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Analysis on Dynamic Relationship and Optimization Path between Public Sports Service and New Urbanization Development in Mainland China

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Short Title: yet to decide Optimization Path between Public Sports Service and New Urbanization Development

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Abstract

In the new period, the state has made every effort to promote the new urbanization of public sports service. Entropy method, coupled coordination model, cold hot spot analysis is used to explore the dynamic relationship between public sports services and the development of new urbanization in China from 2008 to 2017. The results show that: (1) The development of the internal subsystem of public sports service is not balanced, the sports financial investment system grows rapidly, but the development of professional sports talent team is slow. (2) The imbalance of regional development cannot be ignored, and the public sports service level shows a

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decreasing gradient from east to west. (3) The regional development features are different. The eastern region is dominated by the coordinated development of sports public service and urbanization, while the central region is mainly in the type of public sports service lag, while the western region has multiple complex characteristics of low-level coordination and public sports service lag. Therefore, it is proposed that the construction of modern public sports service system should be investigated in the context of the development of new urbanization. It should be promoted from the following aspects: promoting the extension of public sports service to rural areas, engendering the "citizen's right" of sports health to the migrant population, conforming to the trend of mass sports intelligence, developing green sports and revitalizing idle sports assets in cities.

Introduction

In 2011, China's urbanization rate exceeded 50%, marking a new stage in urbanization development. The 18th National Congress clearly defines "new-type urbanization" as "people-oriented urbanization", and its core concept is to improve infrastructure and public services and enhance people's sense of access, happiness and security. Public sports service has the attribute of sharing social public service products and is the basic content of the public service system. The National Fitness Plan (2021-2025) (No. 11 Document of State Council [2021]) clearly points out the establishment of a more complete public sports service system, addressing the negative impacts highlighted by traditional urban development and emphasizing the "quality" of urbanization development. With the deep development of urbanization, especially with the implementation of a series of policies on public sports popularization projects jointly issued by the General Administration of Sports, the National Development and Reform Commission, the Ministry of Housing and Urban-Rural Development and other departments, public sports have become a new hot spot and research trend to facilitate the internal development of society. The 14th Five-Year Plan and the Outline of Vision 2035 adopted by the National People's Congress in 2021 more clearly proposed to accelerate the supply of public welfare and basic sports services while focusing on the quality and expansion of sports resources, indicating the direction and trend of integrating public sports with new urbanization. Public sports services are becoming an important driving force in reconstructing the spatial structure of cities, giving play to overlapping advantages and building the soft power of urban development. Therefore, exploring the development mechanism of public sports services and new urbanization and revealing the spatial relationship between public sports in improving the quality of urbanization will help realize the high-quality integrated development of the two.

The relationship between public sports services and urbanization is a heated topic of interest for scholars at home and abroad. Scholars have conducted investigations based on different entry points, covering the following aspects: (1) the strain of public sports service system on the complex demands of urbanization. With a logical analysis of the literature, Han Hongyu et al. finds that the people's targeting

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of supply and the adaptation of planning decisions are the connotations of accurate urban public sport provision, and on this basis proposed digital, systematic, networked, and dynamic realistic strategies (Han Hongyu, Zheng Jiakun, 2021). While Lmatova, through her research in the United Kingdom, argues that national governing bodies play a central role within the institutional framework of sport governance. The active partnership between the state and localities attracts the participation of the society in mass sport activities and also provides a strong link to the talent pathway system and high-performance sport development in the UK (Lmatova T, 2019). (2) The interaction between public sport supply-side structural reforms and social development. For example, Zu Yatong et al. have explored the unique integration of state, family, society, and people in the development of public sport under the "State plus Public" sport governance mechanism, where citizen rationality and social rationality are amplified (Zu Yatong, Dong Chuansheng, 2021). In addition, Pope proposes a "liberal-modernist" paradigm to explain the history of public sport in the United States as a "rational" adaptation to the "modern forces" of industrialization, urbanization, and the maturation of democratic institutions. He also identifies class, gender, racial, and regional differences in public sport and discusses them in a larger institutionalized narrative (Pope, S, W, 1993). (3) Public sport's restoration of urban ecology. Cheng et al. uses factor analysis and other research methods to construct a structural equation model of the pro-environmental behavior of residents through the construction of sports towns, and finds that the construction of ecological civilization in special towns has a direct impact on residents' pro-environmental behavior through natural empathy (Cheng Wenguang, Wang Ningning, 2021). Cortinovis et al. also finds that the increase of urban green space contributes to the improvement of urban development quality (Cortinovis C，Haase D，Zanon B et al., 2019). (4) Public sports development and the reshaping of urban space. From the perspective of equity and efficiency, Zhao Jun et al. finds that the spatial differentiation of urban sports is the result of the interaction of natural geographic, socioeconomic, and political and cultural factors, as well as a series of social activities such as selective urban renewal and filtering (Zhao Jun, Xu Jie, 2021). Cai Yujun et al. also proposed an ideal development model of urban public sports intensive spatial structure that takes into account population density, spatial accessibility and service radius (Cai Yujun, Shao Bin, Wei Lei et al., 2012). Reimers et al. finds a significant interaction between the distance to gyms and the level of urbanization in a study of the relationship between the proximity of youth to specific sports facilities and their participation in sports activities in Germany (Reimers A, K, Matthias W, Seraphim A, et al. 2014).

In summary, the existing literature has enriched the research connotation and methodological system of public sports services and urbanization and strengthened the research foundation of this paper, but there are still several shortcomings. Firstly, most of the previous studies focus on the efficiency of resource allocation, supply-demand relationship and equalization of public sports services, but there is little research on the mechanism of coupling public sports services and new urbanization.

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Secondly, the literature has explored different aspects of public sports from the perspectives of economics and management, but the research on the coupling and coordination between public sports services and urban development from the perspective of human geography is still weak, and the identification of the spatial structure of the relationship between the two is even more rare. In the context of a strong sports nation and a new urbanization strategy in which China's urbanization is changing from a crude scale expansion to a scientific planning and reasonable layout, allowing all people to share the dividends of urbanization development, is there a long-term and stable interaction between public sports services and urbanization development? What is the development relationship and spatial correlation pattern between these two? How is the interaction mechanism of their spatial pattern formed? These are important questions that need to be addressed.

In view of this, this study takes 31 provinces and urban areas in China as the research objects, and constructs a public sports service evaluation index system based on multiple heterogeneous data. Based on the evaluation index system of public sports services and new urbanization development, this study measures the development relationship between the two from 2008 to 2017, and analyzes the regional differences, trends and patterns of spatial correlation between public sports development and urbanization development in China from the perspective of spatial and temporal heterogeneity by using spatial data analysis, and conducts an in-depth investigation into the interaction mechanism between them. This is conducive to the scientific identification of bottlenecks in the development of public sports services at the stage of building a high-quality development with the domestic cycle as the mainstay and the domestic and international cycles promoting each other, and provides a reference for profoundly promoting the reform of public sports development, changing the social lifestyle and achieving a new height of social civilization.

