



Research article

A research of the evaluation of preschool education resource allocation level and spatio-temporal differences: Based on repeated indicators method and Theil index

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ABSTRACT

Based on the implementation of the third stage of “*Three-year Action Plan for Preschool Education*”, this research took preschool education resources of 31 provinces (cities), autonomous regions (excluding Hong Kong, Macao and Taiwan) and municipalities in China from 2003 to 2019 as research samples. At the same time, according to the data of *Educational Statistics Yearbook of China (2003–2019)* and *China Educational Finance Statistics Yearbook (2004–2020)*, this research collected the data of preschool education human resources, material resources, and financial resources. As for the data analysis, this research was based on the methodology of entropy method, repeated indicators method, and the Theil index and so on, and evaluated the state of preschool education resources allocation in China from 2003 to 2019. Simultaneously, according to the state of preschool education resources allocation, this research analyzed the spatio-temporal differences of preschool education resources allocation between various provinces and various areas, then analyzed the causes of spatio-temporal differences. After that, suggestions were put forward according to the analysis.

The results show that, since the implementation of the third stage of “*Three-year Action Plan for Preschool Education*”, the condition of preschool education resources allocation has been generally improved. However the preschool education resources allocation still presents a low-level and uneven development trend. Preschool education resources have formed a “preschool education resource advantage belt” in Beijing, Tianjin and the Yangtze River Delta; Comparing with material resources, the development of human resources in preschool education lags behind in China; In terms of each regions in China, eastern China has the most significant difference in the preschool education resources allocation, which is followed by western China, and inner China has the least significant difference; The main factor affecting the regional preschool education resources allocation difference is the inter-provincial differences in eastern China, inner China, and western China; And the main factors affecting the differences in preschool education resources in eastern, inner, and western China are respectively financial resources, human resources, and financial resources. At the same time, financial resources in eastern China and human resources in inner China tend to expand. Based on this, this study proposes methods to narrow the regional differences in preschool education resources allocation, so as to provide

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1. Introduction

As the beginning of education, preschool education not only has an important influence on people's lifetime development [[1–3]], but also plays an important role in achieving social fairness. Plenty of evidence shows that, preschool education is positively correlated with early school success [[4]], as well as the development of children's cognitive and non-cognitive skills [[5,6]]. Besides, preschool education appears to be their potential for prevention of future labor force and crime problems [[7]], and narrows the achievement gap between racial and income groups of students [[8]]. Thus, it is crucial for the development of individuals and society to make all the children get high quality preschool education, and implement fair preschool education. However, for a long time, inequities of preschool education exist in most countries [[9–11]]. Studies have shown that, a large percentage of children, especially children from low-income families, do not attend preschool [[10,12]]. The quality of preschool education also has significantly differences between urban and rural areas [[13–16]]. In fact, the key to the inequities of preschool education lies in the inequitable allocation of preschool education resources [[17]]. The key to realize the equity of preschool education lies in the balanced allocation of preschool education resources, including the allocation of human resources, material resources and financial resources [[17]].

As a typical developing country, China is gradually realizing the importance of preschool education equality. In recent years, the total financial investment in preschool education and the financial investment in preschool education per student have increased significantly [[18]]. The development of teacher teams' construction was rapid since the reform and opening-up [[19]]. Preschool attendance rates increased from 59.34% to 66.33%, and these increases were larger in rural areas and in less developed western region (15.27% and 12.71%, respectively) according to the *China Family Panel Studies* (CFPS, waves 2010, 2012, 2014, and 2016) [[20]]. However, despite the remarkable development of preschool education in recent years, the problems of imbalance and inequity of preschool education still exist [[18,21,22]]. Preschool education is still a weak point in China's entire education system [[23]]. The government's investment in preschool education still obviously lags behind other education segments [[18]]. The construction of kindergarten teachers' educational background structure, title optimization and training quality are still not sufficiently improved [[19]]. The allocation of preschool education resources in urban and rural areas is still imbalance [[21,24]].

In order to solve the imbalance and inequity of preschool education resources allocation, since the enacting of “*Several Opinions on the Current Development of Preschool Education*” in 2010, China has enacted three stages of action plan—“*Three-year Action Plan for Preschool Education (2011–2013)*”, “*Three-year Action Plan for Preschool Education (2014–2016)*”, “*Three-year Action Plan for Preschool Education (2017–2019)*”. Until 2019, the third stage of action plan for preschool education has been implemented. At this point, how is the result of implemented the three-year action plan for preschool education? What has been achieved? What kinds of problems do still exist?

Based on this, this research took 31 provinces (cities), autonomous regions (excluding Hong Kong, Macao and Taiwan) and municipalities in China as research objects, and took preschool education resources of 31 provinces (cities), autonomous regions (excluding Hong Kong, Macao and Taiwan) and municipalities in China from 2003 to 2019 as research samples.

The research questions mainly include:

- 1 Under the background for the three stages of action plans— “*Three-year Action Plan for Preschool Education*” (2011–2013), “*Three-year Action Plan for Preschool Education*” (2014–2016), “*Three-year Action Plan for Preschool Education*” (2017–2019), from 2003 to 2019, what is the integral level of preschool education resources allocation (including human resources allocation, material resources allocation, and financial resources allocation) in China; what achievements have been made; and what are the remaining problems?
- 2 Under the background for the three stages of action plans— “*Three-year Action Plan for Preschool Education*” (2011–2013), “*Three-year Action Plan for Preschool Education*” (2014–2016), “*Three-year Action Plan for Preschool Education*” (2017–2019), from 2003 to 2019, what is the level of preschool education resources allocation among provinces in China; what achievements have been made; and what are the remaining problems?
- 3 Under the background for the three stages of action plans— “*Three-year Action Plan for Preschool Education*” (2011–2013), “*Three-year Action Plan for Preschool Education*” (2014–2016), “*Three-year Action Plan for Preschool Education*” (2017–2019), from 2003 to 2019, what is the level of preschool education resources allocation among areas and within areas in China; what achievements have been made; and what are the remaining problems?
- 4 Under the background for the three stages of action plans— “*Three-year Action Plan for Preschool Education*” (2011–2013), “*Three-year Action Plan for Preschool Education*” (2014–2016), “*Three-year Action Plan for Preschool Education*” (2017–2019), from 2003 to 2019, what are the reasons that caused remaining problems of preschool education resources allocation?

