Air PM2.5 inhalation risk assessment based on feature fusion and physical fitness management of long-distance runners

Yanpeng Zhao

Abstract

At this stage, China’s urban population and industries are rapidly gathering, and urbanization continues to increase, creating serious problems for resources and the environment. Among them, PM2.5 and other air pollution problems are the most important. In the early stages of urbanization, due to a series of factors such as urban industrialization, dense population, and traffic congestion, air pollution has been aggravated. At the same time, due to the high population density and high population mobility in most cities, the number of people exposed to pollution is increasing. High pollution and high exposure levels make the city’s health problems significant, and the health problems of these residents inevitably have some economic problems. According to the requirements of China’s health and the requirements of feature integration, inhalation risk assessment of residents’ health risks caused by urban air pollution is very important in planning environmental sanitation policies. This article also analyzes long-distance running training, which is a systematic and scientific training process. To become a long-distance runner, long-term training is required, and the core of the course is the level of education. Starting with youth education is a breakthrough aimed at improving the level of long-distance running in China. In this article, we try to understand the characteristics of adolescents’ long-distance running training and physical fitness management. In the survey of young Chinese long-distance runners, long-distance running coaches and experts are the subjects of the survey, through the use of literature research methods, expert interview methods, and statistical methods. Perform analysis to provide useful references for coaches and players. Through the research of PM2.5 inhalation risk assessment and feature fusion, it is applied to the physical fitness management of long-distance runners, and it has been developed in the field of physical fitness management.

Keywords Feature fusion · PM2.5 · Inhalation risk assessment · Long-distance runners · Physical fitness management

Introduction

After large-scale smog occurred in central and eastern China in early 2013, environmental issues and air pollution have become the focus of attention in all sectors of society. In 2015, 265 of the 338 cities above the county level among the national test points did not meet the standards (Al-Khalaf and Basset 2013). Among them, PM2.5 is the main pollutant, accounting for 67% of the unqualified time. After several years of treatment, the urban air pollution problem has not been effectively solved (Almazroui et al. 2018). Especially at the end of 2016, when the haze weather occurred again, 24 cities launched the red warning of air pollution (Alijani 1988). With the acceleration of China’s industrialization and urbanization, due to the extensive economic development of high pollution, high energy consumption, and low efficiency, air pollution has become a key issue that restricts sustainable development and the construction of urban ecological civilization (Alpert and Shay-El 1990). Especially due to the large amount of coal produced in China, most of the industrial production uses coal as an energy source. Coal combustion produces more air pollutants than other fossil energy sources, and the continuous development of urban population and industrial agglomeration has caused serious resources (Amiri 2008) and environmental issues, especially air pollution. In the early stages of China’s urbanization, urban industrialization, large
population bases, and traffic congestion are exacerbating air pollution. Recently, due to the continuous increase of urban population, the continuous economic development and the continuous development of urbanization, and the continuous deterioration of automobile exhaust emissions, the air pollution situation in the city has become more serious (Ansari 2003). Therefore, in this article, we use the InMAP model established by the MEIC team and the grid emission data operation feature fusion provided by the InMAP research team of the university of Washington, calculate the amount of atmospheric ecological compensation based on this model, and make an inhalation risk assessment that is expected to establish a country ecological compensation mechanism (Awad and Almazroui 2016). However, this article also studied long-distance running, which is a specific endurance and cyclical sport (Awad and Mashat 2018). It uses aerobic metabolism as the main energy supply method of competitive sports (Barth and Steinkohl 2004). Through the development of long-distance running, the ability and record of this sport are greatly improved (Chakraborty et al. 2006). The current world record has reached a very high level. The continuous improvement of the world’s long-distance running sports level is directly related to the continuous development of training methods (Darand et al. 2018). As we all know, the training level of long-distance runners determines to a certain extent whether long-distance runners can reach the world level and whether they can achieve good results in international competitions. In the 21st century, long-distance running training in the world has gradually formed a relatively complete science curriculum, which has more advantages than before (Dayan and Abramsky 1983). The popularity of long-distance running training shows the development trend of “quantification of load, rationalization of load structure, proceduralization of long-term training, improvement of training efficiency, physical management, etc.” It further emphasizes the recovery and psychological training after the competitive load, so that the education theory develops steadily under the vertical and horizontal reference (Dayan et al. 2001).

