Urban-rural disparities in the healthy aging trajectory in China: a population-based study

Haomiao Li
Wuhan University
Yixin Zeng
Southern Medical University
Li Gan
Southern Medical University
Yusupujiang Tuersun
Southern Medical University
Jiao Yang
Southern Medical University
Jing Liu
Guangzhou First People's Hospital
Jiangyun Chen (cjy112@i.smu.edu.cn)
Southern Medical University https://orcid.org/0000-0002-5731-7039

Research Article

Keywords: Health inequality, Urban and rural disparity, China, Healthy aging trajectory

Posted Date: March 28th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-826311/v2

Abstract

Purpose: The aim of this study is to explore the differences and evaluate the equity in healthy aging trajectories between urban and rural areas in China. The hypothesis of this study is that there are differences in healthy aging trends between urban and rural areas, with inequity.

Methods: A total of 9402 respondents aged 45 years and older interviewed in four waves were selected from the China Health and Retirement Longitudinal Study. A latent growth mixture model (LGMM) was applied to distinguish the trajectory of healthy aging. A multinomial logistics regression model (MLRM) was used to explore the relationship between urban-rural areas and healthy aging trajectories, and a concentration index was used to evaluate equity.

Results: Urban-rural respondents differed in socioeconomic background, family characteristics, and personal lifestyle ($P < 0.05$). Three classes (“low risk”, “middle risk”, and “high risk”) were grouped through LGMM. The MLRM results showed that urban living was significantly associated with a healthy aging trajectory (for [middle risk/low risk]: β=-0.41, RRR =0.66, $P < 0.001$, 95% CI =0.55–0.80, and for [high risk/low risk]: β=-1.10, RRR =0.33, $P < 0.001$, 95% CI =0.26–0.41). The concentration index was -0.022 and significantly indicated the inequity of healthy aging between rural and urban areas.

Conclusion: Combined health status showed an irreversible downward trend with age, and this trajectory differed between urban and rural areas, with the rural population more likely to develop a high risk trajectory. Policy inclination and resource investment should be enhanced to reduce inequity in healthy aging between urban and rural areas in China.

Background

China is one of the countries with the highest process and rate of aging, and the situation of aging in China is severe. As of 2019, the population of China accounted for 18% of the global population. Among them, the number of people aged 65 or older reached 165 million, and the number of people aged 80 or older reached 26 million. By 2050, it is expected that the total number of people over 65 years of age in China will reach 365 million [1]. Healthy aging has become the theme of the times [2]. In 2015, the WHO defined healthy aging in its *World report on aging and health* as "the process of developing and maintaining the functional ability that enables well-being in older age." [3]. Healthy aging is a government goal and an important condition for the national health level and national economic and social development. The Chinese government has formulated the "Health China 2030" planning outline, which places health as a strategic priority for development and is an important manifestation of the government’s active response to population aging and achievement of healthy aging (Tan et al., 2017).

A comprehensive understanding of the healthy aging trajectory of society and its risk factors is of great significance for health development strategies. One of the most important issues is the disparity in healthy aging between rural and urban areas. Research on the current status and trajectory of healthy aging between urban-rural areas in China is lacking but important. In 1955, China established a

household registration system that distinguished between rural and urban populations, granting each widely differing rights. There is a great gap between rural-urban areas [5]. Regarding the socioeconomic background, compared to other countries, China has a large urban-rural disparities in terms of economic income [6], with urban populations having higher incomes than rural populations [7]; a larger proportion of older people and a faster aging process in rural areas than in urban areas [8]; and a lower level of education in rural areas than in urban areas due to geographical location and hukou policies [9]. In terms of family structure, a large number of left-behind children and older empty nesters have emerged in rural areas due to population mobility brought about by socioeconomic transformation [10, 11]; there are differences between urban and rural populations in terms of the frequency of contact with children [12] and economic interactions with children [13]. In terms of personal life, rural populations differ from urban populations in smoking rates, alcohol consumption rates, exercise intensity and frequency, and utilization of medical checkups [14–17]. Numerous studies have demonstrated differences between urban and rural areas in China, but it is unclear what the current status and trajectory of healthy aging are between urban and rural areas.

To better study population aging, many studies have focused on defining and measuring healthy aging and established a healthy aging score [18, 19], which provides a good reference for our study. The hypothesis of this study is that there are differences in healthy aging trends between urban and rural areas, with inequity.

Methods

Data source and sample selection

The data used for this study were from the China Health and Retirement Longitudinal Study (CHARLS), which was conducted by the National School of Development of Peking University. The survey was conducted for 4 waves, in 2011, 2013, 2015 and 2018. With nationally representative data in China for middle aged (45 years old) and older individuals, it is widely used for explorations associated with aging issues. A more detailed description of the objectives and methods of CHARLS has been reported elsewhere [20].

Four waves of survey data were used for this study. Respondents aged less than 45 years old in 2011, items generating healthy aging scores less than 26 (80%) and individuals lost to follow-up survey were excluded. A total of 9402 respondents were enrolled in the final analysis.

