Overview of Development of Exposure Factor in China and Abroad

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Abstract

Due to exposure factors play an important role in health risk assessment, the accuracy of exposure factors will greatly affect the scientific of the results of health risk assessment. This article introduced research and progress of exposure factors at home and abroad in detail.

Keywords

Exposure factor; health risk assessment; handbook.

1. Introduction

Health risk assessment has been attracted extensive attentions in the 1980s. It is a quantitative method to measure the risk of human health exposure to pollutants, which takes risk degree as the evaluation index and links the environmental pollution to human health [1]. The exposure factor plays a key role in human health risk assessment. The accuracy of exposure factor is closely related to the scientific and effectiveness of the results of health risk assessment.

2. Exposure factor

The risk of human exposure to pollutants depends on two aspects, one is concentration and harmfulness of pollutants in environment, the other is subjective behavior including the body of pollutants, exposure time and frequency characteristics, namely the exposure factors. The premise of pollutants in environmental medium concentration and accuracy of quantitative harmfulness clearly, exposure to selected parameters closer to the actual evaluation of the target population exposure conditions, exposure dose evaluation more accurate, appropriate health risk assessment result is more accurate [2]. Under the premise that pollutants' concentration and harmfulness in environmental medium is determined, the closer that selected exposure factors' value to the actual exposure condition of target population, the more accurate the result of exposure dose and health risk assessment will be.

3. Exposure Factors Development in Abroad

3.1 The United States

The United States was the first country to publish exposure factors handbook. The exposure factors handbook was published in 1989, which was updated in 1997. It was found that the exposure doses of children were very special in these two version of the factors handbook. Therefore, exposure factors handbook for children was published in 2002 updated in 2008. The latest version of exposure factors handbook is the 2011 edition, which was update data from 1997 to 2011on the basis of 1997. The new version of the exposure factors handbook also replaces the 2008 children's exposure handbook [3].

The main data sources of American exposure factors handbook included survey reports, government reports and scientific literature. A serious of investigation of factors was carried out in the United States. Exposure factors for time activity patterns were obtained by The National Human Activity Pattern Survey (NHAPS) organized by the U.S. Environmental Protection Agency (USEPA). Factors

including weight, dietary exposure factors, skin surface area were obtained by the National Health and Nutrition Examination Survey (NHANES) carried out by the United States Center for Disease Control and Prevention (USCDC). Data about drinking water intake rate, dietary exposure factors can be obtained from Continuing Survey of Food Intakes by Individuals (CSFII) organized by the United States Department of agriculture (USDA) and USEPA. Life parameter was obtained from the U.S. statistical information of the United States Census Bureau (USCB) [4].

The Exposure Factors Handbook in America provide a great convenience for the environmental management. At the same time, as the pioneer of exposure factors study. The Exposure Factors Handbook released by America has guiding significances for other countries, which provides the framework for exposure factors in human health risk assessment in other countries.

3.2 European Union

The Joint Research Centre (JRC) of European Union began developing ExpoFacts exposure factors database to continuously collect data in 2002, which was similar to the handbook of USEPA. It was put into use in 2007 and can be used by the Europeans [5]. It is one of the main tools for environmental exposure and human health risk assessment in European countries. It was effectively applied to environmental risk assessment and other fields.

3.3 Japan

Japan released the first exposure factors handbook in 2007, the framework of the handbook was compiled referring to the framework of American handbook by National Institute for Materials Science (NIMS) [6]. Japanese exposure handbook contains the human body characteristics (such as weight, life expectancy, etc.), exposure factors via mouth and skin exposure route, and exposure time activity patterns. Japanese exposure factors handbook is relatively short and has been published directly on the internet in Japanese and English versions.

3.4 Korean

Studies on the exposure factors and health risk assessment in South Korea have grown up in 2000. Initially, the EPA data were used to make health risk assessment, but the results were lack of certainty and reliability due to differences in populations and regions between countries. According to the study of Jang in 2001 [7], the requirement of exposure factors and its development potential were pointed out for the first time. In the study, some provisional recommended values of exposure factors were obtained by combining some domestic data with the content of exposure factors handbook of USEPA. In 2005, South Korea launched a three-year research project on the development of Korea exposure factors. South Korea first published exposure factors handbook in 2007. This exposure factors handbook was established on the basis of the three-year study between December 2004 and November 2007, which combined characteristics of South Korean residents with exposure factors in the American exposure factors handbook [8].