**Materials and methods**

**Data source**

The data in this article mainly include PM2.5 pollution index, population density and urbanization rate, per capita GDP index, and medical-related data. Air pollution data from satellite remote sensing is used to reduce errors and data loss that may occur due to the use of ground monitoring points and to improve the accuracy of the calculation results (De Vries et al. 2016). Generally speaking, remote sensing image data can better measure the average air pollution level in the area, because compared with data from limited observation points on the ground, remote sensing image data can reflect the combined contribution of all sources (El-Fandy 1947). Therefore, the PM2.5 pollution index in this article is obtained by using PM2.5 products derived from the global annual satellite. The resolution provided by the atmospheric composition analysis team is 0.1 degrees (El-Fandy 1950). The Chinese part has input more statistical data, and its statistical data is used to measure PM2.5 pollution on a Chinese city scale.

At the same time, the end-of-life health exposures with the majority of the permanent population at the end of the year have been calculated to respond to changes (Evans and Smith 2006). The census and spot checks ignore most of the processes, and according to the final results, the overall deviation is relatively large. Therefore, in this article, the satellite remote sensing data used to calculate the population size of each city can more accurately estimate the actual total population currently exposed to PM2.5 pollution (Evans et al. 2004). The specific population density data is calculated from the 1°1 resolution land scan data provided by Geographic Information Science and Technology (GIST).

Regarding the level of cities, most existing studies only use the rate of population urbanization to express the level of urban development (Faraji 1981). However, with the deepening of research, some scholars have found that the urbanization rate of the population is not enough to express the multi-level development level of the city (Haggag and El-Badry 2013). For unreasonable viewing of statistical data, the statistical results are very different. Elvidge made the connection between luminous data and urban development, and in many studies, also proved the rationality of using luminous data to measure the level of urban development (Iqbal et al. 2012). These data are obtained from stable optical data obtained from the line scanning system OLS sensor installed on NOAA’s U.S. Military Weather Satellite Defense Meteorological Satellite Program DMSP. The resolution data is from 2014 to 2016. This survey selected annual data from the VIIRS satellite day and night band night lights to represent the development level of the city (Kahana et al. 2002). In the optical data, the DN value of each pixel is the average value of the DN value of the visible light band in the city, which is used to indicate the progress level of urbanization (Khalaj 2002). The data is divided into two parts. The first part is to first use the selected DMSP/OLS data to obtain only continuous power data through noise removal processing and continuity correction. The VIIRS satellite data removes temporary data and outliers and removes background noise. In addition, due to the high spatial resolution of VIIRS satellite data, the gray values of pixels vary greatly. Set thresholds and use DMSP/OLS data as a mask to further process VIIRS satellite daytime data.
Finally, the regional statistics of the two data can be used to obtain indicators of the level of urban development at the city level.

Feature map fusion method

In this article, we propose a feature fusion network, which is implemented by up-sampling and fusing low-resolution feature maps into high-resolution feature maps using deconvolution operations. After the features are fused, more semantic information will appear in the fusion layer. The feature map fusion method is shown in Figure 1.

In the fusion process of feature maps, the first $2 \times 2$ deconvolution layer is applied to the feature fusion layer $n + 1$, the next backbone network layer $n$ is $3 \times 3$, and it is ensured that it has the same feature layer as the feature layer before fusion size. Finally, the combined feature fusion layer $n$ is obtained through pixel-level superposition at the corresponding positions of the two feature layers. In this case, all feature fusion layers $n$ include not only the functions of the convolutional layer $n$, but also the functions of the fusion layer $n + 1$, and its functions contain rich semantic information.

Establishment of PM2.5 inhalation risk model

In order to analyze the relationship between the urbanization of county-level cities in China and PM2.5-related health risks, we chose to use the STIRPAT model for analysis and testing, while considering the previous fitting comparison between PM2.5 concentration and population urbanization. Choose to use speed and power data, the DN value of the lighting data to indicate the level of urban development, and use the level of urbanization as the main explanatory variable, and set the following model:

$$
\ln(HR_i) = \alpha_0 + \alpha_1 \ln(DN_i) + \alpha_2 \ln(IP_i) + \alpha_3 \ln(GDP_i) + \alpha_4 \ln(POP_i) + \mu_i
$$

Where $i$ is the area, $t$ is the time, and HR represents the number of deaths and diseases caused by PM2.5 pollution, that is, the number of health risks caused by PM2.5 pollution. Intellectual property refers to the industrial structure (expressed as a percentage of the total output value of the secondary industry); GDP is expressed as per capita GDP; population density is expressed as POP.

