

Fairness evaluation of health financing between 2007 to 2010 in China

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Abstract

Background: Population aging and the increasing burden of non-communicable diseases (NCDs) are increasingly a strain on health systems. The World Health Organization (WHO) uses fairness of health financing as one of the criteria for assessing health system performance. The Chinese government has undertaken a series of health reforms to reduce the pace of disease transition towards non-communicable diseases, as well as protecting people from catastrophic health expenditures. The aim of this study was to assess the fairness of health financing among the elderly with different health conditions in China during the year of 2007 to 2010.

Methods: The data source was the WHO Study on global AGEing and adult health (SAGE) Wave 1, a national weighted data collected from adults older than 50 years. In this study, 10099 respondents were included for analysis. Chi-square and partial proportional odds model test were applied to assess the distribution of socioeconomic and health behavior factors among different chronic conditions. Fairness of healthcare financing analysis was used to evaluate how the burden of health financing is distributed according to the household ability to pay (ATP). Dominance tests were applied for comparing different ways of health financing among health conditions.

Results: More than half of the elderly had at least one chronic condition, and around 20% people suffered from multi-morbidity. Several socioeconomic as well as health behavior factors were found associated with developing NCDs. Out-of-pocket payment dominated other health finance sources in Non-NCD, single morbidity and multi-morbidity groups with a regressive pattern. Even though mandatory insurance had covered more than 70% of the elder population in China, due to the relative lower proportion reimbursement for chronic diseases, people still had to pay a lot for seeking healthcare between 2007 to 2010.

Conclusion: When reimbursement for chronic diseases is relatively low, high mandatory insurance coverage does not ensure fairness of health financing. The Chinese health system should be developed further in order to meet the needs of elderly with different chronic conditions.

Background

Aging is a natural process, while population aging is a process which refers to the proportion of the elderly in a population increases all the time(1). Thanks to the relative stable politic environment and fast economic growth in China, the life expectancy has been increased strikingly in the past three decades, from 63.9 years in 1975 to about 76.5 years in 2017(2). The percentage of population with 65 plus years had reached to 7.7% by 2005, which had been ascribed as an “aged society” (3). Since aging population have higher risks in developing chronic diseases and co-morbidities, interventions as well as efficient healthcare delivery specifically for the elderly are getting more concerns(4)(5).

Nowadays, China is undergoing fast industrialization and urbanization. Due to the fast socioeconomic and demographic transition, non-communicable diseases (NCDs) have become the main causes for

death and disability in China(6). Non-communicable diseases (NCDs), which also called chronic diseases, is a type of disease which tend to be in a long duration and are the results of combined genetic, lifestyle or environmental factors(7). Cardiovascular diseases, cancers, chronic respiratory diseases, and diabetes are known as the common NCDs(8). NCDs increase dramatically in Chinese society, which is estimated above 260 million and has already put a big pressure in the field of public health(8)(9). As the prevalence of chronic diseases increases with age, multi-morbidity, which is defined as an individual suffers any two or more chronic or acute diseases, has become more common with the elderly(10). Multi-morbidity has brought several challenges to the health system, as its complex diagnosis, clinical treatment, and polypharmacy prescription(11).

Chinese healthcare system had several transitions since 1949. The most well-known phrase was between 1949-1965, in which the national health advanced dramatically. By conducting a centralized three-tier delivery system, nearly the whole Chinese population were covered by a low and affordable health cost(12). However, since the 1977, along with the reform and opening-up policy, the health inequality was getting obvious. Due to lack of a well-developed health system, larger proportion of Chinese population could not afford to health care, catastrophic expenditure on healthcare occurred a lot(13). It arouse much concern to tackle with the insufficient health system in China(12). Starting from 1990's, the government has taken some measures to rein the accelerating healthcare costs, such as built-up the urban employee-based basic medical insurance scheme (UEBMI) for urban employees(13). During the post-SARS period in 2003, New Cooperative Medical System(NCMS) has been developed in response to the deterioration in access to the health service in rural areas and attempted to reduce the inequity between urban and rural areas(14). Later in 2007, urban resident-based basic medical insurance scheme (URBMI) has been launched for people living in urban areas without having UEBMI like students, children and the elderly without pensions(12)(15). Since then, a multi-level health care financing system has built up gradually for urban and rural population, attempting for healthcare funding equitable distributed(12)(13)(16).

