Did expansion of health insurance coverage reduce horizontal inequity? A decomposition analysis for China

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Abstract

Objectives China has launched new and extended the established types of health care insurance since 1998. Individuals with equal income-levels but different attributes such as social status, profession, geographic access to health care, and health conditions, are covered in the health care insurance. However, research is lacking on horizontal inequity in health care finance. This study aims to examine horizontal inequity in the Chinese health care financing system in 2002 and 2007 through two rounds of national household health surveys.

Setting Heilongjiang Province of China.

Design Two rounds of cross-sectional study.

Participants Adopting a multi-stage stratified random sampling, 3,841 households with 11,572 individuals in 2003 and 5530 households with 15,817 individuals in 2008 were selected.

Methods The decomposition method of Aronson et al. (1994) was used in the study to measure the redistributive effects and horizontal inequity in health care finance.

Findings Over the period 2002–2007, the absolute value of horizontal inequity in total health care payments was reduced from 93.85 percentage points to 35.50 percentage points in urban areas, and from 113.19 percentage points to 37.12 percentage points in rural areas. For public health insurance, it increased from 17.84 percentage points to 28.02 percentage points in urban areas, and decreased from 127.93 percentage points to 0.36 percentage points in rural areas. Horizontal inequity in out-of-pocket payments was reduced from 79.92 percentage points to 24.83 percentage points in urban areas, and from 127.71 percentage points to 53.10 percentage points in rural areas.

Conclusions: Our results have shown that horizontal inequity in total health care

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financing decreased over the period 2002-2007 in China. In addition, out-of-pocket payments contributed most to the extent of horizontal inequity which was reduced both in urban and rural areas over the period 2002–2007.

Key words: horizontal inequity; redistributive effect; health insurance; payment; financing

Strengths and limitations of this study

- This study was the first to evaluate the horizontal inequity in health care finance in China.

- The study was the first to explore the relationship between the vertical and horizontal equity in health care financing system in China.

- Our study has shown that horizontal inequity also contributed to the overall inequity in health care finance and should be simultaneously considered with vertical inequity when renovating the health care financing system.

- The cross-sectional study design precluded any causal interpretation.

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Introduction

Apart from securing access to health care, contributions toward financing health care may redistribute the disposable income of households. This redistribution can be assessed on the vertical and horizontal level. Vertical redistribution occurs when health care payments are disproportionately related to ability-to-pay (ATP). Horizontal redistribution occurs when people with equal ATP contribute unequally to health care payments. Vertical and horizontal redistribution are generally defined as redistributive effect (RE). RE can be quantitatively decomposed into three portions—vertical, horizontal and reranking [1]. Vertical equity implies that people with greater economic ability should pay more and horizontal equity implies that people with equal economic ability should pay the same. Reranking occurs when the rank order changes before and after health care payments.

RE in a particular health care financing system depends not only on vertical inequity, but also on the extent of any horizontal inequity associated with the system and on the extent of any reranking resulting from it. The vertical effect shows how households with different incomes are affected by the financing, and the horizontal effect measures the inequity generated among households with the same pre-financing income, while the reranking effect quantifies the change in the order of income distribution. A considerable amount of literature has been published on vertical equity [2-5]. Horizontal inequity, and reranking, by contrast, were not reported in great detail until 1994. In that year, J. Richard Aronson, Paul Johnson and Peter J. Lambert (hereafter AJL) provided a decomposition method to measure the RE of income tax through pre- and post-Gini coefficients, and revealed the separate contributions to the RE of income tax of: (i) the effective schedule (the 'vertical effect'), (ii) the unequal treatment of equals arising from departures from this effective schedule (the

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'horizontal effect') and (iii) the reranking of unequals as a result of such departures (the 'reranking effect'). [6] Later, in 1997, Wagstaff and van Doorslaer applied the AJL method to decompose the change in income inequality caused by health care finance into vertical, horizontal and reranking effects in the Netherlands; each effect corresponding to a different dimension of equity: vertical equity, horizontal inequity and reranking [1]. By simultaneously revealing these three different dimensions of equity, the AJL decomposition constitutes a useful tool for assessing the fairness of health care financing. Since then, horizontal inequity has been measured and evaluated in empirical studies using the AJL decomposition method. These studies indicated that factors such as social status, geographic distribution, employment type, insurance type, income composition, urban-rural classification, health condition, and race may contribute to horizontal inequity and reranking[1, 7, 8]. However, only three papers conducted empirical evaluation of horizontal inequity in health care finance for the Netherlands, Switzerland, and Sweden, respectively [1, 7, 8]. Moreover, until now, no such empirical assessments have been conducted in China. Little is known about the extent of horizontal inequity in health care finance during the reform of China's health care insurance in the past decades.

