concluded that caffeine consumption is not associated with an increased risk of atrial fibrillation, and may have a protective effect²¹⁻²³.
- A prospective cohort study evaluated the effect of caffeine consumption on atrial fibrillation in women. The participant population, 33,638 women from the Women's Health Study, had an average follow up of 14.4 years and in this period there were 945 cases of incident atrial fibrillation. In this study, caffeine consumption was not associated with an increased risk of incident atrial fibrillation. In this population, on average 81% of the caffeine came from coffee²⁴.
- An earlier prospective study among 47,949 participants in Denmark looked at the association between daily caffeine consumption from coffee, tea, cola, cocoa and chocolate, and increased risk of atrial fibrillation. Over the 6-year follow up period, 373 men and 182 women developed atrial fibrillation or flutter. The authors found no association between caffeine consumption and risk of atrial fibrillation. The main source of caffeine in this study was coffee²⁵.

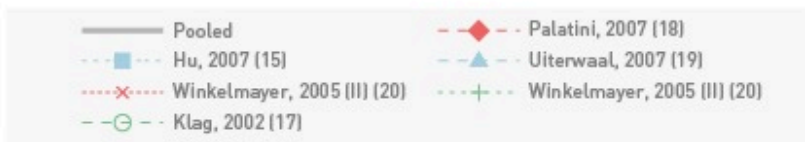
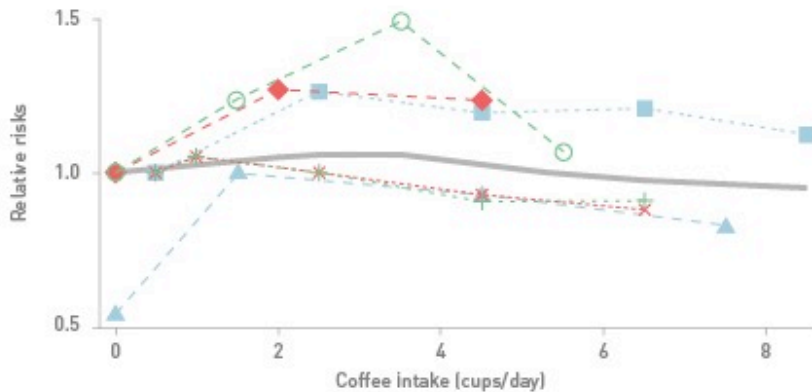
Coffee consumption and blood pressure

Although the precise nature of the relationship between coffee and blood pressure is still unclear, overall the research to date suggests that regular intake of caffeinated coffee does not increase the risk of hypertension.

A 2008 review concluded that data from cross-sectional studies suggest an inverse linear or U-shaped association between habitual coffee intake and blood pressure in different populations²⁶. The authors suggested that prospective studies showed a protective effect of coffee intake (4 or more cups per day) against hypertension, mainly in women. The study stated that further investigation was needed to discover whether abstainers are at a lower or higher risk of hypertension than occasional coffee drinkers (1–2 cups per day). The same study also found that randomised controlled trials, which are mostly of short

duration (1-12 weeks), suggest that coffee intake of around 5 cups per day may cause a small elevation in blood pressure (1-2mmHg) when compared to abstinence or use of decaffeinated coffee.

Dose-response meta-analysis



Dose-response meta-analysis of cohort study results of coffee consumption and hypertension risk (shown by first author and year of publication). The pooled dose-response curve (thick solid line) was obtained by a quadratic model by using generalized least squares for trend estimation in a random-effects model.

Source: Zhang Z. et al. (2011)
Habitual coffee consumption and risk of hypertension: a systematic review and meta-analysis of prospective observational studies.

- A 2011 review of 5 trials concluded that the administration of 200-300mg caffeine produced a mean increase of 8.1mmHg in systolic blood pressure (BP) and of 5.7mmHg in diastolic BP. The increase in BP was observed in the first hour after caffeine intake and lasted for 3 hours. However, in studies over a 2 week period, no increase in BP was observed after coffee consumption. The authors concluded that in hypertensive individuals, caffeine intake can produce a short-term acute increase in BP. Current research does not support an association between longer-term coffee consumption and increased BP, or between habitual coffee consumption and an increased risk of CVD in hypertensive subjects²⁷.
- A dose-response meta-analysis of 172,567 participants and 37,135 incident hypertension cases showed an inverse J-shaped curve, with hypertension risk increasing up to 3 cups per day and decreasing with higher intakes. The results suggest that habitual coffee consumption of >3 cups per day was not associated with an increased risk of hypertension compared with <1 cup per day; however, a slightly

elevated risk appeared to be associated with light-to-moderate consumption of 1 to 3 cups per day²⁸.

