

Recollections

Early Warning Interventions for Environmental Risk Factors at China CDC

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BACKGROUND

President Xi Jinping emphasized the paramount importance of bolstering early surveillance and early warning capacities within a robust public health system (1). These elements constitute one of the five major functionalities of the National Bureau of Disease Control and Prevention (2). As an integral division of the National Bureau of Disease Control and Prevention, the Center for Disease Control and Prevention (CDC) is responsible for executing early surveillance and warning procedures in the realm of public health. Nonetheless, a deficiency persists concerning the early warning of public health risk factors.

In 2019, the National Bureau of Disease Control and Prevention initiated nationwide pilots for environmental health risk assessment. Building upon these pilot studies, the National Institute of Environmental Health (NIEH) of China CDC embarked on research and development for early warning technology in environmental health risk. Utilizing factors such as air quality, heatwave, and cold-spell health risks as key areas of intervention, the NIEH undertook extensive research and development of suitable adaptive technologies. This was done through a systematic coordination of resources among all stakeholders, and exploration of effective mechanisms for health risk early warning interventions in public health.

The NIEH has successfully integrated public health considerations into early warning systems for environmental risk factors, developing intricate, health risk-based warning and intervention technologies.

These encompass air quality, heatwaves, and cold spell-related health risk warnings. Building on this achievement, the NIEH has fervently promoted the early warning intervention through a pilot program on three fundamental aspects: technology research and development, platform construction, and mechanism development. Table 1 outlines the pilot program for health risk early warning initiatives related to air quality, heatwaves, and cold spells.

In recognizing the significance of integrating early warning technology into health services, the NIEH facilitated early risk intervention strategies. This resulted in the pioneering fusion of medical and disease prevention sectors, giving birth to an innovative model for preventative disease control through early health warnings. Moreover, these developments offer a distinctively Chinese solution to global practices of early warning intervention.

WORK CONTENT

NIEH conducted the following tasks.

Technology research and development: In our investigation of the primary environmental risk factors and their associated health risks in China, we focused on air pollution, heatwaves, and cold spells. We developed an early warning intervention system for health risks, grounded on localized data, parameters, and unique innovative technology (3–5). This system aims to forecast health-risk interventions within the next 3–7 days.

The construction of the platform: Building upon the comprehensive environmental health monitoring program by NIEH, we developed a health risk early warning platform for environmental risk factors. This

TABLE 1. Early warning pilots for environmental health risks.

Environmental risk factors	Pilots of early warning
Air quality	Hebei Province, Jiangsu Province, Shandong Province, Henan Province, Sichuan Province, Jinan City, Qingdao City, Ningbo City, Shenzhen City, Hefei City
Heatwaves	Jinan City, Shenzhen City, Qingdao City
Cold spells	Jinan City, Qingdao City

platform is designed to access real-time and predictive data on environmental factor exposure, automatically cleanse and compute the data, match it with health information, and share it with local CDCs for dissemination via a data interface. Figure 1 presents the architecture diagram for the data processing of this early warning system platform. A massive amount of professional real-time and forecasted environmental factor data is processed within the computing platform. This data is then cleansed, aligned and integrated in real time, following which it is paired with the graded warning model. The model is utilized to automatically compute the warning level and associate it with health recommendations. Ultimately, it produces a graded warning index that is readily comprehensible to the general public.

Mechanism development: Since 2019, in cooperation with local CDCs, a pilot program was implemented for demonstrating the application of early warning public health services. The method of data sharing between NIEH and the pilot programs is depicted in Figure 2. NIEH is tasked with the

computation of the warning index, which is subsequently relayed to the local CDCs via an interface program. The local CDCs then access the data and disseminate it through their respective visualization platforms. Through this initiative, a synergistic working mechanism for early warning dissemination between national and local CDCs was gradually developed, thus advancing the technical approach to convert scientific research findings into public health services.