The establishment of a model of PM2.5 economic loss

In order to analyze the relationship between China’s county-level urbanization and PM2.5-related economic losses, the level of urbanization development was also selected as the main explanatory variable of the STIRPAT model, and the following model was established:

$$
\ln(EL_i) = \alpha_0 + \alpha_1 \ln(DN_i) + \alpha_2 \ln(DN_i)^2 + \alpha_3 \ln(IP_i) + \alpha_4 \ln(GDP_i) + \alpha_5 \ln(POP_i) + \mu_i
$$

$$
\ln(EL_i) = \alpha_0 + \alpha_1 \ln(DN_i) + \alpha_2 \ln(DN_i)^2 + \alpha_3 \ln(IP_i) + \alpha_4 \ln(GDP_i) + \alpha_5 \ln(POP_i) + \mu_i
$$

$$
\ln(EL_i) = \alpha_0 + \alpha_1 \ln(DN_i) + \alpha_2 \ln(DN_i)^2 + \alpha_3 \ln(IP_i) + \alpha_4 \ln(GDP_i) + \alpha_5 \ln(POP_i) + \mu_i
$$

Where $i$ is the area, $t$ is the time, and EL represents the number of economic losses caused by PM2.5 pollution.
In the formula, the region is represented by \( i \), and the time is represented by \( t \). Among them, EL represents the economic loss directly caused by health problems caused by PM2.5 pollution; DN is represented by the DN value of night lighting data, and intellectual property refers to the industrial structure (expressed as a percentage of the total output value of the secondary industry); domestic GDP is expressed in terms of per capita gross domestic product; population density is expressed in terms of POP.

**Results**

**Air PM2.5 pollution**

As shown in Figure 2, the left image is a remote sensing image of PM2.5 concentration in 2016, with an accuracy of 1 km², and the right image is an annual distribution map of urban average PM2.5 concentration after small-scale urbanization after regional statistics.

The above analysis shows that the population urbanization rate is compared with the fitting results and optical data indicating the level of urban development. First, as shown in Figure 3, draw the fitting results of the PU model and the PD model, including the following quadratic and cubic terms.

As shown in Figure 3, the model is as follows, in which the level of urbanization development is the main influencing factor.

(1) When the urbanization rate of the population is less than 10%, there is a difference between the PU2 model and the PU3 model. However, as the urbanization rate increases, the PM2.5 concentration is in a state of continuous decline. Before the urbanization level of PD2 and PD3, that is, before the DN value is lower than 15, the PM2.5 concentration increases with the increase of urbanization level. However, due to the large difference between the DN value and the population urbanization rate, if the DN value exceeds 15, the urbanization level is relatively high, and only a few large cities have a DN value greater than 30.

(2) There is a big difference between the PU series model and the PD series model. In particular, the results of the PU2 model and the PD3 model are almost opposite. The PU2 model has no turning point during the survey period, and as the population urbanization rate increases, the PM2.5 concentration continues to decline. On the contrary, the PD3 model shows that as the level of urbanization continues to increase, the PM2.5 concentration shows an increasing trend.

(3) However, the fitting results of the PU3 model and the PD2 model reveal the classic U-shaped inverse law of the curve, showing a certain similarity. All of this initially increased with urbanization, and then increased after the next turning point. Urbanization is in progress. PU3 is a model that contains the following three terms, but there should be two inflection points, but after calculation, the other inflection point exceeds the maximum 100% of the population urbanization rate, so it can be regarded as a fitting result within a reasonable range. As shown in the figure above, the PU3 model has only one inflection point, which is an optimized inflection point. PU3 is a model with the following quadratic terms, including only appropriate inflection points. The fitting results of the two models are slightly different. When the urbanization rate of the population is relatively low, the inflection
point of PU2 appears, and when the urbanization level is relatively high, when the inflection point of the PD2 model appears, according to the spatial panel from the fitting results, it can be seen that the level of urbanization needs to be in a relatively high state, from degradation to optimization.

