



# Assessments of Provincial Infant and Old-age Mortality in China's 2010 Population Census

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# Data source for mortality

- Population census (every 10 years in years ending in 0 since 1982)
- The 1% population sample survey (the inter-censal years ending in 5 since 1990)
- The annual 1‰ sample survey on population changes (since 1983)
- Maternal and Child Mortality Surveillance System (MCMSS)
- Disease Surveillance Points System (DSP)



# Accessibility

- Census and the 1% population sample survey are published in monographs
- The annual 1‰ sample survey is published in demographic yearbook
- MCMSS: detail data is not public accessible, aggregated data is published in “China Health and Family Planning Yearbook”
- DSP: Application needed



# Data quality of each source

- MCMSS: most reliable data source of China maternal mortality level. Its accuracy is checked by a critical assessment. (Gan, Hao et al. 2014)
- DSP: the coverage of infant deaths remains problematic, and as might be expected, is lower than the coverage of adult deaths.(Yang, Hu et al. 2005)
- Population Census: varying with years.



# Data quality of each source

**1953, 1964 census:** data transparency problems (Y. C. Yu, 1978; Wu & He, 2015)

**1982 census:** High (C. Li, 1985; Y. C. Yu, 1986)

**1990 census:** underreporting exists infant and senior age groups deaths, biasing in mortality estimates downward (Zhang and Li, 1997)

**2000 census:** There is undercount of population deaths, infants and children usually suffer most (S. Li & Sun, 2003)

**2010 census:** serious underreporting problems exist in infant and old-age death (Gu et al., 2016; Hu, Wang, & Yu, 2015)

# Aim

- Less studies concentrate on the analysis of the quality of infant and old-age mortality data in province perspective.
- This research re-estimated infant and old-age mortality for China's 31 provinces, municipalities and autonomous regions in 2010 census and analyzed the underreporting on the basis of three-parameter model life table (N. Li, Mi, Gerland, Li, & Sun, 2018)



# Reasons for mortality underestimate in census

- **Infant mortality:** The implementation of the one child
- **Old-age mortality:** **1.** Age overstatement and using the nominal age to count the age, which biasing mortality estimates of census in downwards at old ages (Preston, Elo and Stewart, 1999); **2.** Defrauding the pensions and other social welfare. **3.** The ancestor worship and the taboo of death and dying in Chinese culture (Hsu, O'Connor and Susan Lee, 2009).



# Data and method

- The input parameters of three-parameter MLT:  ${}_5q_0$ ,  ${}_{45}q_{15}$ ,  ${}_{15}q_{60}$ .
- The international data for the analysis of the relationship between infant and old-age mortality rates and development levels, and then, for evaluate the modified values.





# Data and method

- Provincial U5MR: China subnational Millennium Development Goal 4 (MDG 4) (IHME, 2015).

Defect: non-sex-specific data only.

The correlation between non-sex-specific and sex-specific concluded from GBD 2013 Neonatal, Infant, and Under-5 Mortality (GBD 2013, 2014)

$$\text{logit}({}_5q_0) = \begin{cases} -0.01626 + 1.01639 \cdot \text{logit}({}_5q_0^B), & \text{female} \\ 0.01634 + 0.98697 \cdot \text{logit}({}_5q_0^B), & \text{male} \end{cases}$$

$${}_5q_0^M = \left( {}_5q_0^B - c_F \cdot {}_5q_0^F \right) / c_M$$

# Data and method

- Adult mortality  ${}_{45}q_{15}$ : census data
- Mortality between 60-74  ${}_{15}q_{60}$  is re-estimated by General Growth Balance Method open to migration (Bhat,2002), for migration happening in old-age (Tong & Piotrowski, 2012; Dou & Liu, 2017).

$$\frac{N(x)}{N(x+)} - r(x+) + \frac{NM(x+)}{N(x+)} = n + K \cdot \frac{D^*(x+)}{N(x+)}$$

$K$  is taken as the average of the adjustment factor for the population at age 60 and over to preliminarily correct province-specific  ${}_{15}q_{60}$ .

