

Transformación urbana de las ciudades basadas en recursos desde una perspectiva de salud. Caso ciudad de Taiyuan, Shanxi, (China)

Urban transformation of resource-based cities from a health perspective.

Case of Taiyuan City, Shanxi, (China)

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Resumen

A medida que el desarrollo económico y social de algunas ciudades basadas en recursos entra en una fase de declive, cómo promover la transformación y modernización de las industrias económicas urbanas, lograr un desarrollo saludable y sostenible desde el bienestar público y los servicios se ha convertido en un reto. Este artículo toma como ejemplo la transformación y el desarrollo urbano de la ciudad de Taiyuan, provincia de Shanxi, en China. El análisis comparativo de los datos socioeconómicos, medioambientales y de construcción, así como de las políticas y estrategias públicas desde 2006 hasta 2022, refleja la tendencia de desarrollo y la interrelación de las industrias económicas saludables con su entorno ecológico, la construcción urbana y los servicios de salud pública. Se concluye que es necesario promover el desarrollo sinérgico de la salud pública y la transformación urbana para el desarrollo de políticas y estrategias de transformación adecuadas.

Palabras clave

Ciudad basada en recursos, salud, transformación urbana.

Abstract

As the economic and social development of some resource-based cities enters a stage of decline, how to promote the transformation and upgrading of urban economic industries and achieve healthy and sustainable development of urban construction, public well-being, and services has become a challenge faced by these cities. Based on the perspective of healthy cities, this article takes the urban transformation and development of Taiyuan City, Shanxi Province, China as an example, through collections and comparative analysis of socio-economic, environmental, and construction data, as well as public policies and strategies from 2006 to 2022, and summarizes the role, development trend and interrelationship of the healthy economic industries, ecological environment, urban construction, and public health services. It is proposed that it is necessary to promote the synergistic development of public health and urban transformation.

Keywords

health, resource-based city, urban transformation.

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1. Introduction

A resource-based city (RBC) is a type of city whose main function is to exploit and process natural resources (Jianhui Yu et al., 2019). However, as these cities continue to exploit and consume resources, some cities that were originally resource-rich have entered the decline period of their life cycles and are gradually facing problems such as resource depletion and economic recession. Entering the 21st century, the Chinese government attached great importance to the development of these cities. In 2007, the State Council formulated and issued the "Several Opinions of the State Council on Promoting the Sustainable Development of Resource-Based Cities." In 2013, the State Council issued the "National Sustainable Development Plan for Resource-Based Cities (2013~2020)", which covers 262 cities in China and proposes to accelerate the urban transformation and development across the country. In 2021, the National Development and Reform Commission, the Ministry of Finance, and the Ministry of Natural Resources jointly issued the "14th Five-Year Plan Implementation Plan for Promoting High-Quality Development in Resource-Based Areas" to further strengthen the development guidance for these cities (Yujie Wang et al., 2022; Qian Zhang & Roy Brouwer, 2020).

Representative studies on the transformation and development of resource-based cities include Corden and Neary's study on the "Dutch Disease", which believed that the prosperity of the traded goods sector induced deindustrialization, leading to a decline in the competitiveness of the manufacturing and service industries, losing the ability for long-term development (W. Max Corden & J. Peter Neary, 1982). Auty proposed the theory of the "resource curse", that is, the richer the natural endowment, the longer the country will tolerate failed macroeconomic policies and rent-seeking behavior, which will have a negative impact on industrialization (Richard Auty, 2002; Richard M Auty, 1994). Urban transformation and development are also subject to many factors, such as the city's geographical location conditions, policies and management systems, original economic and industrial foundation, education and scientific and technological innovation capabilities, urban natural ecology, and construction environment (Xiaojia Guo et al., 2023; Xiangyan Qian et al., 2021; Huiming Zhang et al., 2018). The transformation path of these cities includes: extensions of industrial chains; industrial substitution patterns, and comprehensive development models (Qiangyi Li et al., 2021).

Healthy cities is a global action strategy proposed in the 1980s to face the challenges of urbanization to human health (Geoff Barness, 2008). In 1998, the WHO announced 32 indicators for healthy city construction (World Health Organization, 1988, 1998). Combining the construction concepts and standard requirements of healthy cities and promoting urban transformation and development is in line with the development trends of the current world (José Fariña et al., 2022). It encourages the coordinated development of cities regarding the ecological environment, social economy, and public health (WHO Regional Office for Europe, March, 1998; Premila Webster & Denise Sanderson, 2013).

There are many studies in the academic community on the economic and urban transformation of resource-based cities, environmental improvement and construction, development capacity assessment, policy and system innovation, etc. However, there are few relative studies based on the concept of healthy city construction and related standards. Based on the perspective of healthy city construction, this article explores the city's policy measures and implementation effects on the ecological environment, social economy, public health, and other aspects. It summarizes the countermeasures and feasible implementation paths for the coordinated development of healthy city construction and urban transformation.

2. Objective and study área

2.1 Objective

Based on the perspective of healthy cities, this article quantifies and evaluates the role and health benefits of urban transformation-related policies and strategies on the main aspects of resource-based cities, including urban healthy economic industries, ecological environment, urban construction, and public health services, analyzing and evaluating the development trends of related elements, their causes, and their mutual relationships.

