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*Research Article*

### **Life expectancy in China and the contribution of regional dynamics**

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## **Life expectancy in China and the contribution of regional dynamics**

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### **Abstract**

#### **BACKGROUND**

Life expectancy in China has been increasing in recent decades, but regional inequalities persist. Unbalanced regional development has resulted in large-scale population movement. Over time, the changing regional distribution of the population changes the proportion of the population exposed to different regional mortality levels.

#### **OBJECTIVE**

The increase in national life expectancy can be attributed to changes in both regional mortality and the regional composition of the population. We aim to quantify the respective contributions of changes in mortality and in the composition of the population.

#### **METHODS**

We apply a decomposition method to data from the Chinese Disease Surveillance Points system from 2010 to 2020 and disaggregate the improvement in Chinese life expectancy into mortality and composition components.

#### **RESULTS**

Improvements in mortality were observed across all regions, positively contributing to the increase in national life expectancy. However, only the most and least economically developed regions – urban-east, urban-central, and rural-west – made positive contributions through the compositional component. All other regions contributed negatively, partially offsetting the progress made by the improvement in regional mortality.

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## CONTRIBUTION

Our work is the first to decompose the increase in Chinese national life expectancy into its regional contributing components of changing mortality and population exposure. This disaggregation of the different components at the regional level provides insights as to how to better address regional health inequality issues in China.

## 1. Introduction

Between 1950 and 2021, life expectancy in China rose by 4.9 years per decade, from 43.7 to 78.2 years (United Nations 2022). Although there were impressive achievements at the national level, inequalities within the country have always been a major concern. Gaps in mortality have been observed between the urban and rural populations, as well as between the residents of eastern, central, and western China (Chen and Canudas-Romo 2022; Fan and Sun 2008; Gao et al. 2002). In general, urban populations have lower mortality than rural populations, which translates into higher life expectancy for the urban populations (Wang and Li 2009; Peng et al. 2021). Life expectancy is also higher in the eastern provinces of China than in the central and western provinces (Yan 2024). While there are discernible differences in life expectancy at the regional level, the extent to which each region has contributed to national life expectancy and the mechanisms through which these contributions have influenced the overall change remain unclear.

The urban–rural divide in China has long existed and has been reinforced since China’s planned-economy era from the mid-1950s to 1978. To reach the country’s goal of rapid industrialization, privileges were granted to urban residents through preferential policies and unbalanced allocation of resources (Lin, Cai, and Li 2004; Whiting 2022), establishing a dual urban–rural system (Chan 2010; Song and Smith 2021; Zhang 2019) which incentivized migration from rural to urban areas. However, the *hukou* system created strong barriers to migration between urban and rural areas, and moving from rural to urban areas was virtually impossible before the late 1980s. In recent decades, especially the period between 2010 and 2020, population movements have been more active than ever. Between the 2010 and 2020 censuses the migrant population in China increased by 69.73%, from 221 million to 376 million, with over 60% (63.2% in 2010, 66.3% in 2020) being rural-to-urban migrants (National Bureau of Statistics of China 2010, 2020).

On top of the urban–rural inequality, there are geographic inequalities. During China’s transition from a planned economy to a market economy, unbalanced regional development was encouraged as a strategy to boost the national economy. In the mid-1980s, Deng Xiaoping, the then national leader, decided that “some regions and some

people may prosper before others do, and then they can help other regions and people to gradually do the same” (Deng 1994). Since then, major cities in eastern China have become the biggest beneficiaries of this policy and have experienced rapid socioeconomic development, while the central and western inland regions lag behind. A socioeconomic gradient gradually formed within the country, with the urban-east at the top of the hierarchy and the poverty-stricken rural-west at the bottom (Luo, Li, and Sicular 2020; Peng and Liu 2010).

Naturally, the unbalanced regional development induced large-scale migration (Liang and White 1996; Liang and Ma 2004; Shi et al. 2020). A large number of migrants moved from the less-developed western and central inland regions to the more-developed eastern coastal areas in pursuit of better employment opportunities and other benefits offered by the destination. In the most recent census, conducted in 2020, the number of internal migrants had reached 375.8 million, or about 26% of China’s total population (National Bureau of Statistics of China 2021). However, much of the internal migration was found to be temporary; previous studies have pointed out that many internal migrants return to their inland villages or nearby towns as they age (Gao, Qing, and Shen 2019; Song 2010).

The health implications of the distinctive regional inequality and large-scale population movement within China are significant and multifaceted. As observed in many societies, the health selection effects among migrants can impact the mortality level of both the origin and the destination (Namer and Razum 2018; Qi and Niu 2013). Meanwhile, population movements result in changes to the size and percentage of the population exposed to the different regional mortality risks in each age group. The demographic changes happening in China underscore the need to look beyond national averages and examine regional contributions to life expectancy more closely. Understanding these contributions can help policymakers identify specific areas where interventions are needed to address health inequalities.

A fair amount of literature has investigated the gap between national and regional health indicators in China, with some successfully depicting a trajectory of change over time (Guo 2018; Wang et al. 2021). However, how the increase in national life expectancy is impacted by changes in both regional mortality levels and population composition is still insufficiently explored. Previous studies have investigated the change in life expectancy at aggregated levels such as national and urban/rural. Such measures hide the regional dynamic behind the changes in national life expectancy over time. The lack of knowledge about regional mortality and compositional components also means that opportunities for targeted intervention are missed, underscoring the need to analyze and decompose population dynamics at the regional level. This study represents a first step toward filling this gap by examining regional changes and their effect on China’s national life expectancy.

## **2. Data**

We derived the data for mortality and population from the nationally representative Chinese Disease Surveillance Points (DSP) data, produced by the Chinese Center for Disease Control and Prevention (2010 and 2020). The nationally representative data cover the period from 2010 to 2020, with over 605 surveillance points and over 300 million people by 2020 (24% of the total Chinese population). The surveillance points were selected using an iterative method involving multistage stratification to cover the 31 provinces in mainland China. The surveillance areas' population size, degree of urbanization, and crude mortality rate were also taken into consideration to make the sample nationally representative (Liu et al. 2016).

The DSP data suffer from underreporting issues, especially among the population groups aged 0–5 and over 85. This issue has been confirmed by previous surveys of the DSP system and discussed in existing literature (Xing, Chen, Y., and Liu 2017; Liu et al. 2016; Guo et al. 2015). Liu et al. (2016), in an underreporting field survey, estimate that around 23% of deaths under age 5 were underreported in all DSP sites during the period 2009–2011, while for age 85+ the number was around 12%. To minimize the impact of underreporting and ensure the reliability of analytical results it is necessary to adjust child and old-age mortality rates prior to any type of analysis.

