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Article

Biophysical and mechanistic insights of declining birth rates on preschool education resource allocation in China: A data-driven perspective

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Abstract: The continuous decline in China's birth rate has profound implications that intersect with biophysical and mechanistic aspects relevant to biomechanics. This article commences by scrutinizing the alterations in China's birth rate over the past decade. The diminishing birth rate, underpinned by biological factors, has a direct bearing on the quantity of children enrolling in kindergartens. This, in turn, instigates modifications in the requisition for preschool education institutions and educators. From a biomechanical vantage point, the reduction in the number of children alters the physical and mechanical environment within preschool settings. For instance, the collective body mass and force distributions during play and physical activities change. With fewer children, the forces exerted on play equipment and the floor surfaces vary, potentially affecting the wear and tear patterns and the biomechanical feedback that the environment provides to the children. The diversity in body sizes and physical capabilities among a smaller cohort of children also demands a reconsideration of the biomechanical suitability of furniture and teaching aids. Based on the biological metamorphoses in the birth population, data analysis prognoses an impending oversupply of preschool education resources in China in the forthcoming years, especially in the eastern region. Conversely, the central and western regions, along with the urban-rural divide, are anticipated to face a dearth of resources. These disparities not only pertain to the quantity but also to the biomechanical adequacy of the resources. Different regions may have children with varying genetic predispositions and environmental exposures that influence their biomechanical development, thereby necessitating region-specific resource optimization. The biological shifts in birth rates thus levy more exacting requisites on education policies, resource optimization, and the equilibration of regional education. To surmount this obstacle, this article proffers bespoke policy recommendations factoring in biophysical and biomechanical considerations. This includes calibrating resource allocation to harmonize with the biomechanical idiosyncrasies of children in diverse regions, augmenting the biomechanical relevance and quality of education in rural areas, and fortifying policy guidance to actualize the judicious utilization and sustainable progression of education resources that are conducive to the healthy biomechanical development of children.

Keywords: change of birth population; preschool education supply; kindergarten teacher; kindergarten enrollment, biomechanics

1. Introduction

In the past few decades, China has faced a continuous decline in birth rates, and the biological background of this trend has had a profound impact on various levels of society. Biological factors, especially changes in the number of births, directly affect the allocation of various resources in human society, especially in the field of education. The decrease in the birth rate not only means a reduction in the future labor

force, but also challenges the redistribution and optimization of resources in areas such as preschool education and basic education. In recent years, with a series of adjustments to the national fertility policy and a decline in fertility willingness, the birth rate in China has been decreasing year by year. This change has prompted education scholars and policy makers to re-examine the supply and demand of preschool education resources [1,2].

The birth rate is determined by a series of biological, sociological, and economic factors. Biological factors mainly include reproductive age, gender ratio, gestational age, etc. In addition, with the development of social economy and changes in people's lifestyles, reproductive decisions are also influenced by many social factors. However, biological changes in birth rates have a direct impact on the supply of preschool education resources. The decline in the total population, especially the decrease in the number of infants and young children born, directly determines the number of students enrolled in preschool education. If the number of births continues to decrease, preschool education resources will face a contradiction between surplus and insufficient demand, especially in areas with uneven allocation of educational resources. Improper allocation of resources may further exacerbate the urban-rural gap and the uneven development of regional education [3–5].

According to the statistical principles of biology, fluctuations in the number of births in different regions and time periods often exhibit significant periodicity and regularity. Taking China as an example, although the birth rate has rebounded in recent years, the overall trend of declining birth rates is still continuing. This trend not only directly affects the enrollment and enrollment of preschool education, but also has a profound impact on educational facilities, teacher demand, and the formulation of educational policies. The changes in biology and demographics force governments and society to face issues such as how to optimize educational resources, how to adapt to changes in population structure, and how to achieve educational equity and rational resource allocation under the influence of biological factors [6,7].

Preschool education is an important component of a country's education system and plays a crucial role in children's cognition, social behavior, and other aspects. The decrease in the birth rate has brought about a need for adjustment in the allocation of preschool education resources. How to scientifically and reasonably plan preschool education resources in the context of biological changes is a key issue that urgently needs to be addressed. The rational allocation of preschool education resources is not only related to the quality of education, but also closely related to social equity and economic development. How to cope with the challenges brought by population decline and how to ensure the sustainable development of preschool education through policy adjustments and resource optimization is a major issue facing the education sector in China [8].