Along with the healthcare reforms for achieving universal health coverage in China, fairness in health system financing has become a major concern for policy-makers as one of the three intrinsic goals in health system performance provided by WHO framework(16)(17).Health system financing mainly addresses two challenges(18), one is about financial risk pooling, the other is to ensure richer people could contribute more than the poor in terms of health financing(18). Fairer financing has been regarded as higher level of health and equality in health distribution(18). Within a fairer health system financing, poorer people could get access to the prompt and efficient medical treatment especially under the change of disease spectrum, where NCDs make poorer people in more vulnerable situation for more health expenses(12). In China, it mainly has four channels for healthcare financing: government-raised revenue; public health insurance; private health insurance as well as out-of-pocket payments (OOPs)(16)(17). Individuals contribute to the provision of health services through taxes on property, purchases and other items, and government-raised financing draws revenues from general taxes for health system, which is a stable and important channel of getting fund for health resources in China(16). Public health insurances are constituted of UEBMI, URBMI and NCMS three types, but the service packages are varied from each other(17). Private health insurance was started late in China comparing to many OECD countries,

although it has been more than 8% of total health expenditure in 2017(19). Those three payments are pre-payment for health financing, which plays an important role in redistribution of health resources. OOP is to purchase health services directly from healthcare providers, which is more likely to generate catastrophic expenditure(18). Based on the four channels above, it has turned an urgent need to examine whether the health reforms have achieved goals in promoting universal coverage of health service as well as fairness financing(18)(20).

Though fairness of health financing has been assessed in many countries, seldom researches looked on whether it was fair for the elderly with different chronic conditions in respect of health financing. The main objectives of this study were: Described distribution of chronic conditions among various socioeconomic status and risk factors and fairness analysis of Chinese healthcare financing system among the elderly with different chronic conditions by applying WHO data. Through this study, it would be clear about the situation of NCDs among the elderly, and whether the health financing system was fair to the elderly with chronic conditions between 2007 to 2010 in China.

Methods

Data collection

The data source for this study was the WHO Global AGEing and Adult Health (SAGE), a longitudinal study of health and ageing in China, Ghana, India, Mexico, Russia and South Africa. The aim of SAGE was to provide reliable data on aging people and their health status in low- and middle-income countries (21). The present study used data from Wave 1 (2007-2010) in the China. In the SAGE study, the elderly population was defined as aged 50 years and above. This age cut-off was based on the WHO definition of younger and older adults in low- and middle-income countries for considering economic and demographic factors (21). Data were collected from Guangdong, Hubei, Jilin, Shanxi, Zhejiang, Shanghai, Shandong and Yunnan with considering geographical and economic effects. The sample design followed a stratified multistage cluster principle. One district (urban) and one county (rural) was randomly selected from each province, and from each district/county, 4 communities/townships were picked out probability proportional to size. Similarly, 2 residential blocks/villages were selected probability proportional to size from each community/township. Afterwards, 84 households were randomly selected in each picked residential block/village: 70 were over 50 years households and 14 were between 18 to 49 years households(21). All the eligible households were included in conducting household interviews, and individual interviews were from the eligible respondents in the household roster. All these questionnaires were piloted as part of the pretest in 2005, then translated into local language from English followed those developed by the World Health Survey(WHS). A strict translation protocol designed by a team of bilingual experts, focused back-translations, and in-depth linguistic analysis had been used to ensure the cultural issues(22). At last, 10278 household surveys and 15050 individual surveys had been collected. Post-stratification weights were used in both household and individual level analysis to adjust for province, locality, age and sex distributions.

In this study, 237 people were excluded for not completing the survey, 1265 people were then excluded for analysis because their ages were under 50 years. Missing check was applied to screen out the respondents who answered all the questions(23). After the missing check, 10099 who completed the questionnaires were derived from 15050 of Chinese sample for future analysis (figure 1).

Variables selection

Variables selection from the individual questionnaire

The results were only for the people who had completed interviews (interview were conducted including body measurement, performance tests and blood sample). NCDs selection was based on the self-reported responses to presence of one or more following diseases: arthritis, stroke, angina, diabetes, chronic lung disease, asthma, cataract, and hypertension. Hypertension was identified as systolic blood pressure was ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg.

Social-demographic variables included age, sex, marriage status and educational level. People above 50 years were selected. Risk factors and health behavior variables contained body mass index (BMI), tobacco using, alcohol consumption, fruit/ vegetables intake as well as physical activity variables. BMI was derived from weight in kilogram (Kg) divided height in meter (m). China's center for disease control guidelines set BMI <18.5 (kg/m²) to underweight, 18.5-23.9(kg/m²) to normal, 24-27.9(kg/m²) to overweight and >28 (kg/m²) to obesity. The fruit/vegetables variable was defined as adequate with intake of fruit and vegetables ≥ 5 servings daily(21). Physical activity was measured by using WHO Global Physical Questionnaires(24).

Variables selection from the household questionnaire

Household asset items were chosen for deriving wealth quintiles. Under household expenditure module, variables like general tax, mandatory health insurance, voluntary health insurance as well as OOPs were picked up. General taxes were consisted of property tax, vehicle tax, income tax and non-health related insurance. These taxes were calculated by applying specific tax rate to corresponding expenditures. Public health insurance would be asked about the premiums paid for health plans. In this SAGE survey, designers summed up UEBMI, URBMI and NCMS as mandatory health insurance, without classifying it into detailed groups. OOPs were made up of hospital care, drug purchases, diagnostic tests, dental care, ambulance fees and other costs with excluding the insurance reimbursement. The time frame for these four payments was set into 12 month.