The mortality and population data are available for both females and males, rural and urban, and for three regions: west, central, and east. The definition of the urban and rural populations and areas included in each region is found in online Appendix 1. Under-5 mortality was adjusted by applying an urban/rural underreporting ratio calculated from the maternal and child health surveillance system (National Health Commission 2020) to account for underreporting. The underreporting ratios were generated after comparing DSP and the Maternal and Child Health Surveillance (MCHS) system data, which has higher data quality for under-5 mortality, although it is aggregated at the urban/rural level (National Health Commission 2020). The log-quadratic model (Wilmoth et al. 2012) with under-5 mortality and adult (ages 15 to 60) mortality as inputs was applied to adjust the regional mortality. Finally, the regional and national adjusted rates were harmonized (see online Appendix 2 for details about the log-quadratic model and step-by-step adjustment measures). The DSP data were grouped in 5-year age intervals (except for ages 0–1 and 1–4), with the highest age being 85. As an output of the log-quadratic model, adjusted mortality rates by single year of age were extrapolated until 110+. For comparison, the estimated Chinese life expectancy by subnational region was contrasted to those from populations in the Human Mortality Database (although it is important to note that HMD data are of particularly high quality) (HMD 2025). To demonstrate the difference from the results presented in the main text, calculations grouping old-age mortality data as 90+ vs. 110+ can be found in online Appendix 3. Table A-6 in online Appendix 4 compares

the all-China age-specific mortality rates from the UN World Population Prospects, China Population Census, and DSP system, as well as the results from the log-quadratic model used in this study.

### 3. Methods

There are multiple studies quantifying how the composition of subnational populations contributes to life expectancy at the national level. For example, the composition of subnational populations by education (Shkolnikov, Andreev, and Begun 2003; Shkolnikov et al. 2006; Luy et al. 2019), occupation group (Andreev et al. 2009), smoking status and health insurance (Horiuchi, Wilmoth, and Pletcher 2008), marital status (Jasilionis et al. 2012), urban–rural status (Torres, Canudas-Romo, and Oeppen 2019), and regional location (Su et al. 2024) can all shape life expectancy at the national level, alongside their respective mortality.

We build on the method of Torres, Canudas-Romo, and Oeppen (2019) and Su et al. (2024) and look at how life expectancy at the Chinese national level is affected by its subnational regions and urban–rural status. Let the national age-specific death rate be denoted as  $m(x, t)$  for age  $x$  and time  $t$ , and expressed as the average of subnational age-specific death rates, or  $m(x, i, t)$  of subpopulation  $i$  (corresponding to urban or rural, and west, central, or east), weighted by the age-specific subnational population composition (or  $c(x, i, t)$ ), as  $m(x, t) = \sum_i m(x, i, t)c(x, i, t)$ .

The life expectancy at time  $t$ , denoted as  $e_0(t)$ , can be expressed in terms of age-specific death rates. This is under the assumption that mortality is constant within each age interval (or piecewise hazard) and the force of mortality is equal to the age-specific death rates, so the survival function is expressed as  $\ell(a) = e^{-\int_0^a m(x,t) dx}$  and in terms of the subnational variables as:

$$e_0(t) = \int_0^\omega e^{-\int_0^a \sum_i m(x,i,t)c(x,i,t) dx} da. \quad (1)$$

To study the changes in national life expectancy, we derive it with respect to time. Let a dot on top of a variable denote the change in a variable with respect to time  $t$  (Vaupel and Canudas-Romo 2002). The changes in national life expectancy are decomposed into the contribution attributable to mortality changes, denoted as  $\Delta mortality$ , and to regional population composition changes, or  $\Delta composition$  (Torres, Canudas-Romo, and Oeppen 2019), as:

$$\begin{aligned} \dot{e}_0(t) = & - \int_0^\omega \ell(x, t) \int_0^x \sum_i \dot{m}(a, i, t) c(a, i, t) \, dadx \\ & - \int_0^\omega \ell(x, t) \int_0^x \sum_i [m(a, i, t) [r(a, i, t) - r(a, t)] c(a, i, t)] \, dadx. \quad (2) \end{aligned}$$

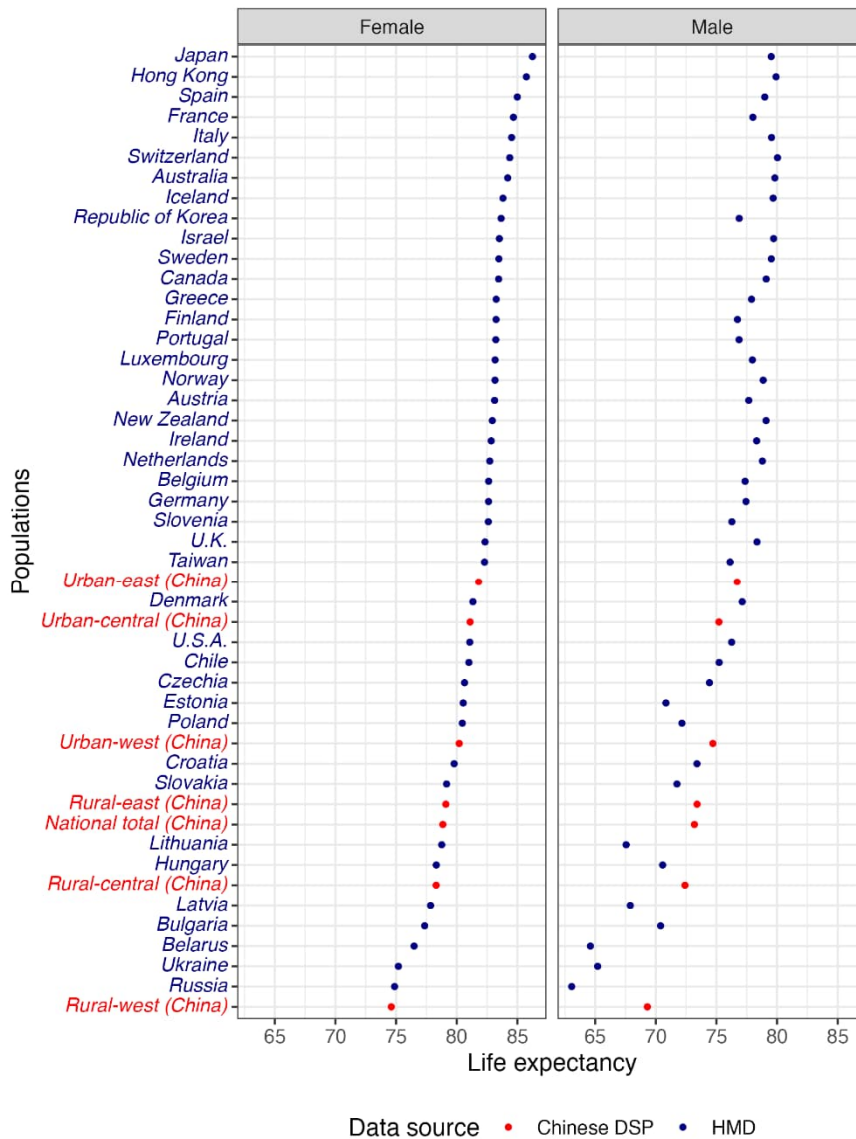
The mortality component,  $\Delta mortality = - \int_0^\omega \ell(x, t) \int_0^x \sum_i [\dot{m}(a, i, t) c(a, i, t)] \, dadx$ , can be interpreted as changes in life expectancy due to the changes in the risk of death, or  $\dot{m}(x, i)$ . The compositional component,  $\Delta composition = - \int_0^\omega \ell(x, t) \int_0^x \sum_i [m(a, i, t) [r(a, i, t) - r(a, t)] c(a, i, t)] \, dadx$ , can be interpreted as the contribution to changes in life expectancy due to changes in exposure to each subnational-level mortality (Torres, Canudas-Romo, and Oeppen 2019). More specifically,  $\Delta composition$  reflects region-mortality weighted by the comparison of national and subnational population growth rates  $[r(x, i) - r(x)]$ , with positive or negative contributions to the change in national life expectancy depending on lower ( $[r(x, i) - r(x)] < 0$ ) or higher ( $[r(x, i) - r(x)] > 0$ ) growth rates than the national growth rate, and a corresponding change in the population exposed to the region's mortality. This property of the compositional component ( $\Delta composition$ ) will enable us to further explore the regional population dynamics and their contribution to improvements in Chinese life expectancy. The detailed derivation of the mathematical expressions, as well as the discrete approximation, are found in online Appendix 5.

