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Exploring the Correlation of Urban Environmental Pollution on Population Health in China: A CiteSpace Visualization Analysis

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Abstract. The rate of urbanization in China has resulted in a growth in the urban population, as well as an increase in the number of industries and motor vehicles. As a result of these developments, human forces are now continually altering the ecosystem in China. The general health of the population has changed dramatically as a result of the dynamic process of urbanization, which also inevitably leads to pollution of the urban environment. Based on this, this paper uses the China Journal Full Text Database (CNKI) as a data source and the CiteSpace 6.1.R3 visualisation tool to analyse authors, institutions, journals and keywords to build a visual knowledge map and analyse the current status of research on the relationship between urban environmental pollution and population health in China. In this paper, the statistical data analysis of research authors and institutions reveals that teams of research authors in this field have gradually emerged in recent years. However, most of them are constrained by their institutions and collaboration across academic or institutional boundaries still needs to be improved. Therefore, it is recommended that institutions should strengthen academic exchanges through information sharing and building platforms to expand the breadth and depth of research and jointly address the challenges in the development of the field of urban environmental pollution and population health correlation research in China.

Keywords: urban environmental pollution, population health, bibliometrics, visualization, knowledge mapping.

1. Introduction

The rate of urbanization in China has increased the number of motor vehicles, industry, and urban residents, eventually leading to environmental implications caused by human activities. There is no question that the dynamic process of urbanization has significantly altered the population's health as a result of the pollution of the urban environment. According to the United Nations Agenda 21 for Sustainable Development, there cannot be sustainable development without a healthy population. However, the majority of development activities have some impact on the environment, and the environment in turn contributes to or exacerbates several health issues (the United Nations, 2010). The Public Health Agency of Canada (PHA) defines population health as an approach to health that aims to improve the health of the entire population and reduce health inequities among population groups. In order to reach these objectives，it looks at and acts upon the broad range of factors and conditions that have a strong influence on our health (Public Health Agency of Canada, 2010). (Meaning: Population health is a technique of conducting medical research that aims to enhance the general health of the populace and lessen health disparities between racial and ethnic groups. It looks for and takes action on a wide variety of conditions and variables that impact health in order to accomplish these aims.)

According to Professor Xiaoying Zheng, Chief Scientist of the 973 Population Health Project of the Ministry of Science and Technology of China and Director of the Institute of Population Research at Peking University, the term "population health" was previously used to describe a population's overall health or the cumulative of a group of medical indicators. Population health is now a growing academic study subject as the scope and focus of health studies have expanded to include the entire population.

Scholars have established that population health, as opposed to merely patient health, is the study of health at the level of a population in advanced economies. The focus on health outcomes rather than health status when researching health issues distinguishes population health from public health and health promotion. Also, the influence of non-medical variables on health has to be given more consideration. Rather than focusing on health status as healthcare does, population health research is more concerned with the health of the entire population as well as the outcomes of population health. It is necessary to establish several indicators and measures to re-measure health because, in addition to medical factors, the inclusion of more non-medical factors, such as social, economic, and environmental non-medical factors, has a synergistic dynamic effect of amplifying and reducing biological effects on health (Zheng, 2003). Population health, according to Professor Junlin Liang of Soochow University and author of the book "Research on Population Health and China's Health Security System," is the general well-being of a population as indicated by a number of health status markers, which include the social, economic, and natural environment, individual health behaviors, individual characteristics and adaptive skills, human biology, early childhood development, and health services.

Population health is a scientific approach that focuses on the important variables and circumstances that affect health, particularly non-medical variables. In an effort to guide population health policy and practice, it strives to give a more thorough and complete account of the factors that affect both individual and overall health. This will help to promote population-wide health and lessen health disparities between different groups within the population (Liang, 2005). Due to their synergistic dynamics of amplifying and dampening the impacts on population health, non-medical elements including social, economic, and environmental factors need to be researched in population health.

Due to the mediating factor of the environment, rapid urbanization creates risks and difficulties to population health. By 2025, there will be 2.5 billion people living in urban areas across Asia, with 87 of these cities already having a population of one million or more (38 in China and 23 in India). African cities are a little less urbanized than those in Asia, whereas South American cities are slightly more urbanized. The number of major cities is growing over the world, while smaller cities are growing larger at a quicker rate than they were previously.