Variables

The healthy aging score was the outcome measure in this study. Based on the WHO framework and previous studies [21–23],we reviewed the information included in the CHARLS survey and identified 32 items (**Supplementary Table S1**) that might indicate the underlying concept of healthy aging. The selected items mainly focused on physical and cognitive function, pain, sleep problems and level of

energy, which strongly influence daily health performance. The selected items were dichotomized into binary variables (0 = presence of difficulties, 1 = absence of difficulties). Item response theory (IRT) modeling was used to incorporate 32 items and estimate latent trait scores for respondents on the basis of the unidimensionality assumption. IRT models can account for variation in response patterns and generate corresponding latent trait scores to reflect such variation. To improve the interpretation of the results, the latent trait scores were transferred into a range between 0 and 100.

The primary independent variable is the residence of respondents (1=rural, 2=urban), indicating the living region of the household, and is defined by the National Bureau of Statistics of the People's Republic of China.

The covariates in this study include respondents' socioeconomic background (age, gender, marital status, educational level, household per capita consumption, public health insurance coverage, current work status and chronic conditions), family characteristics (whether gives care to grandchildren, whether lives near children, weekly contact with children, gave money to children, received money from children) and lifestyle (alcohol intake, smoking status, social participation, physical exercises and physical examination). The definition and classifications are detailed in **Supplementary Table S2**.

Statistical analysis

Mean ± standard deviation and number (percentages) were used for initial description of the respondents' characteristics. Ordinal chi-square tests for categorical variables and Kruskal-Wallis one-way analysis of variance for numerical variables were used to test the significant differences.

A latent growth mixture model (LGMM) was applied to classify the trajectory of the healthy aging score of the respondents across 4 survey waves and to test predictors of membership in these classes [24, 25].The LGMM is efficient at modeling the variation in growth parameters that incorporate information from multiple indicators (repeated measures of an outcome). Furthermore, LGMM analysis does not assume a single population and can test for the presence of multiple groups or classes of individuals who represent distinct multivariate normal distributions [26–28]. We compared one- to four-class unconditional LGMMs and assessed the relative fit with conventional indices. To determine the appropriate class solution, we examined the Bayesian information criterion (BIC), the Akaike information criterion (AIC), entropy values, and the Lo-Mendell-Rubin likelihood ratio test (LRT). After trajectory groups of healthy aging were identified, a multinomial logistic regression model(MLRM) was further performed to investigate the effect of urban and rural areas on trajectory type in middle-aged and older adults. The relative risk ratio (RRR) and confidence interval (CI) were calculated, with an RRR > 1 indicating a higher risk of unsuccessful aging.

A concentration curve and concentration index were applied to quantify the unequal distribution of healthy aging across the wealth asset index. The concentration index is a numerical representation of a concentration curve obtained by plotting the distribution of poor health on the x-axis against a distribution of a socioeconomic variable on the y-axis [29, 30] In this study, the trajectory of the healthy

aging score (3 classes) was used to assess health aging, while household per capita consumption was used to evaluate socioeconomic status. A negative concentration index indicates the concentration of unsuccessful aging at lower economic levels, and a positive concentration index indicates the concentration of unsuccessful aging among those who are more affluent.

The P values were two-sided, and an alpha level of 0.05 was used to define statistical significance. The data were analyzed using Stata (version 15) and R version 3.6.3 (R Foundation for Statistical Computing, Vienna, Austria).

Results

Table 1 shows the descriptive statistics of the variables used in this study for both the rural and urban samples. Of all respondents, rural older adults accounted for 65.59% (6167). Urban-rural respondents differed in socioeconomic background, family characteristics, and personal lifestyle ($P < 0.05$). In terms of socioeconomic background, more than four-fifths of rural older adults were still working, a significantly higher percentage than that among urban older adults (three-fifths), while the average per capita household consumption of older adults in urban areas was almost twice that in rural areas. In addition, the vast majority (93.32%) of rural older adults did not have upper secondary education, a higher proportion than that among urban older adults (81.02%). In terms of family characteristics, a higher proportion of urban older adults cared for grandchildren (57.26%), co-resided with children (93.72%), and were in contact with children (95.71%) than rural older adults (48.34%, 91.47%, and 91.02% respectively). However, only 27.55% of urban respondents received financial support from children, which was much lower than the proportion of rural respondents (39.10%). In terms of personal lifestyles, rural respondents had a less healthy lifestyle than urban respondents in terms of smoking, drinking, and social interactions. In addition, more than half (55.52%) of urban older adults had physical examinations within the past 2 years, which was higher than that of rural adults (47.25%).

Table 1
Baseline descriptions (N=9402)

	Rural(n=6167)	**Urban(n=3235)**	***P* value**
1.socioeconomic background			
Age	58.26±8.48	58.16± 8.84	0.612
Gender			0.066
Male	2818(45.69%)	1414(43.71%)	
Female	3349(54.31%)	1821(56.29%)	
Educational level			<0.001
Less than lower secondary	5755(93.32%)	2621(81.02%)	
upper secondary & vocational	396(6.42%)	509(15.73%)	
tertiary	16(0.26%)	105(3.25%)	
Marital status			0.653
Divorced or widowed	661(10.72%)	337(10.42%)	
Married	5506(89.28%)	2898(89.58%)	
Household per capita consumption	5686.54±7072.63	9052.14±10366.18	<0.001
Public health insurance coverage			<0.001
Not covered	295(4.80%)	278(8.62%)	
Covered	5857(95.20%)	2946(91.38%)	
Current work status			<0.001
Not working	1110(18.06%)	1382(42.92%)	
Working	5036(81.94%)	1838(57.08%)	
Chronic condition			0.317
None	1810(29.35%)	908(28.07%)	
Yes	1844(29.90%)	962(29.74%)	
Morbidity	2513(40.75%)	1365(42.19%)	
2.Family characteristics			
Gave care to grandchildren			<0.001
None	2289(51.66%)	854(42.74%)	