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Empirical Study Design

Research Area and Data Sources

In this study, 31 provinces (municipalities directly under the central government and autonomous regions) in China are adopted as the research objects. Hong Kong, Macao and Taiwan are not included in the scope of the study because of data missing. Based on the consideration of data availability, representativeness, and consistency of statistical caliber, this study covers the period from 2008 to 2017. The indicators involved in the study, such as the amount of spending on mass sports, the area of fitness venues, the consumption level of urban residents, and the number of social organizations per 10,000 people, are mainly obtained from the *China Sports Statistical Yearbook*, the *China Statistical Yearbook*, the *China Labor Statistical Yearbook*, and the *China Population and Employment Statistical Yearbook*, as well as the statistical yearbooks of various provinces and cities and the statistical bulletin of citizens' economy and development.

Research Methodology

This study draws on the existing literature (Cai Z, Xie W, Yu H, et al. 2021) and adopts a combination of indicators such as coupling degree, coordination degree and development degree to explore the characteristics and patterns of the evolution of public sports services and urbanization development in China from 2008 to 2017. Firstly, the entropy value method is used to measure the development index of public sports services and new urbanization, and then, through the study of their coupling and coordination, the state of mutual interaction and influence in their development process is examined, and on this basis, the spatial differentiation pattern and its interaction mechanism in their evolution process are analyzed. The specific measurement methods are as follows:

$$U_S = \sum_{j=1}^{n} \lambda_{sj} u_{sj} \quad (1)$$

In equation (1), U_s is the evaluation index, u_{sj} denotes the standardized value of the jth indicator of the ith province and city, and λ_{sj} is the weight of the jth indicator. The entropy method, as an objective assignment method, has obvious utility value for the index system of multivariate comprehensive evaluation. The larger the weight, the greater the influence of the indicator on the system. The larger the evaluation value is, the better the effect of the sample is, and finally the evaluation conclusion is made by comparing all the values.

$$C = \sqrt{\frac{U_a + U_b}{\frac{1}{2}(U_a + U_b)^2}} \quad (2)$$

$$T = U_a = U_b \quad (3)$$

$$D = \sqrt{C * T} \quad (4)$$

$$H = U_a = U_b \quad (5)$$

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In equation (2) U_a and U_b are the development evaluation indices of public sports service and new urbanization system respectively, and the larger the result, the stronger the interaction state of public sports service and new urbanization. C ∈ (0,0.3] is low level coupling; C ∈ (0.3,0.5] is antagonistic coupling; C ∈ (0.5,0.8] is the grinding stage, and C ∈ (0.8,1] is high level coupling. In equation (3), α and β are the weights of the two systems, and $\alpha+\beta=1$. The larger the result, the greater the overall benefit of public sports services and new urbanization. In equation (4), C is the degree of coordination and D is the degree of development. The larger the result, the higher the quality of synergy between public sports services and new urbanization, combined with the natural break method (Jenks) graded as: advanced coordination, basic coordination, basic dissonance, and serious dissonance. In equation (5), H is the index of synchronous development: when H=0, it means that public sports services and new urbanization system are fully synchronous and coordinated; when $|H|\leq 0.1$ indicates that the development of both is basically synchronous;. $|H|>0.1$ indicates that there is deviation in the development of the system, when H>0.1 indicates that the place belongs to the lagging type of urbanization; conversely, $H<-0.1$ is the lagging type of public sports service.

$$G^*(d) \circledcirc \sum_{j=1}^{n} w_{ij}(d)x_j / \sum_{j=1}^{n} x_j \quad (6)$$

$$Z(G_i^*) = \frac{G_i^* - E(G_{i)}^*}{\sqrt{Var(G_i^*)}}$$

In equation (6), *Getis-Ord Gi** index measures the spatial clustering characteristics of high and low values of the coupling degree of public sports services and new urbanization; $E(G^*_j(d))$ and $Var(G^*i(d))$ are the mathematical expectation and variance of $G^*_i(d)$; ω_{ij} is the spatial weight matrix. If $G^*_i(d)$ is positive and significant, it means there is a high-value hot spot cluster; if $G^*_i(d)$ is negative and significant, it means there is a low-value cold spot cluster; if the confidence interval is 0, it is not statistically significant.

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The Dynamic Development of Public Sports Services and New Urbanization

Construction of the Evaluation Index System of Public Sports Services and New Urbanization

The indicator system is an aggregate of regularity, interactions or dependence forms (Zhu Qingfang, Wu Hanguang, 2001). Therefore, the scientific credibility of quantitative indicators is the criterion of research. In contrast, single sports are easy to measure, while the overall evaluation of the level of public sports services usually involves the comprehensive analysis of multiple elements. Therefore, this paper adopts Barney's (Jay B. Barney, 2011) "practical route" perspective of public sports, draws on the research results of Zheng Jiakun et al (Zheng Jiakun, Huang Junyu, 2013) and Zhang Dachao et al (Zhang Dachao, Li Min, 2013) in the direction of the flow of public sports resources, and operationalizes the indexes into financial investment, infrastructure configuration, professional sports organization network, and professional talent team, etc. from the perspective of the content and actual effect of public sports services. In this study, 38 interrelated and representative original and generated indicators are selected to describe, explain, and evaluate the public sports services in China and the inter-provincial differences that exist.

At present, China's urbanization development is undergoing a qualitative change from quantitative "population urbanization" to "human urbanization", and therefore needs to be evaluated from a more diversified perspective. The 14th Five-Year Plan clearly puts forward the urban development vision of "accelerating the urbanization of the transferred agricultural population, improving the spatial layout of urbanization, and improving the quality of cities for all". This reflects that the focus of research on new urbanization should be on the organic coordination of urban development quality factors such as population, land, economy, society and environment, and the evaluation of new urbanization development level from the perspective of urban function demand. In view of this, this paper, with reference to the National New Urbanization Plan (2014-2020) issued by the Central Committee of the Communist Party of China (CPC) and the State Council, and combining the academic studies of Friedmann (2006), Chen et al (2019), and Fang Chuanglin (2019), views urbanization as a multidimensional and complex process that includes social space. Therefore, in addition to the core indicators of economic development, other important dimensions such as urban public services, livability and ecological environment quality are also paid attention to, and five subsystems such as economic urbanization, demographic urbanization, social urbanization, ecological urbanization and spatial urbanization are established, as shown in **Table 1.**

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Tab.1 Evaluation index system of public sports service and new urbanization in China