As mentioned above, there are other methods that study the influence of compositional changes on changes in life expectancy. Shkolnikov and colleagues (2003, 2006) propose a discrete decomposition method using the concept of a stepwise replacement algorithm. This method had been applied to study the effects of changes in mortality and population structures on differences in life expectancy (Jasilionis et al. 2012; Luy et al. 2019). A decomposition method using the line integral concept can also be found in Horiuchi, Wilmoth, and Pletcher (2008). Our method, based on a continuous framework, generated similar results to those mentioned above, as is generally found in comparisons of discrete and continuous decompositions (Pollard 1988). Torres, Canudas-Romo, and Oeppen (2019) use a continuous framework to study the contributions of mortality and population composition in subnational populations. The method defines the contribution of composition changes as due to “exposure” to mortality. Our method builds on the study of Torres and adds an additional interpretation for the composition components in each subnational Chinese region in terms of the exposure to region-specific mortality from differences in subnational–national population growth. The relation between Torres, Canudas-Romo, and Oeppen (2019) and our decomposition of changes in life expectancy is shown in online Appendix 5.

## **4. Results**

In 2010, Chinese life expectancy at the national level was 78.8 years for females and 73.2 for males. Figure 1 compares regional life expectancy in China and the life expectancy of other populations worldwide. Compared with the life expectancy of populations in the Human Mortality Database (HMD 2023), the female Chinese life expectancy in 2010 was similar to that in Eastern European countries such as Hungary (78.3 years) and Slovakia (79.2 years). For Chinese males, the national life expectancy was similar to males in Croatia (73.4 years) and Poland (72.3 years). For subregions of China, female and male life expectancy in the urban-east region (81.8 and 76.7 years respectively) was similar to that in the USA (81.1 years for females and 76.3 for males). The urban-east region has the highest life expectancy of all the Chinese subregions. Meanwhile, the life expectancy in the rural-west region, which in 2010 had the lowest female life expectancy (74.6 years), was similar to that of Russia (74.9 years for females). The male life expectancy in the rural-west region of China, 69.3 years, was similar to most Eastern European populations at that time. A comparison between regional life expectancy in China and the life expectancy of other populations in the world in 2020 is provided in online Appendix 6.

**Figure 1: Regional life expectancy in China compared to life expectancy of populations in the Human Mortality Database, 2010**



Source: Authors' calculation based on 2010 DSP data and the HMD 2023.

Table 1 presents Chinese female and male life expectancy at birth by region and how they differ between 2010 and 2020. Chinese life expectancy at birth increased by 2.55 years for females and 2.70 years for males between 2010 and 2020. For females, the biggest change in female life expectancy of 4.5 years was in the rural-west (from 74.6 years in 2010 to 79.1 in 2020), and the smallest change of 1.6 years was in the urban-central region (81.1 to 82.7 years). The rural-west had the highest change in male life expectancy, 3.7 years (69.3 to 73.0 years), while the urban-west had the lowest, 1.6 years (74.7 to 76.3 years). However, studying the national and the regional life expectancy independently provides only a fragmented and isolated picture of the mortality dynamics in China.

**Table 1: Difference between Chinese regional female and male life expectancy at birth (with 95% CI) in 2010 and 2020**

Gender	Region	2010	2020	Difference
Female	National	78.8 (78.8, 78.9)	81.4 (81.4, 81.4)	2.6 (2.5, 2.6)
	Urban-east	81.8 (81.7, 81.9)	83.8 (83.8, 83.9)	2.0 (2.0, 2.1)
	Rural-east	79.1 (79.0, 79.1)	81.5 (81.4, 81.5)	2.4 (2.3, 2.4)
	Urban-central	81.1 (81.0, 81.3)	82.7 (82.6, 82.7)	1.6 (1.4, 1.6)
	Rural-central	78.3 (78.2, 78.4)	80.6 (80.6, 80.7)	2.3 (2.3, 2.4)
	Urban-west	80.2 (80.0, 80.4)	82.1 (82.0, 82.2)	1.9 (1.8, 2.0)
	Rural-west	74.6 (74.5, 74.7)	79.1 (79.1, 79.2)	4.5 (4.5, 4.6)
Male	National	73.2 (73.1, 73.2)	75.9 (75.9, 75.9)	2.7 (2.7, 2.7)
	Urban-east	76.7 (76.6, 76.8)	79.0 (79.0, 79.1)	2.3 (2.3, 2.4)
	Rural-east	73.4 (73.3, 73.5)	76.1 (76.0, 76.1)	2.7 (2.6, 2.7)
	Urban-central	75.2 (75.1, 75.3)	77.1 (77.0, 77.1)	1.9 (1.8, 1.9)
	Rural-central	72.4 (72.3, 72.5)	75.2 (75.1, 75.2)	2.8 (2.7, 2.8)
	Urban-west	74.7 (74.4, 74.8)	76.3 (76.2, 76.3)	1.6 (1.5, 1.7)
	Rural-west	69.3 (69.1, 69.4)	73.0 (72.9, 73.0)	3.7 (3.6, 3.8)

Source: Authors' calculation based on 2010 and 2020 DSP data.

