ORIGINAL ARTICLE

Development of educational attainment and gender equality in China: new evidence from the 7th National Census

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Abstract

This paper discusses the status and changes in educational attainment and gender inequality in education for the Chinese population based on the data from the 7th National Census of China and previous censuses since 1982. The results indicate that gender inequality in education has lessened while educational attainment has improved. However, it is necessary to continue to eradicate illiteracy in the West, further promote compulsory education rates, increase the advancement rate to high school, and reduce the urban–rural gap in education to further develop education. This paper indicates that the increased educational opportunities for women combined with their relatively superior academic abilities have resulted in a new reversed gender inequality in that males are at a disadvantage, especially in higher education. The fact that women have benefited more from the expansion of higher education than men have was an unintended consequence of China's one-child fertility policy since the family resources are less diluted by fewer children in a household and daughters are regarded as long-term family members. This paper further reveals that although women outperform men at every level of the educational system, they often voluntarily withdraw from pursuing doctoral degrees due to the increasing pressure as they age and age discrimination which drives them to enter marriage and the labor market earlier than men do.

Keywords Educational attainment · China · Educational structure · Gender inequality in education

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1 Introduction

Education is an important aspect of a country's socio-economic development, and gender equality in education is an important dimension of education development. However, improvements to education resulting from a country's socio-economic development do not lead directly to increased gender equality in education. Since the founding of the People's Republic of China, and especially since the beginning of the reform and opening-up in 1978, the development of education in China has achieved significant milestones. Against this backdrop, researches on the changes and developments in gender equality in Chinese education are worthwhile. As data from the 2020 (7th) National Census of China gradually becomes available, scholars are urged to take advantage of this new data to analyze the latest trends in educational attainment and gender equality in education.

1.1 Advantages of using census data to study educational issues

The analysis in this paper is based mainly on data from 2020 (7th) National Census of China and previous censuses since 1982 (the 3rd National Census).

Representation and measurement are the principal cornerstones of the quality of survey data. As for the census data, it covers the entire population of a country, which means that the representation of the data need not be considered or examined. Besides, the measurement of the highest educational experience is not sensitive or confidential commonly under Chinese cultural background, and the answers to census questions about education are highly reliable, which means census measurements of educational attainment are generally accurate. Furthermore, the census data could present information on demographic and geographic characteristics in a consistent, unified manner. In short, census data is the most reliable source of information for studies on education and educational attainment. The aggregated census data, rather than individual-level data, including on national-level and provincial-level, which are released by the Census Office and National Bureau of Statistics, are used in the analysis of this paper. The aggregated data refers to a defined cross-table of two or several variables based on the micro-level data. Despite that, this constrained information could meet the requirements of the analysis in this study.

1.2 Indicators specification[1]

Several educational indicators are employed in this paper to capture different aspects related to educational attainment. (1) The *Illiteracy Rate* is the proportion of the

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[1] In China, formal education qualifications can be categorized into six levels: primary school, middle school, high school, junior college (most are 3-years college, and some are 2-years; it refers to as "大学专科/大专" in Chinese), undergraduate (in generally 4-year, some special cases are 5-year, for bachelor's degree) and post-graduate (including master's and doctoral degrees). Among these, primary school and middle school constitute the compulsory education, while the last three stage regarded as higher education.

population aged 15 and above who are illiterate or barely literate, while those who did not attend formal schooling but learned to read through other means were not counted among them; it reflects the educational attainment conditions of the society's most disadvantaged groups. (2) The *Compulsory Education Rate* is the proportion of the population aged 6 years and above who have attended at least middle school (thru Grade 9); it reflects the penetration status of the basic education system. (3) The *Higher Education Rate* is the proportion of the population aged 6 years and above with higher education including junior college, undergraduate and postgraduate education; it captures the density of social elites in a given population. (4) *Average Years of Schooling* indicate the overall educational attainment of a certain population. It is calculated based on educational categories; i.e., 0 years for no school or pre-school, 6 years for primary school, 9 years for middle school, 12 years for high school, 15 years for junior college, 16 years for bachelor's degree, 19 years for master's degree, and 22 years for doctoral degree. In addition, the proportions of the population with a specific level of education, for example, the proportion with high schooling or master's degrees, are also used for analysis. It should be noted that the educational statistics presented in the census refer to an individual's academic qualifications, regardless of whether that individual is currently enrolled, has graduated, or has dropped out.

The ratio of females to males (F/M ratio) for a specific educational indicator is used to reflect the trend of gender equality. A ratio less than 1.00 means there are relatively fewer females than males for that educational indicator, while the opposite is true when the ratio is greater than 1.00. The F/M ratio is highly reliable because it is based on the aggregated census data for the entire population and does not require the use of statistical inference methods for sample survey data. This ratio is not intended to determine whether gender equality in educational attainment has been achieved or not, but rather to visually compare the relative numbers of males and females concerning educational attainment. And the widening or narrowing gap between males and females can be used to identify the trend of gender equality status.

1.3 Analysis strategy

The development trajectory of educational status and gender equality in educational attainment are described by changes in various educational indicators and the F/M ratio for these indicators over census years and between birth cohorts. Changes in indicators across census years represent overall trends, while changes in indicators between birth cohorts reflect the change over time without the influence of age structure, especially for birth cohorts that completed their schooling during the 20-years period previous to the census.

This paper would be organized as followed. The second part of the paper presents an overview of educational indicators for the entire population to show the general characteristics of the development of educational attainment in China. Next, changing trends of gender inequality in educational attainment in China are described in the third part, followed by the conclusion in the fourth part.

2 General characteristics of the development of educational attainment in China

2.1 Remarkable achievements in eliminating illiteracy

Since the beginning of the reforms and opening-up in 1978, China has made remarkable progress in increasing the literacy rate; the illiteracy rate has been reduced to a low level. As shown in Fig. 1, the illiteracy rate in China has dropped from 22.81% in 1982 to 2.67% in 2020. This astonishing rate of decline indicates that China's efforts to make compulsory education universal and eradicate illiteracy among young adults have achieved effective results.

During the past two decades, the illiteracy rate in China has continued to decline slowly. Historically, the illiteracy rate declined rapidly between 1982 and 2000, but its decline slowed significantly between 2000 and 2020. As the illiteracy rate has declined to a low level, it has become increasingly difficult to reduce it further. Although it's impossible to completely exterminate illiteracy, there is still room for improvement. Because the majority of the illiterate population now is middle-aged or elderly, the illiteracy rate in China will decline further as these people pass away naturally and as literacy initiatives continue in the western regions of the country.

There are regional differences in illiteracy rates, and western China has the most possibility for further declines. Table 1 indicates that most of the provinces in the eastern, northeastern, and central regions have illiteracy rates lower than the overall national level, but Shandong (3.26%), Hainan (3.25%), and Zhejiang (2.72%) in the East and Anhui (4.49%) in the Center are higher than the national level. In contrast, illiteracy rates in western provinces are generally higher than the national level, except for Chongqing and Guangxi (although there is no data available for Xinjiang and Tibet). The western provinces of Qinghai (7.94%), Gansu (6.72%), and Guizhou (6.68%) have illiteracy rates beyond 6%, which is an estimated 15 to 20 years behind the national average. Therefore, there is still room to reduce the illiteracy rate, particularly in the West.

