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Air pollution and blood lipid markers levels: Estimating short and long-term effects on elderly hypertension inpatients complicated with or without type 2 diabetes☆

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ABSTRACT

With the development of society and the economy, many Chinese cities are shrouded in pollution haze for much of the year. Scientific studies have identified various adverse effects of air pollutants on human beings. However, the relationships between air pollution and blood lipid levels are still unclear. The objective of this study is to explore the short and long-term effects of air pollution on eight blood lipid markers among elderly hypertension inpatients complicated with or without type 2 diabetes (T2D). Blood lipid markers which met the pre-established inclusion criteria were exported from the medical record system. Air pollution data were acquired from the official environmental protection website. Associations between the air quality index and the blood lipid indexes were analyzed by one-way ANOVA and further Bonferroni correction. In an exposure time of 7 days or longer, blood lipid markers were somewhat affected by poor air quality. However, the results could not predict whether atherosclerosis would be promoted or inhibited by poorer air condition. Changes of blood lipid markers of hypertension inpatients with or without T2D were not completely the same, but no blood lipid markers had an opposite trend between the two populations. The air quality index was associated with changes to blood lipid markers to some extent in a population of hypertension inpatients with or without T2D. Further studies are needed to investigate the potential mechanism by which air pollutants induce blood lipids changes.

1. Introduction

In the past few decades, air pollution conditions in many developed countries, such as United Kingdom (Maynard, 2015), Australia (Broome et al., 2015) and Japan (Hasunuma et al., 2014), have noticeably improved. But the opposite has occurred in China, as China is still in the process of industrialization and urbanization (Hu et al., 2010; Kan et al., 2012; Wang et al., 2014; Feng and Liao, 2016). As the biggest city in central China, Wuhan is carrying out large-scale urban infrastructure construction (Ding et al., 2014), generating a lot of dust every day, making the protection of the atmospheric environment immediately relevant.

Scientific studies have revealed that air pollution contributes to adverse birth outcomes (Shah and Balkhair, 2011), cardiovascular diseases (Suwa et al., 2002), respiratory symptoms (Schikowski et al., 2014) and many other adverse human health effects (Eze et al., 2015; Mannucci et al., 2015). Abnormal blood lipid marker levels are closely related to the initiation and progression of atherosclerosis and many other diseases, however, reports which focused on how blood lipid markers were affected by air pollution were relatively limited (Chuang et al., 2010, 2011; O'Toole et al., 2010; Poursafa et al., 2014; Sorensen et al., 2015). Related research from Wuhan has not been reported so far. As the atmosphere pollution conditions differ in various countries and regions,

Abbreviations: AQI, air quality index; T2D, type 2 diabetes; TG, triglyceride; TC, total cholesterol; HDL-C, high density lipoprotein-cholesterol; LDL-C, low density lipoprotein-cholesterol; Apo-A, apolipoprotein A; Apo-B, apolipoprotein B; LP(α), lipoprotein (α); M ± SD, Mean ± Standard deviation; ANOVA, analysis of variance; LY Hospital, Liyuan Hospital.

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it is necessary to explore how blood lipid markers would be affected by air pollution in Wuhan.

The relationships between air pollution and blood lipid markers have not been entirely understood, and studies that focused on this relationship in hypertension populations have not been reported, as far as we know. To fill the gap, in this study blood lipid markers from elderly hypertension inpatients complicated with or without Type 2 diabetes (T2D) in Wuhan were studied to explore whether they were affected by air pollution.

2. Methods

2.1. Ambient air quality in Wuhan

Daily air quality index (AQI) data from Wuhan from November 2013 to November 2015 were available on the official environmental protection website, and were gathered before being carefully examined. Air pollution data before November 2013 were not available and were not collected. Air quality was classified according to AQI values. To be specific, AQI values ranged from 0 to 50, 50–100, 100–150, 150–200, 200–300 and 300+ were considered as excellent, good, lightly polluted, moderately polluted, heavily polluted and severely polluted air quality respectively, according to the standard issued by China's Ministry of Environmental Protection.