2.1 Study area

The study area is located within the municipal jurisdiction of Taiyuan City in central Shanxi Province, China (Fig. 1). Taiyuan City is the capital city of Shanxi Province and one of China's critical industrial bases. It has a complete industrial system in metallurgy, coal, machinery, chemicals, electronics, and other categories. Due to historical evolution and urban development positioning, Taiyuan City has had a high proportion of traditional industries such as coal and steel for a long time, while the development of new industries has lagged. As a representative of China's mining cities, Taiyuan City has persisted in promoting and exploring urban transformation and development for decades. In 2006, the Taiyuan Municipal Government put forward the idea of "innovating development models and promoting green transformation" (Piper Gaubatz & Dean Hanink, 2020; Kairui Guo, 2023), and since then, the city's all-around transformation and development have begun. Taking advantage of Taiyuan City's political, economic, scientific research and education, location and transportation advantages as the provincial capital, it has implemented several measures, including the transformation and upgrading of traditional industries, the introduction and development of emerging industries, comprehensive management of urban and rural environments, and the improvement and construction of public welfare undertakings. Urban transformation and development have achieved considerable results (Piper Gaubatz & Dean Hanink, 2020; Xi Zhang et al., 2022).

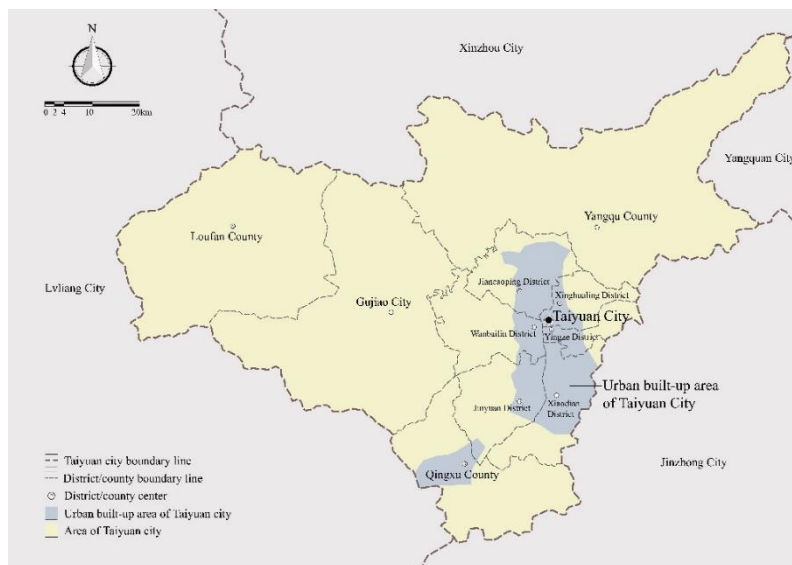


Fig 1. Taiyuan City Municipal District Map (Source: Google Map contributors)

3. Research methods

Based on the perspective of a healthy city, this article takes the urban transformation and development of Taiyuan City, Shanxi Province, China, as a case study. First, this study collected the socio-economic, environmental, and urban construction public data related to healthy city construction of Taiyuan City from 2006 to 2022, as well as relevant public policies and strategies formulated by the Taiyuan Municipal Government. Moreover, the relevant data from Shanxi Province was also collected as comparative study background data. Second, this study used qualitative and quantitative approaches to estimate and analyze the changes and improvements in the urban economy, environment, and construction in the urban transformation process, and their health benefits were evaluated as well (Fig. 2). Third, it summarized the roles, disciplines, development trends, and interrelationships of healthy economic industries, ecological environment, urban construction, and public health services (Min Pang, 2017).

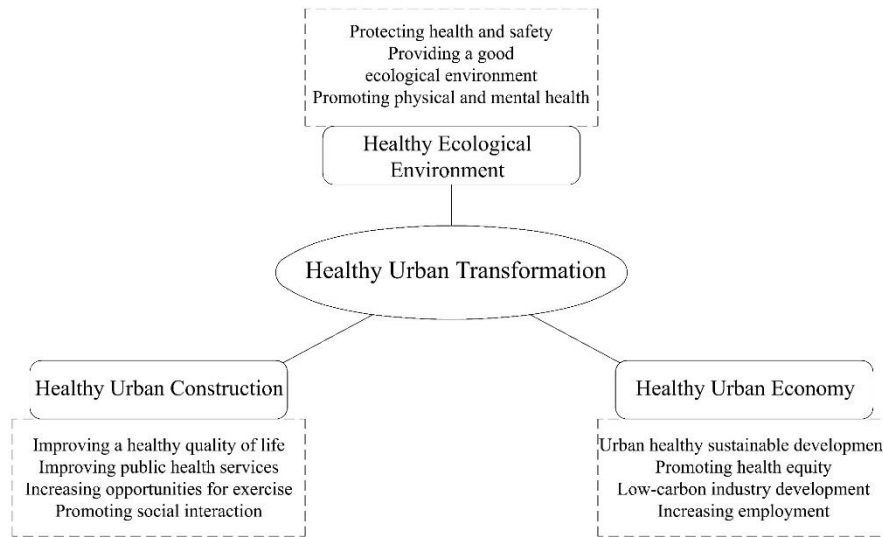


Fig 2. Diagram of the model for assessing healthy urban transformation
Source: author's own work 2023

4. Results

In terms of urban transformation and development, Taiyuan City actively promotes the optimization and adjustment of urban industrial structures. By implementing strict market access for key industries and strictly controlling project environment access, Taiyuan City has developed and expanded emerging industry clusters such as information technology, high-end equipment manufacturing, new materials, biotechnology, and finance, modern logistics, exhibitions, electronics, etc., and the high-end modern service industries such as business and commerce.

