Associations between serum vitamins and serum lipids in healthy Northeast China adults

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Research

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Abstract

Objective In previous studies, serum vitamins were shown associated with lipid levels. However, evidence regarding the associations between various serum vitamins and serum lipids is limited. Therefore, the associations between serum vitamins and serum lipids were investigated in this cross-sectional study.

Methods The study population included 131 adults (42 males and 89 females) ≥ 18 years of age who lived more than three years in Shenyang, Liaoning province, China. Serum lipids included total cholesterol (TC), triglyceride (TG), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C). Analysis of covariance was used to explore the associations between serum vitamins and serum lipids.

Results After multiple adjustments, vitamin A and vitamin C concentrations were positively associated with LDL-C level (P for trend < 0.05). Vitamin A, vitamin B5, and vitamin C concentrations were positively associated with TG level (P for trend < 0.05). However, vitamin B1 concentration was negatively associated with TG level (P for trend = 0.04). Vitamin E concentration was positively associated with HDL-C level (P for trend = 0.02). No association was observed between vitamin concentrations and TC level.

Conclusion The results in the present study indicate that serum vitamin concentrations are associated with serum lipid levels. Vitamin B1 and vitamin E concentrations were associated with a better status of lipid profiles. However, vitamin A, vitamin C, and vitamin B5 concentrations were associated with a worse status of lipid profiles.

Background

Dyslipidemia was shown in epidemiology studies to be an important risk factor for coronary artery disease, cerebral infarction, as well as other cardiovascular and cerebrovascular diseases [1–3]. The role of high-density lipoprotein cholesterol (HDL-C), triglyceride (TG), and low-density lipoprotein cholesterol (LDL-C) have been identified as predictors of cardiovascular disease [4]. Along with the rapid economic development and the subsequent adverse lifestyle changes (e.g., high intake of dietary saturated fat), the prevalence of dyslipidemia in the Chinese population has significantly increased [5]. Serum lipids include total cholesterol (TC), TG, LDL-C, and HDL-C [6]. The main features of dyslipidemia include low HDL-C levels, high LDL-C levels, high TC levels, and high TG levels [7]. The characteristics of dyslipidemia are very complex and mainly due to genetic or environmental factors [8] as well as their interactions [9]. Therefore, formulating an effective method for the prevention of dyslipidemia has important public health significance.

Recent evidence showed that serum vitamin levels are closely associated with serum lipid levels [10, 11]. In a randomized controlled trial (RCT), the concentrations of TG and LDL-C were positively associated with concentrations of vitamin A in obese and non-obese women [10]. In another RCT, serum vitamin E was negatively associated with TC, TG, and LDL-C and positively associated with HDL-C [11]. In the majority of previous studies, the focus was on the associations between serum vitamins and serum lipids in specific populations (e.g., obese people [10], cardiovascular disease patients [11], and diabetics [12]). Furthermore, most studies involving Chinese subjects focused on the association between a single vitamin, especially vitamin D, and serum lipids [13, 14]. However, the associations between other serum vitamins and lipid profiles have not been investigated. In addition, high TG levels were suggested in a previous study as the most prevalent type of dyslipidemia in Northeast China, followed by high TC levels [15]. Thus, the present study was designed to explore the associations between various serum vitamin concentrations and serum lipid profiles, including serum TC, TG, HDL-C, and LDL-C levels in a healthy Northeast China population.

Materials And Methods

Population

In the present study, 166 participants were recruited from Shenyang, Liaoning province, China. The present cross-sectional study was conducted in the Department of Health Examination Center, Shengjing Hospital of China Medical University. Participants were invited to complete questionnaires which included questions relating to their lifestyle, undergo a set of tests, and provide blood and other biological specimens in the examination center. Participants who did not complete blood biochemical analyses were excluded (n=35) and consequently, 131 subjects were included in the final analysis. Full informed written consent was obtained from all the participants and the Ethics Committee of Shengjing Hospital of China Medical University (Shenyang, China) gave ethical approval for the study.

Assessment of serum samples

After an overnight fast, venous blood samples were collected from all participants at the beginning of the study. The blood samples were centrifuged and serum extracted. Sera were stored at 4°C until further use. TC, TG, HDL-C, and LDL-C levels were analyzed using the Sysmex AU-5400 Automatic Biochemical Analyzer. Serum vitamins were quantified using a mass spectrometer. All tests were performed in the Laboratory Medicine of Shengjing Hospital of China Medical University.

Assessment of covariates

All participants completed a self-administered semi-quantitative Food Frequency Questionnaire (FFQ) that included questions regarding age, sex, total energy, and food items. Energy and nutrient intake were estimated using the Chinese Food Composition Tables. Weight and height were measured by trained medical staff using Body Composition Analyzers (TANITA, Japan). Body mass index (BMI) was calculated using the following formula: BMI = Weight (kg)/Height (m2).