	Rural(n=6167)	Urban(n=3235)	*P* value
Yes	2142(48.34%)	1144(57.26%)	
Live near children			<0.001
None	516(8.53%)	199(6.28%)	
Yes	5530(91.47%)	2969(93.72%)	
Weekly contact with children			<0.001
None	544 (8.98%)	136 (4.29%)	
Yes	5515(91.02%)	3035 (95.71%)	
Gave money to children			0.029
None	4980(81.04%)	2673(82.88%)	
Yes	1165(18.96%)	552(17.12%)	
Received money from children			<0.001
None	3745(60.90%)	2341(72.45%)	
Yes	2404(39.10%)	890(27.55%)	
3.Lifestyle			
Alcohol intake			0.524
Do not drink	4161(67.48%)	2204(68.13%)	
Drink	2005(32.52%)	1031(31.87%)	
Smoking status			<0.001
Never	3750(62.02%)	2094(65.60%)	
Quit now	455(7.53%)	254(7.96%)	
Still	1841(30.45%)	844(26.44%)	
Social participation			<0.001
None	3325(53.92%)	1566(48.42%)	
Yes	2841(46.08%)	1668(51.58%)	
Physical exercises			<0.001
None	219(8.74%)	133(9.80%)	
Light	908(36.23%)	607(44.73%)	
Moderate or vigorous	1379(55.03%)	617(45.47%)	

	Rural(n=6167)	Urban(n=3235)	*P* value
Physical Examination			<0.001
None	3252(52.75%)	1438(44.48%)	
Yes	2913(47.25%)	1795(55.52%)	

Table 2 shows that the average healthy aging score gradually decreased from 68.17 in 2011 to 60.38 in 2018 among the total respondents, from 70.83 in 2011 to 62.88 in 2018 among urban respondents, and from 66.77 in 2011 to 59.07 in 2018 among rural respondents. The average healthy aging score of rural respondents was lower than that of urban respondents in each wave.

Table 2
Description of healthy aging scores within different groups (Mean±SD)

	2011	2013	2015	2018
Overall	68.17±15.69	66.66±15.39	64.63±16.06	60.38±15.63
Rural	66.77±15.65	65.46±15.29	63.20±16.03	59.07±15.55
Urban	70.83±15.42	68.96±15.30	67.34±15.74	62.88±15.47

The results of the LGMM are shown in Table 3. We compared two- to four-class unconditional models for healthy aging scores and examined the BIC, AIC entropy values and LRT. We sought a model with lower values for the criterion indices, higher entropy values, and LRT *P* value. The results suggested that a three-class solution was the best. Then, we estimated the means of each class in every survey wave and defined the three classes as “low risk”, “middle risk”, and “high risk” to represent the risk of unsuccessful aging. As shown in Fig. 1, there was an irreversible downward trend in the overall health status with age. The results of the distribution of healthy aging trajectories within different groups (Table 4) show that rural respondents had a higher proportion of high-risk trajectory types than urban respondents (33.91% vs 25.72%) and a lower proportion of low-risk trajectory types (13.28% vs 16.32%).

Table 3
Fit indices for two- to four-class growth mixture models for healthy aging score

	AIC	BIC	Entropy	Lo-Mendell-Rubin test *P* value
2 classes	293865.376	293965.457	0.534	<0.001
3 classes	293701.047	293836.872	0.547	<0.001
4 classes	293885.376	294056.944	0.767	0.4999

Table 4
Distribution of healthy aging trajectory within different groups, N (%)

	Overall	Rural	Urban
Low risk	1347(14.33%)	819(13.28%)	528(16.32%)
Middle risk	5132(54.58%)	3257(52.81%)	1875(57.96%)
High risk	2923(31.09%)	2091(33.91%)	832(25.72%)

MLRM was conducted to investigate the effect of urban and rural areas on trajectory type in older adults with potential confounders adjusted. Urban living was significantly associated with a healthy aging trajectory (for [middle risk/low risk]: β=-0.41, RRR =0.66, $P < 0.001$,95% CI=0.55-0.80; and for [high risk/low risk]: β =-1.10, RRR =0.33, $P < 0.001$,95% CI =0.26-0.41). The details are shown in Table 5.