ACCOMPLISHMENTS AND EXPERIENCES

Development of an Early Warning Technology for Environmental Health Risks in China

Reflecting on the unique aspects of local environmental pollution in China, we developed methods for warning of health risks associated with air quality, heatwaves, and cold spells. In formulating

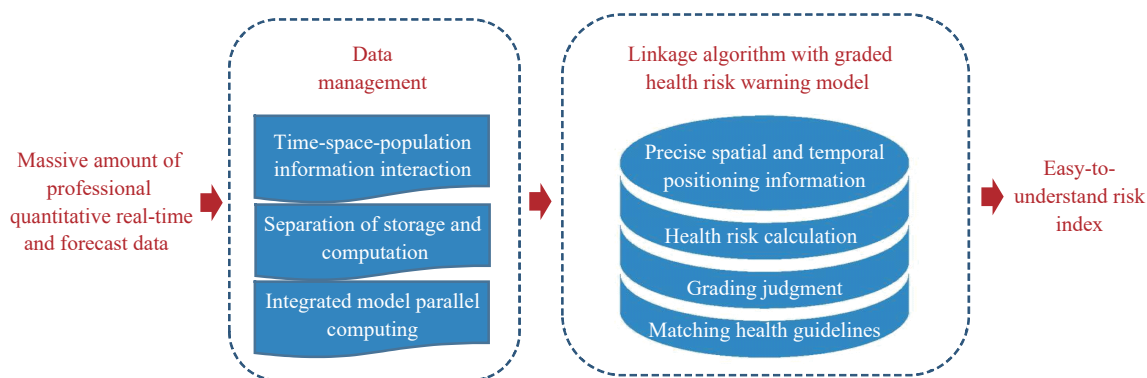


FIGURE 1. Diagram illustrating the data processing architecture of the early warning system platform.

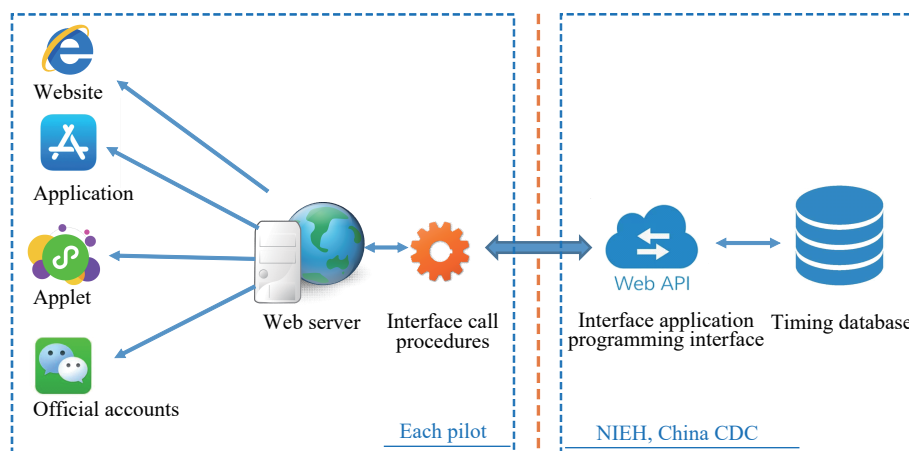


FIGURE 2. Method of data sharing between China CDC and pilot studies.

these approaches, we incorporated considerations of China's varied geographical and climatic characteristics and the adaptability of the populace among other factors. Also, a comprehensive evaluation procedure for warning validation was established, which incorporated the capability of the warning methods to highlight health risks, their synergy with the preexisting warning methods in China, and public acceptability.

Developing a Novel Public Health Service Model for Environmental Risk Factors and Health Risk Alerting

Supported public health services within the CDC: We initiated a pilot program for environmental health risk assessment in ten local CDCs. This program included the regular release of early warning intervention information. To date, the AQHI (air quality health index) has been consistently released in real-time and forecasted for over three years across two provinces and ten cities. This coverage spans a population of approximately 180 million individuals. Additionally, a health risk early warning system for heatwaves has been successfully operational in Jinan for a period of two years. Furthermore, we have implemented health risk early warning systems for cold spells in two cities.

