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Cardiovascular disease: benefits of Tea consumption

Neil K Agarwal[1], Prerna Sharma[2], Shashi K Agarwal[3]☼

1.Internal Medicine Resident, Hahnemann University Hospital, 230 North Broad Street, Philadelphia, PA 19102, USA
Phone: 848 228-6345
Email: neil.k.agarwal@gmail.com

2.5014 Summersky Court, Mississauga, ON L5M 0R3, Canada
Phone: 416 666 3875
E mail: prernasharma89@hotmail.com

3.Center for Contemporary and Complimentary Cardiology
62, Chester Circle, #2B, New Brunswick, NJ, USA
Phone: 732-895-3200 Fax: 732-253-0432
Email: usacardiologist@gmail.com

☼**Corresponding author:**
Center for Contemporary and Complimentary Cardiology
62, Chester Circle, #2B, New Brunswick, NJ, USA; Phone: 732-895-3200 Fax: 732-253-0432
Email: usacardiologist@gmail.com

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ABSTRACT

Cardiovascular disease is one of the leading causes of morbidity and mortality worldwide. Fruits and vegetables are known to be cardio-protective. The beneficial role of tea, brewed from the leaves of the evergreen plant, *Camellia sinensis*, has been the subject of increasing scientific investigation. Tea is abundant in beneficial bioactive compounds that exhibit anti-inflammatory, anti-oxidative, anti-platelet, anti-vasoconstriction and anti-proliferative effects. They help attenuate cardiovascular risk factors and reduce cardiovascular events and cardiovascular mortality. This article briefly reviews the evidence based studies confirming this inverse relationship between tea consumption and cardiovascular disease.

Keywords: Tea, Cardiovascular Diseases, Cardiovascular Mortality, Phytochemicals

Abbreviations: PMC: PubMed Central; CVD: cardiovascular disease; CVDs: cardiovascular diseases; WHO: World Health Organization; LDL: low density lipoprotein

1. INTRODUCTION

Tea is the second most widely consumed beverage in the world, after water (Weisburger, 1997) Conventional tea is a brew of leaves from the evergreen plant, *Camellia sinensis* (Martin, 2007). Tea is often described by how its processed. The most popular tea concoctions are green tea, which is non-oxidized, oolong tea which is partially oxidized and black tea, which is fully oxidized. White tea is wilted and un-oxidized, and is less commonly consumed. Tea originated in China (Harbowy et al, 1997; Guang, 2010) and spread to the UK, and from there, to the rest of the world.Today, the largest producers of tea in the world are China, India, Kenya and Sri Lanka (Wiki).It is estimated that tea consumption in the world is dominated by black tea (78%), followed by green tea (20%) and a small quantity of oolong tea (2%) (Khan et al, 2007). Black tea is popular in the West and several Asian countries; green tea is popular in Asia and the Middle East while oolong tea is mainly consumed in South China. Herbal tea is usually referred to infusions of fruits and herbs (for example rosehip, chamomile, or rooibos), without the conventional tea leavesand caffeine (Dictionary).

Tea was a medicinal beverage in early China.The therapeutic potential of tea has recently gained scientific attention (Chacko et al, 2010). It contains high concentrations of health beneficial polyphenolic compounds. (Balentine et al, 1997) These compounds have significant therapeutic effects in many chronic diseases, including cancer, osteopenia and osteoporosis, Alzheimer's and Parkinson's disease and rheumatoid arthritis. Tea has a preventive effect on carcinogenesis, positively impacting cancer initiation, promotion and progression (Yang et al,2002; Riboli et al, 2003; Kanwar et al, 2012; Mukhtar et al, 2000; Lambert et al, 2010). These benefits are seen in various cancers (Sasazuki et al, 2008; Dai et al, 2010; Larsson et al, 2005; Jian et al, 2004; Li et al, 2008). Tea consumption may also diminish the decline in cognitive function in the elderly and in patients with Alzheimer's disease and Parkinson's disease. (Nurk et al, 2009; Arab et al, 2011; Tan et al, 2003; Li et al, 2012; Rezai-Zadeh et al, 2005; Kuniyama et al, 2006). Tea may also improve bone mineral density (Hegarty et al, 2000; Shen et al, 2011)and help prevent rheumatoid arthritis (Mikuls et al, 2002). More recently, several epidemiological and scientific studies have demonstrated that tea consumption has an inverse relationship with cardiovascular disease events (Nakachi et al, 2000; De Koning et al, 2010; Arab et al, 2009; Hodgson et al, 2010). And color does not matter – white, green or black, all varieties of tea demonstrate these benefits (Thielecke and Boschmann, 2009; Satoh et al, 2005).