Table 5
Multinomial logistic regression of trajectory type (Reference: Low-risk group)

	Middle risk			High risk		
	RRR	95%CI	*P* value	RRR	95%CI	*P* value
Urban	0.66	0.55-0.80	<0.001	0.33	0.26-0.41	<0.001
Age	1.23	1.21-1.25	<0.001	1.43	1.40-1.45	<0.001
Gender						
Female	8.94e+08	-	0.958	4.27e+09	-	0.955
Educational level						
Upper secondary & vocational	0.50	0.40-0.63	<0.001	0.32	0.23-0.45	<0.001
Tertiary	0.27	0.13-0.53	<0.001	0.15	0.06-0.36	<0.001
Household per capita consumption	1.00	1.00-1.00	0.234	1.00	1.00-1.00	0.023
Public health insurance coverage						
Covered	1.19	0.83-1.71	0.339	1.38	0.91-2.10	0.128
Current work status						
Working	0.56	0.42-0.74	<0.001	0.31	0.23-0.41	<0.001
Gave care to grandchildren						
Yes	0.93	0.79-1.11	0.431	0.87	0.72-1.06	0.178
live near children						
Yes	1.18	0.87-1.59	0.301	1.08	0.75-1.54	0.694
Weekly contact with children						
Yes	0.71	0.49-1.03	0.072	0.65	0.43-0.98	0.039
Gave money to children						

RRR: Relative Risk Ratio; CI: Confidence intervals.

	Middle risk			High risk		
	RRR	95%CI	*P* value	RRR	95%CI	*P* value
Yes	0.90	0.73-1.12	0.361	0.69	0.54-0.89	0.004
Received money from children						
Yes	1.07	0.88-1.31	0.493	1.22	0.97-1.53	0.088
Smoking status						
Quit now	1.16	0.88-1.54	0.290	1.69	1.20-2.41	0.003
Still	1.07	0.88-1.31	0.491	1.04	0.81-1.34	0.736
Social participation						
Yes	0.83	0.70-0.98	0.032	0.59	0.49-0.72	<0.001
Physical exercises						
Light	0.98	0.75-1.28	0.858	0.91	0.67-1.23	0.551
Moderate or vigorous	1.01	0.77-1.33	0.923	0.84	0.62-1.15	0.282
Physical examination						
Yes	1.06	0.90-1.26	0.467	1.12	0.92-1.36	0.256

RRR: Relative Risk Ratio; CI: Confidence intervals.

Figure 2 shows the concentration curves for the healthy aging score, which illustrate the share of health by cumulative proportions of individuals in the population ranked from the poorest to the richest. As shown in Table 6, the concentration index was -0.022 (P<0.001) for the whole sample and -0.018 for both the rural and urban respondents. These indices suggest that the poor have a higher risk of suffering from suboptimal health than the rich. Combined with Table 1, which shows a significant difference in household per capita consumption between rural and urban areas, we can conclude that a significant inequity of healthy aging exists between the rural and urban older populations.

Table 6
Concentration Index

	Concentration index	Standard error	*P* value
Overall	-0.022	0.002	<0.001
Rural	-0.018	0.002	<0.001
Urban	-0.018	0.003	<0.001

Discussion

We measured the level of healthy aging by an index (healthy aging score) that integrates the physiological, psychological, and cognitive functional states of the population. Through a latent growth mixture model, an irreversible decreasing trend with age was found, and this decreasing trend differed between urban and rural areas, with a higher proportion of high-risk individuals presenting unsuccessful aging in rural areas. Multivariate logistic regression further proved that rural populations were more likely to develop high risk. Concentration indices and concentration curves showed that the lower the consumption level was, the higher the risk of becoming unhealthy, thus verifying the existence of inequity in healthy aging between urban and rural areas.

Healthy aging is a prominent objective in the development of a country, and rural-urban disparities are an essential obstacle to overcome. In China, the inequity of healthy aging between rural and urban areas is significant. Although the trajectory of being unhealthy is irreversible for older adults, the risk of unsuccessful aging is much higher in rural areas than in urban areas. It is caused by socioeconomic level, family structure, demographic characteristics, public resources etc. Based on our study, older adults with higher levels of education are less likely to develop high risk than those who have not received higher education. Relevant studies have shown that higher levels of education are associated with longer lifespans and delayed disease onset [31]. People with higher education may have higher socioeconomic status, resulting in increased life satisfaction [32]. People who are still working are less likely to develop high risk, which may be related to the fact that those who work are responsible for the family and are generally a source of income, and there is a significant positive gradient between life satisfaction and finances [33]. Furthermore, the empty nest phenomenon is widespread in China, which means that there are a large number of elderly people who lack support because of the absence of children [34]. Rural respondents are more likely to lack support, including economic support and emotional support, which has been proven to be significantly associated with the physical and psychological health of the older population [35]. People who are involved in social life are less likely to develop a high risk, related to the environmental factors in which they live [36]. We should encourage older people to participate more in social activities to develop a good environment and outlook. In addition, based on previous studies, we found that there are differences between urban and rural areas in terms of basic health status [37] and resources that can be accessed for medical services [38], which are the reasons for the differences in healthy aging between urban and rural areas.

According to our study, we know that income level is an important cause of the difference in healthy aging between urban and rural areas. In general, there is a link between income level and consumption level, and the higher the income level is, the higher the consumption level [39]. According to the concentration index curve as income increases, the healthy aging score increases, indicating that income level has an effect on healthy aging. Related studies have shown that the rich have better health status than the poor in terms of self-assessed health [40], health-related quality of life [41], and individual height-for-age z-scores [42]. Despite their higher level of need, the poor typically receive less health care than the better-off [43, 44]. The great disparity of income level between urban and rural areas still exists, and therefore, income levels affect the differences in aging between urban and rural areas, with healthy aging being better among urban older adults than among rural older adults.