China has established new types of health insurance since 1998. Health insurance coverage has been expanded to individuals with different socioeconomic status. In each socioeconomic group, individuals joined in health insurance scheme with different social status, urban-rural classifications, and geographic access to health care. Until recently, there has been no reliable evidence to evaluate whether or not China's expansion of health insurance coverage is successful in reducing horizontal inequity in health care finance. This study aims to examine the RE and horizontal inequity in the Chinese health care financing system in 2002 and 2007 for four different sources

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of financing, namely general taxes, public health insurance, private health insurance, and out-of-pocket (OOP) payments.

The remainder of the paper proceeds as follows: Section 2 contains a brief overview of Chinese health insurance reform. Section 3 outlines our data sources and describes the computational methods used in this study. Section 4 presents the findings of the study, and outlines how empirical results in different financing sources, areas and times are compared. Finally, Section 5 and 6 discuss the empirical results and attempts to draw some conclusions in relation to broad lessons from the Chinese experience.

China's health insurance reform

Influenced by social and economic transitions since the early 1980s, China's health care system was reformed to transit from one based on a planned economic model to a market-based system. Government health input rapidly reduced with the decentralization of health care financing [9]. As a result, the share of public funding in the health care system decreased and the proportion of private financing increased [10]. For instance, under China's planned economy, health care in urban areas had been financed primarily through the Government Welfare Insurance Scheme (GWIS) and the Labor Insurance Scheme (LIS). The former covered mainly civil servants and government employees, college students, and veterans, whereas the latter was for workers and their dependents across all formal sectors of the economy [9, 11]. However, these schemes faced challenges in market-oriented economic reforms, which resulted in huge changes in health care financing patterns. Along with the higher demand by employees for quality care, and corresponding financial pressures making these demands unaffordable, financing from GWIS and LIS decreased markedly and citizens had to pay much higher OOP expenses for health care [12].

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Meanwhile, for the majority of the rural population, the poor in particular, the Cooperative Medical Scheme (CMS) played a key role in guaranteeing access to basic health services [13, 14]. However, CMS began to collapse after the initiation of China's Household Contract Responsibility System in the early 1980s, which decreed that health care would be funded at household level. Only 9.3% of rural farmers were still enrolled in the CMS, and over 80% had no health insurance coverage by 2002 [15]. Rural residents without health insurance had to pay for their health care by direct payment, which created barriers to basic health services, and made medical expenses unaffordable to the poor and vulnerable groups, especially for health services that have become more expensive [16].

Such transformations have greatly changed China's health care financing structure. Between 1980 and 2002, the percentage of government spending for health care dropped from 36.24% to 15.69% and the percentage of citizens covered by public health insurance dropped from 42.57% to 15.64%. Conversely, the share of health care spending as OOP payments increased from 21.19% to 57.72% [17]. Heavy dependence on OOP payments resulted in a segmented and tiered healthcare financing system [18]. The results of China's third round of National Health Services Survey showed that, in 2002, 48.9% of outpatients (57.0% and 45.8% in urban and rural areas, respectively) did not visit any health institution. Among those who were admitted but did not use inpatient services, 75.4% could not afford hospital expenses [15].

In order to decrease OOP and provide basic health insurance to the general population, China's government took steps to establish and extend insurance coverage. In 1998, Urban Employee Basic Medical Insurance (UEBMI) was initiated to cover urban workers in the formal sector. UEBMI coverage was gradually extended from covering employees in the larger formal sector to those working in all forms of

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organizations, such as government institutions, state-owned and collective enterprises, private enterprises, enterprises with foreign investment, social organizations, and private non-enterprise units [19]. However, only providing coverage to urban workers raised equity concern in the remaining urban residents who were not covered by the UEBMI. Thus, in 2007, the Urban Residents' Basic Medical Insurance (URBMI) was initiated to extend urban health insurance coverage to an additional 155 million uninsured citizens, including the unemployed, children, students, and elderly persons without pensions [20]. Meanwhile, in rural areas, the New Rural Cooperative Medical Scheme (NCMS) was initiated in 2003 with the purpose of rebuilding rural health insurance. Since its formation, China's authorities have provided additional public spending on NCMS, which has achieved a high coverage level for rural residents, with the insured rate increasing from 9.64% in 2002 to 94.44% in 2007 [21].