The WHO SAGE study was approved by the Ethics Review Committee, World Health Organization, Geneva, Switzerland; the Ethics Committee, Shanghai Municipal center for Disease control and Prevention, Shanghai, China. All procedures were approval covered in this study. All participants got informed consent forms before started.

Data analysis

Wealth status was derived from household assets and Principal Component Analysis (PCA) was used to produce the wealth quintile(25). Factor test was a measurement to look at the adequacy of sampling, with using Bartlett's Test and KaiserMeyer-Olkin(KMO)(25)(26). At last, component scores were sort into five categories to get the wealth quintile and ranked into poorest to riches with the value of KMO = 0.871, p-value=0.000, and the value of correlation matrix = 0.062. Chi-square test was applied for association analysis between socioeconomic risk factors and different health status. As the dependent variable was ordered while independent variables were partially ordered, partial proportional odds model was then employed for comparing the contributions of each factors to different chronic conditions(27).

Progressivity analysis was applied for examining the vertical equity on healthcare payments(28). Measuring progressivity was to compare shares of general tax, mandatory health insurance, voluntary health insurance as well as OOPs contributed by cumulative wealth of households ranked by the share of ability to pay(ATP)(28). The fairness of healthcare expenditure was analyzed by using Kakwani Index (KI), which was one of the most widely used in measuring inequity in healthcare payment field(18). KI was formulated as the difference between concentration index (CI) for healthcare payments and Gini coefficient(18). CI was known as the measurement of socioeconomic-related health inequality, and Gini coefficient was an indicator for measuring the degree of wealth inequity in a country(29). If health finance was in a vertical equity situation, poorer people would contribute less for the share of health payments than their share of ATP, which was also called progressive system. Whereas it was a regressive system if sharing of health payments were greater than ATP sharing(17)(28). As recommended by the World Bank, household assets were measured to reflect the ATP since assets indices could reduce the currency fluctuation comparing to income or expenditure, which have been widely used in developing countries(12) (28).

Ordinary least squares(OLS) regression was employed in estimation of CI and Gini coefficient in this study. It compared healthcare payment variables with household fractional ranking according to ATP distribution(28)(29).

$$2\sigma_r^2\left(\frac{z_i}{\gamma}\right) = \alpha + \beta R_i + \varepsilon_i$$

where z_i was a health payment variable for household i and γ was the mean. R_i was the household fractional ranking according to ATP distribution, σ_r^2 was the sample variance of the fractional rank. β in OLS was the estimation for CI or Gini coefficient.

The KI for healthcare payment was defined as the difference between CI for healthcare payments and Gini coefficient(18)(28).

$$\pi_k = C - G$$

where C was the CI for healthcare payments, ranging from -1 to 1. G referred to the Gini coefficient, with a range of 0 to 1. Values increased as inequality increased. The value of π_k was from -2 to 1.

The positive value indicated a progressive system in healthcare spending, to the graph, the concentration curve lied outside of the Lorenz curve, which meant the richer households paid more according to the ATP than poor households. While a negative value indicated a regressive spending, as the concentration curve lied inside of the Lorenz curve(18)(28).

As KI was the difference between CI and Gini coefficient, KI value could be computed by the following OLS regression(17)(28):

$$2\sigma_r^2\left[\frac{h_i}{\eta} - \frac{y_i}{\mu}\right] = \alpha + \theta R_i + \varepsilon_i$$

where h_i was a health payment variable for household i and η is the mean, y_i was the ATP variable and μ was its mean. R_i was the household ranking in ATP distribution and σ_r^2 was a sample variance of fractional ranking. In this formula, θ was estimated for KI value.

Sampling weights were included for all the analysis. Statistical software STATA 14.0 was applied in this study.

Results

Population health

Table 1 Characteristics of respondents stratified by NCDs, adults aged 50+ China (2007-2010), SAGE Wave1

Characteristics	China (n=11654)			P-value
	Non-NCD n=4880	Single morbidity n=2962	Multi-morbidity n=2257	
Overall rates	49.86%	29.79%	20.35%	
Sex				P=0.00**
male	2461(54.48)	1361 (28.94)	939 (16.58)	
Female	2419 (45.23)	1601 (30.65)	1318 (24.12)	
Age				P=0.00**
50-59	2704 (60.76)	1270 (28.98)	509 (10.27)	
60-69	1338 (44.89)	950 (31.08)	763 (24.04)	
70-79	671 (34.27)	612 (30.08)	781 (35.65)	
80+	167 (33.97)	130 (27.76)	204 (38.27)	
Marital status				P=0.00**
unmarried	47 (54.86)	20 (25.91)	14 (19.23)	
married/cohabit	4189 (50.94)	2489 (29.93)	1779 (19.13)	
widow/separate	644 (42.62)	453 (29.22)	464 (28.16)	
Residence				P=0.00**
urban	1671 (39.75)	1321 (30.50)	1404 (29.75)	
rural	3209 (56.27)	1641 (29.35)	853 (14.38)	