If  $K > 1$ , then let  $K=1$

# Data and method

- The development is measured by Socio-demographic Index (SDI) from GBD 2016 SDI (Global Burden of Disease Collaborative Network, 2017).
- The international mortality data from GBD 2017 Life Tables (Global Burden of Disease Collaborative Network, 2018).
- The relationship between SDI and mortality rates are fitted by Loess regression.
- The root-mean-squared deviation (RMSD):

$$RMSD = \sqrt{\frac{\sum_{i=1}^n (q_i^m - q_i^e)^2}{n}}$$



# Data and method

- Three-parameter model life table

The two-parameter MLT (Wilmoth et al., 2012) can be augmented to fit also the observed old-age mortality, by adding a constant to  $a_x$  at ages older than 60 (N. Li, 2014).

$$\ln(\hat{m}_x) = \hat{a}_x + b_x \cdot \ln({}_5q_0) + c_x \cdot [\ln({}_5q_0)]^2 + v_x \cdot k$$

$$\hat{a}_x = \begin{cases} a_x, & x < 60 \\ a_x + \ln \left[ \frac{\ln(1 - {}_{15}\hat{q}_{60})}{\ln(1 - {}_{15}q_{60})} \right], & x \geq 60 \end{cases}$$

${}_{15}q_{60}$  is calculated by the two-parameter MLT.

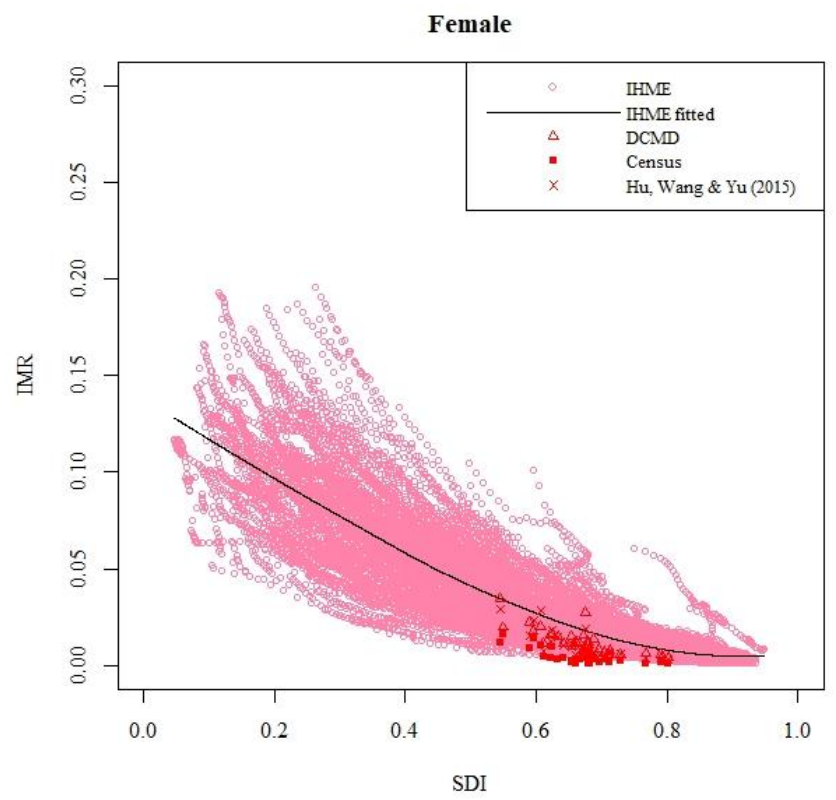
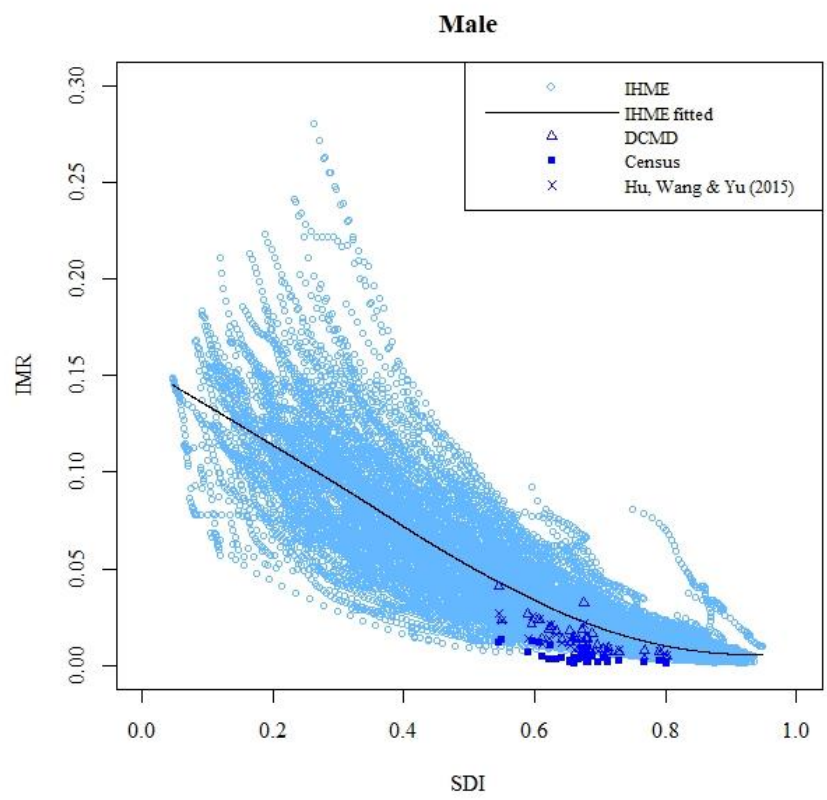