Methods

Data source

The data for the analysis are drawn from two rounds of National Health Services Survey (NHSS) conducted in Heilongjiang Province, China. The two rounds were conducted in 2003 and 2008 in the sample regions, recording the information in 2002 and 2007, respectively. Heilongjiang Province, located in the northeast of China, is a middle-income province in terms of per capita gross domestic product with a population of more than 20 million people [22]. Adopting a multi-stage stratified random sampling method, the survey randomly selected 13 cities or counties. In every city or county, data were collected from eight communities or villages and sorted by economic level and geographic distribution. Then, about 30 households were randomly selected from its communities or villages. Finally, 3841 households with 11,572 individuals in 2003 and 5530 households with 15,817 individuals in 2008,

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respectively, were selected in the survey. Table 1 and table 2 present detailed data about some descriptive and socioeconomic characteristics for urban and rural samples, respectively.

<insert table 1 here>

<insert table 2 here>

The survey contains extensive information about households' socioeconomic and demographic characteristics, including urban-rural classification, number of household members, age, gender, educational attainment, professions of household members, and household expenditures. Monthly household expenditure on food, housing, clothing, traffic, electricity, water, fuel, communication, education, exercise, entertainment, medical care and other types of expenditure were queried through the household head or the member most familiar with the home's affairs. Unexpected expenditures during the previous year were also recorded. Per capita household expenditure adjusted by adult equivalence was used as the measure of ATP in our study [23]. Regarding health care payments, information was computed through two sources of data: one source was the survey above, other data were taken mainly from the local statistic yearbook of tariffs, taxes and contribution rates for public health insurance. With regard to general taxes, specific taxes that were considered included taxes on the purchase of cigarettes, alcohol, entertainment, electricity, gas and any excise taxes on restaurants, bars, lodging, and other consumption taxes. Taxes were approximated by applying specific tax rates to the corresponding expenditures. The proportion of government expenditure on health was 4.12% and 5.19% of government expenditure in 2002 and 2007, respectively [17]. Since the government expenditure

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mainly came from general taxes, we assumed that the health financing took 4.12% and 5.19% of the total general taxes in 2002 and 2007, respectively. With regard to public health insurance, flat rate contributions were recorded directly in household interviews with respondents covered by the URBMI, CMS and NCMS. For respondents covered by the UEBMI, the contribution was estimated by applying contribution rates to the earnings of covered workers. Private health insurance premiums were obtained directly via household interviews. Information about OOP payments included health care expenditures on outpatient care and prescriptions that were paid by individuals during 2 weeks prior to the household interview. Inpatient OOP expenditures during the preceding 12 months were recorded.

Data analysis

AJL decomposition that measures the RE of health care payments on income distribution is used to compare the inequality—as measured by the Gini coefficient—of pre-payment income with that in post-payment incomes[1]. The redistributive impact can be defined as the reduction in the Gini coefficient caused by the health care payments [6]. Thus

$$RE \equiv G^X - G^{X-P}$$

where G^X and G^{X-P} are the pre-payment and post-payment Gini coefficients, respectively, where X denotes pre-payment income, or more generally, some measure of ATP, and P denotes health care payments. AJL demonstrated that the RE can be decomposed as:

$$RE = V - H - R$$

The first term, which AJL refer to as V, measures the inequality reduction that would have obtained if there had been no differential health care payment. The second term, which AJL refer to as H, measures the extent of classical horizontal inequity—the

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unequal treatment of equals. The third term, which AJL refer to as R, measures the extent of reranking in the move from the pre-payment income distribution to the post-payment income distribution [1]. To distinguish and compute these components, groups of pre-payment equals are required to be artificially created. This is done by defining certain pre-payment income intervals, and then labeling all households with incomes in that range as equals. All households within an interval are attributed the mean within-interval income, x_j. V itself can be decomposed into a payment rate effect and a progressivity effect,

$$V = \left(\frac{g}{1-g}\right) K_E$$

with g the sample average health care payment rate (as a proportion of income), and K_E is the Kakwani index of payments computed under the assumption of within-group equality, i.e. that all households in the same (pre-defined) bandwidth of (equal) pre-payment income everyone pays the same amount (i.e. under horizontal equity conditions).