It can be seen from the statistical data of the city's economic industry that Taiyuan City's GDP-added value increased from 100.538 billion yuan in 2006 to 557.117 billion yuan in 2022, an increase of 454.14% ("Taiyuan Statistical Yearbook," 2006-2022). The GDP Per capita has increased

from 29,263 yuan in 2006 to 102,922 yuan in 2022, with an increasing rate of 251.71% (Fig. 3). The proportion of Taiyuan City's three industries has changed from 1.9: 46.6: 51.5 in 2006 to 0.86: 44.27: 54.87 in 2022. The proportion of the tertiary industry increased by 13.84%, and the proportion of the secondary industry decreased by 11.99%. The overall urban economy and its structure have been significantly improved (Fig. 4). During the same period, in 2006, Taiyuan's top five industries in terms of total industrial output value were the ferrous metal smelting and rolling processing industry, coal mining, and washing industry, special equipment manufacturing industry, petroleum coal and other fuel processing industry, chemical raw materials and chemical products Manufacturing industries are almost all traditional energy and heavy chemical industries. By 2020, Taiyuan's top five industries in terms of total industrial output value will become the computer, communications and other electronic equipment manufacturing, ferrous metal smelting and rolling processing industry, coal mining, and washing industry, gas production and supply industry, petroleum and coal industry and other fuel processing industries. Although the energy, heavy, and chemical industries still account for a large proportion, the computer, communications, and other electronic equipment manufacturing industries have become Taiyuan's leading industries, contributing 26.2% of the city's industrial output value. In 2006, the added value of coal mining and washing accounted for 12.4% of Taiyuan's total industrial output value. By 2020, the proportion dropped significantly to 8.3%. The city's health economic industry has significantly progressed and developed (Fig. 5).

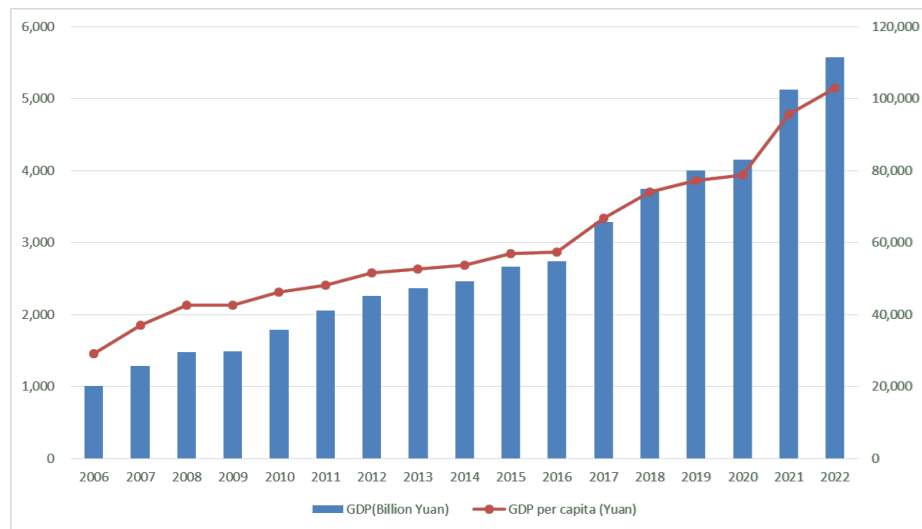


Fig 3. Changes of the economy growth in Taiyuan City
Sources: author's own work 2023

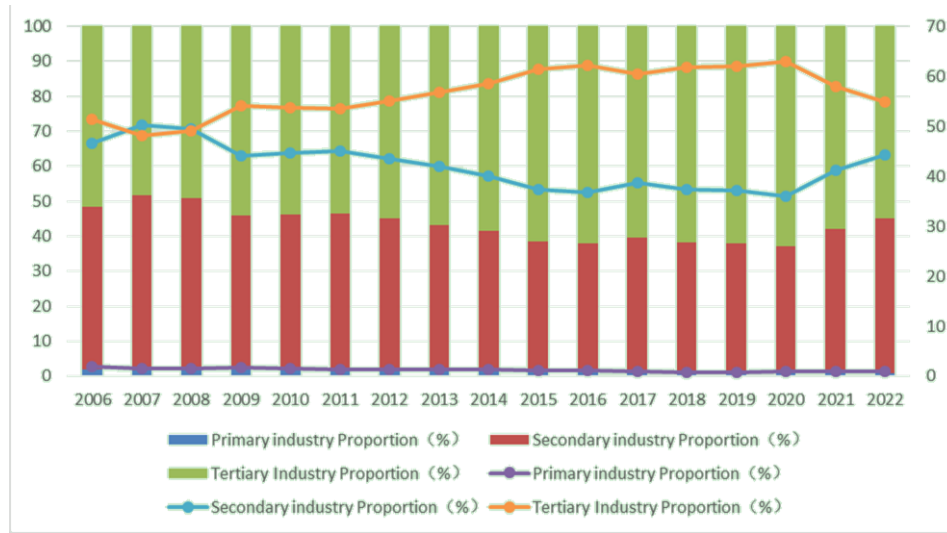


Fig 4. Changes of the industrial structures in Taiyuan City
Sources: author's own work 2023