# Recompiling life tables

- The  ${}_1m_0$  and  ${}_5m_x$  ( $x=60, 65, \dots, 85$ ) calculated from three-parameter model life table will be employed to replace the original data tabulated on the census
- Old-age mortality:  ${}_{30}q_{60}$
- The reason for age restriction of 60 to 85: The debate about “mortality crossover” in the age 90+, which is the main reason? Bad data, (Coale and Kisker, 1986) or “mortality screen” due to heterogeneity? (Zeng and Vaupel, 2003)

# Modification for mortality data

## Infant mortality



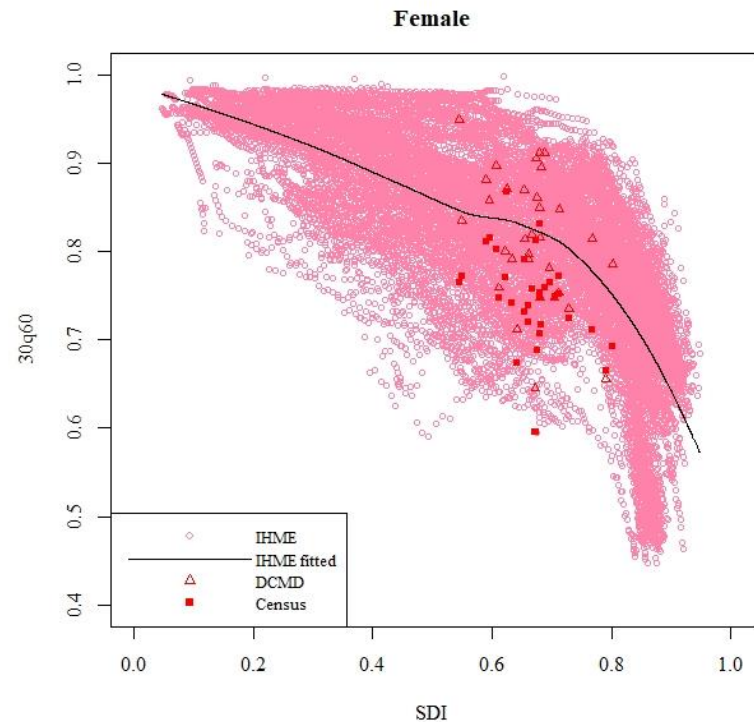
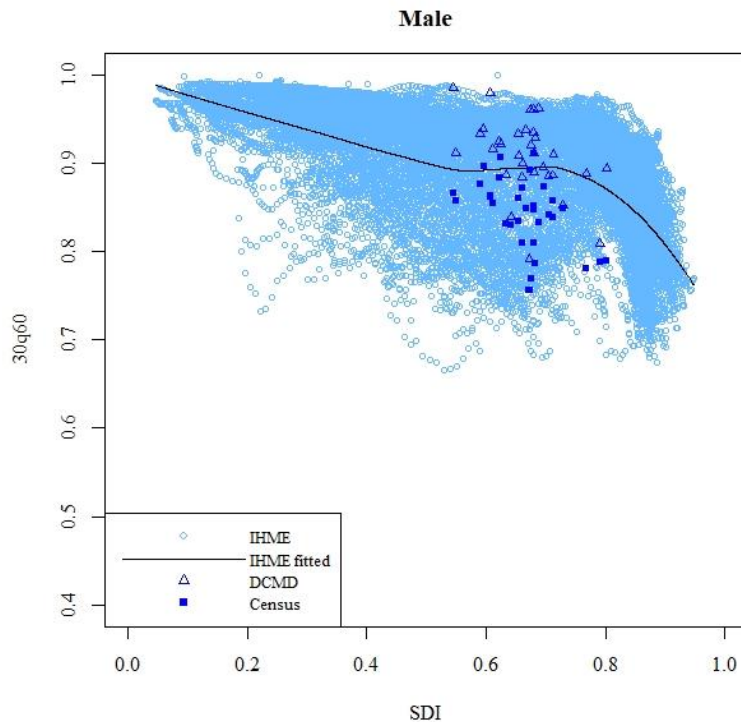
# Modification for mortality data