2.2 Compulsory education: improvement and balanced regional disparities

Nine-year compulsory education is gradually becoming more widespread throughout the entire population. In 2020, the overall compulsory education rate is 65.06%,

Fig. 1 Changes in population educational structure and illiteracy rates in China, 1982–2020. Source: Data are calculated from previous census bulletins at national level. Data for 1982 are based on the recap of the 4th census, which are slightly different from that in the 3rd census
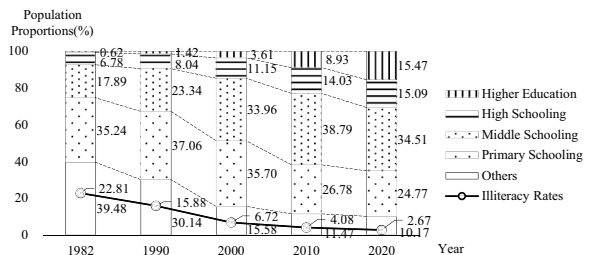
Table 1 Educational indicators by province in China, 2020

Province	Illiteracy rate (%)	Compulsory education rate (%)	Higher education rate (%)	Average years of schooling
East				
Beijing	0.80	82.86	41.98	12.64
Shanghai	1.61	81.83	33.87	11.81
Tianjin	1.23	76.95	26.94	11.29
Guangdong	1.45	69.41	15.70	10.38
Jiangsu	2.61	68.16	18.66	10.21
Hainan	3.25*	69.65	13.92*	10.10
Hebei	1.51	66.23	12.42*	9.84*
Zhejiang	2.72*	64.25*	16.99	9.79*
Shandong	3.26*	64.50*	14.38*	9.75*
Fujian	2.34	60.58*	14.15*	9.66*
Northeast				
Liaoning	0.90	75.69	18.22	10.34
Jilin	1.33	72.05	16.74	10.17
Heilongjiang	1.38	73.11	14.79*	9.93
Center				
Shanxi	1.21	72.79	17.36	10.45
Hubei	2.32	67.21	15.50	10.02

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Province	Illiteracy rate (%)	Compulsory education rate (%)	Higher education rate (%)	Average years of schooling
Hunan	1.71	65.65	12.24*	9.88*
Henan	2.24	64.50*	11.74*	9.79*
Jiangxi	1.94	62.54*	11.90*	9.70*
Anhui	4.49*	60.30*	13.28*	9.35*
West				
Inner Mongolia	3.30*	67.36	18.69	10.08
Shaanxi	2.75*	67.96	18.40	10.26
Xinjiang	–	61.30*	16.54	10.11
Ningxia	4.04*	60.49*	17.34	9.81*
Chongqing	1.63	61.95*	15.41*	9.80*
Guangxi	2.37	60.16*	10.81*	9.54*
Sichuan	3.98*	58.01*	13.27*	9.24*
Gansu	6.72*	54.87*	14.51*	9.13*
Qinghai	7.94*	49.79*	14.88*	8.85*
Yunnan	4.65*	51.18*	11.60*	8.82*
Guizhou	6.68*	51.37*	10.95*	8.75*
Tibet	/	33.83*	11.02*	6.75*
Total	2.67	65.06	15.47	9.91

Source: Data are calculated from the 7th census bulletins at the national and provincial levels. The illiteracy rates for Xinjiang and Tibet are not included because no relevant information is available

An asterisk (*) indicates that the indicator in this province is inferior to the national level. Regions are classified based on criteria from the National Bureau of Statistics

which is about double the rate in 1990 (32.81%). The rate was increasing with time step by step. The rate increased straight from 32.81% in 1990 to 48.72% in 2000, and 61.75% in 2010. Of course, the velocity of increase slowed down during the period of 2010 and 2020.

The compulsory education rate increases with the age decreasing, that is, the proportions with at least 9 years of formal schooling are higher for the younger generation than those for the older generation. As shown in Fig. 2, the proportion of the population aged 60–64 with at least middle schooling is only 57.63%, growing to 96.96% for those aged 20–24. The increase in the compulsory education rate is continuous between birth cohorts.

Meanwhile, the regional disparity is obvious according to the 2020 (7th) Census data, as shown in Table 1 and Fig. 3. Currently, compulsory education rates are somewhat lower in western China than in other regions. According to Table 1, except for Fujian (60.58%) and Anhui (60.30%), the compulsory education rates of the majority of provinces in the East, Northeast, and Center regions are above or close to the national level (65.06%). However, compulsory education rates in the West are generally lower than that of the national level. Except for Shaanxi (67.96%) and Inner Mongolia (67.36%), which are slightly higher than the national level, the compulsory education rates of other provinces in the West are below the national level. For instance, the gaps between the compulsory education rate in Tibet (33.83%), Qinghai (49.79%), Yunnan (51.18%), Guizhou (51.37%), Gansu (54.87%), or Sichuan (58.01%) and national level are obvious.

Over the past three decades, the development of compulsory education rates has been becoming more relatively balanced across provinces with the time passing, and there is a trend indicating narrowing regional disparities. As shown in Fig. 3, the trend lines of compulsory education rates for individual provinces all have similar curves to the line for the nation. Furthermore, the gaps between provinces have hardly widened during the past 30 years; in fact, the gaps in the East are narrowing. As efforts to promote compulsory education continue, provincial disparities may be reduced further in the future.
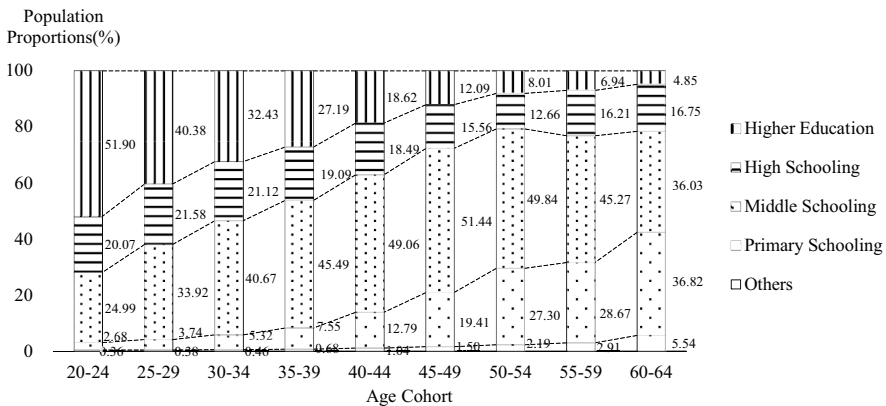

Fig. 2 Changes in population educational structure by age cohort in China, 2020. Source: Data are calculated from the 7th census aggregated data

2.3 Higher education: expansion and widening regional disparities

One of the most significant characteristics of the educational development in China over the past three decades is the expansion of higher education. As Fig. 1 shown, this proportion was only about 0.62% in 1982 and was steadily increasing in the last 40 years to about 15.47% in 2020, especially since the beginning of the twenty-first century.

The increase in this proportion is due to the young generation. The proportion is much higher in the younger generation. For example, for the group aged 20–24, more than half of the population attended higher education, while only about 4.8% of the population aged 60–64 attended.