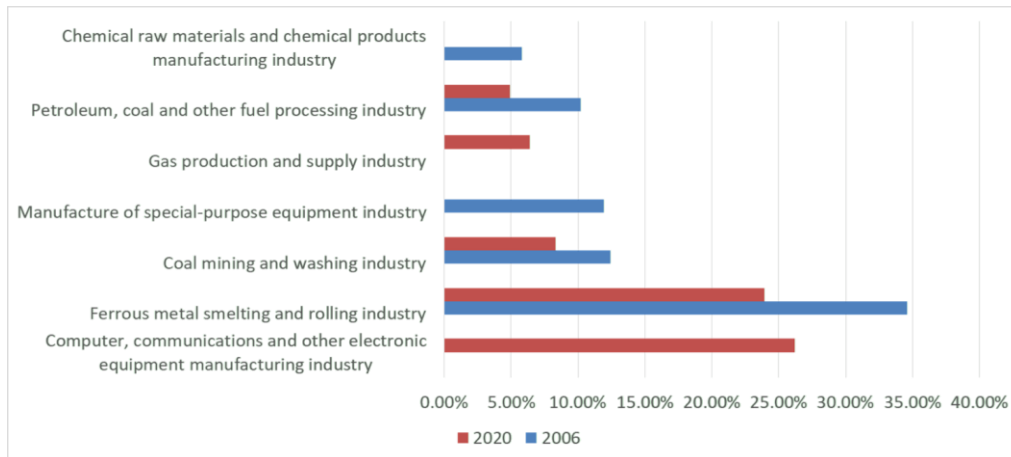


Fig 5. Top 5 Industries with total industrial output value above scale in Taiyuan City
Sources: author's own work 2023

In terms of urban environmental transformation and construction, Taiyuan City has implemented measures such as shutting down and relocating heavily polluting enterprises, eliminating backward production capacity, and promoting cleaner production, such as wind power, photovoltaics, and hydrogen energy. The city has vigorously strengthened the comprehensive improvement of urban and rural land and space environment, carried out comprehensive management of urban and rural atmosphere, water, soil, mines, brownfield, and other environmental damage and pollution, persisted in promoting the integrated protection and restoration of urban and rural mountains, rivers, forests, fields, lakes, and grass, expand urban and rural green space, and comprehensively improved urban and rural ecological environment quality.

It can be seen from the statistical data related to the urban ecological environment that the annual average monitoring value of PM₁₀ in Taiyuan City's atmospheric environment was 0.142 (mg/m³) in 2006 and 0.083 (mg/m³) in 2022, with a decrease of 41.55% ("Taiyuan Statistical Yearbook," 2006-2022). The annual average monitoring value of SO₂ in the atmospheric environment of Taiyuan City was 0.08 (mg/m³) in 2006 and 0.012 (mg/m³) in 2022, with a decrease of 85.00%. The annual average monitoring value of Taiyuan City's atmospheric environment Dust Fall was 27.7 (t/km².month) in 2006 and 6.4 (t/km².month) in 2022, with a decrease of 76.90% (Fig. 6). Among them, there was a decline in 2013 due to climate change in North China and other reasons, but the urban atmospheric environment generally showed an upward trend. It shows that due to Taiyuan City's industrial structure adjustment, energy conservation and emission reduction and other measures, atmospheric environment indicators such as PM₁₀, SO₂, Dust Fall, which are closely related to heavy industry pollution emissions, have been significantly improved, and have had a significant effect on improving the urban atmospheric environment (Fig. 7). However, the annual average monitoring value of NO₂ in the urban atmospheric environment increased from 0.025 (mg/m³) in 2006 to 0.04 (mg/m³) in 2022, with an increase of 60.00%. During the same period, the number of cars in Taiyuan City increased significantly from 299,100 vehicles in 2006 to 2,055,100 vehicles in 2022, with an increase of 587.09%. Due to reasons such as a sharp increase in vehicle exhaust emissions, NO₂ has shown an upward trend. Therefore, the overall atmospheric environment quality of Taiyuan City still faces challenges under the new situation (Fig. 8). The average value of urban noise was 53.1 decibels in 2006 and 50 decibels in 2022. The annual average value of traffic noise was 67.9 decibels in 2006 and 66.1 decibels in 2022. Urban noise shows a downward trend. The overall urban healthy ecological environment has been significantly improved (Fig. 9) (Table 1).

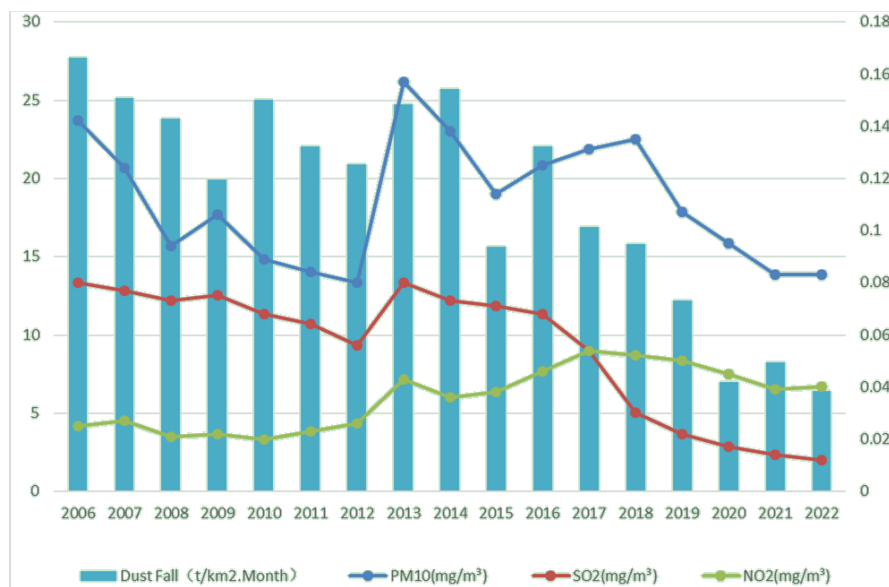


Fig 6. Changes of urban air environmental quality in Taiyuan City from 2006 to 2022