- A large prospective study concluded that neither caffeinated coffee nor caffeine intake was associated with mean systolic or diastolic blood pressure, but decaffeinated coffee intake was associated with a small but clinically irrelevant decrease in mean diastolic blood pressure. Intakes of caffeinated coffee, decaffeinated coffee, and caffeine were not associated with the risk of incident hypertension. These findings suggest that caffeinated coffee, decaffeinated coffee, and caffeine are not risk factors for hypertension in postmenopausal women²⁹.
- A 2012 study considered the variability in the effect of caffeine intake on blood pressure, suggesting that compared with decaffeinated coffee, caffeinated coffee was associated with a significant increase in blood pressure. The authors suggested that the variability in the acute BP response to coffee may be partly explained by genetic polymorphisms of the adenosine A2A receptors and α 2-adrenergic receptors³⁰.

Coffee consumption and cholesterol

The diterpenes cafestol and, to a lesser extent, kahweol, both naturally present in coffee oil, can raise the serum levels of both total and LDL-cholesterol³¹. Whether these diterpenes permeate into brewed coffee, and to what extent, depends on the brewing method. For Scandinavian boiled coffee, cafètiere (plunger pot), Greek and Turkish coffee, these components can pass into the brew, whereas they are largely retained in the paper filter in filtered coffee. Soluble coffee contains hardly any of these diterpenes. Espresso coffee contains approximately half the amount of diterpenes of unfiltered coffee; however, as it is served in small quantities, a moderate consumption of espresso coffee can be expected to have negligible effect on serum cholesterol levels. The effects on cholesterol levels are transient³¹.

- A 2001 meta-analysis of randomised clinical trials concluded that trials using filtered coffee demonstrated very little increase, if any, in serum cholesterol levels³².
- A cross-sectional study from Norway evaluated total cholesterol levels in Sami and Norwegian populations. Information on coffee consumption in this study was collected by self-administered questionnaires. There were 5,647 male and 6,347 female participants. Statistically significant associations were seen for total coffee in men and women, and for unfiltered coffee only in Norwegian men. The lack of an association for unfiltered coffee in the other subgroups might be due to a result by chance, due to the small number of participants³³.
- A 2013 review concluded that unfiltered coffee increased circulating LDL cholesterol and triglyceride concentrations, but filtered coffee had no substantial effects on blood lipids⁴.
- However, a 2013 study of both light and medium roast coffee concluded that paper-filtered coffee increased cholesterol in healthy volunteers³⁴.

- A 2015 study of Italian-style coffee such as espresso concluded that the consumption of over 2 cups per day was not associated with plasma lipid changes³⁵.

Coffee consumption and flow-mediated dilation

Only a small number of studies have considered the impact of coffee and caffeine consumption on flow mediated dilation, with variable results. Clearly, more and larger tests are needed to establish the true nature and implications of this short-term vasoconstrictor effect in the brachial artery.

- In two small experiments, with 15 and 20 participants respectively, researchers tested for effects of decaffeinated and caffeinated espresso coffee on the flow-mediated dilation in the brachial artery^{36,37}. They tested for a very short-term effect, up to 60 minutes after consumption. They observed a 22% reduction of the flow-mediated dilation after consumption of a cup of caffeinated espresso. After the decaffeinated espresso, there was indication of an opposite effect, but this did not reach statistical significance.
- A further small study published in 2016 compared flow-mediated dilation in caffeine consumers to caffeine abstainers, concluding that after 8 weeks no significant difference on flow mediated dilation between the groups was observed³⁸.

Coffee consumption and blood homocysteine

Homocysteine and cardiovascular disease risk

Homocysteine is a naturally occurring amino acid found in the blood and tissues. However, it is not among the twenty amino acids that are the building blocks of proteins, and hence is not found in dietary protein. Several factors influence plasma homocysteine levels, such as intake of folic acid and vitamin B12, age, gender, heredity, smoking, hypertension, and physical activity³⁹.

