

## REVIEW

# China's Demographic History and Future Challenges

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On 28 April 2011, China's state statistics bureau released its first report on the country's 2010 population census. The report states that the total population of mainland China reached 1.3397 billion in 2010, with an annual average population growth rate of 0.57% during the previous 10 years. The share of the total population aged 0 to 14 declined from 22.9% in 2000 to 16.6% in 2010, whereas the proportion aged 65 and above grew from 7.0% to 8.9% during the same period. This indicates that China's population is aging rapidly. The report also shows that China is urbanizing, with nearly half of the population—665.57 million people, or 49.7%—living in urban areas, an increase of 13 percentage points over the 2000 figure. Moreover, about 260 million Chinese people are living away from where they are formally registered, and the overwhelming majority of them (about 220 million) are rural migrants living and working in urban areas but without formal urban household registration status. China is at a demographic turning point: It is changing from an agricultural society into an urban one, from a young society to an old one, and from a society attached to the land to one that is very much on the move.

There was considerable uncertainty about the size of China's population before 1953, when the country held its first national census of modern times (1). The population enumerated by the 1953 census, 594.4 million, revealed rapid population growth at a very high rate (2). China then conducted a partial census in 1964 and a complete one in 1982 with support from the United Nations Population Fund (UNFPA). China has since carried out censuses in 1990, 2000, and 2010 (Table 1). Although the national population census is the most reliable source of demographic data, the household registration system and other survey data collected by various government agencies and academic institutions also provide information of varied coverage and quality. However, there are widespread concerns in the scientific community regarding the quality of some of these population data. An example is the current controversy as to the level of fertility in the country and its regions (3). Users of Chinese population data should bear these concerns in mind.

## Review of the Past and Current Demographic Situation

The current demographic situation in China reflects the profound demographic transition of the past several decades. Both mortality and fertility have declined substantially.

The country's crude death rate fell from about 25 deaths per thousand per year in the early 1950s to about 7 per thousand today; life expectancy at birth has almost doubled, from 40 years to around 73 years [see (4) for a discussion of mortality during the early years of the PRC]. The period 1959–1961 witnessed an exceptional demograph-

ic fluctuation mainly attributable to the great famine, with more than 20 million excess deaths and the postponement of 20 million births (5). China's most substantial mortality decrease took place in the period between 1950 and 1975, when the country was still one of the poorest in the world. This rapid decline of the death rate is mainly a result of economic development and improvements in education and health services, especially the public hygiene movement that resulted in a sharp drop in mortality from infectious diseases (6). Rapid mortality decline was recorded first among children and young adults and then spread to middle- and old-age groups (7). The infant mortality rate has declined from 203 per thousand

births in 1949 to 14 in 2010. Mortality decline has continued throughout the period of China's economic reform since the late 1970s, although at a slower pace. Cardiovascular disease, cancers, and respiratory and digestive diseases are now the leading causes of death, and the situation is quite similar to that of developed countries (8).

High fertility and declining mortality dominated China's demographic profile before the early 1970s. As a consequence, the first two decades of the PRC (1950 to 1970) were a time of rapid population growth, with an average annual growth rate of above 2%. Fertility decline emerged first in the country's urban areas in the mid-1960s and is attributed partly to the increased availability of contraceptive services provided to urban residents. However, the country's nationwide fertility transition dates from the early 1970s and was initiated by the government-sponsored family planning program. The total fertility rate (TFR) declined sharply from about 5.8 births per woman in 1970 to 2.8 births in 1979, a decrease of more than 50%. The TFR dropped to below the replacement level in the early 1990s and is now thought to be around 1.5 births per woman.

There is no doubt that government commitment, and the efficient and sometimes coercive implementation of the family planning program, were the major determinants of China's rapid fertility decline. No numerical birth-control target was set when China began its nationwide family planning program in the 1970s. Instead, the program of the 1970s emphasized late marriage and childbearing, longer interbirth intervals, and therefore fewer children. The so-called "one-child policy" was introduced in the late 1970s—after most of the fertility decline had occurred, and partially as a response to China's ambitious stride toward

**Table 1.** Major demographic indicators for mainland China. National Population Census data for 1953, 1964, 1982, 1990, 2000, and 2010 were provided by the National Bureau of Statistics of China.

Indicator	1953	1964	1982	1990	2000	2010
Population (millions)	594.4	694.6	1008.2	1133.7	1265.8	1334
Birth rate (per 1000)	37.0	39.3	22.3	21.1	14.0	12.6
Death rate (per 1000)	14.0	11.6	6.6	6.7	6.5	7.1
Natural increase (per 1000)	23.0	27.8	15.7	14.4	7.6	5.5
Family household size	4.3	4.4	4.4	4.0	3.4	3.1
Percent aged 65+	4.4	3.6	4.9	5.6	7.0	8.9
Percent aged 0 to 14	36	39.9	33.6	27.7	22.9	16.6
Total fertility rate	5.8	5.8	2.6	2.3	1.7	1.5†
Female life expectancy	—	—	69.3	70.5	73.3	76†
Male life expectancy	—	—	66.3	66.8	69.6	72†
Infant mortality rate	138.5	84.3	34.7	32.9	28.9	13.8
Sex ratio at birth (female = 100)	104.88	103.86	108.47	111.3	116.86	118.06
Illiteracy rate*	—	33.6	22.8	15.9	6.7	4.1
Percent urban	13.0	18.3	20.9	26.4	36.2	49.7
Per capita GDP (RMB yuan)	—	—	528	1644	7858	25575†

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\*For 1964, this refers to the population aged 13 and over who are unable to read; for 1982, 1990, 2000, and 2010, this refers to the population aged 15 and over who are unable to read or have difficulty reading. †Figures for 2009. ‡Estimated.