Education				P=0.00**
			632	
no education	1194 (46.76)	754 (29.92)	(23.32)	
			784	
less & primary school	2006 (52.40)	1133 (29.55)	(18.06)	
	1549 (50.44)	948 (29.59)	714	
secondary & high school			(19.97)	
			127	
college & university	131 (35.59)	127 (33.75)	(30.66)	
Wealth				P=0.00**
			339	
1 poorest	1437 (58.69)	652 (27.47)	(13.84)	
			421	
2	1134 (52.45)	675 (30.58)	(16.97)	
			517	
3	941 (48.96)	609 (29.44)	(21.60)	
			508	
4	702 (40.20)	553 (32.78)	(27.02)	
			472	
5 richest	667 (43.48)	472 (29.42)	(27.10)	
				P =
Household insurance				0.04*
			334	
None of insurance	555 (46.41)	359 (28.20)	(25.39)	
Mandatory insurance			1748	
	3846 (49.94)	2303 (29.72)	(20.34)	
			101	
Voluntary insurance	253 (51.67)	152 (29.96)	(18.37)	
Both of insurance	226 (52.50)	148 (33.08)	74 (14.41)	
Body Mass Index				P=0.00**

underweight	266 (55.13)	131 (28.77)	83 (16.10)	
			1224	
normal	3314 (54.70)	1734 (27.63)	(17.67)	
			744	
overweight	1147 (42.93)	914 (33.41)	(23.66)	
			206	
obese	153 (29.68)	183 (35.07)	(35.25)	
Smoking				P=0.00**
			1611	
Non-smoker	3052 (46.12)	1981 (30.74)	(23.14)	
			647	
Smoker	1828 (56.13)	980 (28.21)	(15.66)	
Alcohol drinking				P=0.00**
			1661	
No	3246 (47.61)	2047 (30.26)	(22.13)	
			596	
Yes	1634 (54.13)	915 (28.90)	(16.97)	
Fruit/veg intake				P=0.71
			362	
Inadequate	735 (49.80)	443 (28.98)	(21.22)	
			1895	
adequate	4145 (49.86)	2519 (29.91)	(20.23)	
Physical activity				P=0.00**
			859	
Low	1388 (42.79)	945 (30.69)	(26.52)	
			726	
Moderate	1175 (44.25)	802 (30.44)	(25.31)	
			672	
High	2317 (57.03)	1215 (28.92)	(14.04)	

Actual numbers of observations; Proportions in brackets sum across rows and include survey sampling weights. Person χ^2 tests were undertaken for comparisons. *P-value < 0.05;**P-value < 0.01

Table 1 described the distribution of socioeconomic and behavior risk factors among the elder population in China and survey sampling weights were employed during the analysis. Among these population, 49.86% did not have any chronic diseases, 29.79% had single NCD morbidity and 20.35% were in multi-morbidity status. By applying chi-square test, sex, age, marriage status, residence, education, wealth, insurance coverage, BMI, smoking, alcohol consumption and physical activities were found statistically significant difference with the selected eight chronic diseases.

Fairness in healthcare financing

Table 2 Distribution of household assets and health care payments by wealth quintiles, concentration index (CI), and Kakwani Index (KI)

*p-value < 0.05;**p-value < 0.01

Table 3 Tests of dominance between concentration curves for different sources of health finance

Classification of health status	Household wealth quintiles	Ability to pay(ATP)	general tax	mandatory health insurance	voluntary health insurance	OOPs
Non-NCD	Q1	5.00%	1.05%	10.30%	1.20%	11.64%
	Poorest					
	Q2	15.98%	13.07%	13.09%	10.29%	16.79%
	Q3	19.75%	21.41%	13.49%	12.49%	19.39%
	Q4	24.00%	27.69%	22.83%	22.81%	22.53%
	Q5	35.28%	36.77%	40.29%	53.21%	29.65%
	Richest					
	Gini/CI	0.37	0.46	0.43	0.49	0.25
	P-value	-	0.00**	0.00**	0.00**	0.00**
	KI	-	0.09	0.06	0.12	-0.12
	P-value	0.00**	0.48	0.49	0.32	0.01**
Single morbidity	Q1	3.45%	2.33%	6.48%	1.23%	13.50%
	Poorest					
	Q2	13.37%	14.70%	11.49%	14.14%	15.49%
	Q3	18.06%	17.17%	16.95%	15.56%	20.38%
	Q4	28.17%	31.19%	23.37%	33.80%	22.49%
	Q5	36.96%	34.55%	41.71%	35.28%	28.15%
	Richest					
	Gini/CI	0.33	0.41	0.40	0.41	0.09
	P-value	-	0.00**	0.00**	0.00**	0.03*
	KI	-	0.08	0.07	0.08	-0.23
	P-value	0.00**	0.54	0.63	0.41	0.00**
Multi-morbidity	Q1	2.33%	0.17%	4.26%	0.48%	4.36%
	Poorest					
	Q2	9.31%	4.82%	10.02%	12.64%	11.19%
	Q3	17.35%	12.25%	10.94%	14.27%	21.24%
	Q4	29.56%	25.41%	37.35%	29.39%	27.54%