Higher education rates are relatively higher in the East and Northeast of China, with Beijing, Shanghai, and Tianjin leading the way, and relatively lower in the Center and West. Overall, these rates are nonetheless relatively balanced across regions. According to Table 1, except for Hebei (12.42%), most of the provinces in the East and Northeast have higher education rates that exceed or are close to the national level. In the East, Beijing (41.98%), Shanghai (33.87%), and Tianjin (26.94%) are more than or nearly twice the national level (15.47%). This is because, more resources are allocated to higher education in these provincial-level municipalities, and more people completing higher education choose to work in these cities. In the Center and West, except for Inner Mongolia (18.69%) and Shaanxi (18.40%), which are both slightly higher than the national level, other provinces in the regions are close to or lower than the national level. It is worth mentioning that higher
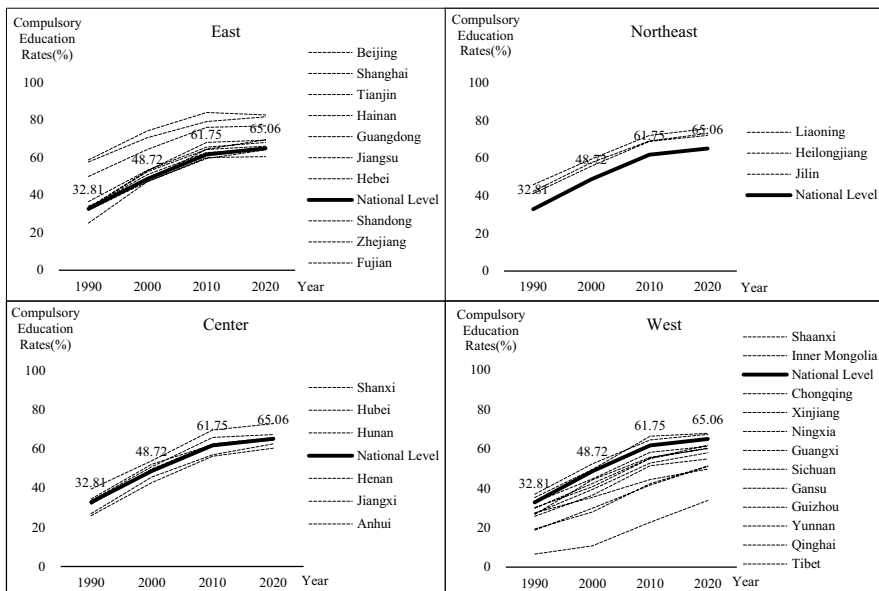

Fig. 3 Changes in compulsory education rates by region in China, 1990–2020. Source: Data are calculated from census bulletins at the national and provincial level. Data for 1990 are based on the recap of the 5th census. Provinces in the legend of this chart are sorted by the rates in 2020 from highest to lowest

education rates exceed 10% in all provinces, which is a favorable condition for balanced regional economic and social development in the future.

The situation is changing, however, with regional disparities in provincial higher education rates widening rapidly. As seen in Fig. 4, the increases in higher education rates in Beijing, Shanghai, and Tianjin were significantly higher than those in other provinces during the period from 1990 to 2020, and the gap between provinces widened significantly. The growth of the higher education rate in the provinces of the Northeast was comparable to the national development rate. The growth of the rate in the provinces of the Center and West was generally lower than the national level, showing a trend of widening gaps between provinces. Based on historical performance, it can be expected that regional differences in higher education rates will widen further in the coming decades.

People with higher education are clustering in developed regions of China, which could boost the economic development of these regions. Conversely, economic developed regions would attract more people with higher education with the boost of economic development, which leads to further clustering of the people with higher education, and the gap in higher education rate is further growing.

2.4 Average years of schooling are relatively regionally balanced

The average years of schooling of the population in China are increasing steadily, from 7.60 years in 2000 to 8.76 years in 2010, and 9.08 years in 2020, as shown
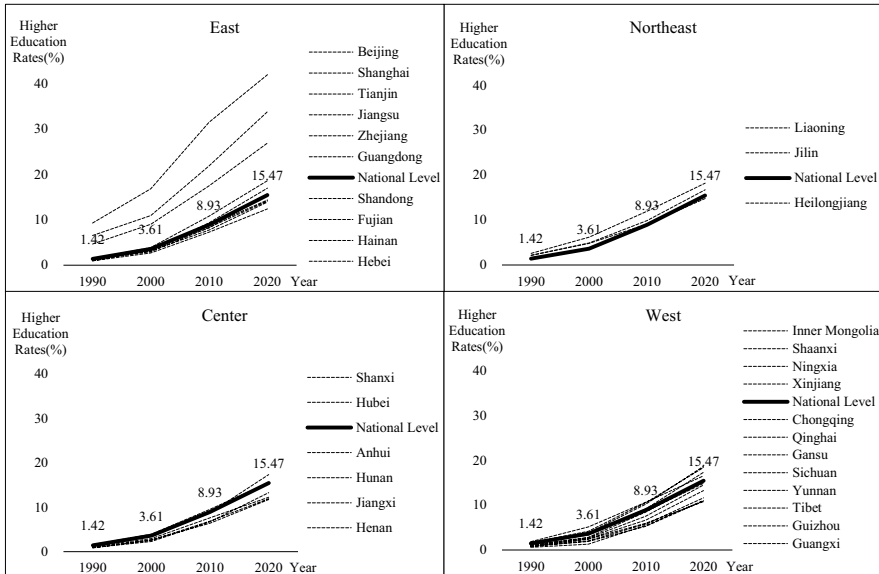

Fig. 4 Changes in higher education rates by region in China, 1990–2020. Source: Data are calculated from previous census bulletins at national and provincial level. Data for 1990 is based on the recap of the 5th census. Higher education rates are converted from the number of people in each education level per 100,000 population. Provinces in the legend of this chart are sorted by the rates in 2020 from highest to lowest

in Table 2. The young generation contributed more to the growth. As shown in Table 6, the average years of schooling increased with birth cohort younger. For the birth cohort 1990, the average years of schooling are 11.79 years, while it became 13.29 years for those of 2000.

Concerning regional distribution, the average years of schooling are relatively balanced in China. Table 1 shows that there is a distinct geographical and spatial gradient in education (Huang & Yuan, 2014). The average years of schooling are higher among the population in the East of China compared to that in the West, but in general, the regional distribution is relatively balanced. Twenty-one out of the 31 provinces have an average of 9.50 to 10.50 years of schooling for their populations; there is a gap of one year or less. However, the average years of schooling in Tibet are only 6.75 years. Tibet's relative underdevelopment in education is mainly due to environmental and other external factors. Tibet is immense and sparsely populated; it lacks sufficient transportation links; scattered populations of farmers and herdsmen live in alpine areas; the high-altitude air is deficient in oxygen; and religious culture influences Tibet's development (He & Ma, 2005). The relatively balanced regional distribution of average years of schooling in China is due to the widespread of compulsory education in most locales. However, promoting education in the Center and West, especially in provinces such as Tibet, will remain a priority in the future.

3 Changing trends of gender inequality in education in China

Gender equality is one of the guiding principles of the People's Republic of China as a socialist country, and since 1949, significant achievements advancing gender equality have been made in many economic and social areas, including education. Women were not encouraged to pursue an education in traditional Chinese society. The degree of gender inequality in educational attainment has gradually decreased in tandem with urbanization, economic development, and increased investment in education (Shi & Yu, 2021), since the founding of the People's Republic of China in 1949, as the educational system and institutions in both urban and rural areas have improved. Different types of increased gender equality in education alongside the improvement of educational attainment are the main characteristics of educational development in China.