Figure 2 shows the regional contributions to changes in national life expectancy between 2010 and 2020. For females, the highest contribution was from the rural-west (1.09 years), followed by the urban-east and the rural-central regions (0.75 years each). There is no contribution from females in the urban-west region. For males the patterns are similar, but the rural-west contributed 1.03 years to the changes in life expectancy, while the urban-east and the rural-central regions contributed 0.77 years and 0.42 years respectively. Like for females, the urban-west region contributed almost nothing to changes in male life expectancy (−0.03 years).

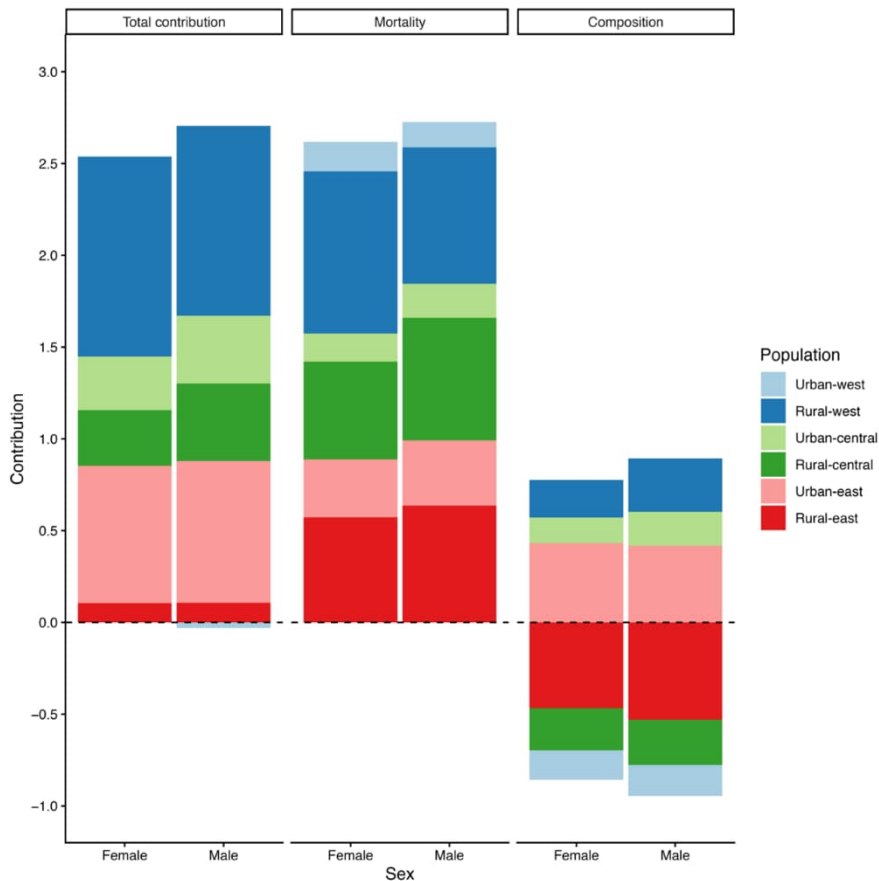
The total change in life expectancy between 2010 and 2020 can be further separated into regional contributions to mortality ( $\Delta mortality$ ) and differences in exposure ( $\Delta composition$ ). For both females and males, the contributions from  $\Delta mortality$  are all positive values, corresponding to mortality improvement across all the regions. A large share of  $\Delta mortality$  comes from the rural regions, with females contributing 1.99 years for all rural regions combined (74% of the total mortality component) and males contributing 2.05 years (75% of the total mortality component).

For the  $\Delta composition$  component, as seen in Figure 2, the positive contributions indicate that the exposed population in that region decreased between 2010 and 2020, and was therefore less exposed to that region's mortality risk. Conversely, the negative contribution below zero indicates an increase in the contribution of the exposed population to the region's mortality. These regional changes in exposure can offset the progress made by  $\Delta mortality$ . For example, the mortality component for rural-east females contributed 0.57 years to the gain in national life expectancy. However, the progress was offset by the increase in the population exposed to the region's mortality, resulting in  $-0.47$  years from the composition component. This makes the total contribution from rural-east females to the national level 0.11 years. Males have a similar trend, with changes in regional population exposure ( $-0.53$  years for rural-east,  $-0.25$  for rural-central,  $-0.17$  years for urban-west) offsetting the mortality improvements (0.64 years for rural-east, 0.67 years for rural-central, 0.14 years for urban-west). These numbers reduce the national-level contribution to 0.11 years for males from the rural-east, a 0.42-years gain from the rural-central region, and a  $-0.03$  years loss from the urban-west. In the urban-east, progress made in mortality improvements (0.32 years), combined with declines in the regional population exposed to the region's mortality (0.43 years), led to a contribution to female national life expectancy of 0.75 years between 2010 and 2020. The pattern for males shows the same phenomenon.

Figures 3 and 4 show each region's age-specific contribution to the total differences in life expectancy between 2010 and 2020, for females and males respectively. For both females and males, the total contributions from age 60 and up account for a significant proportion of the total differences in life expectancy between 2010 and 2020 (females 76.6%, males 64.9%). The mortality contribution of females and males shows comparable patterns. The age-specific contributions of both females and males peak at older ages (around age 80 for females and around age 75 for males). At the same time, all contributions from  $\Delta mortality$  are positive, corresponding to the nation-wide improvements in mortality. In the age-specific contributions of  $\Delta composition$  there is some heterogeneity among the different regions and at different ages. For females and males of all ages, populations from the rural-west and urban-east contribute positively to the differences in life expectancy, indicating less population exposure in these two regions. This observation corresponds to the lower population growth rates in these