Q5	41.45%	57.34%	37.43%	43.23%	35.67%
Richest					
Gini/CI	0.28	0.28	0.32	0.30	0.17
P-value	-	0.01**	0.00**	0.36	0.00**
KI	-	-0.01	0.03	0.01	-0.11
P-value	0.00**	0.92	0.72	0.98	0.00**

Classification of health status	Sources of health financing	General tax	Mandatory health insurance	Voluntary health insurance	OOPs
Non-NCD	General tax		D	D	D
	Mandatory health insurance			None	D
	Voluntary health insurance				D
Single morbidity	General tax		D	D	D
	Mandatory health insurance			None	D
	Voluntary health insurance				D
Multi-morbidity	General tax		D	D	D
	Mandatory health insurance			None	D
	Voluntary health insurance				D
	OOPs				

Note: D indicated that concentration curve of row source was dominated by the column source; None indicated failed to reject the null hypothesis that curves were indistinguishable at the 5 percent significance level.

Table 2 reported the distribution of household assets and health care payments by wealth quintile. In all three health status groups, the CI were all positive. This indicated that the rich contributed more in terms of healthcare payments than the poor. The Gini coefficient and CI values were the highest in the non-chronic disease group, and were lower as higher number of chronic conditions. An exception was OOP

payment, for which the CI was the lowest in the group with a single chronic condition. CI values for voluntary health insurance were consistently higher than for other types of healthcare payment. This suggested that voluntary health insurance was more unequally distributed. Comparing to other healthcare payments, OOP payment distributed proportionally to the household wealth.

In addition, dominance test was employed to compare the extent of inequity between different ways of health financing. Dominance test was used to determine whether one concentration curve lies above (i.e. dominates) the other Lorenz or concentration curve. The results of the dominance tests between concentration curves for the different sources of health financing were presented in Table 3. OOP payment dominated the other three health payments regardless of the number of chronic conditions, meaning it was the most unfair payment for healthcare.

The CI value was limited in that it only indicated whether healthcare payments were equally distributed with respect to household wealth. To further evaluate the fairness of health financing, KI were calculated with considering the ATP in a household. (Values were represented in table 3). The KI values for general tax, mandatory health insurance, and voluntary health insurance payments were all positive across different health status, with only one exception. These positive values indicated that general tax, and both types of health insurance were all progressive ways of financing. Furthermore, KI values were always higher in the voluntary health insurance group. While KIs in OOP groups were always in negative regardless of health conditions. The lowest KI in OOP classification was -0.23, which was in single morbidity group and the highest KI was in multi-morbidity group with value of -0.11.

It could be seen from figure 3 that OOP payment was in a regressive spending, for the curves always lied inside of Lorenz curves, indicating OOP payment was beyond people's ATP. In multi-morbidity group, the distance was shortest between OOP and ATP curves, while presented the longest in single morbidity group, stating people with single NCD morbidity suffered a most unfair financing distribution with OOP payment. General tax curve had intersected with ATP in non-chronic diseases group at nearly 60% cumulative wealth sharing, while almost overlapped with ATPs in the other two groups. Mandatory health insurance curves coincided with ATPs mostly in all three groups, showing it was a progressive spending in most cases. Voluntary health insurance payment was below ATP in non-NCD and single morbidity groups, while intersected with ATP in multi-morbidity group, stating elder population from 28% to 70% cumulative proportions of wealth level in the group, could not afford for the voluntary insurance.

Discussion

This study used data from WHO SAGE WAVE1 (2007-2010) to evaluate the fairness of health financing for the elderly with chronic conditions in China. More than half of the elderly had some chronic conditions, and 20.35% had multi-morbidity; these results fall within the prevalence range reported by researchers during past years(30)(31). Socioeconomic and several health risk factors were found to play an important role in developing chronic diseases. Previous studies found the rise of NCDs in most developing countries were probably linked to the urbanization(32). Due to profound changes in exercise

and diet, the risk of having diabetes and cardiovascular diseases attendant increase(32). People living in rural areas were less likely to develop chronic conditions owing to a better natural environment, healthier lifestyle and less densely population comparing to the urban people(32)(33). However, the finding might also arise because the presence of chronic conditions in this study was self-reported. Due to inequalities in the allocation of health resources, access to prompt and effective healthcare is not as good in rural areas, and chronic conditions may not be diagnosed properly(30)(34). There may similarly be a bias towards under-reporting in a poorer population for lack of accurate diagnosis(35).

Healthcare financing mainly consisted of four types, of which OOPs stood out in this study. OOP payment was found to be the most regressive type regardless of health status, even though OOP spending decreased from 57.7% in 2002 to 34.8% in 2011 under health reforms(36)(37). In the single morbidity group, the KI had the smallest value (-0.23) value comparing to the rest two groups, which indicated poorer people spent more for their healthcare treatment according to the ATP sharing. This finding was similar to some countries like Tunisia, India and Cambodia over the same period, where OOP has caused unfair health financing, and catastrophic health expenditure has more commonly occurred among the poor (38,39,40).