Statistical Analysis

Continuous variables were presented as means ± standard deviation (SD). Continuous variables not following normal distribution were logarithmically transformed (serum vitamins and all serum lipids) for modeling. For the adjusted model, gender, age, BMI, and total energy intake were adjusted. Analysis of covariance was used to assess the associations between vitamins and serum lipids. All statistics were two-tailed and a P-value < 0.05 was considered statistically significant. Data processing and statistics were performed using the Statistical Analysis System 9.3 edition for Windows (SAS Institute Inc, Gary, NC, USA).

Results

A total of 131 adults (89 females, 42 males) were recruited in the present study. The average age was 28.07 ± 10.72 years in males and 32.21 ± 13.98 years in females. The serum vitamin concentrations, TC, TG, HDL-C, and LDL-C levels are shown in Table 1.

The associations between serum vitamin concentrations and TC level were shown in Table 2. The results showed TC level was associated with vitamin A (*P* for trend < 0.001), vitamin B3 (*P* for trend = 0.02), vitamin B6 (*P* for trend = 0.02), and vitamin E concentrations (*P* for trend < 0.01). However, after multiple adjustments, no association was observed between vitamins and TC level.

Table 3 showed the association between serum vitamin concentrations and TG level. Vitamin A (*P* for trend < 0.001) and vitamin B5 (*P* for trend < 0.01) concentrations were positively associated with TG level (*P* for trend = 0.01, *P* for trend = 0.02). In addition, vitamin A (*P* for trend = 0.01), vitamin B5 (*P* for trend = 0.02), and vitamin C (*P* for trend = 0.02) concentrations were positively associated with TG level based on multivariate models. However, vitamin B1 concentration was negatively associated with TG level (*P* for trend = 0.04).

Table 4 showed the associations between serum vitamin concentrations with HDL-C level. Vitamin B9 concentration was positively associated with HDL-C level (*P* for trend = 0.03), which was not significantly associated after multivariate adjustment. In addition, vitamin E concentration was associated with HDL-C level based on the adjusted model (*P* for trend = 0.02).

As shown in Table 5, vitamin B1, vitamin B2, vitamin B5, vitamin B6, vitamin D3, and vitamin E concentrations were associated with LDL-C level (all *P* for trend < 0.05). After adjusting for variates, vitamin C concentration was positively associated with LDL-C level (*P* for trend < 0.01). The association between vitamin A and LDL-C was the strongest (*P* for trend < 0.0001), however, after adjusting for variables, the association was weakened (*P* for trend < 0.01).

Discussion

In the present study, the results indicate vitamin A and vitamin C concentrations were positively associated with LDL-C level. Vitamin A, vitamin B5, and vitamin C concentrations were positively associated with TG level. However, vitamin B1 concentration was negatively associated with TG level. Vitamin E concentration was positively associated with HDL-C level. However, statistical association was not observed between vitamin concentrations and TC level.

The results of the present study indicate that vitamin B1 and vitamin E concentrations were associated with a better status of lipid profiles. In a previous study, the concentration of vitamin B1 was negatively associated with HDL level in patients with type 1 diabetes without any effect on TG and LDL-C levels [12]. However, in another study, vitamin B1 was shown to potentially improve serum lipids in healthy people [16]. Similar results were observed in the present study, vitamin B1 concentration had favorable effects on serum lipid levels. Thus, the differences in study subjects may be the reason for the conflicting results. However, the role of vitamin B1 in the lipid profile is unclear and further explorations are necessary.

In a previous RCT, serum vitamin E was positively associated with HDL-C in cardiovascular disease subjects [11]. In addition, vitamin E was suggested to increase the serum HDL levels in middle-aged-to-elderly healthy individuals [16]. In another previous study, vitamin E was shown to effectively lower the serum TC and LDL levels and increase the serum HDL levels in healthy individuals [17]. In accordance with the previous study, vitamin E concentration was positively associated with HDL level in the present study ($P = 0.03$). Vitamin E can counteract lipid peroxyl radicals, thus terminating the peroxidation chain reaction and thereby reducing oxidative damage. Vitamin E is the major lipophilic, radical-scavenging antioxidant in vivo, protecting against oxidative stress mediated by active oxygen as well as nitrogen species [18]. The negative associations between HDL-C and oxidative stress may primarily result from the antioxidant properties of HDL-C. The antioxidant activity of HDL-C is mainly mediated by the content of the enzyme esterase-paraoxonase-1 [19]. Thus, vitamin E may have a positive association with HDL-C and significant effect on serum lipid levels.