(4) Compared with the general panel test, the spatial measurement panel takes into account the interaction factors between cities, indicating that the inflection point of improvement from inferior to excellent is delayed, which accelerates the diffusion of air pollutants between cities and delays air quality improvement. In addition, it shows that it is very difficult to improve the air quality in a city, and it is likely to be affected by external urban disturbances, which will affect the final air quality results. The future air quality improvement is the result of local joint governance and efforts.

**Health risk assessment of air PM2.5 inhalation**

Hospital expenses or outpatient services can be obtained from the “China Health and Family Planning Statistical Yearbook,” and other economic indicators, such as mortality and per capita net income, can be obtained from the “City Statistical Yearbook” and “Statistical Yearbook of Provinces.”

In order to understand the urban health problems caused by PM2.5 pollution, the year 2019 is selected as the analyzed data to calculate the changes in health risks. The exposure response function includes PM2.5 concentration data and population data to calculate changes in health conditions such as premature deaths, hospitalizations, and diseases caused by PM2.5 pollution in these cities. The estimated results show that the premature deaths caused by PM2.5 pollution caused 90,100, 8,060,000, and 476,000 person-times of respiratory diseases and cardiovascular diseases, respectively. The number of patients with chronic and acute bronchitis was 1.33 million and 1.38 million, respectively, and the number of patients with asthma was 3.15 million. Then, I selected the top 30 cities to draw the histogram. At the same time, in order to determine the relative degree of PM2.5 impact, the ratio of premature deaths caused by PM2.5 to the total number of urban deaths was calculated, and a line chart was drawn, as shown in Figure 4.

In Figure 4, first, the total number of chronic bronchitis and asthma caused by PM2.5 pollution is the highest, followed by the number of premature deaths and hospitalizations due to respiratory and cardiovascular events, while acute
bronchitis suffers the number of patients is relatively small. Nationally, premature deaths caused by PM2.5 accounted for an average of 6% of the total urban deaths, which shows that compared with other factors; the proportion of health problems caused by pollution is relatively large. In 30 cities, the incidence rate is higher than the national average. From a regional perspective, in addition to relatively small changes in the number of hospitalizations and premature deaths, the differences between different medical stations between regions show increasingly important changes. The increase in diseases and outpatients caused by PM2.5 pollution mainly occurred in J area and surrounding areas, including H and S provinces, C province urban agglomerations and densely populated areas, and even some provincial capital cities such as W, J, N, and N. Significant changes have also taken place in the medical terminal. In addition, mainly in areas with high PM2.5 concentrations, the ranking of the percentage of premature deaths caused by PM2.5 in the total number of urban deaths is also slightly different. It can be seen that dense distribution and changes in PM2.5 concentration together affect the changes in health outcomes. The two sides work together, but relatively speaking, the impact of pollutant changes is greater. For example, the southeast coastal cities and the Pearl River Delta are also densely populated areas, but due to low pollution levels, their impact is relatively high compared with other factors.

In order to better understand the process of changes in the health risks caused by PM2.5 pollution over time, we calculated the total population of nearly 400 cities in 10 years and the health risks over time. See Figure 5 for details.

**Analysis of economic losses caused by air PM2.5 inhalation**

By combining the changes in the health terminal obtained above with the unit economic loss, we calculated the sum of the economic loss caused by the health problems caused by PM2.5 pollution and the economic loss caused by the changes in all health terminals in each city. Choose to analyze in a visual manner, visualize the calculation results of economic losses caused by diseases such as premature death, hospitalization, bronchitis, and asthma, and plot the spatial distribution of economic losses, as shown in Figure 6.

According to the distribution characteristics of Figure 6, the direct economic losses caused by various medical terminals are usually similar across the country. Combining the abovementioned changes in health terminals and unit economic losses, we calculated the sum of the economic losses caused by the health problems caused by PM2.5 pollution and the economic losses caused by the changes in all health terminals in each city. In order to facilitate more intuitive observation, selection, and analysis, the calculation results of economic losses due to overall economic losses are visualized, and the spatial distribution diagram of direct economic losses as shown in Figure 7 is drawn.

The level of urbanization development is the main influencing factor model, see Figure 8 for details.

