Understanding Health and Social Challenges for Aging and Long-Term Care in China

Yang, W., Wu, B., Tan, S.Y., Li, B., Lou, V.W.Q., Chen, Z.f., Chen, X.h., Fletcher, J.R., Carrino, L., Hu, B., Zhang, A., Hu, M., Wang, Y.
Understanding health and social challenges for ageing and long-term care in China

Abstract

The 2nd King’s College London Symposium on Ageing and Long-term Care in China was convened from 4 to 5th July 2019 at King’s College London in London. The aim of the Symposium was to have a better understanding of health and social challenges for ageing and long-term care in China. This symposium draws research insights from a wide range of disciplines, including economics, public policy, demography, gerontology, public health and sociology. A total of 20 participants from eight countries, seek to identify the key issues and research priorities in the area of ageing and long-term care in China. The results published here are a synthesis of the top four research areas that represent the perspectives from some of the leading researchers in the field.

Key words: Healthy ageing, Long-term care, China
Population ageing has created an unprecedented global challenge: the number of older people (aged 65 and above) is expected to grow from one in eleven people in 2019 (9%) to one in six (16%) in 2050 (United Nations, 2019), with most of the increase taking place in low- and middle-income countries (World Health Organization, 2015). In China, the total number of older people reached approximately 176 million, or 13% of the entire population in 2019. The proportion of older people is projected to increase to 26% by 2050, exceeding that of most European countries (National Bureau of Statistics of China, 2011). As people age, it is expected that they will develop a higher propensity to suffer from various illness and chronic conditions. Ageing is a lifelong process. Scholars to date have identified various risk factors relating to health outcomes in later life, and suggest that taking a life course perspective to look for causes of various health conditions and illness will provide valuable insights into healthy aging. Healthy ageing will reduce the financial burden of care and delay the use of long-term care (LTC), which involves a variety of services/activities designed to meet a person's health or personal care needs and to help them live as independently and safely as possible when they can no longer perform everyday activities on their own (World Health Organization, 2015). Currently, most older people will need to use LTC at some point of their life. Informal care has been the primary source of care for disabled older people, but reliance on family provision has become untenable due to changing demographic structures and rapid socioeconomic shifts in many ageing countries, including China. This not only implies that a formal care system is needed, but also means that the government should carefully design its LTC system to ensure equity in access and financing among the older population. Attention should also be paid to technological advancement which can play an important role in developing innovative care delivery models. Today, technologies in gerontology and geriatrics that are powered by Artificial Intelligence (AI), the Internet, sensors and actuators have already been developed to help meet care needs, and these technologies can be useful in
their capacities to support older people and caregivers in care provisions. Facing a significant increase of LTC demands but with limited resources, it is particularly important to use technology to develop innovative care delivery models in China and other developing countries.

The 2nd Symposium on Ageing and Long-term Care in China was convened from 4 to 5th July 2019 to discuss these topics. While the 1st symposium focused on key drivers for population ageing, such as increased life expectancy and low fertility, the 2nd symposium drew research insights from a wider range of topics related to LTC policies and systems. A total of 20 leading researchers and scientists from eight countries, sought to identify key issues and research priorities in the area of ageing and LTC in China. International lessons were also discussed in the symposium. The participants discussed these four priority research areas:

1. Understanding healthy ageing from a life course perspective: How do risk factors from early life onwards affect health outcomes in later life?
2. Improving care provision: How do long-term care and health care utilisation vary among older people, and what are the potential access barriers?
3. Addressing issues in LTC financing: How is the LTC sector financed, and what problems do we see in terms of the current LTC financing model?
4. Promoting technology and innovation in LTC: What roles do technology and innovation play in LTC provision?

Health inequality and disparities in old age can be substantial due to multiple environmental, behavioural and social circumstances that affect individuals’ life trajectories. A large and growing body of research has suggested that *in utero* and childhood risk factors may
contribute to health in later life. These risk factors, including poor health in childhood (Gong et al., 2015; Kendig et al., 2017; Wang & Shen, 2016; Wang et al., 2018), limited access to healthcare (Zeng et al., 2007), low parental socioeconomic status (Zhang & Crimmins, 2018), childhood adversities (Tian et al., 2019; Yang & Lou, 2016), low residential mobility (Xu et al., 2019), malnutrition (Zhang et al., 2018), lack of social support (Zhang et al., 2018), low education and cognitive stimulation (Langa & Larson, 2014), unfavourable sibling sex-composition such as daughters growing up in families with sons (Huang & Elo, 2009), and negative parent-child relationship (Zhang et al., 2018), have been found to contribute to individuals’ susceptibility to mental health problems, chronic diseases, functional and cognitive impairment, and premature death in China. The association between mid-life lifestyle factors and late-life physical and mental health status has also been established (Lafortune et al., 2016; Sun et al., 2009; Tyas et al., 2003). Lifestyle factors, such as smoking (Tyas et al., 2003) and the transition into spousal caregiving (Liu & Lou, 2019) are found to be significantly associated with health in older age for Chinese population. Higher smoking intensity was also associated with higher risks of Alzheimer’s disease (Tyas et al., 2003). Other risk factors, such as regional and rural/urban status at birth (Yan, Chen, & Gill, 2020), exposure to famine (Sun et al., 2018), low educational attainment and poor neighbourhood quality (Li et al., 2020) and migration (Xu et al., 2017), also increase the risk of worse health in later life in China.

