

Article

The Places Children Go: Understanding Spatial Patterns and Formation Mechanism for Children's Commercial Activity Space in Changchun City, China

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Abstract: In recent years, the demand for children's activities has been increasing, and the children's consumer market has expanded annually. A large number of urban commercial spaces for children's activity that meet the needs of children's activities have been built in Chinese cities. This paper analyzed the distribution of these spaces in Changchun City, divided children's activity space into five categories, analyzed the distribution and spatial differentiation using ArcGIS tools, and discussed the formation mechanism of the spatial pattern of children's activity space. The results show that: (a) The spatial agglomeration of children's activity places in Changchun was remarkable and formed a multicore spatial pattern of three municipal and six district-level centers. (b) Different varieties of children's activity places showed significant spatial differences with "center-periphery" and spatial distribution patterns and each block unit had specialized characteristics. (c) The diversification and social demand for children's activities, children's consumption (a new growth factor for the modern service industry), market competition for rent, coupling relationship with urban functional areas, traffic convenience and accessibility, and changes of children's activity behavior patterns and preferences were the main factors that influence commercial children's activity space in Changchun. (d) The inequitable spatial distribution of children's activities, the poor accessibility of children's activity places, the lack of outdoor places and natural elements, the excessive concentration of children's activities, and the lack of reasonable guidance of children's commercial activity places in the city pose challenges for daily activities of urban children. Based on these results, this paper put forward some constructive policy suggestions, such as the planned addition of children's public places and children's outdoor places, enriched green and natural elements of children's places, the construction of children's activities facilities in residential areas, and the addition of children's activity facilities in the compulsory standards for urban construction.

Keywords: children; activity space; POI data; space structure; planning strategy; Changchun City

1. Introduction

The international community is increasingly paying more attention to children's education and development. The healthy growth of children is an important part of a country's economic and social development. Since the convention on the Rights of the Child and the construction of "child-friendly cities" were put forward, many developed countries have proposed to build child-friendly cities, and include children in the design and planning of children's spaces (which have become the focus of urban planning) [1,2]. These days, parents pay more attention to children's education and have higher expectations. Additionally, parents want children to participate in a wide range of activities so that they can broaden their horizons and improve their skills [3].

China has the largest urban population and the largest number of children in the world. In January 2016, China changed its family planning policy from a one-child to a two-child policy; the number of newborn babies is expected to increase from 2.3 to 4.3 million annually [4]. In the future, there will be more children living in cities in China and the demand for children's activity space will significantly increase. However, in the past, urban spaces in China were designed mainly to meet the needs of adults [5,6], without fully considering the needs of children [7–9]. Therefore, there is a relative lack of spaces for children's activities in urban cities. The lack of spaces for activities, the stress on adult-centered-designs, and the presence of unsafe hidden dangers greatly limit children's enthusiasm for activities, hinder the accumulation of social knowledge, influence the development of children's imagination and creativity [10], and gradually exclude children from public spaces. With the emergence of new facilities in Chinese cities for children's activities (such as early childhood education centers, children's training, counseling organizations, and interest classes), children are more likely to visit institutionalized and commercialized spaces with their parents [11].

Although the concept of children's activity space is not new [12–14] a universal definition of children's activity space does not exist. Scholars have successively proposed that the children's activity space is a conventional place that meets children's needs for walking, playing, learning, rest, etc. [10,15], which is the interaction between children and the environment. The interaction between children and the environment plays a very important role in children's development and physical health [16] and directly affects children's interaction with society [17]. For children, the activity space includes home, school, and a "third place" [18]. In the competition for the development of urban built-up spaces, children's public activity spaces are neglected; public activity space gradually decreases, and children are blocked from streets, squares, nature and other activity spaces. Semipublic commercial activity spaces gradually become the main center for children's activities in the city [19–21]. This paper focuses on children's activity spaces, i.e., commercial activity places for children in cities, where they often move around with adults. Previous international studies on children's activity space have paid more attention to children's activity neighborhood space [22,23], public space [24,25], school, and family [26,27], and have not focused on children's commercial activity spaces. These studies lacked empirical evidence on spatial distribution and the forming reasons for children's activity space. A study on the spatial distribution of children's commercial activities is of great significance for the improvement of urban spaces and the rational planning of urban residential and public activity spaces.

Based on this, this paper proposes the following research questions:

- (1) What is the distribution pattern of urban children's commercial activity space?
- (2) How is the distribution pattern of urban children's commercial activity space formed?
- (3) How can planners optimize the limited space for children to meet the increasing needs of society?

In order to answer these questions, this paper first reviews the relevant literature on children's activity space. Next, taking Northeast Asia's regional center city, Changchun, as a case study, point of interest (POI) data and spatial analysis methods are used to explore the distribution of children's commercial activity places. This paper summarizes the hierarchical distribution, cluster characteristics, and the formation mechanism of the spatial distribution pattern of children's commercial activity space in Changchun. This research on children's activity space, based on POI data, fills research gaps (in the space of children's commercial activity space in China) and enriches the research results of international children's geography. Additionally, the results will also help urban planners and professionals to improve urban planning and provide a research basis for Changchun to build a child-friendly city in the future.

2. Literature Review

Since the 1990s, research on children's geography has developed rapidly [28–30], and relevant studies on children's activity space have increasingly paid more attention to children's geography [31]. Most research on children's activity space has focused on children's access to parks [32], accessibility and design of playground facilities [33–36], children's neighborhood activity and play

space [37–39], children's play in public open spaces [24,25], children's interaction with natural spaces [40–43], etc. Children use spaces differently than adults; they tend to play and learn in these places rather than work or use them for leisure [44]. Children's activities in their free time may have a significant positive impact on their level of physical fitness [24,27]. Researchers have divided the important daily life areas of children into outdoor play space, leisure club, and kindergarten according to their use of daily activity spaces [19], and divided the children into outdoor children, indoor children, and backseat generation. The most recent addition to this classification is the child in the back seat of cars (backseat generation), which includes most urban children, and it referred to children escorted by adults whose activity space was mainly represented by children's activities organized by adults [45].

The term "children's activity space" is often replaced by distance in traditional studies. Children's activities in the neighborhood are usually carried out within 400 meters of their home [18]. In some studies, researchers taught children to wear GPSs and accelerators to measure their physical and daily life activities [14,22,38]. In contrast to activity distance which measures activity space, many studies measured the area covered by children's activities and considered it to capture the space that children use in the neighborhood to play; where children explore their surroundings, practice social skills, and develop friendly relationships with other children, neighbors, and employees of existing community institutions [46]. In other studies, children and their parents were made to draw the range of neighborhood activity of the children to explore the differences between the perception of children and their parents on the range of children's neighborhood activity [23] and statistically quantify the activity range of children to nearby places (either independently or accompanied by adults) [16]. Neighborhood activity spaces may have a significant and lifelong impact on children's health and are regulated by both parental behavior and the surrounding environment [15,47]. In Western countries, the most common places for children's activities were their garden [41], neighborhood spaces, and designated extracurricular activity places. Conversely, in China, the most commonly used places for children's activities were public recreational facilities and business destinations outside the community (even children living in remote areas often play in these places) [37]. Recently, online and video games have become a major component of children's entertainment activities [48,49]; these have a greater impact on the scope of children's daily activities. Although Chinese online companies have developed several new technologies to strictly control children's play time and game categories; children's daily activities, especially outdoor and sports activities, are still strongly affected by video games [50].