It was first suggested back in 1999 that elevated levels of homocysteine in the blood are associated with a higher risk of cardiovascular disease⁴⁰. However, not all studies have been able to demonstrate this association^{41,42}. It is still unclear whether reducing high homocysteine levels will lead to a lower risk of cardiovascular disease. In addition, no causal relationship has been established between high total plasma homocysteine levels (tHCYs) and cardiovascular disease⁴³.

Coffee, caffeine and homocysteine

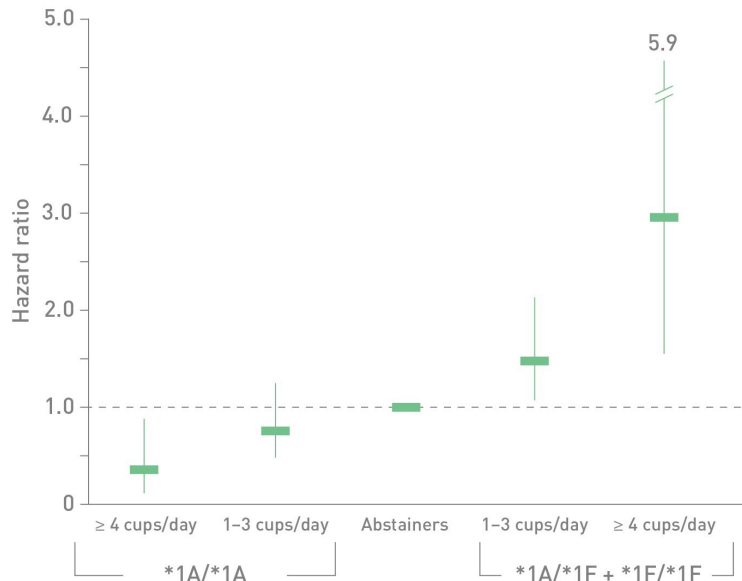
Intervention studies have shown that high levels of coffee consumption (6 to 10 cups of coffee per day) increase tHCYs^{44,45}, and tHCYs decrease if regular coffee consumers stop

drinking coffee⁴⁶. However, a study based on 5 cups of espresso a day did not show a significant effect on tHCYs, possibly because of the smaller volume consumed⁴⁷. It has been suggested that caffeine may be partly responsible for the effect of coffee on tHCYs⁴⁸, but the presence of chlorogenic acid in coffee can also contribute to the effect on homocysteine⁴⁹.

Patient studies

The previously-mentioned epidemiological studies on coffee/caffeine consumption and various heart effects were conducted with healthy participants. Additionally, there have been an increasing number of studies that start with patients having a specific disease, such as diabetes, myocardial infarction, or hypertension^{27,50,51}. Effects in diseased people can be different from effects in healthy people. These observations deserve further exploration, and may explain some of the variation in results mentioned above in the epidemiological studies.

Adjusted associations between CYP1A2 genotype and incident hypertension



Adjusted associations between CYP1A2 genotype (homozygous for the fast CYP1A2 *1A allele versus carriers of the slow *1F allele) and incident hypertension in 553 HARVEST participants. All hazard ratios are from multivariable Cox regression and represent risk of hypertension needing antihypertensive treatment for coffee drinkers versus abstainers (reference)*. *Adjusted for sex, age, BMI, family history for hypertension, duration off hypertension, physical activity, smoking status, alcohol consumption, and baseline blood pressure.

Source: Palatini P. et al. (2009)
CYP1A2 genotype modifies the association between coffee intake and the risk of hypertension.

- In the Health Professionals Follow-up Study, results from 3,497 diabetic men indicated that regular coffee consumption is not associated with increased risk of cardiovascular disease or mortality⁵⁰.
- In a Swedish cohort, coffee consumption and mortality after a first acute myocardial infarction was evaluated (1,369 participants and 289 subsequent cases). Coffee consumption at the time of hospitalisation for the first myocardial infarction was inversely associated with subsequent post-infarction mortality⁵¹.
- In a small Italian prospective cohort, 553 stage-1 hypertensives were followed up for 8 years, with 323 developing hypertension. Patients with genetic differences, in particular different P450-1A2 genotypes, showed a different risk of hypertension

associated with coffee consumption. The slow metabolizers (carriers of the slow *1F allele) showed a risk associated with coffee, whereas this was not the case in the fast metabolizers⁵².

