ELSEVIER

Atherosclerosis 198 (2008) 403–411

ATHEROSCLEROSIS

www.elsevier.com/locate/atherosclerosis

Greater habitual soyfood consumption is associated with decreased carotid intima–media thickness and better plasma lipids in Chinese middle-aged adults

Bo Zhang [a], Yu-ming Chen [b,*], Li-li Huang [a], Xiao-xing Zhou [a], Chao-gang Chen [c], Yan-bin Ye [d], Yi-xiang Su [a,**]

[a] *Faulty of Nutrition, School of Public Health, Sun Yat-sen University, 74# Zhongshan Road 2, Guangzhou 510080, People's Republic of China*

[b] *Faulty of Medical Statistics & Epidemiology, School of Public Health, Sun Yat-sen University, 74# Zhongshan Road 2, Guangzhou 510080, People's Republic of China*

[c] *The Second Affiliated Hospital, Sun Yat-sen University, Guangzhou 510120, People's Republic of China*

[d] *The First Affiliated Hospital, Sun Yat-sen University, Guangzhou 510080, People's Republic of China*

Received 21 December 2006; received in revised form 27 September 2007; accepted 1 October 2007
Available online 26 November 2007

Abstract

Many clinical studies have shown high-dose supplemental soy protein has beneficial effects on cardiovascular risk factors. We examined the association between habitual soyfood intake and carotid intima–media thickness (IMT) and plasma lipids in a cross-sectional study including 406 (M 134, F 272) middle-aged Chinese adults (40–65 years) without confirmed relevant diseases. We found significantly dose-respondent decreases in bifurcation IMT, total and LDL cholesterol associated with increased usual soyfood intake after adjusting for potential confounders (p for trend, all $p < 0.05$). Covariate-adjusted mean bifurcation IMT, total and LDL cholesterol decreased by 9.4%, 6.2% and 10.4% in women ($p = 0.020$, 0.035, 0.110), 16.0%, 12.3% and 19.6% in men ($p = 0.036$, 0.005, 0.002), and 9.9%, 9.3% and 15.4% in total men and women combined ($p = 0.010$, <0.001, <0.001) when the mean intake of soy protein increased from 0.87 (F) or 0.64 (M) g/day (1st tertile) to 8.35 (F) or 7.48 (M) g/day (3rd tertile), respectively. Significant interaction between sex and soy consumption on bifurcation IMT was observed ($p = 0.008$). In conclusion, higher habitual soyfood consumption is associated with decreased bifurcation IMT, plasma TC and LDL-c in middle-aged Chinese adults. The association is more apparent in men than in women.

Keywords: Soyfood; Intima–media thickness; Plasma lipids; Chinese adults

1. Introduction

Cardiovascular diseases (CVD) were the leading cause of death in the world in 2005. They were responsible for 30% of all deaths – or about 17.5 million people [1]. About 80% of cases of coronary heart disease (CHD) could be prevented by eating healthily, maintaining normal weight, and exercising throughout the life span [2]. Among dietary factors, high intake of total fat, saturated fat, *trans*-fatty acid or cholesterol and low intake of dietary fiber are well-known factors associated with increased risk of CVD [3]. Soy is a traditional Asian food. However, limited studies have examined the effects of soy intake on CVD risk. In the recent decade, a few studies have postulated that high soyfood consumption may be one of the possible explanations for the low risk of CHD in some Asian populations [4,5].

During the past 10 years, many well-controlled trials examined the effects of supplemental soy protein and/or isoflavones on cardiovascular risk factors. A meta-analysis of 23 randomized clinical trials by Zhan and Ho [6] showed that soy protein with isoflavones could significantly decrease

* Corresponding author. Tel.: +86 20 8733 0605; fax: +86 20 8733 3166.
** Corresponding author. Tel.: +86 20 8733 1937; fax: +86 20 8733 3166.
E-mail addresses: chenyum@mail.sysu.edu.cn (Y.-m. Chen), suyx@mail.sysu.edu.cn (Y.-x. Su).

0021-9150/$ – see front matter © 2008 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.atherosclerosis.2007.10.001

serum total cholesterol (−0.22 mmol/L), LDL cholesterol (−0.21 mmol/L), and triacylglycerols (−0.10 mmol/L) and significantly increase serum HDL cholesterol (+0.04 mmol/L). Many studies also found that soyfood could improve blood pressure [7], vascular and endothelial cell function [8], platelet activation, aggregation and serotonin storage [9], and other CVD risk factors [10]. Large doses (25–60 g soy protein/day) of soyfood or soy extracts were administrated in the previous clinical trials. However, it is hard to consume such a large amount of soy products for general population over a long time. Limited studies have assessed the effects of habitual soy intake on CVD. Zhang et al. [4] found that habitual soyfood consumption reduced the risks of CHD in Shanghai middle-aged women. However, such an effect was not observed in a Japanese study [11]. It is still uncertain whether the benefits of soy products could remain at a low dose of soy intake in usual diets.