Sources: author's own work 2023

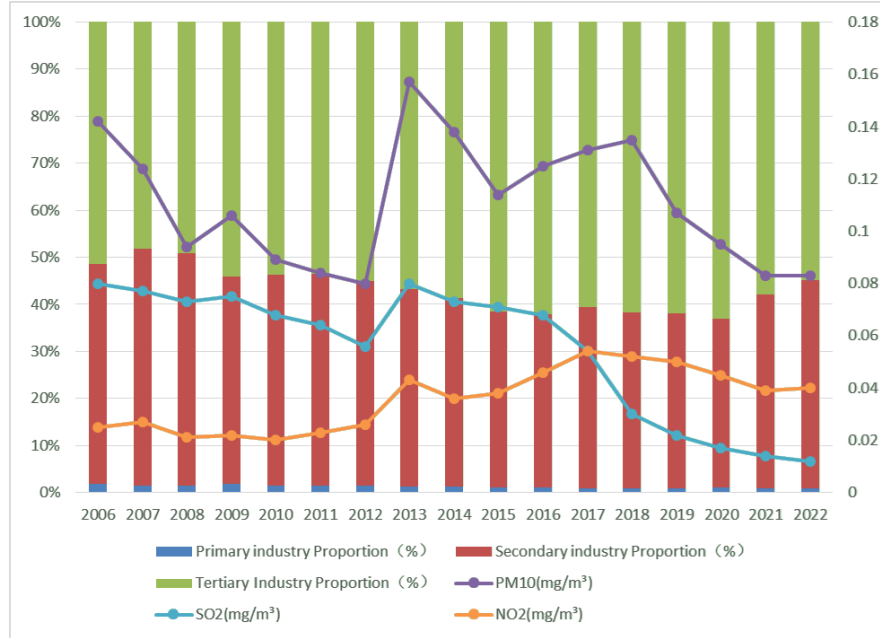


Fig 7. Changes of urban atmospheric environmental quality and economic structure in Taiyuan City from 2006 to 2022
Sources: author's own work 2023

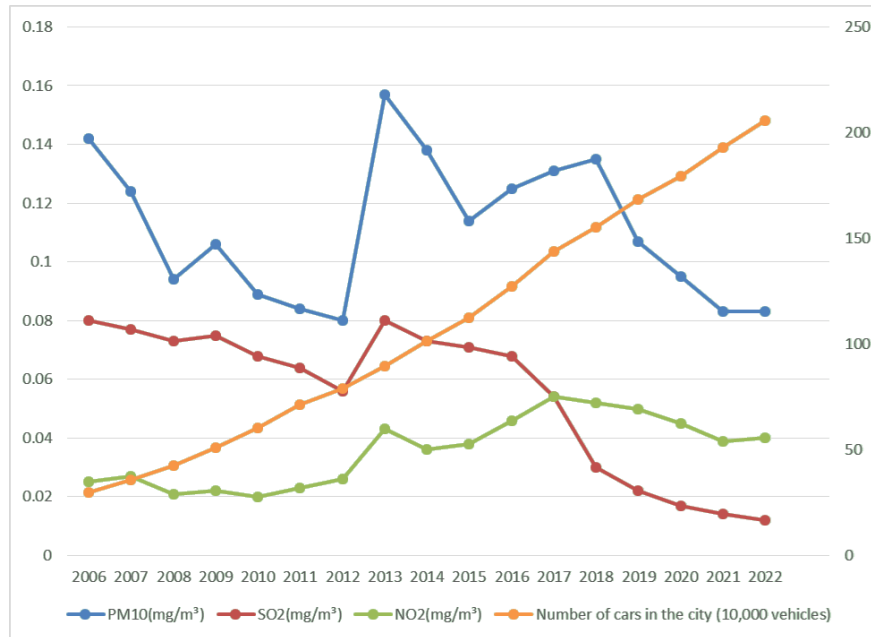


Fig 8. Changes of urban atmospheric environmental quality and number of cars in Taiyuan City from 2006 to 2022
Sources: author's own work 2023

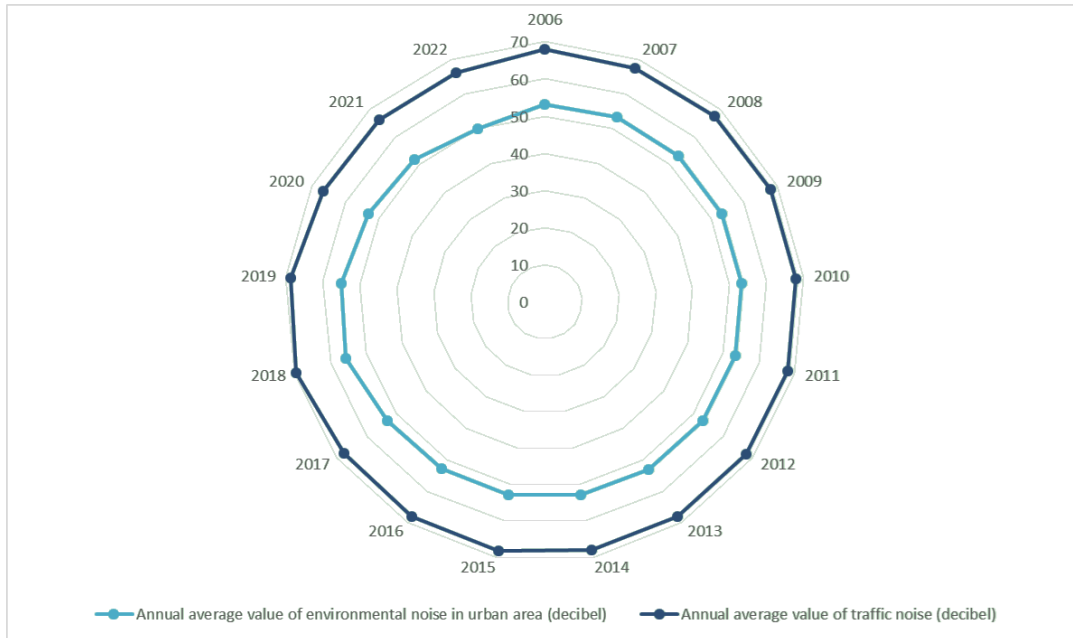


Fig 9. Changes of urban noise in Taiyuan City from 2006 to 2022
 Sources: author's own work 2023