**Table 2.** China's provincial population statistics around two census years in the 1980s and 2010s. Grouping of provincial units into three main areas (eastern, central, and western) is based on an official government statement in 2000. Census statistics for Chongqing and Hainan were not available in 1982 because

these two provincial units were set up in later years. The overall dependency ratio is calculated as [(number of people aged 0 to 14 and those aged 65 and over)/(number of people aged 15 to 64)] × 100. Data were unavailable for empty cells. (View map of China's provinces at [www.scim.ag/pRObQz](http://www.scim.ag/pRObQz).)

Region	Province	2010s						1980s				
		Total fertility rate (2010)*	Life expectancy (2010)*	Overall dependency ratio (2010)†	Sex ratio at birth (2005)‡	Percentage of urban population (2009)†	Per capita gross regional product (\$US, 2010)\$	Total fertility rate (1982)†	Life expectancy (1981)#	Overall dependency ratio (1982)†	Percentage of urban population (1982)†	Per capita gross regional product (\$US, 1982)\$
P.R. China		1.63	73.7	34.17	118.6	45.68	4358	2.60	67.8	62.60	21.13	277
Eastern area (11 provinces)	Beijing	1.00	77.8	20.92	113.9	85.00	9233	1.44	72.0	40.10	58.62	883
	Tianjin	1.20	76.8	22.43	114.6	78.01	7789	1.61	71.1	41.96	53.00	776
	Hebei	1.65	74.7	33.46	120.1	43.00	2869	2.48	70.7	57.38	—	169
	Liaoning	1.20	75.4	27.76	112.3	60.35	3654	1.70	70.8	50.40	49.00	467
	Shanghai	0.90	79.3	23.08	117.4	88.60	10711	1.42	73.0	34.48	61.95	1513
	Jiangsu	1.30	75.9	31.41	124.3	55.60	4847	2.01	69.6	52.72	15.66	341
	Zhejiang	1.35	76.7	29.12	113.6	57.90	6184	1.59	69.7	53.96	—	317
	Fujian	1.50	74.7	30.46	122.0	51.40	4432	2.57	68.6	69.15	—	241
	Shandong	1.65	75.9	34.37	114.1	48.32	4846	2.11	70.2	57.85	10.33	281
	Guangdong	1.80	74.4	30.96	118.9	63.40	5506	2.48	68.6	64.85	17.93	333
Central area (8 provinces)	Hainan	1.70	75.0	38.50	123.0	49.13	1957	—	—	—	—	—
	Shanxi	1.80	73.9	32.77	116.2	45.99	3091	2.44	67.9	62.23	21.47	291
	Jilin	1.20	75.2	25.58	112.5	53.32	2655	1.87	69.0	59.13	39.60	284
	Heilongjiang	1.40	74.6	25.44	109.6	55.50	2748	1.91	68.4	62.10	39.91	403
	Anhui	1.87	74.0	39.20	130.8	42.10	2087	2.49	69.4	67.22	14.30	198
	Jiangxi	2.00	71.8	41.80	125.6	43.18	2157	2.62	66.3	76.34	19.45	213
	Henan	1.65	73.7	41.56	115.4	37.70	2684	2.90	69.8	67.03	14.42	187
	Hubei	1.70	73.4	29.87	128.8	46.00	2752	2.46	65.8	60.54	17.68	267
Western area (12 provinces)	Hunan	1.75	73.1	37.74	121.3	43.20	2567	2.43	64.5	63.72	14.21	227
	Sichuan	1.55	73.5	38.73	114.8	38.70	1612	2.00	64.3	64.10	12.13	200
	Guizhou	1.80	69.7	51.03	124.5	29.89	1064	3.03	61.9	83.65	33.27	147
	Yunnan	1.70	69.3	39.59	112.1	34.00	1876	2.67	61.5	77.53	13.19	179
	Xizang	—	68.3	41.76	103.7	23.80	2015	3.81	—	70.07	9.84	287
	Shannxi	1.70	72.7	30.28	133.1	43.50	2693	2.67	65.2	60.36	—	203
	Gansu	1.65	70.8	35.85	114.9	32.65	1752	2.30	66.1	66.14	15.49	208
	Qinghai	1.96	69.7	37.40	116.6	41.90	2774	2.59	61.6	76.05	20.36	271
	Ningxia	2.00	72.7	38.68	106.8	46.10	2569	2.60	65.9	80.02	18.57	248
	Xinjiang	2.20	70.8	36.91	105.0	39.85	2580	3.13	61.3	82.42	28.48	258
	Guangxi	1.90	73.6	44.82	120.7	39.20	2166	2.71	68.3	74.13	12.24	187
	Neimenggu	1.50	72.5	27.65	115.4	53.40	3827	2.13	67.0	64.28	29.11	254
Chongqing	1.50	74.0	39.94	112.2	51.59	2346	—	—	—	—	—	