2. Construction of index system, methodology, and data resource

2.1. Construction of index system

Preschool education resources refer to, in the process of preschool education, the occupation, usage, and expending of human

resources, material resources, and financial resources. It is the summation of human resources, material resources, and financial resources [[21]]. According to this definition and the existing research results [[25,26]], this research divided preschool education resources allocation into three first-level indexes– human resources (HR), material resources (MR), and financial resources (FR). Human resources mainly focus on studying the human resources of educators, which are mainly measured in the aspects of quality and quantity. The proportion of teachers and students reflects the quantity of human resources. The proportion of the teachers who have Bachelor Degree or above as full-time teachers, and the proportion of senior teachers reflect the quality of human resources. Material resources mainly refer to the fixed assets, materials, and low value consumables in schools. Considering the validity of the data collection, this research chose the area of living house per student, the construction area of school building per student, the area of teaching aids building per student, and the area of administrative building per student as the 4 s-level indexes for the measurement of the material resources. Financial resources refer to the expenditure of preschool education, which is mainly used for paying teachers' salary, purchasing education equipment and improving campus environment and so on [[27]]. Thus, this research chose public funds for preschool education per student, general public budget funds per student, the proportion of funding for preschool education in GDP, and the proportion of government expenditure on preschool education as the second-level indexes of financial resources (See Table 1).

2.2. Methodology

2.2.1. Repeated indicators method

In order to test whether the constructed index system was scientific, this research used Repeated Indicators Method (RIM) to assess the index system of preschool education resources allocation level. Smart-PLS requests low data quantity (30–100), and can deal with partial least squares of abnormal distributing data, effectively overcome the collinearity issues between variables, and remove the effect of unhelpful noise on regression [[28]]. Thus, this research used Smart-PLS to assess the index system of preschool education resources allocation level. However, since Smart-PLS can only deal with cross-section data, according to the data of *Educational Statistics Yearbook of China (2003–2019)* and *China Educational Finance Statistics Yearbook (2004–2020)*, this research took the data of preschool education resources of 31 provinces (cities), autonomous regions (excluding Hong Kong, Macao and Taiwan) and municipalities in China in 2019 as research samples and processed data analysis to assess the index system of preschool education resources allocation level.

2.2.2. The entropy method

Before studying the preschool education resources allocation level, this research needs to comprehensively calculate the data. The specific calculation model is:

Firstly, the original data is needed to be standardized to eliminate the effect of measurement unit of the indicators and the effect of the differences of dimension and magnitude. The detail is:

$$\text{Positive indicator : } y_{kij} = \frac{x_{kij} - \min(x_{kij})}{\max(x_{kij}) - \min(x_{kij})} \tag{1}$$

$$\text{Negative indicator : } y_{kij} = \frac{\max(x_{kij}) - x_{kij}}{\max(x_{kij}) - \min(x_{kij})} \tag{2}$$

In the formula, x_{kij} refers to sample value; $\max(x_{kij})$ and $\min(x_{kij})$ refer to the maximum value and minimum value in the sample data.

Secondly, the Entropy Method in the Objective Weighting Method is used to calculate the weight of all the indicators. The detail is:

$$p_{kij} = \frac{y_{kij}}{\sum_{k=1}^m y_{kij}} \quad ; \quad e_{kj} = \left[-\frac{1}{\ln(m)} \right] \sum_{i=1}^m p_{kij} \ln p_{kij} \tag{3}$$

Table 1
Preschool education resources allocation index system.

First-Level Index	Second-Level Index	Unit
MR	area of living house per student	m ² /student
	construction area of school building per student	
	area of teaching aids building per student	
	area of administrative building per student	
FR	public funds for preschool education per student	¥/student
	general public budget funds per student	
	proportion of funding for preschool education in GDP	
HR	proportion of government expenditure on preschool education	%
	proportion of the teachers who have Bachelor Degree or above	
	proportion of teachers and students	
	proportion of senior teachers	

$$w_j = (1 - e_{ki}) / \sum_{i=1}^m (1 - e_{ki}) \tag{4}$$

At last, the preschool education allocation level is calculated. The formula is:

$$U = \sum_{j=1}^m w_{kij} y_{kij} \quad ; \quad \sum_{j=1}^m w_{kij} = 1 \tag{5}$$

2.2.3. Theil Index Decomposition

On one hand, Theil Index Decomposition was proposed by econometrician Theil [29]]. For the reason that it can decompose mutual independent differences in a group and differences between groups, Theil Index Decomposition is widely used in the testify and analysis of the total difference in one region and differences between regions [30]]. The detailed formula is:

$$T_{bi} = \frac{Y_i}{Y} \ln \left(\frac{Y_i}{Y} / \frac{N_i}{N} \right) \tag{6}$$

$$T_b = \sum_i T_{bi} \tag{7}$$

$$T_{wi} = \sum_j \frac{Y_{ij}}{Y} \ln \left(\frac{Y_{ij}}{Y_i} / \frac{N_{ij}}{N_i} \right) \tag{8}$$

$$T_w = \sum_i \frac{Y_{ij}}{Y} \ln \left(\frac{Y_{ij}}{Y_i} / \frac{N_{ij}}{N_i} \right) \tag{9}$$

$$T_i = T_{wi} + T_{bi} \tag{10}$$

$$T = T_b + T_w \tag{11}$$

In the formula, *i* refers to region, *j* refers to province, *T_b* refers to Theil index between groups, *T_w* refers to Theil index in a group, *T* refers to Theil index in total, *T_{bi}* refers to *i*th regional Theil index between groups, *T_{wi}* refers to *i*th regional Theil index in a group, *T_i* refers to *i*th regional Theil index in total, *Y_i* refers to *i*th regional preschool education resources allocation level, *Y* refers to preschool education resources allocation level in total, *Y_{ij}* refers to preschool education resources allocation level in *i*th region *j*th province, *N* refers to the total population in kindergarten, *N_i* refers to the population in kindergarten in *i*th region, *N_{ij}* refers to the population in kindergarten in *i*th region, *j*th province.

On the other hand, Theil index can be used to calculate the rate of contribution in a group and between groups. The detailed formula is:

$$W_{bi} = \frac{T_{bi}}{T_i} \tag{12}$$

$$W_{wi} = \frac{T_{wi}}{T_i} \tag{13}$$

$$W_b = \frac{T_b}{T} \tag{14}$$

$$W_w = \frac{T_w}{T} \tag{15}$$

$$W_i = \frac{T_i}{T} \tag{16}$$

In the formula, *W_b* refers to the contribution degree of Theil index between groups, *W_w* refers to the contribution degree of Theil index in a group, *W_{bi}* refers to the contribution degree of Theil index in *i*th region between groups, *W_{wi}* refers to the contribution degree of Theil index in *i*th region in a group, *W_i* refers to the total contribution degree of Theil index in *i*th region.

