Non-alcoholic beverage and caffeine consumption and mortality: The Leisure World Cohort Study

Annlia Paganini-Hilla, Claudia H. Kawas, María M. Corrada

Abstract

Objective. To examine the effects of non-alcoholic beverage and caffeine consumption on all-cause mortality in older adults.

Methods. The Leisure World Cohort Study is a prospective study of residents of a California retirement community. A baseline postal health survey included details on coffee, tea, milk, soft drink, and chocolate consumption. Participants were followed for 23 years (1981–2004). Risk ratios (RRs) of death were calculated using Cox regression for 8644 women and 4980 men (median age at entry, 74 years) and adjusted for age, gender, and multiple potential confounders.

Results. Caffeine consumption exhibited a U-shaped mortality curve. Moderate caffeine consumers had a significantly reduced risk of death (multivariable-adjusted RR=0.94, 95% CI: 0.89, 0.99 for 100–199 mg/day and RR=0.90, 95% CI: 0.85, 0.94 for 200–399 mg/day compared with those consuming <50 mg/day). Individuals who drank more than 1 can/week of artificially sweetened (but not sugar-sweetened) soft drink (cola and other) had an 8% increased risk (95% CI: 1.01–1.16). Neither milk nor tea had a significant effect on mortality after multivariable adjustment.

Conclusions. Moderate caffeine consumption appeared beneficial in reducing risk of death. Attenuation in the observed associations between mortality and intake of tea and milk with adjustment for potential confounders suggests that such consumption identifies those with other mortality-associated lifestyle and health risks. The increased death risk with consumption of artificially sweetened, but not sugar-sweetened, soft drinks suggests an effect of the sweetener rather than other components of the soft drinks, although residual confounding remains a possibility.

Keywords: Mortality; Longevity; Caffeine; Coffee; Tea; Milk; Carbonated beverages; Risk factors

Introduction

Coffee, tea, and soft drinks are the major sources of caffeine in the diets of US adults, with coffee being the primary and most potent source (Knight et al., 2004; Frary et al., 2005). In cohort studies of younger (<60 years old) adults, coffee has shown a reduced risk of death with moderate (1–4 cups/day) drinking (Woodward and Tunstall-Pedoe, 1999; Kleemola et al., 2000; Jazbec et al., 2003). However, studies in older adults and those including other sources of caffeine are limited.

Coffee and tea contain many different chemical compounds and no certainty exists as to which ones may be associated with disease risk. In addition to caffeine, coffee contains chlorogenic and caffeic acids that may have antioxidant properties (Kleemola et al., 2000). Likewise, tea contains antioxidant flavonoids (Mukamal et al., 2002). Antioxidants may reduce mortality by decreasing the incidence of cardiovascular disease (Steinberg and Witztum, 2002), cancer (van Poppel and van den Berg, 1997), and dementia (Deschamps et al., 2001).

In 1981 we undertook a prospective cohort study of nearly 14,000 elderly men and women with the aim of studying factors, especially modifiable lifestyle practices, associated with longevity and successful aging. We report here the results of non-alcoholic beverage consumption intake on all-cause mortality.
Methods

The Leisure World Cohort Study was established in the early 1980s when 13,978 (8877 female and 5101 male) residents of a California retirement community (Leisure World Laguna Hills) completed a postal health survey. The population and the cohort are mostly Caucasian, well-educated, and upper-middle class. The baseline health survey asked demographic information (birth date, sex, height, weight); brief medical history (high blood pressure, angina, heart attack, stroke, diabetes, rheumatoid arthritis, fractures after age 40, cancer, gallbladder surgery, glaucoma, cataract surgery); medication use (hypertensive medication, digitalis, nonprescription pain medication); personal habits (cigarette smoking, exercise, alcohol); food and beverage intake (chocolate, coffee, tea, milk, soft drinks).