Table 1. Changes of ecological environment in Taiyuan City from 2006 to 2022

Year	PM10 (mg/m ³)	S02 (mg/m ³)	N02 (mg/m ³)	Dust Fall (t/km ² .month)	Annual average value of environmental noise in urban areas (decibel)	Annual average value of traffic noise (decibel)	Number of cars in the city (10,000 vehicles)
2006	0.142	0.08	0.025	27.7	53.1	67.9	29.91
2007	0.124	0.077	0.027	25.1	53.4	67.4	35.65
2008	0.094	0.073	0.021	23.8	53.3	67.8	42.6
2009	0.106	0.075	0.022	19.9	53.1	68	51.08
2010	0.089	0.068	0.02	25	53.1	68	60.53
2011	0.084	0.064	0.023	22	53.2	67.9	71.4
2012	0.08	0.056	0.026	20.9	53.3	67.9	78.84
2013	0.157	0.08	0.043	24.7	53	68	89.5
2014	0.138	0.073	0.036	25.7	52.9	68	101.58
2015	0.114	0.071	0.038	15.6	52.9	68.3	112.29
2016	0.125	0.068	0.046	22	52.9	68.1	127.23
2017	0.131	0.054	0.054	16.9	53.2	67.8	143.63
2018	0.135	0.03	0.052	15.8	55.7	69.7	155.3
2019	0.107	0.022	0.05	12.2	55.1	68.7	168.37
2020	0.095	0.017	0.045	7.000	53	66.8	179.44
2021	0.083	0.014	0.039	8.22	52	66.2	192.92
2022	0.083	0.012	0.04	6.4	50	66.1	205.51

Sources: author's own work 2023

In terms of urban greening construction, Taiyuan City actively carries out greening conservation and construction work in urban parks, street green spaces, country parks, and suburban woodlands. The city actively carries out the restoration, management and greening reclamation of abandoned

mine lands and industrial brownfields. Combined with urban and rural water supply and drainage municipal infrastructure improvement projects, it promotes the construction of urban and rural blue-green infrastructure such as "sponge cities" and promotes the green transformation and improvement of urban and rural gray infrastructure. After construction from 2006 to 2022, the green coverage area of Taiyuan's urban built-up areas increased from 7,342 hectares in 2006 to 16,228.8 hectares in 2022, an increase of 121.04%. The green coverage rate of built-up areas will increase from 37.3% in 2006 to 45.08% in 2022. The green space rate of built-up areas will increase from 32.2% in 2006 to 39.94% in 2022. The area of garden green space and park green space increased from 6343 hectares and 2270 hectares in 2006 to 14378.4 hectares and 5530.91 hectares in 2022, an increase of 126.68% and 143.65% respectively (Fig. 10) (Table 2).

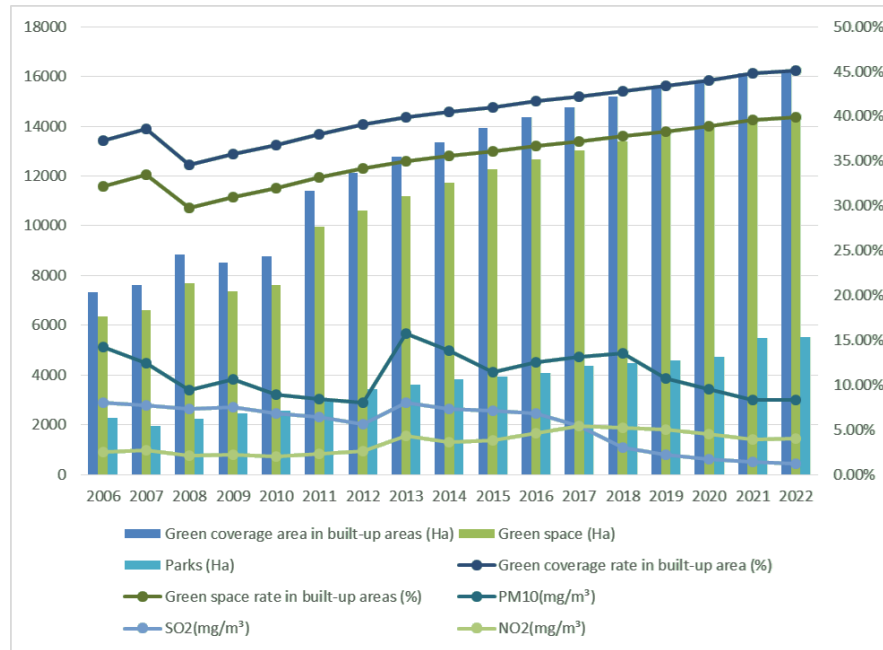


Fig 10. Urban greening construction in Taiyuan City from 2006 to 2022
Sources: author's own work 2023

Table 2. Changes in urban greening construction in Taiyuan City from 2006 to 2022