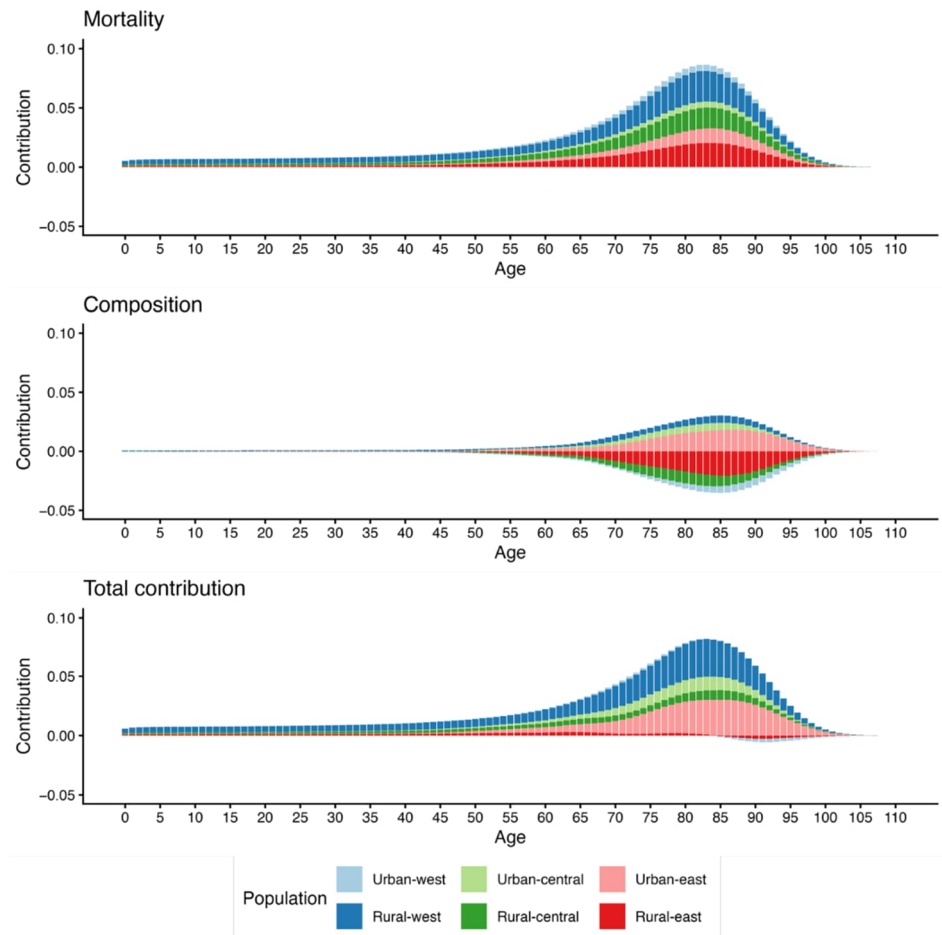
regions as opposed to the national level. By contrast, at all ages among females and males, the urban-west contributed negatively to the differences in life expectancy between 2010 and 2020, signifying an increase in population in the region and thus higher exposure to the region’s mortality. The combined composition component from the rural-east and rural-central regions contributed around  $-0.69$  years for females and  $-0.78$  years for males. Detailed regional contributions, with confidence intervals to quantify uncertainty, can be found in online Appendix 7.

**Figure 2: Regional contribution to changes in Chinese life expectancy and its components, 2010–2020**



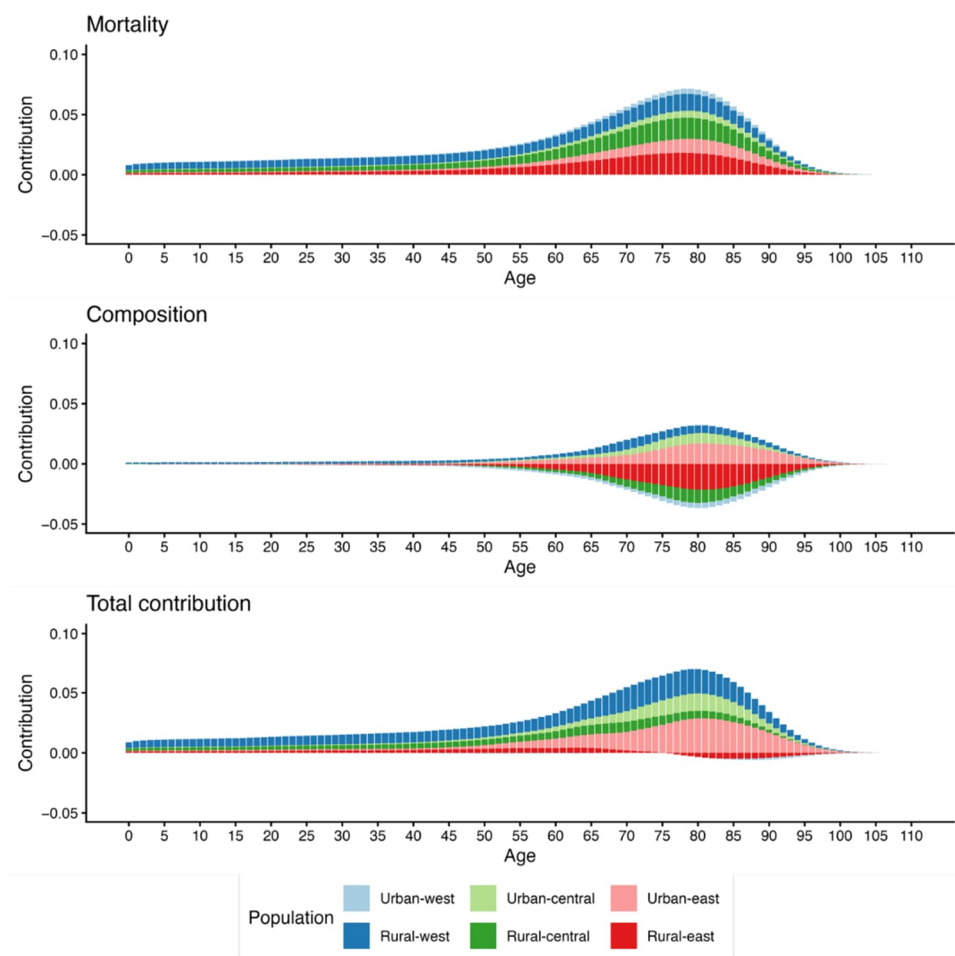
Source: Authors' calculation based on 2010 and 2020 DSP data

**Figure 3: Age and regional contribution to changes in Chinese female life expectancy and its components, 2010–2020**



Source: Authors' calculation based on 2010 and 2020 DSP data.

**Figure 4: Age and regional contribution to changes in Chinese male life expectancy and its components, 2010–2020**



Source: Authors' calculation based on 2010 and 2020 DSP data.

## 5. Discussion

In the observed decade, all the regional populations except for the urban-west contributed positively to the increase in Chinese national life expectancy. The biggest contributions

were made by the urban population in east China and the rural populations in west and central China, which are the population groups living in the most and least developed areas in the country, respectively. The decomposition method breaks down the regional contribution to national improvement into two parts, the contribution through changes in regional mortality and the contribution through changes in regional population exposure to mortality. For the mortality component, the mortality level in all regions declined between 2010 and 2020, leading to a positive contribution to the increase in national life expectancy. Rural populations made the biggest contributions to mortality declines, confirming the finding of previous studies that rural mortality is declining faster than urban mortality in China (Chen and Canudas-Romo 2022; Zhang 2016). This decline in mortality is attributable to China's rapid economic development, but is also closely associated with the success of poverty reduction campaigns and the re-establishment of the medical care system (Zhao, Chen, and Jin 2016). The re-establishment of the medical care system in rural China significantly contributed to lower mortality rates by expanding health insurance coverage, improving the availability and quality of healthcare facilities, and increasing the number of trained medical professionals. Additionally, government investment in healthcare and poverty alleviation initiatives has enabled better access to treatments, reducing the financial burden on families and promoting timely medical intervention (Hao et al. 2020).