The biological changes in the birth population are not only related to the supply and demand of preschool education resources, but also closely related to the country's economic development, structural changes in the labor market, and other factors. The decline in birth rate means a gradual contraction of labor supply, which may lead to a shortage of talent in the labor market, thereby affecting the productivity and innovation capabilities of various industries. In this context, the quality and resource allocation of preschool education also need to be considered from a broader perspective. Through

the interdisciplinary research of biology, sociology, and economics, more scientific and reasonable basis can be provided for the planning and policy adjustment of preschool education.

Therefore, this article will explore the profound impact of changes in birth rates on the supply of preschool education resources in China from a biological perspective, analyze the supply-demand relationship of preschool education resources under the background of population changes, and propose corresponding policy recommendations. The perspective of biology provides important theoretical support for us to understand the changes in the field of education, and also provides necessary scientific basis for the formulation and implementation of educational policies.

2. The research methods

This paper adopts literature research method, policy analysis method, and carries on the statistics and analysis to the relevant data. Based on China's population data and forecast data, combined with the supply of China's preschool education resources, including the number of preschool education institutions, the number of kindergarten enrollment, the number of kindergarten students, the number of kindergarten teachers, college enrollment data and so on, a comprehensive analysis is conducted. Through the existing data of preschool education resources, the trend of the data is analyzed. Combined with the number of newborns in China, this paper analyzes the demand for preschool education resources in the future, and speculates the reasonable positioning of preschool education resources supply. The data came from population data released by the National Bureau of Statistics and the number of preschool education institutions, teachers and students in kindergartens published by China Education Statistics Yearbook. For the data not explicitly given in the above data, the method of calculation based on the original data is obtained by combining the academic research results [5,6].

This article first introduces the background of the writing, namely, the change of China's birth population and the status quo of preschool education resources. Then it introduces the research methods used in writing this paper. The third part uses the listed research methods to sort out and analyze the data collected during the writing process. The fourth part is based on the data analysis, put forward the research conclusions of this paper, and pointed out the direction of further research. The fifth part shows the relevant table data. Finally, the references of this paper are listed.

3. Result analysis

3.1. Independent analysis of each data

In this part, a line chart is made for the birth population data, the number of children in kindergartens, the number of kindergartens and the number of teachers in kindergartens in China from 2011 to 2020. After the comparison of R^2, the program with the best fitting effect is selected to predict the data in 2021 and 2022 [7,8].

The first is birth data. In **Table 1**, China's historical population data are converted according to the natural population growth rate and birth rate released by the National Bureau of Statistics. As can be seen from the data in **Table 1**, China's population growth rate and birth rate have been declining year by year. As can be seen from this,

the number of births in China has decreased year by year from 16.04 million in 2011 to 12 million in 2020. The line chart (**Figure 1**) based on the birth population data in past years shows that the polynomial fitting effect is the best after comparison of R^2, $R^2 = 0.8543$. The formula $y = -15.663x^2 + 140.99x + 1419.4$ is obtained, which predicts that the number of births in 2021 and 2022 is about 10.75 million and 8.55 million. Among them, the birth data of 2021 is basically consistent with the data published by various media at present.

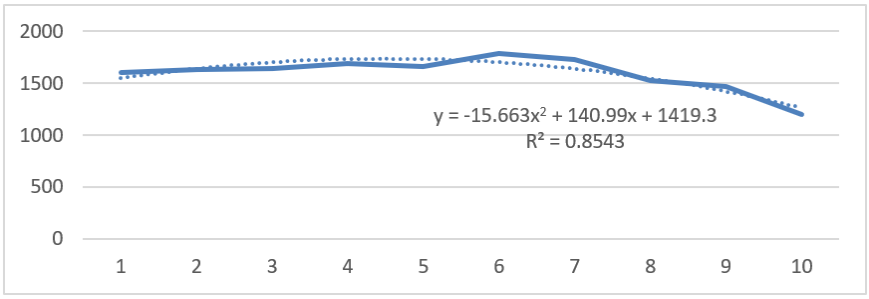

Figure 1. A line chart based on the data of births between 2011 and 2020.