Childhood and parental attitudes have changed; children spend more time in activities organized in schools, communities, or commercial spaces [51,52]. The number of activities that children can participate in has increased, the activities have become more diversified, and spaces for these activities have become more extensive. Traditional physical activities are modernized into newer versions and are now differentiated (such as baby swimming and children's theaters). The demand for children's activities is growing, especially in urban centers and a culture of new consumers (children) has promoted the development of new business areas [23]. Many parents consider it necessary that children participate in extracurricular activities. While younger children are mainly involved in math tutoring, sports, and creative skills, the older ones are mainly involved in language and music courses. Although time, experience, and money are needed, parents are keen to develop their children's skills [53].

In recent years, big cities in China have gradually realized the social value of children's activity space, and many cities have tried to implement the concept of "child-friendly cities" [54]. The government has provided a lot of support for the construction of facilities for children's public welfare activities, especially public cultural education. Due to refined management methods and strong affinity, children's commercial activity places have formed a good complementary effect on public places [55]. Although the Chinese government does not manage children's commercial activities separately [56], it has recently imposed strict age restrictions on commercial places such as song and dance halls, Internet cafes, and video game halls [57]. For other children's commercial activity places, the government has adopted only general commercial place management measures

focusing on environmental health, safety, and consumer rights. Cultural and educational places are managed by the education department with certain business access and business content restrictions [58]. In general, the government's management of commercial children's activity places is still at the level of market management, and no management policy based on the goal of children's growth has been formulated yet [56,59].

Only a few studies have summarized the importance of children's commercial activity places [11] and have focused on the distribution of children's commercial activity in urban spaces [19,60]. Moreover, the studies are mostly from developed countries and lack empirical data from developing countries and are mostly concerned with after-school clubs [51,53]. This paper examines Changchun in China and analyzes the places with children's commercial activity, summarizes and classifies children's commercial activity places, explores the distribution pattern, characteristics, and formation mechanism of children's commercial activity space, and adds to the existing knowledge on children activity space.

3. Materials and Methods

3.1. Study Area and Data Sources

The area chosen for the study was the central urban area of Changchun, which has a total area of 612.08 km² (source: Changchun City Master Plan (2011–2020)). Changchun (an important industrial city, the earliest automobile industry base and film production base) is one of the central cities in Northeast China. By the end of 2017, Changchun had a total population of 3.341 million, including 513,000 children under the age of 18, which accounted for 15.35%. The GDP was 649.5 billion yuan, and the total retail sales of consumer goods was 292.27 billion yuan (source: 2018 Jilin Statistical Yearbook). The per capita disposable income of urban residents was 35,332 yuan, the structure of the three industries was 4.2:48.9:46.9, and there were 1.72 million motor vehicles (source: Statistical Communique of Changchun City on the 2018 National Economic and Social Development). Spatial registration and digital processing of remote sensing image data enabled the collection of vector data on main roads, green spaces in urban parks, and water areas. Next, the central urban area was divided into several TAZ (traffic analysis zones) grid units (based on the vector data of urban trunk roads).

The POI data were obtained from the Baidu Map Open Platform in October 2019. The Baidu Map Open Platform provides a query service for point of interest (POI) data in a certain area. Store operators, consumers, and Baidu employees upload the city's POI data. The data is updated in real time, which ensures accuracy. The data included six major categories: parks, cultural places, sports places, recreational places, schools, training institutions, and other smaller categories. As different countries and regions have separate definitions for children's age, for consistency in this paper, the children were referred to according to the Convention on the Rights of the Child as "anyone under the age of 18 is classified as a child." All the children in this study were under 18 years of age. In order to guarantee the quality of the data, this paper collected the POI data for an artificial selection of those closely related to children's activities and dedicated to the activities of children, and then reclassified them. The places for children's commercial activities were divided into children's tuition, children's art activities, children's amusement activities, children's sports activities, and children's early education activities (Figures 1 and 2). After spatial matching, de-duplication, and deletion of low-recognition children's activity places, a total of 1587 valid POI data was obtained (Table 1).

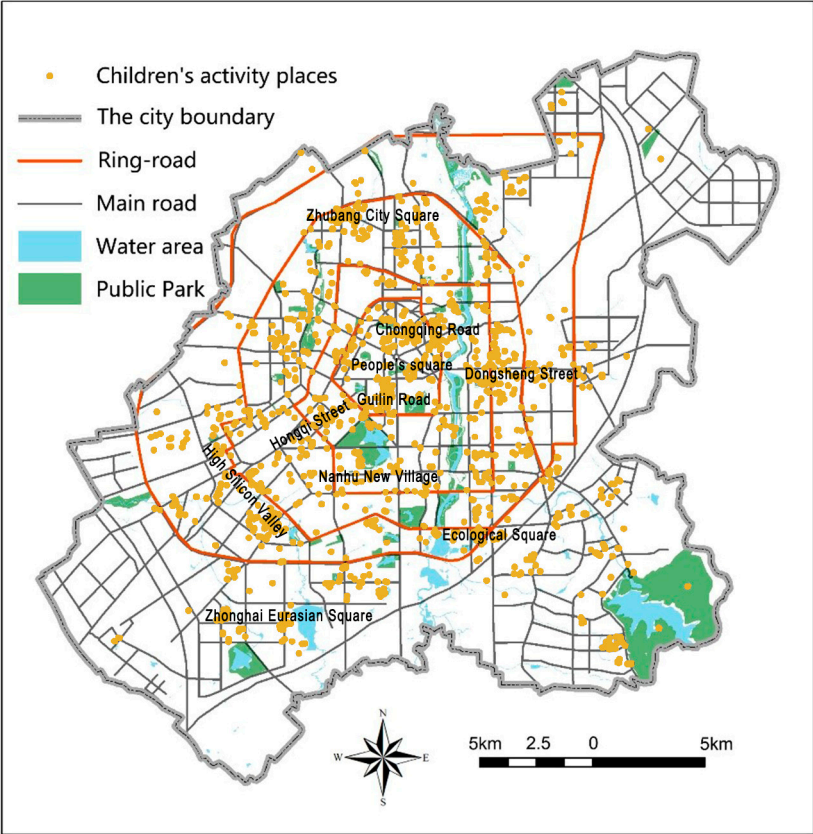


Figure 1. The spatial distribution of point of interest (POI) points in children’s activity places in Changchun.