The composition component, or the changes in the exposure of the population to mortality, is another part of the regional contribution to the increase in national life expectancy. The composition of all the subnational populations added together comes to 100%. In other words, between two time points, increases in one region are cancelled by decreases in another region. This is observed in Figures 2 to 4, with some regions contributing to the increase in national life expectancy and others to its decline, so that, taken alone, the compositional component is close to zero. This phenomenon is also found among US Census regions during the decade before the COVID-19 pandemic (Su et al. 2024). However, for each subnational population, both the positive and negative percentage changes in the population composition, which can be linked to the difference between subnational and national population growth, impact their specific contribution to the national life expectancy alongside their respective mortality levels. For the Chinese population between 2010 and 2020, the negative and minor total contribution of the composition component arises from the noticeable contributions from opposite directions across different regions, which could be related to population growth differences between regions. If the regional population increase is greater than the national population growth, as shown in the methods section, it contributes negatively to improvement in national life expectancy, thus offsetting the positive contribution made by the mortality component. This is the case for populations in the rural-east, rural-central, and urban-west.

The age-specific growth rates of each region are compared with the national-level growth rates. The addition of this age-pattern-of-growth comparison dictates the contribution of the compositional component (see online Appendix 8 for an illustration with examples). The link between higher population growth and a negative contribution from the composition component may seem counter-intuitive; it essentially implies that higher population growth means relatively more people are exposed to the risk of mortality in the region. Therefore, regional population growth that is lower than the national level results in a positive contribution to national life expectancy, which is true for populations in the urban-east, urban-central, and rural-west. The composition component essentially signifies the disparity in age-specific regional population growth compared to the national growth level. This element plays a crucial role in shaping the age-related contributions to changes in national life expectancy. Apart from the regional differential in fertility and the pace of aging that contributed to changes in regional population size and age structure, another possible explanation for these differential growths is the population movement across regions.

The number of internal migrants reached a new high in China in the decade 2010–2020, as documented by Shi, Liu, and Feng (2025). Most migrants are temporary rather than permanent, typically leaving their hometowns to seek employment opportunities when they become of working age and returning to their hometowns or more developed regions near their hometowns when they approach retirement age. This return migration at older ages is the result of several factors rooted in Chinese culture, such as the attachment to hometown and preference for a rural and natural environment rather than urban surroundings (Liu, Dou, and Perry 2020). Other contextual factors include first-generation migrants (cohorts that entered the labor force after the Mao era) returning to their hometowns due to declining job opportunities (Chan and Yang 2020). In migration literature this is referred to as the ‘salmon bias’, and previous research has observed this phenomenon in China (Pablos-Méndez 1994; Lu and Qin 2014). This is consistent with our findings that the popular migration destinations – the urban-east and urban-central regions – are seeing a decrease in population groups aged 60 and above and thus are making a positive contribution through the compositional component, as relatively fewer people are exposed to mortality over the years. However, there might be a different reason why the rural-west, considered the least developed area in China (Luo, Li, and Sicular 2020), had lower-than-national population growth: the elderly in the least developed regions were moving away due to poor medical conditions and inadequate healthcare resources (Song et al. 2019; Zhang 2012). Another possible explanation is that these older populations migrate to areas where their children reside, where they can either receive care from their children or can care for their grandchildren, and which usually have better economic opportunities and educational resources (Liu, Dou, and Perry 2020; Shi, Liu, and Feng 2025). Apart from the reasons mentioned above, there could be other push

factors behind the lower population growth rates which reduced population exposure to those regions' mortality (Dorigo and Tobler 1983; Babiarz et al. 2019; Yuan and Zhang 2023).

It is important to note that the mortality and compositional components may have been mutually influential. On the one hand, mortality rates, which are often related to the level of regional socioeconomic development, are a driver of the regional population growth rate and underpin the compositional component. On the other hand, changes in the population growth rate, which might be the result of migration, could in turn affect the local mortality rate. Given that migration is a selective phenomenon, the departure and arrival of healthy migrants and the resulting changes in population composition could have influenced mortality in both the origin and destination regions. However, in this analysis, our focus is on the contributions of mortality and compositional components to the change in the national life expectancy during the observed period.

The limitations of this study mainly originate from the constrained data availability. We are unable to disentangle the impact of international migration from that of internal migration due to a lack of relevant information. However, China's international migration is significantly smaller than internal migration. The net international migration rate in China was only  $-0.23$  migrants per 1,000 of the population between 2015 and 2020 (International Organization of Migration 2022), so that data limitation is not anticipated to have a significant impact on our results. However, it should be noted that national migrations are distributed unevenly across regions, with a majority of internal migrants moving to eastern China. This study would benefit from data on the geographic distribution of the origin and destination of migrants within China, but such data is not available. The National Health Commission of China has stopped monitoring the distribution of migrants, as it previously did through the China Migrants Dynamic Survey. A similar limitation is a lack of data that would make it possible to disentangle the mortality of migrant populations (internal and international) from that of the non-migrant populations. Our analysis indirectly accounts for this by disentangling the differential regional population growth (see online Appendix 9 with further sensitivity analysis). Another limitation is that the population-count data from the DSP system only covers over 24% of the national population, but the surveillance points were sampled so as to be nationally representative. We compared national population counts from the DSP and other sources and there was very little difference in the total population aged 60 and above, where the main contributions to national life expectancy were observed (see Appendix 4).

The outbreak of COVID-19 in early 2020 could potentially have had an impact on both the mortality and compositional components, but the number of Covid deaths was relatively low in China in 2020 (Johns Hopkins University Coronavirus Resource Center 2022). However, the series of coping measures in China, including lockdowns,

quarantines, and the zero-case policy in the following years, might also affect population health outcomes and the migration behaviour of people (Chen et al. 2020; Ding and Zhang 2022; Shah et al. 2021). The long-term impacts have yet to be observed.

## **6. Conclusion**

This is one of the first studies to decompose China's increase in national life expectancy into the regional contributing components of changing mortality and population exposure. The disaggregation of these different components at the regional level provides insight as to how to better address the regional health inequalities in China. Future research in this area could benefit from an availability of data at the provincial or county level, and the incorporation of more detailed information on international and internal migration.