\*Data from the 2010 Internal Statistics Reports of the National Population and Family Planning Commission of China. †Data compiled using the National Population Census in 2010 and 1982. ‡Data from the National Sample Survey of Population Changes in 2005. §Data calculated by using reports of provincial population data of 2010 Census and corresponding Statistics Bulletin of the National Bureau of Statistics of China. Per capita dollar amounts are calculated from the yearly average exchange rates for 2010 (\$US 100 = 682.67 RMB) and 1982 (\$US 100 = 189.25 RMB). #Data from China Population Information and Resources Center, China Population Data Sheet 1987.

modernization—and its implementation relied heavily on government administrative systems with financial and other incentive and disincentive measures. In fact, China has never implemented a pure one-child policy. In general, a strict “one-child policy” has only been carried out among urban residents. The majority of the rural families are allowed to have two children, whereas regulations for minority ethnic populations are more flexible (9). Therefore, the term “one-child policy” is an oversimplification. It is also evident that other social and economic factors, such as advances in education, improvements in the position of women, and reductions in mortality, also contributed to the general fertility decline.

There has always been marked regional variation in all demographic indicators in China. Thus, TFRs today range from above 2.2 births per woman in some of the inland provinces to well below 1 in the major cities of Shanghai and Beijing (Table 2). Similar variation exists with respect to life expectancy: The highest, 79 years, is recorded in Shanghai; the lowest, about 69 years, is reported for Yunnan and Qinghai provinces and Xizang (Tibet) autonomous region. Urbanization and population aging show similar regional patterns. Thus, the more socioeconomically advanced regions of the country tend to be much more urbanized and to have older populations.

The level of urbanization in China before the 1980s was quite low, and it increased very slowly over time. Indeed, the country was widely viewed as an example of “underurbanization”—that is, a case of industrial growth without parallel urbanization. Only about 20% of the population lived in urban areas in the late 1970s (Table 1). However, the urbanization process has accelerated since the beginning of China's economic reforms in the early 1980s. Today about half of the population lives in the country's 655 cities and more than 20,000 towns. Between 2000 and 2010, the urban areas absorbed more than 15 million newcomers each year. People are increasingly

concentrated in relatively small geographic regions, particularly in city belts such as those of the Yangtze River and Pearl River deltas and the Beijing-Tianjin region.

The urbanization process during the reform era follows a worldwide trend of an increasing share of the population residing in cities. However, it also has a distinctive trait that challenges how we understand the increasing complexity of global urbanism, which can be partly attributed to China's social segregation based on the household registration system (*Hukou*) (10). The country's economic reforms have led to an unprecedented rural-to-urban migration, and this has contributed greatly to the rise of the urbanization level. Because the family planning policy has been implemented more rigorously in urban areas, and because many big metropolitan areas (such as Shanghai) have already experienced negative growth of their own native populations, recent rises in urbanization level and in the number of urban residents have mainly been due to changes in city scale and urban territorialization (11) and the settlement of migrants. Unprecedented rural-urban migration has reshaped the geographic distribution of the Chinese population.

As in other eastern Asian countries, the demographic transition created a favorable impetus that contributed to the nation's rise (12). Lower fertility increases women's participation in the labor force and helps to improve levels of education, health, and nutrition. Lower fertility reduces the dependency ratio—that is, the ratio of the working-age population to the younger and older (nonworking) segments of the population—within families. Lower fertility also increases opportunities to acquire income beyond the basic necessities of life. For China as a whole, the labor force continually increases as a result of the high fertility of two or three decades ago. The working-age population (aged 15 to 64), according to the 2010 census, accounted for 74.5% of the total population—a much higher share than that of many developed and developing countries. This results in a low overall dependency ratio (Table 2). Millions of young peasants migrate into the cities to match the strong growth of labor demand in the manufacturing and service industries, which also has been encouraged by various reforms of the social security and welfare systems. As a result, China has been able to have more investment and savings and a steadily rising gross domestic product (GDP). In other words, China has happily enjoyed its so-called “demographic bonus” during the past 30 years (13). But the window for harvesting this bonus may close soon (14).

China has avoided a massive population explosion, but there have been huge social and economic costs. The abnormally masculine sex ratio at birth is one such example. This was first reported in the 1980s and has worsened since then. The latest census reveals that in 2010, for every 100 newborn girls there were 118 boys. The current

male-to-female ratio of 118 is slightly lower than the figure reported previously, 119 in 2005, even though tough policies and measures have been introduced to address the issue in the past decade. There are marked regional differences in this regard. In general, the abnormalities are less severe in some western provinces and the autonomous regions, but more serious in the central and southern parts of China. Strong son preference and widely available pre-birth sex identification and sex-selective abortion are the main causes of this gender imbalance at birth (15).