Objective	Criterion	Indicator
Public Sports Services	Sports Financial Revenue	Expenditure on mass sports projects (ten thousand yuan) x_{11}^{+}; Expenditure on funds for stadiums (ten thousand yuan) x_{12}^{+}; Expenditure on sports and media (ten thousand yuan) x_{13}^{+}; Expenditure on sports management projects (ten thousand yuan) x_{14}^{+}
	Infrastructure	Number of national physical fitness testing stations (pcs) x_{21}^{+}; Number of fitness bases (pcs) x_{22}^{+}; Area of fitness venues (square meters) x_{23}^{+}; Total investment in fitness venues (ten thousand yuan) x_{24}^{+}
	Sports Organization Network	Number of institutions of the sports system (pcs) x_{31}^{+}; Number of sports schools (pcs) x_{32}^{+}; Number of sports research institutions (pcs) x_{33}^{+}; Number of youth sports clubs (pcs) x_{34}^{+}
	Specialized Teams	Number of sports system employees (person) x_{41}^{+}; Number of sports coaches (person) x_{42}^{+}; Number of sports science institutes (person) x_{43}^{+}; Number of sports health technicians (person) x_{44}^{-}
New Urbanization	Economic Urbanization	Per capita gross regional product (yuan) y_{11}^{+}; Ratio of secondary industry to GDP (%) y_{12}^{+}; Ratio of tertiary industry to GDP (%) y_{13}^{+}; Consumption of urban residents (yuan) y_{14}^{+}; Urban fixed asset investment (billion yuan) y_{15}^{+}
	Population Urbanization	Urbanization ratio of resident population (%) y_{21}^{+}; Employment rate of the number of people in secondary and tertiary industries (%) y_{22}^{+}; Number of people employed in urban units (persons) y_{23}^{+}; Urban registered unemployment rate (%) y_{24}^{-}
	Social Urbanization	Internet penetration rate (%) y_{31}^{+}; Number of beds in medical institutions per 10,000 people (pcs / 10,000 people) y_{32}^{+}; Per capita ownership of public library collections (pcs / per person) y_{33}^{+}; Number of social organizations per 10,000 people (pcs / per 10,000 people) y_{34}^{+}; Urban natural gas penetration rate (%) y_{35}^{+}
	Ecological Urbanization	Unit GDP energy consumption (tons of standard coal / ten thousand yuan) y_{41}^{+}; Urban per capita green space in parks (square meters / person) y_{42}^{+}; Built-up greening coverage rate (%) y_{43}^{+}; Industrial SO_2 emissions (ten thousand tons) y_{44}^{-}
	Space Urbanization	Built-up area (square kilometers) y_{51}^{+}; Urban population density (people/square kilometers) y_{52}^{+}; Urban road area per capita (square meter) y_{53}^{+}; Total public transportation passenger volume (ten thousand passengers) y_{54}^{-}

Note: "+" indicates a positive indicator, the larger the value the more favorable to the system; "-" indicates a negative indicator, the larger the value the more unfavorable to the system.

Temporal Characteristics of the Development of Public Sports Services and New Urbanization

According to the index system in Table 1, the development indexes of public sports services and new urbanization in the country and major regions from 2008 to 2017 are calculated respectively, and their evolution characteristics are analyzed on this basis. Figure 1 shows the trends of the development index of public sports services and its subsystems. In general, China's public sports development index

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shows a fluctuating upward trend, with the national average value increasing from 0.256 to 0.271. From the decomposition of the index, the subsystem of financial investment in sports increases from 0.231 to 0.326; the subsystem of infrastructure allocation increases from 0.186 to 0.202; the subsystem of sports organization network increases from 0.310 to 0.343; the subsystem of professional talent increases from 0.352 to 0.343; and the subsystem of public sports service development index increases from 0.352 to 0.343. Among them, the largest increase is the financial investment system in sports, with 41.34%, and the smallest increase is the professional talent system, with 2.27%, while the total system increases by 5.83%. Among them, 2012-2014 is a period of rapid development of public sports services in China. The public sports service development index reaches a peak of 0.285 in 2014, influenced by the provision of the National Fitness Regulation (2013 Revision) that "incorporates the national fitness cause into the national economic and social development plan".

By calculating the overall level of public sports services and the development level of each subsystem in each region of China, it is found that the overall public sports services in China show a gradual decline in the east, west and central regions. In terms of overall indicators, the eastern region (0.395) is generally higher than the national average (0.268), while the central and western regions are slightly lower than the national average at 0.161 and 0.154 respectively. By area, (1) in the area of sports financial investment, the eastern region occupies a greater advantage, with the average value of 0.432 for the eastern provinces and cities during the study period, much higher than the national average (0.296). The western region is 0.227, slightly higher than the central region's 0.178, but all are below the national average, supported by the national fiscal policy. (2) Considering infrastructure allocation, the development trend remains high in the east and low in the west, with the eastern region averaging 0.325 annually and the central region 0.3. The eastern region outperforms the central and western regions by 29.637% and 13.303%, respectively, with an average annual development level of 0.325. (3) The field of sports organization network also shows similar characteristics, but the regional gap has narrowed, with the eastern region (0.370) slightly higher than the central region (0.350), while the overall level in the western region remains at a lower level of 0.211. (4) In the area of professional talent, the regional gap widens again, with the eastern region outperforming the central region by 16.695% and the western region by 52.512% at 0.529.

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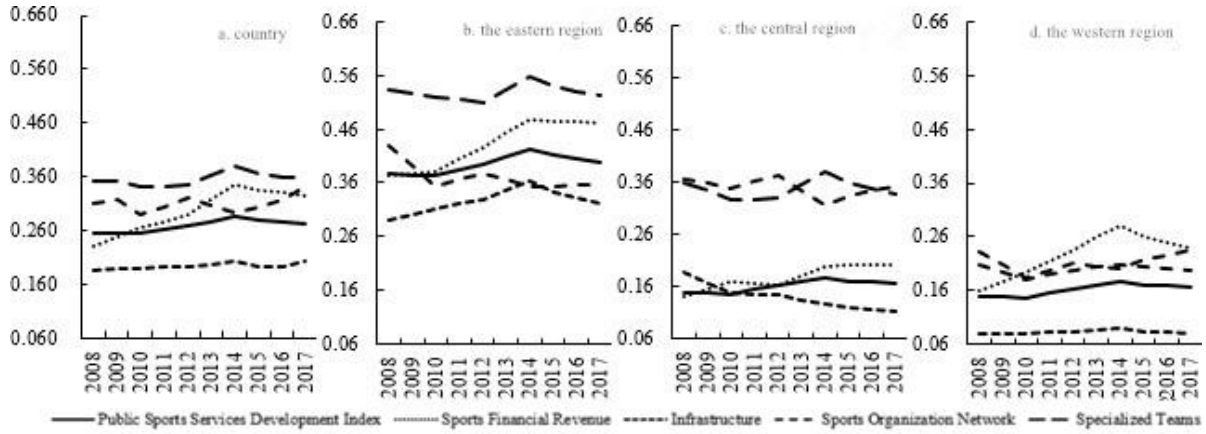

Figure 1 The change trend of public sports service development index and its subsystems in China

