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Habitual coffee consumption inversely associated with metabolic syndrome-related biomarkers involving adiponectin

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ABSTRACT

Objectives: The goal of this cross-sectional study was to assess whether habitual coffee consumption shows beneficial association with metabolic syndrome (MetS) in adults.
Methods: The association of coffee consumption and MetS-related biomarkers including visceral fat area (VFA) and subcutaneous fat area (SFA), total serum adiponectin (T-Ad), low-molecular-weight serum adiponectin (LMW-AD), medium-molecular-weight serum adiponectin (MMW-Ad), and high-molecular-weight serum adiponectin (HMW-Ad) levels were analyzed among 364 Japanese men (36–61 y old) using two models of multivariate regression analyses; model 1 (adjusted for age, alcohol drinking, smoking, and walking status) and model 2 (adjusted for body mass index in addition to model 1 analysis). Participants were categorized into two groups according to their MetS risk score (raised blood pressure and hemoglobin A_{1c} levels, and reduced high-density lipoprotein cholesterol levels).
Results: Both light (1–3 cups/d) and moderate (≥4 cups/d) coffee consumption showed significant inverse associations with VFA and VFA/SFA ratio ($P < 0.0001$). Moderate coffee consumption showed a favorable tendency toward these associations with T-Ad ($P = 0.06$) and HMW-Ad ($P = 0.07$) levels in model 1 analysis. In participants with lower MetS risk score (≤1), moderate coffee consumption showed significant associations with T-Ad and HMW-Ad levels ($P < 0.05$) in both analyses, whereas no significant associations of coffee consumption with adiponectin levels were seen in the men with higher MetS risk scores (≥2).
Conclusions: Habitual moderate coffee consumption shows significant inverse associations with MetS-related biomarkers possibly involving adiponectin, which is inversely related to visceral fat accumulation.

Introduction

Metabolic syndrome (MetS), a cluster of multiple cardiovascular risk factors including visceral obesity, dyslipidimia, hypertension, and glucose intolerance and/or insulin resistance, has become a major public health problem worldwide [1,2]. In Japan, despite the relatively lower frequency of obesity compared with Western countries, the prevalence of MetS has been increasing markedly. According to the recent publication in Japan, an estimated 10.7 million people suffered from MetS and another 9.4 million were estimated to be at risk in 2006 [3]. MetS is strongly associated with the development of cardiovascular disease (CVD), coronary heart disease (CHD), and diabetes mellitus [4,5], and has been found to be related to colon and breast cancers [6,7]. Thus, finding preventive measures for this syndrome is a matter of great importance.

In addition to improving lifestyles (i.e., increasing physical exercise and/or reducing caloric intake), specific diets have been found effective at reducing the risk for diabetes mellitus, CVD, and MetS [8–10]. Recently, emerging epidemiologic evidence has

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suggested inverse associations between coffee consumption and the risk for type 2 diabetes mellitus, CHD, and some types of cancer [11–13]. More recently, a large prospective study has shown that coffee consumption was inversely associated with total and cause-specific mortality [14]. Despite numerous studies conducted on these diseases, studies with healthy participants on MetS-related biomarkers have been relatively few, including our recent study [15–17]. Thus, it is very important to investigate whether or not habitual coffee consumption is beneficial in this regard.

In this contribution, we investigate the association of habitual coffee consumption with MetS-related biomarkers among healthy men. Although several definitions for MetS have been published by different international organizations, the definitions are largely similar. The basic components are central obesity, raised systolic or diastolic blood pressure (SBP or DBP), reduced high-density lipoprotein cholesterol (HDL-C), and raised triglycerides and fasting plasma glucose (FPG) [18]. In the present study, we have used hemoglobin A_{1c} (HbA_{1c}) as a substitute for FPG, because it does not require fasting and has been reported to be more sensitive and useful for diagnostic criteria for prediabetes and diabetes [19]. We measured the visceral fat area (VFA) and subcutaneous fat area (SFA) by computed tomography (CT), using VFA and the VFA/SFA ratio as indicators of central obesity. Furthermore, in the view of extensive evidence showing the important role of adipokines in MetS and related diseases [20], we measured the serum adiponectin levels in low-, medium- and high-molecular-weight forms as an anti-inflammatory biomarker.

To our knowledge, this is the first study to investigate the associations of habitual coffee consumption with MetS-related biomarkers together with VFA, SFA, and the serum levels of each form of adiponectin.

Participants and methods

Participants

Before recruiting participants, the study design was approved by the ethical committee for analytical research on the human genome of Wakayama Medical University (Approval No. 44). In 2006, 731 Japanese were recruited from a workplace in Wakayama for this study with informed consent (33% participation rate). These participants also were asked whether they would participate for the genotyping study in addition to this study. After eliminating those who had taken medications for hypertension, diabetes, dyslipidimia, CVDs and cerebrovascular diseases, 364 men who had undergone a CT scan were studied. The men's mean age (± SD) was 51.8 ± 5.9 y (range, 36–61). Information about lifestyle factors including alcohol drinking (d/wk), smoking and walking status (min/d) was collected using a self-administered questionnaire. Habitual coffee consumption status was determined according to one of three choices: none, one to three or at least four cups per day. The cut off-point of four cups per day was taken from a previous study finding beneficial effects of moderate coffee consumption [21]. Alcohol drinking was categorized into two groups, drinking alcoholic beverages no more than 5 or no less than 6 d/wk. Smoking habits were categorized into two groups, non- or ex-smokers and current smokers. Walking status was also categorized into two groups, walking <30 or ≥30 min/d.