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## References

- Andreev, E., Hoffmann, R., Carlson, E., Shkolnikov, V., and Kharkova, T. L. (2009). Concentration of working-age male mortality among manual workers in urban Latvia and Russia, 1970–1989. *European Societies* 11(1): 161–185. doi:10.1080/14616690802054358.
- Babiarz, K.S., Ma, P., Song, S., and Miller, G. (2019). Population sex imbalance in China before the One-Child Policy. *Demographic Research* 40(13): 319–358. doi:10.4054/DemRes.2019.40.13.
- Chan, K.W. (2010). The household registration system and migrant labor in China: Notes on a debate. *Population and Development Review* 36(2): 357–364. doi:10.1111/j.1728-4457.2010.00333.x.
- Chan, K.W. and Yang, X. (2020). Internal migration and development. In: Bastia, T. and Skeldon, R. (eds.). *Routledge handbook of migration and development*. London: Routledge. doi:10.4324/9781315276908-55.
- Chen, M. and Canudas-Romo, V. (2022). Urban-rural lifespan disparities and cause-deleted analysis: Evidence from China. *BMJ Open* 12(2): e050707. doi:10.1136/bmjopen-2021-050707.
- Chen, S., Yang, J., Yang, W., Wang, C., and Bärnighausen, T. (2020). COVID-19 control in China during mass population movements at New Year. *Lancet* 395(10226): 764–766. doi:10.1016/S0140-6736(20)30421-9.
- Chinese Center for Disease Control and Prevention (2010). *National disease surveillance points – cause of death surveillance database*. Military Medical Science Press.
- Chinese Center for Disease Control and Prevention (2020). *National disease surveillance points – cause of death surveillance database*. Military Medical Science Press.
- Deng, X. (1994). *Selected works of Deng Xiaoping: Vol. III*. New Delhi: People's Publishing House.
- Ding, D. and Zhang, R. (2022). China's COVID-19 control strategy and its impact on the global pandemic. *Frontiers in Public Health* 10. doi:10.3389/fpubh.2022.857003.
- Dorigo, G. and Tobler, W. (1983). Push-pull migration laws. *Annals of the Association of American Geographers* 73(1): 1–17. doi:10.1111/j.1467-8306.1983.tb01392.x.
- Fan, C.C. and Sun, M. (2008). Regional inequality in China, 1978–2006. *Eurasian Geography and Economics* 49(1): 1–18. doi:10.2747/1539-7216.49.1.1.

- Gao, H., Qing, X., and Shen, T. (2019). Spatial variation of migrant population's return intention and its determinants in China's prefecture and provincial level cities. *Geographic Research* 38(8).
- Gao, J., Qian, J., Tang, S., Eriksson, B., and Blas, E. (2002). Health equity in transition from planned to market economy in China. *Health Policy and Planning* 17(S1): 20–29. doi:10.1093/heapol/17.suppl\_1.20.
- Guo, K., Yin, P., Wang, L., Ji, Y., Li, Q., Bishai, D., Liu, S., Liu, Y., Astell-Burt, T., Feng, X., You, J., Liu, J., and Zhou, M. (2015). Propensity score weighting for addressing under-reporting in mortality surveillance: A proof-of-concept study using the nationally representative mortality data in China. *Population Health Metrics* 13(16): 1–11. doi:10.1186/s12963-015-0051-3.
- Guo, Y. (2018). Analysis of spatio-temporal changes in life expectancy and its influencing factors in China. *Chinese Journal of Health Policy* 11(8): 44–49.
- Hao, L., Xu, X., Dupre, M.E., Guo, A., Zhang, X., Qiu, L., Zhao, Y., and Gu, D. (2020). Adequate access to healthcare and added life expectancy among older adults in China. *BMC Geriatrics* 20(1): 129. doi:10.1186/s12877-020-01524-9.
- Human Mortality Database (HMD) (2023). University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). [www.mortality.org](http://www.mortality.org).
- Horiuchi, S., Wilmoth, J.R., and Pletcher, S.D. (2008). A decomposition method based on a model of continuous change. *Demography* 45(4): 785–801. doi:10.1353/dem.0.0033.
- International Organization of Migration (2022). *Country profile – Data and research*. International Organization for Migration. <https://www.iom.int/node/29989/facts-and-figures>.
- Jasilionis, D., Andreev, E.M., Kharkova, T.L., and Ward Kingkade, W. (2012). Change in marital status structure as an obstacle for health improvement: Evidence from six developed countries. *European Journal of Public Health* 22(4): 602–604. doi:10.1093/eurpub/ckr065.
- Johns Hopkins University Coronavirus Resource Center (2022). Mortality analysis. <https://coronavirus.jhu.edu/data/mortality>.
- Liang, Z. and Ma, Z. (2004). China's floating population: new evidence from the 2000 census. *Population and Development Review* 30(3): 467–488. doi:10.1111/j.1728-4457.2004.00024.x.

- Liang, Z. and White, M.J. (1996). Internal migration in China, 1950–1988. *Demography* 33(3): 375–384. doi:10.2307/2061768.
- Lin, J.Y., Cai, F., and Li, Z. (2004). *The China miracle: Development strategy and economic reform (revised edition)*. Hong Kong: The Chinese University of Hong Kong Press. doi:10.1353/book82023.
- Liu, S., Wu, X., Lopez, A.D., Wang, L., Cai, Y., Page, A., Yin, P., Liu, Y., Li, Y., Liu, J., You, J., and Zhou, M. (2016). An integrated national mortality surveillance system for death registration and mortality surveillance, China. *Bull World Health Organ* 94(1): 46–57. doi:10.2471/BLT.15.153148.
- Liu, Y., Dou, X., and Perry, T.E. (2020). Return migration in later life in Mainland China: Motivations, patterns, and influences. *Ageing International* 45(1): 30–49. doi:10.1007/s12126-018-9336-8.
- Lu, Y. and Qin, L. (2014). Healthy migrant and salmon bias hypotheses: A study of health and internal migration in China. *Social Science and Medicine* 102: 41–48. doi:10.1016/j.socscimed.2013.11.040.
- Luo, C., Li, S., and Sicular, T. (2020). The long-term evolution of national income inequality and rural poverty in China. *China Economic Review* 62: 101465. doi:10.1016/j.chieco.2020.101465.
- Luy, M., Zannella, M., Wegner-Siegmundt, C., Minagawa, Y., Lutz, W., and Caselli, G. (2019). The impact of increasing education levels on rising life expectancy: A decomposition analysis for Italy, Denmark, and the USA. *Genus* 75(11). doi:10.1186/s41118-019-0055-0.
- Namer, Y. and Razum, O. (2018). Convergence theory and the salmon effect in migrant health. In: McQueen, D.V. (ed.). *Oxford research encyclopedia of global public health*. New York, NY: Oxford Academic. doi:10.1093/acrefore/9780190632366.013.17.
- National Bureau of Statistics (2010). *The sixth national population census 2010*. <http://www.stats.gov.cn/tjsj/pcsj/rkpc/6rp/indexch.htm>.
- National Bureau of Statistics of China (2021). Communiqué of the Seventh National Population Census 7. [http://www.stats.gov.cn/english/PressRelease/202105/t20210510\\_1817192.html](http://www.stats.gov.cn/english/PressRelease/202105/t20210510_1817192.html).
- National Health Commission (2020). China National Maternal and Child Health Surveillance (MCHS): Child mortality.