Another major consequence of China's demographic transition is rapid population aging. The country reached the threshold of an aging society (i.e., population aged 65 and above accounting for more than 7% of the total population) in 2000. The aging process has progressed very rapidly as the cohort of baby boomers has reached the retirement age. By 2010, the population aged 65 and above amounted to 118.8 million, versus 100.45 million in 2000. It is interesting to note that in eastern China and the major urban centers, the aging process has slowed because of the immigration of many young laborers from the countryside (Fig. 1A) (16). However, in turn, this leads to a more serious aging challenge in the rural areas (Fig. 1). Moreover, aging in China is occurring at a much earlier stage of socioeconomic development than seen in European countries and in Japan.

### What Lies Ahead for China's Demographic Transition?

China's population will certainly grow in the future, even though the current TFR is well below the replacement level of 2.1. However, two key questions remain: (i) For how long will this growth continue? (ii) What will be the peak future size of the population? Given the current sociopolitical setting, the government's population policy will be one of the decisive factors that determine the answer to these questions. There is a consensus that the mortality rate will continue to decrease, although perhaps on a slower path. Therefore, differences in population projections are mainly due to varied assumptions regarding the family planning policy and the fertility level.

Many population projections for mainland China have been made by scholars and organizations both in and out of China. It is impossible to cover all of them in this article; therefore, only a few are selected for discussion. Figure 2A refers to projections that assume a constant fertility rate, and Fig. 2B shows projections that allow for changes in population policy and consequent change in fertility rate. All projections agree that China's population will continue to grow for at least another decade. However, there are marked differences in terms of the peak population, which ranges from 1.35 to 1.507 billion because of disagreement about the present fertility level in China. Projections made by Goldman Sachs are exceptional, showing that China's population will continue to

grow even after 2050. By assuming that the current policy remains unchanged and assuming a TFR of 1.6 to 1.7, Zeng (17) and NPPFC (National Population and Family Planning Commission of China) (18) project that the population will reach a peak of around 1.41 billion in 2025 (Fig. 2A), which will be followed by a rapid decline after 2030. The latest version of projection made by the United Nations Population Division (19) is very much in line with this. Assuming a TFR of 1.47, a rate lower than the official one, Wang Feng projects a peak population of 1.35 billion in 2023 (20). Goldman Sachs (21) based their projections on detailed assumptions from the World Bank Population Unit (slightly adjusted toward the UNPD medium-variant standard) and claimed that the population will continue to grow during the next 40 years, and that in 2050 its size will reach 1.53 billion.

The projections shown in Fig. 2B are based on varied assumptions with regard to population policy. Relaxing the current “one-child policy” to a “two children for one-only-child couples” (i.e., couples in which one party was an only child) policy (22) will lead to a peak population of about 1.45 billion in 2030 (18) or 1.49 billion in 2037 (17). If there is a shift to a universal “two children for all couples” policy, then China's peak population size will be about 1.5 billion, reached in 2030. Under the “two children with late childbearing” scheme, the peak population will be about 1.48 billion in 2038. With entirely different assumptions, Goldman Sachs (21) assumed a total relaxation of the “one-child policy” from 2010 onward, with the result that the population will continue to grow to 1.67 billion in 2050.

Except for the projection made by Goldman Sachs, most recent projections—including others not mentioned in this review—envision a peak population for mainland China of around 1.45 billion to 1.5 billion, a figure that will be reached around 2025 to 2030. In fact, there is a near consensus among researchers that the country's population growth will be slower, and stop earlier, than previously projected; for example, the earlier forecast made by NPPFC, assuming no policy change, projected a peak population of 1.6 billion by 2035.

The age structure of the population is another important component of the projections. As shown in Fig. 2C, aging will undoubtedly characterize China's demographic prospects for much of the 21st century. Population aging is foreseen under all scenarios and is roughly comparable. The proportion of the elderly aged 65+ will slowly exceed 10% from now to 2015 and then rise rapidly, reaching 20% and 25%, respectively, in the periods 2015–2035 and 2040–2050 (17, 18, 23). The absolute size of the elderly population is expected to reach 200 million by 2025 and 300 million by 2040. In addition, note that the proportion of the population aged 65+ under the “current policy unchanged” scenario will be higher than in other scenarios by an appreciable