- A 2016 study of 715 hypertensive participants suggested that those consuming ≥ 3 cups of coffee per day showed higher 24-hour systolic blood pressure (BP) than non-coffee drinkers. The association was similar among individuals who were smokers, had excess weight, low adherence to the Mediterranean diet, or hypercholesterolemia. In conclusion, habitual coffee consumption was associated with uncontrolled BP in a hypertensive older population⁵³.
- A study evaluated the association between long-term coffee consumption and 10-year cardiovascular disease incidence among Acute Coronary Syndrome (ACS) patients, suggesting that 1-2 cups of coffee per day versus no consumption had an adverse effect on the ACS incidence. The authors concluded that avoidance of coffee may be beneficial in those with Acute Coronary Syndrome⁵⁴.
- A dose response meta-analysis in patients who had suffered acute myocardial infarction concluded that drinking coffee habitually following AMI was associated with a reduced risk of mortality⁵⁵.

In addition, there are also a number of trials and cross-sectional studies of coffee and caffeine intake:

- A small Greek cross-sectional study within a group of 374 patients, who had suffered an acute coronary syndrome, compared the subgroups who did and did not develop left ventricular systolic dysfunction. They observed that in normotensive patients, coffee consumption at all levels was associated with a substantially lower risk of developing left ventricular systolic dysfunction, whereas in hypertensive patients, the risk increased in the group consuming 3 or more cups per day⁵⁶. It is, however, not clear whether the association in hypertensives reached statistical significance.
- A UK randomised trial tested heart rate variability in myocardial infarction patients after they consumed either caffeinated or decaffeinated coffee for 5 days. Coffee consumption was not associated with an adverse cardiovascular outcome in the short term⁵⁷.
- A small Swiss trial (15 patients with coronary heart disease and 15 age-matched controls) tested for myocardial blood flow response during physical exercise before and after 200mg of oral caffeine. They observed reduced myocardial blood flow in the caffeine/exercise groups, the strongest in the patient group. No change was seen for both groups in the caffeine/resting situation⁵⁸.
- A small trial comparing patients with and without coronary artery disease concluded that acute caffeine ingestion significantly improved endothelial function in both groups and was associated with lower plasma markers of inflammation⁵⁹.

Results of patient studies should be interpreted with caution. Because of the inherent difficulty in recruiting diseased participants, these studies tend to have relatively small

numbers of participants. Also, the (ongoing) treatment of the patient can interfere with the study/trial. Therefore, results in patients and in healthy people can differ.

Mechanisms – beyond caffeine

In the past, it was thought that any effect of coffee on the cardiovascular system was likely to be due to caffeine. Many studies therefore only tested for the effect of caffeine. However, consideration should be given to other factors, such as polyphenols, as well as the potential effect on circulating cholesterol levels.

Cholesterol

The coffee components responsible for increasing cholesterol are cafestol and kahweol³¹. These are naturally-occurring compounds found in coffee oil. Whether these compounds permeate in the brew and to what extent depends on the brewing method.

Filtered coffee and soluble coffee contain hardly any cafestol or kahweol and have virtually no effect on the cholesterol levels⁴. Moderate consumption of espresso also has a negligible effect, as levels of cholesterol-raising compounds are approximately half that of unfiltered coffee and serving sizes are small³⁵. However, Scandinavian boiled coffee, Cafetière (plunger pot), Greek and Turkish coffee contain cafestol and kahweol in higher amounts^{4,31-35}. Consuming substantial amounts of these types of coffees can raise serum cholesterol levels^{4,31-35}. The effects on the cholesterol level are transient after the cessation of consumption^{4,31-35}.

Polyphenols

The antioxidant potential of different foods and beverages also provide further insight into potential mechanisms. Different antioxidant compounds found in coffee may affect the body. Research published in 2016 concluded that coffee consumption increases the antioxidant capacity of plasma and the overall effect of this on the body could be interesting³⁸, but there is a need for further research on the bioactive and potential health-related roles of these compounds before conclusions can be drawn⁶⁵.

The effect of habitual coffee consumption on blood pressure is smaller than expected from tests with challenging caffeine doses. One study tested the effect of caffeine capsules versus placebo on blood pressure⁶⁰. There is ample scientific research to show that volunteers who abstain from, or are used to a low caffeine level, show a short-term increase in blood pressure when challenged with a high caffeine dose⁶⁰. The size of the blood pressure effect of these caffeine doses is clearly larger, e.g. 4mm systolic in this study, than the effect of coffee containing similar amounts of caffeine e.g. 1-2mm systolic⁶⁰. This indicates that in habitual coffee consumption, more factors are involved than just caffeine, and some of them seem to have opposing effects.

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