REVIEW

Is there any evidence that tea drinking impacts on cardiovascular health in the UK?

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Abstract

Epidemiological studies in the Netherlands first demonstrated an inverse relationship between ordinary (technically known as black) tea drinking and cardiovascular disease (CVD) mortality. Subsequent population-based studies have variously agreed with, been opposite to (notably in the UK) or produced null results. Currently, UK epidemiological studies look out of step with the rest of the world. This review highlights that, in the UK, tea drinking is more pronounced in the lower socio-economic (SE) groups, whilst tea drinking is associated with higher SE groups in the other countries that have linked tea to CVD. It is this key difference that may account for the apparent positive relationship between tea drinking and CVD mortality in the UK; low SE status (and high tea drinking) is also strongly associated with a high prevalence of the major CVD risk factors.

Any positive benefits from tea drinking are likely to be due to a high content of antioxidant flavonoids, particularly the catechins. *In vitro* and intervention studies support mechanisms, such as improved endothelial function, whereby tea flavonoids may be cardioprotective.

Whilst there is no evidence from population studies of positive cardiovascular benefit from tea drinking in the UK, tea is still contributing flavonoids to individual diets and these may well be beneficial. Tea drinking can safely be encouraged as part of a healthy diet. Further studies are required to clarify the situation.

Key words: black tea, cardiovascular risk, coronary heart disease, vascular function, endothelium.

Harvesting tea leaves in Sri Lanka. Evidence is equivocal whether tea flavonoids confer cardioprotective effects
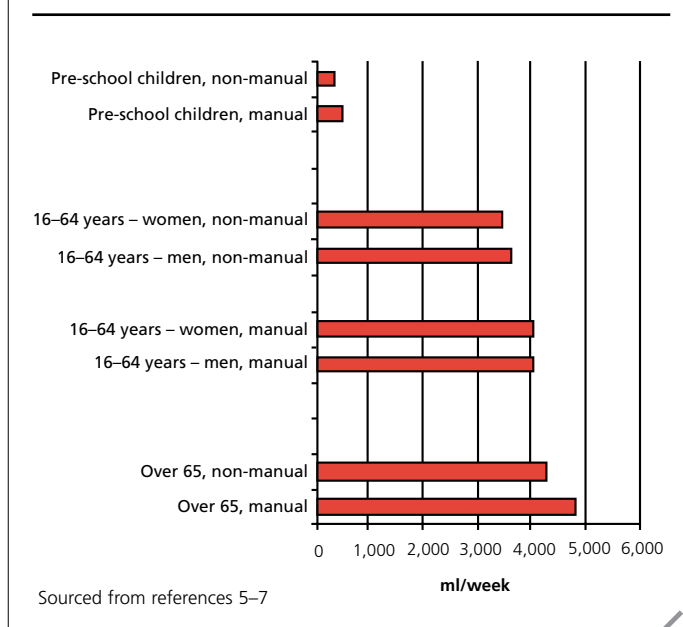
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Introduction

Dietary factors may both reduce and contribute to cardiovascular disease (CVD) risk in a number of ways. Antioxidants, such as vitamins C, E and a range of other plant compounds such as the flavonoids,[1] are considered beneficial. Hertog and colleagues published one of the first observational studies suggesting that ordinary (black) tea may have a protective effect on cardiovascular health.[2] This prospective study followed an elderly Dutch cohort of 939 men for five years and found that those with an intake of flavonoids in the top third and those drinking more than 2.5 cups of tea per day (the major source of flavonoids) had a significantly lower relative risk of CVD mortality than those in the bottom third or non-tea drinkers, respectively. A typical cup of tea contains around 140 mg total flavonoids, of which 10 mg are catechins, 15 mg theaflavins and the rest are mainly complex thearubigins.[3] The tea drunk in the Netherlands tends to be the same type as in the UK, but it is generally taken weaker and without milk. In Europe, only 2–12% of the population drink tea, compared with around 70% in the UK, where an average daily intake is about 2.5 servings.[4]

In most developed countries, other than the UK, tea drinking tends to be more common in the higher socio-economic groups. Whilst this mirrors the early tea drinking pattern in the UK when tea was a luxury item, it is in sharp contrast to UK tea

Table 1. Overview of intervention studies on tea and vascular function

Reference	Duffy et al.[23]	Hodgson et al.[26]	Takenami et al.[27]
Country	USA	Australia	Japan
Population	66 CAD patients, men + women	22 healthy men + post-menopausal women	10 healthy men and women
Design	Crossover design	Crossover design, analysed as parallel design	Crossover, placebo-controlled
	Acute effect of single dose **Long-term** (4 wk) effect	**Long-term** study (4 wk)	**Acute** effect of single dose
Intervention	**Short-term** study: single dose of black tea (4.4 g black tea leaf) **Long-term** study: black tea (8.7 g/d black tea leaf)	Black tea made from 10 g black tea leaf	**Short-term** study: single dose of black tea (500 mls) accompanied by a high fat meal (79% energy)
			Control – same meal with water placebo
Method	FMD measurement	FMD measurement	FMD measurement Serum triglyceride
Results	**Short-term:** significant increase in FMD from 6.0 to 9.4% **Long-term:** significant increase in FMD from 6.0 to 9.5% **Short-on-long-term** tea intake increased the FMD response from 6.0 to 10.8%	FMD increased from 5.1 to 7.2% in tea group. Significant 2.1% increase compared to water group	Black tea with the high fat meal restored the endothelial dysfunction caused by that meal

Key: CAD = coronary artery disease; wk = week; FMD = flow-mediated dilation

relate directly to CV outcomes in observational population studies.

