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Research Article

Gender differences in the association of hypertension with gamma–glutamyltransferase and alanine aminotransferase levels in Chinese adults in Qingdao, China

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Abstract

The aim of the study was to study the associations of hypertension with gamma–glutamyltransferase (GGT) and alanine aminotransferase (ALT) levels. Data of 3575 men and 5504 women were analyzed. Multivariate logistic regression analysis was performed to estimate the odds ratio (OR) for hypertension with GGT and ALT. Compared with the lowest quartile, the multivariate adjusted ORs for hypertension were 0.97 (0.79, 1.19) in men and 0.88 (0.74, 1.04) in women for ALT and 2.29 (1.68, 3.14) and 1.52 (1.27, 1.83) for GGT in the highest quartile group. The ORs for hypertension in the low waist circumference category were 2.61 (1.56, 4.36) in men and 1.41 (0.94, 2.12) in women and in the high waist circumference category 4.01 (2.21, 7.29) and 2.26 (1.54, 3.32) for GGT. The elevated GGT, but not ALT, was associated with the presence of the hypertension in men and women. The association is stronger in obese men and women than in their lean counterparts. J Am Soc Hypertens 2015;9(12):951–958.

Keywords: Alanine aminotransferase; gamma–glutamyltransferase; gender; hypertension.

Introduction

Serum gamma–glutamyltransferase (GGT) is commonly used as an indicator of alcohol consumption and oxidative stress.[1,2] Another liver enzyme, alanine aminotransferase (ALT), is the most specific marker of liver pathology and a strong biomarker for liver fat accumulation and hepatic insulin sensitivity.[3,4] Recently, emerging evidence suggests GGT and ALT are associated with the presence of hypertension.[5–16]

However, the levels of ALT and GGT differ between men and women, with higher values observed in men,[17,18] only a few studies have compared these liver enzymes for their associations with hypertension separately by men and women,[15,18–20] and it is not entirely clear to clarify if there is a difference in this association between men and women. Moreover, both ALT and GGT are associated with obesity; it is, thus, important to check whether the associations of elevated blood pressure levels with ALT and GGT are not confounded by obesity.

In this study, first, the association of hypertension with serum GGT and ALT levels is examined separately by men and women in a Chinese adult living in Qingdao, China. Second, a stratified analysis by the waist circumference (WC) levels was, thus, performed to check whether the association between the serum GGT and ALT with hypertension depend on obesity in men and women.

Conflict of interest: None.

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Research Design and Methods

Study Population

Population-based cross-sectional surveys were conducted separately in 2006 and 2009 in Qingdao, China. A stratified, random cluster sampling method was used to recruit a representative sample of the general population aged 35–74 years old for all surveys. Both surveys were conducted in the same three urban districts (Shinan, Shibei and Sifang) and three rural counties (Jiaonan, Huangdao, and Jimo). Five residential communities from each area with 200–250 individuals from each community were randomly selected, and a total of 6100 individuals were invited to the survey in 2006 and 6000 individuals in 2009, respectively. All participants were invited to a survey site near their resident communities. Similar approaches were applied in two surveys. The number of participants in each survey was 5355 (giving a response rate of 87.8%) in 2006 and 5165 (giving a response rate of 86.1%) in 2009.

Each survey participant completed a questionnaire and underwent a detailed medical examination by a trained doctor or nurse. WC was calculated at the umbilical level. Height and weight were measured with participants wearing light clothes and without shoes. Body mass index (BMI) was then measured by dividing weight (kg) by height (m) squared (kg/m^2). Blood pressure was measured with mercury sphygmomanometer (Yuyue, China). Three consecutive blood pressure readings, apart by at least 30 seconds, were taken from the right arm of seated subjects in a quiet room, and the average of the three readings was used in the data analysis. The alcohol drinking was classified as heavy drinkers (with an alcohol intake of $\geq$40 gram per day), moderate drinkers (with an alcohol intake of $<$40 gram per day), and nondrinkers (including ex-drinking or not drinking at all).[21] The smoking status was defined as current smokers (smoking every day) and nonsmokers (including ex-smoking, smoking now and then, and not smoking at all). A family history of hypertension was classified as having at least one of parents, siblings, or offsprings with diagnosed hypertension. Education levels were divided into two levels ($\leq$9 or $>$9 school years). Blood samples were collected locally, and all participants were informed to be fast at least 10 hours before blood samples were collected. The laboratory assays were performed in the central laboratory of Qingdao Hiser Medical Center using Olympus AU analyzers in 2006 and in Qingdao Endocrinology and Diabetes Hospital using Hitachi AU analyzers in 2009. Fasting serum triglycerides (TGs) and total cholesterol were determined by enzymatic method, whereas fasting serum high-density lipoprotein (HDL) cholesterol by direct method. Low-density lipoprotein cholesterol was calculated using the Friedewald equation. Fasting plasma glucose (FPG) was determined by the glucose oxidize method. ALT and GGT were measured by using an International Federation of Clinical Chemistry method. The concentration of fasting insulin was measured using the chemiluminescence immunoassay method (Abbott AxSym). The index of the homeostasis model assessment of insulin resistance was calculated using the formula [homeostasis model assessment of insulin resistance = fasting insulin (mU/L) $\times$ FPG (mmol/L)/22.5].

The inclusion criteria for the present study were participants who had no data missing for age, BMI, WC, alcohol status, smoking status, lipids, FPG, and blood pressure. Finally, a total of 9079 (40% men) subjects were included in the analysis. The two surveys were approved by the Ethic Committee of Qingdao Municipal Hospital and Qingdao Municipal Center for Disease Control and Prevention, respectively. Verbal and written consent was obtained from each participant before the data collection.

Classification of Hypertension

Newly diagnosed hypertension was defined as systolic blood pressure (SBP) $\geq$140 mm Hg and/or diastolic blood pressure (DBP) $\geq$90 mm Hg. Subjects who reported a history of hypertension and/or who were under treatment with oral antihypertensive medication were considered as previously diagnosed hypertension, regardless of their blood pressure levels. There was no difference in the mean levels of ALT and GGT between the subjects with a history of hypertension and the subjects with newly diagnosed hypertension; therefore, newly and previously diagnosed hypertension were included in the data analysis.

Statistical Analysis

Data were summarized as mean ($\pm$standard error) for continuous variables and proportions for categorical variables. Because of skewed distribution, values derived from logarithmically transformed means were used for GGT and ALT in data analysis. The general linear model approach for continuous variables and a chi-square test for categorical variables were used to compare differences in age-adjusted means and prevalence between hypertension and normotension in both surveys. The linear association of ALT and GGT with SBP and DBP was tested using multivariate linear regression model, adjusting for age, school years, family history of hypertension, current smoking, alcohol drinking, BMI, HDL, and TG, and the standard beta coefficients and 95% confidence interval (CI) were calculated. The multivariate logistic regression was performed to investigate the association of hypertension with serum ALT and GGT levels in both genders, adjusting for age, current smoking, alcohol drinking, school year, family history of hypertension, BMI, HDL, and TG. We divided