### 3.1 The history of educational improvement and the critical period of those improvements

Illiteracy rate: The most significant improvements in illiteracy rates occurred in the three decades before the reforms and opening up began. When the People's Republic of China was founded, the country's total population was 550 million, of which more than 80% were illiterate, and the illiteracy rates in rural areas were over 95% (Asai et al., 1997). Literacy education began in the 1950s when a government-led literacy education system was established, and literacy classes were promoted on

Table 2 Average years of schooling by urban/rural area and gender in China, 2000–2020

Area	2000				2010				2020			
	Male	Female	Total	F/M ratio	Male	Female	Total	F/M ratio	Male	Female	Total	F/M ratio
Urban	9.45	8.55	9.01	0.91	10.19	9.62	9.91	0.94	10.08	9.76	9.92	0.97
Rural	7.33	6.15	6.76	0.84	7.99	7.12	7.57	0.89	7.99	7.19	7.60	0.90
Total	8.12	7.05	7.60	0.87	9.11	8.39	8.76	0.92	9.31	8.84	9.08	0.95

Source: Data are calculated from the 5th, 6th, and 7th census aggregated data

Fig. 5 Illiteracy rates by birth cohort, gender, and urban/rural area in China, 2020. Source: Data are calculated from the 7th census aggregated data
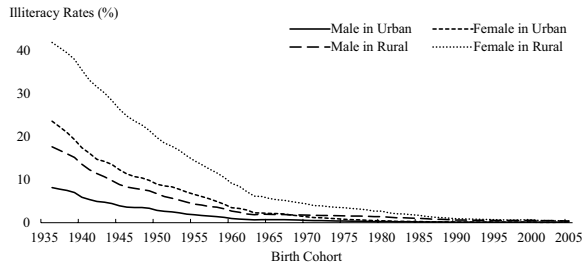
a large scale until the end of the twentieth century. Four groups of people were the main focus of the literacy movement: worker-peasant cadres, staff in factories and mines and institutions, young and middle-aged rural farmers, and urban residents (National Institute of Education Sciences, 1997). As Fig. 5 shows, between the birth cohort 1935 and the birth cohort 1965, the formal education period for both of which ended before the reforms and opening up began, illiteracy rates fell significantly for both males and females, and in both urban and rural areas. The illiteracy rate for urban females declined faster than that of rural males, and the gap between the two groups gradually narrowed. After the birth cohort 1965, the gap between urban and rural illiteracy rates become more salient than the gap in illiteracy rates of males and females. For cohorts born after 1965, the rate of decline in illiteracy rates has slowed considerably. By the birth cohort 1990, the illiteracy rate was already at a low level, especially in urban areas, and had even fallen to below 1% for females in rural areas.

Compulsory education rate: Significant improvements in the compulsory education rate also occurred during the pre-reform period. Although these improvements were interrupted during the Cultural Revolution (1966–1976), the compulsory education rate began rising again after the reforms and opening up began in 1978. As shown in Fig. 6, there was significant growth in the compulsory education rates for all groups between the birth cohort 1935 and the birth cohort 1965. There was a discernible fluctuation in the growth trend of the compulsory education rate. The interruption began with the birth cohort 1965 and growth of the rate resumed with the birth cohort 1975. For cohorts born between 1975 and 1985, there was a significant increase in the compulsory education rate for females in rural areas, and this significantly narrowed the gap with males, which occurred after the reforms and opening up began in 1978. By the time the birth cohort 1990 arrived, the compulsory education rate had reached high levels for all groups. Although there were still urban–rural disparities, even in rural areas the rate for females was over 90%.

Higher education rate: The significant improvement in higher education rates occurred mainly after the implementation of higher education expansion policies got underway in the early twenty-first century. As shown in Fig. 7, the higher education rate remained relatively constant without an improving trend until the birth cohort 1970. The higher education rate began increasing rapidly after the birth cohort 1980; cohort 1980 began attending college at exactly the time measures to expand higher education were undertaken. It is among the cohorts born during the 1980s

Fig. 6 Compulsory education rates by birth cohort, gender, and urban/rural area in China, 2020. Source: Data are calculated from the 7th census aggregated data
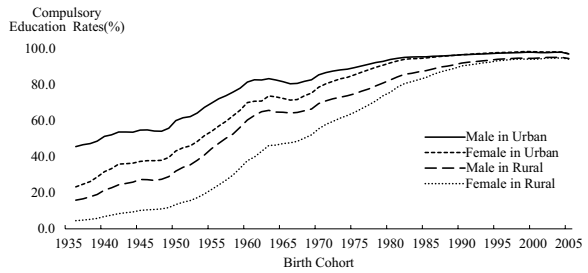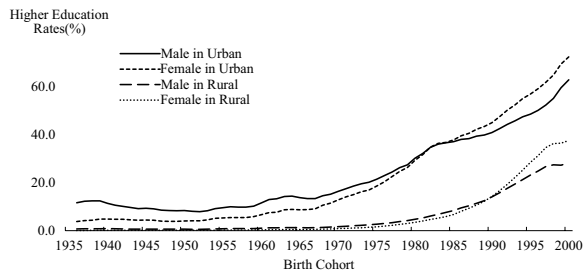

Fig. 7 Higher education rates by birth cohort, gender, and urban/rural area in China, 2020. Source: Data are calculated from the 7th census aggregated data

that the proportion of females with higher education began to exceed that of males, as we discuss in more detail later. In comparison, the higher education rate for rural populations has consistently lagged behind that of urban populations, owing to both general educational inequalities and the migration and settlement of disproportionate numbers of relatively well-educated rural people to urban areas.

Average years of schooling: In general, the situation of gender equality in education has improved alongside overall improvements in education. Figures 5, 6 and 7 show the gradual narrowing of the gender gap in education in both urban and rural areas as education improves overall. There is a new trend in recent cohorts, showing females overtaking males in higher education (see Fig. 7). Using the comprehensive indicator for average years of schooling, Fig. 8 shows a discernible fluctuation in educational development during the Cultural Revolution and tracks women overtaking and exceeding men concerning average years of schooling in the twenty-first century. Figure 8 also shows that the gender gap in education gradually narrowed in both urban and rural areas as the average years of schooling increased, but the urban–rural gap in education remained significant. In addition, Table 2 shows the F/M ratio for average years of schooling improved in both urban and rural areas alongside overall improvements in education during the years 2000–2020. The urban–rural gap in average years of schooling still maintains its historical disparity, and this issue needs to be given full attention.

Fig. 8 Average years of schooling by birth cohort, gender, and urban/rural area in China, 2020. Source: Data are calculated from the 7th census aggregated data
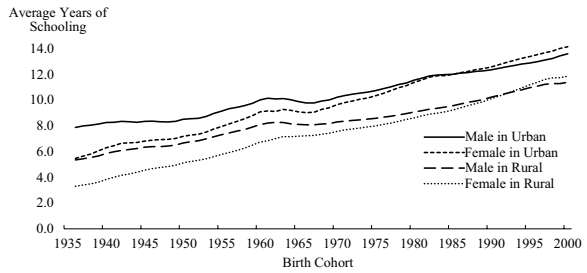
3.2 Stable compulsory education rate and acceptable gender parity

In general, gender equality in compulsory education has improved in tandem with overall improvements in education. Figure 6 shows that the gaps in compulsory education rates for men and women have narrowed in both urban and rural areas, and it indicates that the compulsory education rate has achieved stability at a high level.

For birth cohorts that completed their compulsory education during the last 20 years, the compulsory education rate barely increased, although there is still room for improvement, especially in rural areas. As Table 3 indicates, the compulsory education rate did not increase after reaching 98% in urban areas and 95% in rural areas. This means that nearly 2% of the young people in urban areas and nearly 5% in rural areas today do not complete the compulsory education years mandated by the Compulsory Education Law enacted in 1986. These people should be given priority attention by efforts to promote educational development, even though the compulsory education rate equal to 100% is an ideal stat and there would be some possible special cases.