Furthermore, higher concentrations of vitamin A, vitamin C, and vitamin B5 were associated with a worse status of lipid profiles in the present study. In a previous study, the TG level was higher in women after vitamin A supplementation than in subjects without supplementation and the concentrations of serum LDL-C increased significantly in healthy women after vitamin A supplementation [10]. In another study, vitamin A was significantly associated with TG level [20]. Similar results were observed in the present study, vitamin A concentration was positively associated with LDL-C and TG levels. This association may be explained by the proposed mechanism that vitamin A enhances the hepatic production of apoprotein C-III, which prevents very-low-density lipoprotein from binding to the surface of endothelial cells of blood vessels and delays lipolysis by lipoprotein lipase, eventually leading to higher serum TG concentrations [21]. Thus, increased vitamin A concentration can lead to an increase in TG and LDL-C levels, which can have harmful effects.

In a previous RCT, as serum vitamin C increased, significant favorable effects were not observed on TC, HDL-C, LDL-C, and TG in atrophic gastritis subjects [22]. However, in another study, vitamin C was found to effectively lower the serum TC and LDL-C levels and increase the serum HDL-C level in middle-aged-to-elderly healthy individuals [23]. In contrast, vitamin C was positively associated with LDL-C and TG levels in the present study. However, associations were not observed between serum vitamin C concentration and TC and HDL-C levels. The dose of vitamin C, the type of intervention, study subjects and/or other differences in study conditions may have caused the conflicting results. Furthermore, biological explanations for the association between serum vitamin B5 and serum lipid levels are unknown.

In addition, the prevalence rate of dyslipidemia varies by region due to different climatic environments, diets, and lifestyles. In an epidemiology study, a high prevalence of dyslipidemia was found among adults in Northeast China, especially in urban areas [15]. The study results also indicated that high TG was the most prevalent type of dyslipidemia in Northeast China, followed by high TC [15]. However, the awareness and control rate of dyslipidemia were significantly below desirable levels. Therefore, to determine the associations between serum vitamins and serum lipids in Northeast China is necessary.

The main strength of the present study is the comprehensive investigation into the associations between serum vitamins and serum lipids in healthy subjects from Northeast China. Several limitations should be taken into consideration in this study. First, the present study was cross-sectional in design, therefore, the findings do not indicate any causality and limits any inferences that could be derived from the results. Second, the sample size in the study was relatively small, thus, the results may not be conclusive. Third, although we adjusted for a multitude of covariates, potential unmeasured and residual confounding factors cannot be excluded.

Conclusion

In conclusion, the results from the present study indicate that serum vitamin concentrations are associated with serum lipid levels in the general healthy adult population in Northeast China. Vitamin B1 and vitamin E concentrations were associated with a better status of lipid profiles. However, vitamin A, vitamin C, and vitamin B5 concentrations were associated with a worse status of lipid profiles. The results of this study require further verification which could significantly contribute to the prevention of dyslipidemia.

List Of Abbreviations

total cholesterol (TC), triglyceride (TG), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), randomized controlled trial (RCT), Food Frequency Questionnaire (FFQ), Body mass index (BMI), standard deviation (SD)

Declarations

Ethics approval and consent to participate

Full informed written consent was obtained from all the participants and the Ethics Committee of Shengjing Hospital of China Medical University (Shenyang, China) gave ethical approval for the study.

Consent for publication

Not applicable.

Availability of data and materials

Not applicable.

Competing interests

The authors have no conflicts of interest to declare

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Author Contributions

WL. designed the study. QC. and QW.: performed participants’ data collection. YX.: analyzed and interpreted the data. WL. and YX.: wrote this manuscript. YZ. and FO.: supervision. All authors were responsible for the critical revision of the manuscript.

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References

[1]. Ghaddar F, Salameh P, Saleh N, Farhat F, Chahine R, and Lahoud N, et al., Noncardiac Lebanese hospitalized adult patients' awareness of their coronary artery disease risk factors. Vasc Health Risk Manag. 2018. 14.371-82.

[2]. Helkin A, Stein JJ, Lin S, Siddiqui S, Maier KG, and Gahtan V, Dyslipidemia Part 1–Review of Lipid Metabolism and Vascular Cell Physiology. Vasc Endovascular Surg. 2016. 50(2).107-18.

[3]. Isomaa B, Almgren P, Tuomi T, Forsen B, Lahti K, and Nissen M, et al., Cardiovascular morbidity and mortality associated with the metabolic syndrome. Diabetes Care. 2001. 24(4).683-89.

[4]. Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III). JAMA. 2001. 285(19).2486-97.

[5]. Yang W, Xiao J, Yang Z, Ji L, Jia W, and Weng J, et al., Serum lipids and lipoproteins in Chinese men and women. Circulation. 2012. 125(18).2212-21.

[6]. 2019 ESC/EAS guidelines for the management of dyslipidaemias: Lipid modification to reduce cardiovascular risk. Atherosclerosis. 2019.