1. The fitting results of HD model and ED model are similar. For example, the HD2 model and ED2 model including the following items only have a general panel fitting inflection point, both have a high level of urbanization, and there is a degradation optimization
inflection point in the optimization. However, there is no practically significant inflection point in the results of the spatial fitting involving the quadratic term.

(2) The models including HD3 and ED3 did not show a turning point during the survey period, indicating that the health risks of urban residents have increased, and as the level of urbanization continues to increase, they are relevant and economic losses are also increasing. If the proportion of the urbanization level of the model is increased, the turning point will be degraded and optimized and appear in a series of actual effective values, indicating that there is no turning point, and positive external influence means reducing the environmental damage caused by the economy. The effect of scale economy integration, the effect of resource redistribution, reduce environmental health risks by improving the quality of health care, improve health care services, and ultimately save the economic system by improving health insurance. The growth of total population demand and economic development has negative external effects, and the loss does not exceed the process of urbanization.

(3) Compared with the general panel test, taking into account the interaction factors between cities, the spatial measurement panel changes from inferior to superior to improve the inflection point delay, and there is no turning point in the practical sense. The results show that the diffusion of air pollutants between cities is accelerating the deterioration of air quality, and the health risks and economic losses it brings are also largely dependent on spatial factors. This also shows that it is very difficult to improve the atmospheric governance and environmental management of a single city, and the health risks and economic losses of the city may always be affected by the surrounding cities.

Discussion

The characteristics of the guiding ideology and training tasks of long-distance runners’ physical training

Considering the long-term development of middle- and long-distance running, it is very important to develop a long-term and systematic training plan and young to long-distance running training. In this period, to understand the direction of training, it is necessary to establish clear and scientific guiding ideology and training tasks.

According to the survey results, 83% and 78% of coaches in the training of long-distance runners between 14 and 16 years old believe that long-distance runners between 14 and 16 years old mainly learn cultural knowledge and exercise and have a solid foundation. During the establishment process, the athlete’s ability should be gradually improved. As a result, it can be seen that the education of 17-19 years old has a higher quality of intellectual and intellectual development thoughts of sports athletes. The proportion of special education is higher than that of 14-16 years old, and their proportions are 62% and 46%, respectively. Training for athletes from 14 to 16 years old is mainly about mental fitness, enhancing endurance and speed, while improving physical fitness, the proportion of which is more than half. For athletes aged 17 to 19, the main task is to strengthen the athlete’s specialty and general endurance and improve the athlete’s competitive environment. Developing the athlete’s overall adaptability is no longer a major task. The “Chinese Youth Sports Course” describes the teaching tasks and requirements of each stage of the middle and long-distance running events. The basic stage of education is between 13 and 15 years old. The main tasks are to build interest, promote the normal development of the body, and master accurate middle and long-distance running techniques to produce...
endurance. The age of 16-22 is the elementary special and special promotion stage. It will continue to strengthen physical strength and start special training. First, master the understanding strategy, continue to improve the special ability, and strengthen the strategy and psychological training. The statistical results show that with the transition from education at different ages, the ideology of guiding education is gradually shifting from cultural process to vocational education, and training tasks have also shifted from the overall development of physical health to the development of specific skills. This is in line with Chinese youth sports. The requirements of the courses are roughly the same.

**Fig. 6** The spatial distribution of economic losses of different health terminals
Fig. 7 The spatial distribution of direct economic losses

Fig. 8 Schematic diagram of panel data test results of urban health risks and economic losses from 2010 to 2020
Periodic planning characteristics of physical training arrangements for long-distance runners

Track and field training is inseparable from the theory of education cycle. Matveyev divides the annual cycle into three types according to the changes in the athlete’s annual sports performance (that is, the number of competition members formed in a year: one cycle, two cycles, and three cycles. The central concept of the sports training cycle theory is divided into three training periods according to the year. During training, according to the number of training and training, while transferring attention to training intensity and special training, effective rest is used to promote the recovery of athletes’ physical functions and participate in the next training. This is also the theory of Matveyev’s sports training cycle.

In China, as the number of youth competitions is increasing every year, coaches will also adjust the regular preparations for youth middle and long-distance running training.