2. METHODS

A comprehensive literature search was performed using the PubMed and PMC database of the United States National Library of Medicine, National Institutes of Health, on 'tea and cardiovascular risk factors' and 'tea and cardiovascular diseases'. Additional studies were identified by searching bibliographies of reviews and were consulted, if relevant. Available scientific grey material was also reviewed.

3. RESULTS

'Tea and cardiovascular risk factors' revealed 258 citations on PubMed dating back to 1978 while 'tea and cardiovascular diseases' revealed 1439 citations dating back to 1948. 'Tea and cardiovascular risk factors' revealed 5571 full length articles on PMC while 'tea and cardiovascular diseases' revealed 7283 full length articles on PMC.

4. DISCUSSION

Cardiovascular diseases (CVDs) are responsible for over 17.5 million deaths in the world - representing 31% of all global deaths (WHO). A plant based diet has been recommended to reduce this scourge (Lichtenstein et al, 2006). A diet rich in fruits and vegetables helps reduce cardiovascular risk (Hertog et al, 1997; Shashi K. Agarwal, 2013a),coronary artery disease (Hertog et al, 1995),myocardial infarction (Hirvonen et al, 2001),stroke (Keli et al, 1996),and cardiovascular mortality (Hertog et al, 1993). Bioactive compounds in fruits and vegetables, such as polyphenols play an important role in providing these benefits (Boeing et al, 2012; Ginter et al, 2012).

The health beneficial bio-active ingredients in tea are also primarilypolyphenols (Graham et al, 1992). The major polyphenols found in tea are catechins and flavonols (Balentine et al, 1997). Catechins include epigallocatechin, epicatechin gallate, and epigallocatechin gallate and epicatechin. Epigallocatechin represents 50-75% of the total amount of catechins and is the most powerful bioactive polyphenol found in green tea. Catechins present in smaller amount include catechin gallate, gallocatechin, gallocatechingalllate, epigallocatechin digallate, methylepicatechin and methyl EGC. Flavanols in tea include quercetin, kaempferol, myricetin, and their glycosides (Graham, 1992). Catechins constitute about 80–90% and flavanols about 10% of the total flavonoids in green tea. On the other hand, theaflavins account for 50–60% and catechins only 20–30% of total flavonoids in black tea (Balentine et al, 1997)

The polyphenols in tea providepotent anti-oxidant, anti-inflammatory, anti-platelet, anti-vasoconstriction and anti-proliferative effects (Kris-Etherton et al, 2002; Higdon et al, 2003; Basu et al, 2007). LDL oxidation is critical for the development of atherosclerosis (Witztum et al, 1991) and its prevention helps retard atherosclerosis (Stocker et al, 2004). Tea and its extracts inhibit LDL oxidation (Nakagawal et al, 2002; Miura et al, 1994; Osada et al, 2001; Ishikawa et al, 1997).Inflammation also plays an important role in atherogensis (Libby, 2002). Tea has anti-inflammatory effects (Dona et al, 2003; De Bacquer et al, 2006; Neyestani et al, 2010)Platelet aggregation is intricately involved with acute ischemic cardiac episodes (Libby, 2002).Tea reduces platelet activation (Steptoe et al, 2007).Abnormalities of endothelial function, mainly controlled by nitric oxide, also plays a role in atherogenesis (Tabit et al, 2010). Tea consumption can reverse this endothelial dysfunction (Duffy et al, 2001; Hodgson et al, 2002' Alexopoulos et al, 2008; Kim et al, 2006; Jochmann et al, 2008) and reduce arterial stiffness (Li et al, 2014). These beneficial changes help reduce cardiovascular risk factors, cardiovascular diseases and cardiovascular mortality.

4.1. Cardiovascular Risk Factors

Cardiovascular risk factors positively modulated by tea consumption include blood pressure, diabetes mellitus, dyslipidemia, metabolic syndrome, obesity and stress, anxiety and depression.