Cities in developing nations are becoming more and more unsuitable for human habitation because of the lack of government capability to collect and dispose of municipal wastewater and solid waste as

well as the inability to manage industrial waste emissions and pollutants from transportation. Urban borders and their downstream areas, where pollutant concentrations greatly surpass the capacity of natural ecosystems to purify the air, frequently experience a lack of infrastructure development and service supply that cannot keep up with pollution emissions (Brandon, 1998). A favorable setting for the emergence of diseases could well be created by the combined effects of urban environmental pollution. The ultimate price associated with urban environmental deterioration is the cost of harm to human health.

The costs to producers and consumers rise as a result of environmental issues, and the expenses associated with harm to human health as a result of increasing production costs also become more apparent. The following are the areas where there is a direct correlation between public health and urban environmental degradation:

(i)air pollution causes respiratory conditions

(ii)water pollution leads to conditions like cholera, typhoid, and cholera that are associated with water

(iii)solid waste causes conditions like the plague

(iv)toxic waste facilitates the increase in cancer cases and neurological conditions that are related to toxicity. Premature death (mortality) and disease (morbidity), as well as hospitalization in some situations, are two main categories of health impacts.

According to studies by the World Bank, significant human resource has been lost as a result of air and water pollution in many of the world's largest cities, causing tens of thousands of deaths annually and millions of patients who were previously moderately ill to become severely ill. This results in lost productivity for each city annually as well as other losses totaling billions of dollars. In Africa, southern, southeastern, and central Asia, water pollution has the most detrimental effects on human health, whereas air pollution has the most detrimental effects in China, Latin America, and Eastern Europe.

Generally, air pollution is worse in temperate cities with higher per capita income, especially in the winter, whereas water pollution is worse in warmer places with lower income levels and less access to clean water and sanitary facilities. Accurate quantitative analysis of this damage can assist decision-makers in incorporating efficient economic tools into environmental and health considerations at a time when environmental contamination affecting health is growing in many cities. In order to raise public awareness and promote communication between various groups and interests, such as environmentalists, health professionals, and Organizations fighting against poverty, quantitative analysis can be used to identify priority initiatives. Yet, urban environmental pollution can also have a positive impact on population health through significant adjustments to the healthcare system that are necessary to address the demographic, economic, and sociocultural changes brought on by migratory trends. Relevant studies have shown that the correlation coefficient (percentage) between the total population and population chronic disease prevalence is 0.97, and the correlation coefficient between the rural population and chronic disease prevalence is 0.04, indicating that there is no association between the two. There was a strong correlation between the number of people living in cities and the incidence of chronic diseases (0.89). So, it may be assumed that the urban population's health is negatively impacted by the development of the urban population.

According to data provided by the World Health Organization, metropolitan areas play a significant role in the socioenvironmental trends that have an impact on public health. So, it is essential to lower the risk of disease for a greater number of individuals by improving urban space. The prevalence of chronic diseases has grown while the prevalence of infectious diseases has reduced as a result of better health care services. The prevalence of malignancies varies significantly, with higher rates reported among urban residents. Incidences of mental illnesses, neoplasms, and diseases of the cardiovascular and endocrine systems are also rising along with the urban population.

Through this research, it is observed that there is a certain deficiency in evidence-based statistical studies in the systematic studies on the correlation between environmental pollution and population health in Chinese cities after analyzing the scientific literature on the correlation between urban

environmental pollution and population health studies in China over the past 20 years. As bibliometric software, CiteSpace 6.1.R3 visualization is used in this study to examine the current state of China's research on the relationship between urban environmental pollution and population health. The goal of the research is to serve as a resource for China's future, more thorough and scientifically developed studies on the subject.

2. Data and Methods

2.1.Data sources

The selected retrieved literature catalogs were exported in plain text format, the database platform was established to process the file sets independently, and CiteSpace 6.1.R3 software was used to format and clean the literature data again. In this paper, the research database platform of China Journal Full Text Database (CNKI) was utilized as the data source, and established a search strategy for "environmental pollution," "urban," and "population health." The search period was set from January 1, 2003, to January 1, 2023, and there was no restriction on the choice of subject areas (Guo et al., 2022).