2.2. Blood lipid markers

Elderly inpatients (≥60 years old) in the departments of Cardiology, Endocrinology and Geriatrics who were diagnosed with hypertension complicated with or without T2D and left Liyuan Hospital (LY Hospital) between 1 January 2014 and 1 December 2015 were the study population. Triglyceride (TG), total cholesterol (TC), high density lipoprotein-cholesterol (HDL-C), low density lipoprotein-cholesterol (LDL-C), apolipoprotein A (Apo-A), apolipoprotein B (Apo-B), lipoprotein a (LP(α)) and homocysteine data were collected from the medical record book stored in LY Hospital. As a considerable part of the inpatients had been checked for blood lipid markers for more than once after admitted in the hospital, the earliest test report was chosen when an inpatient had more than one blood lipid test report after hospitalization. Since some inpatients did not take blood lipid test until a few days of medical treatment had been given, blood lipid data were not adopted when they were taken too late to reduce the interference of medical activities, and within three days after a patient was hospitalized was set as the time during which lipid data were valid.

2.3. Statistical analyses

The study population was divided into two populations, according to whether a hypertension inpatient was simultaneously diagnosed with T2D or not. To estimate the short and long-term effects of air pollution, different multi-day lag (L) structures including L0, L0-2, L0-6, L0-14, L0-29, L0-59, L0-89 and L0-119 were analyzed respectively. For example, a lag of 0 day (L0) referred to the current-day AQI, and L0-2 refers to 3-day average of AQI of the current and previous two days. Using the air quality standard and the air quality conditions in Wuhan, all blood lipid marker data from the two study populations was classified into Group A, B and C. Group A referred to AQI $\leq$ 100, group B referred to 100 < AQI $\leq$ 150 and group C referred to AQI > 150. One-way ANOVA was adopted to compare blood lipid levels across three AQI groups (A, B and C), and the further multiple comparisons were conducted by using Bonferroni correction. The level of the *P*-value is 0.05. Blood lipid levels across the two populations (T2D and no T2D) were not compared, and what we have done is to study whether complicated with or without T2D would have an influence on the effects of air pollution on blood lipid markers. The Flow chart of the design and statistic analysis of this study is shown in Fig. 1.

3. Results

3.1. Characteristics of the AQI data

As shown in Fig. 2, air quality in Wuhan from 1 November 2013 to 30 November 2015 varied a lot. AQI values between 50 and 100 were the most common situation, accounting for 45.13 percent. Air quality which was considered excellent was rarely seen; on the contrary, AQI values higher than 100 accounted for nearly half of all the days, showing that air pollution happened regularly. Air quality which was considered heavily polluted and severely polluted added up to 8.82 percent, reflecting that serious air pollution was not only a potential threat, but also a reality to residents in Wuhan.

3.2. Characteristics of the blood lipid markers

718 subjects comprised the hypertension without T2D population, and 578 subjects comprised the hypertension with T2D population. The two populations were similar in age and gender composition. Characteristics of the eight blood lipid indexes of the two populations are shown in Table 1. Because some people were not measured in all eight indexes, the sample size of every lipid marker was smaller than the size of the corresponding population.

3.3. Blood lipids effects on hypertension inpatients without T2D

In lag0, lag0-2 and lag0-6 structures, none of the eight lipid markers showed any difference among the AQI groups. TG, LDL-C and Lp(α) showed no difference among group A, B and C in every lag structure. In the lag0-119 structure, TC was higher in group C than in group A. Apart from the lag0, lag0-2 and lag0-6 structures, HDL-C was higher in group C than in group A, and in the lag0-59 and lag0-89 structures, HDL-C levels in group C > group B > group A. Apo-A was lower in group A than in group B and C in the lag0-29 and lag0-59 structures, and in the lag0-89 and lag0-119 structures, Apo-A levels in group C > group B > group A. In the other lag structures, no difference of Apo-A levels was found among the groups. As to Apo-B, only in lag0-59 structure did we find that Apo-B level in group B was higher than that in group C. Homocysteine level was higher in group A than in group B in lag0-29 structure, higher in group A than in group C in lag0-59 structure, and lower in group C than in group A and B in lag0-89 structure. Detailed results are shown in Supplementary Tables 1–4 and Tables 2–5.

3.4. Blood lipids effects on hypertension inpatients with T2D

Among the eight lipid markers, no differences were found among three groups in lag0 and lag0-2 structures. TG, TC, HDL-C and Apo-A did not vary among groups in any lag structure. LDL-C levels in group C were higher than in group A in lag0-14, lag0-29, lag0-59 and lag0-89 structures. Apo-B levels were lower in group C than in group B in lag0-59 structure, and were lower in group C than in group B and group A in lag0-89 structure. Lp(α) levels were higher in group B than in group A in lag0-6 structure, and were higher in group C than in group A in lag0-89 structure. Homocysteine levels were higher in group A than in group B in lag0-119 structure and no differences were found among groups in the other lag structures. Detailed results are also shown in Supplementary Tables 1–4 and Tables 2–5