Hypertension is the most prevalent controllable risk factor for CVDs (Kearney et al, 2005). Even small reductions in blood pressure translate into significant reductions in cardiovascular morbidity and mortality (Black, 2004; Law et al, 2003; Pierdomenico et al, 2009; Bangalore et al, 2014). A large cohort study found that tea drinking120–599 ml/d, reduced the risk of hypertension by 46%, and in those who consumed 600 ml/d, the risk was reduced by 65%, when compared to non-habitual drinkers (Yang et al, 2004) Several studies have demonstrated a 2mm Hg – 5mm Hg reduction in systolic blood pressure with tea intake (Stensvold et al, 1992; Potenza et al, 2007; Nanty et al, 2009). An inverse relationship with diastolic pressure has also been noted in some studies (Hodgson et al, 2003; Brown et al, 2009; Tong et al, 3014). Recent metanalysis confirm the blood pressure lowering effects of both green and black tea (Khalesi et al, 2014) and black tea (Greyling et al, 2014).

Obesity is global epidemic (Caballero, 2007, Marie et al, 2014) and transmits a significant disease burden (Must et al, 1999) including cardiovascular diseases (Bray et al. 2004; Nakamura et al, 2014). Weight loss is associated with significant cardiovascular benefits (Goldstein, 1992, Lisa et al, 2009; Samuel et al, 2004; Klein et al, 2004; Scott et al, 2010.) Dietary choices often play an important role in reversing this major risk factor (Goran et al, 2012).Tea drinking has a beneficial effect on weight loss (Sae-tan et al., 2011)and has been documented in animal as well as human studies (Auvichayapat et al., 2008; Chantre et al, 2002). There is also a reduction in body fat associated with tea consumption (Nagao et al., 2005; Nagao et al., 2007; Hursel et al, 2011). Meta-analytical reviews have reached similar outcomes (Phung et al. (2010) There is a reduction in waist circumference (Wang et al, 2010). due to a reduction in abdominal and subcutaneous fat (Maki et al, 2009), due to an increase in thermogenesis (Dulloo et al, 2000). and fat oxidation induced by tea catechins (Venables et al, 2008). A decrease in waist to hip ratio has also been reported (Wu et al, 2003)

Diabetes mellitus is a powerful independent risk factor for cardiovascular disease (Ferrannini et al, 2012; Epstein, 1997; Mahler, 1990). It affected almost 9% of all the adults over 18 years in the world and its prevalence is growing (WHO, 2014; Mathers et al, 2006). Lifestyle interventions, specifically dietary prudence, are extremely helpful (Smolen et al, 2014). Tea drinking reduces the incidence of diabetes mellitus (Basu et al, 2011). Drinking 3-4 cups of tea per day may reduce the incidence of diabetes by about 30% (Huxley et al. (2009) (Song et al., 2005).In one study on Japanese adults aged 40-65 years, drinking more than 6 cups a day lowered the risk of diabetes by 33% (Iso et al., 2006). Recent studies have confirmed the diabetes preventing effects of green tea (Huang et al, 2013). Catechins in tea appear to reduce glucose and insulin levels resulting in the beneficial effect on diabetes (Sae-tan et al., 2011; Song et al., 2005). Inflammation is reduced in these patients (Neyestani et al, 2010). A recent European study revealed significant protective effects of tea drinking and the incidence of type 2 diabetes. There was a linear inverse association, and a 16% reduction in the risk of developing diabetes when compared to non-tea drinkers with 4 cups or more tea per day was noted (TIACX, 2012)Benefits are also noted in metabolic syndrome (Thielecke et al, 2009; Basu et al, 2010).

There is a close direct relationship between dyslipidemia and coronary heart disease risk (Stamler et al, 1986; Neaton et al, 1992) as such reduction is cardioprotective (Gotto et al, 2000; HPSCG, 2002). Tea has total cholesterol and LDL cholesterol lowering effects (Tsubono et al, 1997; Davies et al, 2003; Maron et al, 2003; Unno et al, 2005). Total serum cholesterol was reduced by 8 mg/dl with nine or more green tea cup consumption per day.(Kono et al, 1992). A reduction in LDL cholesterol with green tea has also been noted (Maron et al, 2003; Hooper et al, 2008). A reduction has also been seen with consumption of black tea (Stensvold et al, 1992). Besides total cholesterol, reductions have also been noted in LDL cholesterol (Davies et al, 2003). Tea extracts have demonstrated similar reductions (Fujita et al, 2008). Favorable effects on HDL levels are seen in patients with diabetes mellitus (Fenerciouglu et al, 2010).In mice studies, tea extract and gallic acid suppressed the normally noticed rise in blood triglycerides induced by consumption of a corn oil emulsion(Oi et al., 2012). In vivo studies have also shown the inhibition of LDL oxidation with green tea extract (Pearson et al, 1998).