2.3. Data resource

This research took preschool education resources of 31 provinces (cities), autonomous regions (excluding Hong Kong, Macao and Taiwan) and municipalities in China from 2003 to 2019 as research samples. At the same time, according to the data reduction of *Educational Statistics Yearbook of China (2003–2019)* and *China Educational Finance Statistics Yearbook (2004–2020)*, this research collected the data of preschool education human resources, material resources, and financial resources. Among the two yearbooks, *China Educational Finance Statistics Yearbook* is edited by the Department of Finance, Ministry of Education and the Statistics

Department of Social science, Technology and Cultural Industry, National Bureau of Statistics. It is the statistical yearbook published by China Statistics Press. All the data in *China Educational Finance Statistics Yearbook* are collected from the grassroots units, and gathered step by step from the educational authorities of townships (towns), counties (cities, districts), prefectures (cities), provinces (autonomous regions, municipalities). *China Educational Finance Statistics Yearbook* carries on data statistics annually, and the data comprehensively and systematically reflect the sources and usages of Chinese educational funds at every level and of various types in the previous year. For instance, *China Educational Finance Statistics Yearbook 2019* reflects the sources and usages of Chinese educational funds at every level and of various types in 2018. Thus, this research took *China Educational Finance Statistics Yearbook (2004–2020)* as the source of the data, summarized the state of preschool education financial resources allocation in China from 2003 to 2019. *Educational Statistics Yearbook of China* is edited by the Department of Development Planning, Ministry of Education, PRC. It is a statistical yearbook codified according to the reported figures of basic level schools, which is submitted by the Education Committee and the Department of Education in all the provinces, autonomous regions, and municipalities in China. *Educational Statistics Yearbook of China* carries on data statistics annually, and the data comprehensively and systematically reflect the development conditions of Chinese educational enterprises at every level and of various types in current year. For instance, *Educational Statistics Yearbook of China 2019* reflects the development conditions of Chinese educational enterprises at every level and of various types in 2019. Thus, this research took *Educational Statistics Yearbook of China (2003–2019)* as the source of the data, summarized the state of preschool education human resources and material resources allocation in China from 2003 to 2019.

3. The test of preschool education resources allocation index system

3.1. Unidimensionality Test

First of all, the principal component of the three first-level indexes were analyzed, and used for processing Unidimensionality Test. The result is showed in [Table 2](#). According to [Table 2](#), the characteristic values of the first principal component in every dimension are more than 1. And other characteristic values of the principal component are all less than 1. So every dimension has passed Unidimensionality Test.

This research used repeated indicators method to establish model in the software Smart PLS 3.0 (See [Fig. 1](#)). In the model, no matter how many factors are there in a scale, one factor and the indicator which the factor belongs to, respectively become one latent variable (exogenous variables) [31]. In addition, latent variables which are made of repeated indicators (endogenous variables) are also added into the model. Then all the indicators of this scale are set as observing indicators of the endogenous variable [32]. Besides, “when PLS algorithm is used, Smart PLS 3.0 will firstly standardize the origin data itself, so the output results of the software are all standardized results” [33].

3.2. Repeated indicators method test

3.2.1. Model predicting ability and test of reliability and validity

In the test of reliability and validity, the reliability index (Cronbach’s Alpha and composite reliability which is shorten as CR.) of Repeated Indicators Method (RIM) should be more than 0.7 [34], and validity index (average variance extracted which is shorten as AVE, rho A and discriminant validity) should be more than 0.5 [35,36]. As it is shown in [Table 3](#) and [Table 4](#), the reliability and validity of the preschool education resource allocation index system model which was constructed in this research, both meet the criterion. It indicates that the reliability and validity of this model are high.

In the aspect of model predicting ability, Q^2 is more than 0.35 [35,36]. It indicates that exogenous variables have high effect on endogenous variables, and it means that the predicting relation of the model is quite strong. In [Table 3](#), the value of Q^2 is 0.518. It indicates that exogenous variables have high effect on endogenous variables, and the integral predicting ability of preschool education resource allocation index system is quite strong.

3.2.2. Factor loading and path coefficient estimation

According to [Fig. 1](#), the 11 factor loadings which were constructed in this research are all more than 0.6. It indicates that these indicators can explain the latent variables well. Besides, each path coefficient estimation of latent variables shows that (See [Table 5](#)) the contribution rate of financial resources to preschool resources allocation level is 34.6%; the contribution rate of material resources is 40.8%; the contribution rate of human resources is 37.1%. Besides, Bootstrapping results show that all the path coefficients have high level of T-statistic (See [Table 5](#)). It indicates that all the path coefficients have passed the corresponding significant level test, and the stability of the model is quite good.

According to the path coefficients of respective latent variables, the most of contribution to preschool education resource allocation

Table 2
Unidimensionality test.

Variable	Characteristic value of the first principal component	Characteristic value of the second principal component
HR	2.195	0.668
MR	3.316	0.400
FR	3.867	0.091

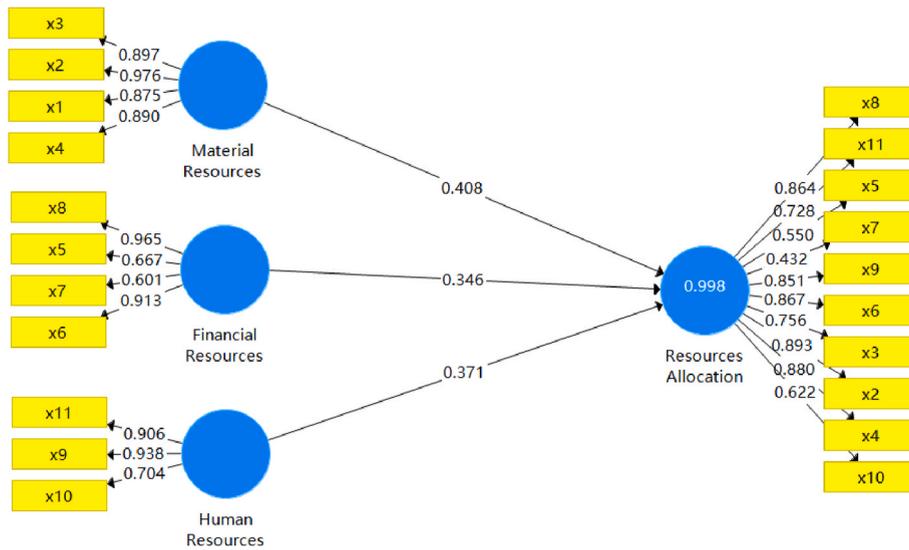


Fig. 1. The RIM of preschool education resource allocation.

Table 3
The results of model predicting ability and test of reliability and validity.

	Cronbach's Alpha	rho_A	CR	AVE	R ²	Q ²
HR	0.809	0.841	0.890	0.732	0.998	0.518
MR	0.930	0.937	0.951	0.829		
FR	0.807	0.889	0.874	0.643		

Table 4
The test results of discriminant validity.

	HR	MR	FR
HR	0.855		
MR	0.670	0.910	
FR	0.641	0.732	0.802

Notes: if the AVE square root of latent variables is more than the correlation of other variables, it represents that there is discriminant validity. RA belongs to repeated indicators, and its purpose is to export the factor loading of other latent variables. Thus, it is not listed in the discriminant validity analysis [36].

is from material resources, followed by human resources, and the least of contribution is from financial resources. It indicates that, for now, the development of human resources and financial resources of preschool education is not enough in China. Comparing with material resources, the development of human resources of preschool education is hysteretic.