Although increases in the compulsory education rate have stagnated, currently the rates for males and females are almost equal. As shown in Table 3, the F/M ratio for the compulsory education rate was consistently at 1.00 in urban areas and reached 1.00 among the birth cohort 2001 and later in rural areas. It should be noted that the compulsory education rate for males was slightly lower than the rate for females in urban areas and slightly higher for males than for females in rural areas according to the specific numbers in Table 3. In general, there were small gender differences in the compulsory education rate, but these differences are acceptable.

3.3 The reversal of male dominance in higher education

While recent studies have concluded that the gender gap between males and females pursuing higher levels of education began to close after the economic reforms and opening up began in 1978 (Treiman, 2013), gender inequalities still exist at high school level or beyond in China (Zeng et al., 2014; Zheng & Zhang, 2013). However, the latest census data by birth cohort analysis suggests it is no longer true that traditional gender inequality exists at the higher levels of China's education system.

In fact, males were already overtaken by females in education in recent years. In addition to the slightly lower rates of compulsory education for males than for

Table 3 Compulsory education rates by brth cohort, urban/rural area and gender in China, 2020

Birth cohort	Urban				Rural				Total (%)
	Male (%)	Female (%)	Total	F/M ratio	Male (%)	Female (%)	Total	F/M ratio	
1995	97.47	97.79	97.63	1.00	94.11	93.29	93.74	0.99	96.45
1996	97.57	97.91	97.74	1.00	94.36	93.61	94.02	0.99	96.61
1997	97.71	98.06	97.88	1.00	94.60	94.00	94.33	0.99	96.80
1998	97.87	98.25	98.05	1.00	94.73	94.23	94.50	0.99	97.00
1999	98.05	98.42	98.23	1.00	94.67	94.20	94.46	0.99	97.20
2000	98.01	98.41	98.20	1.00	94.69	94.15	94.46	0.99	97.25
2001	97.87	98.26	98.06	1.00	94.84	94.37	94.63	1.00	97.17
2002	97.86	98.11	97.98	1.00	95.23	94.91	95.09	1.00	97.22
2003	98.06	98.22	98.13	1.00	95.18	94.78	95.01	1.00	97.38
2004	98.07	98.17	98.12	1.00	95.20	94.87	95.06	1.00	97.36
2005	97.14	97.21	97.17	1.00	94.52	94.20	94.37	1.00	96.25

Source: Data are calculated from the 7th census aggregated data

females in urban areas presented in Table 3, our analysis identifies some trends for younger birth cohorts (born after 1990) that are noteworthy. In these cohorts born after 1990, illiteracy rates are higher for males than females in most cases (see Table 4), higher education rates are lower for males than females (see Table 5) and average years of schooling are fewer in most cases (see Table 6) for males than for females.

The reversal of male dominance in higher education is evident, as shown in Fig. 7. The gender gap in higher education rates gradually narrowed until the birth cohort 1980 in urban areas, and the rate for females is increasingly greater than that for males among the birth cohort 1982 and later. The reversal of male dominance occurred later in rural areas, beginning with the birth cohort 1990. The gap in favor of women over men widened after the initial reversal point, confirming that the rate of women surpassing that of men was not a single-time occurrence. As indicated in Table 5, the ratio of women to men in the higher education rate grew between the birth cohort 1990 and 2000 in both urban and rural areas. Table 5 also shows that the gender gap is much wider in rural areas than in urban areas. The fact that educated men in rural areas are more likely to migrate to urban areas than women may contribute to the gender gap being wider in rural areas than in urban areas. However, the disadvantaged position in education of rural men may be attributable to other factors and need to be explored further.

It seems that the reversal of men's advantage in higher education rates has been replaced by a new form of gender inequality in which males are at a disadvantage. Why was there a simultaneous slowdown in the overall growth rate of higher education rates and the reversal of male dominance in the birth cohorts from 1981 to 1985? Were women outperforming men across the board at all levels of higher education? To understand this widening gender gap, Sect. 4 discusses these cohorts in terms of the gender context and their chances to enter higher education, and

Table 4 Illiteracy rates by birth cohort, urban/rural area and gender in China, 2020

Birth cohort	Urban				Rural				Total (%)
	Male (%)	Female (%)	Total	F/M ratio	Male (%)	Female (%)	Total	F/M ratio	
1995	0.14	0.13	0.13	0.94	0.53	0.69	0.60	1.31	0.28
1996	0.14	0.13	0.13	0.88	0.52	0.66	0.58	1.27	0.27
1997	0.15	0.13	0.14	0.87	0.52	0.63	0.57	1.21	0.27
1998	0.14	0.12	0.13	0.86	0.52	0.60	0.56	1.16	0.26
1999	0.15	0.13	0.14	0.86	0.55	0.64	0.59	1.16	0.26
2000	0.16	0.13	0.14	0.81	0.56	0.65	0.60	1.15	0.26
2001	0.13	0.10	0.11	0.76	0.50	0.54	0.52	1.08	0.22
2002	0.14	0.11	0.12	0.80	0.49	0.49	0.49	1.02	0.22
2003	0.12	0.10	0.11	0.81	0.49	0.48	0.48	0.99	0.20
2004	0.13	0.11	0.12	0.86	0.46	0.43	0.45	0.95	0.20
2005	0.20	0.18	0.20	0.90	0.41	0.40	0.40	0.98	0.26

Source: Data are calculated from the 7th census aggregated data

Table 5 Higher education rates by birth cohort, urban/rural area and gender in China, 2020

Birth Cohort	Urban				Rural				Total (%)
	Male (%)	Female (%)	Total	F/M ratio	Male (%)	Female (%)	Total	F/M ratio	
1990	40.90	45.02	42.93	1.10	14.07	14.27	14.16	1.01	34.50
1991	42.57	47.52	44.99	1.12	15.85	16.67	16.22	1.05	36.51
1992	44.31	50.19	47.17	1.13	17.63	19.27	18.38	1.09	38.63
1993	45.76	52.44	49.01	1.15	19.50	22.23	20.73	1.14	40.58
1994	47.42	55.02	51.10	1.16	21.24	25.22	23.04	1.19	42.75
1995	48.53	56.93	52.58	1.17	23.16	28.47	25.55	1.23	44.39
1996	50.13	59.12	54.46	1.18	24.80	31.26	27.73	1.26	46.33
1997	52.34	61.82	56.89	1.18	26.73	34.61	30.30	1.29	48.80
1998	55.10	64.87	59.77	1.18	27.41	36.30	31.42	1.32	51.39
1999	59.54	69.41	64.27	1.17	27.29	36.48	31.37	1.34	55.31
2000	62.83	72.44	67.43	1.15	28.27	37.54	32.32	1.33	58.49

Source: Data are calculated from the 7th census aggregated data

discusses the advancement rates, i.e., the percentage of the population that moves from one educational level to the next.