[7]. Marchesini G, Forlani G, Cerrelli F, Manini R, Natale S, and Baraldi L, et al., WHO and ATPIII proposals for the definition of the metabolic syndrome in patients with Type 2 diabetes. Diabet Med.

2004. 21(4).383-87.

[8]. Teslovich TM, Musunuru K, Smith AV, Edmondson AC, Stylianou IM, and Koseki M, et al., Biological, clinical and population relevance of 95 loci for blood lipids. Nature. 2010. 466(7307).707-13.

[9]. Yin RX, Li YY, Liu WY, Zhang L, and Wu JZ, Interactions of the apolipoprotein A5 gene polymorphisms and alcohol consumption on serum lipid levels. PLoS One. 2011. 6(3).e17954.

[10]. Farhangi MA, Keshavarz SA, Eshraghian M, Ostadrahimi A, and Saboor-Yaraghi AA, Vitamin A supplementation, serum lipids, liver enzymes and C-reactive protein concentrations in obese women of reproductive age. Ann Clin Biochem. 2013. 50(Pt 1).25-30.

[11]. Barzegar-Amini M, Ghazizadeh H, Seyedi S, Sadeghnia HR, Mohammadi A, and Hassanzade-Daloee M, et al., Serum vitamin E as a significant prognostic factor in patients with dyslipidemia disorders. Diabetes Metab Syndr. 2019. 13(1).666-71.

[12]. Al-Daghri NM, Alharbi M, Wani K, Abd-Alrahman SH, Sheshah E, and Alokail MS, Biochemical changes correlated with blood thiamine and its phosphate esters levels in patients with diabetes type 1 (DMT1). Int J Clin Exp Pathol. 2015. 8(10).13483-88.

[13]. Ge H, Sun H, Wang T, Liu X, Li X, and Yu F, et al., The association between serum 25-hydroxyvitamin D3 concentration and serum lipids in the rural population of China. Lipids Health Dis. 2017. 16(1).215.

[14]. Chen WR, Sha Y, Chen YD, Shi Y, Yin DW, and Wang H, Vitamin D, parathyroid hormone, and serum lipid profiles in a middle-aged and elderly Chinese population. Endocr Pract. 2014. 20(6).556-65.

[15]. Zhang FL, Xing YQ, Wu YH, Liu HY, Luo Y, and Sun MS, et al., The prevalence, awareness, treatment, and control of dyslipidemia in northeast China: a population-based cross-sectional survey. Lipids Health Dis. 2017. 16(1).61.

[16]. Hooper PL, Hooper EM, Hunt WC, Garry PJ, and Goodwin JS, Vitamins, lipids and lipoproteins in a healthy elderly population. Int J Vitam Nutr Res. 1983. 53(4).412-19.

[17]. Rezaian GR, Taheri M, Mozaffari BE, Mosleh AA, and Ghalambor MA, The salutary effects of antioxidant vitamins on the plasma lipids of healthy middle aged-to-elderly individuals: a randomized, double-blind, placebo-controlled study. J Med Liban. 2002. 50(1-2).10-13.

[18]. Gackowski D, Kowalewski J, Siomek A, and Olinski R, Oxidative DNA damage and antioxidant vitamin level: comparison among lung cancer patients, healthy smokers and nonsmokers. Int J Cancer. 2005. 114(1).153-56.

[19]. Zablocka-Slowinska K, Placzkowska S, Skorska K, Prescha A, Pawelczyk K, and Porebska I, et al., Oxidative stress in lung cancer patients is associated with altered serum markers of lipid metabolism.

PLoS One. 2019. 14(4).e215246.

[20]. Toyoshima H, Hayashi S, Miyanishi K, Wakai S, Enoki S, and Kumagai H, et al., [Effects of serum lipid concentrations and smoking and drinking habits on serum vitamin A and E levels]. Nihon Eiseigaku Zasshi. 1989. 44(2).659-66.

[21]. Vu-Dac N, Gervois P, Torra IP, Fruchart JC, Kosykh V, and Kooistra T, et al., Retinoids increase human apo C-III expression at the transcriptional level via the retinoid X receptor. Contribution to the hypertriglyceridemic action of retinoids. J Clin Invest. 1998. 102(3).625-32.

[22]. Kim MK, Sasaki S, Sasazuki S, Okubo S, Hayashi M, and Tsugane S, Long-term vitamin C supplementation has no markedly favourable effect on serum lipids in middle-aged Japanese subjects. Br J Nutr. 2004. 91(1).81-90.

[23]. Najafpour BS, Yusof RM, Nasir MTM, Mirzaei K, Yazdekhasti N, and Akbarzadeh S, Effect of vitamin supplementation on serum oxidized low-density lipoprotein levels in male subjects with cardiovascular disease risk factors. Iran J Basic Med Sci. 2012. 15(4).958-64.

Tables

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