4. The test of preschool education resources allocation

Based on the index system of preschool education resources allocation, this research collected the relative data of preschool education resources allocation level from 2003 to 2019. In order to calculate the comprehensive level of preschool education resources allocation, this research used entropy method to standardized the original data for eliminating the effect of measurement unit of the indicators and the effect of the differences of dimension and magnitude. After calculating the preschool education resources allocation

Table 5
Path coefficient significance test.

	Original Sample	Sample Mean	Standard Deviation	T	P
HR	0.371	0.354	0.037	9.978	0.000
MR	0.408	0.404	0.033	12.375	0.000
FR	0.346	0.358	0.039	8.774	0.000

level, the results of Chinese preschool education resources allocation and its variation tendency from 2003 to 2019 were shown in Fig. 2. In Fig. 2, the level of preschool education resources allocation in 2003 was the lowest, and the level of preschool education resources allocation in 2019 was the highest. From 2003 to 2006, Chinese preschool education resources allocation was on slowly rising tendency. From 2006 to 2007, it appeared slightly declining tendency. From 2007 to 2008, it showed sharply rising tendency. From 2008 to 2011, it appeared slowly declining tendency. However, after 2011, except that it showed slightly declining tendency from 2014 to 2015, until 2019, it presented sharply rising tendency all through. Generally speaking, from 2003 to 2019, Chinese preschool education resources allocation level appeared waved rising tendency. Besides, as shown in Fig. 2, from 2003 to 2011, the development of Chinese preschool education resources allocation level was slow. But, after 2011, until 2019, Chinese preschool education resources allocation level raised rapidly. The main reason was that Chinese State Council introduced *Several Opinions on the Current Development of Preschool Education* which pointed out overall planning, editing the plan about “*Three-year Action Plan for Preschool Education*”, which regarded county as unit. After this, the first stage of “*Three-year Action Plan for Preschool Education*” (2011–2013), the second stage of “*Three-year Action Plan for Preschool Education*” (2014–2016), and the third stage of “*Three-year Action Plan for Preschool Education*” (2017–2019) were edited separately. Compared with the time before 2011, Chinese preschool education resources allocation level appeared rapidly rising tendency after 2011. It indicated that the implementation of “*Three-year Action Plan for Preschool Education*” achieved remarkable results.

5. The analysis of spatio-temporal differences of preschool education resources allocation

5.1. Province differences of preschool education resources allocation level

In 2010, Chinese State Council introduced *Several Opinions on the Current Development of Preschool Education* which pointed out overall planning, editing the plan about “*Three-year Action Plan for Preschool Education*”, which regards county as unit. After this, the first stage of “*Three-year Action Plan for Preschool Education*” (2011–2013), the second stage of “*Three-year Action Plan for Preschool Education*” (2014–2016), and the third stage of “*Three-year Action Plan for Preschool Education*” (2017–2019) were edited. This research was based on the measurement results of preschool education resources allocation level, according to these time points, and drew the chart of preschool education resources allocation (See Fig. 3) and the increasing chart of preschool education resources allocation (See Fig. 4).

As shown in Fig. 3, completely speaking, from 2003 to 2019, Chinese preschool education resources allocation was on rising tendency in the 31 provinces (cities) and municipalities (not including Hong Kong, Macaw, and Taiwan). Until 2019, there were some provinces (cities), such as Beijing, Tianjin, Shanghai, Jiangsu, Zhejiang, Hainan, Inner Mongolia, Tibet and so on, of which preschool education resources allocation is comparatively high (See Fig. 3). However, there were provinces (cities) such as Hebei, Anhui, Henan, Hubei, Hunan, Guangxi, Sichuan, Chongqing, which have relatively lower preschool education resource allocation. It indicated that the development of preschool education resources allocation was not balanced in the 31 provinces (cities) and municipalities (not including Hong Kong, Macaw, Taiwan) in China. And “preschool education advantage area” was formed in Beijing, Tianjin and Yangtze River Delta region.

As shown in Fig. 4, compared with other time periods in every province, preschool education resources allocation growth range showed that: (1) The provinces (cities) with the fastest growth before 2010 included Liaoning, Heilongjiang, Hunan, Guangdong, Xinjiang. It indicated that the implementation effect in these provinces was not impressive during the “*Three-year Action Plan for Preschool Education*”. (2) The rising range of Shandong, Guangxi, Hainan, Gansu, Qinghai was the highest during 2010–2013. It indicated that, compared to other provinces (cities), the implementation effect of these provinces was relatively highlighted during the first stage of “*Three-year Action Plan for Preschool Education*” (2010–2013). (3) The rising range of Shanxi, Inner Mongolia, Hubei, Tibet, Ningxia was the highest during 2013–2016. It indicated that, compared to other provinces, the implementation effect of these provinces was highlighted during the second stage of “*Three-year Action Plan for Preschool Education*” (2014–2016). (4) The rising

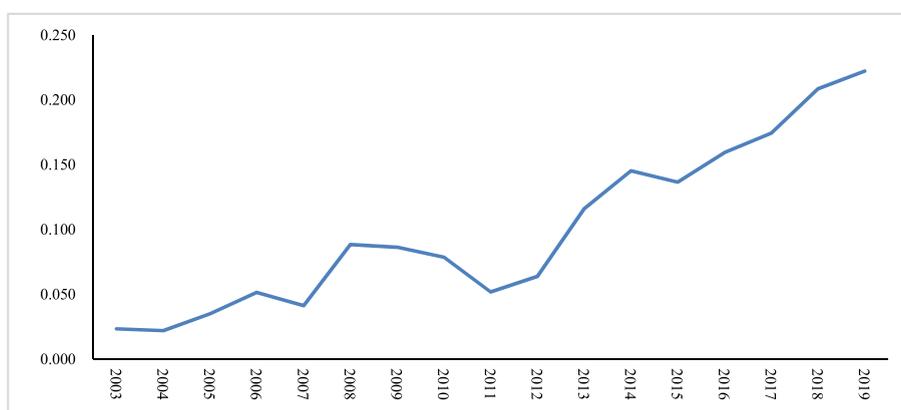


Fig. 2. Preschool education resources allocation level in 2003–2019.