3.4 Educational improvements and educational gender equality lag behind in rural areas

There is much evidence that the improvements to education in rural areas have, to some extent, lagged behind the improvements in urban areas. Figures 5, 6, 7 and

Table 6 Average years of schooling by birth cohort, urban/rural Area and gender in China, 2020

Birth Cohort	Urban				Rural				Total (%)
	Male (%)	Female (%)	Total	F/M ratio	Male (%)	Female (%)	Total	F/M ratio	
1990	12.36	12.58	12.47	1.02	10.22	10.10	10.17	0.99	11.79
1991	12.48	12.76	12.61	1.02	10.38	10.30	10.34	0.99	11.94
1992	12.60	12.94	12.76	1.03	10.52	10.50	10.51	1.00	12.09
1993	12.69	13.09	12.89	1.03	10.66	10.73	10.69	1.01	12.23
1994	12.81	13.26	13.03	1.04	10.80	10.94	10.87	1.01	12.39
1995	12.89	13.39	13.13	1.04	10.96	11.19	11.06	1.02	12.50
1996	12.99	13.53	13.25	1.04	11.08	11.38	11.22	1.03	12.63
1997	13.12	13.69	13.39	1.04	11.23	11.62	11.41	1.03	12.79
1998	13.25	13.82	13.52	1.04	11.28	11.74	11.49	1.04	12.92
1999	13.45	14.02	13.72	1.04	11.28	11.75	11.49	1.04	13.11
2000	13.60	14.15	13.87	1.04	11.39	11.87	11.60	1.04	13.29

Source: Data are calculated from the 7th census aggregated data

8 all suggest general improvements to education in both urban and rural areas. For indicators like the illiteracy rate and the compulsory education rate, the urban–rural gap narrowed, though in the case of the higher education rate that gap widened. The urban–rural gap in education is to some extent caused by the migration of more educated elements of the rural population to urban areas (Wang & Zhou, 2018). However, more study is required to determine how much of the urban–rural gap in education is caused by educational inequity.

In addition, improvements in gender equality in education in rural areas also lag behind improvements in urban areas. One of the most obvious examples is that the point when females overtook males as the dominant gender in higher education was reached earlier in urban areas and later in rural areas (see Fig. 7). Table 3 shows that the F/M ratio for the compulsory education rate in rural areas did not reach 1.00 until the cohort 2001, while the ratio in the urban area remained at 1.00 from the cohort 1995 through the cohort 2005. Table 4 shows the illiteracy rate for females in urban areas was lower than for males throughout all birth cohorts from 1995 to 2005, while in rural areas it was higher for females than for males from cohort 1995 to cohort 2002. Studies show that educational gender inequality remains prevalent within rural populations, in ethnic minority areas, and some parts of the West (Wu et al., 2020). The overall reduction in gender inequality in education may hide from view a wide and varied range of experiences that women from different kinds of family backgrounds or parts of the country have. It may be that only women from socio-economically advantaged family backgrounds can achieve equality with or surpass men (Wang, 2021; Wu, 2012).

4 The process of reversing gender inequality in higher education

The end of male dominance in higher education is a worldwide phenomenon. The gender gaps that advantaged men in college enrollment and graduation are gradually reaching parity, with women even further outperforming men (Becker et al., 2010; Buchmann & Hannum, 2001; Goldin et al., 2006; Vincent-Lancrin, 2008; Wu & Zhang, 2010). Why have women surpassed men in higher education instead of simply catching up to them? Goldin et al. (2006) argue that once barriers to females entering a wide range of careers were reduced and their chances to obtain higher education chances were expanded, two key factors gave women an advantage concerning higher educational attainment: one is that women received relatively greater economic benefits than men for college attendance, the other is that men need to do more effort for college entrance. That is to say, a broader, more balanced playing field has enabled women to blossom and to take advantage of the potential for higher lifetime earnings that college attendance offers. However, in the Chinese context, it is questionable that the overtaking of men by women in higher education is due to lower returns to higher education for men. In this section, the historical background of the gender reversal in higher education and the possible reasons for that reversal are discussed.

4.1 Opportunities for higher education and the gender context at the reversal point

Figure 9 shows that the higher education rate was increasing since the birth cohort 1960. The growth rates accelerated since the birth cohort 1968. However, the growth of the higher education rate suddenly and temporarily slowed in the birth cohorts from 1981 to 1985, which was reflected in the proportions with undergraduate and graduate education; and it was the initial reversal point when women overtook men in undergraduate and graduate education occurred during the birth cohorts from 1981 to 1985. Possible explanations of the reversal could be the age-sex specific population structure, which could affect the higher education enrollment chances, and gender context at birth and upbringing for cohorts born in the first half of the 1980s.

The cohorts born during the 1980s, which attended college at the beginning of the period when policies to expand higher education got underway, experienced a slowdown in the growth of higher education rates, mainly due to the changes in the base size of the population. Analytically, the chance to attend college/university (junior college or undergraduate education) for a given birth cohort depends on the yearly enrolment quota set by China's Gaokao college entrance examination (numerator) and the population size of the cohort (denominator). It is assumed that each birth cohort begins college at the age of 18. For cohorts born in the 1970s, enrolment quotas for college grew slowly between 1989 and 1998 (see Fig. 10), with an increase of only 0.49 million places to junior college and undergraduate education; while during the same period, the corresponding size of the college-eligible population base decreased by 7.12 million (see Fig. 11). This resulted in less competition
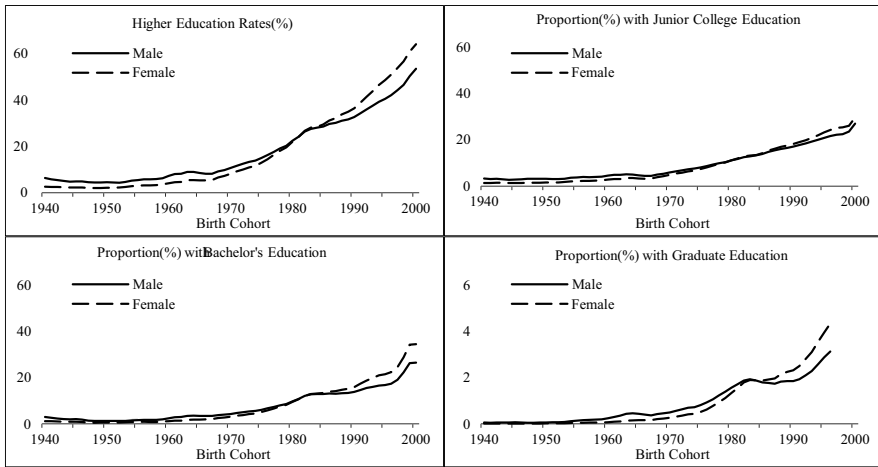
Fig. 9 Proportion with each level of higher education by birth cohort, gender in China, 2020. Source: Data are calculated from the 7th census aggregated data

and more access to college/university year on year. Thus, the birth cohorts 1971 to 1979 showed a rapid upward trend in the higher education rate in Fig. 9. For cohorts born in the 1980s, there was a significant increase in the enrolment quotas for college from 1999 to 2008, with 4.53 million more places made available for junior college and undergraduate education; while during the same period the size of the college-eligible population base increased by 6.91 million. This means that the impact of the increased availability of college/university places was diluted by the larger population base. Therefore, as Fig. 9 shows, the growth of the higher education rate slowed temporarily for cohorts born during 1981 to 1990. For cohorts born in the 1990s, the expansion of higher education slowed between 2009 and 2018, with the enrolment quota for junior college and undergraduate education increasing by only 1.52 million; while the size of the college-eligible population base decreased by 5.95 million during this period. As a result, the higher education rate again trended upward rapidly for cohorts born during 1991 to 2000 (see Fig. 9).