Evidence from the developed world has drawn attention to the relationship between life course events and old age health, but limited research has been done in the context of China. A number of researchers have looked into how historical events happened in China, such as famine and war, may affect population health. For instance, a few studies compared cohorts
who were exposed to the Great Chinese famine\(^1\) from 1959 to 1961 with those who were not directly exposed, and found that the Great Chinese Famine had negative effects on height, weight, educational attainment and labour supply (Sun et al., 2018; Wang et al., 2016, 2015, 2017; Wang et al., 2016). Researchers have also attributed reductions in mortality and morbidities early in the People’s Republic to evolving healthcare system including the now obsolete barefoot doctor scheme (Blumenthal & Hsiao, 2015). However, evidence on the longitudinal relationship between individual’s lifestyle in early- and mid-life and health outcomes in the context of China is rather limited, with exceptions of several qualitative studies that have examined how historical contexts and social changes could affect people’s perceptions and choices and thus health in the life course (Liang & Luo, 2012, 2017). Although studies from the U.S. and Singapore showed that lifestyle interventions demonstrated positive effects on reducing the development of diabetes and diabetes-associated microvascular complications in later life (Sathish, 2019), evaluations on similar interventions were rather limited in China. The Chinese government has adopted chronic disease prevention programs in the spirit of Health in All Policies and stressed the role of communities in healthy ageing (Ministry of Health, 2010; Yang et al., 2008; Shen, 2014). China’s Non-communicable Disease Prevention Demonstration Area Project\(^2\) has been shown to improve disease management and reduce unhealthy diet and smoking in the short-term, but its long-term impact on health and demand for LTC requires a systematic evaluation (Jiang et al., 2018).

\(^1\) The Great Chinese Famine was a period in the People's Republic of China between the years 1959 and 1961 characterized by widespread famine.

\(^2\) Noncommunicable Disease Prevention Demonstration Area Project was launched from 2010, with the aim of preventing and controlling non-communicable diseases in the People's Republic of China.
2. Improving care provision

Providing access to affordable care for all people in need is one of the most important goals for an LTC system. The most common form of care for older people is informal, provided by families and friends without remuneration (Bloom et al., 2015). In Europe, it is estimated that between 20% to 44% of the LTC is provided by informal caregivers (Jang et al., 2012; Jegermalm & Grassman, 2012; Sole-Auro & Crimmins, 2014; Verbakel et al., 2017). Similar trends are observed in Hong Kong, Japan, Singapore, and South Korea (Census and Statistics Department, 2009; Jang et al., 2012). In terms of formal care, most high-income countries provide some degrees of institutional care for older people with limited informal support and/or a high degree of dependency. However, over the past few decades, the public institutional care system has gradually evolved into home- and community-based care. Recent data show that only 2 to 5 percent of the population aged 65 and above are institutionalised in Australia, Japan, Sweden, US, and Italy (Gori et al., 2015).

Although LTC provision in China has been largely reliant on family care, the availability of informal care is of particular concern in the context of population ageing due to low fertility (Yang & Tan, 2019), a distorted gender ratio (Ebenstein & Sharygin, 2009) and substantial internal migration (Giles et al., 2010). Older people from low income groups and with migrant children who live far away from them may be unable to receive informal care and are more likely to require publicly funded care. In order to help older people to live interpedently, it is crucial to understand what types of care services are needed, as well as factors that contribute to people’s transition into institutional care facilities. It is also important to understand how caregiving may impact informal caregivers in terms of physical and mental health (Li et al., 2019; Liu et al., 2017; Lu et al., 2017), social support (Jiang et
al., 2018) and financial status. We have seen some evidence from the international literature, but evidence from China remains scant.

Institutional care has developed rapidly during the past decade. There has been approximately 70% growth in the number of care home beds (6.7 million), reaching the target of 30 beds per 1000 older people (Luo & Zhan, 2018). In addition, a wide range of care facilities from board-and-care facilities to modern nursing homes with skilled carers, nurses, doctors and medical services have emerged (Feng et al., 2012). Some local governments have made significant progress in providing home- and community-based services, including purchasing services from grassroots social organisations, building day care centres, and providing meals on wheels services (Du, 2015; Yang, 2014; Yang, 2014). Initiatives have been developed to monitor, inspect and regulate care providers. A number of cities, such as Beijing and Shanghai, have published guidance to promote training for care providers (Du, 2015). Governments have also issued new policies regarding professional development of care workers, including lowering the thresholds for entering the sector, strengthening professional development as well as detailing career paths for care workers. However, compared to developed countries, formal care in China is under-developed, especially in the vast rural areas, where access to and quality of LTC remain limited (Du, 2015; Wu et al., 2009; Yang, 2016).