2.2.Data processing

The selected literature titles were exported in Refworks format from the Chinese Journal Full Text Database (CNKI) (Jiang, 2018).The database platform for processing file sets was established, and the CiteSpace 6.1.R3 software was used to convert the literature data into an analyzable format and re-clean the data.

3. Results

3.1.Statistical analysis of literature publication volume

The statistical analysis of the literature publication volume for the research literature on the relationship between urban environmental pollution and population health in China was conducted after selecting the data from the Chinese Journal Full Text Database (CNKI) for the chosen years ranging from 01/ 01/2003 to 01/01/2023.

From the statistical analysis,there is an increasing amount of study in China that examines the relationship between urban environmental pollution and population health (Wang, 2013).The statistical findings of the literature that has been published on the relationship between urban environmental pollution and population health in China are depicted in Figure 1. This figure demonstrates how the importance and focus of research on this relationship have increased year by year while also demonstrating a more stable incremental status (Liu, 2016).

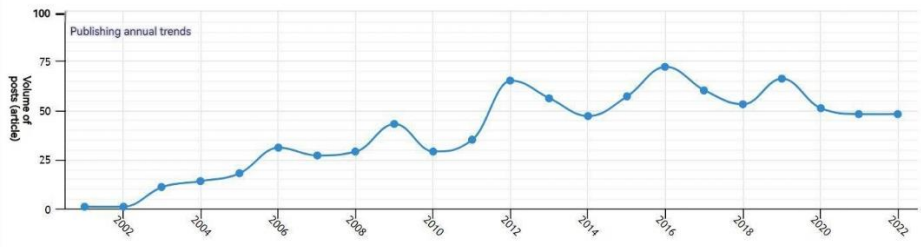

Figure 1.2003-2022 Publication of Research Papers on Safety Evaluation of Traditional Chinese Medicine Compound Health Products

3.2.Statistical analysis of authors and institutions of literature publication

In Citespace 6.1.3R, the LLR algorithm was chosen to visualize and analyze research organizations as well as the authors of published papers (Feng, 2017). We can learn about the status of the key authors, the teams that are working with them, and the future directions of the scientific study on the relationship between urban environmental pollution and population health in China from the findings of the visualization analysis (Liu, 2016). The researcher or research institution that published the relevant

topic is represented by each node on the visualization map, and the relationships between these nodes are shown by the connecting lines. The graphical analysis of the authors of publications is shown in Figure 2. Figure 2 shows that the research author teams of Shimou Yao, Xiaoping Li, and Zongmei Chen represent the research authors in related fields. The research authors in related fields form cooperative research relationships in a condensed area, and the cooperative intersection between research teams is not particularly obvious (Zhong, 2011). In addition, there is a need to improve the mutually beneficial research conducted by each team and researcher.

Figure 3 represents the visual analysis of research institutes. As shown in Figure 3, Chinese publishing research institutions in the Chinese journal full-text database (CNKI) are represented by the Chinese Research Academy of Environmental Sciences, the University of Chinese Academy of Sciences, Research Center for Eco-Environmental Sciences,Chinese Academy of Sciences, the State Key Laboratory of Urban and Regional Ecology of the Research Center for Eco-Environmental Sciences,Chinese Academy of Sciences, the Institute of Geographical Sciences and Resources of Chinese Academy of Sciences, and the Institute of Geography and Lakes of Chinese Academy of Sciences, etc. The collaboration between research institutes still has to be strengthened because it is currently rather underdeveloped (Liu, 2022).