Year	Green coverage area in built-up areas (Ha)	Green space (Ha)	Parks (Ha)	Green coverage rate in built-up area (%)	Green space rate in built-up areas (%)
2006	7342	6343	2270	37.30%	32.20%
2007	7615	6610	1961	38.60%	33.50%
2008	8849.75	7704.5	2233.74	34.60%	29.80%
2009	8519	7372	2442	35.80%	31.00%
2010	8759	7611	2576	36.80%	32.00%
2011	11403	9948	3027	38.01%	33.16%
2012	12112	10596	3416	39.07%	34.18%
2013	12762	11190	3617	39.88%	34.97%
2014	13365	11738	3828	40.50%	35.57%
2015	13940	12264	3930	41.00%	36.07%
2016	14369	12655	4099	41.65%	36.68%
2017	14767	13013	4384.8	42.19%	37.18%
2018	15186.9	13397.7	4492.8	42.78%	37.74%
2019	15617	13788	4601	43.38%	38.30%
2020	15840	14004	4716	44.00%	38.90%
2021	16117.2	14270.4	5487.22	44.77%	39.64%
2022	16228.8	14378.4	5530.91	45.08%	39.94%

Sources: author's own work 2023

In terms of urban health development, Taiyuan City has made great efforts to improve the urban and rural medical service system and enhance medical and health service capabilities. Increase and upgrade the construction of general hospitals, primary medical service points, and rural health clinics. Increase the introduction and training of professional doctors, nurses, and other health technical personnel. Improve the essential health and welfare system in urban and rural areas. From relevant statistics on urban health services, the number of urban health institutions (excluding village clinics) has increased from 3,305 in 2006 to 4,087 in 2022. The number of beds in health institutions will increase from 23,116 beds in 2006 to 46,102 in 2022. Health technicians will increase from 32,186 in 2006 to 70,074 in 2022. The city's public health undertakings have greatly progressed (Fig. 11) (Table 3).

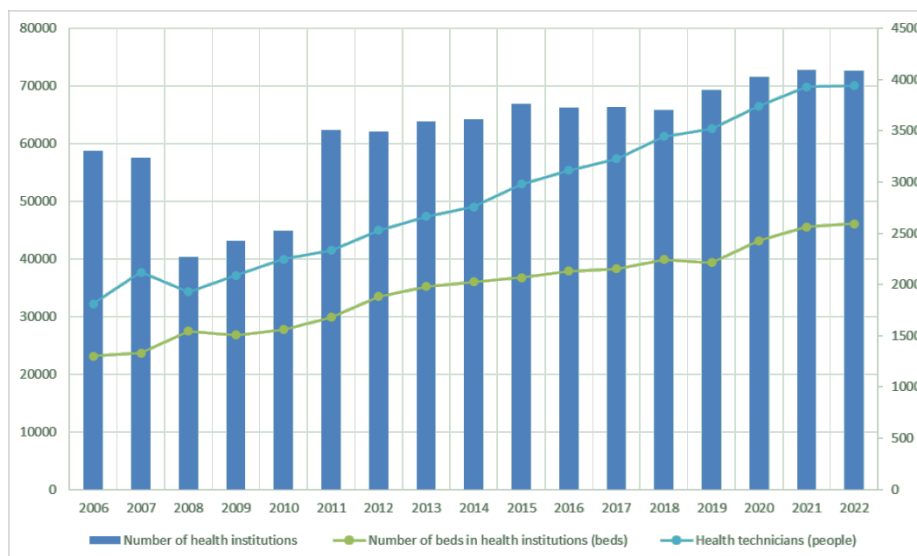


Fig 11. Changes in urban health services in Taiyuan City from 2006 to 2022

Sources: author's own work 2023

Table 3. Changes in urban health services in Taiyuan City from 2006 to 2022

Year	Number of health institutions	Number of beds in health institutions (beds)	Health technicians (people)
2006	3305	23116	32186
2007	3240	23687	37658
2008	2265	27505	34278
2009	2425	26815	37155
2010	2527	27771	39930
2011	3505	29876	41506
2012	3489	33461	44947
2013	3590	35247	47388
2014	3612	36022	49053
2015	3759	36760	52952
2016	3724	37897	55389
2017	3731	38318	57348
2018	3705	39917	61269
2019	3898	39358	62575
2020	4025	43166	66540
2021	4089	45589	69847
2022	4087	46102	70074

Sources: author's own work 2023

5. Discussion

From 2006 to 2022, Taiyuan City has made significant progress in transforming and upgrading urban industries, improving the ecological environment, landscaping construction, and improving urban and rural health services. Taiyuan City's per capita GDP increased by 248.92% in 17 years, and its growth rate was significantly higher than the other three aspects of construction and development. However, the proportion of the tertiary industry in Taiyuan City has experienced an increase first and then decreased. In 2015, the tertiary industry accounted for 61.5%, but it dropped to 54.87% in 2022. Although most of the polluting heavy industries in the city have been transformed by technology there have been transformations such as upgrading or closure and relocation. However, secondary industry still accounts for a large proportion. During the urban transformation of Taiyuan City, how to increase the proportion of service industries and emerging industries and promote the healthy and sustainable development of urban industries remains a long-term challenge facing the city.

Urban greening construction had rapid growth before 2015, with its growth rate being close to the per capita GDP growth rate. However, after 2015, the growth rate declined significantly lower than the urban per capita GDP growth rate. This shows that investment in greening construction in Taiyuan City lags the regional economic development level after 2015. The growth rate of urban and rural health services is close to 50% of the urban per capita GDP growth rate during the same period. This shows that investment in health and sanitation increases simultaneously with urban economic development but lags regional economic development.