Access to geriatric care has been improved over the years due to the launch of a national level Social Health Insurance (SHI) system in the late 1990s. In the past decade, the Chinese government has made progress in developing its geriatric departments (Dong et al., 2018). In 2016, the National Health and Family Planning Commission (NHFPC) established a national centre on geriatric, stressing the importance of geriatric in China. NHFPC then issued a
policy, which requires all tertiary public hospitals to have a geriatric clinical program. In 2017, the Ministry of Science and Technology funded six research centres for geriatric (Li et al., 2018). In addition, some local governments have taken measures to support the development of geriatric care. For example, the Jiangsu provincial government provides financial incentives for geriatric nursing staff who have worked in the field for more than five years, and the Nanjing municipal government subsidises geriatric services at day care centres in the communities (Li et al., 2018). At the primary care level, the government has also developed measures to strengthen the capacity of its primary care sector and provide geriatric training to primary care staff (Liu et al., 2017). However, China is still lagging behind in terms of trainings in geriatrics. Limited specialised geriatric training is offered in medical schools, and no geriatric qualifications are offered at the national level (Flaherty et al., 2007; Leng et al., 2008).

Another key challenge for the researchers and policy makers is to address the divided health and LTC service provision. How to bring different stakeholders on board to make efficient use of resources and deliver accessible and integrated services, and how to regulate and monitor the service providers to deliver quality and affordable care for older people is another research area which needs further investigation.

3. Addressing issues in long-term care financing

Improving LTC coverage and financial protection for older people is an essential component in ensuring equitable access to LTC for older people. LTC services are often needed for an extended period of time, as many disabled people or people with a debilitating illness need services until the end of life. The lifetime costs for LTC can be prohibitive, therefore, it is
important to improve state support for those with the greatest LTC needs and with the least ability (Rhee et al., 2015; Tamiya et al., 2011).

China’s LTC financing is a mixed system which mirrors institutional and historical developments of the health and social care system, and recent development made by the government. Since the 1990s, the financial base of the LTC institutions has shifted from reliance on public funding to more diversified revenue sources, including self-payers. Older people are expected to pay out of pocket for care provided in government-run LTC facilities. For specialised nursing homes, costs are usually high, and often considered too expensive for self-payers to afford. The 2000s marked a significant break with previous decades in which the Chinese government’s attention was predominately occupied by economic development. In 2006, the State Council issued series policy initiatives that have sought to develop a system of services for older people (The State Council of P.R. China, 2006). In particular, a 2006 State Council Policy document on the Development of the LTC sector outlined the guiding principle of building an equitable, affordable and regulated LTC financing and provision system. Nationally, institutional LTC services are largely financed through public funding (i.e., government revenue and welfare lottery schemes). The central government required local governments to secure sufficient funds for LTC care. It is also stipulated that at least half of the surplus earned by the welfare lottery schemes must be earmarked for the LTC system (The State Council of P.R. China, 2011, The State Council of P.R. China, 2013). Although services are subsidised by the government, many complain that associated care costs are often too high. In 2005, nearly 60% of older people (about 3.5 million) did not seek care when needed, and this number is predicted to increase to 16 million by 2050 (Gu & Vlosky, 2008).
In the 2010s, the Chinese government started to look for new models to finance LTC services. A public LTC insurance has been piloted to improve access to LTC in fifteen cities. The LTC insurance is a dedicated funding mechanism which can be used to reimburses part of the LTC costs for disabled people. The goals of the LTC insurance are to improve equitable access to LTC and reduce financial burden of the older people. In 2012, Qingdao was the first city to officially initiate an urban LTC insurance scheme (Yang et al., 2016), and around 3.7 million people participated in the scheme in 2014 (Du, 2015). In 2016, the scheme was expanded to fifteen cities with growing ageing populations. While the insurance design varies significantly across these pilot cities (Wang et al., 2018), the revenue of the LTC insurance comes primarily from SHI. Approximately 74% of funds are drawn from the SHI, only 14% from specific premiums from individual contributions. Therefore, it is unclear whether the current funding mechanism will be sustainable in the future (Wu et al., 2018; Yang & Du, 2018). Within the pilot cities, the LTC insurance varies significantly, in terms of eligibility, covered services, reimbursement level, etc. Most cities only cover people with formal employment, or have implemented a less comprehensive package for those who are unemployed or from rural areas (He et al., 2019; Zhao & Chen, 2017). For instance, in cities, like Anqing, Chengde, Chengdu, Chongqing, Qiqihar, and Guangzhou, only urban residents with formal employment can participate in the scheme. In Ningbo and Changchun, institutional care is covered but not home- and community-based care. In Jingmen, Shihezi, Nantong, Qingdao, Shanghai, Suzhou, and Shangrao, the benefit package is comprehensive and covers more population and a wide range of services. Covered target populations include both urban and rural residents, and both institutional care and community-based care is covered (Wu et al., 2018; Zhu & Österle, 2019).
China’s LTC insurance differs from the ones implemented in other countries in terms of revenue collection and covered services. The current pilot LTC insurance scheme in China rarely requires a separate premium and draws its funds primarily from SHI. This is not the case in Germany, the Netherlands and Japan, where working age adults are expected to make individual contributions through monthly or annual premiums to its LTC insurance fund. Further, the LTC insurance in some cities, for example Qingdao, focuses on nursing care services instead of services designed to help older people with disabilities to perform daily activities.

Early assessments of the pilot LTC insurance have yielded mixed results regarding the impacts (Qin et al., 2014; Zhao, 2015). Some studies found that the scheme has made services more affordable for participants (Deng & Guo, 2015), and has generated substantial savings for hospital care (Lv & Wu, 2016). However, other studies reported discrepancies in reimbursement rates of services for participants with different SHI status (An et al., 2017) and poor coverage of older people with cognitive impairments (Yang et al., 2017; Zhang, 2017). As the LTC insurance is still in the pilot stage, systematic evaluations and analyses are needed to understand the eligibility of services, levels of coverage, benefit package, and purchasing mechanisms in order to inform the insurance design in the longer term (Du, 2015; Yang et al., 2018).