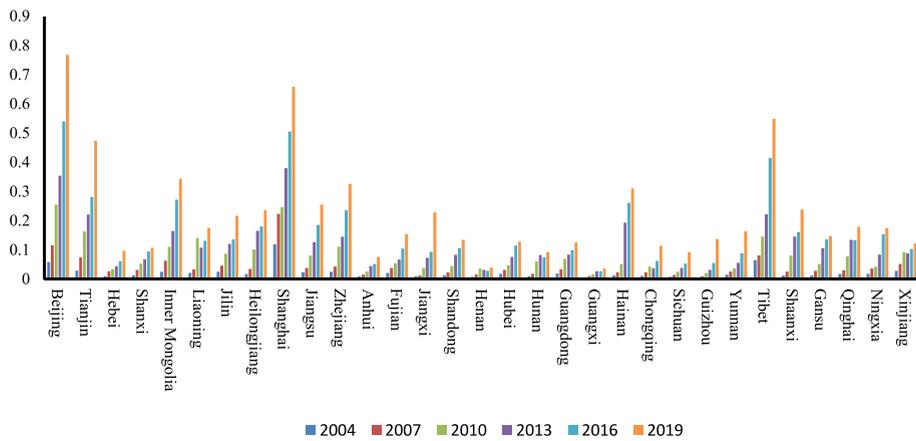


Fig. 3. Preschool education resources allocation.

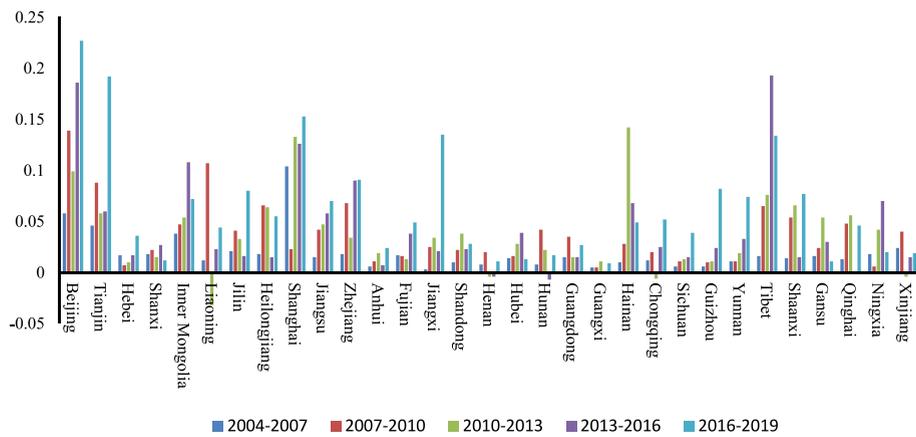


Fig. 4. Increasing tendency of preschool education resources allocation.

Table 6
Clustering result of preschool education resources allocation.

	High Level	Medium Level	Low Level
2004	Beijing, Tibet	Shanghai	Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangdong, Guangxi, Hainan, Chongqing, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang
2007	Shanghai	Beijing, Tianjin, Inner Mongolia, Tibet	Hebei, Shanxi, Liaoning, Jilin, Heilongjiang, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangdong, Guangxi, Hainan, Chongqing, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang
2010	Beijing, Shanghai	Tianjin, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Jiangsu, Zhejiang, Tibet, Shaanxi, Qinghai	Hebei, Shanxi, Anhui, Fujian, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangdong, Guangxi, Hainan, Chongqing, Sichuan, Guizhou, Yunnan, Gansu, Ningxia
2013	Beijing, Shanghai	Tianjin, Inner Mongolia, Jilin, Heilongjiang, Jiangsu, Zhejiang, Tibet, Shaanxi, Qinghai, Xinjiang	Hebei, Shanxi, Liaoning, Anhui, Fujian, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangdong, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Gansu, Ningxia, Xinjiang
2016	Beijing, Shanghai, Tibet	Tianjin, Inner Mongolia, Jilin, Heilongjiang, Jiangsu, Zhejiang, Hainan, Tibet, Shaanxi, Ningxia	Hebei, Shanxi, Liaoning, Jilin, Anhui, Fujian, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangdong, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Gansu, Qinghai, Xinjiang
2019	Beijing, Shanghai, Tibet	Tianjin, Inner Mongolia, Jiangsu, Zhejiang, Hainan	Hebei, Shanxi, Liaoning, Jilin, Heilongjiang, Anhui, Fujian, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangdong, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang

range of Beijing, Tianjin, Hebei, Jilin, Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Chongqing, Sichuan, Guizhou, Yunnan, Shaanxi was the highest during 2016–2019. It indicated that compared to before, the implementation effect of these provinces was highlighted during the third stage of “Three-year Action Plan for Preschool Education” (2017–2019). To sum up, from 2010 until now, the achievement of “Three-year Action Plan for Preschool Education” was out-standing. The speed of Chinese preschool education resources allocation had increased fast, and preschool education resources allocation situation was developed obviously.

In order to study deeply in the group characteristic of preschool resource allocation, and comprehend the preschool resources allocation in 31 provinces (cities) and municipalities, this research divided the 31 provinces (cities) and municipalities into 3 groups—high, medium, and low, and used K-means clustering in non-class analysis, which was limited into 3 groups, to analyze the data in 2004, 2007, 2010, 2013, 2016, and 2019. The results are shown in Table 6.

According to Table 6, before 2010, all the provinces were all on low-level in preschool education resources allocation except for Beijing, Shanghai, Tianjin, Inner Mongolia, Tibet. After 2010, although provinces (cities) on medium preschool education resources allocation level were increasing, only developed economic provinces (cities) such as Beijing, Shanghai, Tianjin, Jiangsu, Zhejiang, Hainan, etc. reached medium and high level, and most of the provinces (cities) were on low level until 2019. Besides, the results of analysis of variance for the three groups after clustering showed that there were significant differences between the three groups in preschool education resources allocation. It indicated that “preschool education advantage area” was formed in Beijing, Tianjin and Yangtze River Delta region in China and preschool education resources allocation was under unbalanced development tendency.

5.2. Regional differences of preschool education resources allocation

In order to study the regional differences of preschool education resources allocation, this research used Theil Index Decomposition to analyze the total differences, differences between groups, and differences in a group of preschool education resources allocation in eastern, western, and inner China. Eastern China included Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan; Inner China included Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan; Western China included Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang. The results of calculation are shown as follow:

5.2.1. Regional differences and its evolution tendency

Table 7 described the evolution tendency of total differences, differences between groups and differences in a group of preschool education resources allocation separately in China, eastern China, inner China, and western China from 2003 to 2019. Table 7 showed that, from 2003 to 2019, the total differences of preschool education resources allocation in China declined in wave mode, differences

Table 7
Theil index decomposition of regional Differences.