Horizontal inequity H is measured by the weighted sum of the group (j) specific post-payment Gini coefficients, G_j^{X-P}, where weights are given by the product of the group's population share and its post-payment income share, a_j.

$$H = \sum_j a_j G_j^{X-P}$$

R captures the extent of reranking of households that occurs in the move from pre-payment to post-payment income distributions. It is measured as the difference between the post-payment Gini coefficient G^{X-P} and the post-payment concentration index C^{X-P}. The latter differs from the former in that households are ranked by their pre-payment income, not their post-payment income. If there is no

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reranking, R is zero.

$$R = G^{X-P} - C^{X-P}$$

All in all, the total RE can be decomposed into four components: an average rate effect (g), the departure-from-proportionality or progressivity effect (K_E), a horizontal inequity effect H and a reranking effect R.

Results

Decompositions of the RE of health care financing sources are presented in Tables 3–6. The distribution of health care financing sources across equivalent income deciles, along with the corresponding values of g, V, H, R and RE. V, H, and R is also presented as the percentage of RE.

RE of urban areas in 2002

In urban areas, payments to health care accounted for 15.70% of the total household expenditures (Table 3). The health care financing system had a pro-poor redistribution as its RE value was positive (0.004278). As a proportion of total health care payments, horizontal inequity (H) accounted for 93.85 percentage points of the RE, whereas reranking (R) accounts for 165.57 percentage points. That is, the health care financing system did not treat households with equal household expenditures equally, and households were also reranked after health care payments. The system would have been 259.42% more redistributive without differential treatment. In addition, general taxes were shown slightly pro-rich with a negative RE value (−0.000084). It would have been 24.68% less redistributive in the absence of differential treatment, which was entirely determined by horizontal inequity (H). With regard to public health insurance, which, in 2002, was mainly UEBMI in urban areas, the RE value was positive (0.000970), indicating that the use of financing through public insurance contributions was pro-poor. The value of V for public insurance

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indicated that the extent of the pro-poor redistribution would have been 19.77% more in the absence of differential treatment, which was determined by horizontal inequity (H) by 17.84 percentage points and reranking (R) by 1.93 percentage points. Private health insurance had a pro-rich effect because its RE value was negative (−0.001349). The pro-rich redistribution would have been 50.60% less without differential treatment, 28.32 percentage points being due to horizontal inequity and 22.28 percentage points being due to reranking. A much higher degree of differential treatment occurred in OOP payment—this source would have been 231.53% more redistributive in the absence of differential treatment, which depends on horizontal inequity by 79.92 percentage points and reranking by 151.62 percentage points.

<insert table 3 here>

RE of rural areas in 2002

In rural areas, 14.61% of household expenditure was payments to health care (Table 4). RE was negative (−0.004308) for the overall health care financing system, indicating that it was a pro-rich redistribution. It would have been 411.62% less redistributive without differential treatment, 113.19 percentage points being due to horizontal inequity and 298.43 percentage points being due to reranking. In terms of special financing sources, general taxes showed a regressive structure, the pro-rich redistribution would have been 15.41% less in the absence of differential treatment, being entirely due to horizontal inequity (H). RE for public health insurance was negative (−0.000033) and the redistribution was pro-rich. The redistribution would have been 215.17% less without differential treatment, 127.93 percentage points being due to horizontal inequity and 87.24 percentage points due to reranking. RE for

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private health insurance (−0.000431) and OOP payments (−0.003648) were both negative, suggesting their redistributions were both pro-rich. The RE of private insurance would have been 124.18% less redistributive if there had been no differential treatment, which was determined by reranking (R) by 37.94 percentage points and horizontal inequity (H) by 86.25 percentage points. The RE of OOP payments would have been 462.90% less redistributive if there had been no differential treatment, which was determined by horizontal inequity (H) by 127.71 percentage points and reranking (R) by 335.18 percentage points.