Figure 2. Different types of children’s activity places in Changchun.

Table 1. POI data and source description of various children’s activity places in Changchun.

| Categories | 0 – 3 years (Infant) | 4–6 years (Preschool) | 7–18 years | Quantity | Proportion (%) |
|------------|-------------------------|--------------------------|------------|----------|-------------------|
|------------|-------------------------|--------------------------|------------|----------|-------------------|

| (Middle and primary school) | | | | | |
|--|-------------------------|--|---|-----|------|
| Children's tuition activity places | ---- | After-school care, English for children | After-school counseling, language education | 308 | 19.4 |
| Children's art activity places | ---- | Art interest class | Art interest class | 678 | 42.7 |
| Children's amusement activity places | Parent-child play | Indoor playground | Outdoor playground | 229 | 14.4 |
| Children's sports activity places | Physical training | Physical training, ball games | Taekwondo, boxing, ball games | 113 | 7.1 |
| Children's early education activity places | Whole-brain development | Abacus mental arithmetic, whole-brain development, preschool education | ---- | 259 | 16.3 |

Note: This paper focused on children's exclusive activity space. Since children's clothing, maternal and infant retail spaces mainly relate to their parents, it was not appropriate to include them in the space for children's exclusive activity. Therefore, this study did not include children's shopping space. Internet cafes and electronic game halls are not counted as commercial children's activity places because they are not allowed to open to minors in China.

3.2. Methods

3.2.1. Kernel Density Estimation

Kernel density estimation is a common research method in geography. It is used to identify the gathering area of children's activity places and analyze the degree of concentration of children's activity places in the surrounding areas [61]. In this paper, the density estimation was used to analyze the spatial distribution pattern of children's commercial activity space in Changchun. The kernel density estimation uses a nonparametric method to calculate the probability density of random variables [62]. It estimates the aggregation degree of spatial point features distribution by a regular moving quadrat [63]. The formula used was:

$$f(s) = \sum_{i=1}^n \frac{1}{h^2} k\left(\frac{s - c_i}{h}\right). \quad (1)$$

where $f(s)$ is the calculated kernel density function at the spatial position s , k is the spatial weight function, h is the distance decay threshold, and n is the number of children's activity places whose distance from position s is less than or equal to h .

3.2.2. Concentric Analysis

The concentric analysis technique is used in urban geography to study of the spatial pattern of urban service facilities and urban functional land [64–66]. Concentric analysis refers to a circle with its center on the city center and extrapolated with a fixed radius [65]. The Changchun People's Square was selected as the center of the circle, and a buffer was made every 2 km from the center to the periphery. Then, the number of children's activity places in each circle was counted; finally, the "center–periphery" spatial distribution of children's activity places in each circle was analyzed.

3.2.3. Location Quotient

Location quotient is usually used to analyze the degree of specialization of an industry sector in the region [67]. The location quotient analyzed the specialization degree of children's activity space in different TAZ blocks [68]. The higher the location quotient value, the higher the specialization degree of children's activity space for that block. When the location quotient index $Q > 2$ of children's activity place in the TAZ block was high, its specialization degree and competitiveness in the block was high, forming the industry advantage cluster; When $1 < \text{the location quotient index } Q < 2$, the children's activity place had medium degree of specialization and certain competitiveness in the block, and the concentration of industry advantages was not significant; When the location quotient index (Q) was < 1 , children's activity place had low degree of specialization and poor competitiveness in the block, and there was no agglomeration of industry advantages. The formula used was:

$$Q_{K-A} = E_{K-A} / E_K \quad (2)$$

where Q_{K-A} is the location quotient of children activity place type A in region K , E_{K-A} is the ratio of the number of children's activity place type A in region K to the number of all places in the whole region and E_K is the ratio of the total number of places in region K to the number of places in the whole region.

4. Results

4.1. The Spatial Pattern of Children's Activity Places

4.1.1. The Overall Pattern of Spatial Distribution

Children's activities places form a multicentric agglomeration spatial pattern in Changchun; it included three high-density (Guilin Road, High Silicon Valley, and Dongsheng Street), six medium-high density (Zhubang City Square, Chongqing Road, Hongqi Street, Nanhu New Village, Ecological Square and Zhonghai Eurasian Square), and several medium-density children's activity areas (Figure 3).

The high-density areas of children's activity were mainly distributed in the core urban areas; the density decreased successively from the center to the periphery, and several medium-high density areas were in the periphery of the city. A large number of areas in the middle of the city had children's activity areas. Among them, the activity areas of Chongqing Road and Dajing Road had been connected into a single gathering area; Guilin Road and Hongqi Street, High Silicon Valley, and Eurasian Shopping Mall were connected, forming a main center and a pair of double-core gathering centers. In the periphery of the city, children's activity places were combined with commercial complexes (Zhubang City Square, Ecological Square, Zhonghai Eurasian Square, etc.) to form several point-like high-density children's activity areas, which were the secondary service center of children's activity space in Changchun.

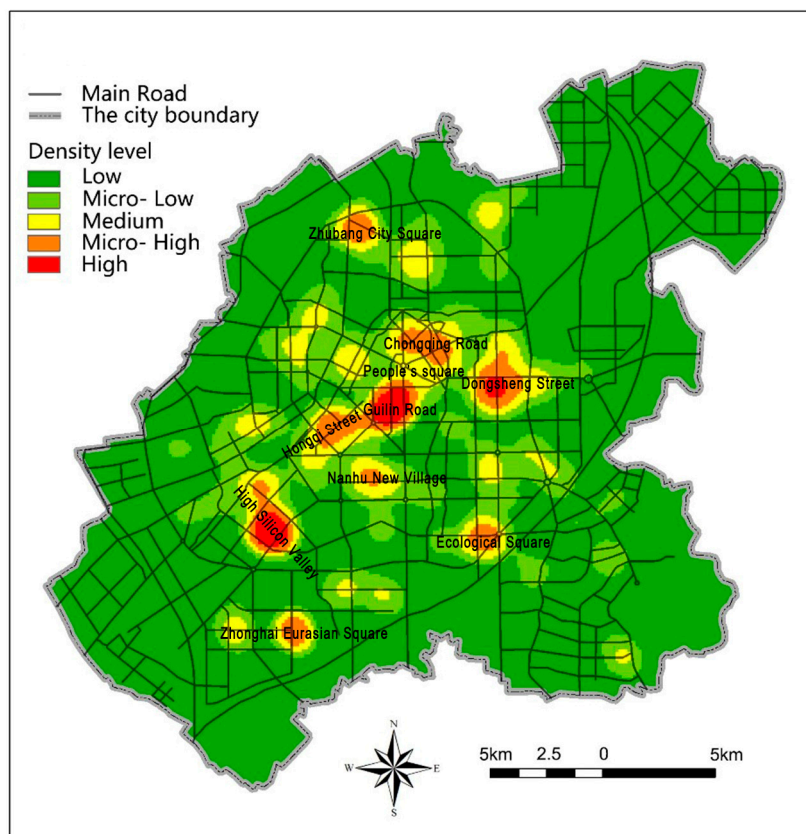


Figure 3. Spatial density distribution of children's activity places in Changchun.