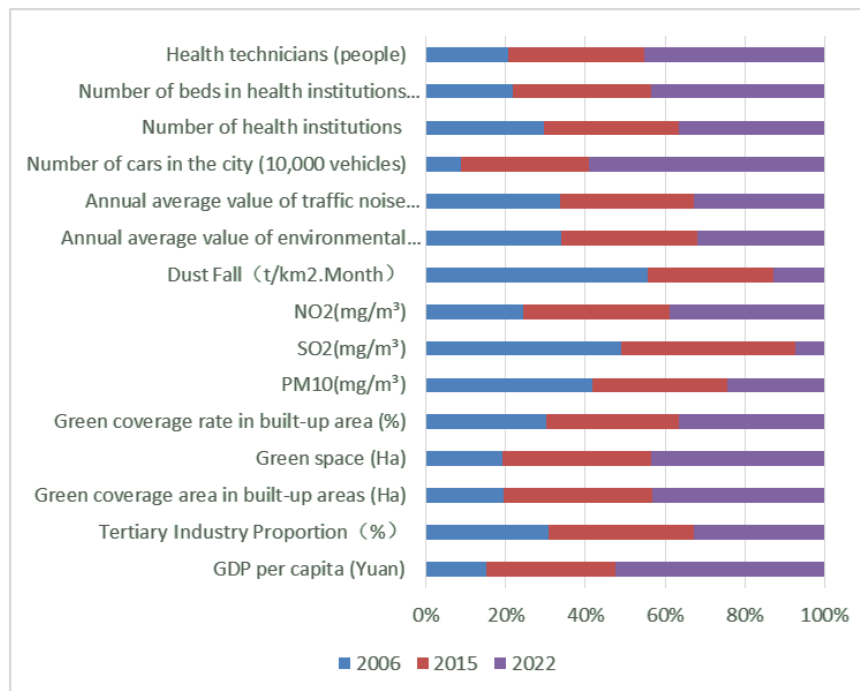


Fig 12. Changes of main healthy city elements in Taiyuan City from 2006 to 2022.
 Sources: author's own work 2023

Although Taiyuan City's atmospheric and noise environmental quality fluctuated between 2006 and 2022, they have shown an overall improvement trend. Still, they are lower than the growth rate of the city's per capita GDP and lower than the growth rate of urban greening construction and health services. During the same period, the growth rate of Taiyuan City's car ownership (10,000 vehicles) was much higher than that of per capita GDP and other factors. This shows that improving an urban healthy ecological environment still requires increased investment, which is synchronized with the construction and development of different aspects of the city. Controlling the growth of car use is also an issue that needs to be focused on in building a healthy urban environment in Taiyuan City (Fig. 12) (Table 4). The construction of a high-quality, healthy city, the cultivation of emerging industries, and the replacement of old production capacity in regional industrial transformation and upgrading require a long cycle. Long-term attention to urban transformation, construction, and development is needed for further study.

Table 4. Changes of main healthy city elements in Taiyuan City from 2006 to 2022

		2006	2015	Change rate 2006-2015	2022	Change rate 2006-2022
Health economy	GDP per capita (Yuan)	29497	63483	115.22%	102922	248.92%
	Tertiary Industry Proportion (%)	51.5%	61.5%		54.87%	
				19.42%		6.54%
Greening construction	Green coverage area in built-up areas (Ha)	7342	13940	89.87%	16228.8	121.04%
	Green space (Ha)	6343	12264	93.35%	14378.4	126.68%
	Green coverage rate in built-up area (%)	37.30	41.00%	9.92%	45.08%	20.86%
Ecological environmental quality	PM ₁₀ (mg/m ³)	0.142	0.114	-19.72%	0.083	-41.55%
	SO ₂ (mg/m ³)	0.08	0.071	-11.25%	0.012	-85.00%
	NO ₂ (mg/m ³)	0.025	0.038	52.00%	0.04	60.00%
	Dust Fall (t/km ² .Month)	27.7	15.6	-43.68%	6.4	-76.90%
	Annual average value of environmental noise in urban areas (decibel)	53.1	52.9	-0.38%	50	-5.84%
	Annual average value of traffic noise (decibel)	67.9	68.3	0.59%	66.1	-2.65%
	Number of cars in the city (10,000 vehicles)	29.91	112.29	275.43%	205.51	587.09%
Health services	Number of health institutions	3305	3759	13.74%	4087	23.66%
	Number of beds in health institutions (beds)	23116	36760	59.02%	46102	99.44%
	Health technicians (people)	32186	52952	64.52%	70074	117.72%

Sources: author's own work 2023

6. Conclusions

Research shows that Taiyuan City's healthy social economy, ecological environment, and public health have been comprehensively developed through urban transformation, construction, and development. The leading indicators of healthy city construction have been significantly improved. Policies to stimulate the transformation of urban-related industries, environmental protection policies, and related construction of healthy cities have all achieved significant results.

The growth rate of economic development during urban transformation is close to twice that of an urban healthy ecological environment, urban greening construction, and health service supply. In the urban economic structure, the proportions of the three industries have fluctuated significantly over the years. It shows that the development of an urban healthy economy still needs to be further optimized in terms of industrial structure. The urban healthy ecological environment, urban greening construction, and health service supply need to be further strengthened to achieve coordinated development with the urban healthy economy.

Healthy urban transformation and development is a long-term and arduous task. It requires the joint support and efforts of the government, enterprises, social institutions, and urban and rural residents. It needs the promotion of the coordinated development of urban public health and industrial transformation through measures such as enhancing policies for sustainable development, broadening the scope of the health economy framework, encouraging the healthy transformation and upgrading of existing regional industries, improving the quality of the regional health environment, and ensuring the provision of high-quality health benefits and services.

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