	China			Eastern China			Inner China			Western China		
	Differences in a Group	Differences between Groups	Total Differences	Differences in a Group	Differences between Groups	Total Differences	Differences in a Group	Differences between Groups	Total Differences	Differences in a Group	Differences between Groups	Total Differences
2003	1.64	0.19	1.83	0.70	0.03	0.73	0.13	0.08	0.21	0.80	0.08	0.89
2004	1.70	0.19	1.88	0.84	0.07	0.90	0.11	0.08	0.19	0.75	0.04	0.79
2005	1.54	0.16	1.69	0.85	0.06	0.91	0.15	0.07	0.22	0.54	0.03	0.57
2006	1.63	0.19	1.82	0.89	0.06	0.96	0.13	0.08	0.21	0.61	0.05	0.66
2007	1.61	0.19	1.80	0.91	0.07	0.98	0.14	0.08	0.22	0.56	0.04	0.61
2008	1.42	0.17	1.58	0.85	0.09	0.94	0.14	0.07	0.21	0.42	0.00	0.42
2009	1.50	0.18	1.68	0.82	0.07	0.89	0.14	0.08	0.22	0.54	0.03	0.57
2010	1.42	0.18	1.60	0.78	0.06	0.84	0.16	0.08	0.24	0.48	0.04	0.53
2011	1.55	0.28	1.83	0.95	0.13	1.07	0.11	0.11	0.22	0.49	0.05	0.54
2012	1.50	0.29	1.79	0.89	0.14	1.02	0.11	0.11	0.22	0.50	0.05	0.55
2013	1.42	0.23	1.66	0.79	0.10	0.89	0.17	0.10	0.27	0.46	0.04	0.50
2014	1.42	0.25	1.67	0.85	0.15	1.00	0.16	0.10	0.26	0.41	0.01	0.42
2015	1.47	0.28	1.75	0.78	0.12	0.90	0.16	0.11	0.27	0.53	0.06	0.59
2016	1.46	0.27	1.73	0.77	0.12	0.88	0.15	0.11	0.26	0.54	0.05	0.59
2017	1.38	0.26	1.64	0.73	0.10	0.82	0.15	0.10	0.25	0.50	0.06	0.57
2018	1.38	0.25	1.64	0.73	0.09	0.82	0.16	0.10	0.26	0.49	0.06	0.55
2019	1.41	0.25	1.66	0.77	0.11	0.88	0.17	0.10	0.27	0.47	0.04	0.51

between groups rose in wave mode, and differences in a group declined in wave mode. As total differences in regions, from 2003 to 2019, the total differences of western China reduced, however, the total differences of inner China and eastern China rose in wave mode. Comparatively speaking, the total differences of preschool education resources allocation in eastern China was the most significant, followed by western China, and the differences of preschool education resource allocation in inner China was the least significant. In aspect of differences between groups, from 2003 to 2019, the differences in a group in the western China declined in wave mode, and the minimum value of the differences appeared in 2008 and 2014. Differences rose in wave mode between groups in inner China and eastern China. And the increasing rang of inner China was the smallest, increased from 0.080 to 0.099. However, the increasing rang of eastern China was comparatively larger, increased from 0.030 to 0.108. As the differences in a group, as it was shown in Table 7, from 2003 to 2019, differences in a group of western China reduced, and the difference value reached the minimum value in 2008 and 2014. Differences rose in wave mode in a group of eastern China and inner China. Comparatively speaking, differences in a group of preschool education resources allocation was the most significant in eastern China, followed by western China, then the least significant in inner China.

5.2.2. Regional difference contribution rates and its evolution tendency

In order to put one step forward to analyze the difference contribution rates in preschool education resource allocation in different regions, this research used Theil Index Difference Decomposition to calculate the Theil contribution rates of differences between groups (Db) and Theil contribution rates of differences in a group (Dw) in regional differences of preschool education resources allocation from 2003 to 2019 (Shown in Table 8). In aspect of China, as shown in Table 8, from 2003 to 2019, the main reason of differences that revealed in China was the differences of preschool education resources allocation between eastern China and western China. Besides, as shown in sequential variation, Theil contribution rates were in increasing tendency in eastern China, and in decreasing tendency in western China.

In aspect of regions, Theil contribution rates of differences between groups of preschool education resources allocation in eastern China and western China were both between 5% and 15%. Theil contribution rates of differences between groups of preschool education resources allocation in inner China were between 30% and 50%. At the same time, Theil contribution rates of differences in a group of preschool education resources allocation in eastern China and western China were both above 85%, and Theil contribution rates were between 50% and 70% in inner China. This indicated that the total regional differences of preschool education resources allocation in eastern China, western China, and inner China were caused by the inter-provincial differences in eastern China, western China, and inner China separately, and especially in eastern China and western China.

5.2.3. The difference contribution rates of material resources, financial resources, and human resources in regions

According to the analysis above, the main reason why there were regional differences in preschool education resources allocation in China was the differences within regions. Thus, this research used Theil Index Decomposition Contribution Rate to measure the difference contribution rates of material resources, financial resources, and human resources in every region (See Table 9). As shown in Table 9, the characteristics of material resources, financial resources, and human resources in regions in China were that, (1) the material resources contribution rates of preschool education were on reducing tendency, but the financial resources and human resources difference contribution rates were on rising tendency. Comparatively speaking, except for 2003, the difference contribution rates of financial resources in eastern China were all higher than the contribution rates of material resources and human resources. It indicated that the main reason led to the differences of preschool education resources allocation in eastern China was the differences of financial resources of preschool education resources allocation in eastern China. (2) The contribution rates of preschool education material resources and financial resources were both on increasing tendency, but the differences of human resource

Table 8
Theil decomposition contribution rates unit: %.

Year	China			Eastern China		Central China		Western China	
	Eastern China	Inner China	Western China	Db	Dw	Db	Dw	Db	Dw
2003	39.82	11.71	48.47	4.09	95.91	37.17	62.83	9.24	90.76
2004	47.87	10.11	42.02	7.22	92.78	41.11	58.89	5.29	94.71
2005	53.78	12.69	33.53	6.26	93.74	31.95	68.05	5.56	94.44
2006	52.44	11.53	36.02	6.40	93.60	37.85	62.15	7.38	92.62
2007	54.38	11.93	33.68	6.86	93.14	37.18	62.82	7.14	92.86
2008	59.75	13.54	26.71	9.96	90.04	32.95	67.05	0.02	99.98
2009	53.07	12.96	33.97	7.66	92.34	35.18	64.82	5.94	94.06
2010	52.28	14.80	32.92	6.90	93.10	32.17	67.83	8.09	91.91
2011	58.52	11.75	29.73	11.65	88.35	49.41	50.59	9.58	90.42
2012	57.09	12.5	30.41	13.21	86.79	48.95	51.05	8.96	91.04
2013	53.44	16.18	30.37	10.77	89.23	35.69	64.31	8.20	91.80
2014	59.71	15.29	25.00	14.75	85.25	39.06	60.94	1.32	98.68
2015	51.08	15.22	33.69	12.90	87.10	40.33	59.67	9.65	90.35
2016	51.04	14.91	34.05	13.00	87.00	40.85	59.15	8.65	91.35
2017	50.15	15.42	34.43	11.62	88.38	40.58	59.42	10.97	89.03
2018	50.12	16.08	33.80	11.16	88.84	38.35	61.65	11.22	88.78
2019	53.01	16.39	30.60	12.26	87.74	36.21	63.79	8.02	91.98

Table 9
Theil index difference contribution rates of difference unit: %.