| <i>RMSD</i>                    | Male     | Female   |            |
|--------------------------------|----------|----------|------------|
| DCMD                           | 0.0102   | 0.0078   |            |
| Hu, Wang & Yu<br>(2015)        | 0.0130   | 0.0092   |            |
| Census Value                   | 0.0206   | 0.0155   |            |
|                                | Both (‰) | Male (‰) | Female (‰) |
| 2010 Census                    | 3.80     | 3.72     | 3.91       |
| DCMD                           | 13.14    | 14.22    | 11.86      |
| CHFPY (2017)                   | 13.1     | —        | —          |
| UN IGME                        | 13.6     | 14.5     | 12.6       |
| IHME                           | 13.87    | 15.00    | 12.51      |
| WHO                            | 13.6     | —        | —          |
| United States<br>Census Bureau | 13.6     | 13.3     | 13.8       |

\*CHFPY: China Health and Family Planning Yearbook

# Modification for mortality data

## Old-age mortality



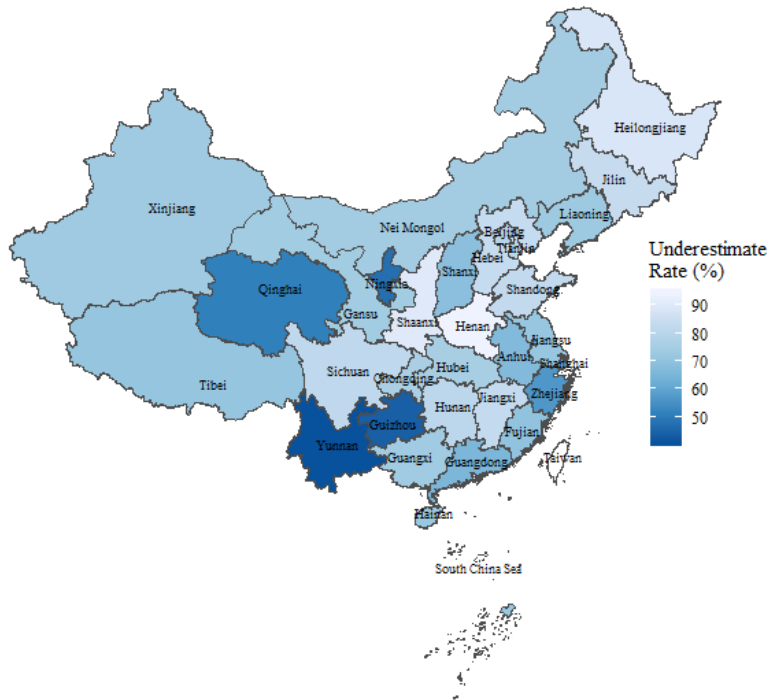
| <i><b>RMSD</b></i> | <b>Male</b> | <b>Female</b> |
|--------------------|-------------|---------------|
| Modified           | 0.0359      | 0.0426        |
| Census             | 0.0621      | 0.0867        |