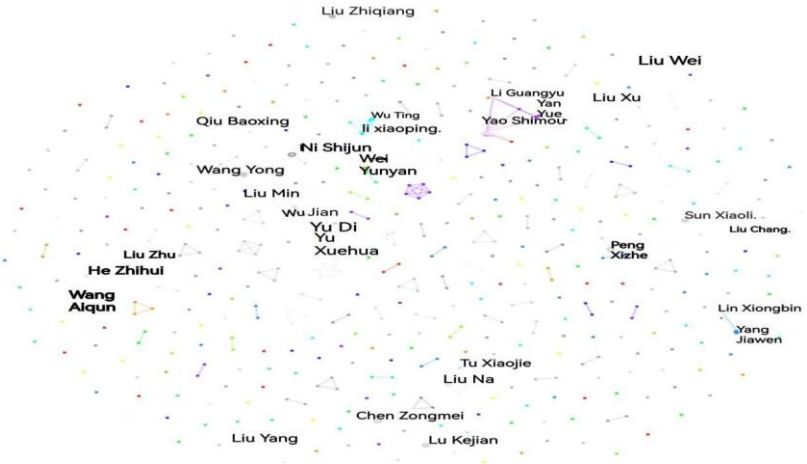

Figure 2. Co-occurrence map of authors in the study on the correlation between environmental pollution and population health in Chinese cities

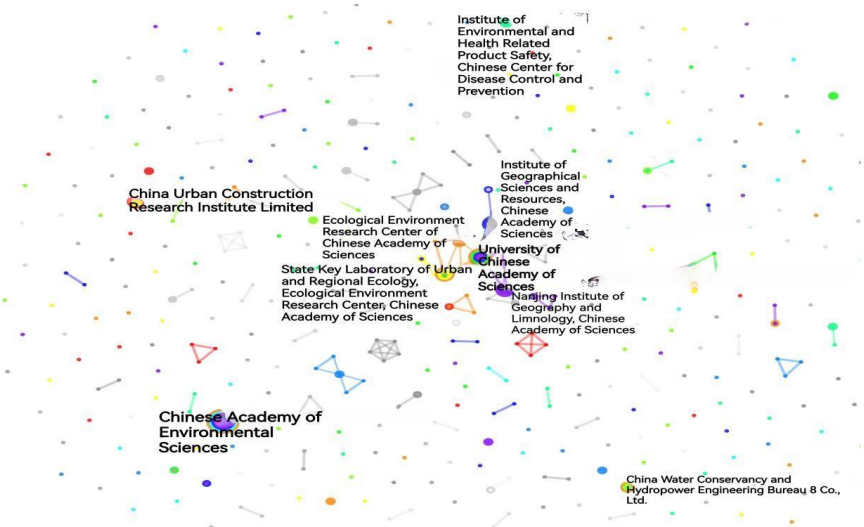

Figure 3. Co-occurrence map of research institutions on the correlation between environmental pollution and population health in Chinese cities

3.3.Analysis of research hotspots and frontiers

3.3.1. Keyword co-occurrence clustering analysis

We conducted a cluster analysis of high-frequency keyword co-occurrence since it is known that keywords are the literal representation of an article's topic. As a result, we examined the research hotspots and directions in the field (Jiang et al., 2020). Using the LLR log-likelihood rate approach in Citespace 6.1.3R, the keywords from the collected article data were subjected to a clustering analysis of keyword co-occurrence. According to Figure 4, the higher the frequency of keyword co-occurrence, the lower the ranking number, and the higher the research hotness. The clearer and more independent the clustering blocks are, the clearer the research direction will be. The top five blocks of clusters in Figure 4 may be observed to be primarily concerned with environmental pollution, governance, pollution, urban planning, and environmental protection (Qin, 2019). Thus, it can be concluded that the primary areas of scientific study on the relationship between environmental pollution and population health in Chinese cities are focused on environmental pollution, environmental governance, urban planning, and environmental protection. Contrarily, cross-disciplinary research on population health and linkages between urban environmental pollution and population health in China is underdeveloped, and this field of study still needs more development.