The overall level of new urbanization in China fluctuated around 0.331 from 2008 to 2017. The subsystem with the largest growth rate is social urbanization, with an increase of 14.027%. In terms of regional development trend, the new urbanization in the eastern region maintains a higher development level (0.437), and while enjoying a higher economic urbanization (0.470), the level of population urbanization and ecological urbanization has decreased. The mean value of the Central Region New Urbanization Index is 3.179, which is slightly lower than the national average. However, social urbanization and economic urbanization in the central region have developed faster during the study period, with increases of 16.112% and 10.802%, respectively. The overall development level of new urbanization in the western region is lower at 0.257, which is lower than the national average of 22.487%, but it has a positive development trend, and the increase of all subsystems is higher than the national average. Among them, social urbanization has increased by as much as 51.432%. This shows that economic urbanization may have a coercive effect on the ecological environment in the eastern region, and the large-scale construction activities have a certain negative impact on the urban ecology, limiting the sustainable development of the urban ecological environment. Meanwhile, with the socioeconomic development of the central and western regions, the willingness to stay of the urban inflow population in the eastern regions may have changed, and these regions are also under pressure to transform the urbanization dynamics in recent years as the inflow of population to large cities slows down and the trend of population return gradually emerges (Cao Guangzhong, Chen Sichuang et al., 2021). As for the central and western regions, although the urbanization development base is lagging behind, the spatial pattern of urbanization in China is promoted to be continuously optimized through areas with conditions to form high-quality development areas led by central cities and strengthen the role of radiation.

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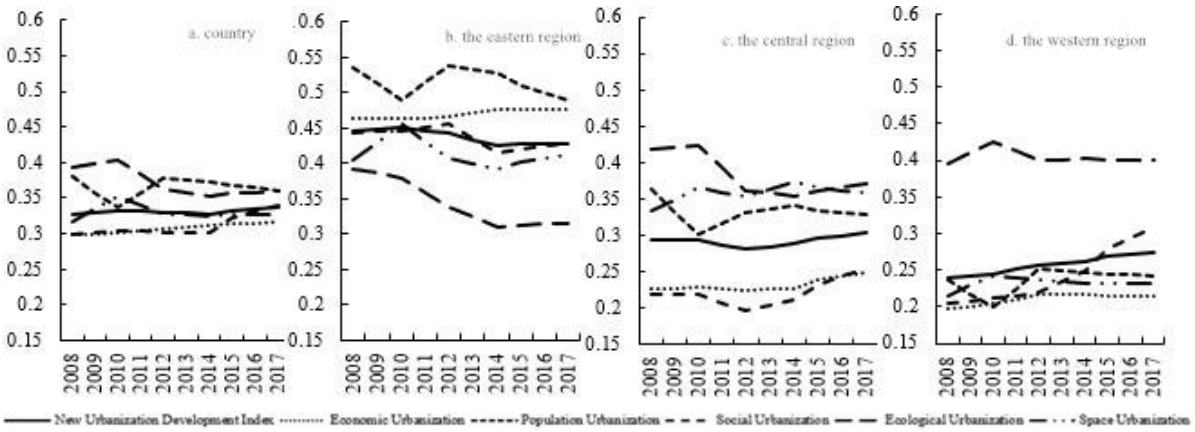

Figure 2 The change trend of new urbanization development index and its subsystems in China

Spatial characteristics of public sports services and new urbanization development

In order to analyze the divergent characteristics of the two and the evolution of their spatial patterns, this study selects the overall development indices of 31 provinces and urban areas in 2008 and 2017 for comparative analysis. It also combines the calculation results with the natural breakpoint grading method to divide them into: (1) public sports services: higher-level area [0.501,0.630); high-level area [0.338,0.501); average-level area [0.222,0.338); lower-level area [0.152,0.222); low-level area [0.02, 0.152). (2) New urbanization: higher-level area [0.503,0.630); high-level area [0.442,0.503); average-level area [0.300,0.442); lower-level area [0.225,0.300); low-level area [0.120,0.225). The evolution of the spatial distribution is shown in Figure 3.

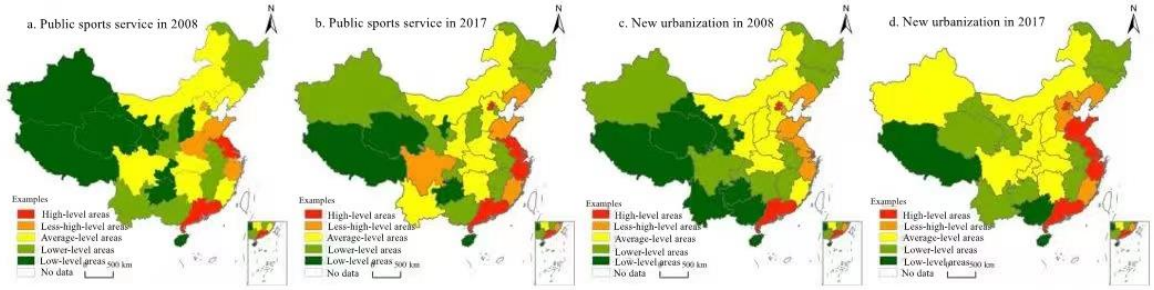

Figure.3 Spatial evolution of public sports service and new urbanization development in China from 2008 to 2017

In 2008, there is 3 high-level public sports service areas in China, namely Shanghai, Jiangsu and Guangdong, and 4 less-high-level areas, namely Zhejiang, Shandong, Beijing and Henan, accounting for 22.581%. The average-level areas are Liaoning, Sichuan, Hubei, Fujian and other 7 provinces and cities. Except for Liaoning and Fujian, the other 5 provinces are all in the central and western regions. There are 8 provinces and 9 provinces in the lower-level and low-level regions respectively, accounting for 25.806% and 29.032%, most of which are located in the western regions such as Guangxi, Yunnan, Xinjiang and Tibet. This shows that the overall level of public sports services in China is not high in 2008, and the level of public sports services in the eastern regions, especially in the developed eastern

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regions, is generally higher than that in other regions. Spatial variability in the development of public sports services in China has changed in 2016. In terms of evolving types, the number of high-level zones increased from 3 to 5, and the number of less-high-level zones remains the same as in 2006, with the overall percentage increasing by 6.451%, Beijing, Zhejiang and Liaoning, Fujian and Sichuan achieving a jump. The number of provinces and cities belonging to the average-level zone remains the same 7, Henan falls from the less-high-level zone, Yunnan and Shaanxi jump from the lower-level zone to the average-level zone. 2016 public sports services lower-level zone scale basically remains the same, except for Shaanxi, Chongqing, Xinjiang, Gansu 4 provinces from the lower-level zone among the lower-level zone, Guangxi, Anhui, Jiangxi and other 6 places remain the same classification. And the number of areas belonging to the low-level zone plummet, leaving only 5 provinces such as Guizhou, Ningxia and Qinghai, accounting for a decrease of 12.903%.