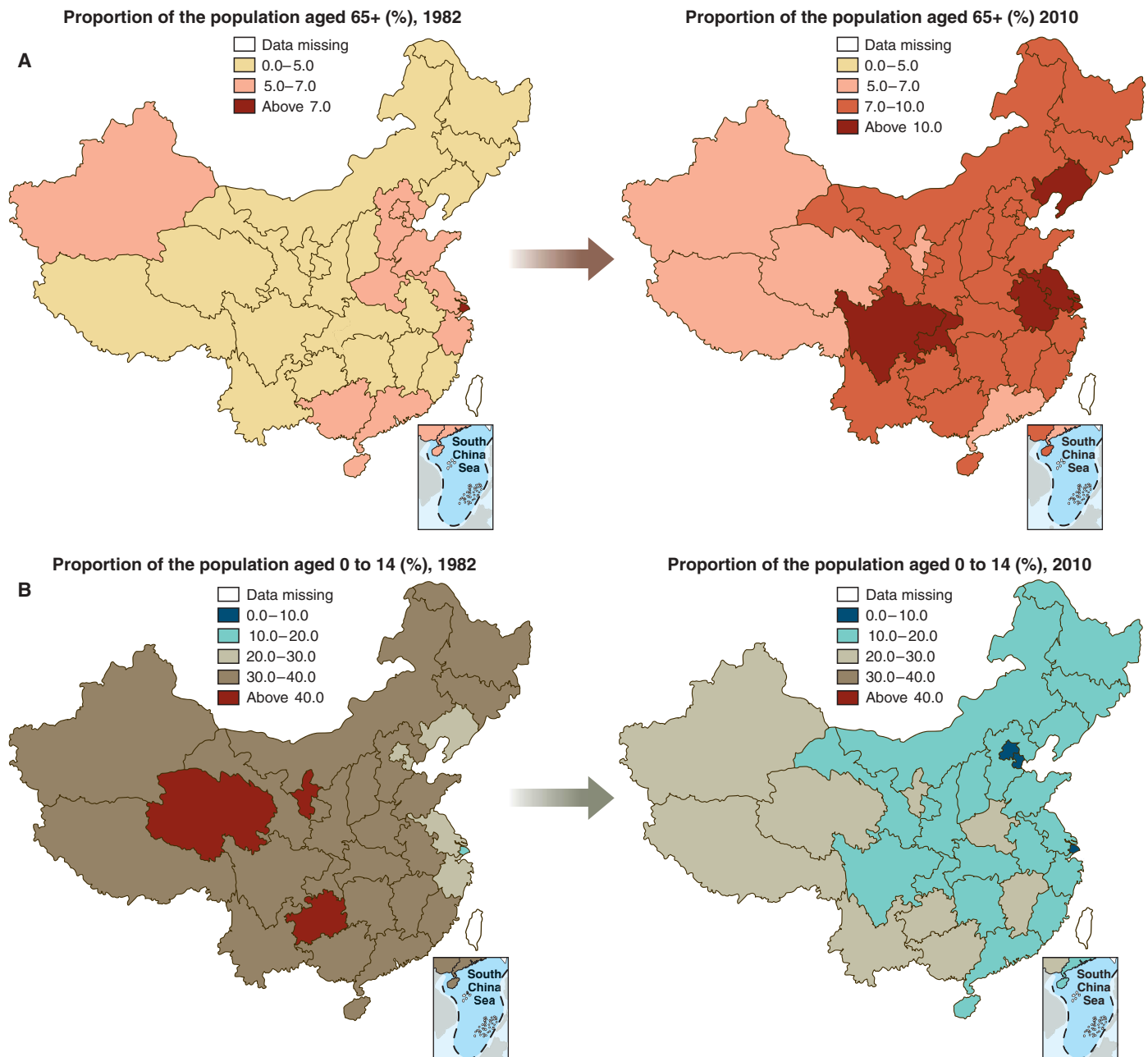
degree. This is because lower fertility will inevitably mean more rapid aging (18).

Although the increase of the elderly population will surpass the rest of the age groups, the working-age population (aged 15 to 64) in China will remain enormous, both in terms of absolute size and as a share of the total population. The influence of potential adjustments in population policy on the size of the working-age population will only emerge after the period 2025–2030. All projections show that China's working-age population will continue to grow in the next decade, that it will reach a peak of around 980 to

1000 million around 2016–2020, and that this will then be maintained for a while. The shrinking of the working-age population is more or less inevitable around the time that the population stops growing. The size of the working-age population will largely be determined by changes in population policy and the prevailing fertility level. The working-age population would gradually decline to 800 million under the “current policy unchanged” scenario and would be a little less than 900 million under the “two children for one-only-child couples” scenario. Varied policy adjustment and TFR options can result in the size

of the working-age population in China ranging between 780 million and 1000 million in 2050.

Moreover, the huge migration involved in the process of urbanization has always been regarded as one of the motive forces of China's economic growth and development. The scale and pace of urbanization promise to continue at an unprecedented rate. If current trends hold, the urban population will expand from about 665 million in 2010 to 926 million in 2025 and will hit the 1 billion mark by 2030 (24). This means that China's cities will add 335 million people in the next 20 years—more than the entire



**Fig. 1.** (A) Provincial distribution patterns of the population aged 65 and over (left, 1982; right, 2010). (B) Provincial distribution patterns of the population aged 0 to 14 (left, 1982; right, 2010).



population of the United States today. Most of these 335 million new urban residents (240 to 260 million) will be rural-urban migrants. This growth will undoubtedly imply mounting pressures for many cities. After all, there will be 219 cities with more than 1 million inhabitants by 2025, compared with just 35 in Europe today. Moreover, 24 of these cities will have more than 5 million people (24).