4.1.2. Spatial Agglomeration State

The global Moran's I value for the spatial distribution of children's activity places was 0.14 (at the significance level of 0.01), indicating a positively significant spatial correlation. The cold and hot spot distribution of the local G_i index for children's activity places is indicated in Figure 4. There were several significant hotspots and cold spots showing the distribution of children's activity places. The hotspots were mainly distributed in the urban core areas. Guilin Road, Hongqi Street, and High Silicon Valley together formed a northeast–southwest strip of hotspots, which was a highly concentrated area of children's activity space in Changchun. The distribution of cold spots was mainly in the northeast and southwest of the urban periphery, indicating that children's activity places in Changchun were not equipped enough in the northeast and southwest areas of the urban periphery and that the service level was low. Guilin Road, High Silicon Valley, Dongsheng Street, and other hotspots had high G_i values in adjacent blocks, and the characteristics of grid clusters of the "High–High" type were obvious, which had a significant impact on their neighboring areas. Chongqing Road, Ecological Square, Zhonghai Eurasian Square, and other places did not show obvious characteristics of hotspot gathering areas, which indicated that its scale was relatively small and that its impact on adjacent areas was weak.

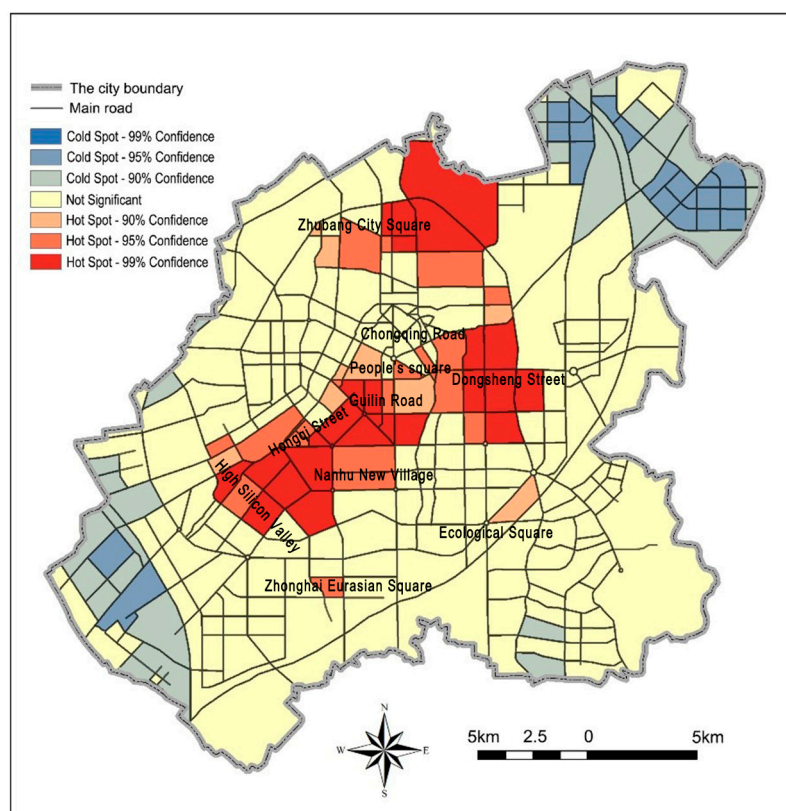


Figure 4. Cold and hotspot gathering pattern of the spatial distribution of children's activity places in Changchun.

4.1.3. Hierarchical Organization

The identified areas of medium-high density hotspots were used to extract the area, number of POIs, and the average kernel density of each hotspot. Using the group analysis tool in GIS, the space constraint parameter, NO_SPATIAL_CONSTRAINT, was selected. The nine hotspots identified were clustered and divided into two levels, i.e., municipal center and district center, for children's activity places (Table 2).

Table 2. Classification of hotspots in the central urban area of Changchun.

| Grading | Hotspots | Number of POIs | Hotspot area(ha) | Mean kernel density |
|------------------|--------------------------|----------------|------------------|---------------------|
| Municipal Center | Guilin Road | 89 | 430 | 14.126 |
| | High Silicon Valley | 108 | 395 | 14.037 |
| | Dongsheng Street | 72 | 355 | 12.051 |
| District Center | Chongqing Road | 52 | 265 | 10.367 |
| | Zhubang City Square | 40 | 143 | 11.141 |
| | Zhonghai Eurasian Square | 41 | 118 | 10.043 |
| | Hongqi Street | 37 | 220 | 11.101 |
| | Ecological Square | 33 | 132 | 10.756 |
| | Nanhua New Village | 17 | 62 | 9.854 |

The results of clustering showed that (Table 3): (1) Changchun city initially consisted of Guilin Road, High Silicon Valley, and Dongsheng Street as the municipal children's activity center. Chongqing Road, Zhubang City Square, Zhonghai Eurasian Square, Hongqi Street, Ecological

Square, and Nanhu New Village were the district-level children's activity center for the space pattern of children's activity space. (2) From the perspective of functional composition, the activity places of municipal children's activity centers were relatively coordinated and their functions tended to be comprehensive. The district-level children's activity centers were usually dominated by one or two kinds of activity places, and their internal functions were relatively simple. For example, children's activity centers in Chongqing Road and Hongqi Street mainly provided school guidance and art activities, and the district-level children's activity centers of Zhonghai Eurasian Square and Ecological Square mainly provided early education. (3) From the perspective of service objects, the service objects of municipal children's activity centers were more focused on primary and secondary school students, while district children's activity centers were more focused on preschool children (3–6 years old) and infants (under 3 years old). (4) From the perspective of environmental characteristics, municipal children's activity centers were usually concentrated in the vicinity of urban commercial streets and key primary and secondary schools. The operation scale for 1–3 floor storefront shops or office buildings on both sides of the streets was relatively small, with poor facilities and environment. District-level children's activity centers were often concentrated near large comprehensive shopping centers selling branded merchandise and had better environmental facilities.