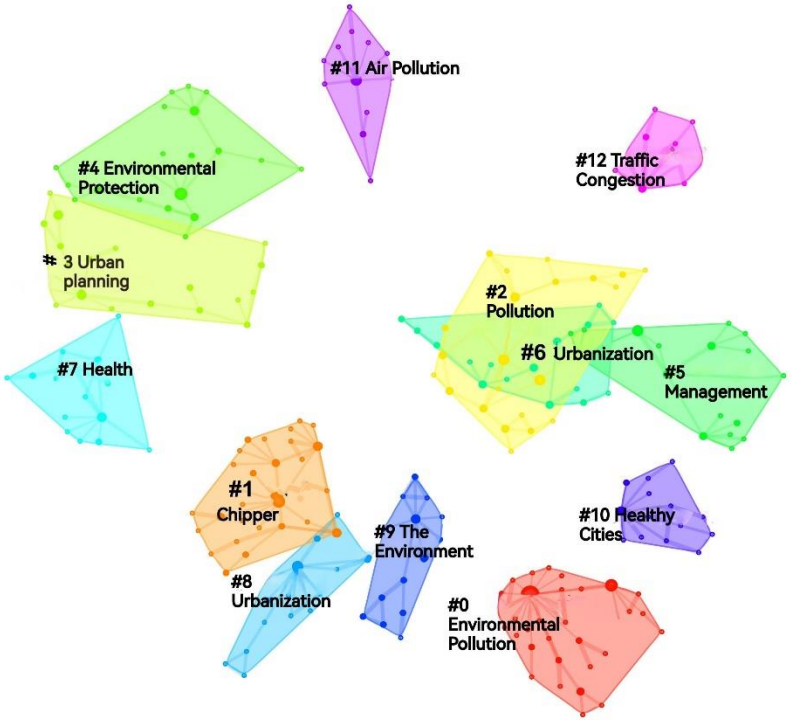

Figure 4. Co-occurrence cluster analysis map of key words in research on the correlation between environmental pollution and population health in Chinese cities

3.3.2. Frequency of LLR algorithm fit

Once the downloaded data is imported into Citespace 6.1.3R and the LLR algorithm is used to build an algorithmic ranking of the frequency of fit. It compares the correlation study with the highest frequency of fit that emerges with the search formula of the selected data. The higher the frequency of fit the closer it is to ranking 1. The rankings are arranged in descending order from 0. The higher the frequency of fit the smaller the value of the ranking. We may infer from Figure 5 that environmental pollution, environmental protection, and urban planning are the correlation studies with the highest frequency of fit. Considering the frequency of fit, health studies are ranked seventh, and the scientific literature on this topic just recently began to be published as early as 2014. The LLR algorithm fit frequencies once more support our hypothesis that population health is not adequately addressed in cross-sectional scientific research on associations between environmental pollution and population health in Chinese cities, and that population health or health-related scientific research needs to be strengthened (Guo et

al., 2021).

ClusterID	Size	Silhouette	mean(Year)	Label (LLR)
0	35	1	2013	Environmental pollution (50.08, 1.0E-4); Cities (11.91,0.001); Garbage disposal (9.45, 0.005); Traffic noise (9.45, 0.005)
1	29	0.965	2011	Governance (39.36,1.0E-4); Air pollution (27.57,1.0E-4); Haze (25.37,1.0E-4); Pollution prevention (17.32,1.0E-4); Hazards (16.52, 1.0E-44); Hazards (16.52, 1.0E-4)
2	26	0.903	2012	Pollution (38.28, 1.0E-4); Urban environment (32.58, 1.0E-4); Rural areas (20.25, 1.0E-4); Heavy metals (16.17,1.0E-4); Noise pollution (12.110.0
3	20	0.965	2014	Urban planning (35.32, 1.0E-4); Construction (16.65, 1.0E-4); Application (16.65, 1.0E-4); Public Health (11.07,0.001); Ecological Garden (11.07.0.001) Environmental Protection (33.121
4	20	1	2016	Environmental protection (35.32,1.0E-4); Pollution control (27.7,1.0E-4); Environmental monitoring (26.56, 1.0E-4); Role (13.76, 0.001); Municipal solid waste (13.76, 0.001)
5	19	0.982	2013	Management (27.06, 1.0E-4); Status quo (26.96, 1.0E-4); Problems (23.83, 1.0E-4); Measures (16.88,1.0E-4); Sewage Treatment (16.72,1.0E-4) Urbanization (24.02, 1.0E-4);
6	16	0.946	2012	Ecological environment (19.84,1.0E-4); Industrial clusters (11.92, 0.001); Urumqi (11.92, 0.001); air Quality (8.21,0.005)
7	15	0.87	2014	Health (27.15,1.0E-4); Low-carbon (12.58,0.001); Environmental governance (8.85, 0.005); Low-carbon cities (6.27,0.05); Environmental information disclosure (6.27,0.05) Disclosure (6.27, 0.05)
8	15	0.938	2009	Urbanization (32.74, 1.0E-4); urban disease (15.02, 0.001); urban management (12.9, 0.001); ecological function (12.9, 0.001); sustainable development (11.35,0.001)