From the projections above, it seems that for the short run, China's population will continue to grow, and the working-age population will remain abundant. The trend, however, will begin to change in the next decade as the aging of the population accelerates, and this will have profound impacts on China's future development. China's population will decrease not because of war, plague, or famine, but rather because of human choices, and China will face the challenge of population decline and population aging.

There are uncertainties. Many population projections emphasize an adjustment of government population policy. But fertility policy and retirement policy may undergo further changes in the future. If so, when will any such changes occur? Will any changes in policy have much effect? Little attention is devoted to the impacts of socioeconomic and political factors; China's social, economic, and cultural variants mean that we may never exactly grasp what lies ahead in terms of future demographic trends. There are uncertainties from the regional differences, and most projections treat China as a whole and ignore the vast regional variation. Uncertainty also comes from population migration. Whether Chinese cities can absorb ever larger numbers of newcomers under environmental and development constraints is unknown. Also, little is known about how urbanization will change millions of Chinese farmers' demographic behavior and further affect future demographic trends.

### Challenges and Opportunities

China is completing its demographic transition within a compressed time period relative to most other countries in the world. Although the country has benefited, particularly in terms of economic growth, from rapid and constant mortality and fertility decline and rapid urbanization, it also faces great challenges to adapt to

these changes. If not properly managed, such adaptations could incur a variety of risks.

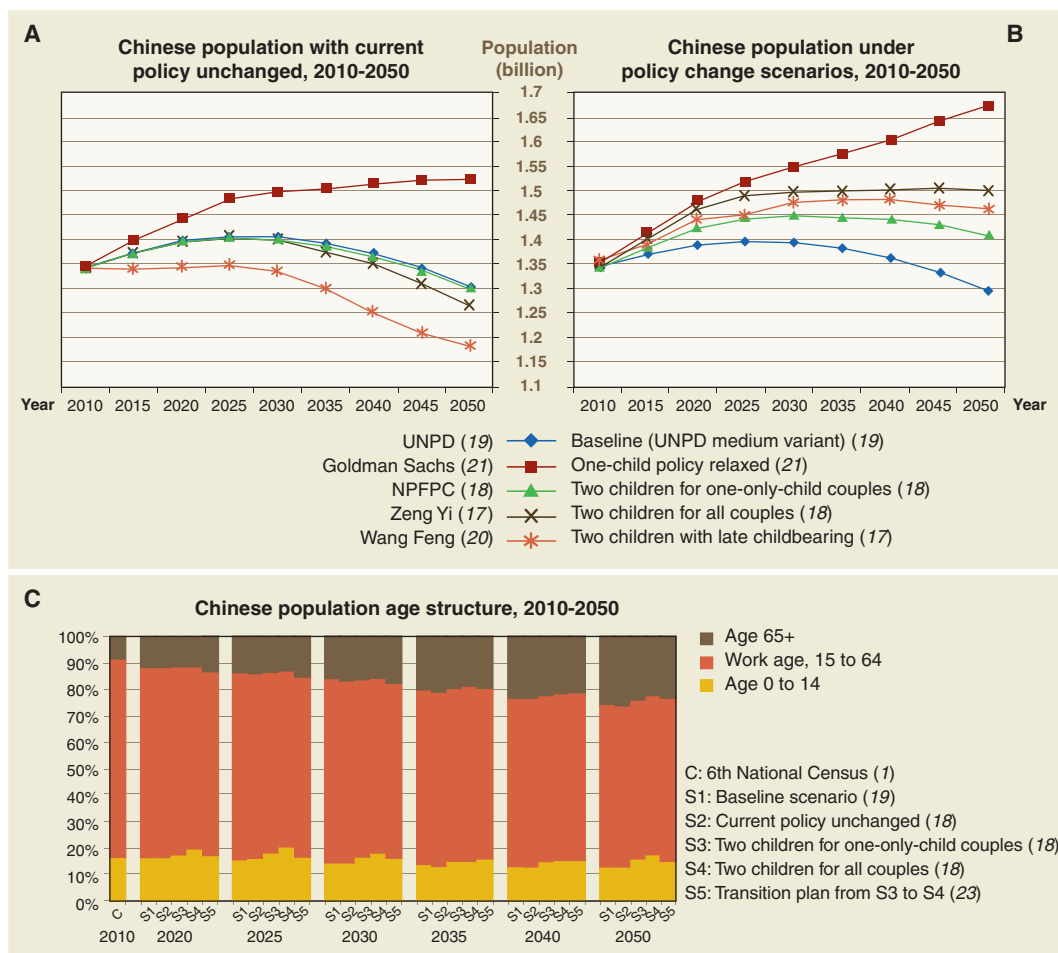
It is clear that demographic factors are crucial to economic growth in China. One-fourth (26%) of China's economic growth from 1965 to 2005 can be attributed to the growth of the working-age population (25). China's working-age population is estimated to peak at 1 billion by 2015 and will start to decline thereafter (19). As a result, the labor market demand/supply relationship is changing. On the other hand, even as one of the fastest-growing economies, China is struggling to keep up with millions of new entrants into the urban labor market, which needs to create about 20 million jobs annually to absorb both local labor market entrants and incoming rural migrants.