In 2008, China's new high level urbanization area is only distributed in 3 places in North, Shanghai and Guangzhou, and the less-high-development area is in 5 provinces such as Jiangsu, Zhejiang and Shandong, which are distributed in the eastern coastal area, and these 2 types account for 25.806% of the country. There are 7 general-level zones, except for Hebei and Fujian, all of which are in the central and western regions. In 2017, China's new urbanization pattern evolves mainly by the expansion of high-level areas and contraction of low-level areas at the same time. Jiangsu, Zhejiang and Shandong are among the high-level areas from the less-high-level areas, while Fujian and Hebei jump from the average-level areas to the less-high-level areas, and the proportion of these two types increases to 32.258%. At the same time, the average-level zone is expanded in 2017, and five provinces, including Hubei, Shaanxi and Henan, cross the level, and the percentage of this type increases by 9.677%. In addition, the number of provinces and cities belonging to lower-level zones decreases, while only three provinces of Guangxi, Hainan, and Tibet remains in lower-level zones. Overall, both public sports services and new urbanization levels have improved during the study period, both showing a trend of the eastern region leading the country while the central and western regions gaining a steady increase due to national policy tilts. As a result of a series of policy dividends, several central and western provinces and cities, such as Sichuan, Yunnan and Xinjiang, have leapfrogged in both public sports services and new urbanization development.

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Analysis of the Relationship Between Public Sports Services and the Development of New Urbanization

Temporal Characteristics of Coupling and Coordination Between Public Sports Services and New Urbanization

In order to deeply study the type of coupling and spatial pattern characteristics of public sports and urbanization development in different parts of China, this study calculates the coupling development status of different parts of the country and the East, Central and West regions during the study period through the coupling coordination evaluation model, and draws on the relevant studies of Lu Jin (2012) and Guo Xiangyang (2021). Combined with the natural break method (Jenks) grading, the coupling degree of public sports services and new urbanization index in the past years is divided into four stages: qualified coordination, basic coordination, basic disorder, and serious disorder, see Table2. Overall, the coordination degree is roughly at a high-level of 0.7~0.9, and shows the characteristics of central>eastern>national average>western location. The development degree is basically in the range of 0.2~0.5, showing the step characteristics of eastern>national average>central>western. The coupling degree is roughly between 0.3~0.6, showing the same spatial characteristics as the development degree. In the time dimension, the overall coupling coordination degree of public sports services and new urbanization in China shows an upward trend from basic disorder to basic coordination. In 2008, the whole country is at the basic disorder stage (0.490), while the eastern (0.599), central (0.502) and western (0.366) regions is at the basic coordination and basic disorder stages, respectively. By 2013, the country as a whole (0.498) remains in the basic dissonance stage, but the eastern (0.613) region jumps to the quality coordination, and the central and western regions maintains the same rank but improves the coupling level to 0.509 and 0.407, respectively. By 2017, the stage to which each region belongs remained unchanged, but the overall level of the country jumps to basic coordination.

Table 2 Coupling development stage and type division in China from 2008 to 2017

Regions	2008			2013			2017			Average			Coupling Stage
	C	T	D	C	T	D	C	T	D	C	T	D	
Country	0.848	0.292	0.490	0.862	0.299	0.498	0.856	0.304	0.503	0.857	0.300	0.500	basic coordination
Eastern	0.875	0.416	0.599	0.886	0.431	0.613	0.901	0.425	0.614	0.875	0.423	0.604	qualified coordination
Central	0.912	0.275	0.502	0.954	0.272	0.509	0.942	0.269	0.502	0.939	0.271	0.503	basic coordination
Western	0.725	0.187	0.366	0.790	0.213	0.407	0.727	0.215	0.391	0.752	0.203	0.387	basic disorder
Jiangsu	0.978	0.556	0.737	0.876	0.709	0.788	0.959	0.671	0.802	0.941	0.625	0.766	qualified coordination
Guangdong	0.969	0.629	0.781	0.996	0.553	0.742	0.999	0.549	0.741	0.988	0.587	0.761	qualified coordination
Beijing	0.966	0.498	0.693	0.991	0.54	0.735	0.998	0.519	0.719	0.988	0.532	0.725	qualified coordination
Shanghai	0.984	0.578	0.754	0.971	0.517	0.709	0.997	0.54	0.734	0.966	0.535	0.719	qualified coordination
Zhejiang	0.998	0.461	0.679	0.974	0.504	0.7	0.959	0.543	0.721	0.986	0.496	0.699	qualified coordination

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Shandong	0.993	0.47	0.683	0.997	0.466	0.682	0.996	0.466	0.683	0.997	0.477	0.69	qualified coordination
Liaoning	0.967	0.373	0.601	0.993	0.43	0.653	0.997	0.357	0.596	0.987	0.39	0.621	qualified coordination
Fujian	0.984	0.31	0.552	0.999	0.338	0.582	0.999	0.339	0.582	0.986	0.325	0.566	basic coordination
Henan	0.998	0.337	0.58	0.977	0.294	0.536	0.985	0.308	0.55	0.987	0.324	0.565	basic coordination
Sichuan	0.986	0.311	0.554	0.967	0.334	0.568	0.989	0.34	0.58	0.988	0.313	0.556	basic coordination
Hubei	0.998	0.311	0.557	0.993	0.31	0.557	0.982	0.315	0.556	0.994	0.3	0.546	basic coordination
InnerMongolia	0.958	0.276	0.514	0.973	0.324	0.562	0.915	0.303	0.527	0.958	0.3	0.536	basic coordination
Hebei	0.96	0.294	0.532	0.992	0.295	0.543	0.996	0.301	0.549	0.975	0.294	0.535	basic coordination
Hunan	0.999	0.27	0.52	0.997	0.278	0.527	0.989	0.28	0.526	0.996	0.271	0.519	basic coordination
Heilongjiang	0.934	0.25	0.483	0.955	0.249	0.488	0.931	0.247	0.48	0.947	0.252	0.489	basic disorder
Shaanxi	0.857	0.244	0.458	0.943	0.287	0.521	0.934	0.273	0.505	0.882	0.261	0.48	basic disorder
Guangxi	0.992	0.214	0.462	0.983	0.22	0.465	0.996	0.216	0.465	0.994	0.222	0.47	basic disorder
Anhui	0.973	0.226	0.469	0.978	0.223	0.467	0.917	0.231	0.46	0.963	0.227	0.468	basic disorder
Yunnan	0.99	0.21	0.459	0.997	0.212	0.46	0.993	0.226	0.475	0.999	0.215	0.464	basic disorder
Jilin	0.893	0.236	0.459	0.974	0.238	0.482	0.931	0.204	0.436	0.93	0.225	0.457	basic disorder
Xinjiang	0.72	0.212	0.39	0.921	0.27	0.499	0.911	0.273	0.499	0.838	0.245	0.453	basic disorder
Shanxi	0.697	0.244	0.412	0.821	0.263	0.465	0.835	0.263	0.468	0.784	0.255	0.447	basic disorder
Jiangxi	0.979	0.24	0.485	0.917	0.208	0.436	0.861	0.23	0.445	0.884	0.219	0.44	basic disorder
Gansu	0.964	0.176	0.412	0.969	0.204	0.445	0.922	0.198	0.427	0.956	0.194	0.431	basic disorder
Chongqing	0.757	0.193	0.382	0.775	0.22	0.413	0.855	0.246	0.458	0.771	0.218	0.409	basic disorder
Tianjin	0.648	0.298	0.44	0.715	0.274	0.443	0.738	0.263	0.441	0.615	0.27	0.406	basic disorder
Guizhou	0.839	0.147	0.351	0.888	0.166	0.384	0.801	0.19	0.39	0.855	0.167	0.377	basic disorder
Qinghai	0.447	0.136	0.246	0.469	0.143	0.259	0.311	0.143	0.211	0.433	0.137	0.242	serious disorder
Ningxia	0.335	0.174	0.242	0.381	0.188	0.267	0.231	0.189	0.209	0.308	0.18	0.235	serious disorder
Tibet	0.334	0.073	0.156	0.576	0.107	0.248	0.318	0.093	0.172	0.486	0.089	0.206	serious disorder
Hainan	0.173	0.11	0.138	0.224	0.116	0.161	0.27	0.123	0.182	0.199	0.12	0.154	serious disorder