Figure 5. The frequency ranking of the LLR algorithm for the correlation between environmental pollution and population health in Chinese cities

3.3.3. Keyword emergence analysis

The LLR algorithm in Citespace 6.1.3R is used in the statistical and scientific algorithm known as the "keyword emergence analysis," which examines the keywords that reflect the article's subject and that occur more frequently over time. With the aid of this software, the analysis findings are visualized. We can deduce the research trends and research frontiers in the pertinent scientific domains we examine throughout a specific time period by employing keyword emergence analysis (Fang, 2009).

As shown in Figure 6, which represents the keyword emergence analysis mapping of research on the correlation between urban environmental pollution and population health in China, it was found that the keywords of research on the correlation between urban environmental pollution and population health in China in the past two decades are mainly reflected in the research on urbanization, noise pollution, health measures, current situation, air pollution, air quality, haze, application, environmental protection, pollution prevention and control, atmospheric environment, strategy, environmental monitoring, air pollution, and urban planning.

We discovered that over the past 20 years, the majority of research in this area has concentrated on studies that examine urban environmental pollution in China, with less attention paid to population health and cross-functional studies that examine the relationship between urban environmental pollution and population health in China. As a result, it may be inferred that researchers in China have not yet conducted comprehensive research on the relationship between urban environmental pollution and population health. We can also infer from the research that the subject of how to conduct more thorough and scientific research on the relationship between environmental pollution and population health in Chinese cities will be a hot topic for upcoming research (Chen et al., 2018).

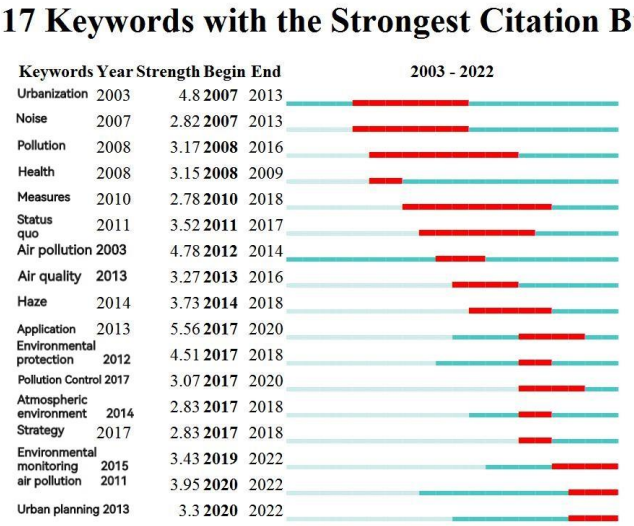

Figure 6. Keyword emergence analysis map of the correlation between China's urban environmental pollution and population health

4. Conclusion

In recent years, China has experienced a stage of rapid economic development that has resulted in accelerated urbanization and a remarkable increase in the average annual growth rate of GDP. This rapid economic development has also been accompanied by several environmental pollution issues involving air pollution, noise pollution, water pollution, soil pollution, and many other aspects. Since the turn of the 20th century, the overall level of pollution has been rising yearly. Urbanization has also helped people's living standards and quality of life to rise, but unhealthy lifestyle choices including an overreliance on automobiles for transportation and a lack of physical activity have increased the prevalence of non-communicable illnesses.