The second is the number of children in kindergartens. According to the line chart (**Figure 2**) made by the number of children in kindergartens over the years, the polynomial fitting effect was found to be the best after comparison of R^2, $R^2 = 0.9973$, and the formula $Y = -11.223x^2 + 277.07x + 3160.5$ was obtained. The number of births in 2021 and 2022 is estimated at 48.5 million and 48.69 million respectively [9,10].

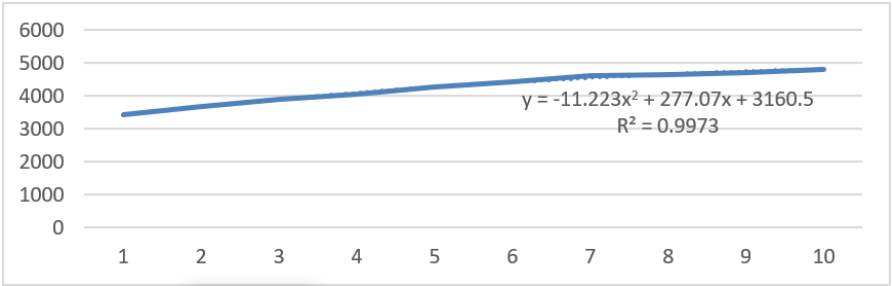

Figure 2. Line chart based on the number of kindergarteners from 2011 to 2020.

The third is the number of kindergartens in China. According to the same method mentioned above, as shown in **Figure 3**, the formula is obtained: $Y = -144.18x^2 + 15{,}623x + 151{,}069$, where $R^2 = 0.9991$. The fitting effect is very good. According to this, the data of Kindergartens in China in 2021 and 2022 are 305,476 and 317,783 respectively.

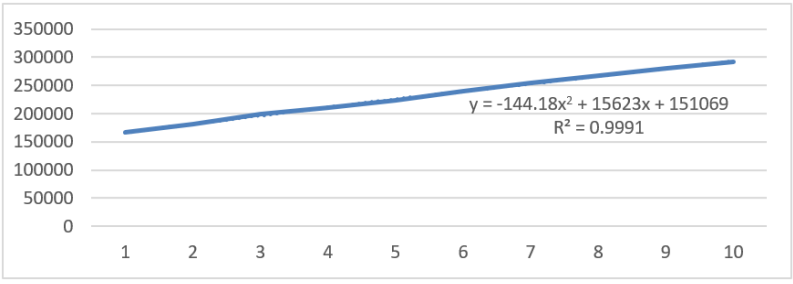

Figure 3. A line chart based on the number of kindergartens from 2011 to 2020.

Finally, the number of kindergarten teachers in China. According to the above method, as shown in **Figure 4**, the formula $Y = -0.1363x^2 + 19.649x + 109.87$, $R^2 = 0.9993$ was obtained. It is estimated that the number of teachers in kindergartens in 2021 and 2022 will be 3.09 million and 3.26 million respectively.

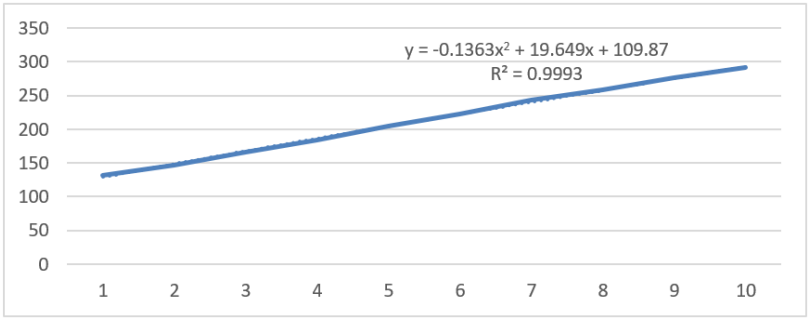

Figure 4. A line chart based on the number of kindergartens from 2011 to 2020.

3.2. Correlation analysis between groups of data and birth population

Changes in birth population data will directly affect the number of children in kindergartens. According to the age standard of entering kindergarten at 3 years old, this effect has a certain lag. By cyclizing the data, regression was made with "birth population in past years as independent variable" and "number of kindergartens in past years as dependent variable", as shown in **Figure 5**. Appropriate regression function was selected through fitting degree, $R^2 = 0.6501$. Then calculate the numbers for 2021 and 2022. The regression equation is $Y = 3.5572x - 1457.8$, and it can be concluded that the number of children in kindergartens in 2021 and 2022 is 39.63 million and 37.53 million respectively.