Spatial Characteristics of Coupling and Coordination Between Public Sports Services and New Urbanization

In the spatial dimension, the comprehensive coupling degree and synchronous development degree are divided into 4 major categories and 9 subtypes. This paper finds that from 2008-2017 the development types of coupling between public sports services and new urbanization in China show an east-to-west strip-like pattern, which can be mainly summarized as follows: the eastern coastal quality coordination

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zone shows a pattern of quality coordination, the central basic coordination zone and the western dysfunctional zone, see Figure 4. During the study period, the eastern coastal high-quality coordination zone shows the clustering characteristics of "high coupling-high synchronization". Beijing, Shanghai, and Liaoning maintain the qualified coordination status while gradually solving the problem of lagging public sports services. In the central region, except for Jiangxi, which has shifted to the basic dysfunctional public sports service lagging subtype, and Jilin, which has moved up to the basic coordination type, the other provinces and cities remain unchanged. The change in the western region is more complex, showing a harmonious state of "high synchronization" and a state of "low synchronization" at the same time. Inner Mongolia, Guizhou and Tibet maintain the same broad categories, but the separation of public sports services lags behind the new urbanization development. In Hainan region, the severely dysfunctional-public sports service lagging type has changed to the severely dysfunctional general type.

This is related to the differences in resource endowment and development timeline between provinces and cities. In recent years, Beijing and Shanghai have further improved the government purchase service system and incorporated public sports into the government purchase service guideline catalog. In the meantime, each district in Shanghai has launched an action plan to build a healthy city, continue to increase the construction of public sports facilities, improve the public welfare and public sports venues, realize the linkage of sports venues, and promote the social opening of school sports venues during non-teaching hours. Around 2015, Jilin Province issued intensive policy documents on public sports, which accelerated the decoupling of the sports industry from government departments and promoted the development of sports social organizations. The decoupling of functions has promoted the development of sports social organizations. In western regions such as Inner Mongolia and Tibet, new urbanization has increased significantly in recent years due to the inclination of national policies, and the driving ability of core cities has been enhanced significantly, with various resource factors gathering in towns with convenient transportation and suitable climate. The rapid development of new urbanization has resulted in poor synchronization with the development of public sports services.

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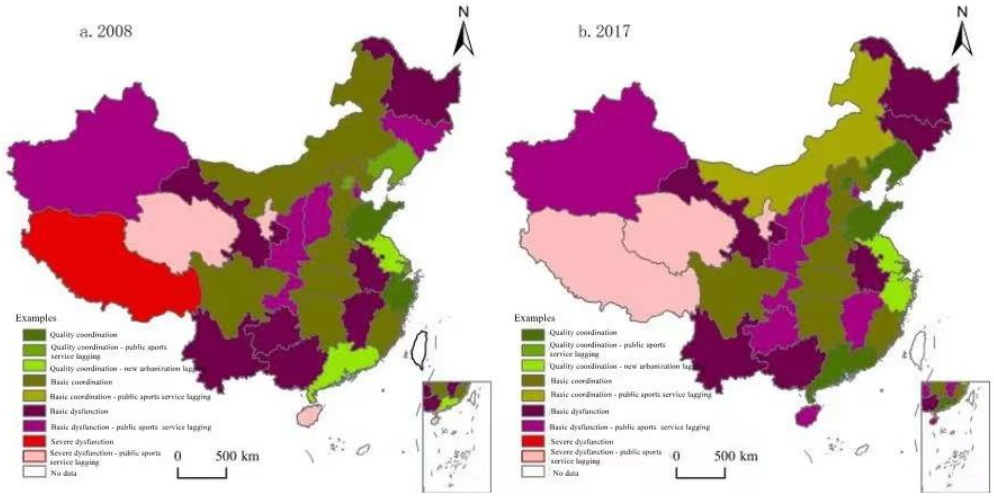

Figure. 4 Spatial and temporal distribution of the coupled synchronous types of public sports services and new urbanization in China from 2008 to 2017

By calculating the coupling degree *Getis-Ord G* * index in 2008 and 2017, this study further analyzes the spatial clustering trends and association characteristics of public sports services and new urbanization, and divides them into five levels according to their confidence levels: cold spot area, sub-cold spot area, hot spot area, sub-hot spot area and insignificant area, as shown in Fig. 5. Overall, in 2008, the clusters of high coupling degree are concentrated in the east-central coastal region, showing a circle pattern with the Yangtze River Delta as the center and decreasing to the periphery. The hot spot includes Shanghai, Jiangsu, Zhejiang, Fujian and Anhui, and the secondary hot spot includes Beijing, Tianjin, Hebei, Shandong and other seven provinces and cities. These provinces and cities have higher coupling levels themselves and their surrounding areas, thus forming a patchwork of high-level clustering areas. Low-value clusters are mainly in the northwest of China, including 4 provinces of Gansu, Qinghai, Xinjiang and Tibet, with a cluster-like distribution trend. By 2017, these two types of agglomerations show a contraction trend while maintaining a relatively stable overall pattern. The main changed areas lie in the disappearance of sub-hot spot agglomerations in Beijing, Tianjin and Hebei, the disappearance of cold spot areas in Xinjiang, and the change of Tibet from a cold spot area to a sub-cold spot area.