- Pablos-Méndez, A. (1994). Mortality among Hispanics. *Journal of the American Medical Association JAMA* 271(16): 1237–1238. doi:10.1001/jama.1994.03510400023017.
- Peng, W. and Liu, Y. (2010). The changing gap in regional economy of East, Central and West China over time. *Economic Geography* 30(4): 574–578.
- Peng, Y., Dong, L., Liang, H., Yang, L., Jiang, S., Tuljapurkar, S., and Guo, Z. (2021). The changing trend of life expectancy for the Chinese elderly and its rural–urban disparity. *China Population and Development Studies* 5(1): 25–40. doi:10.1007/s42379-021-00080-y.
- Pollard, J.H. (1988). On the decomposition of changes in expectation of life and differentials in life expectancy. *Demography* 25(2): 265–276. doi:10.2307/2061293.
- Qi, Y. and Niu, J. (2013). Health selection effects in China’s internal migration. *Asian Population Studies* 9(2): 142–155. doi:10.1080/17441730.2012.752241.
- Shah, T., Shah, Z., Yasmeen, N., and Ma, Z.-R. (2021). Psychological impact of the COVID-19 pandemic on Chinese population: An online survey. *World Journal of Clinical Cases* 9(31): 9500–9508. doi:10.12998/wjcc.v9.i31.9500.
- Shi, L., Chen, W., Xu, J., and Ling, L. (2020). Trends and characteristics of inter-provincial migrants in Mainland China and its relation with economic factors: A panel data analysis from 2011 to 2016. *Sustainability* 12(2): 610. doi:10.3390/su12020610.
- Shi, Q., Liu, T., and Feng, C. (2025). The changing geography of interprovincial migration in China: history and new trends. *Eurasian Geography and Economics* 66(4–5): 507–529. doi:10.1080/15387216.2024.2379847.
- Shkolnikov, V.M., Andreev, E.M., Jasilionis, D., Leinsalu, M., Antonova, O.I., and McKee, M. (2006). The changing relation between education and life expectancy in central and eastern Europe in the 1990s. *Journal of Epidemiology and Community Health* 60(10): 875–881. doi:10.1136/jech.2005.044719.
- Shkolnikov, V.M., Andreev, E.M., and Begun, A. (2003). Gini coefficient as a life table function: Computation from discrete data, decomposition of differences and empirical examples. *Demographic Research* 8(11): 305–358. doi:10.4054/DemRes.2003.8.11.
- Song, J. (2010). Migrant employment in urban China: Characteristics and determinants – a comparative study with rural left- behind people. *Population Research* 6(34).

- Song, Q. and Smith, J.P. (2021). The citizenship advantage in psychological well-being: An examination of the *Hukou* system in China. *Demography* 58(1): 165–189. doi:10.1215/00703370-8913024.
- Song, S., Yuan, B., Zhang, L., Cheng, G., Zhu, W., Hou, Z., He, L., Ma, X., and Meng, Q. (2019). Increased inequalities in health resource and access to health care in rural China. *International Journal of Environmental Research and Public Health* 16(1): 49. doi:10.3390/ijerph16010049.
- Su, W., van Raalte, A., Aburto, J.M., and Canudas-Romo, V. (2024). Subnational contribution to life expectancy and life span variation changes: Evidence from the United States. *Demographic Research* 50(22): 583–624. doi:10.4054/DemRes.2024.50.22.
- Torres, C., Canudas-Romo, V., and Oeppen, J. (2019). The contribution of urbanization to changes in life expectancy in Scotland, 1861–1910. *Population Studies* 73(3): 387–404. doi:10.1080/00324728.2018.1549746.
- United Nations (2022). *World population prospects: 2022 revision*. <https://population.un.org/wpp/Download/Standard/Mortality/>.
- Vaupel, J.W. and Canudas-Romo, V. (2002). Decomposing demographic change into direct vs. compositional components. *Demographic Research* 7(1): 1–14. doi:10.4054/DemRes.2002.7.1.
- Wang, Y.-H. and Li, L.-M. (2009). Evaluation of impact of major causes of death on life expectancy changes in China, 1990–2005. *Biomedical and Environmental Sciences* 22(5): 430–441. doi:10.1016/S0895-3988(10)60022-0.
- Wang, W., Yin, P., Wang, L.J., Liu, Y.N., Liu, J.M., Qi, J.L., You, J.L., Lin, L., and Zhou, M.G. (2021). Analysis on all-cause mortality rate and life expectancy in China, 2005–2018. *China Journal of Epidemiology* 42(8): 1420–1428. doi:10.3760/cma.j.cn112338-20200825-01095.
- Whiting, S.H. (2022). Land rights, industrialization, and urbanization: China in comparative context. *Journal of Chinese Political Science* 27: 399–414. doi:10.1007/s11366-022-09786-3.
- Wilmoth, J., Zureick, S., Canudas-Romo, V., Inoue, M., and Sawyer, C. (2012). A flexible two-dimensional mortality model for use in indirect estimation. *Population Studies* 66(1): 1–28. doi:10.1080/00324728.2011.611411.

- Xing, X., Chen, Y., and Liu, Z. (2017). Under-reporting of mortalities in areas of Anhui province covered by national disease surveillance system, 2013–2014. *Chinese Journal of Public Health* 33(7): 1101–1104.
- Yan, Y. (2024). Trends in life expectancy and life disparity in the older population in China by regions, 1981–2020. *Chinese Journal of Sociology* 10(3): 404–430. doi:10.1177/2057150x241264327.
- Yuan, C. and Zhang, D. (2023). Moving towards gender equality in China: The influence of migration experiences on rural migrants' gender role attitudes. *Demographic Research* 49(14): 355–384. doi:10.4054/DemRes.2023.49.14.
- Zhang, H. (2019). The evolution of China's urban-rural relations in the past seven decades: From separation to integration. *Chinese Rural Economy* 3.
- Zhang, L. (2012). Economic migration and urban citizenship in China: The role of points systems. *Population and Development Review* 38(3): 503–533. doi:10.1111/j.1728-4457.2012.00514.x.
- Zhang, Z. (2016). Trends in lifespan disparity in China since the 1950s: An international comparison. *Population Research* 40(1).
- Zhao, Z., Chen, W., and Jin, Y. (2016). Recent mortality trends in China. In: Guilmoto, C.Z. and Jones, G.W. (eds.). *Contemporary demographic transformations in China, India and Indonesia*. Cham: Springer International Publishing: 37–53. doi:10.1007/978-3-319-24783-0\_2.