One of the unintended consequences of China's "one-child policy", introduced in the early 1980s, was that it enabled women more access to education. The one-child policy contributed to the emergence of the important turning point that women began to dominate higher education when the birth cohorts of 1981–1985 began going to college. From 1970 to 1979, the fertility policy in China permitting a maximum of two children and requiring "later births, longer intervals, fewer children" were in place nationwide. From autumn of 1980 to spring of 1984, adjustments to this fertility policy were made, with the Central Committee of the Communist Party of China advocating "one child per couple". From the spring of 1984 to 1991, the one-child fertility policy, which did not distinguish between urban and rural areas, was implemented in varying degrees throughout China, in some cases strictly, in other cases rather loosely to make the policy more suitable for local conditions (Feng, 2000; Liang, 2014). Based on data from the 4th census in 1990, Guo (2001)

estimated the proportions of only children in different birth cohorts: in the cohorts born from 1976 to 1980, 25.8% of urban males, 21.3% of urban females, 5.1% of rural males, and 2.4% of rural females were only-children; however, in the cohorts of born from 1981 to 1985, 63.1% of urban males, 58.8% of urban females, 12.6% of rural males, and 8.4% of rural females were only-children. The birth cohorts of 1981–1985 were heavily influenced by the one-child policy, which was the strictest during the years people in these cohorts were born. The birth cohorts of 1981–1985 were born under the strictest fertility policy in history, and a large proportion of them, both boys and girls, were the only children in their families.

In families with few children, especially one-child families, daughters are seen as long-term family members, and parents are prepared to invest generously in their daughters' education and are less inclined to adopt a "son first" strategy (Gu & Jean Yeung, 2021; Ye & Wu, 2011). However, there tends to be a large gap between the treatment of sons and daughters in families with multiple children (Lee, 2012; Xu, 2015). It has been argued that, compared to boys, girls generally have better non-cognitive skills like obedience and self-discipline. Moreover, grandparents and parents have higher expectations in academic performance for girls and supervise their studies more closely (Gu & Jean Yeung, 2021; Wanless et al., 2013). From a life course perspective, females' better performance in early life creates cumulative advantages (Gu & Jean Yeung, 2021; Lai, 2010). These factors all contribute to females having an advantage in access to higher education. Moreover, the birth cohorts of 1981–1985 reached college age as the expansion of higher education began, and given their greater ability, women were more likely than men to benefit from this expansion. In summary, the one-child fertility policy and the corresponding reduction in the number of children in a family had the unintended consequence of creating increased educational opportunities for females, allowing women to

Fig. 10 Numbers of students enrolled at each level of higher education in China, 1989–2020. Source: Data are from the section of annual data on the website of National Bureau of Statistics (http://www.stats.gov.cn/)
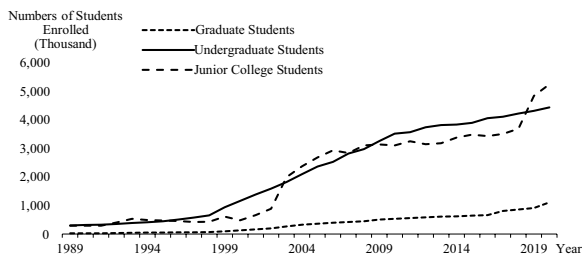
Fig. 11 Population size by birth cohort in China, 2020. Source: Data are calculated from the 7th census aggregated data. The death population in each birth cohort are ignored in the analysis
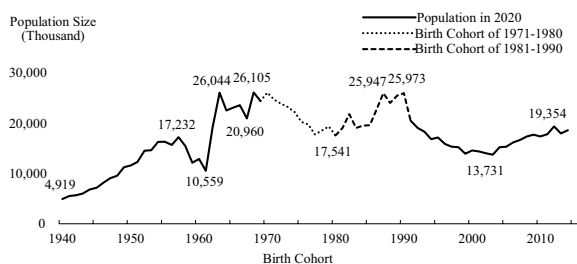
Table 7 Proportion at each level of higher education by birth cohort and gender in China, 2020

Birth cohort	Junior college		Bachelor's degree		Master's degree		Doctoral degree	
	Total (%)	F/M ratio	Total (%)	F/M ratio	Total (%)	F/M ratio	Total (%)	F/M ratio
1956–1960	3.31	0.60	1.42	0.50	0.10	0.31	0.02	0.25
1961–1965	4.17	0.68	2.49	0.51	0.22	0.34	0.05	0.27
1966–1970	4.54	0.78	3.15	0.66	0.26	0.49	0.06	0.42
1971–1975	6.79	0.87	4.76	0.79	0.45	0.60	0.09	0.55
1976–1980	9.75	0.97	7.77	0.94	0.92	0.79	0.17	0.66
1981–1985	13.03	1.02	12.34	1.01	1.59	1.02	0.22	0.72
1986–1990	16.46	1.06	14.01	1.11	1.73	1.24	0.23	0.76
1991–1995	20.04	1.09	17.62	1.24	2.41	1.42	0.31	0.90
1996–2000	24.63	1.12	25.20	1.29	1.97	1.44	0.09	0.91

Source: Data are calculated from the 7th census aggregated data

Data by gender are omitted for simplicity

outpace males in higher education in the birth cohorts of 1981–1985 and subsequent birth cohorts.

4.2 Proportions at each level of higher education and related advancement rates

It should be noted that women from younger cohorts have surpassed men from these cohorts at most stages of higher education. As shown in Table 7, after the birth cohort 1981–1985, the F/M ratios in junior college, bachelor's degree programs, and master's degree programs all exceeded 1.00. Moreover, the more advanced the degree, the higher the F/M ratio, indicating that women surpassed men in greater proportions at more advanced levels of higher education. However, a smaller proportion of women than men in younger cohorts achieve the doctoral level, making the situation at the highest level of educational attainment very different from the situation at lower levels of higher education.

Human capital investment theory offers one possible explanation for women's outperformance over men in education (Goldin et al., 2006). The theory states that men can expect higher labor market returns than women when they stop at a high school graduation, and this encourages men to leave school earlier than women. If this explanation is correct, then the gender reversal in education should first occur at lower levels of educational attainment, as men will stop at a lower level to begin working and earning earlier.

Concerning the advancement rates from one educational level to another, women overtook men first in advancement to college, then in advancement to high school, then to postgraduate school, and finally to middle school. In Table 8, we see that in the birth cohorts of 1956–1975, advancement rates for males exceeded those of females at all levels of education. With the increasing level of gender equality in education, the advancement rate of women completing high school exceeded that

Table 8 Advancement rates for graduates at each level of education by birth cohort and gender in China, 2020

Birth cohort	Primary school graduates		Middle school graduates		High school graduates		Bachelor's degree graduates		Master's degree graduates	
	Total (%)	F/M ratio	Total (%)	F/M ratio	Total (%)	F/M ratio	Total (%)	F/M ratio	Total (%)	F/M ratio
1956–1960	61.02	0.79	37.48	0.96	22.44	0.79	7.98	0.62	17.93	0.84
1961–1965	70.47	0.84	33.83	0.90	29.98	0.82	9.87	0.66	19.37	0.84
1966–1970	72.09	0.88	29.31	0.90	38.76	0.93	9.18	0.74	17.38	0.88
1971–1975	80.30	0.92	34.96	0.93	43.72	0.97	10.22	0.77	17.21	0.93
1976–1980	87.08	0.96	43.06	0.97	50.17	1.02	12.34	0.84	15.77	0.86
1981–1985	92.40	0.98	50.43	1.00	58.76	1.04	12.83	0.97	12.28	0.74
1986–1990	94.65	0.99	56.83	1.02	60.57	1.07	12.27	1.05	11.72	0.65
1991–1995	96.25	1.00	64.62	1.06	65.16	1.11	13.37	1.08	–	–
1996–2000	97.32	1.00	74.23	1.08	72.11	1.12	–	–	–	–
2001–2005	97.53	1.00	75.60	1.06	–	–	–	–	–	–

Source: Data are calculated from the 7th census aggregated data

Data by gender are omitted for simplicity. It is assumed that all the doctoral degree holders advanced from a Master's degree program

Fig. 12 Advancement rates of high school graduates and its F/M ratio by birth cohort in China, 2020. Source: Data are calculated from the 7th census aggregated data
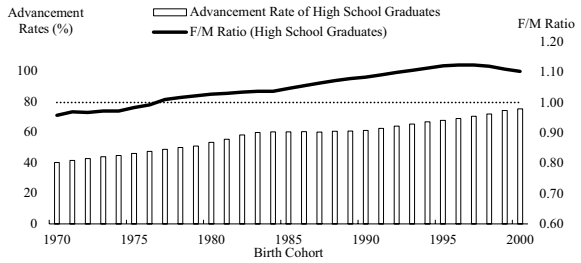
of men for the first time in the birth cohorts of 1976–1980. The gender reversal in the advancement rate of middle school graduates took place in the birth cohorts of 1981–1985, and the advancement rate of bachelor's degree graduates in the birth cohorts of 1985–1990. Finally, the gender reversal took place in the advancement rate of primary school graduates in the birth cohorts of 1991–1995. In short, gender reversals of advancement rates did not move from the lower levels to higher levels of education.