In addition, the danger of developing chronic illnesses including diabetes, cardiovascular disease, and obesity has been rising annually, resulting in progressively deteriorating well-being of the population (Song, 2005). The influence of various urbanization processes on health may be used to show how the dynamic urbanization process has unquestionably resulted in substantial changes in the population's health. Yet, this can be the result of advancements made in metropolitan health systems, particularly in terms of illness diagnosis. Due to the extreme complexity of environmental and health issues, their study must be at the cutting edge of interdisciplinary interaction. Environmental pollution is a severe issue on a worldwide scale right now, and developing nations are particularly affected. Urbanization growth must not come at the expense of the natural environment, human health, and social civilization. Increasing urbanization will surpass the ecological environment's yield stress and cause several ecological and environmental issues. As a result, we need to control the excessive urbanization that further accelerated growth has created. Yet, if the process of urbanization is slowed down, the ecological environment will be protected to some extent. But, this will also restrict industrialization and economic growth, and it will result in low levels of economic non-agriculturalization, sluggish urban development, a large labor surplus, social instability, etc., all of which contribute to low levels of urbanization (Yang, 2010). For effective public health services, a region's population must be in proportion to its degree of economic and social development. Excessive or insufficient urbanization development is either harmful to the health of the urban population or the health of the rural population. Compared to the United States, China has a larger burden of disease (21%) caused by the environment and variables associated with it, and environmental pollution factors are significant cancer risk factors. This clearly suggests that environmental pollution can have a negative impact on people's health (Ge et al., 2019). The current environmental health situation has a serious negative impact on people's health. According to research on environment and health in China conducted by the Chinese Academy of Sciences, waste pollution

from manufacturing and lifestyle activities causes 75% of chronic diseases, and by the year 2610, it is predicted that there would be roughly 2 million cancer deaths in China. It is impossible to overlook the negative effects of urban environmental pollution on population health. Studies on the relationship between the environment and health have a significant impact on economic analysis, forecasting, policy development, and policy implementation. The circular economy is founded on the "reduce, reuse, and recycling" (3R) principle and aims to efficiently utilize and recycle resources. It is distinguished by closed-circuit material circulation, energy ladder usage, and compliance with the material cycle of natural ecosystems.

According to this ideology, to achieve the ecologicalization of economic activities, it is necessary to adhere to ecological rules, utilize natural resources and environmental capacity effectively, establish an economy based on continuous material recycling, and harmoniously incorporate the economic system with the natural ecosystem's material cycle. The growth of a circular economy promotes resource efficiency, reduces environmental pollution, and improves population health. Scholars from both home and abroad have also focused on the connection between environmental pollution and population health, albeit the research's specific objectives have varied.

Hancock assert that only cities that work to enhance their natural and social environments and fully use local resources so that their inhabitants can support one another and reach their maximum potential can be referred to as healthy cities. Urban health is influenced by three main types of variables: variables relating to health, such as health education, immunization planning, disease control, health care, and health supervision; variables relating to socioeconomic statuses, such as employment, income, and population control; and variables relating to the residential environment, such as the home, water supply, and infrastructure. At this time, building healthy cities in China should concentrate on solidifying the framework for establishing national sanitary cities, enhancing disease prevention and control, strengthening the system of health services, and successfully accomplishing a people-oriented and population-centered approach. As we know, a good ecological environment is the basis of human survival and health, and analyzing and studying the relationship between the environment and health is the current hot topic and a difficult point in global environmental science research. This is a challenging area of study. As a result, it is crucial to research the relationship between environmental pollution and population health in Chinese cities. Clarifying the harm to human health caused by pollution of the air, water, and solid waste does not add to the burden on municipalities. The fact that competent municipal administration also takes into account problems with public health brought on by pollution explains why the concerns of such plans are similar to those of urban environmental strategies. We have learned from history that the best strategy is to manage municipalities with due consideration for the environment in which they live and the health of their citizens by obtaining a return on investment in the form of user fees, which are obtained through reasonable pricing of natural resources like water and fuel. As a result, many countries have a problem in implementing an urban management plan that combines efficient financial management with the security of municipal services through efficient environmental legislation. In this study, we use CiteSpace 6.1.R3 to visualize and analyze the knowledge map of urban environmental pollution and population health correlation research in China, interpret the hot spots and frontiers of urban environmental pollution and population health correlation research in China through statistical analysis, and make assumptions about its future development. It has been discovered through the statistical analysis of research authors and institutions that teams of research authors have gradually started focusing research efforts on this subject, but that most of them are restricted to their institutions and that cooperation between academics or institutions still needs to be strengthened.

In order to broaden the scope and depth of research and jointly address the challenges in the development of the research field of urban environmental pollution and population health correlation studies in China, it is suggested that institutions can improve academic exchanges through information sharing and platform building. We observed that the challenge of how to conduct a more comprehensive

and scientific study on the relationship between urban environmental pollution and population health in China is the main focus of forthcoming studies.

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