4. Promoting technology and innovation in LTC

Technology can be an innovative approach to serve the ageing population. Assistive technologies such as wearable devices and smart home technology are able to facilitate caregiving and improve quality of life for older people (Chen et al., 2019). Technology that incorporates AI features and robotics can be harnessed as a part of the solution for LTC. For
example, Japan, a super-aged country, has long been a forerunner in the adoption of
technology in LTC (Siripala, 2018). AI is also fuelling the development of precision
medicine which is powered by machine learning approaches that are able to generate large
numbers of quantitative biomarkers, synthetic molecular and patient data (Zhavoronkov et al.,
2019). The advancement in technology may also have the potential to facilitate quality LTC
at a relatively low cost (American Geriatrics Society, 2016; Wang et al., 2019). In China, AI
is expected to revolutionize the healthcare and LTC industries by ushering in up to $147
billion of health investment in the next 20 years. AI solutions, such as speech recognition,
image recognition, natural language processing, data mining and robotics, can facilitate
medical decision-making, advance the accuracy of medical diagnosis and streamline medical
record-keeping (Kong et al., 2019). It may also help improve health equity by better
redistributing medical resources across the country. AI can also help researchers and
clinicians better use electronic health records (Kong et al., 2019).

In China, technology has been used in several ways to facilitate care and assist older people’s
daily living. For instance, the expansion of the Internet Hospitals demonstrated positive
effects in terms of improving access to care in rural areas (Tu et al., 2015). The use of mobile
health to monitor/treat health conditions has also become common among older people, and
evidence show that these technologies are effective in areas such as blood pressure
monitoring, cognitive therapy, fall prevention, etc (Sun et al., 2016). Furthermore, the
internet of things has been incorporated into smart home systems to facilitate LTC through
the installation of sensors in wearables to detect falls, record motions, and monitor the sleep
quality of older people at home (Lei et al., 2019; Wei, 2019). Nevertheless, the deployment of
these technologies ought to be implemented with caution as technology is not a panacea for
LTC. We believe that it is important to understand how to target the appropriate beneficiaries
and ensure that technologies are accessible to older people who need them. There is also a lack of regulation on the use of technologies in LTC in China and many other countries, like European countries. It is important to develop clear guidelines and regulations on how to best govern the implementation of technology to improve the quality of care for older people.

Conclusions

This article presents four key issues regarding the health and social challenges of aging in China. It is essential for researchers to engage in multidisciplinary research collaborations to understand how to achieve an efficient and equitable LTC system in China. Lessons from high-income countries, such as the U.S., Germany, Japan and South Korea, in terms of understanding risk factors for functional and cognitive impairment, LTC service planning, financing and the application of technology in LTC, would be valuable for China. These top four research areas are proposed as key areas that could pave the way to many important inquiries, discussion, and future research priorities to examine challenging issues surrounding ageing and LTC development in China as well as other low- and middle-income countries.
References

An, P., Chen, N., & Xiao, B. (2017). System practice, experience and trends on the long-term care insurance of China: Based on a comparative study of Qingdao model and Nantong model (in Chinese). *Chinese Journal of Health Policy, 10* (8), 1.

Bloom, D. E., Chatterji, S., Kowal, P., Lloyd-Sherlock, P., McKee, M., Rechel, B., … Smith, J. P. (2015). Macroeconomic implications of population ageing and selected policy responses. *The Lancet, 385*(9968), 649–657. doi: 10.1016/S0140-6736(14)61464-1

Blumenthal, D., & Hsiao, W. (2015). Lessons from the East — China’s rapidly evolving health care system. *The New England Journal of Medicine, 372*(14), 1281–1285. doi:10.1056/NEJMp1410425

Census and Statistics Department. (2009). *Thematic Household Survey Report - Report No.40 - Socio-demographic Profile, Health Status and Self-care Capability of Older Persons.* Retrieved from https://www.censtatd.gov.hk/hkstat/sub/sp160.jsp?productCode=C0000071

Chen, K., Lou, V. W. Q., & Lo, S. S. C. (2019). A Tablet-Based Volunteer-Mediated Intervention for Cognitively Impaired Older People: A Pretest–Posttest. *Research on Social Work Practice, 1*–10. doi:10.1177/1049731519863103

China, N. B. of S. of. (2011). *2010 People’s Republic of China Census*. Beijing.

Deng, D., & Guo, T. (2015). The construction of China’s long-term care insurance system - a case study of Qingdao (in Chinese). *China Health Economics Review, 10*(1), 33–37.