Stress, anxiety, anger and depression result in an increase in the incidence and severity of cardiovascular diseases (Rozanski et al, 1999; Lichtman et al, 2008; Dimsdale et al, 2008.Treatment reduces future cardiovascular events in otherwise healthy individuals (Stewart et al, 2014) and following a cardiovascular event (Berkman et al, 2003; van Melle et al, 2007; Welton et al, 2009; Davidson et al, 2010).Tea contains L-theanine, theophylline, and bound caffeine which improves alertness and explains its popularity as a hot beverage in the morning. (Penelope et al, 2000). Afternoon tea, including High Tea and tea ceremonies exist in several cultures (Keenan, 1996; Shiah et al, 2013).Tea drinking is often the major beverage served during work breaks and at social gatherings (Lee, 1999). These rituals can help improve social bonding and reduce stress from the daily stressors of life (Donnelly, 2007).

4.2. Cardiovascular Diseases

Tea drinking has an inverse relationship with cardiovascular mortality (Kuriyama et al, 2006) and drinking tea reduces the risk of CVDs (Deka and Vita, 2011; Vita, 2003). As mentioned earlier, tea phytochemicals are responsible for most of these beneficial effects (Apranta et al, 2011). Tea drinking may also reflect a healthier lifestyle (Sesso et al, 1999) and the resultant beneficial impact on cardiovascular diseases.

Coronary artery disease is the leading cause of heart disease,(CDC, 2015; CT-STAT, 2011;Pinkstaff et al, 2011) and is a major killer globally. More than 95 percent of all coronary artery disease is due to atherosclerosis, an inflammatory disorder (Libby et al, 2002). Atherosclerosis can be prevented (Paoletti et al, 2004), and thus reduce major cardiovascular events (Gundy, 1997; Gundy, 1999; Peter, 2005).Tea helps prevent atherosclerosis (Sasazuki et al, 2000). An inverse relationship between tea consumption and myocardial infarction has been documented (Hirano et al, 2002, and drinking 3 cups of tea per day decreases the rate of myocardial infarction by 11% (Peters et al, 2001). Meta-analysis of observational studies and data from epidemiological studies suggest that 1 cup/d of green tea is associated with a 10% decrease in the risk of developing coronary artery disease (Wang et al, 2011, Bøhn et al., 2012).

Stroke is the second-leading global cause of death behind heart disease and a leading cause of disability (Heart.org2). Tea drinking reduces strokes (Wen et al, 2008), and this reduction may be 10%–20% (Bøhn et al, 2012). More studies are needed on the beneficial effects of tea on stroke.

4.3. Cardiovascular Mortality

Several large studies have demonstrated reductions in cardiovascular mortality with drinking tea (Nakachi et al., 2000; Sano et al., 2004; Yusuf et al., 2005). In an epidemiological survey of 76 979 Japanese individuals, drinking more than 6 cups of tea per day resulted in a reduced CVD mortality (Mineharu et al., 2011). A 13 year study from Netherlands involving 37,514 healthy adults again showed the mortality reducing benefits of drinking tea - in this case 3-6 cups of black tea (de KoningGans et al., 2010). When

compared to black tea, green tea appears to be more cardiovascular mortality protective (Mineharu et al, 2011). In a prospective cohort study, drinking 2 cups/day of green tea attained a reduction in CVD mortality (Kuriyama et al, 2006).

5. CONCLUSIONS

Cardiovascular disease and its related death and disability have the dubious distinction of reigning at the top of ill-health and mortality charts, all across the world. Although tremendous advances have been made in prevention, control and treatment of these diseases, the negative impact on the physical, emotional, social, and economic facets of human life remains significant. Tea consumption has repeatedly shown an inverse relationship with cardiovascular diseases. The benefits accrue primarily from the phytochemicals, especially catechins and flavonoids, abundantly present in the tea leaves. Drinking tea also yields many other benefits, including a reduction in certain cancers and improvement in cognitive function. Social interaction is improved. Tea is pleasant, popular, relatively cheap, easy to brew and safe. Drinking tea should be incorporated as a lifestyle in present day humans.

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CONFLICT OF INTEREST

None

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