Estimation of intake

Participants were asked “How many cups or glasses per DAY do you drink of the following—milk, decaffeinated coffee, coffee, black or green tea?” and “How many cans or glasses per WEEK do you drink of the following—cola beverages with sugar, other soft drinks with sugar, cola beverages artificially sweetened, other soft drinks artificially sweetened?” Response choices were none, less than 1, 1, 2–3, 4–5, and ≥ 6. Also asked was intake of “CHOCOLATE (milk chocolate, fudge, M&M’s, Tootsie Rolls, chocolate covered centers, chocolate topping, chocolate cake, chocolate pie, hot chocolate, chocolate milk?” Response choices were rarely or never, a few times per year, about monthly, a few times a month, a few times per week, daily, or almost daily.

We estimated the caffeine content (mg/standard unit) of each beverage category and chocolate as 115, 3, 50, 50, and 6 mg for regular coffee, decaffeinated coffee, tea, cola soft drinks, and chocolate, respectively (Brown et al., 2001). Daily cola soft drink intake was derived by dividing the weekly intake by 7. Total daily intake of caffeine was calculated by multiplying the servings/day of each beverage source by its estimated caffeine content and then summing for all sources.

Determination of outcome

Cohort members have been followed by periodic resurvey, review of local hospital discharge data, and determination of vital status by search of death indexes and ascertainment of death certificates. Participants were followed to death or December 31, 2004, whichever came first. Forty-two cohort members were lost to follow-up. Previous reports present details of data collection (Paganini-Hill et al., 1986, 1991, 1993; Paganini-Hill, 2001).

Statistical analysis

Age- and sex-adjusted risk ratios (RRs) and 95% confidence intervals (CIs) for each beverage, chocolate, and caffeine were obtained using Cox regression analysis (Cox, 1972). For these Cox models, chronological age was used as the fundamental time scale, age at death was the event of interest, and delayed entry was used with baseline age as the age of entry. To control for potential confounding factors previously found to be related to mortality in this cohort, we adjusted in the regression analyses for age at entry (continuous), sex, smoking (never, past, current), alcohol intake (0, ≤1, 2–3, and 4+ drinks/day), exercise (0, 1/4, 1/2, 3/4–1 3/4, 2+ hour/day), body mass index (<18.5 (underweight), 18.5–24.9 (normal), 25–29.9 (overweight), 30+ kg/m² (obese)), and seven separate histories (no, yes) of hypertension, angina, heart attack, stroke, diabetes, rheumatoid arthritis, and cancer. Statistical analyses were performed using SAS® version 9.1 (SAS Institute Inc., Cary, NC). No adjustment in the p-values was made for multiple comparisons.

Several additional analyses were performed. To account for the possibility that recent disease development may have altered beverage intakes as well as be related to mortality, we repeated the analyses excluding the first 5 years of follow-up. We also repeated the analyses excluding persons with major disease (hypertension, angina, heart attack, stroke, diabetes, rheumatoid arthritis, cancer) at baseline. Since caffeine consumption was related to age, we checked for a cohort effect by stratifying on age (<75 and 75+ years). In addition, we examined risk of death among tea drinkers in cohort members reporting cardiovascular disease at baseline. This study was approved by the Institutional Review Boards of the University of Southern California and the University of California, Irvine.

Results

After excluding 233 women and 121 men with missing information on the variables of interest or potential confounding variables, data on 8644 women and 4980 men were analyzed. At study entry, the participants ranged in age from 44 to 101 years (median, 74 years). By December 31, 2004, 11,386 had died at ages 59 to 110 years (median, 87 years).

Table 1 presents selected characteristics of the participants by sex and coffee consumption. About 90% of the cohort drank coffee (60% regular, 62% decaffeinated coffee) and 50% drank tea. Over two-thirds of the cohort drank less than one can of soft drink per week or not at all. Just over 15% ate chocolate a few times a week or more frequently. Caffeine consumption was significantly related to age and sex in our cohort. Median age decreased with increasing caffeine consumption: 75, 74, 73, and 71 years for <50, 50–99, 100–199, 200–399, and 400+ mg/week.