Dong, B., Yue, J., Cao, L., Yang, M., Ge, N., Qiukui, H., … Flaherty, J. H. (2018). Transformation of a Geriatric Department in China. *Journal of the American Geriatrics Society, 66*(1), 184–190. doi:10.1111/jgs.15217

Du, P. (2015). *Long-term care for older persons in China*: United Nations Economic and Social Commision for Asia and the Pacific; 2015, Working paper
Ebenstein, A. Y., & Sharygin, E. J. (2009). The consequences of the “missing girls” of China. 
*World Bank Economic Review, 23*(3), 399–425. doi:10.1093/wber/lhp012

Feng, Z., Liu, C., Guan, X., & Mor, V. (2012). China’s Rapidly Aging Population Creates 
Policy Challenges In Shaping A Viable Long-Term Care System. *Health Affairs, 31*(12), 
2764–2773. doi:10.1377/hlthaff.2012.0535

Flaherty, J. H., Liu, M. L., Ding, L., Dong, B., Ding, Q., Li, X., & Xiao, S. (2007). China: 
The aging giant. *Journal of the American Geriatrics Society, 55*(8), 1295–1300. 
doi:10.1111/j.1532-5415.2007.01273.x

Giles, J., Wang, D., & Zhao, C. (2010). Can China’s Rural Elderly Count on Support from 
Adult Children? Implications of Rural-to-Urban Migration. *Journal of Population 
Ageing, 3*(3–4), 183–204. doi:10.1007/s12062-011-9036-6

Gong, C. H., Kendig, H., & Silverstein, M. (2015). The Influence of Childhood Health and 
Early Life Experience on Adult Health and Wellbeing: Evidence from China. *The Gerontologist, 55*(Suppl_2), 520–521. doi:10.1093/geront/gnv239.05

Gori, C., Fernández, J.-L., & Wittenberg, R. (2015). *Long-term care reforms in OECD countries*. Policy Press. doi:10.2307/j.ctt1t88zbz

Gu, D., & Vlosky, D. A. (2008). Long-term care needs and related issues in China. *Social Sciences in Health Care and Medicine, 2*, 51–84, Janet B. Garner and Thelma C. Christiansen, eds., Nova Science Publishers, 2008. Available at SSRN: https://ssrn.com/abstract=2194384

Huang, C., & Elo, I. T. (2009). Mortality of the oldest old Chinese: The role of early-life nutritional status, socio-economic conditions, and sibling sex-composition. *Population Studies, 63*(1), 7–20. doi:10.1080/00324720802626921
Jang, S. N., Avendano, M., & Kawachi, I. (2012). Informal caregiving patterns in Korea and European countries: A cross-national comparison. *Asian Nursing Research, 6*(1), 19–26. doi:10.1016/j.anr.2012.02.002

Jegermalm, M., & Grassman, E. J. (2012). Helpful citizens and caring families: Patterns of informal help and caregiving in Sweden in a 17-year perspective. *International Journal of Social Welfare, 21*(4), 422–432. doi:10.1111/j.1468-2397.2011.00839.x

Jiang, N., Lou, V. W. Q., & Lu, N. (2018). Does social capital influence preferences for aging in place? Evidence from urban China. *Aging and Mental Health, 22*(3), 405–411. doi:10.1080/13607863.2016.1249455

Jiang, Y., Kong, L., & Li, L. (2018). Implementing the strategy of “Healthy China” and strengthening the setting-up of National Demonstration Areas, for Comprehensive Prevention and Control of Non-communicable Diseases. *Chinese Journal of Epidemiology, 39*(4), 391–393.

Kendig, H., Gong, C. H., Yiengprugsawan, V., Silverstein, M., & Nazroo, J. (2017). Life course influences on later life health in China: Childhood health exposure and socioeconomic mediators during adulthood. *SSM - Population Health, 3*, 795–802. doi:10.1016/j.ssmph.2017.10.001

Kong, X., Ai, B., Kong, Y., Su, L., Ning, Y., Howard, N., … Fang, Y. (2019). Artificial intelligence: A key to relieve China’s insufficient and unequally-distributed medical resources. *American Journal of Translational Research, 11*(5), 2632–2640.

Lafortune, L., Martin, S., Kelly, S., Kuhn, I., Remes, O., Cowan, A., & Brayne, C. (2016). Behavioural Risk Factors in Mid-Life Associated with Successful Ageing, Disability, Dementia and Frailty in Later Life: A Rapid Systematic Review. *PLoS ONE, 11*(2), 1–34. doi:10.1371/journal.pone.0144405
Langa, K. M., & Larson, E. B. (2014). Education, brain health, and improving life opportunities for women. *The Journal of the Economics of Ageing, 4*, 56–58. doi:10.1016/j.jeoa.2014.08.001

Lei, X., Chen, J., Li, G., Chen, F., & Wu, L. (2019). A Design and Implementation of an Intelligent Care System for the Elderly Based on Internet of Things. In *11th International Conference on Advanced Computational Intelligence, ICACI 2019* (pp. 234–238). doi:10.1109/ICACI.2019.8778502

Leng, S. X., Tian, X., Durso, S., Lazarus, G., Lu, C., Park, E., … Fried, L. P. (2008). The aging population and development of geriatrics in China. *Journal of Chemical Information and Modeling, 56*(3), 571–573. doi:10.1111/j.1532-5415.2008.01581.x

Li, M., Mao, W., Chi, I., & Lou, V. W. Q. (2019). Geographical proximity and depressive symptoms among adult child caregivers: social support as a moderator. *Aging and Mental Health, 23*(2), 205–213. doi:10.1080/13607863.2017.1399349

Li, X., Fan, L., & Leng, S. X. (2018). The Aging Tsunami and Senior Healthcare Development in China. *Journal of the American Geriatrics Society, 66*(8), 1462–1468. doi:10.1111/jgs.15424