Table 3. Summary of hotspots in children's activities in Changchun.

| Grading | Hotspots | Category | Place location | Service object |
|------------------|--------------------------|---|---|---|
| Municipal Center | Guilin Road | Comprehensive | Office buildings on both sides of Tongzhi Street | Primary and middle school students |
| | High Silicon Valley | Comprehensive | Commercial complex, gymnasium, storefront | Infant, preschool children |
| | Dongsheng Street | Comprehensive | Street shops 1–3 floors | All ages |
| District Center | Chongqing Road | School guidance and art | Street shops in residential areas around the school | Primary and middle school students |
| | Zhubang City Square | Art | Inside commercial complex | Preschool children, primary school students |
| | Zhonghai Eurasian Square | Comprehensive | Inside commercial complex | Infant, preschool children |
| | Hongqi Street | School and art | Street shops in residential areas around the school | Primary and middle school students |
| | Ecological Square | Art | Inside commercial complex | Infant, preschool children |
| | Nanhu New Village | Early childhood education and school guidance | Street shops in residential areas around the school | Preschool children |

4.2. The Spatial Differentiation of Functional Types of Children's Activity Places

4.2.1. Spatial Differentiation of "Center–Periphery" Function Types

In this paper, the point density of children's activity places in each circle was used to represent the spatial distribution characteristics of the "center–periphery" of children's activity places (Figure 5). In general, children's activity places were mainly distributed within an 11 km circle with Changchun People's Square as the core. The spatial differentiation of "center–periphery" of various

children's activity places showed that: (1) The distribution range of children's art activity was the widest and the density was highest in the central area and formed a secondary peak at 5 km with a downward decreasing trend. (2) The circular trend of the distribution of children's tuition activity places and children's amusement activity places was similar; the circular distribution density gradually decreased from the center to the periphery. (3) The circular distribution of children's sports activity places and children's early education activity places showed an "inverted u-shaped trend", with the circle distribution density reaching a peak at 5 km which decreased successively outward, mainly within 3–9 km.

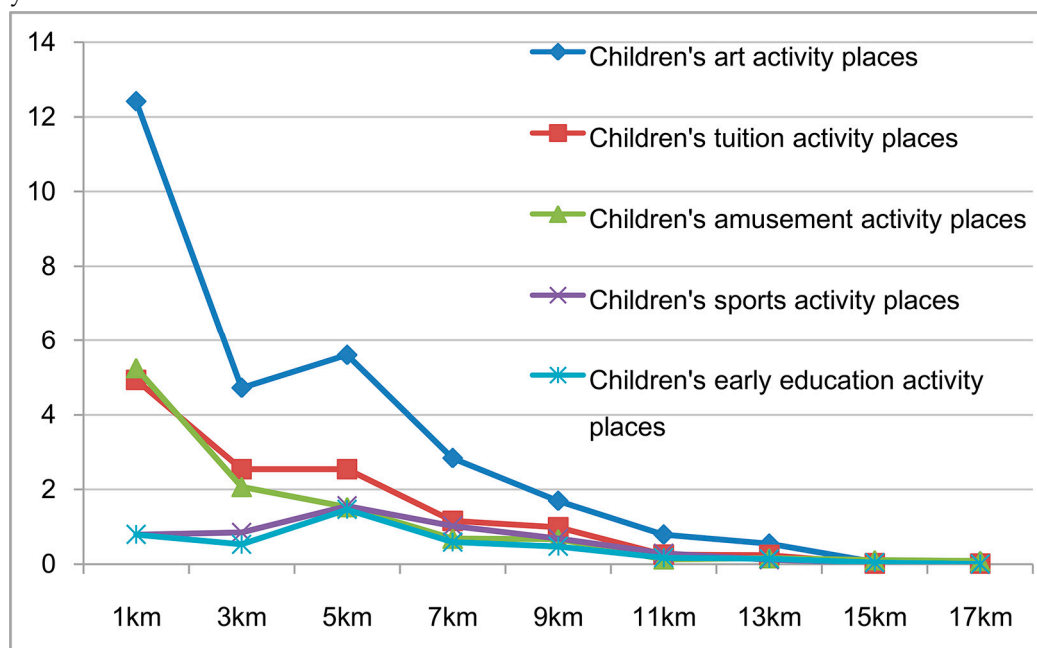


Figure 5. Distribution of dot density circles in children's activity places in Changchun (unit: individual/km²).

4.2.2. Distribution and Specialization of Children's Activity Places in Different Categories

Various kinds of children's activity places formed multiple hotspots with a high density in space; all were distributed within the city's fourth ring road (Figure 6). A polycentric spatial agglomeration was prominent. All kinds of children's activity places coexisted in spatial agglomeration and diffusion, with mainly point-shaped central agglomeration. Along the main "axial" roads, with the help of traffic nodes and commercial centers with "skip" diffusion, hotspots of multiple levels were formed in the central urban area, and the agglomeration centers of various levels were staggered.

There were significant differences in the spatial distribution of children's activity places for different categories. The high-density hotspots of children's tuition activity places, children's art activity places and children's amusement activity places were mainly distributed in the urban core area, and the kernel density decreased in a step-like manner from the urban center to the periphery. However, the high-density hotspots of children's sports activity places and children's early education activity places were mainly distributed in the urban periphery, forming a spatial distribution pattern of "low-core-high-periphery". The space diffusion characteristics of children's tuition activity places, children's art activity places, and children's sports activity places were the most significant, forming a cluster center of multiple levels within the urban center. The number of high-level, medium-level, and low-level cluster centers increased successively, and the spaces crisscrossed with a wide range of services. However, the space agglomeration characteristics of children's amusement activity places and children's early education activity places were more significant. The number and scale of 2–3 primary centers, secondary centers, and tertiary centers were very low and they had not yet developed. The spatial diffusion characteristics were not significant and the service scope was small.