In this study, we found mandatory health insurance covered more than 70% of elder population. However, the services for treating chronic diseases included in the insurance package were limited, especially in NCMS and URBMI(41), people still need to pay a lot for healthcare expenditure through OOPs, which might account for the KI was lowest in disease group. The government should include more chronic diseases into national insurance and enlarge the coverage for population to be insured in the future.

In the multi-morbidity group, tax payment was also somewhat regressive. In other words, tax posed a financial burden on the poor with multi-morbidity. A common finding in both high and middle income countries is that tax revenue is a progressive form of healthcare financing(42). In contrast to most high-income countries, indirect taxes such as value-added tax, sales tax, and excise taxes (e.g. on alcohol and tobacco) constitute the majority of total tax revenue in China (52% in 2010) (16). In this study, tobacco and alcohol consumption were taken as risk factors for having chronic conditions. Thus, higher consumption on tobacco and alcohol could partly explained why people in multi-morbidity status were in a regressive system for tax payment. Regarding this, redistribute of income wealth through tax payment, reforms are called to ensure the equity.

We also found the different values of redistribution for household insurance in three groups. Although both mandatory and voluntary health insurance were all in a progressive pattern in three groups, they did not contribute proportionally comparing to the according ATP sharing. As mandatory health insurance was consisted of UEBMI, URBMI and NCMS types, and the way of financing for different types varied from each other, people could face the health payment beyond their ATP(17)(41). UEBMI-covered population were requested to pay a certain proportion of their salary as premiums (17)(43), while it was a fixed number for premium of URBMI and NCMS from the insured health payment, without considering so much about the ATP in most of cases(44)(45). It explained partly that in all three groups, mandatory

insurance curve was always higher than ATP sharing at the beginning. As a typical pre-paid payment for healthcare financing, national health insurance should play an important role in preventing people from catastrophic and impoverishing in health expenditures(16)(17). To achieve this objective, Chinese government should take measures to ensure the public health insurance could be afforded in any income groups according to their ATP. Since 2016, a series of health insurance reforms has been taken to ensure patients with chronic conditions seeking for healthcare, for example, in most provinces of China, URBMI and NCMS have been merged for improving the management efficiency and reducing the health inequity between urban and rural areas(46)(47).

Even though the value of voluntary health insurance was positive (0.01) in multi-morbidity, the curve fluctuated the most in this group, and the negative effect could be offset due to the crossed over curves(28), which could find at the third picture in figure 3, the curve of voluntary insurance was inside of ATP sharing at middle class households. Not like most OECD countries, voluntary health insurance only takes smaller proportion under health financing in China(42). We found the voluntary health insurance covered around 10% of elder population, and the proportion of insured was much smaller comparing to the mandatory health insurance. Since the service benefits insured by URBMI and NCMS were limited for both outpatient and inpatient care, people still had to pay more than half of whole expenses when seeking healthcare(6)(17)(48), which increased the demand for voluntary insurance specifically for the elderly. Previous studies also showed that the commercial insurance was highly associated with socio-economic status as well as personal knowledge on insurance purchase(16)(17). People with chronic conditions were more likely to consume voluntary health insurance for reducing OOP expenses. As premiums of private insurance were more related to personal risk factors rather than income, it is very likely to exceed people's ATP(49). These might explain why the commercial insurance was in regressive pattern among the middle-class in multi-morbidity group. Heterogeneity of health risks as well as asymmetric information between insurers and insureds could cause problems since people in higher risks of developing diseases might pay more than lower risks(50)(51)(52). Likewise, moral hazard could also occur when policyholders were lack of honesty(53). Due to the imperfect rules of private health insurance, it still has long way to go for a fairness financing system.

Since this study was the first time to evaluate the fairness of health financing for the elderly with different health conditions, thus some findings could provide implications to other countries with similar situations as China. For example, government could reduce the tax for people with chronic conditions, improve the reimbursement of national insurance for chronic diseases and develop a better private insurance system. Under the context of population aging, the government should prioritize primary prevention of NCDs, and strengthen its health system on a fairer health financing.

Our studies had several limitations. First of all, our data was based on WHO SAGE wave1 (2007-2010), and because Chinese health system has experience a lot in past decade, the findings could be varied from updated setting. Secondly, SAGE only took arthritis, stroke, angina, diabetes, chronic lung disease, asthma, hypertension, cataracts, oral health as chronic conditions. More chronic conditions such as cancers or cardiovascular diseases could be included in future questionnaire design for a comprehensive

comparison between non-NCDs and NCDs groups. Another weakness was since the questionnaires do not classify the mandatory health insurance into UEBMI, URBMI and NCMS, fairness of the compulsory insurance could not be looked in detail. Future analysis should be carried on this study.