Table 1. Characteristics of the Leisure World Cohort at baseline

<table>
<thead>
<tr>
<th>Number</th>
<th>Male</th>
<th>Female</th>
<th>Regular coffee drinker</th>
</tr>
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<tbody>
<tr>
<td>4980</td>
<td>2452</td>
<td>2528</td>
<td>5502</td>
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<td>8644</td>
<td>4476</td>
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<table>
<thead>
<tr>
<th>Mean±standard deviation</th>
<th>Sex</th>
<th>Regular coffee drinker</th>
</tr>
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<tbody>
<tr>
<td>Age at baseline (years)</td>
<td>74.3±7.2</td>
<td>73.2±7.4</td>
</tr>
<tr>
<td>Age at last follow-up (years)</td>
<td>85.6±6.9</td>
<td>87.5±7.0</td>
</tr>
<tr>
<td>Follow-up years</td>
<td>11.2±6.8</td>
<td>14.3±6.8</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>24.2±2.9</td>
<td>23.1±3.5</td>
</tr>
<tr>
<td>Exercise (h/day)</td>
<td>1.1±1.3</td>
<td>0.9±1.1</td>
</tr>
<tr>
<td>Caffeine (mg/day)</td>
<td>177±172</td>
<td>168±165</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Percent</th>
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<tr>
<td>Alive</td>
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<td>20</td>
</tr>
<tr>
<td>Female</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>History of disease</td>
<td>Sex</td>
<td>Regular coffee drinker</td>
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<tr>
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<tr>
<td>Angina</td>
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<tr>
<td>Heart attack</td>
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<td>6.6</td>
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<tr>
<td>Stroke</td>
<td>7.1</td>
<td>3.7</td>
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<tr>
<td>Cancer</td>
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<td>Decaffeinated coffee drinker</td>
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<td>62</td>
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<tr>
<td>Black or green tea drinker</td>
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<td>53</td>
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<tr>
<td>Soft drinks (≥1/week)</td>
<td>37</td>
<td>28</td>
</tr>
<tr>
<td>Chocolate</td>
<td>17</td>
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Adjustment for potential confounders had little effect on the observed RRs for caffeine consumption but reduced any significant effect on mortality observed for milk and for black or green tea. Those who drank 4+ cups of decaffeinated coffee had significantly reduced mortality compared with nondrinkers. However, intake of regular coffee and decaffeinated coffee were inversely related (r = −0.31). Among nondrinkers of regular coffee, intake of decaffeinated coffee was unrelated to risk of death. Individuals who drank more than 1 can/week of

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artificially sweetened soft drink (cola or other) had an 8% increased risk (95% CI: 1.01–1.16).

Neither exclusion of the first 5 years of follow-up (including 1864 early deaths) nor exclusion of 8013 individuals with histories of hypertension, angina, heart attack, stroke, diabetes, rheumatoid arthritis, or cancer substantially changed the findings for caffeine consumption or artificially sweetened soft drinks (Table 3). The multivariable-adjusted risk estimates changed by less than 4% and remained statistically significant.

Analyses stratified by age showed RRs similar to those for the cohort as a whole. For 50–99, 100–199, 200–399, and 400 mg/day of caffeine compared with <50 mg/day, the multivariable-RRs (95% CI) were 1.03 (0.94–1.12), 0.94 (0.87–1.02), 0.92 (0.85–0.99), and 0.96 (0.86–1.06) for those less than 75 years old at baseline and 0.96 (0.88–1.04), 0.93 (0.87–1.00), 0.89 (0.82–0.95), and 0.96 (0.86–1.08) for those 75 or older.

Analyses limited to 6946 subjects with cardiovascular disease (hypertension, angina, heart attack, stroke, or diabetes) showed a small reduction in risk of death among tea drinkers. RRs (95% CI) were 0.94 (0.89–1.01), 0.92 (0.86–0.99), and 0.96 (0.88–1.04) for <1, 1, and 2+ cups/day compared with nondrinkers. After multivariable adjustment, the RR for 1 cup/day was no longer significantly decreased (RR = 0.93, 95% CI: 0.87–1.00).

Discussion

Among adults aged 65 years and older, over 90% consume caffeine, with females consuming an average of 188 mg/day and males 217 mg/day (Frary et al., 2005). In our cohort, the average daily caffeine intake was 168 mg in females and 176 mg in males. We observed a clear U-shaped mortality curve for total caffeine consumption with moderate consumers (100–399 mg/day) having a significantly reduced risk and heavy drinkers (400+ mg/day) having the same risk compared with those consuming <50 mg/day.