<insert table 4 here>

RE of urban areas in 2007

In urban areas, payments to health care accounted for 19.30% of household expenditures (Table 5). The RE value for total health care payments was negative (−0.017901) and thus the health care financing system was a pro-rich redistribution. The redistribution would have been 121.70% less in the absence of differential treatment, 35.50 percentage points being due to horizontal inequity and 86.20 percentage points being due to reranking. With regard to special financing sources, general taxes were marginally pro-rich redistributive. The distribution would have been 52.60% less without different treatment, which was entirely determined by horizontal inequity (H). Public health insurance was a pro-poor redistributive structure, which would have been 40.92 more without differential treatment, determining by horizontal inequity by 28.02 percentage points and reranking by 12.91 percentage points. Private health insurance was also a pro-poor redistribution and it would have been 306.03 percentage points more in the absence of differential

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treatment. Horizontal inequity (H) accounted for 169.28 percentage points of the RE, whereas reranking (R) accounted for 136.75 percentage points of the RE. OOP payments had a pro-rich RE. It would have been 88.42 percentage points less without differential treatment, 24.83 percentage points being due to horizontal inequity (H) and 63.59 percentage points being due to reranking.

<insert table 5 here>

RE of rural areas in 2007

In rural areas, 14.98% of household expenditure was payment to health care (Table 6). The RE value for total health care payments was −0.015593 and thus the health care financing system was a pro-rich redistribution. The redistribution would have been 113.71% less in the absence of differential treatment, 37.12 percentage points being due to horizontal inequity and 76.59 percentage points being due to reranking. With regard to special financing sources, general taxes were slightly pro-rich redistributive. The redistribution would have been 35.42% less without differential treatment, which was fully determined by horizontal inequity (H). Public health insurance was pro-rich redistributive. The redistribution would have been 0.36% less in the absence of differential treatment, almost being fully due to horizontal inequity (H). Private health insurance has a pro-rich RE. It would have been 52.01 percentage points less without differential treatment, 23.13 percentage points being due to horizontal inequity (H) and 28.88 percentage points being due to reranking (R). OOP payments were a pro-poor redistribution and would have been 152.92 percentage points less in the absence of differential treatment, 53.10 percentage points being due to horizontal inequity and 99.82 percentage points being due to reranking (R).

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<insert table 6 here>

Discussion

In terms of absolute value, in urban areas, horizontal inequity accounted for 93.85 percentage points in 2002, while it accounted for 35.50 percentage points in 2007. In rural areas, horizontal inequity accounted for 113.19 percentage points in 2002, while it accounted for 37.12 percentage points in 2007. These findings show that horizontal inequity decreased over the period 2002–2007. Furthermore, the extent of reranking was also reduced over the same period in both urban and rural areas, indicating that the impact of health care finance on impoverishment was reduced.

The biggest challenge for horizontal equity in China's health care finance originated from OOP payments. OOP payments as fraction of income (g) were far larger than all other health care financing sources. This implied that the RE of total health care payment was largely dominated by OOP payments. Our study has shown that horizontal inequity in OOP payments has been reduced both in urban and rural areas over the period 2002–2007. The horizontal inequity in OOP payments mainly stemmed from the different health conditions and health insurance schemes among individuals with the same income level. As the distribution of health conditions among population was unlikely changed markedly during a relatively short time period, the reduction of horizontal inequity was largely attributable to the reform and establishment of the new health insurance programs. However, the extent of reranking of OOP payments was much larger than other health care payments. It was indicated that the rank order of individuals who financed health care through OOP payments decreased markedly.