As a result, it can be seen that there are three-period segmentation methods for both medium-distance driving and long-distance driving. Long-distance running events accounted for nearly half of the distribution in the second period. The distribution of mid- and long-distance running events was relatively even, but the proportion of the two periods was still the largest. Therefore, when the Chinese youth middle- and long-distance coach prepares for training young players, it can be used as a comprehensive analysis of this year’s competition plan. Due to the significant increase in the number of games, some coaches use small-cycle and multi-cycle batch processing, while most coaches use a two-cycle training arrangement that combines planning and youth physical exercise.

In addition, it is mentioned that the annual training preparation for Chinese young women’s mid- and long-distance running is mainly two cycles. The specific division is shown in Table 1.

Table 1 is the national track and field frequency table of the number of competitions in each training phase of the middle- and long-distance running events. Middle-distance and long-distance race. Middle- and long-distance runners between the ages of 13 and 17 have about 2-5 competitions. Athletes between the ages of 18 and 22 will need about 6 to 12 reps. A well-known kinesiologist pointed out: “Middle long-distance runners can participate in 3 sprint runs so they will try their best to achieve excellent results.” The number of games for outstanding players should be limited, and frequent competitions will limit the rehabilitation of athletes. Athletes should compete regularly, rest, and systematically. By limiting the number of young people participating in national competitions to about 11 per season, this is conducive to the emergence of outstanding results.

By comparing the above data, it can be concluded that the actual number of competitions of Chinese young middle- and long-distance runners each year is basically the same as the number of ideal competitions reviewed by some coaches, but the current educational theories are less than the current international theoretical competitions advocated. Therefore, it is necessary to appropriately increase the number of annual competitions of young Chinese middle- and long-distance runners in order to adapt to the scientific development of the athletic ability of young long-distance runners.

Table 2 Athletics training syllabus stipulates the number of competitions throughout the year in each training phase of the middle and long-distance running events

Table 2: Athletics training syllabus stipulates the number of competitions throughout the year in each training phase of the middle and long-distance running events

| Project               | Basic training period (about 14 years old) | Initial and special training period (16-17 years old) | Special improvement training stage (18-22 years old) |
|-----------------------|-------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|
| Middle-distance running | 2-4 times                                 | 3-5 times                                           | 8-12 times                                          |
| Long run              | 2-3 times                                 | 3-4 times                                           | 6-8 times                                           |

The characteristics of physical fitness training content and training methods for long-distance runners

The book Sports Training says “Sports training refers to how to improve the level of competitive sports in sports training activities and completing training tasks.” Sport training methods are a variety of specific training methods and are tools used in educational content and training work. It can complete training and improve the competitiveness of athletes. Educational methods include specific application and implementation of various educational methods in sports training, which are defined as “intensity training used in sports training courses to improve certain sports skills and complete certain training tasks.”

According to the characteristics of human energy supply, endurance training can be divided into aerobic endurance

Springer
training, mixed oxygen endurance training, and anaerobic endurance training. The results of the research show that there are a variety of methods that can be used for endurance training in middle- and long-distance races. Table 3 is a survey of endurance training methods used by coaches on Chinese youth long-distance running. It is not difficult to see from the table that some traditional teaching methods are still recognized by most coaches. These are the three most commonly used teaching methods, accounting for more than 70%. The main purpose of training is to develop a fusion of aerobic and mixed aerobic endurance among athletes. It can be seen that long-distance running training for young people pays more and more attention to improving the speed and endurance of athletes.

The directionality of middle- and long-distance runners can improve the level of aerobic and anaerobic exercise. The ratio of aerobic exercise to anaerobic exercise is different in each middle- and long-distance running category. Middle- and long-distance runners should consider the percentage of aerobic exercise when conducting their own special training to significantly improve their special abilities.

Nowadays, the level of expansion of middle and long-distance running events is getting higher and higher, the pace is getting faster and faster, and the acceleration of athletes is getting more and more attention from coaches. This article lists 11 main training teaching methods, believes that special speed training is an important teaching content, and listens to the opinions of relevant education experts (Table 4).

Table 4 shows the statistical results of the survey. When training youth speed in middle- and long-distance running, most coaches use short-distance training and special speed training. It can be seen from the table that sprint running and sprinting are the two most commonly used training methods for coaches to improve athletes’ speed and quality.