By clarifying the differences in healthy aging between urban and rural areas and finding the factors that influence the differences between urban and rural areas, we can take more effective measures to reduce inequities. To alleviate the disparity in healthy aging between urban and rural areas, China has established a relatively well-developed social security system. However, this system still separates urban and rural areas and maintains a "dual-track" operation, and inequities remain. For this reason, it is important to balance the urban and rural economies, promote rural revitalization, and establish a national social security network to maintain efficiency and equity and alleviate the urban-rural healthy aging gap [43, 44]. Rural areas have low population density and large distances between homes and services [46]. Health care facilities are difficult to operate, and the level of population health utilization is low. For this reason, rural infrastructure should be well developed. Finally, the older population should be encouraged to participate more in social activities, and a good social atmosphere should be formed by setting up clubs, promoting a diversity of activities, strengthening publicity and education for the older population in urban and rural communities, etc.

There are some limitations of this study. First, because our study used CHARLS data from respondents' self-administered questionnaires, the results of the questionnaire depend on the respondents, and respondents may inevitably experience recall bias when filling out the questionnaire due to unclear recall and other reasons. Second, our study is a retrospective study, which cannot explore the relationship between urban-rural disparities and healthy aging trajectories in a deeper way. Third, when we compiled the CHARLS database, we found that many respondents did not provide income indicators, but we found a link between income and consumption, so we selected household consumption indicators when studying the impact of income level on the urban-rural healthy aging trajectory.

Conclusion

Our study used data on middle-aged and older adults from 2011–2018 to examine the impact of urban-rural disparities on the healthy aging trajectory. We found that the combined health status showed an irreversible downward trend with age, and this downward trajectory differed between urban and rural areas, with the rural population being more likely to develop a high risk. We build concentration curves and find that the lower the level of consumption, the higher the risk of becoming unhealthy, thus verifying

the existence of inequities in healthy aging between urban and rural areas. The policy inclination and resource investment should be enhanced to reduce inequity in healthy aging between urban and rural areas in China.

List Of Abbreviations

CHARLS
China Health and Retirement Longitudinal Study
IRT
Item response theory
MLRM
Multinomial logistics regression model
BIC
Bayesian information criterion
AIC
Akaike information criterion
LRT
Lo-Mendell-Rubin likelihood ratio test
LGMM
Latent growth mixture model
RRR
Relative Risk Ratio
CI
Confidence intervals
MLRM
Multinomial logistic regression model
SD
Standard deviation

Declarations

Funding

This work was supported by the Medical Scientific Research Foundation of Guangdong Province (A2020420). The funders had no role in the study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had the final responsibility for the decision to submit for publication.

Competing interests

The authors have no conflicts of interest to declare.

Availability of data and materials

All the original data could be obtained from the official website of CHARLS (http://charls.pku.edu.cn/) and Harmonized CHARLS (www.g2aging.org). The deidentified analysis dataset is available to other researchers and others upon request by emailing the corresponding author.

Authors' Contributions

JL and CJY contributed to the conception and design of the study. MHL and YXZ completed data analysis and wrote the first draft of the manuscript. JYC and JL contributed to supervising data analysis and developing the manuscript. All authors contributed to revising the article and approved the final draft as submitted.

Ethics approval and consent to participate

The Biomedical Ethics Review Committee of Peking University approved CHARLS, and all participants were required to provide written informed consent. The ethical approval number was IRB00001052-11015. The study was carried out following the tenets of the Declaration of Helsinki and Good Clinical Practice guidelines.

Consent for publication

Not applicable.

References

1. Fang EF, Xie C, Schenkel JA, Wu C, Long Q, Cui H, Aman Y, Frank J, Liao J, Zou H *et al*: **A research agenda for ageing in China in the 21st century (2nd edition): Focusing on basic and translational research, long-term care, policy and social networks**. *AGEING RES REV* 2020, **64**:101174.
2. Nie P, Li Y, Zhang N, Sun X, Xin B, Wang Y: **The change and correlates of healthy ageing among Chinese older adults: findings from the China health and retirement longitudinal study**. *BMC GERIATR* 2021, **21**(1).
3. Organization WH: **World report on ageing and health**: World Health Organization; 2015.
4. Tan X, Liu X, Shao H: **Healthy China 2030: a vision for health care**. *Value in health regional issues* 2017, **12**:112–114.
5. Wu X, Treiman DJ: **The household registration system and social stratification in China: 1955-1996**. *DEMOGRAPHY* 2004, **41**(2):363–384.
6. Xie Y, Zhou X: **Income inequality in today's China**. *Proc Natl Acad Sci U S A* 2014, **111**(19):6928–6933.
7. Xie Y: **Understanding inequality in China**. *Chinese Journal of Sociology* 2016, **2**(3):327–347.