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In 2002, urban public health insurance was UEBMI, and it covered mainly workers in the public sector. In 2007, UEBMI and URBMI were both in effect, with UEBMI covering workers in both the public and private sectors, while URBMI covered citizens who were ineligible to enroll in UEBMI, such as students, the elderly, and the unemployed. China's public health insurance was managed and run at the city level. UEBMI premiums were different among cities. This was the main reason for the horizontal inequity in public health insurance in urban areas in 2002. Excluding this reason, in 2007, the different financing schemes between UEBMI and URBMI, and the disparity in financing contribution to UEBMI between public and private sectors, also resulted in horizontal inequity. This explained why horizontal inequity in urban public health insurance increased over the period 2002–2007. In 2002, CMS provided rural public health insurance, covering less than 10% of rural residents. In 2007, NCMS, covered over 90% of rural residents. Both CMS and NCMS were based on flat rate contributions. Thus, the horizontal inequity in rural health insurance came from the different financing contribution among different cities, and came from the covered and the uncovered. Since almost all rural residents were covered by NCMS in 2007, the horizontal inequity in rural public health insurance was dramatically decreased over the period. Private health insurance did not play an important role in China's health insurance reform because the government decided to achieve Universal Health Coverage through public health insurance. Currently, only about 5% of the population is enrolled in private health insurance [2]. The insurees purchase different types of insurance from different insurance companies. Therefore, the horizontal inequities are comparatively high.

Our findings demonstrated that horizontal inequity in general taxes increased from 2002 to 2007, and that horizontal inequity was higher in urban areas than in rural

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areas. The main income source for households in China was wages. Taxes for households consisted primarily of personal income tax. Because of economic development, individuals, especially in urban areas, earned their income in a variety of sources, and people with the same income levels had a much greater variety of income compositions than in the past. Different income types were subject to different tax rates, which resulted in increased horizontal inequity.

Despite that horizontal, vertical and reranking effects are usually expressed and explained as a percentage of the total RE, some results need to be interpreted with caution. Whilst the horizontal inequity of OOP and total payments in relative terms reduced over the period 2002–2007, in absolute terms, the horizontal inequity increased over 2002-2007 in both urban and rural areas. As the horizontal inequity was measured by the weighted sum of Gini coefficients in each income quintile group [1, 7], the increase of horizontal inequity in the absolute term indicated a more inequitable distribution within the income quintile group. Furthermore, RE decreased both in urban and rural areas from 2002 to 2007 in our study, indicating that the health care financing system had become more pro-rich over the period. In a previous study in the same area, Chen et al. had found that the Kakwani index of the total health care payments decreased over 2002 to 2007 [24]. This is consistent with the finding in the current study that the vertical equity (V) decreased over 2002 to 2007. We have also found that the horizontal inequity (H) increased in both urban and rural areas over the same time period. In addition, the reranking (R) decreased in rural area but increased in urban area over 2002 to 2007. When considering V, H and R together, RE decreased in both urban and rural areas. This finding indicated that improving both vertical and horizontal equity in health care financing system could improve pro-poor redistribution to a large extent in the study population. However, the equitable vertical

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and horizontal distribution are hard to achieve simultaneously. Taking NCMS as an example, a flat rate premium could result in an equitable horizontal distribution, but at the cost of worsened vertical equity as all insured individuals paid the same premium, irrespective of their incomes. Therefore, we have to weigh the horizontal equity against vertical equity in the health care financing system reform. Future work is merited to investigate the optimal trade-off between horizontal and vertical equity to achieve a more pro-poor redistribution in the health care financing system.

The current study has only examined data from one province in China. It is unlikely to fully represent the horizontal equity in China's health care financing system. Studies using national representative data are merited to evaluate the horizontal equity of the national health insurance reform in China.

Conclusions

Overall horizontal inequity in China's total health care finance has decreased during 2002 to 2007. In addition, OOP payments contributed most in the overall health care payments and horizontal inequity in OOP payments decreased. These findings are of important implications for the future health care financing reform: China's further health insurance reform should target on cost and service coverage to decrease the impact of OOP payments.

Ethics approval and consent to participate

This study was approved by the Academic Research Ethics Committee of Nanjing Medical University. All procedures were in accordance with the ethical standards of the Helsinki Declaration. Participants provided informed consent prior to data collection.

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Data sharing statement

The datasets used in this study are not publicly available due to a confidentiality policy, but they are available from the corresponding author on reasonable request.