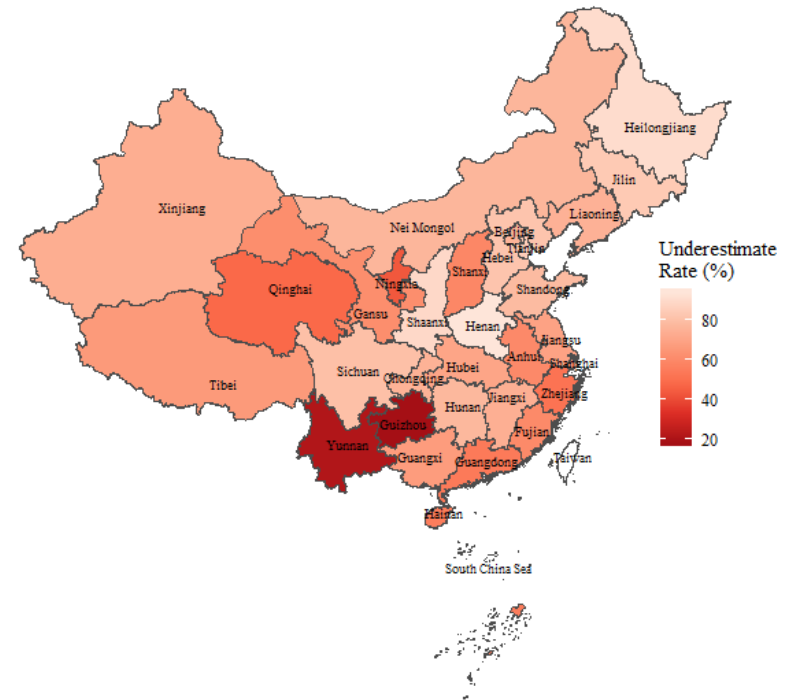
# Analysis for underestimate

## Underestimate rate of infant mortality

Male



Female

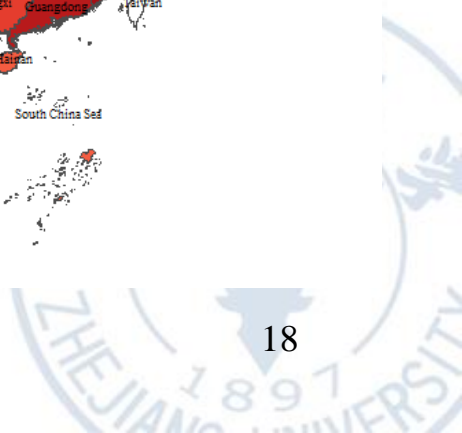
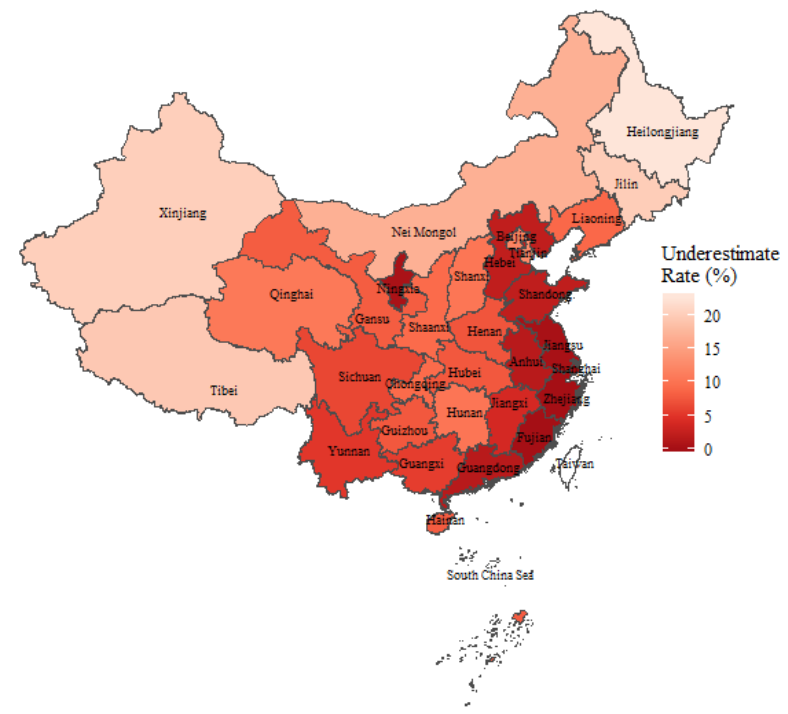
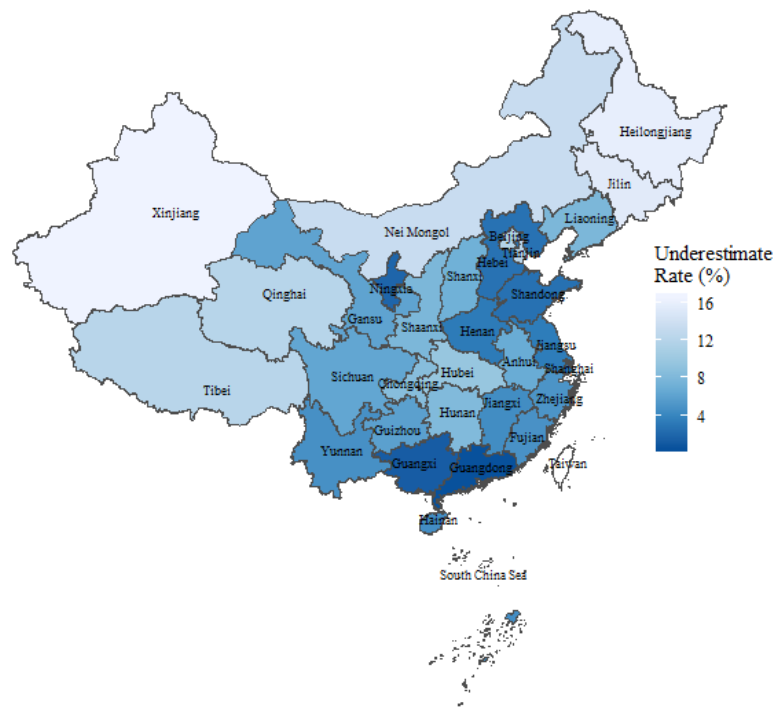