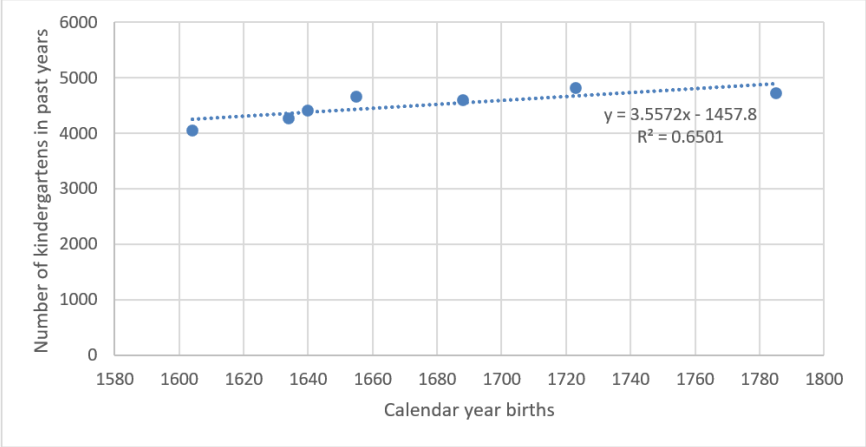

Figure 5. Correlation between the number of births and the number of kindergarteners from 2011 to 2020.

According to the same method above, the correlation between the number of kindergartens, the number of kindergarten teachers and the children in kindergartens in past years was calculated respectively, and the following two groups of data were obtained:

The correlation between the number of kindergartens over the years and children in kindergartens is made by taking "the number of kindergartens over the years" as the

independent variable and "the number of kindergartens over the years" as the dependent variable. The appropriate regression function is selected through fitting degree, and the formula $Y = 72.073X - 3917$ is obtained. The number of kindergartens is expected to be 296,423 in 2021 and 300,564 in 2022. Where $R^2 = 0.9947$.

As for the correlation between the number of kindergarten teachers and children in kindergartens over the years, "the number of kindergarten teachers in kindergartens over the years" is the independent variable, and "the number of kindergarten teachers over the years" is the dependent variable, and the appropriate regression function is selected through fitting degree, and the formula $Y = 0.0927X - 135.14$ is obtained. The number of kindergarten teachers is expected to reach 2.96 million in 2021 and 3.01 million in 2022. Where $R^2 = 0.9965$.

3.3. The correlation between the number of kindergarten teachers and the number of school enrollment

The number of students enrolled in Chinese universities has increased recently, reaching over 9 million in 2019 at a growth rate of 15.7%. The number of kindergarten teachers and the number of college students are correlated, according to data association analysis. The three-year cycle is chosen in accordance with the three- to four-year academic system of colleges and universities by using "the number of kindergarten teachers over the years" as the dependent variable and "the number of college enrollment over the years" as the independent variable to do regression [11,12,13]. As shown in **Figure 6**, through the fitting degree, an appropriate regression function is selected and the formula $Y = 1.2347X - 648.67$ is obtained. The number of "kindergarten teachers in past years" is predicted to be 3.27 million and 4.8 million in 2021 and 2022. Where $R^2 = 0.9819$.

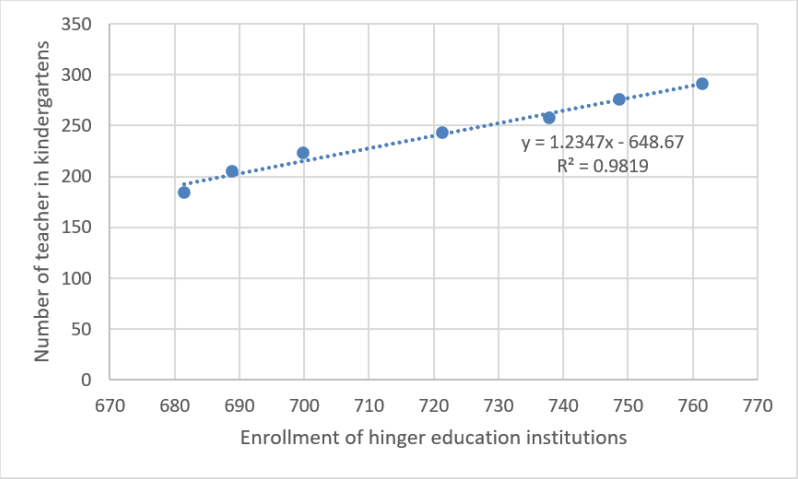

Figure 6. Correlation between the number of kindergarten teachers and the enrollment of higher education institutions from 2011 to 2020.