8. Feng J, Hong G, Qian W, Hu R, Shi G: **Aging in China**: **An International and Domestic Comparative Study**. *SUSTAINABILITY-BASEL* 2020, **12**(12).
9. Wu X: **The household registration system and rural-urban educational inequality in contemporary China**. *CHINESE SOCIOL REV* 2011, **44**(2):31–51.
10. Mou J, Griffiths SM, Fong HF, Dawes MG: **Defining migration and its health impact in China**. *PUBLIC HEALTH* 2015, **129**(10):1326–1334.
11. Gao Y, Li LP, Kim JH, Congdon N, Lau J, Griffiths S: **The impact of parental migration on health status and health behaviours among left behind adolescent school children in China**. *BMC PUBLIC HEALTH* 2010, **10**.
12. You X, Zhang Y, Zeng J, Wang C, Sun H, Ma Q, Ma Y, Xu Y: **Disparity of the Chinese elderly's health-related quality of life between urban and rural areas: a mediation analysis**. *BMJ OPEN* 2019, **9**(1):e24080.
13. Lee Y, Xiao Z: **Children's support for elderly parents in urban and rural China: Results from a national survey**. *Journal of Cross-Cultural Gerontology* 1998, **13**(1):39–62.
14. Yang T, Li F, Yang X, Wu Z, Feng X, Wang Y, Wang X, Abdullah AS: **Smoking patterns and sociodemographic factors associated with tobacco use among Chinese rural male residents: a descriptive analysis**. *BMC PUBLIC HEALTH* 2008, **8**:248.
15. Mao Z, Wu B: **Urban-rural, age and gender differences in health behaviours in the Chinese population: findings from a survey in Hubei, China**. *PUBLIC HEALTH* 2007, **121**(10):761–764.
16. Dong X, Simon MA: **Health and aging in a Chinese population: urban and rural disparities**. *GERIATR GERONTOL INT* 2010, **10**(1):85–93.
17. Ge D, Chu J, Zhou C, Qian Y, Zhang L, Sun L: **Rural-urban difference in the use of annual physical examination among seniors in Shandong, China: a cross-sectional study**. *INT J EQUITY HEALTH* 2017, **16**(1):86.
18. Nguyen H, Wu YT, Dregan A, Vitoratou S, Chua KC, Prina AM: **Multimorbidity patterns, all-cause mortality and healthy aging in older English adults: Results from the English Longitudinal Study of Aging**. *GERIATR GERONTOL INT* 2020, **20**(12):1126–1132.
19. Daskalopoulou C, Prince M, Koukounari A, Haro JM, Panagiotakos DB, Prina AM: **Healthy ageing and the prediction of mortality and incidence dependence in low-and middle-income countries: a 10/66 population-based cohort study**. *BMC MED RES METHODOL* 2019, **19**(1):1–11.
20. Zhao Y, Hu Y, Smith JP, Strauss J, Yang G: **Cohort profile: the China Health and Retirement Longitudinal Study (CHARLS)**. *INT J EPIDEMIOL* 2014, **43**(1):61–68.
21. Beard JR, Officer AM, Cassels AK: **The World Report on Ageing and Health**. *GERONTOLOGIST* 2016, **56 Suppl 2**:S163-S166.
22. Beard JR, Officer A, de Carvalho IA, Sadana R, Pot AM, Michel JP, Lloyd-Sherlock P, Epping-Jordan JE, Peeters G, Mahanani WR *et al*: **The World report on ageing and health: a policy framework for healthy ageing**. *LANCET* 2016, **387**(10033):2145–2154.

23. Wu YT, Daskalopoulou C, Muniz TG, Sanchez NA, Rodriguez-Artalejo F, Ayuso-Mateos JL, Bobak M, Caballero FF, de la Fuente J, de la Torre-Luque A *et al*: **Education and wealth inequalities in healthy ageing in eight harmonised cohorts in the ATHLOS consortium: a population-based study**. *Lancet Public Health* 2020, **5**(7):e386-e394.
24. Muthen B, Muthen LK: **Integrating person-centered and variable-centered analyses: growth mixture modeling with latent trajectory classes**. *ALCOHOL CLIN EXP RES* 2000, **24**(6):882–891.
25. Smith KV, Ehlers A: **Cognitive predictors of grief trajectories in the first months of loss: A latent growth mixture model**. *J Consult Clin Psychol* 2020, **88**(2):93–105.
26. Min JW: **A longitudinal study of cognitive trajectories and its factors for Koreans aged 60 and over: A latent growth mixture model**. *Int J Geriatr Psychiatry* 2018, **33**(5):755–762.
27. Curran PJ, Hussong AM: **The use of latent trajectory models in psychopathology research**. *J ABNORM PSYCHOL* 2003, **112**(4):526–544.
28. Curran PJ, Willoughby MT: **Implications of latent trajectory models for the study of developmental psychopathology**. *DEV PSYCHOPATHOL* 2003, **15**(3):581–612.
29. Drozdzak Z, Turek K: **Retirement and perceived social inferiority strongly link with health inequalities in older age: decomposition of a concentration index of poor health based on Polish cross-sectional data**. *INT J EQUITY HEALTH* 2016, **15**:21.
30. Musheiguza E, Mahande MJ, Malamala E, Msuya SE, Charles F, Philemon R, Mgongo M: **Inequalities in stunting among under-five children in Tanzania: decomposing the concentration indexes using demographic health surveys from 2004/5 to 2015/6**. *INT J EQUITY HEALTH* 2021, **20**(1):46.
31. Hamid TA, Momtaz YA, Ibrahim R: **Predictors and prevalence of successful aging among older Malaysians**. *GERONTOLOGY* 2012, **58**(4):366–370.
32. Murrell SA, Meeks S: **Psychological, economic, and social mediators of the education-health relationship in older adults**. *J AGING HEALTH* 2002, **14**(4):527–550.
33. White CM, St. John PD, Cheverie MR, Iraniparast M, Tyas SL: **The role of income and occupation in the association of education with healthy aging: results from a population-based, prospective cohort study**. *BMC PUBLIC HEALTH* 2015, **15**(1):1181.
34. Zhou Y, Zhou L, Fu C, Wang Y, Liu Q, Wu H, Zhang R, Zheng L: **Socio-economic factors related with the subjective well-being of the rural elderly people living independently in China**. *INT J EQUITY HEALTH* 2015, **14**:5.
35. Guo W, Chen L, Perez C: **Economic status, family dependence, and health outcomes of older people in Western Rural China**. *J GERONTOL SOC WORK* 2019, **62**(7):762–775.
36. Lu W, Pikhart H, Sacker A: **Domains and measurements of healthy aging in epidemiological studies: A review**. *The Gerontologist* 2019, **59**(4):e294-e310.
37. Jiang J, Wang P: **Health status in a transitional society: urban-rural disparities from a dynamic perspective in China**. *POPUL HEALTH METR* 2018, **16**(1):22.