To summarise this section, internationally, the epidemiological evidence for a beneficial effect of tea drinking *per se* on CVD is only weak. The reported national differences in the relationship between tea and CV mortality are strongly influenced by different social patterns of consumption. If plausible mechanisms are confirmed that flavonoids in tea can influence the aetiology of CVD development and progression/regression (see below), then tea drinking along with fruits and vegetables could be contributing to CV benefit.

Possible mechanisms
Tea and CVD risk factors
Tea, under the right socio-lifestyle circumstances, could be a significant contributing dietary factor for reducing CV risk. Recent advances in the understanding of mechanisms underlying atherosclerosis are consistent with a potential role for constituents in tea to promote heart health. This has prompted a number of different lines of research including examination of potential effects of tea on blood pressure,[14] platelet aggregation,[15] blood cholesterol,[16] plasma homocysteine concentrations[17] and *ex vivo* low density lipoprotein (LDL) oxidation.[18] In all, 45 human studies (including epidemiological and intervention studies) have been published, which indicates the growing level of interest in this area. To date, tea's effects on blood pressure, cholesterol, LDL oxidation, homocysteine and platelet

aggregation appear inconsistent, at least partly due to the mixed quality of the studies. The evidence base looks more promising for blood cholesterol because the two studies that demonstrated beneficial effects were well controlled,[19,20] relative to those studies that did not.[15,21-23]

Tea and endothelial function
It is now generally accepted that endothelial dysfunction plays a role in the early development of atherosclerosis.[24,25] Some interesting data are emerging on the potential for tea to effect vascular function mediated through the endothelium. Table 1 gives examples of three individual studies in this area.

Rupture of atherosclerotic plaques results in platelet activation, which leads to formation of a thrombus and potentially to MI or stroke. Soluble P-selectin is one of a family of adhesion molecules, released by platelets, and is considered to be a marker of platelet activation. Hodgson et al.[15] found a 15% decrease in soluble P-selectin following daily ingestion of 5.5 cups of tea for four weeks in healthy subjects; other markers of blood flow were not influenced in this crossover study. Two additional studies investigating the effect of tea on platelet activity did not demonstrate beneficial effects on any other markers of platelet function.[28,29]

The assessment of flow-mediated dilation (FMD) of the brachial artery is currently widely used as a sophisticated and non-invasive method of determining changes in nitric oxide regulated vascular tone and thus endothelial function. Two

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Key messages

- International differences in the relationship between tea and cardiovascular disease are likely to be due to different social patterns in tea consumption

- *In vitro* and intervention studies support mechanisms, such as improved endothelial function, whereby tea (tea flavonoids) may be cardioprotective

- Tea is an important provider of fluids, but further studies are required to clarify any specific health benefits

- Tea drinking can safely be encouraged as part of a healthy diet

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studies have investigated the effects of tea consumption on FMD: one in patients with proven CVD[23] and the other in healthy subjects with mildly elevated serum cholesterol or triglyceride concentrations.[26] Both studies examined the effects of ingestion of usual levels of ordinary (black) tea and its short and longer-term effects using crossover designs. Hot water was the control beverage. Both studies reported that regular ingestion of ordinary tea improved brachial artery vasodilatation responses. The observed effects were quite consistent within each study and between studies and represented an improvement in FMD of approximately 41% (in normal subjects) and 56% (in patients with CVD). The latter represents a restoration of vessel reactivity to the levels found in healthy individuals. Another FMD study has been performed in Japan with similar positive outcomes.[27]

The precise mechanism by which tea improves endothelial function was not considered in either study, but tea flavonoids were suggested to:

- favourably affect tissue redox status
- improve endothelial-derived nitric oxide bioavailability through enhanced synthesis.

These studies have limitations since they were not fully blinded and either a placebo effect, or an effect of other dietary antioxidants or CVD medications, may have contributed to the results.

Overall, however, the evidence is beginning to suggest that some mechanistic pathways do exist whereby tea constituents can influence vascular health.

Conclusions

To summarise we can conclude that tea is a good source of dietary antioxidant flavonoids and their actions on endothelial function may help explain the cardioprotective effects of tea drinking that is observed in some countries.

In the UK, tea drinking is more strongly associated with the lower socio-economic groups that exhibit a higher prevalence of major CVD risk factors (smoking, hypertension, obesity and low levels of physical activity). Opposite trends exist in the other countries studied. This means International differences in the

relationships between tea drinking and CVD mortality are likely to be due to different social patterns of tea consumption and/or inadequate controlling for dietary intake of other antioxidant nutrients.

Tea drinking *per se*, may only be demonstrably cardioprotective when it is associated with an overall healthy lifestyle.

Conflict of interest

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