Li, Y., Xue, Q. L., Odden, M. C., Chen, X., & Wu, C. (2020). Linking early life risk factors to frailty in old age: evidence from the China Health and Retirement Longitudinal Study. *Age and Ageing, 49*(2), 208–217. doi:10.1093/ageing/afz160

Liang, J., & Luo, B. (2012). Toward a discourse shift in social gerontology: From successful aging to harmonious aging. *Journal of Aging Studies, 26*(3), 327–334. doi:10.1016/j.jaging.2012.03.001

Liang, J., & Luo, B. (2017). It was all planned … now what? Claiming agency in later life in reforming China. *Ageing and Society, 37*(10), 2074–2102. doi:10.1017/S0144686616000830
Liu, G. G., Vortherms, S. A., & Hong, X. (2017). China’s Health Reform Update. *Annual Review of Public Health, 38*(1), 431–448. doi:10.1146/annurev-publhealth-031816-044247

Liu, H., & Lou, V. W. Q. (2017). Patterns of productive activity engagement as a longitudinal predictor of depressive symptoms among older adults in urban China. *Aging and Mental Health, 21*(11), 1147–1154. doi:10.1080/13607863.2016.1204983

Liu, H., & Lou, V. W. Q. (2019). Transitioning into spousal caregiving: Contribution of caregiving intensity and caregivers’ multiple chronic conditions to functional health. *Age and Ageing, 48*(1), 108–114. doi:10.1093/ageing/afy098

Liu, J., Lu, N., & Lou, V. W. Q. (2017). Care Tasks in the Stress Process for Family Caregivers in Urban China. *Clinical Gerontologist, 40*(5), 428–434. doi:10.1080/07317115.2017.1305033

Lu, N., Liu, J., Wang, F., & Lou, V. W. Q. (2017). Caring for disabled older adults with musculoskeletal conditions: A transactional model of caregiver burden, coping strategies, and depressive symptoms. *Archives of Gerontology and Geriatrics, 69*(November), 1–7. doi:10.1016/j.archger.2016.11.001

Luo, B., & Zhan, S. (2018). Crossing the river by feeling for the stones: contesting models of marketization and the development of China’s long-term care services. *Journal of Chinese Governance, 3*(4), 438–460. doi:10.1080/23812346.2018.1523296

Lv, S., & Wu, J. (2016). Long-term Care Insurance in Qingdao: System Achievements, Implementation Obstacles and Policy Optimization (in Chinese). *Chinese Health Economics, 35*(8), 30–32.

Ministry of Health, C. (2010). Guidance Scheme of Demonstration Areas for Integrated Prevention and Control of chronic and non-communicable Diseases.
Qin, J., Li, H., & Yin, J. (2014). Design consideration and implementation outcomes of the long-term care insurance in Qingdao (in Chinese). *Chinese Journal of Hospital Administration, 30*(7), 1–4. doi:10.3760/cma.j.issn.1000-6672.2014.07.012

Rhee, J. C., Done, N., & Anderson, G. F. (2015). Considering long-term care insurance for middle-income countries: Comparing South Korea with Japan and Germany. *Health Policy, 119*(10), 1319–1329. doi:10.1016/j.healthpol.2015.06.001

Sathish, T. (2019). Diabetes prevention and lifestyle intervention in resource-limited settings. *Lancet Diabetes Endocrinol, 7*(3), 165–167. doi:10.1016/S2213-8587(19)30027-0

Siripala, T. (2018). Japan’s Robot Revolution in Senior Care. Retrieved from https://www.japantimes.co.jp/opinion/2018/06/09/commentary/japan-commentary/japans-robot-revolution-senior-care/#.XUOws_IzaUk

Sole-Auro, A., & Crimmins, E. (2014). Who cares? A comparison of informal and formal care provision in Spain, England and the USA. *Ageing and Society, 34*(3), 495–517. doi:10.1038/jid.2014.371

Sun, J., Guo, Y., Wang, X., & Zeng, Q. (2016). mHealth For Aging China: Opportunities and Challenges. *Aging and Disease, 7*(1), 53. doi:10.14336/ad.2015.1011

Sun, Q., Townsend, M. K., Okereke, O. I., Franco, O. H., Hu, F. B., & Grodstein, F. (2009). Adiposity and weight change in mid-life in relation to healthy survival after age 70 in women: Prospective cohort study. *BMJ (Online), 339*(7725), 851. doi:10.1136/bmj.b3796

Sun, Y., Zhang, L., Duan, W., Meng, X., & Jia, C. (2018). Association between famine exposure in early life and type 2 diabetes mellitus and hyperglycemia in adulthood: Results from the China Health And Retirement Longitudinal Study (CHARLS). *Journal of Diabetes, 10*(9), 724–733. doi:10.1111/1753-0407.12653
Tamiya, N., Noguchi, H., Nishi, A., Reich, M. R., Ikegami, N., Hashimoto, H., … Campbell, J. C. (2011). Population Ageing and Wellbeing: Lessons from Japan’s Long-Term Care Insurance Policy. *The Lancet, 378*(9797), 1183–1192. doi:10.1016/S0140-6736(11)61176-8

The American Geriatrics Society Expert Panel on Person-Centered Care. (2016). Person-Centered Care: A Definition and Essential Elements. *Journal of the American Geriatrics Society, 64*(1), 15–18. doi:10.1111/jgs.13866

The State Council of P.R. China, 02/17/2006, 2006-last update, The State Council’s Opinion on the development of the long-term care sector [Homepage of The State Council of China], [Online]. Available: http://www.gov.cn/zwgk/2006-02/17/content_202553.htm [07/03, 2015].