A few studies show that an increased carotid intima–media thickness (IMT), measured by high-resolution ultrasound, is a strong predictor of CVD and has additional value to traditional CVD risk factors [12,13]. In this cross-sectional study, we examined the association between habitual soyfood intake and carotid IMT and plasma lipid profiles in middle-aged Chinese adults.

2. Methods

2.1. Study subjects

Study subjects were recruited for this cross-sectional study during December 2005 and April 2006. They were required to be Guangzhou residents of Chinese origin aged 40–65 years old. We excluded those who had any diseases, such as diabetes, hypertension, CVD, dislipidemia, cancers, which might change their dietary habit or lifestyle, a body mass index $\geq$30 kg/m^2, or took any medicines (e.g., statin, anti-hypertension or anti-diabetes drugs) known to affect plasma lipids in recent three months. Subjects were recruited via community and clinic advertisement, publicity through health talks and subject referral.

After initially screening for their eligibility using a short questionnaire, 739 potential subjects were then invited to the First or the Second Affiliated Hospital of Sun Yat-sen University, Guangzhou, China. Staff with relevant knowledge in medical sciences screened the subjects for eligibility via face-to-face interview to ensure that they met the inclusion and exclusion criteria. 333 subjects were further excluded mainly because they had the confirmed medications indicated in the exclusion criteria or had not completed the relevant tests or questionnaire interview. 406 subjects (M 134, F 272) were finally enrolled and completed relevant tests and questionnaire interview. All participants signed the written informed consent prior to the enrollment. The study protocol was approved by the Medical Ethics Committee of Sun Yat-sen University.

2.2. Data collection

2.2.1. Questionnaire interview

Information on sociodemographic data, health history, general risk factors of CVD, physical activities, current and habitual dietary intakes, and female reproductive history were collected by trained interviewers with face-to-face interviews using a structured questionnaire. Questionnaire interview was conducted prior to laboratory assay and intima–media thickness (IMT) measurement.

2.2.2. Dietary assessment

Dietary soy protein and other dietary intakes were assessed with a quantitative food frequency questionnaire (FFQ) by face-to-face interview. This FFQ contained 119 food items/groups with specified portion sizes. Study participants were asked to recall how often (times per day, week, month or year depending on the frequency of consumption) and how many (standard servings), on average, they had consumed these food items during the previous year. Food models in the reference portion sizes and standard tableware were provided as visual aids. Soy intake was estimated based on eight main soyfood items/groups: soft tofu, firm tofu, deep fried tofu, soy vegetarian items/tofu-dried stick, sheet, or skin, tofu pudding/soy milk, soybean sprouts, soy bean, and fermented soy products. Soy protein and other nutrients were calculated from the Chinese Food Composition Table [14]. Reliability check of soy protein intake based on the FFQ after 3 months was $r = 0.49$, $p < 0.001$ among 90 of 406 subjects. The FFQ validity was evaluated by the comparison of the results of soy protein generated from 3-day dietary record in each quarter for 1 year and the FFQ in 310 of 406 subjects. Correlation coefficient between the second FFQ and the 24-h dietary record was 0.46 for soy protein ($p < 0.001$).

2.2.3. Anthropometric and blood pressure measurement

Height was measured to the nearest 0.5 cm, and weight to the nearest 0.1 kg in light clothing and without shoes. Body mass index (BMI) was calculated as weight (kg)/height (m)^2. Waist circumference (WC) was measured half way between the lowest rib margin and the iliac crest, while hip circumference was measured at the level of the greater trochanters. Waist to hip ratio (WHR) was then calculated. Measurements of waist and hip circumference were performed twice to the nearest 0.5 cm and the mean of the two measurements were used for subsequent analysis. Two consecutive measurements of blood pressure were taken from right arm after each subject had been sitting for at least 10 min. Systolic blood pressure (SBP) and diastolic blood pressures (DBP) were recorded to the nearest 2 mm Hg. If the two systolic or diastolic blood pressures recorded were $\geq$4 mmHg apart, a third measurement was made. The average of the two blood pressures was used for the subsequent analysis. SBP and DBP were defined as the point of the appearance (Korotkoff I) and disappearance (Korotkoff V) of Korotkoff sounds, respectively.