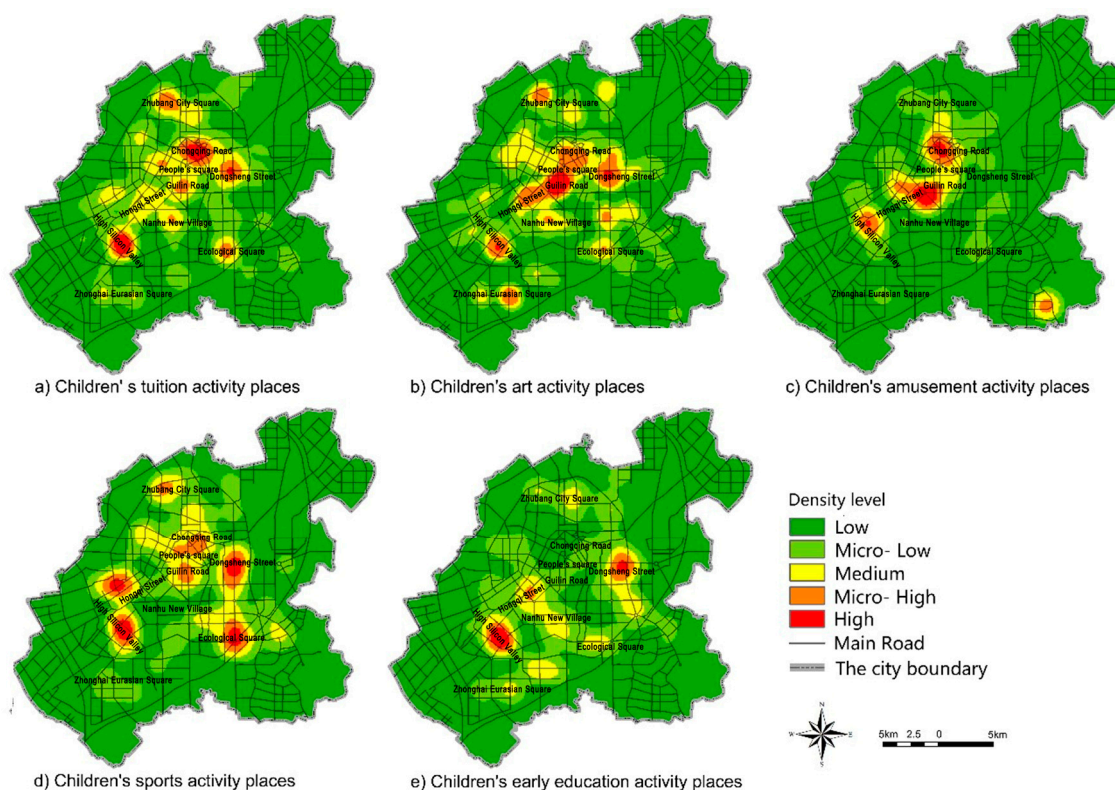


Figure 6. Distribution of kernel density of various children's activity places in Changchun.

As shown in Figure 7, there were also significant differences in the degree of specialization of different types of children's activity places in each block unit. The high degree of specialization of children's art activity places and children's amusement activity places was similar to the spatial distribution characteristics of high-density hotspots. The number and distribution of highly specialized blocks of children's art activity places were the largest, showing strong industrial advantages in each block of the city. The highly specialized blocks of children's amusement activity places were mainly concentrated in the urban park green space and large commercial complex in the city center, showing strong industrial advantages in the urban core area.

Compared with children's art activity places and children's amusement activity places, the highly specialized blocks of children's tuition activity places, children's early education activity places, and children's sports activity places were distributed more in the urban peripheral areas, indicating that the three types of children's activity places had no obvious competitive advantages in the urban central areas. At the same time, the high-density hotspots of children's tuition activity places, children's early education activity places, and children's sports activity places were located in neighborhoods that did not show the characteristics of a high degree of specialization, indicating that these three types of children's activity places were more dispersed in the city than children's art activity places and children's amusement activity places.

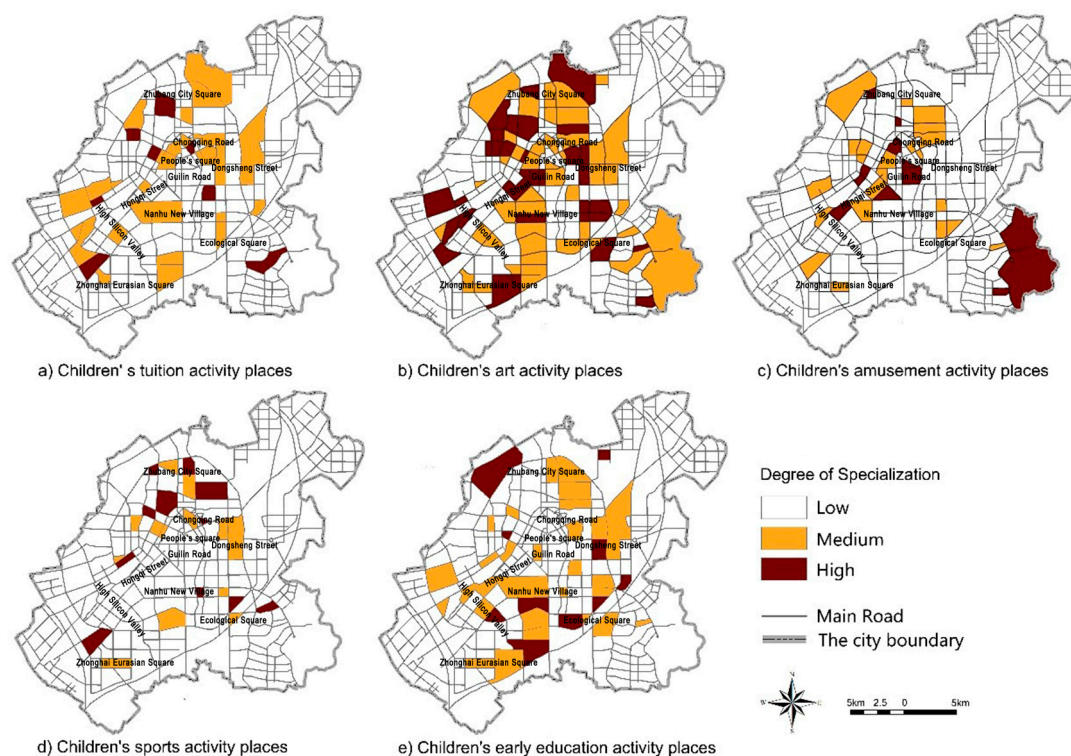


Figure 7. Distribution of specialization of various children's activity places in Changchun.

4.3. The Formation Mechanism of Children's Activity Space

4.3.1. The Diversification and Social Demand of Children's Activities

With the transformation of China's basic education concept to quality education, training of children is no longer limited to institutionalized exam-oriented education, and children's needs tend to be diversified and personalized. Presently, Chinese families pay an increasing amount of attention to children's education and the improvement of children's overall quality to cultivate children's interest in activities that stimulate their nature. However, teaching in Chinese schools tends to be standardized and consists of repetitive activities that inhibit children's active nature, curiosity, and imagination; this does not help cultivate children's creativity and innovation. Therefore, it is difficult to meet parents' demand for children's education. In this context, children's activity places, that focus on the development of children's potential interests (such as early childhood education, whole-brain development, and art training) are expanding rapidly within the city.

The continuous improvement of children's activities makes the places more significant; children are able to play there. Exclusive activity spaces for children encourages cultural improvement and social communication. Children are no longer confined to the streets and green space around the community but prefer to spend time in the exclusive activity places where the facilities are concentrated. Children's commercial activity spaces provide abundant leisure facilities and exclusive spaces that meet the diversity, safety, and social demand for children's activities. Some places with commercial activities also encourage parents to participate in children's entertainment activities. Through a series of parent-child interaction leisure projects, children can establish more intimate parent-child contact with their parents.