The State Council of P.R. China, 13/09/2013, 2013-last update, The State Council’s opinion on promoting the development of long-term care sector [Homepage of The State Council of P.R. China], [Online]. Available: http://www.mca.gov.cn/article/zwgk/jd/201309/20130900518508.shtml [07/13, 2013].

The State Council of P.R. China, 17/09/2011, 2011-last update, The State Council’s opinion on developing the long-term care sector in the Twelfth Five Year plan [Homepage of The State Council of P.R. China], [Online]. Available: http://www.gov.cn/xxgk/pub/govpublic/mrlm/201109/t20110923_64080.html [07/03, 2015].

Tian, F., Meng, S. S., & Qiu, P. (2019). Childhood adversities and mid-late depressive symptoms over the life course: Evidence from the China health and retirement longitudinal study. *Journal of Affective Disorders, 245*, 668–678. doi:10.1016/j.jad.2018.11.028
Tu, J., Wang, C., & Wu, S. (2015). The internet hospital: An emerging innovation in China. *The Lancet Global Health, 3*(8), e445–e446. doi:10.1016/S2214-109X(15)00042-X

Tyas, S. L., White, L. R., Petrovitch, H., Ross, G. W., Foley, D. J., Heimovitz, H. K., & Launer, L. J. (2003). Mid-Life Smoking and Late-Life Dementia: The Honolulu-Asia Aging Study. *Neurobiology of Aging, 24*(4), 589–596. doi:10.1016/S0197-4580(02)00156-2

United Nations, Department of Economic and Social Affairs, P. D. (2019). *World Population Prospects 2019: Highlights*. United Nations. Department of Economic and Social Affairs. World Population Prospects 2019. Retrieved from https://population.un.org/wpp2019/Publications/Files/WPP2019_Highlights.pdf

Verbakel, E., Tamlagsronning, S., Winstone, L., Fjaer, E. L., & Eikemo, T. A. (2017). Informal care in Europe: Findings from the European Social Survey (2014) special module on the social determinants of health. *European Journal of Public Health, 27*, 90–95. doi:10.1093/eurpub/ckw229

Wang, J., Wu, B., Bowers, B. J., Lepore, M. J., Ding, D., McConnell, E. S., & Corazzini, K. N. (2019). Person-Centered Dementia Care in China: A Bilingual Literature Review. *Gerontology & Geriatric Medicine, 5*, 1–11. doi:10.1177/2333721419844349

Wang, N., Chen, Y., Ning, Z., Li, Q., Han, B., Zhu, C., … Lu, Y. (2016). Exposure to Famine in Early Life and Nonalcoholic Fatty Liver Disease in Adulthood. *Journal of Clinical Endocrinology and Metabolism, 101*(5), 2218–2225. doi:10.1210/jc.2016-1076

Wang, N., Wang, X., Han, B., Li, Q., Chen, Y., Zhu, C., … Lu, Y. (2015). Is exposure to famine in childhood and economic development in adulthood associated with diabetes? *Journal of Clinical Endocrinology and Metabolism, 100*(12), 4514–4523. doi:10.1210/jc.2015-2750
Wang, N., Wang, X., Li, Q., Han, B., Chen, Y., Zhu, C., … Lu, Y. (2017). The famine exposure in early life and metabolic syndrome in adulthood. *Clinical Nutrition, 36*(1), 253–259. doi:10.1016/j.clnu.2015.11.010

Wang, Qing, & Shen, J. J. (2016). Childhood health status and adulthood cardiovascular disease morbidity in rural china: Are they related? *International Journal of Environmental Research and Public Health, 13*(6), 565. doi:10.3390/ijerph13060565

Wang, Qing, Zhang, H., Rizzo, J. A., & Fang, H. (2018). The effect of childhood health status on adult health in China. *International Journal of Environmental Research and Public Health, 15*(2), 212. doi:10.3390/ijerph15020212

Wang, Qun, Zhou, Y., Ding, X., & Ying, X. (2018). Demand for long-term care insurance in China. *International Journal of Environmental Research and Public Health, 15*(1), 1–15. doi:10.3390/ijerph15010006

Wang, Z., Li, C., Yang, Z., Zou, Z., & Ma, J. (2016). Infant exposure to Chinese famine increased the risk of hypertension in adulthood: Results from the China Health and Retirement Longitudinal Study. *BMC Public Health, 16*, 435. doi:10.1186/s12889-016-3122-x

Wei, X. (2019). Research on the Falling Detection System for Elderly-assistant and Walking-assistant Robot. *Journal of Physics: Conference Series, 1302*(3). doi:10.1088/1742-6596/1302/3/032014

World Health Organization. (2015). *World Report on Ageing and Health*. Retrieved from https://apps.who.int/iris/handle/10665/186463