Supported public health services in the meteorological sector: Our approach integrated health factors into the forecasting of extreme weather events through collaboration with other governmental departments. An example of this is our technical support to the Public Meteorological Service Center of the China Meteorological Administration during national extreme weather forecast gatherings. This allowed the inclusion of public health factors into predictions and warnings.

Supported public health services in medical institutions: Supported public health services in medical institutions played crucial roles in providing early warning intervention services for susceptible populations. For example, in partnership with the Chinese Cardiovascular Association, a health-risk warning linked to cold spells was disseminated to over 1,000 hospitals across the country. This notice, targeting vulnerable cardiovascular populations, provided health guidelines ahead of extreme weather events. This novel approach to risk prevention and management for individuals with high cardiovascular risk has shifted the health protection paradigm forward. Thus, it encourages the integration and

synchronization of medical prevention.

Rationalizing the Collaborative Mechanism for Health Risk Warnings Related to Environmental Risk Factors

Construction of a national-provincial-municipal CDC joint working mechanism: The China CDC, the primary entity responsible for intervening early with environmental risk factors, has developed a collaborative model involving national, provincial, and municipal CDC branches. This model leverages the technical and data resources of the national CDC and utilizes local CDCs' accessibility to the general public. The initial work has rationalized a data information sharing mechanism and work content collaboration within the CDC, laying the groundwork for the subsequent implementation of operational tasks.

Construction of a joint working mechanism with the meteorological department: A collaborative mechanism has been developed in conjunction with the meteorological department, leveraging its established public service channel to create a joint early warning system. This system enhances the integration of health considerations into governmental early warning decisions while also broadening the demographic reach of these early warning interventions.

Construction of a joint working mechanism with medical institutions: This framework was designed with the aim of specifically identifying populations at risk from environmental factors. This targeted approach seeks to enhance the effectiveness and precision of risk warnings and interventions.

CHALLENGES AND PROSPECTS

Challenges

The work encountered two primary obstacles. First, the current early warning technology system lacked effective standardization. Previous health risk early warning effort did not possess consistent documentation, like guidelines for early warning technology or specifications for the release of early warning information. This significantly impeded the progress towards achieving systematic, scalable, and standardized early warning procedures.

Second, an operational mechanism for the prediction and alerting of health risks associated with environmental factors has yet to be established. Although early warnings for health risks attributed to environmental factors are crucial tools for public health

services, they have not been integrated into the routine operations of environmental health work. The lack of an established mechanism for conducting early warning work leaves the respective responsibilities of all involved parties unclear, impeding the orderly initiation and seamless execution of these crucial tasks.

Outlook

The optimization and advancement of health-risk early warning and intervention systems for environmental risk factors are necessitated. Building on existing progress, the NIEH aims to enhance the early warning intervention model and compile technical specification documents that expand and refine mature health-risk early warning intervention technologies for air pollution, heatwaves, and cold spells. Concurrently, researches on other significant environmental risk factors, such as those related to water pollution, should be emphasized in order to establish health-risk early warning intervention technologies. Following the verification and evaluation of the intervention effects of the primary environmental risk factors' health risk early warning intervention technology, there is a clear need for further enhancement of the early warning model technology, health protection recommendations, and the early warning dissemination methods.

Second, there is a need for enhanced collaborative efforts across multiple departments. Agencies such as health, environmental protection, and data management should collaboratively strategize and establish a mechanism for sharing environmental risk factor monitoring and forecasting data, as well as early warning intervention information. There should also

be well-defined communication channels established for the systematic dissemination of health risk early warnings to medical and health institutions. This would facilitate efficient early warnings for populations vulnerable to environmental risk factors and bolster the role of environmental health risk early-warning interventions in the precise management and control of sensitive diseases.

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