# Analysis for underestimate

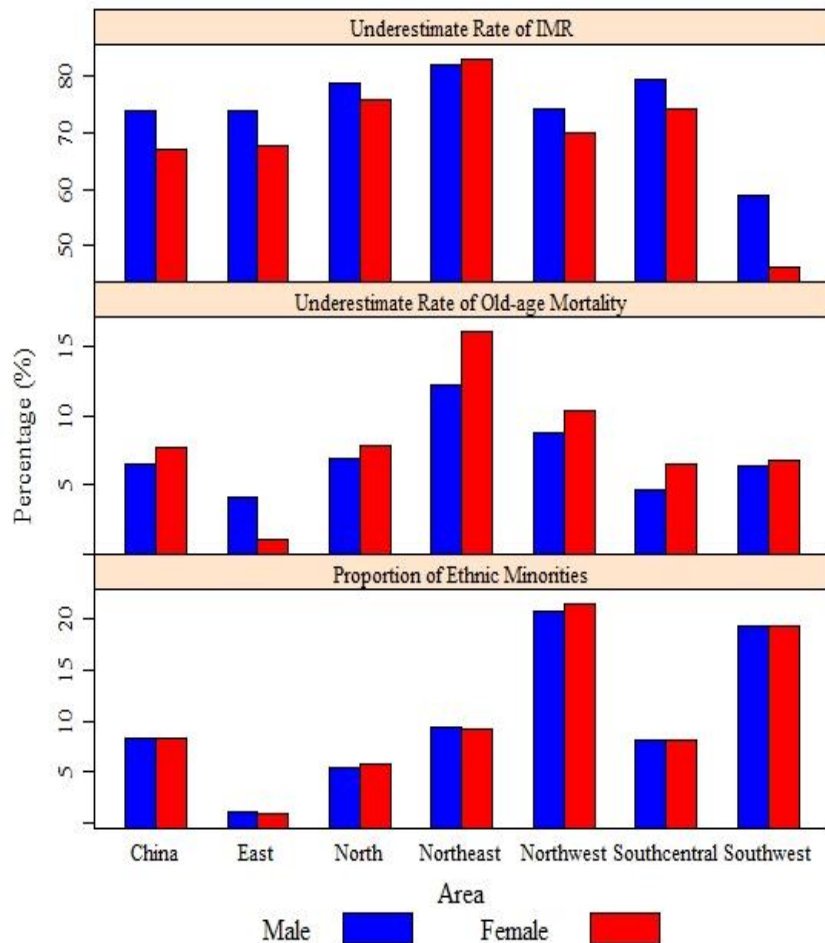
## Underestimate rate of old-age mortality

Male

Female



# Analysis for underestimate



The provinces with developed economy and urbanization locate mainly in the eastern region where the quality of medical staff, the registration system and living conditions are better than those in other regions (Yang et al., 2005)

The main population living the eastern, south-central and northern regions belongs to Han Chinese, while the southwestern and northwestern regions are the major inhabitation of ethnic minorities.