Women's outperformance over men in higher education is more likely to be the result of academic excellence than economic disadvantages in the labor market. When the fact that the gender gap in the proportion of women versus men with bachelor's degrees is greater than the gender gap in the proportion of women versus men who attended junior college is taken into consideration, it is more likely that differences in academic performance are the key reason why men lag behind women. For high school graduates who go on to college, the more capable graduates enter undergraduate programs while the less capable enter junior colleges. Men are relatively more likely than women to enter junior colleges rather than undergraduate programs, indicating that men are relatively less proficient academically than women. The analysis shows that women's outperformance over men in higher education has not been due solely to the increased economic rewards that more education has to offer, but to a combination of factors.

Though women have surpassed men at most levels of higher education, the proportion of women with doctoral degrees has not yet surpassed that of men and will not do so for a period of time in the future. Increased pressure on women as they age and age discrimination faced by women are likely to be the reasons for this. The F/M ratios of advancement rates from high school to college and from bachelor's degree programs to graduate level programs are above 1.00 for younger birth cohorts, and the ratios increase from birth cohort to birth cohort (see Figs. 12 and 13). The F/M ratio of the advancement rate from Master's programs to Ph.D. programs, however, is always below 1.00 and decreases from birth cohort to birth cohort (see Fig. 14). It is obvious that although women have a gender advantage in higher education, women face gender inequality at the doctoral level and have become increasingly reluctant to advance to the Ph.D. program level. Though the investment they have in graduate-level education has increased, women face considerable pressure as they age and suffer from age discrimination as they make choices about pursuing a doctoral degree. As a result, women have a desire to marry and enter labor markets

Fig. 13 Advancement Rates of Bachelor's Degree Graduates and its F/M Ratio by Birth Cohort in China, 2020. Source: Data are calculated from the 7th census aggregated data
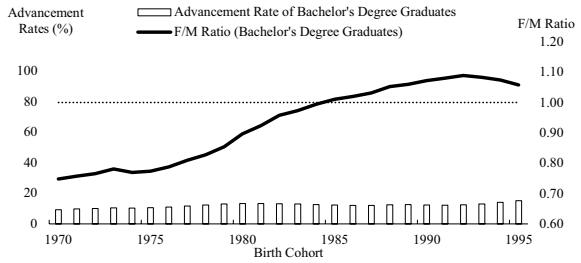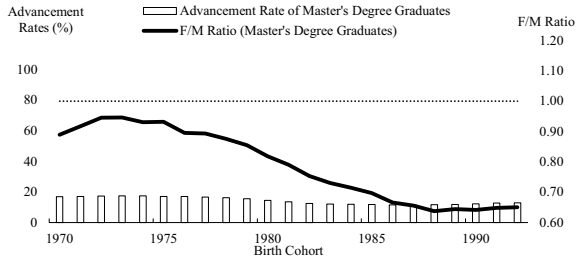

Fig. 14 Advancement rates of Master's Degree graduates and its F/M Ratio by Birth cohort in China, 2020. Source: Data are calculated from the 7th census aggregated data

earlier than men do (Zhang, 2022). These conditions prevent women from pursuing the highest degrees and reaching higher levels of achievement.

The reversal of gender inequality in higher education has created a new form of gender inequality in which males are disadvantaged, but the disadvantage males face in higher education has been moderated somewhat in recent birth cohorts. As shown in Figs. 12 and 13, the F/M ratios of the advancement rates of high school graduates have decreased slightly for birth cohorts between 1997 and 2000, and the F/M ratios of the advancement rates of those receiving bachelor's degrees have decreased for birth cohorts between 1992 and 1995. However, trends of gender gaps in advancement rates should be the subject of further dynamic tracking (Fig. 14).

5 Conclusion and discussion

Drawing on data from the 7th National Census and several previous censuses, this paper discusses the development of educational attainment and gender inequality in education. The results show that gender inequality in education has lessened at the same time there have been overall improvements in education, and these are the main characteristics of educational development in China. Education in China has improved enormously in recent decades, as evidenced by lower illiteracy rates, higher compulsory education rates, greater higher education rates, and more average years of schooling. During these decades, gender inequality in education has decreased, as illustrated both by census year trends and birth cohort trends. However, there are still some aspects of educational development that go beyond general trends and that should be noted.

Firstly, there is room for further improvements that can enhance the current state of educational development. With the illiteracy rate in China already at a very low level, continuing efforts to eradicate illiteracy face difficult challenges. Literacy improvements should be focused on the West of the country. Increases to compulsory education rates are currently stagnant, with more than 2.6% of young people failing to advance to middle school; there is still a need for progress. People who do not intend to go to college often choose not to enter high school, and this reduces the proportion of the population with high schooling in the educational structure, even in younger cohorts. To ensure further improvements in the educational structure and the development of higher education, it is necessary to encourage these people to advance to the high school (including vocational high school) level (Wang 2017). Regional disparities in higher education rates are increasing, and the negative consequences of this trend should be a focus of attention. The education of the rural population needs to be further improved and the urban–rural gap in education needs to be reduced. It seems that urban–rural inequality in education is now much more of a concern than gender inequality.

Secondly, improvements to education have, for the most part, favored women over men, and gender inequality in education has been reversed, resulting in the emergence of a new form of gender inequality that puts males at a disadvantage. Increased educational opportunities for females and their relatively better academic abilities have enabled women to catch up with and surpass men in educational attainment. The increase in women's access to education has been made possible by the higher education expansion programs, and lower fertility rate, which means that resources are less diluted by fewer children (or even just one child) in the family. To some extent, women have benefited more from the expansion of higher education is an unintended consequence of a strict fertility policy. In addition, women's greater access to college is largely due to their better academic abilities rather than their disadvantaged position in the labor market. The fact that women are more educated than men may lead to a range of social changes and social problems, such as a shift in family values and a challenge in finding suitable partners for marriage. Such changes should be the subject of further research.

Lastly, women are still at a gender disadvantage in advancing to Ph.D. programs, which indicates there is a ceiling that discourages or prevents women from pursuing the most specialized careers. As women are academically more capable than men, they give up advancing to Ph.D. programs largely by choice. The increased pressure women face as they age and age discrimination could be key factors explaining women's lower advancement rates from Master's degrees to Ph.D. programs and the lower proportion of women with doctoral degrees. Therefore, more effective social support policies should be implemented for highly educated women so that they do not feel compelled to give up their careers because of marriage and childbirth.

Declarations

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