The slower growth and eventual decline of the labor force could constrain future economic growth and could have a profound impact on development (26). Excess cheap labor supply, which is one of the major factors driving China's economic miracle, will no longer be available; this will push wages upward and possibly reduce the global competitiveness of China's manufac-

turing exports. On the other hand, higher wages may increase internal consumption and standard of living. On the whole, this demographic change may transform China from an "abnormal economy" into a "normal dynamic emerging economy" (27). Some have argued that it is approaching the "Lewis turning point" and that any demographic dividend is to be exhausted (13).

These changes in labor supply will inevitably lead to a geographic restructuring of the economy. Labor-intensive, export-oriented industrial clusters in the big city centers and the coastal regions may have to move into inland provinces where cheap labor is still available, or may be transferred to other developing countries.

With the working-age proportion beginning to decline in the country, it will be a good chance for China to raise the legal retirement age, currently set at 60 years for men and 55 for women. This is an arrangement that was introduced in the early 1950s, when life expectancy at birth was only about 40 years. Furthermore, regulations and policy measures should be adapted to increase old-age labor force participation and to remove direct



**Fig. 2. (A)** Chinese population with current policy unchanged, 2010–2050. **(B)** Chinese population under policy change scenarios, 2010–2050. **(C)** Chinese population age structure, 2010–2050.

or indirect barriers to workers continuing in employment beyond the normal retirement age.

Another response to the potential labor shortage in China is to improve labor productivity by investing more in human capital and skills, by moving up the value chain and creating higher-productivity jobs, by more efficient allocation of labor between sectors, and by improving the efficiency of the labor market. Remarkable success has been achieved in raising the educational level of the Chinese people over the past several decades. The latest population census reveals that the illiteracy rate for people aged 15 and over has decreased from 6.72% in 2000 to 4.08% in 2010 (Table 1) and that people attending a university and pursuing a college education amounted to 120 million, including around 29 million students currently studying in higher education institutions, which makes China's higher education system the largest in the world (28). The Chinese government has committed to increasing its investment in education, but public spending on education was only 3.59% of the GDP in 2009—a figure lower than in many developing countries. China must make the transition from a country with a large labor force to one with abundant human capital (29). To reach this end, more innovation and reform in China's overall education system are absolutely required.

The elderly population will increase markedly over the next half century, both in terms of absolute numbers and as a proportion of the total population. At present and for the near future, the very large younger segment of the old-age population (i.e., people in their 60s) is the result of the baby boom in the 1950s and early 1960s. However, the proportion of the oldest old (i.e., 75 years and over) will increase substantially within about 20 years. This will put huge pressure on pension and health care systems.

China introduced a Western-style pension system in the late 1990s, and the system today is divided along rural-urban lines and regionally fragmented with decentralized financial and administrative management (30). The existing social protection arrangements, including pension, in China is in itself inequitable and therefore tends to broaden the urban-rural and regional gap rather than narrowing it (31). By the end of 2010, the Urban Basic Pension System covered 257 million urban residents, or about 40% of the urban population. In addition, 100 million rural people—15% of all population living in the countryside—have joined the new rural social pension system (32).

Moreover, the sustainability of these systems is a major issue. Huge deficits in the country's pension system are expected if no further reform is conducted. Some argue that under the current system, assuming a replacement rate (pension as a percentage of final salary) of 52%, an annual deficit in the urban basic pension system will emerge as early as in 2015, and the total deficit would be equivalent to 95% of the total annual

GDP in 2050 (33). Relaxation of current family planning regulations and a higher fertility rate may ease the future burden of any pension deficit to some extent, but it cannot reverse the general aging trend. More reforms of the integrated multi-pillar pension arrangements must be carried out to expand the financial and service resources for old-age support and make the system more equitable (34).

The government launched its ambitious universal medical insurance program only a few years ago. By 2010, the urban basic medical insurance scheme covered 432 million people, or two-thirds of total urban residents. In the countryside, 95% of farmers joined the new rural cooperative health-care system. The quality of and accessibility to the public health service varies among regions and among different social strata; this has become an issue of social justice and equity. Demographic changes, and population aging in particular, will certainly be one of the main causes of increasing expenditures for medical service. Although it is crucial to provide better medical service to the elderly population, it is equally important to promote a healthy lifestyle among younger age groups.

One of the results of China's demographic change is the weakening of family capacities and functions. The traditional family support system is eroding with migration and fewer children per family, and this will present a great challenge to the continuation of the country's cultural traditions. There is a whole generation of families, or about one-quarter of all families, that have only one child. The size of the single-child group amounts to more than 100 million at present. The single-child generation has some special characteristics (such as self-centeredness) and behaves differently from other generations, although the difference may not be as big as is commonly stereotyped (35). This unique demographic phenomenon will certainly influence the country's socioeconomic development and its political future as well. However, systematic research on the potential societal impacts of adults who grew up in single-child families has been extremely limited.