# Summary

- The average underestimate rate of infant death is 73.85% for male and 67.07% for female; and the infant mortality underestimate in the east and southwest regions is less severe than that in other four regions.
- For the old ages between 60–89 years, the underestimate of male mortality is lower than that of female. The eastern, south central and northern provinces have old-age mortality data with better quality than southwestern, northwestern and northeastern provinces.
- This research utilized developed countries' experiences to re-estimate China's provincial  ${}_1q_0$  and  ${}_{30}q_{60}$ , which means “what's the provincial levels of infant and old-age death are under the condition of developed countries' situation.”

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# Reference

- Li, C. (1985). The reliability of China's 1982 population census data. International Population Conference. Florence, Italy. **4**.
- Yu, Y. C. (1986). The reliability of China's 1982 population census. A census of one billion people : papers for International Seminar on China's 1982 Population Census. C. Li. Boulder, Colorado, Westview Press: 269-287.
- Zhang, W. and X. Li (1997). Analysis on mortality level of Chinese population. International Population Conference, Beijing, International Union for the Scientific Study of Population.
- Li, S. and F. Sun (2003). "Mortality Analysis of China's 2000 Population Census Data: A Preliminary Examination." The China Review **3**(2): 31–48.
- Hu, S., et al. (2015). "Evaluation and Estimation of the Provincial Infant Mortality Rate in China's Sixth Census." Biomedical and Environmental Sciences **28**(6): 410-420.
- Gu, D., et al. (2016). "Assessments of mortality at oldest-old ages by province in China's 2000 and 2010 censuses." International Journal of Population Studies **2**(2): 1-25.

# Reference

- Li, N., et al. (2018). Establishing a Developing Countries Mortality Database (DCMD) on the Empirical Basis of Child, Adult, and Old-age Mortality. the Annual Meeting of the Population Association of America. Denver, CO, USA.
- IHME (2015). China subnational MDG 4/5. University of Washington. IHME. <http://vizhub.healthdata.org/subnational/china>
- Bhat, P. N. M. (2002). "General growth balance method: A reformulation for populations open to migration." Population Studies **56**(1): 23-34.
- Tong, Y. and M. Piotrowski (2012). "Migration and Health Selectivity in the Context of Internal Migration in China, 1997–2009." Population Research and Policy Review **31**(4): 497–543.
- Dou, X. and Y. Liu (2017). "Elderly Migration in China: Types, Patterns, and Determinants." Journal of Applied Gerontology **36**(6): 751-771.
- Global Burden of Disease Collaborative Network. (2017). Global Burden of Disease Study 2016 (GBD 2016) Socio-demographic Index (SDI) 1970-2016. IHME. Seattle, United States.

# Reference

- Global Burden of Disease Collaborative Network. (2018). Global Burden of Disease Study 2017 (GBD 2017) Life Tables 1950-2017. IHME. Seattle, United States.
- Wilmoth, J., et al. (2012). "A flexible two-dimensional mortality model for use in indirect estimation." Population Studies **66**(1): 1-28.
- Attane, I. (2009). "The determinants of discrimination against daughters in China: evidence from a provincial-level analysis." Population Studies **63**(1): 87-102.
- Preston, S. H., et al. (1999). "Effects of age misreporting on mortality estimates at older ages." Population Studies **53**(2): 165–177.
- Yang, G., et al. (2005). "Mortality registration and surveillance in China: History, current situation and challenges." Population Health Metrics **3**(3): 3-12.
- Gan, X., et al. (2014). "Provincial Maternal Mortality Surveillance Systems in China." Journal of Biomedicine and Biotechnology(3).



# Reference

- Yang, G., et al. (2005). "Mortality registration and surveillance in China: History, current situation and challenges." Population Health Metrics **3**(1): 3-12.
- Yu, Y. C. (1978). "The Demographic Situation in China." Population Studies **32**(3): 427-447.
- Wu, X. and G. He (2015). "The Evolution of Population Census Undertakings in China, 1953–2010." China Review **15**(1): 171-206.
- Coale, A. J. and E. E. Kisker (1986). "Mortality Crossovers: Reality or Bad Data?" Population Studies **40**(3): 389-401.
- Zeng, Y. and J. W. Vaupel (2003). "Oldest-Old Mortality in China." Demographic Research **8**(7): 215-244.
- Hsu, C. Y., et al. (2009). "Understandings of death and dying for people of Chinese origin." Death Studies **33**(2): 153-174.