### Table 3  Survey statistics on training methods of adolescent middle- and long-distance running events (n=22)

| Training method                  | The proportion | Examples of specific methods                                      | Training purpose |
|----------------------------------|----------------|------------------------------------------------------------------|------------------|
| Interval training method         | 75%            | 5 groups of 100 meters (1-minute interval) * 2 groups           | Anaerobic        |
| Variable speed practice          | 75%            | 100m sprint+50m slow+100m sprint+50m slow                      | Mixed oxygen     |
| Continuous running training method| 70%            | Run at an average speed of 20 kilometers and finish within the specified time | Endurance        |
| Simulated game practice          | 60%            | The competition result must not be lower than the training result, the specific distance | Mixed oxygen     |
| Repetitive running training      | 45%            | 5 sets of 1600 meters (overrun by 400 meters in the middle)     | Mixed oxygen     |
| “Fatlake” training method        | 40%            | One hour grass run                                              | Aerobic          |
| Natural running training method   | 35%            | Field training                                                  | Aerobic          |
| Comprehensive running training method| 35%        | 1000m+2000m+3000m+2000m+1000m                                   | Mixed oxygen     |

**Characteristics of training load for long-distance runners**

Training load refers to various sports that stimulate the athlete’s organism in the process of sports training. Because organisms have strong biological adaptability. Therefore, it is not always possible to maintain the exercise load level on the original basis, but it is necessary to continuously and systematically increase the exercise load level, but the increase in the exercise load is not limited. If the load level exceeds the maximum that the athlete can bear, the athlete’s functional ability will not improve, but it will also lead to deterioration of health and poor athletic performance. In the actual exercise training process, exercise load is divided into load intensity and load amount. Load intensity and load volume are two inseparable and interrelated parts of exercise load. They influence and restrict each other. Generally, load intensity is considered to be a direct factor that affects performance, and load is considered to be an indirect factor that affects performance. The mutual influence between quantity and intensity is limited. Generally speaking, the maximum intensity should be the smallest, the second-largest intensity should be moderate, and the smallest intensity should be the largest.

According to the statistical results of the survey on the number of training per week, the average number of training sessions per week for middle- and long-distance running is about 10 times. The weekly running volume statistics show that in the basic training state, the average weekly running volume for long-distance running events is about 120 kilometers, while the average weekly running volume for middle-distance running events is about 90 kilometers.

Since the training load intensity contains some quantitative data, most coaches answered very poorly to this part of the question during the survey process. The problems related to training load intensity are summarized because the results
are distorted to ensure that the reliability of the results is not affected by the load intensity part of the problem, which is one of the missing parts. It is recommended that the training team use data collection methods to investigate the load intensity characteristics of young middle- and long-distance runners.

Conclusion

Based on the remote sensing image data of the past 10 years, this paper studies the PM2.5 data of more than 300 cities in 31 provinces in China and analyzes the relationship between air pollution and the urbanization rate of the population and the urbanization level expressed by the night lighting data. Therefore, it provides comprehensive health risk assessments and population density data for 338 cities and then analyzes China’s health images, as well as the economic loss of premature deaths and related medical consumption data. Study the economic losses under various levels of urbanization, study the internal links between urbanization and economic losses, and increase efforts to improve air quality. Finally, according to the grid emission data provided by the MEIC team and the InMAP model of the InMAP research team, the amount of atmospheric ecological compensation for the spatial emission of phased air pollutants was quantified, and the national ecological compensation was calculated according to corresponding calculations. It also creates a series of related systems to analyze the physical management of long-distance runners.

Declarations

Conflict of interest The authors declare no competing interests.