4.3.2. Children's Consumption is Becoming a New Growth Point of the Modern Service Industry

Due to China's one-child policy, most young Chinese are the only child in their families and can have one child after marriage. Young contemporary families have a family structure of 1 + 2 + 4 (1 represents the only child, 2 represents the father and mother, and 4 represents the maternal grandparents and paternal grandparents). Both parents and grandparents pool all resources for the

development of the only child who then becomes the center of the contemporary Chinese family. Children's education and physical and mental development have become the center of Chinese families. Children's education accounts for a vast majority of family expenditure, and the proportion of services that provide child-related tertiary services is increasing. Additionally, the national two-child policy promotes the growth of children's population, and market demand for children's consumption will remain high in the future. Children's education and training, art counseling, leisure, entertainment, early childhood education and other children's activity places have rapidly developed due to a large investment of social capital. The service industry for children, which mainly focuses on children's education and play, is gradually expanding into diversified and experiential areas for children's education, entertainment, and services. Children's consumption is becoming a new growth driver for the modern urban service industry.

4.3.3. Market Competition and Behavior of Children's Activity Places

Rent in urban areas is an important factor that affects the spatial distribution of children's activity places. Children's activity places of different categories and sizes influence in-store investments, operations, management expenses, and economic benefits in different ways. Rent in urban areas is decreasing from the center to the periphery. The places with children's activities that have grown economically and have high rent remain in the city center. Urban land rent is decreasing step by step from the center to the periphery. Only the children's activity places with good economic benefits and strong rental capacity remain in the city center. However, the children's activity places with weak ability to compete for rent, such as children's sports places, have been replaced by children's activity places and commercial facilities with a strong ability to compete for rent, gradually shifting to the periphery of the city. Additionally, core urban areas (mostly buildings preserved from the last century, operation areas of commercial stores, floor, fire facilities) and other infrastructural facilities are greatly limited, making it difficult to provide a suitable operating environment for some children's activity places.

4.3.4. Coupling Relationship between Children's Activity Places and Urban Functional Areas

Urban children's activity places are related to urban functional areas in space, have a coupling relationship with urban functional land and have strong passenger volume orientation and location orientation in location selection. Children's activity places have a high demand for passenger volume and are usually located near important urban commercial blocks or commercial complexes. Some children's activity places have greater location requirements, for example, children's amusement activity places are mostly distributed in urban parks and green space, children's tuition activity places and children's art activity places are usually distributed around schools, and children's early education activity places are distributed near high-end residential areas. At the same time, children's activity places can promote the development of urban functional areas. Urban commercial blocks and complexes take advantage of the importance families attach to children and focus on satisfying children's activities. By building children's activity places, they attract other family members to shopping malls, thus promoting the rapid growth of urban commerce. Real estate developers have built supporting children's activity centers near residential areas to attract more young people to buy houses by improving the children's service functions in residential areas.

4.3.5. Transportation and Accessibility of Children's Activity Places

Convenient urban traffic is required for urban social and economic activities, and the main framework of urban roads affects the spatial pattern of children's activity space. The spatial characteristics of children's activity places along the main roads and transportation nodes are prominent. Children's activity centers at all levels of the city are mostly distributed at the intersections of main roads. Within 100 m of main city roads, the number of different children's activity places accounted for over 31.49% of the total (Table 4). At the same time, the distribution of urban children's activity places is also affected by the distance traveled by children, especially for

early childhood education places suitable for infants and young children. Due to the limitation of travel distance for infants and young children, early education activity places are concentrated more in residential areas with a large number of infants and young children (such as residential areas on both sides of Changchun Economic and Technological Development Zone and Dongsheng Street).

Table 4. Proportion of children's activity places in the main road buffer of the Changchun.

| Buffer | Activity places | Tuition activity places | Art activity places | Amusement activity places | Sports activity places | Early education activity places |
|--------|-----------------|-------------------------|---------------------|---------------------------|------------------------|---------------------------------|
| 50 m | 18.27 | 19.16 | 15.63 | 22.71 | 18.58 | 20.08 |
| 100 m | 34.15 | 31.49 | 33.33 | 38.43 | 38.05 | 33.98 |
| 150 m | 47.07 | 45.45 | 45.43 | 53.71 | 48.67 | 46.72 |
| 200 m | 58.54 | 57.79 | 56.93 | 62.01 | 60.18 | 59.85 |

4.3.6. Changes in Children's Activity Behavior Patterns and Preferences

Recently, the daily behavior pattern of Chinese children has changed significantly. Children's sedentary behavior has increased, and the frequency of outdoor and physical activities has decreased. In China, parents consider a child's academic performance to be the most important activity. Therefore, children spend more time on homework and off-school cultural activities (reading, writing, drawing, etc.) [69]. Art activities and tutoring activities have become part of the daily lives of most urban children. Children's outdoor activities and group activities have also greatly reduced, which limits social development of children to a great extent. At the same time, the commercial operation of children's activity places has greatly improved the level of fine service of places. Commercial activity places have better presentation and richer environmental facilities, which appeal to children and have changed children's interests and activities.

At the same time, with the progress of science and technology and the growth of Chinese family income, the penetration rate of high-tech electronic products such as televisions, computers and mobile phones has increased rapidly in Chinese families (source: 2019 China Statistical Yearbook). These have become important tools for children's home entertainment in China. Compared with traditional entertainment and sports activities, more and more children prefer to use electronic products and the Internet for several entertainment activities at home, such as browsing animation works and playing video games. This phenomenon reduces children's enthusiasm for outdoor activities to some extent and limits the development of urban children's sports and entertainment places.

5. Conclusion and Discussion

5.1. Conclusion

This study analyzed urban children's commercial activity space based on POI data. The location information from POI data can be used to analyze spatial distribution patterns, "center-periphery" distribution characteristics, and the hierarchical organization of children's activity space. The attribute information from POI data can reveal the functional and structural characteristics of children's commercial activity space. Besides, as data that supports the preliminary analysis of urban planning, POI data can help urban planners and managers make better decisions (such as improving the construction of urban children's activity facilities) and transform plans for children's activity places and the construction of "Child-Friendly Cities".

According to the results of spatial analysis, this paper finds that the spatial pattern of children's commercial activity places in Changchun has multiple levels and centers and that the spatial agglomeration of children's activities is obvious. Municipal children's activity centers are mostly distributed in the core urban areas, with comprehensive internal functions, mainly serving primary

and secondary school students. District-level children activity centers are scattered in the urban periphery, with relatively single internal functions, mainly serving infants and preschool children.