Like studies in younger subjects in which coffee exhibited a beneficial trend on mortality with moderate drinking (Woodward and Tunstall-Pedoe, 1999; Kleemola et al., 2000; Jazbec et al., 2003) but an increased risk with high (5+ cups/day) intake (Woodward and Tunstall-Pedoe, 1999; Kleemola et al., 2000), we observed a U-shaped mortality response with regular coffee consumption in our older cohort. In another cohort which included older individuals (40–79 years), Japanese men who consumed 2+ cups/day of coffee had a lower mortality risk (RR = 0.43) compared with those who consumed less than 1/2 cup/day; for those who consumed 1/2–1 cup/day risk was 0.70 (Iwai et al., 2002). No statistically significant effect was seen in women. In contrast, other studies have found no association of coffee consumption and mortality (Dawber et al., 1974; Yano et al., 1977; Heyden et al., 1978; Klatsky et al., 1993; Jazbec et al., 2003; Mukamal et al., 2004) or a small increased risk (Lindsted et al., 1992).

While some prospective cohort studies have found lower mortality among moderate and heavy tea drinkers than among those who drank no tea (Mukamal et al., 2002; Nakachi et al., 2003), others have seen no significant effect (Klatsky et al., 1993; Woodward and Tunstall-Pedoe, 1999; Iwai et al., 2002; Stensvold et al., 1992). In a Japanese cohort of 8852 individuals followed for 13 years, increased consumption of green tea was associated with higher ages at death (Nakachi et al., 2003). Tea consumption may have the strongest benefit in persons with cardiovascular disease. In individuals without baseline disease in the Kaiser Permanente cohort, risk of mortality was reduced 2% for each cup of tea (p = .04) (Klatsky et al., 1993). In the male Health Professionals Follow-up Study, the inverse association between flavonoid intake (main source being tea) and risk of death from coronary heart disease was limited to men who had previously had cardiovascular disease but was not statistically significant (Rimm et al., 1996). In a cohort of 1900 US patients hospitalized with acute myocardial infarction, tea consumption was associated with lower mortality (RR = 0.69 for moderate (<14 cups/week) drinkers and RR = 0.61 for heavy drinkers (14+ cups/week) compared with nondrinkers) (Mukamal et al., 2002). We found that the significantly decreased association between tea and mortality in our cohort was attenuated and no longer significant after multivariable adjustment. The perception of tea as a healthful beverage might cause some health conscious persons to choose tea or for some ill persons to switch from coffee to tea.

Few studies have reported on the relationship of soft drink intake and mortality. Caffeinated cola consumption was not associated with death among 1902 patients hospitalized for acute myocardial infarction and followed for 3.8 years (Mukamal et al., 2004). In the Nurses’ Health Studies, sugared and diet cola beverages were associated with increased risks of hypertension (Winkelmayer et al., 2005) and diabetes (Schulze et al., 2004). While the consumption of caffeine from soft drinks is increasing (Frary et al., 2005), in our elderly population this was a minor source of caffeine. We found mortality was increased in consumers of artificially sweetened soft drinks (colas and others) but not with sugar-sweetened drinks. Although artificially sweetened soft drinks may be consumed by more diabetics and overweight individuals and thereby indirectly related to mortality, the association remained significant after adjusting for these and other confounding factors. The increased death risk with consumption of artificially sweetened, but not sugar-sweetened, soft drinks suggests an effect of the sweetener rather than other components of the soft drinks. However, residual confounding remains an alternative explanation.

Coffee, tea, and soft drink intake habits might be identifying groups of people with different lifestyles. In our study, non-coffee-drinking subjects had higher prevalences of several diseases than coffee drinkers (Table 1). Some may have stopped drinking coffee because of their underlying diseases. We did not ask about history of coffee drinking and, therefore, cannot answer this question. However, exclusion of the first 5 years of follow-up did not appreciably change the mortality and caffeine association. In two studies (Murray et al., 1981; Jacobsen et al., 1986) and in women in a third (Iwai et al., 2002), the increased mortality among those with no or low coffee consumption was limited to the first few years of follow-up. A study of potential
confounders contributing to the reported associations of caffeine with disease found that of 32 risk factors only sex and cigarette smoking were important confounders (Schreiber et al., 1988b). Others have found coffee and tea consumption related to each other and to smoking, alcohol, body mass index, exercise, high blood pressure, diabetes mellitus, heart attack, and soft drink consumption (Murray et al., 1981; Jacobsen et al., 1986; Lindsted et al., 1992; Stensvold et al., 1992; Klatsky et al., 1993; Woodward and Tunstall-Pedoe, 1999; Iwai et al., 2002; Kleemola et al., 2000; Mukamal et al., 2002, 2004). In our study, neither adjustment for these and other confounders including age and sex nor stratification by age materially changed the lower risk seen for coffee or caffeine drinkers.