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Tables

Table 1

Descriptive statistics and socioeconomic characteristics for the urban sample

Variable	2002			2007		
	Obs	Mean	Std. dev.	Obs	Mean	Std. dev.
Female	2613	0.50		3140	0.51	
Age	5265	38.86	18.96	6188	43.25	19.11
0-14	699	8.41	4.14	579	8.13	4.11
14-59	3738	38.07	11.41	4332	40.36	11.74
60+	828	68.14	6.43	1277	68.99	6.65
Average number of household members	1923	2.74	0.91	2433	2.67	0.97
Equivalent household income	1923	6673.96	8536.51	2433	8113.18	6698.25
1st quintile	383	1632.37	388.58	485	3106.48	684.43
2nd quintile	385	2853.21	352.19	489	4878.06	431.32
3rd quintile	385	4230.77	481.25	486	6556.05	554.44
4th quintile	385	6515.92	900.16	487	8913.53	813.41
5th quintile	385	18111.36	13648.11	486	17119.82	10167.41
Health insurance						
None	3120	59.26		2909	47.01	
Any	2145	40.74		3279	52.99	
Public health insurance types	1922	36.51		2988	48.29	
UEBMI	1374	26.10		2100	33.94	
URBMI	0	0.00		273	4.41	
CMS (NCMS)	6	0.11		50	0.81	
Other insurance	542	10.29		565	9.13	
None	3343	63.49		3200	51.71	
Private health insurance types	359	6.82		297	4.80	

Source: Authors' calculations from 2003–2008 NHSS data.

Table 2
Descriptive statistics and socioeconomic characteristics for the rural sample

Variable	2002			2007		
	Obs	Mean	Std dev	Obs	Mean	Std dev
Female	3063	0.49		4808	0.50	
Age	6307	33.39	18.02	9638	36.57	19.17
0-14	1133	8.22	4.42	1497	7.33	4.22
14-59	4704	35.92	11.91	7080	37.95	12.33
60+	470	68.70	7.06	1061	68.57	7.46
Average number of household members	1918	3.29	1.12	3097	3.25	1.16
Equivalent household income	1918	3381.07	2772.73	3097	6160.81	4470.30
1st quintile	383	1290.94	293.39	619	2691.81	551.94
2nd quintile	385	2013.65	193.44	620	4040.15	310.04
3rd quintile	383	2706.09	227.53	620	5218.73	364.09
4th quintile	384	3674.15	378.62	619	6790.10	588.12
5th quintile	383	7226.90	4077.39	619	12068.21	6813.69
Health insurance						
None	5311	84.21		905	9.39	
Any	996	15.79		8733	90.61	
Public health insurance types						
UEBMI	71	1.13		34	0.35	
URBMI	0	0.00		4	0.04	
CMS (NCMS)	347	5.50		8401	87.16	
Other insurance	179	2.84		188	1.95	
None	5710	90.53		1012	10.50	
Private health insurance types	402	6.37		773	8.02	

Source: Authors' calculations from 2003–2008 NHSS data.

Table 3

Decomposition of the redistributive effects of the Chinese urban health care financing system in 2002

Decile	income	General taxes	Public health insurance	Private health insurance	OOP	Total payments
1 (poorest)	1.97%	2.07%	0.52%	1.01%	1.53%	1.44%
2	2.95%	3.12%	0.81%	4.92%	2.19%	2.18%
3	3.86%	4.08%	1.33%	6.00%	2.83%	2.86%
4	4.76%	4.97%	2.83%	3.65%	3.94%	3.92%
5	5.74%	5.89%	3.82%	4.54%	5.28%	5.12%
6	6.98%	7.22%	4.91%	6.45%	5.87%	5.95%
7	8.64%	9.09%	8.40%	14.02%	6.91%	7.70%
8	10.86%	11.33%	17.03%	9.31%	8.70%	10.60%
9	14.60%	14.85%	34.95%	28.02%	13.24%	17.58%
10 (richest)	39.64%	37.38%	25.40%	22.10%	49.51%	42.66%
total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
g		0.003789	0.011082	0.008820	0.133309	0.157001
V		−0.000063	0.001162	−0.000666	0.014464	0.015376
H		0.000021	0.000173	0.000382	0.003487	0.004015
R		0.000000	0.000019	0.000301	0.006615	0.007083
RE		−0.000084	0.000970	−0.001349	0.004363	0.004278
RE / RE		100.00%	100.00%	100.00%	100.00%	100.00%
V / RE		75.32%	119.77%	49.40%	331.53%	359.42%
H / RE		−24.68%	17.84%	−28.32%	79.92%	93.85%
R / RE		0.00%	1.93%	−22.28%	151.62%	165.57%

g: Payments as fraction of income
V: Vertical effect
H: Horizontal inequity
R: Reranking
RE: Redistributive effect