Year	Eastern China			Central China			Western China		
	MR	FR	HR	MR	FR	HR	MR	FR	HR
2003	66.30	1.94	31.77	29.19	8.27	62.54	22.95	65.57	11.48
2004	38.79	44.06	17.15	41.07	5.67	53.26	30.67	58.70	10.64
2005	26.83	61.50	11.66	42.68	7.59	49.73	46.61	8.76	44.63
2006	26.81	59.02	14.17	27.82	12.23	59.96	47.34	26.19	26.46
2007	24.47	61.09	14.44	28.88	12.18	58.94	53.82	15.89	30.29
2008	35.53	43.04	21.44	27.28	30.74	41.98	50.77	16.47	32.75
2009	35.46	41.21	23.33	25.81	31.08	43.12	41.27	30.57	28.16
2010	36.57	40.03	23.39	18.14	42.83	39.03	34.40	35.25	30.35
2011	29.10	45.31	25.59	33.53	13.85	52.62	30.07	45.05	24.87
2012	25.62	46.34	28.04	32.57	16.52	50.90	25.46	51.61	22.93
2013	25.21	41.99	32.80	29.00	34.72	36.28	31.48	44.12	24.40
2014	21.18	52.01	26.81	35.02	23.31	41.67	35.17	36.31	28.53
2015	20.27	47.47	32.26	37.09	20.25	42.66	29.30	52.39	18.30
2016	17.74	52.47	29.79	39.75	17.65	42.60	34.76	42.99	22.24
2017	16.25	50.65	33.10	38.42	19.53	42.05	39.15	34.39	26.46
2018	18.29	48.64	33.07	39.95	19.33	40.72	32.89	42.38	24.73
2019	16.92	48.84	34.24	38.16	21.44	40.40	36.29	41.49	22.22

contribution rates were on decreasing tendency in inner China. It indicated that the differences of human resources in the provinces in inner China reduced, but the differences of material resources and human resources expended tendency. Comparatively speaking, except for 2010, the difference contribution rates of preschool human resources were higher than the difference contribution rates of material resources and financial resources. It indicated that the main reason led to the differences of preschool education resources allocation in inner China was the differences of human resources of preschool education resources allocation in eastern China. (3) The difference contribution rates of preschool material resources and human resources were on increasing tendency in wave mode in western China, and the difference contribution rates of financial resources were on decreasing tendency in wave mode. It indicated that the differences of financial resources in the provinces in western China were reducing, but as for human resources and material resources were rising. Comparatively speaking, the difference contribution rates of preschool financial resources were higher than the difference contribution rates of material resources and human resources. It indicated that the main reason led to the differences of preschool education resources allocation in western China was the differences of financial resources of preschool education resources allocation in western China.

6. Research conclusion and prospects

6.1. Research conclusion and discussion

Firstly, the results of entropy method and clustering analysis showed that, on one hand, from 2013 to 2019, Chinese preschool education resources allocation was on raising tendency in general. Especially from the third “*Three-year Action Plan for Preschool Education*” put into effect, the development of preschool education accelerated in most provinces. It made the condition of preschool education resources allocation improve. However, on the other hand, preschool education resources allocation was still on low-level and imbalanced developing tendency. “Preschool education advantage area” was formed in Beijing, Tianjin and Yangtze River Delta region. The same research results were shown in the researches of Jiang et al. [19], Li et al. [33], Zheng et al. [24], Huo et al. [37]. The main reason of this problem is that preschool education is not compulsory education [38]. The aiming at development of preschool education is only limited to relevant policies, and legal restraint is lack [39]. At the same time, the development of preschool education is not taken into consideration of evaluation of local governments’ performance. Local government does not need to face the rigid evaluation of the “three increasing” [22,40]. Because of this, government financial capacity and the will of financial investment become the main factors which influence Chinese preschool education resources allocation [39]. But, the policy planning of “Overall planning, taking county-level government as main body” makes the county-level government be the main body of the development of preschool education. And the financial capacity and will of financial investment are very uneven in each county-level government [41]. In Beijing, Tianjin and Yangtze River Delta region, the economy is better. With stronger government financial capacity, the government has the ability and will to develop preschool education [40]. Therefore the preschool education resources allocation is relatively high. In the areas with relatively slow-developed economy, such as inner China, western China, and some provinces (cities) in eastern China, the government has weaker financial capacity, and limited ability of developing preschool education [42]. Therefore, the preschool education resources allocation is relatively low.

Secondly, as shown in the result of Theil Index Decomposition and its rate of contribution, the total differences of preschool education resources allocation in China have reduced. In term of each area, the differences in eastern China is the biggest, followed by western China, and the smallest in inner China. Among these areas, the total differences of preschool education resources allocation differences in eastern China and inner China maintain shows an expending situation in wave mode, and reducing situation in wave mode in western China. The main reason of affecting preschool education resources allocation in different areas is the inter-provincial

differences in eastern China, inner China and western China. This research result shows the same as the research result of Tu et al. [43], Zhuang et al. [18]. It is the financial resources, human resources and financial resources, which could be considered as the main reasons of affecting preschool education resources allocation separately in eastern China, inner China and western China. At the same time, financial resources in eastern China and human resources in inner China present expending trend. The reason of this problem occurring is that eastern China includes not only economy developed provinces such as Beijing, Tianjin and Yangtze River Delta region, but also includes economy undeveloped provinces such as Hainan, Hebei and so on [44]. And the economy development of western China is slow, but there are more provinces, in western China, such as Tibet, Inner Mongolia, Xinjiang which have relatively small amount of population, get more financial support by the central government, have minorities living in a compact community [44]. Therefore, the differences of financial resources become the main differences of affecting preschool education resources between eastern China and western China. Most of the provinces in inner China have big amount of population, and the economy of these provinces are generally undeveloped. Therefore, financial resources in these provinces state at low-status and balanced situation. The differences of preschool education resources are affected by human resources more.

