Pollution characteristics and harm to human health during the Spring Festival in Hohhot

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Abstract. This paper analyzes AQI, PM2.5, PM10, SO2, NO2 during the Spring Festival in 2019, at the same time, and all kinds of pollutants exceeded the range of national secondary standard concentration during this period. According to the previous data, the relationship between PM2.5 and atmospheric visibility and the harm of fine particles to human body were analyzed. The results showed that the mass concentration of PM2.5 has a great impact on the visibility of the atmosphere, when the concentration of fine particles exceeds a certain degree, it is harmful to human body. According to the standard, PM2.5 and PM10 are the most harmful to the environment and human body.

1. Introduction:
Research shows setting off fireworks massively during the Spring Festival will result in a sharp increase in the concentration of atmospheric pollutants, which will lead to the deterioration of air quality and even harm human health. In recent years, many domestic specialists and scholars have carried out many research on the impact of fireworks on air quality during the festival, Xiaoling Zhang[1] and others found that the large amount of fireworks during the new year's Eve and Lantern Festival in Beijing will lead to a dramatic rise in the concentration of particulate matter in a short time, but the impact on the concentration of sulfur dioxide and nitrogen dioxide is not obvious. The outcome is consistent with the results obtained by other experts.

However, currently studies mostly focus on Beijing, Shanghai and other big cities. There are few studies about air pollutants in Hohhot during the Spring Festival. Based on the daily average values of PM2.5, nitrogen dioxide, sulfur dioxide and other air pollutants in Hohhot during the Spring Festival in 2019, this study explored the pollution characteristics of air pollutants and their health risk assessment on human body.

2. Data and methods
In this paper, the monitoring data of AQI, PM2.5, nitrogen dioxide, sulfur dioxide and other pollutants in Hohhot during the Spring Festival in 2019 were collected and sorted out based on the data provided by China environmental monitoring station, the Department of ecological environment of Inner Mongolia Autonomous Region and PM2.5 historical data network. Excel is used to sort out and compare the data to obtain the characteristics of air pollution during the Spring Festival.
2.1. Data collection and analysis
According to <Technical regulation of ambient air quality index>, the issue adopts Air Quality Index (AQI) to assess the urban air quality.

On the basis of the monitoring data of air pollutant concentration in Hohhot during the Spring Festival in 2019, the article plots the change trend of AQI, PM2.5, PM10, SO2, NO2 in Hohhot during this period.

As can be seen from Figure 1, here were five days being polluted even extremely polluted. On Feb.5, AQI touched 271(μg/m³), and on the basis of data from Weather Network, the average hourly concentration at 3’o clock that day reached 307(μg/m³) which can make people breathe poorly. Yet AQI of the remaining twelve days were all below 100 and air quality was in the good range. Hence one can see that, the air quality in Hohhot was good when there were no fireworks.

It can be seen from Figure 2 to Figure 5 that the changed trend of PM2.5, PM10, SO2, NO2 was nearly the same. They all got an increase from Feb.2 to Feb.5 and peaked at 221(μg/m³), 223(μg/m³), 45(μg/m³), 51(μg/m³) respectively on Feb.5, which was then followed by a sharp decrease on Feb.6. After that, except a small peak on Feb10, the data were all stable at a number separately. And with a significant rise on Feb.19. However, the variation trend of NO2 had a little difference from Feb.16, which stood at the higher value.

The reasons is easy to find out, that is, the human activities in Chinese New Year of 2019 starting from Feb.5. However, Feb.2, which was Lunar New Year 29, people were getting ready to welcome the New Year with setting off firecrackers. Moreover, everyone would like to set off fireworks on midnight of New Year’s Eve, thus there was a peak on Feb.5. And the fifth day of Lunar New Year has a custom which is setting off fireworks to drive out all the bad things. Besides, Lantern Festival was on Feb.19.

According to Form 1, compared to the annual average concentration of PM2.5, PM10, SO2 in Hohhot in 2019, those average data during Spring Festival all exceed the annual average. In particular, average concentration SO2 of Spring Festival was 140% of that in the whole year.