Conclusions

This study used the data from WHO SAGE WAVE1 (2007-2010) for evaluation the fairness of health financing system for the elderly with chronic conditions in China. More than half of the elderly had some chronic conditions, and 20.35% had multi-morbidity. Different socioeconomic status as well as risk factors accounted for reasons in developing the chronic conditions. During the period of 2007 to 2010, OOPs was in regressive pattern among different chronic conditions, and KI value was lowest in single morbidity group. Even though mandatory insurance covered more than 70% of the elderly, but due to the relative lower proportion reimbursement for chronic diseases as well as fragmented public health insurances, people still have to pay a lot for seeking care and the poorer suffered more from the increased health expenses. A health system which allows majority of people could afford for health service is still a big challenge in China especially under population aging and epidemiological transition background. Health system should be developed in order to meet the needs of elderly with different chronic conditions as well as achieve the universal health coverage.

Declarations

Ethics approval and consent to participate

The WHO-SAGE study was approved by the Ethics Review Committee, World Health Organization, Geneva, Switzerland and the individual ethics committees in each of the SAGE countries. Written consent was obtained from all respondents before the interviews were initiated. Confidential records of participants are maintained by SAGE country teams.

Consent for publication

The data were provided after completion of User's agreement available through the WHO SAGE website. The manuscript does not contain individual personal data, therefore statement of consent is not applicable.

Available of data and materials

The anonymized datasets are in the public domain:

<http://apps.who.int/healthinfo/systems/surveydata/index.php/catalog/central> SAGE is committed to the public release of study instruments, protocols and meta- and micro-data: access is provided upon completion of the Users Agreement available through WHO's SAGE website:

www.who.int/healthinfo/systems/sage and the WHO archive using the National Data Archive application (<http://apps.who.int/healthinfo/systems/surveydata>). The questionnaires and other materials can be

found at: <http://www.who.int/healthinfo/sage/cohorts/en/index2.html>. SAGE is committed to the public release of study instruments, protocols and meta- and micro-data: access is provided upon completion of the Users Agreement available through WHO's SAGE website (www.who.int/healthinfo/systems/sage).

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

GW made a substantial contribution to the conception of the study, analyzed the data, wrote the first draft and reviewed the literature. QS helped in developing and finalizing the draft. All authors read and approved the final draft.