Thirdly, path coefficient estimation of RIM test showed the result that comparing with material resources, human resources of preschool education has lagged behind, which showed the same research result of Jiang & Lan [19], Chen & Fan [45]. The reason of this problem is that from 2001 until now, preschool education is continuously developing because of the effect of all aspects of policy [46]. Especially, in 2010, China published “*Outline of the National Medium and Long-term Plan for Educational Reform and Development (2010–2020)*” and “*Three-year Action Plan for Preschool Education*”. This made the government at all levels enlarge the investment of preschool education, so the financial resources of preschool education got improved. According to relative research, “it was about 3.9 times more in 2016 than in 2010 that, in the whole financial budget of China, the kindergarten educational appropriation expenditure occupied in each level and each kind of educational institutions’ total appropriation expenditure, and the quantity of occupation was 7.44%” [47]. Although the increasing range of preschool educational investment was obvious, problems of uneven preschool educational investment still existed. According to the relative research, “it is relatively reasonable if the salary of teachers occupies 65%–70% in the total educational expenditure. But, in 2018, the salary of teachers in preschool education occupied only about 58% in the total preschool educational expenditure” [48] Thus it can be seen that preschool educational investment is partial to material resources investment, and lack of human resources investment. This made the human resources of preschool education lag behind.

6.2. Expectation

Aiming at the imbalance developing situation of preschool education resources allocation at present, Chinese government should set about legislating to guarantee rational allocation of preschool education resources, improving the mechanism of preschool education resources allocation and the system of management, paying attention to preschool education human resources development.

6.2.1. Legislating to guarantee rational allocation of preschool education resources

“Laws play a role in adjusting, coordinating, restricting, and standardizing in accomplishing fair and good quantity of preschool education process” [49]. In terms of the perspective of principal-agent, on account of that preschool education in China is managed by multiple levels of government, the relationship of each level of government is actually the relationship of principle-agent. And on account of the asymmetric information, agents would sometimes do the actions to harm the benefit of principals. In this situation, relevant laws and regulations are needed to supervise and restrict these actions. However, up until now, the section of preschool education is still the only section without legislating in the whole education system. Although, Ministry of Education has published “*Draft Law of the People’s Republic of China on Preschool Education (Draft for Public Comments)*”, “*Preschool Education Law*” which is complete, standard, promoted, implemented, is still not enacted. For this purpose, the suggestion is that the government should speed up the progress of “*Preschool Education Law*”, legislate to clarify the property and status of preschool education, clarify the obligation of each level of government in preschool education resources allocation, clarify the educational and public welfare nature of preschool education, improve the management system and investment system etc ... of preschool education to promote rational allocation of preschool education, provide strong legal protection to reach “fair, good quality, balanced, and wide-covered” preschool education resources allocation.

6.2.2. Improving the mechanism of preschool education resources allocation and the system of management, rationally allocating the obligation of each level of government

Government is the main body of preschool education resources allocation, constructing balance preschool education resources allocation clarifies the right and obligation of each level of the government [50]. However, at present, scientific and rational preschool education resources allocation mechanism and management system are not enacted to clarify the rights and liabilities of each level of government [51]. Thus, the suggestion is that speeding up constructing scientific and rational preschool education resources allocation mechanism and management system, and rationally allocating the rights and liabilities of each level of government. Detailed suggestions: (1) central government is responsible for financial transfer to pay the provinces and cities with weak economic strength. Not only inner China and western China should be focused, but also some provinces and cities in eastern China need to be focused, such as Hebei Province, Hainan Province and so on. Besides, central government needs to fulfill the responsibility for supervising the development of preschool education. (2) Provincial governments are responsible for overall planning, ensuring the investment of preschool education funds, and fulfilling the responsibility of supervising the development of preschool education in municipal (county) level of government. (3) The municipal-level (county-level) government should be responsible for the specific management, and should measure the requirements for kindergarten admission, teachers’ conditions, supporting facilities and capital

budget year by year, and report them to the provincial government on time. Besides, in terms of the perspective of mechanism design theory, “If the formulated mechanism could satisfy the participation constraint, then this mechanism is feasible; if the formulated mechanism could satisfy the incentive compatibility constraint, then this mechanism is implementable; if both are satisfied, then it is feasible and implementable” [52]. In this regard, it is suggested that the rights and obligations of government of each level involved in the development of preschool education should be included in the government performance assessment, so as to encourage government of each level to rationally allocate preschool education resources.

6.2.3. Paying attention to preschool education human resources development

Preschool education human resources development is the core of preschool education resources allocation [53]. In view of the current preschool education human resources development lag, there are some suggestions that, firstly, the government should manage and protect the construction of teacher team in accordance with the law. The key point of preschool education human resources development lag is lack of protecting from the law [39]. In this regard, the suggestion is speeding up the progress of legislating “*Preschool Education Law*” to maintain preschool teachers’ reasonable and legitimate rights, and to protect the construction of teacher team; Secondly, the government should improve preschool teachers’ salary. Teachers’ salary is an important factor affecting the allocation of human resources [54]. In this regard, on the one hand, it is suggested to formulate a scientific and feasible management for preschool teachers’ authorized system. Preschool teachers’ authorized management system plays an important role in ensuring preschool teachers’ salary [55]. But, at present, China has not yet formulated specifically authorized management system for preschool teachers [46]. Management of preschool teachers’ authorized system has been mixed with primary school teachers’ authorized system. It is causing the preschool teachers’ authorized system to be chaos, and the problem of a serious shortage of preschool teachers has shown up [40]. These problems seriously restrict the allocation of human resources in preschool education. So, It is suggested that the establishment and management system of preschool teachers should be accelerated to guarantee their salary. On the other hand, it is suggested to set up a special subsidy policy for preschool teachers in private kindergartens and kindergarten teachers in rural remote areas, so as to attract more professional and high-quality preschool teachers to take root in private kindergartens and rural remote areas, and improve the quality of preschool teachers in private kindergartens and rural remote areas. Thirdly, all sectors of society should improve the professional status and social prestige of preschool teachers. For a long time, the professional status of preschool teachers in China is not high enough [56]. The professional status of preschool teachers is not recognized and often regarded as a work of “taking care of children” [48]. In this regard, it is suggested to publicize the professional image of preschool teachers through TV, media, radio and other ways, and emphasize the professionalism, specialism and importance of preschool teachers. As for the representative and typical preschool teachers, they should be praised through network media and other forms, so as to improve the professional status and social prestige of preschool teachers. This will attract more high-quality, high-level crew to engage in preschool teacher profession.

7. Limitations

There are some limitations in this research. On one hand, the data used in this research is from the official website of *National Data Bureau of Statistics of China*. At present, the relevant data in *National Data Bureau of Statistics of China* is only updated to 2019, so the data analysis in this study is only up to 2019. On the other hand, the analysis of the reasons for the imbalance in the preschool education resources allocation in China is limited by length of the paper. It is only theoretically analyzed, and lacking the evidence of relevant statistical data. Therefore, in future research, the empirical analysis of the reasons affecting the imbalance in the preschool education resources allocation in China will be continued.

Author contributions

J.H.S. drafted paper, H.C.W. proofread paper, S.S. collected data and proofread paper.

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Author contribution statement

Jiahui Sun: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Hechun Wu: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Song Shi: Performed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Data availability statement

Data will be made available on request.

Additional information

No additional information is available for this paper.

Declaration of competing interest

All authors disclosed no relevant relationships.

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