The spatial differentiation characteristics of urban children's commercial activity places can be classified into different categories. The spatial distribution characteristics of children's tuition activity places, children's art activity places, and children's amusement activity places are similar. The distribution density of these three types of children's commercial activity places decreases gradually from the center to the periphery, with high-density hotspots in the urban core areas and point-like medium-high-density hotspots in the edge of the urban core area. The spatial distribution characteristics of children's early education activity places and children's sports activity places are similar. The distribution density of children's sports activity places and children's early education activity places is the highest ~5 km away from the city center, with an "inverted u-shaped" distribution. The high-density hotspots of children's sports activity places and children's early education activity places are located at the edge of urban core areas, while the size and number of medium-high hotspots are small.

From the perspective of the specialization of children's commercial activity places, children's art activity places are numerous and are widely distributed with highly specialized blocks. The highly specialized blocks of children's amusement activity places are concentrated in the city center and are closely integrated with parks and large commercial facilities. The highly specialized places with blocks of children's tuition activity, children's sports activity, and children's early education activity are out of place with their high-density hotspots. The highly specialized blocks of these three kinds of activity places are mainly distributed in the urban periphery, indicating that their competitive advantages in the urban center are not obvious.

The formation and development of children's commercial activities space are mainly influenced by the following factors: the diversification of children's activities and social demand, children's consumption (which have become a source of growth for the modern service industry), market competition ability, behavior of children's activity places, coupling relationship between children's activity places and urban functional areas, transportation convenience, accessibility of children's activity places, and the changes of children's activity behavior patterns and preferences.

5.2. Discussion

5.2.1. Problems in Children's Commercial Activity Space

Space for children's commercial activity is not distributed equally in Changchun. In recent years, various kinds of children's commercial activity places have developed rapidly and had decreased the pressure of insufficient supply of children's activities. However, children's commercial activity places also have many disadvantages. The principle of location selection of children's commercial activity places is to maximize the interests of shops, with less consideration for spatial justice. Low-income residential areas and urban fringe areas are not favored by the market and eventually became "food deserts" for the spatial distribution of children's commercial activity places. Children in these areas do not have access to better services. Compared with other children, they have to pay a greater distance cost to enjoy children's commercial activity places.

However, even children's commercial activity places in core urban areas cannot fully meet all the needs of children. Limited by urban rent, business area and other factors, children's sports activity places and children's early education activity places are mainly located at the edge of core urban areas and only a few upscale activity centers remain in the city center. Children in urban core areas need to spend more money at upscale activity centers or pay higher transportation costs to children's commercial activity places in urban fringe areas. Correspondingly, children's tuition places and children's amusement activity places are scarce in peripheral areas of the city. Children on the edge of cities often have to pay higher transportation costs to the urban core.

Children have lesser space and fewer opportunities for outdoor activities in their natural environment; this limits physical and mental health development. Similar the rest of the world, there is a lack of natural outdoor spaces for children's commercial activity in Changchun. A natural

environment for regular outdoor activities promotes children's intellectual, emotional, social, spiritual, and physical development which is essential for child development [70,71]. However, most commercial activity places for children are indoors, artificial, and unnatural, which is obviously detrimental to children's development.

Places for children's commercial activity are concentrated in cities; this increases transportation costs for children's daily activities. Since the scope of children's daily activities is restricted by their psychological and physical conditions, children's facilities should be as close as possible to their homes. Although centralized distribution of children's commercial activity places meets the diversified needs of children's daily activities, the overly centralized spatial distribution model is not suitable for children. When children spend more time to reach the activity places, it limits their enthusiasm to participate in daily activities and also exposes them to the dangers of urban traffic and strangers.

Presently, there is a lack of reasonable guidance for commercial children's activity places in China. First, the proportion of children's tuition activity places and art activity places accounted for 62%, which is much higher than other children's activity places (Table 1). This proportion of children's activity places has largely met the needs of parents' "investment in education". Most parents send their children to children's tuition activity places and art activity places to improve their children's entrance exam scores. Second, strict industry regulations do not exist to limit commercial children's places in China, which has led to an increasing number of informal children's places with rough environments and potential risk of fire. Third, there are other problems such as overcommercialization and convergence in urban children's activity places. Due to the overcommercialization, children's development may deviate from the natural, healthy, and scientific growth trajectory.

5.2.2. Suggestions for Improvement of Children's Activity Space

First, local governments should set up more public places for children's activities and encourage the development of children's commercial activity places in peripheral areas of cities. The government should build public welfare places suitable for children's activities (such as children's museums, children's science and technology centers, and children's activity centers) to distribute spaces for children's activity facilities fairly and ensure easy access for children in surrounding areas. At the same time, the government should introduce policies and financial subsidies to develop children's activity places in outlying areas of cities, encouraging and guiding the spread of children's commercial activity places to peripheral areas in order to meet the diversified activity needs of children in urban peripheral areas.

Second, the local government should build more places for children's outdoor activities in the city, enrich the natural elements around children's activity places, and encourage children to participate in outdoor activities. Outdoor activities encourage the healthy growth of children. In combination with the existing urban green space, the corresponding scale of children's formal outdoor activities should be set up in municipal and district-level parks. In the existing children's activities places, natural elements such as green plants, soil slopes, sand rocks, and streams should be added to create a safe, healthy, and natural environment for children.

Third, the construction of children's activity places and facilities in residential areas can decrease the distance between children and children's activity places and meet the basic needs of children's daily activities. Urban planners should pay more attention to children while designing new residential areas and build more community activity centers and public squares for children's activities. Additionally, in the old residential areas, local governments should introduce regulations to encourage community managers to allocate a portion of the community's public space for children's outdoor activities.

Finally, local governments should pay attention to the needs of children's activities and incorporate the construction of children's activity facilities into the government's mandatory provisions in urban planning to ensure the protection of children's rights and interests in urban space. Although the government had proposed integrating construction of children's facilities with the

urban system planning in 2000, it is not properly implemented. The government should specify the minimum standards for children's activity facilities for urban planning and construction. The government should pay attention to the physiological and psychological characteristics of children and set up special areas for children in urban sports fields, libraries, parks, and green spaces. The government should enforce stricter industry standards to improve the facility environment and service quality of commercial children's places in cities. The government needs to introduce some preferential policies to increase the number of children's amusement and sports activity places and enrich the diversity of children's places.

5.3. Limitations and Future Research Direction

This study has two main limitations. First, a large number of data on children's activity places were used to analyze children's activity space. However, there are certain differences in the opening time, scale, and popularity of each activity place, which may have had an impact on children's daily activities. Second, although there are many similar developmental characteristics in Chinese cities, each city has its own unique spatial pattern, which may affect the spatial distribution of children's commercial activity places.

Future research needs to consider the size and popularity of children's activity places and improve the scientific nature of the research by assigning different spatial weights. Additionally, children of different ages have different behavioral preferences, and the differences in the daily activity space for children of different ages need to be studied. Finally, the phenomenon of overcommercialization of children's activity space is becoming increasingly prominent. It is of great significance to explore the social effects of this phenomenon and its impact on children's physical and mental development.

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