The reason for such a spatial pattern is that the hotspot areas are mainly distributed in the eastern coast and some central regions. The eastern coastal provinces have outstanding location conditions, the earliest and deepest urbanization development, and are the benchmark areas for urban development in China. As early as 2003, Shanghai has included citizens' sports and fitness in its socio-economic development plan, and government finance provides strong financial guarantee for public sports. With the implementation of the strategy of the rise of central China, the Yangtze River Delta has played a more significant role in promoting the radiation-driven development of the region, leading to the coupling and coordinated development of public sports services and new urbanization in the central region, resulting in the formation of a high-value cluster of east-central circles. In contrast, the natural conditions and transportation factors in the western region greatly limit the development of regional urbanization and public sports services, resulting in the formation of clusters of low-value clusters.

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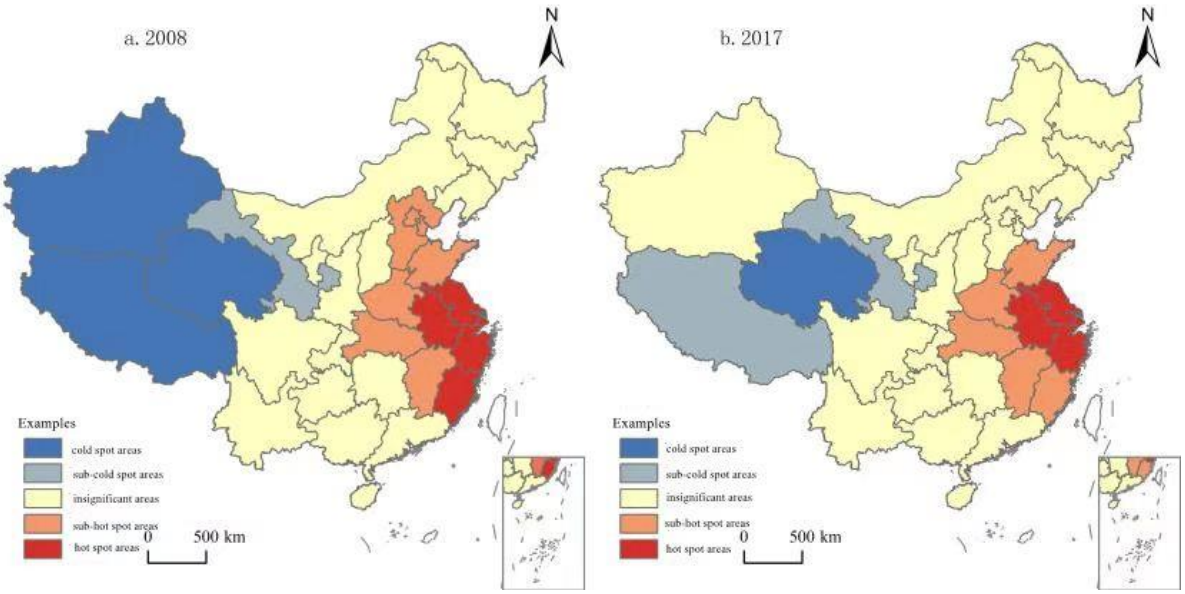

Figure. 5 Evolution chart of coupling cold and hot spots of public sports services and new urbanization in China from 2008 to 2017

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Analysis of the Optimization Path of Public Sports Services in the Context of New Urbanization

Interaction mechanism of co-evolution of public sports services and new urbanization

The construction of new urbanization plays a fundamental role in the development of public sports services and is the social foundation for the development of public sports services. First of all, public sports services are a reflection of social needs after the material life of urbanization has been enriched. In the history of human civilization, cities carry the hope of the ideal life. Improving the living environment and enhancing the quality of urban functions is an important manifestation of the transformation and upgrading of urban construction away from the concept of "extensive" city building in the new era, and as a result, public sports services are gradually being emphasized. The Health China Action promulgated in 2019 once again clearly reaffirmed the government's responsibility to promote the construction of a public sports service system, and public sports has become an important development goal to promote higher quality urbanization on the basis of what has already been in place. Second, the level, scale and level of development of public sports services are limited by the material abundance brought by urbanization development. On the one hand, the development of economic urbanization, the core dimension of new urbanization, has increased fiscal revenue and raised the consumption level of residents, which has increased the scale of funds and consumption capacity of public sports services and facilitated the improvement of the development level of public sports services; on the other hand, the development level of population urbanization and social urbanization has determined the scale and system integrity of public sports services. The transformation of China's public sports services, from non-existent to existing, from single structure, lack of system and low coverage to differentiated, multi-level and wide coverage, is accompanied by the continuous transformation and upgrading of the social structure of urban population.

Public sports service is a stabilizer for the high-quality development of new urbanization and an important guarantee for the high-quality development of urbanization. At present, China's urbanization has entered the second half of the Northam "S-curve", with high-quality urban construction as the focus of development (Zhang Yuejin, Li Sirui, Li Zhaopeng, 2021). First of all, public sports services play an important role in strengthening physical fitness, health promotion and prevention and control of chronic diseases through health management, providing a group health foundation for urbanization development. Under the social reality of "aging before getting rich" in the rapid aging process, residents inevitably face social risks in health, medical care and nursing care, and these risks lead to family crises that negatively affect the stability and security of society. The participation of all people in public sports helps society to build health security and promote the normal process of labor reproduction, thus maintaining social stability

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and promoting social progress. Second, public sport services iron out the inequalities in health consumption by narrowing the income gap through public finance for sport. In a market economy where efficiency is paramount, inequalities in economic income and living standards among members of society cannot be avoided. Public sport service provision relies on a large government financial guarantee, and the secondary distribution is shifted to the disadvantaged groups of low-income sport consumers to prevent inequalities in sport services caused by large income disparities, to the detriment of urban development benefits. From the perspective of welfare economics, public sport provision guarantees a fair and equitable distribution of the national economy in the field of sport, builds a guarantee system for inclusive urban development, and optimizes the construction of a new type of urbanization with "people at the core". Finally, public sports services can reverse the demand for new urbanization through implicit factors such as cultural concepts and ideologies, and are an opportunity to optimize the allocation of urban resources. In the process of urbanization, the flow of capital, technology and population is transferred between urban and rural areas, and the development of social civilization and economy triggers people's pursuit of higher quality of life, which activates the endogenous momentum of new urbanization development and drives the construction of high-quality cities.