38. Wang W, Zhang Y, Lin B, Mei Y, Ping Z, Zhang Z: **The Urban-Rural Disparity in the Status and Risk Factors of Health Literacy: A Cross-Sectional Survey in Central China**. *INT J ENV RES PUB HE* 2020, **17**(11).
39. Diacon P, Maha L: **The relationship between income, consumption and GDP: A time series, cross-country analysis**. *Procedia economics and finance* 2015, **23**:1535-1543.
40. Yang W, Kanavos P: **The less healthy urban population: income-related health inequality in China**. *BMC PUBLIC HEALTH* 2012, **12**:804.
41. Sun S, Chen J, Johannesson M, Kind P, Xu L, Zhang Y, Burström K: **Population health status in China: EQ-5D results, by age, sex and socio-economic status, from the National Health Services Survey** 2008. *QUAL LIFE RES* 2011, **20**(3):309-320.
42. Chen L, Wu Y, Coyte PC: **Income-related children's health inequality and health achievement in China**. *INT J EQUITY HEALTH* 2014, **13**:102.
43. Ghosh S: **Equity in the utilization of healthcare services in India: evidence from National Sample Survey**. *Int J Health Policy Manag* 2014, **2**(1):29–38.
44. Zhou Z, Su Y, Gao J, Campbell B, Zhu Z, Xu L, Zhang Y: **Assessing equity of healthcare utilization in rural China: results from nationally representative surveys from 1993 to 2008**. *INT J EQUITY HEALTH* 2013, **12**:34.
45. Fan Z: **The Dual Economy and Social Security in Rural China**. 2018.
46. Arcury TA, Preisser JS, Gesler WM, Powers JM: **Access to Transportation and Health Care Utilization in a Rural Region**. *The Journal of Rural Health* 2005, **21**(1):31–38.

