Journal of Clinical Lipidology (2016) ■, ■–■

Journal of Clinical Lipidology

Original Article

Effects of climatic factors on plasma lipid levels: A 5-year longitudinal study in a large Chinese population

Xiaoming Zhou, Haiyan Lin, Shigang Zhang, Jianwei Ren, Zhe Wang, Yun Zhang, Mansen Wang**, Qunye Zhang, PhD*

Division of Endocrinology and Metabolism, Shandong Provincial Hospital Affiliated to Shandong University (Drs Zhou and Wang); Department of Pharmacology, Shandong University School of Medicine, Jinan, China (Drs Zhou and Wang); Health Examination Center, Shandong Provincial Hospital Affiliated to Shandong University, Jinan, China (Dr Lin); Department of Neurosurgery, Liaocheng People's Hospital, Liaocheng, China (Dr S. Zhang); Health Division of Guard Bureau, General Staff Department of Chinese PLA, Beijing, China (Dr Ren); The Key Laboratory of Cardiovascular Remodeling and Function Research, Chinese Ministry of Education and Chinese Ministry of Health (Drs Y. Zhang and Q. Zhang); The State and Shandong Province Joint Key Laboratory of Translational Cardiovascular Medicine, Qilu Hospital of Shandong University, Jinan, China (Drs Y. Zhang and Q. Zhang); and Medical Data Research Center, Providence Health & Services, Portland, OR, USA (Dr Wang)

KEYWORDS:
Plasma lipids;
Climatic factor;
Seasonal variation;
Longitudinal investigation;
Temperature

BACKGROUND: The rules and mechanisms of seasonal changes in plasma lipid levels, which may be related to annual rhythmicity of incidence and mortality of cardiovascular diseases, are still controversial.

OBJECTIVE: The objectives of this study were to study the effects of climatic factors on plasma lipid levels and to preliminarily reveal mechanisms of annual rhythmicity of plasma lipid levels.

METHODS: A longitudinal study was performed using health examination data of 5 consecutive years (47,270 subjects) in Jinan, China. The climate in Jinan is typical temperate continental monsoon climate with huge temperature difference between winter and summer (>30°C).

RESULTS: After considering and adjusting those classical lipid-associated risk factors, such as age, gender, diet, exercise, blood pressure, body weight, change of body weight, body mass index, glycemia, alanine aminotransferase, and creatinine, only air temperature could still significantly affect plasma lipid levels among the main climatic factors (humidity, precipitation, and so forth). For men, total cholesterol, high-density lipoprotein cholesterol, and low-density lipoprotein cholesterol was decreased significantly 0.35, 0.18, and 0.06 mmol/L, respectively, whereas triglyceride was increased significantly 0.12 mmol/L for every 10°C increase in air temperature. For women, total cholesterol and high-density lipoprotein cholesterol were decreased notably 0.73 and 0.32 mmol/L, and low-density lipoprotein cholesterol was increased significantly 0.26 mmol/L for every 10°C increase in air

This work was supported partly by the National Natural Science Foundation of China (81370270, 91439111, 81570712, and 81370890), Shandong Provincial Natural Science Foundation (JQ201519, ZR2010HL012, and ZR2014HQ003), and Science and Technology Development Program of Shandong Province (2012YD18079).

* Corresponding author. Qilu Hospital of Shandong University, Jinan, Shandong, China.

** Corresponding author. Medical Data Research Center, Providence Health & Services, Portland, OR, USA.

E-mail addresses: mansenwang@yahoo.com; wz.zhangqy@gmail.com

Submitted December 20, 2015. Accepted for publication June 18, 2016.

http://dx.doi.org/10.1016/j.jacl.2016.06.009

temperature, whereas triglyceride was not significantly affected by air temperature.

CONCLUSION: Air temperature is an independent risk factor for plasma lipid levels besides those classical lipid-associated risk factors. The annual air temperature fluctuations might be an important mechanism of the seasonal changes of lipids.

Introduction

In recent years, the cardiovascular and cerebrovascular diseases have become the number-one cause of mortality in the world.[1] It is well recognized that dyslipidemia plays crucial roles in the pathogenesis and development of these diseases.[2] Therefore, lipid-lowering treatment is an important strategy for the prevention of them in many treatment guidelines. In fact, the incidence of cardiovascular deaths per 100,000 in the US population has been decreased by 67% with the primary and secondary prevention in which statin lipid-lowering therapy was the key component since the 1970s.[3] Nonetheless, cardiovascular diseases (CVDs) still remain the number-one cause of mortality in the United States. Moreover, CVD morbidity and mortality are still increasing rapidly in developing countries.[1,2] All these indicate that more in-depth studies are needed to reveal the characteristics of CVD risk factors, including dyslipidemia.

Many human physiological processes have daily and monthly rhythmicity, such as hormone circadian rhythm and menstrual cycle. It had been reported that men who lived in the cold regions of Sweden had a higher coronary mortality. Moreover, the annual rhythmicity of incidence of AMI and coronary mortality was significant, namely highest in winter and lowest in summer.[4–8] Hyperlipidemia is one of the most important risk factors for CVD, and its seasonal variation might contribute to the seasonal changes of coronary mortality.[9] Most studies considered that there were significant seasonal changes in plasma or serum lipid levels.[10,11] However, it still remained controversial for the fluctuations of different lipids, such as triglyceride (TG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C), in different seasons and genders.[12–15] The differences of experimental conditions in many studies might lead to the conflicting results, such as the population, races, climate, and length of study time. Obviously, the seasonal changes of plasma lipid levels are old, but still, controversial problems need to be studied in more depth.

To date, many studies on seasonal variations of plasma lipids have been reported, but, there were still some shortcomings in them, for example, small number of samples, short study time (1–3 years), less lipid species, unobvious differences in climate of 4 seasons.[11,16] Although some studies investigated the relationship between temperature and plasma lipids, the results were still conflicting.[17–19] Moreover, in addition to air temperature, it is still unclear whether and how other seasonal or climatic factors including humidity, precipitation, sunshine time, and atmospheric pressure impact on plasma lipids and which of them plays key roles in seasonal changes of plasma lipids. The mechanism behind the seasonal variations in plasma lipid levels remains unknown, and it should be investigated by considering more geographic regions, races, ages, and lifestyle.

In this study, health examination data of 5 consecutive years in Jinan were analyzed to investigate the relationship between plasma lipid levels and climatic (ie, air temperature, atmospheric pressure, precipitation, humidity, and sunlight) and other factors. The climate in Jinan is typical temperate continental monsoon climate with markedly distinct seasons and huge temperature difference between winter and summer (>30°C). These climate characteristics are more suitable for studying the seasonal variation of plasma lipids. Moreover, the data of 5 consecutive years also allowed us to examine more reliably the relationship between seasonal variation of plasma lipids and climatic and many other factors.

Material and methods

Ethical statement

This study was performed according to the ethical principles for medical research involving human subjects outlined in the Declaration of Helsinki. The study was also approved by local institutional review committees, and all subjects were well informed.

Study location

Jinan has 4 distinct seasons due to its location in the temperate continental monsoon climate zone. The data of monthly averaged air temperature, atmospheric pressure, precipitation, humidity, and sunlight in Jinan between 2008 and 2012 were collected from China Climate Resources Database. This city is dry and warm in spring, rainy and hot in summer, cool and clear in autumn, and dry and cold in winter. January has an average low temperature of −5.4°C, and the average high temperature in July is 33°C. The annual precipitation is around 675 mm, most of which happen in July and August.