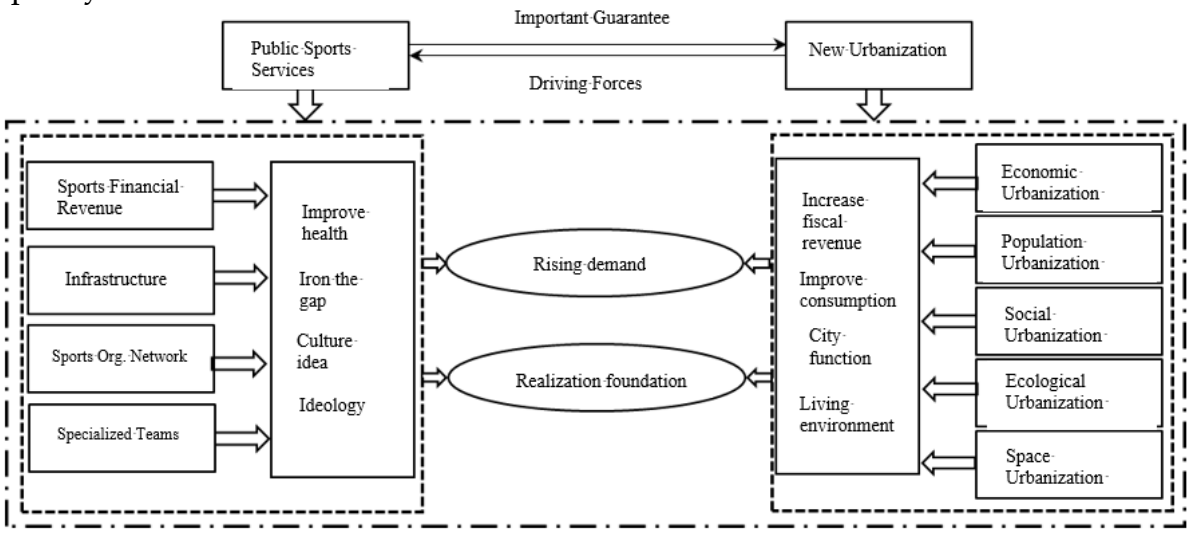

Figure. 6 Interaction mechanism between public sports services and new urbanization

Implementation Paths for Promoting the Development of Public Sports Services in Multiple Dimensions

Building a higher level of public sports service system is one of the core objectives of sports work during the 14th Five-Year Plan. As a long-term and complex systemic project, it should be adapted to the demands of high-quality development and the essential requirements of modernization in China, and promoted it step by step (Shi Xiaoqiang, Dai Jian, 2021). First, economic urbanization increases the vitality of urban markets. The sports industry is an important part of the construction of a

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strong sports nation, a driving force for socioeconomic development, and a characteristic area for deepening economic urbanization. As an enjoyment- and development-oriented consumer product, if sports can achieve demand-driven market expansion, it will be of positive significance to "drive sports industry by residents' consumption and optimize and upgrade residents' consumption structure by sports industry structure" (Cai Penglong, Liu Guangfei, 2021). In order to accelerate the development of sports industry and promote sports consumption, the government needs to accelerate the implementation of sports industry development policies, effectively play the leverage effect of financial funds to support sports industry, tap the potential and momentum of sports industry development to attract social capital participation, and enhance the core competitiveness of sports economic development. At the same time, it should enhance the ability of cities to feed rural areas, coordinate resource allocation, promote the extension of public sports services to rural areas and the coverage of public sports facilities to rural areas, reduce the impact of the dual structure of urban and rural areas on public sports services, and realize a public sports service system with unified standards, parallel systems and urban and rural areas.

Second, in the face of the current problems faced by China, such as the excessive growth of chronic diseases, over-reliance on traditional medical treatment, and lack of initiative in health governance (Dong Chuansheng, 2021), a deep awakening of mass health awareness and health behavior is the mass foundation for building a public service system in the new era. In the post-epidemic era, to proactively respond to the uncertainty crisis brought by the changing disease spectrum, the government must enhance the action plan of mass physical literacy through strong policy tools, guide social sports participation, consider sports participation as a more proactive way of health intervention, and implicitly reshape the cultural system of sports power-driven behavior, activity inertia and life structure. On the other hand, the core requirement of population urbanization is to complete the urbanization of "citizenship" and the coordinated development of public services. Only the spatial transfer of population is not urbanization in the real sense, but the enjoyment of basic public services, the improvement of quality of life, and the improvement of living environment is the embodiment of high-quality urbanization in the new era. Let the foreign population enjoy equal rights with the urban population in terms of sports public services, and give full "citizenship rights" to sports and health.

In addition, the establishment of smart cities is a requirement of new urbanization. For public sports, it is important to fully leverage the power of smart city construction to achieve seamless integration of mass sports needs and resources with the help of modern technology, and to improve the convenience, accessibility, and accuracy of public sports services (Zhu Yiran, Liu Anguo, Sun Jinhai, 2021). Sports public services should follow the trend of mass sports intelligence, be oriented to meet their growing demand for diversified sports services, innovate the supply mechanism of sports public products, realize the service innovation of online and

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offline integration development, and promote the high-quality and sustainable development of public sports services. In addition, a sports public service technology system should be established to explore modern information technology represented by artificial intelligence, big data, and blockchain to promote the intelligent upgrading of mass sports governance and build a ubiquitous sports governance model (Bai Yang, Xun Changdian, Gao Yue et al., 2019. Dong Chuansheng, Zhang Li, 2019).

Finally, the government is vigorously promoting the transformation of old urban areas, which happens to be an opportunity to develop public sports services. First, by mapping existing community sports venues and facilities, we can accelerate the construction of a number of highly accessible, small-scale fitness venues for residents. At the same time, we can renew aging, low applicability sports facilities in a timely manner to make up for the shortcomings of community sports facilities for urban residents. Secondly, we should guide social forces to revitalize idle assets in cities, encourage strong social sports enterprises to take root in communities, integrate and reasonably use resources of idle assets such as waste factories, property warehouses, and old commercial facilities, and effectively increase the number of comprehensive sports and fitness venues for residents (Bao Mingxiao, 2019).

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Conclusion

Keeping in mind the development proposition of the new era, promoting the high-quality development of China's public sports services have become a fundamental requirement for deepening sports reform and implementing the strategy of a strong sports nation. At present, China's public sports services have achieved good development, but the development of its internal subsystems is not balanced, and the lack of talents is a major bottleneck in the development of public sports in China. At the same time, China is a vast country with huge regional development differences, and the overall level of public sports services shows a gradient of weakening from east to west, and the imbalance of regional development cannot be ignored. In terms of the relationship between public sports services and new urbanization, the overall trend is from basic imbalance to basic coordinated development, showing a stepwise regional profile of east > national average > central > west.

China's urbanization development conditions vary significantly from region to region, so different zones should develop diversified public sports services, taking into account local characteristics and implementation conditions. The eastern region, which has the highest level of urbanization and the highest density of cities and towns in China, should enjoy the fruits of quality public sports development while focusing on the development of a broader hinterland in the future. With the national strategic plan of "urbanization in the vicinity", the central and western regions will be the main battlefield of the next round of urbanization, and should consider the different stages of urbanization and the carrying capacity of regional resources and environment to develop public sports services with regional characteristics, cultural heritage and local adaptation. In practice, it should fully adapt to and effectively respond to the economic, demographic, social, ecological, spatial and other dimensional changes brought by the new urbanization, and promote the high-quality development of public sports.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author.

The data are not publicly available due to privacy or ethical restrictions.

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