The severe imbalance in sex ratio at birth is expected to be gradually reversed in the near future, and the consequence of this phenomenon—which lasted for three decades—will soon begin to emerge. By 2025, China will have a deficit of young females at typical marriage ages ranging from 20 million to 30 million (36). A severe “marriage squeeze” (the extent to which changes in marital ages by sex reflect the relative supply of potential husbands and wives) is expected and has become the most widely discussed implication of sex-selective abortion, not only in scholarly literature but in the popular media as well. The marriage squeeze may lead to serious instability in the institutions of marriage and family and consequently poses a great threat to the

stability of the country's social order. The poorest poor in China's countryside will be the social group suffering most. Changes in marriage pattern, including importation of brides from abroad, are expected, although the factors that may alter the pool of potential spouses are much more complicated. Marriage squeeze will inevitably affect the country's future development in all aspects, even its huge foreign exchange reserves (37).

As the world is becoming more urbanized around both megacity regions and smaller cities, China offers valuable lessons on the continued power and limitations of top-down state planning relative to the growing influence of global capital and local markets in shaping megacity regions on the booming coast and smaller centers in the less-developed interior. The Chinese government has just published a national plan that has defined the functions of regions at local levels with differentiated policies to sustain the country's development. Local governments must optimize, accelerate, restrict, or prohibit industrial development and urbanization as well, in different regions according to the national plan of the development priority zones (38). Although state-guided development of major city regions will continue to drive urbanization and economic growth in China, increasing differentiation in catch-up development—in conjunction with varied historical conditions and local endowments—may become more important in determining the future trajectory and socioeconomic consequences of urbanization in China (39).

With its huge population, China must find ways to sustain and conserve natural resources. An ever-increasing population will inevitably exert greater impacts on China's already troublesome food supply, water shortage, and environmental pollution problems.

Per capita water resources in China are only about 2200 m<sup>3</sup>, about one-fourth of the world's average. With population growth and industrial development, water shortages have already affected major cities and have become one of the bottlenecks for sustainable development. China may be caught between growing demand for fresh water on the one hand and limited and increasingly polluted water supplies on the other.

China lost around 12.4 million ha of arable land between 1980 and 2008. This reduction in arable land can be attributed to three main factors: industrialization, construction of residential buildings, and land degradation. With a constantly decreasing arable land area and continued increase of the population, China is getting closer to the threshold of arable land scarcity, whose rough benchmark was defined by geographer Vaclav Smil as 0.07 ha per person (40). China may have the ability to ensure food supply by intensifying the use of land and increasing reliance on modern material input and agricultural technology (41). China's demand will certainly

affect international food markets and the global food balance.

China is already among the largest emitters of carbon dioxide in the world. Population growth is viewed as one of the decisive factors that will drive future climate change. New research suggests that, in addition to population size, changes in population structure, urbanization, and household size also contribute to climate change. Urbanization leads to a substantial increase in carbon emissions, whereas the aging process leads to a decrease. The net effect of demographic change is to increase projected emissions for China by 45% over time (42). However, the demographic impact on climate change should not be overstated, as it accounted for only one-third of the country's emission increase; industrialization, urbanization, and consumption are more important factors determining future carbon emissions in China (43).

Demographic changes in China will have important global impacts. Given all of the factors discussed above, a future population decline may be desirable for China. But rapid or even sudden population decline would be disastrous, and it would be very difficult to stop. Maintaining the present low fertility would be worrisome. Overall, it would be rational for China to modify its current population policy and to relax the rigid control on childbearing sooner rather than later, and to allow the TFR to grow and be maintained at around 1.8 in the near future. Then the country's population would decline and its aging process would be slower in the future, which would provide more time and a better social environment for China to cope with future population-related socioeconomic changes. China's population issues should be dealt with in an integrated and balanced way.

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## REVIEW

# Global Human Capital: Integrating Education and Population

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Almost universally, women with higher levels of education have fewer children. Better education is associated with lower mortality, better health, and different migration patterns. Hence, the global population outlook depends greatly on further progress in education, particularly of young women. By 2050, the highest and lowest education scenarios—assuming identical education-specific fertility rates—result in world population sizes of 8.9 and 10.0 billion, respectively. Better education also matters for human development, including health, economic growth, and democracy. Existing methods of multi-state demography can quantitatively integrate education into standard demographic analysis, thus adding the "quality" dimension.

Human beings have many observable and measurable characteristics that distinguish one individual from another; these char-

acteristics can also be assessed in aggregate and used to distinguish one subgroup of a population from another. Here, we focus on the level

## EDITOR'S NOTE

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In the Review “China’s demographic history and future challenges” in the 29 July special section on Population (1), Fig. 1 showed a map of the South China Sea. We have become aware that some readers are interpreting the publication of this map as a statement by *Science* on the maritime borders marked in the image. This is not the case.

*Science*’s policy, found on the masthead page of each issue, states that “all articles published in *Science*—including editorials, news and comment, and book reviews—are signed and reflect the individual views of the authors and not official points of view adopted by AAAS or the institutions with which the authors are affiliated.” *Science* does not have a position with regard to jurisdictional claims in the area of water included in the map. We are reviewing our map acceptance procedures to ensure that in the future *Science* does not appear to endorse or take a position on territorial/jurisdictional disputes.

**MONICA BRADFORD**

Executive Editor

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