3.4. Comparative analysis of the above groups of data

Comparative analysis of the above data. Through the analysis of the above data, it is found that the number of children in kindergartens, the number of kindergartens and the number of kindergarten teachers are different from the predicted values after

adding correlation factors according to the trend of the discount chart [14,15]. The specific comparison is as follows:

As shown in **Table 1**, the number of kindergartens in 2021 and 2022 will be 48.5 million and 48.69 million, respectively. According to the birth population data, the number of kindergartens in 2021 and 2022 will be 39.63 million and 37.53 million, respectively. In other words, a decrease in the number of births will result in a shortfall of about 10 million children in kindergartens. In scenario 1, China's population will peak at 1.416 billion in 2026, In scenario 3, during the 13th Five-Year Plan period, the population will increase by 12.71 million more than that in Scenario 1, and the peak population will be delayed to 2028 [1].

Table 1. Projected data of births, growth rate, and birth rate from November to 2020.

	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Birth Population (ten thousand)	1604	1634	1640	1688	1655	1785	1723	1524	1465	1200
Natural population growth rate (‰)	6.13	7.43	5.90	6.71	4.93	6.53	5.58	3.78	3.32	1.45
Birth rate (‰)	13.27	14.57	13.03	13.83	11.99	13.57	12.64	10.86	10.41	8.52

As shown in **Table 2**, in 2021 and 2022, there will be 305,476 and 317,783 kindergartens, respectively, according to the line chart of its own data trends. In 2021 and 2022, there will be 296,423 and 300,564 kindergartens, respectively, based on the population of kindergartens in 2021 and 2022, specifically the number of kindergartens in demand, which is approximately 100 million, will decline if fewer children are enrolled in kindergartens. The demand for kindergartens will be further decreased by fewer kindergartens, which is influenced by the number of births.

Table 2. Data of kindergartens, full-time kindergarten teachers and children in kindergartens from 2011 to 2020.

	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Kindergarten (institute)	166,750	181,251	198,553	209,881	223,683	239,812	254,950	266,677	281,174	291,715
Children in kindergartens (ten thousand)	3424.45	3685.76	3894.69	4050.71	4264.83	4413.86	4600.14	4656.42	4713.88	4818.26
Full-time teachers (ten thousand)	131.56	147.29	166.35	184.41	205.1	223.21	243.21	258.14	276.31	291.34
Enrollment of Kindergartens over the years (ten thousand)	1872.31	1911.92	1970.03	1987.78	2008.85	1922.09	1937.95	1863.91	1688.23	1791.4

As shown in **Table 3** that the number of kindergarten teachers in 2021 and 2022 will be 3.09 million and 3.26 million, respectively, whereas the number of kindergarten teachers in 2021 and 2022 will be 2.96 million and 3.01 million, respectively, based on the kindergarten population forecast; in other words, as the number of kindergarten students declines, the number of kindergarten teachers will also decline, by 130,000 and 250,000, respectively. Affected by the number of births, the reduction in the number of kindergartens will further reduce the demand for kindergarten teachers. Meanwhile, according to the expansion of college enrollment, the number of kindergarten teachers will be 3.27 million in 2021 and 4.8 million in 2022, as shown in **Table 4**. That is, the continuous increase in college enrollment will result in more graduates flooding into preschool education institutions than the actual demand for kindergartens.