Measurement error may explain some of the discrepancies in studies of caffeine and mortality (Schreiber et al., 1988a,b; Brown et al., 2001). Some studies are limited to coffee intake and do not include caffeine from tea and soft drinks. Others have not separated caffeinated from decaffeinated coffee. We, like many others, did not ask consumption on weekdays separately from weekends, the size of the containers, the methods of brewing coffee, or variations with the season or over time. As we asked subjects to report their consumption of black or green tea, we may have misclassified subjects who predominantly drank decaffeinated teas. Although we included soft drinks in our questionnaire, we did not ask about other beverage sources of caffeine including caffeinated fruit juices/drinks and bottled water or caffeine-containing medications, such as analgesics. The combined caffeine contribution from these other sources in the general population is small: <1% for the beverages in Americans (Knight et al., 2004) and 1.7% and 3.2% for medications in Canadian males and females aged 60–75 years (Brown et al., 2001).

The beneficial effect of coffee and caffeine on mortality may be due to the antioxidant properties of chlorogenic and caffeic acids in coffee (Kleemola et al., 2000). Antioxidants may prevent oxidation of low density lipoproteins which occur in atherosclerotic plaques in the cardiovascular system. Caffeine may also increase an individual’s awareness of hypoglycemia and thus may be useful for the early identification of diabetes (Watson and Kerr, 1999). This increased sensitivity to hyperglycemia may be mediated through the combined effects of reducing substrate delivery to the brain via constriction of the cerebral arteries and increasing brain glucose metabolism and augmenting catecholamine production. In addition, coffee consumption has been inversely related with blood pressure and indices of liver enzymes (Iwai et al., 2002).

Our investigation is an observational study, not a randomized trial, with the possibility that unrecognized confounders or bias accounts for the observed results. In general populations, health-promoting habits often cluster resulting in two extreme groups. For example, individuals who drink coffee may differ from those who do not drink coffee in their smoking, exercise habits, and medical history. They may also differ from nondrinkers in unmeasured ways that influence longevity. Although differences between drinkers and nondrinkers of coffee, tea, soft drinks, and milk in this study are not great and adjusting for other risk and potentially confounding factors did not change the observed RRs for caffeine, uncontrolled confounding cannot be ruled out.

Our data on beverage consumption and potential confounders were self-reported using a mailed questionnaire. Previous studies in our population and others support the reliability of recall medical history of major chronic disease. In the Leisure World community agreement between self-report and physician/hospital record was 96% for diabetes, 90% for hypertension, and 80% for cancer (Paganini-Hill and Ross, 1982; Paganini-Hill and Chao, 1993). The self-reports of heart attack were less accurate; however, the false positives generally included other cardiovascular disease. Although we assigned one caffeine value to each category of beverage and chocolate, the true caffeine content varies within a category due to both manufacturer and preparation method. The subjects in our study were also healthier and better educated than the general population. In addition, changes over time in all potential risk factors may affect our outcomes.

Conclusions

Results in this large elderly cohort with long follow-up showing a U-shaped association of caffeine intake (from coffee, tea, soft drinks, and chocolate) suggest a beneficial effect of moderate consumption. Individuals drinking 100–399 mg/day had the lowest risk. Those consuming more than 1 can/week of artificially sweetened soft drinks had a small increased risk of death.

References


Steinberg, D., Witztum, J.L., 2002. Is the oxidative modification hypothesis relevant to human atherosclerosis? Do the antioxidant trials conducted to date refute the hypothesis? Circulation 105, 2107–2111.