Wu, B., Mao, Z. F., & Zhong, R. (2009). Long-Term Care Arrangements in Rural China: Review of Recent Developments. *Journal of the American Medical Directors Association, 10*(7), 472–477. doi:10.1016/j.jamda.2009.07.008
Wu, H., Shao, Y., & Zhou, T. (2018). Study on financing mechanism of long-term care insurance—based on the comparison of 15 pilot schemes (in Chinese). Financial Theory & Practice, (10):98-101. doi:10.3969/j.issn.1003-4625.2018.10.016

Xu, H., Dupre, M. E., Østbye, T., Vorderstrasse, A. A., & Wu, B. (2019). Residential Mobility and Cognitive Function Among Middle-Aged and Older Adults in China. Research on Aging, 41(1), 3–30. doi:10.1177/0164027518770780

Xu, H., Zhang, Y., & Wu, B. (2017). Association between migration and cognitive status among middle-aged and older adults: A systematic review. BMC Geriatrics, 17(1), 1–15. doi:10.1186/s12877-017-0585-2

Yan, B., Chen, X., & Gill, T. M. (2020). Health inequality among Chinese older adults: The role of childhood circumstances. Journal of the Economics of Ageing, 17(January), 100237. doi:10.1016/j.jeoa.2020.100237

Yang, F., & Lou, V. W. Q. (2016). Childhood adversities, urbanisation and depressive symptoms among middle-aged and older adults: Evidence from a national survey in China. Ageing and Society, 36(5), 1031–1051. doi:10.1017/S0144686X15000239

Yang, G., Kong, L., Zhao, W., Wan, X., Zhai, Y., Chen, L. C., & Koplan, J. P. (2008). Emergence of chronic non-communicable diseases in China. The Lancet, 372(9650), 1697–1705. doi:10.1016/S0140-6736(08)61366-5

Yang, J., & Du, S. (2018). Financing of long-term care insurance: current situation, predicament and countermeasures (in Chinese). Chinese Journal of Health Policy, 11(8), 8-14. doi:10.3969/j.issn.1674-2982.2018.08.002

Yang, J., Wang, S., & Du, S. (2018). Regional Comparison and implications of China’s long-term care insurance system. Chinese Journal of Health Policy, 4(11), 1–7.
Yang, T. (2014). Exploring Home and Community-Based Long-Term Care Social Policies (in Chinese). *Study and Practice*, 6, 82–91. doi:10.19624/j.cnki.cn42-1005/c.2014.06.010

Yang, T (2016). Policy Selection for China’s Long-Term Care (in Chinese). *China Social Science* 11, 87–110.

Yang, W., Chang, S., Zhang, W., Wang, R., Mossialos, E., & Wu, X. (2017). *Financing long-term care in a rapidly ageing society: evidence from Long-term Care Nursing Insurance in Qingdao, China*.

Yang, W., He, A. J., Fang, L., & Mossialos, E. (2016). Financing institutional long-term care for the elderly in China: a policy evaluation of new models. *Health Policy and Planning*, 31(July), 1391–1401. doi:10.1093/heapol/czw081

Yang, W., & Tan, S. Y. (2019). Is informal care sufficient to meet the long-term care needs of older people with disabilities in China? Evidence from the China Health and Retirement Longitudinal Survey. *Ageing & Society*, 1–20. doi:10.1017/S0144686X1900148X

Yuying Shen. (2014). Community building and mental health in mid-life and older life: Evidence from China. *Social Science & Medicine, 107*, 209–216. doi:10.1016/J.SOCSCIMED.2013.12.023

Zeng, Y., Gu, D., & Land, K. C. (2007). The association of childhood socioeconomic conditions with healthy longevity at the oldest-old ages in China. *Demography, 44*(3), 497–518. doi:10.1353/dem.2007.0033

Zhang, W. (2017). Study on the Practical Implementation of Long-term Care Insurance System and the Social Care:A Case Research on Qingdao Long-term Care Nursing Insurance. *Journal of Beijing University of Technology*, 17(6), 25–33.
Zhang, Y., & Crimmins, E. (2018). The Long-arm of Early Life Conditions on Cardiovascular Risk in Old Age. *Innovation in Aging, 2*(Suppl 1), 378. doi:10.1093/geroni/igy023.1405

Zhang, Z, Xu, H., Li, L., & Liu, J. (2018). The Influence of Early-life Social Relationships on Cognitive Function among Older Adults in China. *Innovation in Aging, 2*(Suppl 1), 351. doi:10.1093/geroni/igy023.1294

Zhang, Zhenmei, Liu, J., Li, L., & Xu, H. (2018). The Long Arm of Childhood in China: Early-Life Conditions and Cognitive Function Among Middle-Aged and Older Adults. *Journal of Aging and Health, 30*(8), 1319–1344. doi:10.1177/0898264317715975

Zhao, X. (2015). Implementation and evaluation of the recent development of long-term care nursing insurance in Qingdao (in Chinese). *Journal of Insurance Professional College, 1*, 12.

Zhavoronkov, A., Mamoshina, P., Vanhaelen, Q., Scheibye-Knudsen, M., Moskalev, A., & Aliper, A. (2019). Artificial intelligence for aging and longevity research: Recent advances and perspectives. *Ageing Research Reviews, 49*(September 2018), 49–66. doi:10.1016/j.arr.2018.11.003

Zhu, Y., & Österle, A. (2019). China’s policy experimentation on long-term care insurance: Implications for access. *International Journal of Health Planning and Management, 0–14*. doi:10.1002/hpm.2879