There may be other reasons why the annual average of NO2 was more than this period.

| Average concentration/μg/m³ | Spring Festival | 2019 over-limit rate |
|---------------------------|----------------|---------------------|
| PM2.5                     | 49             | 38                  | 28.90%              |
| PM10                      | 82             | 77                  | 6.50%               |
| SO2                       | 21             | 15                  | 40%                 |
| NO2                       | 32             | 39                  | -17.90%             |

Meanwhile, compared to National Standard of the People’s Republic of China Ambient Air Quality Standard(GB3095-2012), even the daily concentration of SO2 got the peak at 45(μg/m³), but it is still under the concentration limit of national secondary standard which was 150(μg/m³) per day. The same result can be obtained by comparing the NO2 data between the Twos, PM2.5 and PM10, that is, both of them were seriously exceeding the national class of 75(μg/m³) and 150(μg/m³) respectively. AQI was significantly correlated with PM2.5, PM10, SO2, NO2, especially PM10 and PM2.5, with correlation coefficients of 0.959 and 0.8, respectively.[2] It can be concluded that fine particular matter has the greatest impact on the environment during the Spring Festival.
2.2. Atmospheric visibility during Spring Festival
Atmospheric visibility refers to the maximum horizontal distance that people with normal vision can
see under the weather conditions. As an important physical parameter to characterize the transparency of the atmosphere, it not only reflects the quality of regional atmospheric environment and air pollution, but also directly affects people's life and health, and is also the most direct indicator of air quality [3]. According to the previous data of relative humidity (RH) analyzed by Linchun Liu [4] in Hohhot, the daily average RH in winter was mainly 40%-60%, then was less than 40%. And when RH is in the range of 0% - 60%, RH has no obvious effect on atmospheric visibility [5]. Therefore, in order to analyze the relationship between atmospheric visibility and particulate matter concentration in Hohhot during the Spring Festival and avoid the influence of RH on atmospheric visibility, the data of particulate matter concentration and atmospheric visibility in the range of 0% -60% RH were selected. A study has revealed the relationship between fine particulate matter and atmospheric visibility, which said when the mass concentration of PM2.5 was greater than 50(μg/m³), the visibility decreased significantly with the increase of PM2.5 mass concentration, indicating that PM2.5 concentration is the main influencing factor of atmospheric visibility. When the mass concentration of PM2.5 is in the range of 50-150(μg/m³), the average visibility is 2.6 km. When the mass concentration of PM2.5 is in the range of 150-300(μg/m³), the average visibility is 1.1km. Combined with data in the Spring Festival of 2019, in those days when air pollution was the most serious, the visibility was almost less than 2km.

2.3. Harm to human health
When the concentration of these air pollutants reaches a certain level, they are all harmful to human health. SO2 can oxidize itself to form sulphuric acid, which will eventually cause lung damage, such as wheezing and shortness of breath. NO2 can increase children's susceptibility to respiratory diseases, especially in winter.[6]

The surface area of PM2.5 with complex structure is larger than that with simple structure composed of large particles. It is easier to adsorb some harmful heavy metals and organic matters, so it has higher toxicity. It has great harm to every system of human body. For example, respiratory diseases such as sinusitis, chronic obstructive pulmonary disease, pulmonary insufficiency, lung cancer, allergic lung disease, sarcoidosis and other respiratory diseases are related to exposure to PM2.5. What’s more, it can enter the deep respiratory tract and alveoli, and even enter the blood circulation, resulting in multiple system damage, especially cardiovascular system. Arrhythmia, atherosclerosis, myocardial infarction, coronary heart disease and heart failure are all related to PM2.5 inhalation. Besides that, it also involved circulation, nerve, immunity, digestion, metabolism, blood, reproduction, eye, skin and so on. Therefore, it is particularly important to strengthen the protection of the population and reduce the pollution of atmospheric particles. Although researchers have made some scientific achievements at present, the understanding of the air pollution on human health is still limited. And due to the acceleration of urbanization and the increasingly serious urban air pollution, it has not yet formed a comprehensive understanding of the health effect mechanism of PM2.5.[7]

3. Discussion
The control of fireworks should be strengthened during the Spring Festival in Hohhot. At the same time, the government should go into the community to popularize the harm of setting off fireworks and firecrackers to the environment, so that the citizens can be aware of the disadvantages of doing so from the heart and will not set off fireworks secretly. Although we do not have the company of fireworks in the Spring Festival currently, I believe that in the future, there will be an environment-friendly substance or a kind of bioluminescent microorganisms that can replace sulfur to help us retrieve the flavor of the year.

4. Conclusion
The air quality of Hohhot during the Spring Festival in 2019 is generally good, with 70.5% of the days with good air quality. However, in the days with more fireworks and firecrackers, there will be serious pollution, the concentration of PM2.5, PM10, sulfur dioxide, nitrogen dioxide would surge in varying degrees.
Even at the maximum concentration in a single day, the concentration of sulfur dioxide was still within the scope of the national secondary standard, and the change of nitrogen dioxide was small, so the main harm to the environment and human body was fine particles.

Without considering the relative humidity of the environment, the fine particulate matter had a great impact on the atmospheric visibility during the Spring Festival, especially on the night of New Year's Eve.

PM2.5 has different degrees of harm to various human systems. When the air quality is poor, outdoor activities should be reduced as much as possible.

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