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Figures

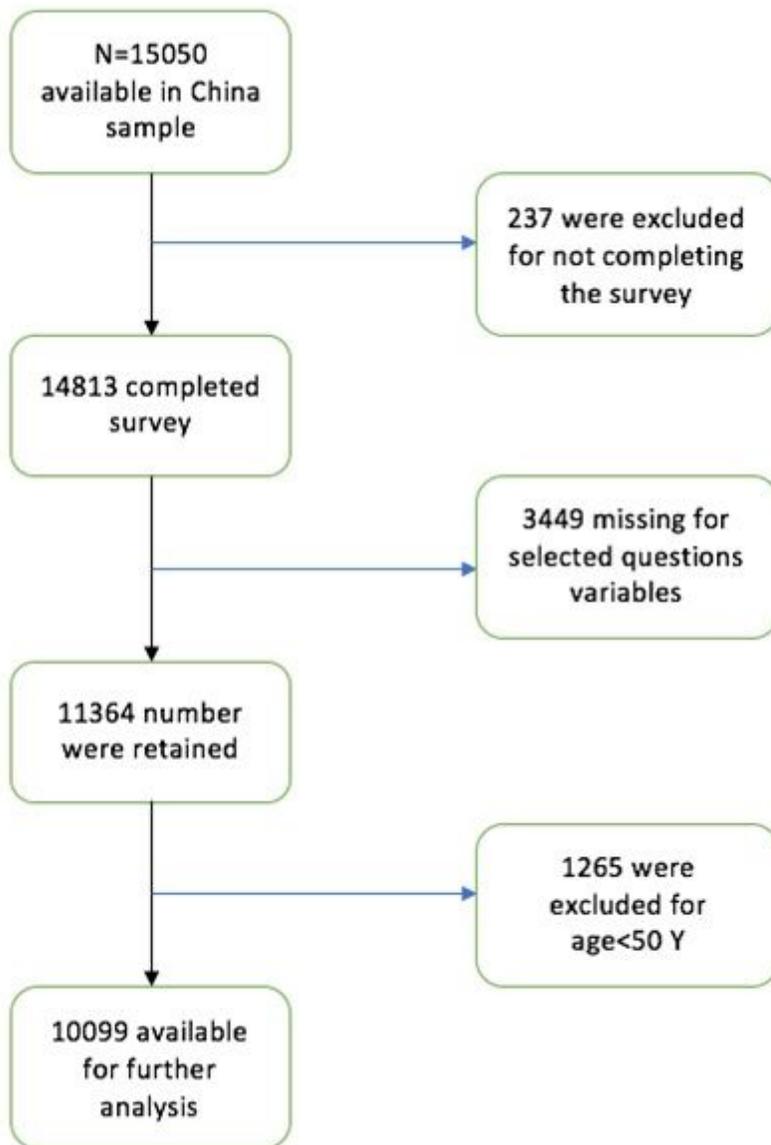


Figure 1

Derivation of study sample from SAGE WAVE1 Chinese population

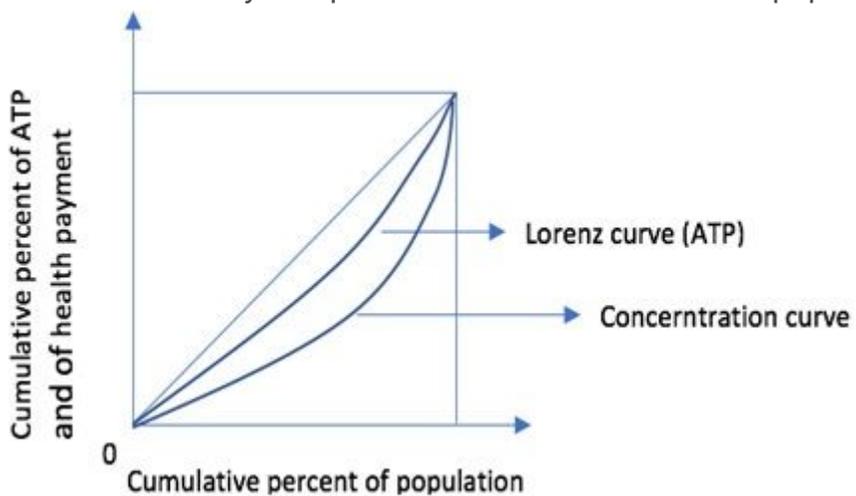


Figure 2

Conceptual cumulative concentration curve for healthcare payment and household wealth

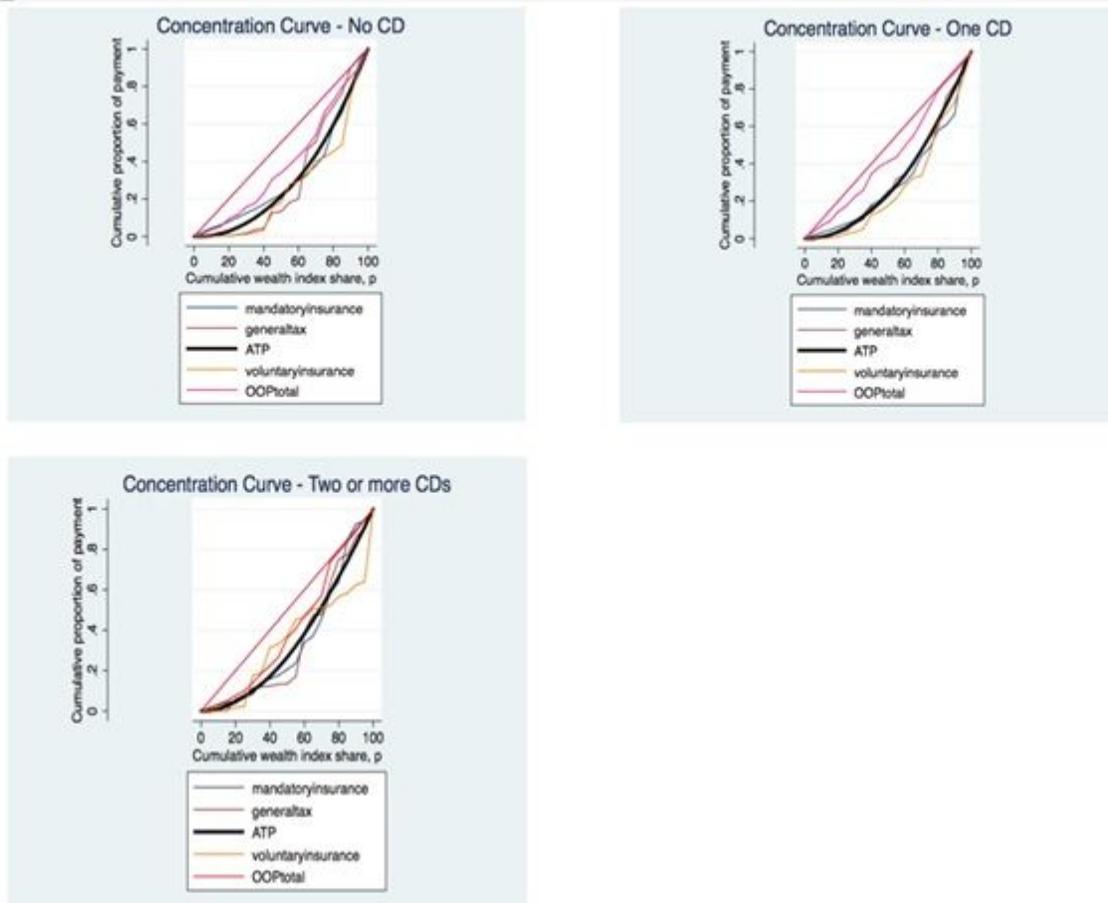


Figure 3

Concentration curve of healthcare payments and Lorenz curve sorted by health status

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