4. Exposure Factor Development in China

4.1 Existing Studies

The United States, the European Union, Japan and South Korea have published their own exposure factors handbook before China published exposure factors handbook. When China's exposure factors handbook did not be published, we have no choice but to use the exposure factors of other countries in exposure calculation and environmental health risk assessment, mainly using the factors values listed in the exposure factors handbook published by USEPA. Since there is a great difference in the region, race and living habits between American and Chinese, there is a big difference in exposure characteristics and behavior between residents and foreign residents. There is a great deal of uncertainty in the selection of factors, which may lead to greater errors in the results of health risk assessment, and have adverse effects on the effectiveness and scientificity of environmental risk management and risk decision-making. Wang studied on exposure factors of residents in China, based on the theories of exposure factors establishing method proposed by USEPA [9]. Discussed

factors including inhalation exposure factors, skin exposure factors, drinking water and dietary exposure factors, lifetime, weight and other basic exposure factors. The results showed that respiratory rates of adult men and women in 18 to 60 years old were about 19 m^3/d and 14 m^3/d, respectively. Inhalation rate of both men and women under the age of 18 in China were lower than residents of the United States. On the contrary, the inhalation rate of Chinese residents over 18 were about 22% higher than the United states. Compared with the United States, the surface areas of adult men and women were about 85% and 90% of the skin area of American adults, respectively. The average values of weight of adult men and women in China were 62.70kg and 54.40kg, respectively. The average values of weight of the adult men and women were 80kg and 67kg, respectively. Chinese adult male and female's weight were about 78.4% and 81.2% of the United States. Therefore, when making health assessment for residents in China, citing the American factor of inhalation rate, skin area and weight will result in about 22% error, 10%-15% error and 5%-20% error, respectively. It is necessary to study and obtain our own exposure factors for China.

Before the publication of exposure factors handbook in China, many scholars have made relevant investigations and studies on exposure factors and health risk assessment. Because China is a big country, great differences do exist between the North and the South. Regional differences will lead to differences in body characteristics and lifestyle habits, so many investigations were carried out specially aimed at a certain region. A questionnaire survey was used to study time activity patterns of 2860 participants from Taiyuan (a typical region in northern China) [10]. Respiration rate factors suitable for residents of Taiyuan were calculated using a combined body energy estimation model, and compared with those both from China and the United States. By comparison, the inhalation rate of rural residents in Taiyuan was highest, followed by the average value of China's residents. Inhalation rate of urban residents in Taiyuan was lowest, which was lower than the residents of the United States. Citing directly China's overall average data or the United States' data in health risk for Taiyuan residents, will result in 30%-50% deviation. Yang investigated on exposure factors of 4225 residents of three cities (Wuxi, Changzhou, Zhenjiang) in Taihu Lake basin of the southern part of Jiangsu province by a questionnaire survey, which based on the methodology of exposure factors published by the USEPA [11]. The long-term inhalation rate of the men and women in the study area were 18.68 m^3/d and 14.03 m^3/d, respectively, which were lower than the respiratory rate mean values of Chinese men and women, was 12.71% lower than that in USA. Yang also conducted a survey on exposure factors of the residents in Wenling, Zhejiang province [12]. The respiration rates of males and females in study area were 13.95 m^3/d and 10.88 m^3/d, respectively. It was found that Jiangsu and Zhejiang are in the South, but inhalation rate of residents in Zhejiang Taihu basin were higher than that in Wenling area, which showed the region differences in exposure factors. At the same time, the difference in inhalation rate between males and females also reflects the influence of sex on exposure parameters.

4.2 National Survey

In fact, some large scale investigations have been carried out in succession, which provide lots of data to support for the establishing of exposure factors handbook in china [13]. In early 1959, National Nutrition and Health Survey was carried out by Chinese Centre for Disease Control and Prevention. Methods and contents of the survey included questionnaires, medical examinations, laboratory tests, and dietary surveys. The survey involved about 200 thousand people in all 31 provinces. Since then, investigations have been carried out in 1982, 1992, 2002 and 2010 every five years. 2002 carried out the first comprehensive survey of nutrition and health. From the beginning of 2004, Chinese Centre for Disease Control and Prevention carried out China Chronic Disease and Risk Factor Surveillance, residents in 31 provinces were investigated by questionnaires every three years. The survey population was 18-60 years old, and content included body measurements such as height, weight, waist circumference, and so on. The State Administration of Sports carried out the National Physical Fitness Monitoring in 2000 and 2005, which involves about 50 thousand people in 3-69 years old in 31 provinces. The survey content included health examination, such as pulse, vital capacity and so on.

4.3 Exposure Factors Handbook

In December 2013, Environmental Protection Department of China published the first exposure factors handbook [14]. According to the National Environmental Protection Plan for Environment and Health in 12th Five-Year, in the 2011-2012, China Academy launched Chinese exposure behavior patterns survey, involved people aged above 18 in China. In combination with other domestic exposure factors of the investigation and research results, and eventually formed Exposure Factors Handbook of Chines Population (Adults). The handbook provides detailed intake factors, time behavior patterns factors and other factors of different populations, and gives the average and range values of each factor under different conditions. Exposure Factors Handbook of Chines Population (Children) was published in 2016. The publishing of Chinese exposure factors handbook provides great conveniences for health risk assessment.

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