Figures

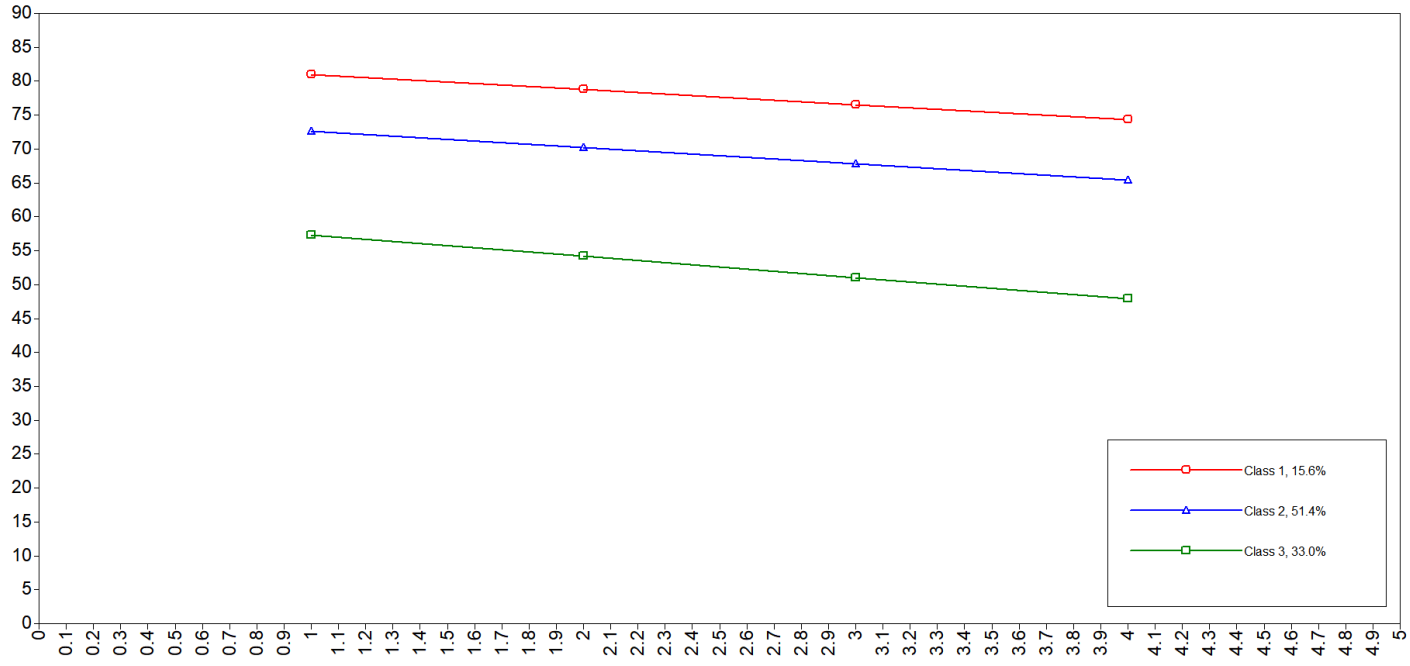

Figure 1

Trajectory of healthy aging score by latent growth mixture model.

The definition of the classes: Class 1, low risk; Class 2, middle risk; Class 3, high risk.

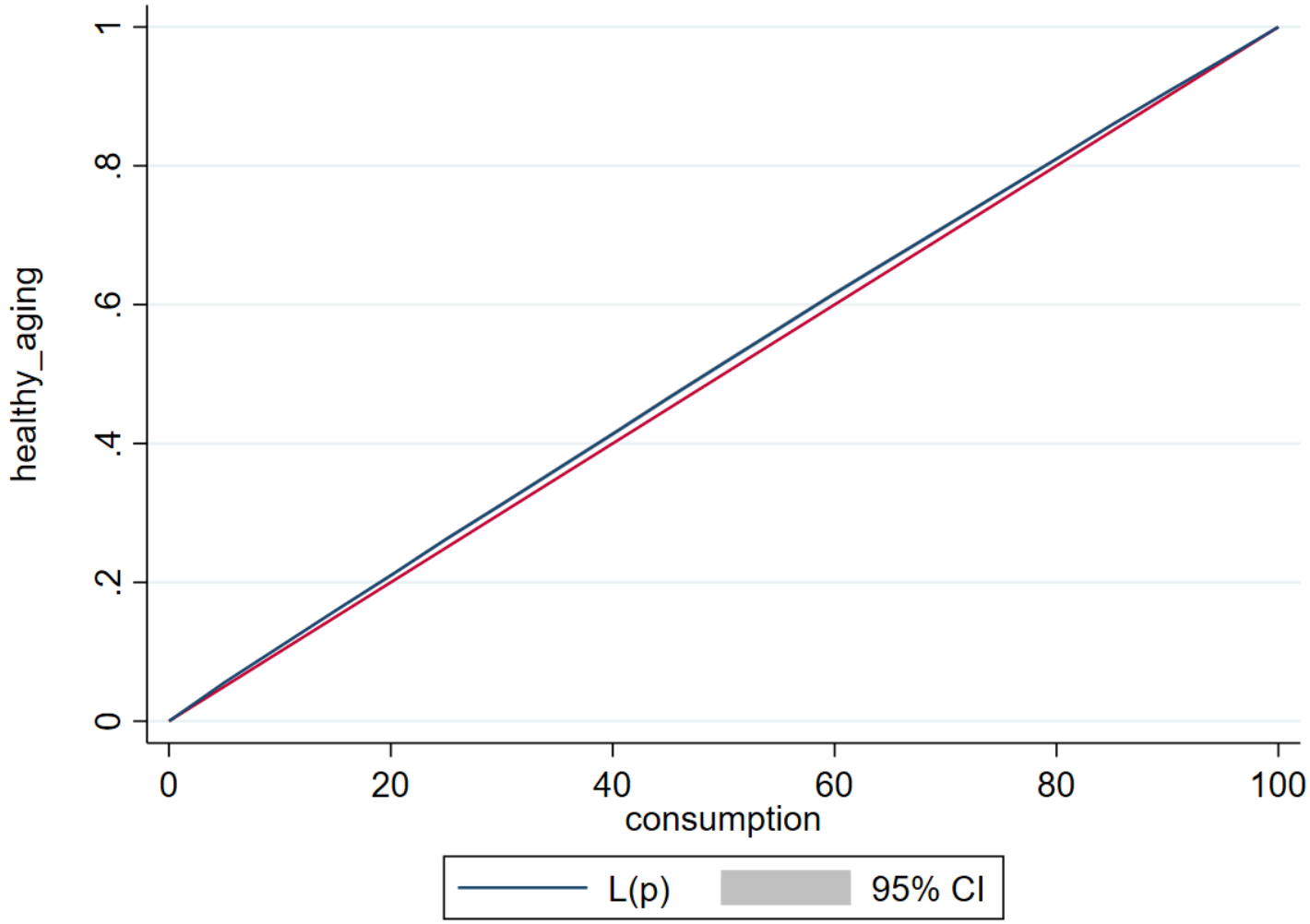

Figure 2

Concentration curve of healthy aging score

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryMaterial.docx