Table 3. The growth rate of kindergartens, teachers and children in kindergartens and the ratio of students to teachers in China.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Growth rate of kindergartens (%)	-	8.7%	9.5%	5.7%	6.6%	7.2%	6.3%	4.6%	5.4%	3.7%
Growth rate of children in kindergartens (%)	-	7.6%	5.7%	4.0%	5.3%	3.5%	4.2%	1.2%	1.2%	2.2%
Growth rate of faculty (%)	-	12.0%	12.9%	10.9%	11.2%	8.8%	9.0%	6.1%	7.0%	5.4%
Average number of children (persons)	205	203	196	193	191	184	180	175	168	165
Number of Teachers (per capita)	7.9	8.1	8.4	8.8	9.2	9.3	9.5	9.7	9.8	10.0
Student to teacher ratio	26.0	25.0	23.4	22.0	20.8	19.8	18.9	18.0	17.1	16.5

Table 4. Enrollment and growth rate of colleges and universities nationwide.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
General undergraduate and junior College Enrollment (ten thousand)	681.50	688.83	699.83	721.40	737.85	748.61	761.49	790.99	914.9	967.45
The growth rate of		1.1%	1.6%	3.1%	2.3%	1.5%	1.7%	3.9%	15.7%	5.7%

"According to the results of the current survey on fertility intention and fertility behavior, it is more likely that the progressive fertility level of the second child can be stabilized at around 50% or lower, and it is not likely to reach 60% or 80%." "The goal of stabilizing the total fertility rate at around 1.8 cannot be achieved by the current adjustment of fertility policy." "Reference [2]".

"The specialty rate of preschool education in China is as high as 93 percent," "reference [3]" "Nearly 50 percent of the students clearly said they would not work as kindergarten teachers after graduation, and the students' professional identity level is low." "Reference [4]" "89.3% of students would like to pursue their major; 80.89% choose public kindergartens", "Students and parents have high demand for job stability under the policy environment". "Reference [5]"

4. Conclusion

It is evident from the preceding data analysis that when the birth population declines, the number of kindergarten-aged children will also alter. Due to this shift, there will be less of a need for kindergartens and kindergarten teachers than there currently is. In the meantime, the situation will worsen due to the ongoing growth of higher education. "The specialty rate of preschool education in China is as high as 93 percent," according to employment figures from 2011, comes in second. In 2017, however, researchers discovered that "nearly 50% of them clearly stated that they would not work as kindergarten teachers after graduation, and their professional identity level was low" among college and university students majoring in preschool education. In July 2021, the Chinese government issued the Document "Opinions on Further Reducing the Homework Burden and Off-campus Training Burden of Students in compulsory Education", requiring that the heavy homework burden and off-campus training burden of students in compulsory education should be effectively reduced. Against this backdrop, the latest study shows that "89.3% of students are willing to pursue their major; 80.89% choose public kindergartens" "Students and parents have high demand for job stability under the policy environment". These

studies indicate that in the next few years, the supply of preschool education resources in China will exceed the demand.

Effective action must be taken quickly to stop the overabundance of preschool education resources from degrading. The first is to put in place efficient measures right now to boost fertility and stop the birth rate decrease. The second is to maximize the availability of resources for preschool education, from increasing quantity to improving quality. Low-quality kindergartens should be promptly integrated and optimized. Schools should quickly cut or eliminate their preschool education majors if they are of poor quality. Simultaneously, we will investigate ways to enhance preschool education quality and progressively advance junior college to undergraduate education. Finally, the enrollment scale of higher education should adapt to the number of population. Appropriately control the trend of college enrollment expansion. All specialties in institutions of higher learning should be optimized and integrated, and the number of students in each specialty should be adjusted to meet the needs of demographic changes and social and economic development.

The next stage of research:

The shifting demographics of Chinese-born people have a multifaceted effect on how resources are distributed within the current educational system. This paper's research focuses on how birth population shift affects preschool education. It also examines how this element will impact China's primary, secondary, and higher education resource supplies in the future. The impact of the above-mentioned birth population change on the availability of educational resources at other levels is the first issue that requires ongoing attention in the next stage of research. The second issue is the necessity to further concretize the macro analysis at the national level. With 1.4 billion people, China is a large nation. From a macro point of view, the decline of birth population will lead to the problem of oversupply of education resources. However, in different regions of the country, there are differences in the allocation of educational resources between the east and the west, between urban and rural areas, and between developed areas and less developed areas. Future research should not only continue to focus on the macro level, but also carefully analyze the relationship between population change and educational resource supply in different regions. According to the local conditions of education resources to make a reasonable analysis of the supply.

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