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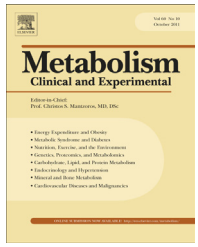

Coffee and green tea consumption is associated with insulin resistance in Japanese adults

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ABSTRACT

Objective. Higher coffee and green tea consumption has been suggested to decrease risk of type 2 diabetes, but their roles in insulin resistance (IR) and insulin secretion remain unclear. This study examined the association between habitual consumption of these beverages and markers of glucose metabolism in a Japanese working population.

Materials/Methods. Participants were 1440 Japanese employees (1151 men and 289 women) aged 18–69 years. Consumption of coffee and green tea was ascertained via a validated brief diet history questionnaire. Multilevel linear regression was used to estimate means (95% confidence intervals) of fasting insulin, fasting plasma glucose, homeostatic model assessment of IR (HOMA-IR), homeostatic model assessment of β-cell function (HOMA-β) and glycated hemoglobin (HbA1c) with adjustment for potential confounding variables.

Results. Coffee consumption was significantly, inversely associated with HOMA-IR (P for trend = 0.03), and the association appeared to be confined to overweight subjects (BMI ≥ 25 kg/m^2) (P for trend = 0.01, P for interaction = 0.08). Unexpectedly, green tea consumption was positively associated with HOMA-IR (P for trend = 0.02), though there was no dose–response relationship among daily consumers of green tea. Neither coffee nor green tea consumption was associated with HOMA-β and HbA1c.

Conclusions. Our findings indicate that coffee consumption may be associated with decreased IR, but not with insulin secretion. The positive association between green tea consumption and IR warrants further investigation.

Abbreviations: BMI, Body mass index; BDHQ, Brief diet history questionnaire; CI, Confidence interval; HbA1c, Glycated hemoglobin; HOMA-β, Homeostatic model assessment of β-cell function; HOMA-IR, Homeostatic model assessment of insulin resistance; IR, Insulin resistance; T2D, Type 2 diabetes.

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1. Introduction

Coffee and tea are two popular beverages worldwide, and their roles in human health have received much attention [1,2]. Coffee contains multiple potent antioxidants [1], which can decrease oxidative stress — a predisposition to the development of insulin resistance (IR) *in vitro* and *in vivo* [3]. Chlorogenic acids and quinides in coffee beans have been shown to inhibit glucose-6-phosphatase [4] and increase insulin sensitivity [5]. As with coffee, animal studies show that tea catechin can decrease glucose production and enhance insulin sensitivity [6]. Epidemiological evidence supports a protective role of coffee and tea [7] including green tea [8], a widely consumed beverage in Asian countries, against type 2 diabetes (T2D). Given that IR and impaired insulin secretion are major features of T2D [9], it is of interest to examine whether coffee and green tea consumption is associated with these conditions.

Findings from epidemiological studies on this issue, however, are not entirely consistent and/or scarce. Several cross-sectional studies observed that higher coffee consumption was associated with lower concentrations of fasting insulin [10], increased insulin sensitivity [11,12] and decreased homeostatic model assessment of IR (HOMA-IR) [10,13,14], a good marker of IR [15]. Nonetheless, others found no association of coffee consumption with fasting insulin [16,17] or HOMA-IR [17]. In clinical trials, coffee ingestion had no effect on fasting insulin [18–21] and HOMA-IR [19–21] or even increased fasting insulin [22]. Studies of habitual coffee consumption and homeostatic model assessment of β-cell function (HOMA-β), a marker of insulin secretion [23], are scarce [13,14], showing no association in apparently healthy subjects [13,14] but an inverse association in those with impaired glucose tolerance [13]. Similarly, data are limited on the association between regular coffee consumption and glycated hemoglobin (HbA1c) [14,24,25], with one reporting a suggestion of an inverse association [25] and the others exhibiting no association [14,24]. Concerning green tea, a few studies reported no association with HOMA-IR [14], HOMA-β [14] and HbA1c [14,25]. Two meta-analyses have reached contradictory conclusions about the effect of green tea on insulin sensitivity [26,27].

Although data from observational studies appear to support a beneficial role of coffee [10–14] but not green tea [14] in IR, some questions remain to be resolved. Obesity and smoking, which have been closely linked to T2D [28,29], may modify the association of coffee and green tea consumption with markers of glucose metabolism, but few studies addressed this issue [30,31]. Moreover, previous studies on coffee consumption and glucose metabolism were conducted mainly among Westerners [10–13] but less among Asians [14,17,25], who are leaner and have lower capacity of insulin secretion compared with Westerners [32]. We therefore conducted a cross-sectional study to investigate the association of habitual coffee and green tea consumption with fasting glucose and insulin, HbA1c, HOMA-IR and HOMA-β in a Japanese working population, with consideration for the potential role of smoking and BMI as effect modifiers.

2. Methods

2.1. Study procedure

This study included cross-sectional epidemiological surveys conducted in 2009 [33] and 2012 [34] among employees of three workplaces: two municipal offices in Kyushu and one manufacturing company in Kanto, Japan. At the time of the periodic health examination, all workers except those on long sick or maternity leave were invited to participate in the surveys. Two types of survey questionnaire were used: one specifically designed for assessing diet and another for measuring overall health-related lifestyles. Of 605 employees who received their health checkup in 2009, 567 (aged 20–68 years) agreed to take part in the study (response rate 94%). Of 1675 workers who underwent a health checkup in 2012, a total of 1212 (aged 18–69 years) consented to participate in the survey (response rate 72%). On the day of health checkup, research staff checked each questionnaire for completeness, and where necessary, asked participants for clarification. Additionally, we obtained health checkup data, including anthropometric measurements, biochemical data, and information about medical history, smoking, and alcohol drinking. The study was approved by the Ethics Committee of the National Center for Global Health and Medicine, Japan, and written informed consent was obtained from all subjects before the survey.

2.2. Study subjects

Data obtained from the aforementioned surveys were combined. Of 1779 participating subjects, we excluded those who did not return the lifestyle survey questionnaire (n = 3) and dietary questionnaire (n = 6). We further excluded pregnant women (n = 8) and participants reporting a history of stroke or cardiovascular disease (n = 25), cancer (n = 27), diabetes (n = 52) and chronic kidney disease (n = 9), and those who were current users of anti-diabetic drugs (n = 1) or under medical care for hepatitis (n = 4), giving 1665 participants. Of these, we excluded individuals who received health checkup in non-fasting condition (n = 32) and those who did not donate blood samples for insulin measurement (n = 144). We further excluded subjects whose plasma glucose was not measured (n = 35) and those who had missing data on covariates (n = 14), leaving 1440 subjects (1151 men and 289 women) for the analysis of fasting glucose and insulin, HOMA-IR and HOMA-β. Some of the subjects had two or more conditions for exclusion. As regards HbA1c, we analyzed data for 1307 subjects (1087 men and 220 women) with HbA1c measurement, regardless of their fasting status at the checkup.

2.3. Laboratory procedures

Blood samples were obtained on the day of the health checkup. Venous blood (7 mL) was drawn into vacuum tubes and then transported in a cooler box to the laboratory. Serum samples were stored at −80 °C until analysis for insulin. Insulin was measured by a chemiluminescent immunoassay (Architect insulin, Tokyo, Japan), and the coefficients of