References

Alijani B (1988) Using dispersion using middle east cyclone locations with high-level air systems, nurmax research center. No. 1988(4): 125–143 (In Persian)
Al-Khalaf A, Basset H (2013) Diagnostic study of a severe thunderstorm over Jeddah. Atmos Clim Sci 3:150–164
Almazroui M, Raju PVS, Yusef A, Hussein MAA, Omar M (2018) Simulation of extreme rainfall event of November 2009 over Jeddah, Saudi Arabia: the explicit role of topography and surface heating, Theor Appl Climatol 132:89–101. https://doi.org/10.1007/s00704-017-2080-2
Alpert BU, Shay-El NY (1990) Intermontly variability of cyclone tracks in the Mediterranean. J Clim 3(12):1474–1478
Amiri H (2008) Synoptic study of flooding in the catchment area of Zohreh River, Master Thesis in Natural Geography, Shahid Beheshti University
Ansari S (2003) Synoptic investigation of flooding systems in Kohgiluyeh and Boyer Ahmad Basin, MSc in Natural Geography, Tarbiat Moallem University
Awad AM, Almazroui M (2016) Climatology of the winter Red Sea trough. Atmos Res 182:20–29. https://doi.org/10.1016/j.atmosres.2016.07.019
Awad AA, Mashat AW (2018) Climatology of the autumn Red Sea trough. Theor Appl Climatol 135:1545–1558. https://doi.org/10.1007/s00704-018-2453-1
Barth HJ, Steinkohl F (2004) Origin of winter precipitation in the central coastal lowlands of Saudi Arabia. J Arid Environ 57:101–115
Chakraborty A, Behera SK, Mujumdar M, Ohba R, Yamagata T (2006) Diagnosis of tropospheric moisture over Saudi Arabia and influences of IOD and ENSO. Mon Weather Rev 134:598–617
Darand M, Garcia-Herrera R, Asakereh H, Amiri R, Barriopedro D (2018) Synoptic conditions leading to extremely warm periods in Western Iran. Int J Climatol 38:307–319
Dayan U, Abramsky R (1983) Heavy rain in the Middle East related to unusual jet stream properties. Bull Am Meteorol Soc 64(10):1133–1140
Dayan U, Ziv B, Margalit A, Morin E, Sharon D (2001) A severe autumn storm over the middle-east: synoptic and mesoscale convection analysis. Theor Appl Climatol 69:103–122
De Vries AJ, Feldstein SB, Riemer M, Tyrlis E, Sprenger M, Baumgart M, Fnais M, Lelieveld J (2016) Dynamics of tropical-extratropical interactions and extreme precipitation events in Saudi Arabia in autumn, winter and spring. Q J R Meteorol Soc 142:1862–1880

Table 4 Survey statistics on special speed training methods

| Training content          | Training methods              | The proportion |
|---------------------------|-------------------------------|----------------|
| Special speed training    | Short sprint                  | 72%            |
|                           | Short distance running        | 54%            |
|                           | Repeated runs of 80~300 meters| 44%            |
|                           | Ladder run                    | 40%            |
|                           | Downhill                      | 35%            |
|                           | Variable speed running of 60-300 meters | 35%         |
|                           | Traction run                  | 35%            |
|                           | Short start                   | 35%            |
|                           | Speed special practice        | 26%            |
|                           | Relay running                 | 17%            |
|                           | Run against the wind          | 13%            |
El-Fandy MG (1947) The effect of the Sudan monsoon low on the development of thundery conditions in Egypt, Palestine and Syria. RMetS 74(319):31–38. https://doi.org/10.1002/qj.49707431904
El-Fandy MG (1950) Effects of topography and other factors on the movement of lows in the Middle East and Sudan. Bull Am Meteorol Soc 10:375–381
Evans JP, Smith RB (2006) Water vapor transport and the production of precipitation in the eastern fertile crescent. J Hydrometeorol 7:1295–1307
Evans JP, Smith RB, Oglesby RJ (2004) Middle East climate simulation and dominant precipitation processes. Int J Climatol 24:1671–1694
Faraji I (1981) Investigating the path of low-pressure generator systems on Iran and providing patterns of their position, MSc Thesis, Institute of Geophysics, University of Tehran
Haggag M, El-Badry H (2013) Mesoscale numerical study of quasistationary convective system over Jeddah in November 2009. Atmos Clim Sci 3(1):73–86
Iqbal MJ, Hameed S, Khan F (2012) Influence of Azores high pressure on Middle Eastern rainfall. Theor Appl Climatol 111:211–221. https://doi.org/10.1007/s00704-012-0648-4
Kahana R, Ziv B, Enzel Y, Dayan U (2002) Synoptic climatology of major floods in the Negev desert, Israel. Int J Climatol 22:867–882
Khalaj A (2002) Analysis on the effect of Zagros range on synoptic systems affecting central Iran climate, PhD Thesis in Natural Geography, Tarbiat Modares University