Anthropometric and biomedical data collection

All anthropometric and biomedical measurements were performed at the laboratory in the Wakayama Wellness Foundation. Height and weight were measured to obtain body mass index (BMI). Abdominal scanning was performed at the level of the umbilicus (PRATICO; Hitachi Medico, Tokyo, Japan). CT values between −70 to −150 Hounsfield units were considered as adipose tissue. Abdominal fat area and VFA were calculated using the PC software (Hitachi Medico). SFA was calculated by deducting VFA from abdominal fat area. Blood pressure and pulse rate were measured twice, and mean value was calculated. A venous blood sample was taken for measuring HDL-C, low-density lipoprotein cholesterol (LDL-C), HbA_{1c}, high-sensitive C-reactive protein (hs-CRP), adiponectin, and so on. HDL-C was measured directly using a commercial kit (MetaboRead HDL-C; Kyowa Medix, Tokyo, Japan) and LDL-C was measured directly using a commercial kit (Determiner LDL-C; Kyowa Medix). Then, hs-CRP was measured using a latex agglutination kit (CRP-HS II LT; Wako Chemicals, Tokyo, Japan). HbA_{1c} was measured by high-performance liquid chromatography method using an auto glycohemoglobin analyzer (HLC-723G9; Tosoh, Tokyo, Japan) in accordance with Japanese Diabetes Society (JDS), thus, the conversion equitation was used for calculating National Glycohemoglobin Standardization Program (NGSP), such as NGSP (%) = JDS (%) × 1.02 + 0.25% [22].

Serum adiponectin levels

Serum adiponectin levels were assessed by an enzyme-linked immunoassay system (Sekisui Medical, Tokyo). The total adiponectin (T-Ad), high-molecular-weight adiponectin (HMW-Ad) and the combination of HMW-Ad and medium-molecular-weight adiponectin (MMW-Ad) levels were measured directly by this system. The MMW-Ad level was calculated by subtracting the HMW-Ad level from the mixture of HMW-Ad and MMW-Ad levels. Low-molecular-weight adiponectin (LMW-Ad) was calculated by subtracting the mixture of HMW-Ad and MMW-Ad levels from the T-Ad level.

Statistical analysis

All statistical analyses were carried out using SPSS Statistics software 20 (IBM, Chicago, IL). Variables with skewed values such as HDL-C, HbA_{1c}, hs-CRP, and adiponectin levels were transformed into logarithmic values before analysis. The association of coffee consumption with MetS-related biomarkers was analyzed by the analysis of covariance (ANCOVA) adjusted for age, alcohol drinking, smoking, and walking status. Multivariate regression analyses were performed in two models; model 1 analysis was adjusted for age, alcohol drinking, smoking, and walking status, and model 2 was adjusted for BMI in addition to model 1. Both light and moderate coffee consumption were included as the dummy variables; for "coffee 1–3 cups/d" 0 and ≥4 cups/d were given 0 and 1–3 cups/d was set as 1, and for "coffee ≥4 cups/day" 0 and 1–3 cups/d were given 0 and ≥4 cups/d was set as 1. Preferable habits or statuses were given 0 and less preferable habits or statuses were given 1 for all lifestyle factors. *P*-values were obtained by assigning ordinal values to categories of coffee consumption in the trend analyses. As for MetS risk factors, raised blood pressure (SBP ≥ 130 mm Hg or DBP ≥ 85 mm Hg), reduced HDL-C (<40 mg/dL), and elevated HbA_{1c} (≥5.5%) levels were chosen. Proportions of alcohol drinking, smoking, and walking status, and MetS risk scores were tested using the χ^2 test. *P*-values of <0.05 were considered statistically significant.

Results

Characteristics of participants with coffee consumption and MetS-related biomarkers are summarized in Table 1. In the ANCOVA analyses, both light and moderate coffee consumption showed significant associations with lower VFA and VFA/SFA, and also with HbA_{1c} level. Other MetS-related biomarkers such as blood pressure, cholesterol levels, and hs-CRP showed no associations. Moderate coffee consumption showed the highest adiponectin levels compared with no and light coffee consumption; however, differences were not statistically significant.

The associations of coffee consumption and MetS-related biomarkers were evaluated using regression analyses (Table 2). Both light and moderate coffee consumption were significantly associated with lower VFA and VFA/SFA in both analyses ($P < 0.0001$). As for HbA_{1c} levels, light coffee consumption showed a significant inverse association in model 1 analysis ($P = 0.014$) and a tendency of favorable association in model 2 analysis ($P = 0.054$), whereas moderate coffee consumption showed a significant inverse association in both model 1 and model 2 analyses ($P = 0.009$ and $P = 0.027$, respectively). As for adiponectin levels, moderate coffee consumption showed tendencies toward favorable associations with T-Ad and HMW-Ad levels in model 1 analysis ($P = 0.06$ and $P = 0.07$, respectively); whereas light coffee consumption showed no associations. In the trend analyses, coffee consumption showed significant associations with most of MetS-related biomarkers except cholesterol levels, and also showed significant associations with serum adiponectin levels.