

## **Study on outdoor trip route based on particulate matter distribution**

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With the rising attention on health, outdoor exercises, such as road running and line dancing, are becoming more and more popular among urban residents in China. However, due to industry development, rise of car ownership and city construction, air pollution, especially particulate matter (PM<sub>2.5</sub>/10), has become a significant issue in urban environment. According to previous studies, PM exposure is associated with a danger of respiratory diseases while maximum daily concentration and annual average concentration of PM<sub>2.5</sub> in many big cities in China exceeds the standard of air quality, which has drawn greater public concern.

In this context, weather bureau and other commercial companies began to provide real time broadcast and forecast of PM<sub>2.5</sub> concentration. But the existing forecast of PM<sub>2.5</sub> concentration is more focused on a city scale or even national scale, which has little practical use for daily trip guide that directly related to everyday life and personal health. This research attempts to provide roadrunners a less affected route and suggest less affected places for outdoor activities. A correlation between PM concentration data and congestion index is established to represent the healthy level of built environment.

The research comprises two spatial scales. At the city scale, we conduct a cross-sectional survey of 849 people living in Shanghai, among which 267 people had lung cancer. The survey consists of factors of individual level, such as age, smoking status and cooking habits; dwelling unit level, such as per capita living space and house age; and residential community level, such as external traffic volume and surrounding land use. Through a multi-level correlation analysis with individuals, dwellings and residential communities, we find built environment is related to lung

cancer incidence. For instance, external traffic volume ( $R=0.101$ ), per capita living space ( $R=0.195$ ), and time for outdoor activities ( $R=0.146$ ) all have a mildly association with higher lung cancer incidence. The survey derived analysis suggests that built environment is independently associated with respiratory disease incidence with a focus on lung cancer. Based on previous studies on correlation between PM and built environment and between PM and respiratory diseases, the research build a mutual association between these three aspects and the findings identify built environment factors that have impact on respiratory disease incidence and PM distribution.

At the neighborhood scale, we select five blocks for case study to collect data of PM concentration in Shanghai. The PM detectors are located at 1) intersections of roads; 2) specific density places such as open spaces and high-rise clusters, which would accelerate or moderate the diffusion of PM; 3) particular use of land such as parks and schools where people would like to have outdoor exercises. The data was then 1) spatially interpolated through universal kriging to achieve a raster data covering the testing area; 2) imported into an analysis with road congestion index from Baidu map to build a regression model to revise the PM distribution data on the road. The outcome data demonstrated the PM distribution at a more micro level. And we also measure the walkability of the streets in test area according to their imageability, enclosure, human scale and transparency index which including accessible parks, street trees, lightening system, etc.

Using the revised data of PM distribution at a neighborhood scale, we can 1) identify the relatively healthy place for outdoor activities in terms of risk of respiratory diseases; 2) calculate the PM concentration of each section of the streets and bring streets walkability index into consideration, so that once origin, destination and route length was determined, network analysis would be conducted to plan a better running route for road runners with relatively less PM exposure and better running circumstances; and 3) explore holistic improved intervention strategies in urban design, traffic control and retro-fitting of the built environment in case area in pursuit of healthy urban planning, such as PM concentration on streets may be declined by continuous street trees, relocated elevated highway exits and relatively low buildings.

The research underscores the need for effective improvement in planning index, design of residential built environment, activity space layout and traffic flow management accordingly to PM distribution and reduce its exposure to outdoor exercises to achieve the goal of a healthy city. The research provides an empirical basis for planning a healthy city in order to decrease the incidence of respiratory diseases. Further work is required to explore the causal mechanisms that are involved.