Table 4

Decomposition of redistributive effects of Chinese rural health care financing system in 2002

Decile	income	General taxes	Public health insurance	Private health insurance	OOP	Total payments
1 (poorest)	3.09%	3.43%	1.35%	0.89%	2.17%	2.22%
2	4.53%	4.80%	1.46%	3.23%	4.43%	3.96%
3	5.46%	5.86%	3.26%	3.35%	4.58%	4.55%
4	6.46%	6.86%	6.37%	4.59%	5.34%	5.76%
5	7.38%	7.75%	14.62%	11.23%	6.07%	7.95%
6	8.59%	8.74%	13.18%	10.80%	8.90%	9.65%
7	9.93%	10.29%	8.46%	8.14%	7.91%	8.42%
8	11.81%	11.73%	12.11%	20.12%	12.55%	12.51%
9	14.97%	15.08%	7.19%	17.32%	13.22%	12.60%
10 (richest)	27.78%	25.46%	31.99%	20.33%	34.83%	32.39%
total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
g		0.003705	0.001190	0.003403	0.137787	0.146085
V		−0.000094	0.000038	0.000104	0.013238	0.013424
H		0.000017	0.000043	0.000163	0.004659	0.004876
R		0.000000	0.000029	0.000371	0.012227	0.012856
RE		−0.000111	−0.000033	−0.000431	−0.003648	−0.004308
RE / RE		100.00%	100.00%	100.00%	100.00%	100.00%
V / RE		84.58%	−115.17%	−24.18%	−362.90%	−311.62%
H / RE		−15.41%	−127.93%	−37.94%	−127.71%	−113.19%
R / RE		0.00%	−87.24%	−86.25%	−335.18%	−298.43%

g: Payments as fraction of income
V: Vertical effect
H: Horizontal inequity
R: Reranking
RE: Redistributive effect

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Table 5

Decomposition of redistributive effects of Chinese urban health care financing system in 2007

Decile	income	General taxes	Public insurance contributions	Private insurance premiums	OOP	Total payments
1 (poorest)	3.14%	3.49%	1.05%	5.17%	2.68%	2.59%
2	4.52%	4.80%	2.36%	2.82%	4.16%	3.85%
3	5.55%	5.66%	4.07%	4.49%	5.91%	5.37%
4	6.49%	6.59%	5.30%	6.46%	6.75%	6.36%
5	7.47%	7.46%	6.82%	5.56%	8.02%	7.51%
6	8.66%	8.57%	9.01%	4.27%	9.10%	8.77%
7	10.16%	9.95%	10.59%	10.31%	11.43%	10.83%
8	11.82%	11.48%	12.68%	15.70%	13.55%	12.92%
9	14.54%	14.62%	17.35%	16.01%	13.35%	14.70%
10 (richest)	27.66%	27.39%	30.77%	29.20%	25.04%	27.11%
total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
g		0.004710	0.045590	0.008282	0.134454	0.193035
V		−0.000022	0.005007	0.000428	−0.002364	0.003885
H		0.000024	0.000995	0.000352	0.005067	0.006355
R		0.000000	0.000459	0.000284	0.012975	0.015431
RE		−0.000046	0.003553	−0.000208	−0.020406	−0.017901
RE / RE		100.00%	100.00%	100.00%	100.00%	100.00%
V / RE		47.40%	140.92%	−206.03%	11.58%	−21.70%
H / RE		−52.60%	28.02%	−169.28%	−24.83%	−35.50%
R / RE		0.00%	12.91%	−136.75%	−63.59%	−86.20%

g: Payments as fraction of income

V: Vertical effect

H: Horizontal inequity

R: Reranking

RE: Redistributive effect

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Table 6

Decomposition of redistributive effects of Chinese rural health care financing system in 2007

Decile	income	General taxes	Public insurance contributions	Private insurance premiums	OOP	Total payments
1 (poorest)	3.63%	3.75%	11.08%	4.30%	3.36%	5.29
2	5.10%	5.20%	9.74%	10.25%	4.97%	6.33
3	6.13%	6.27%	9.70%	5.94%	5.81%	6.84
4	6.97%	7.04%	10.05%	10.28%	7.15%	7.92
5	7.97%	8.08%	9.74%	9.46%	7.77%	8.37
6	8.98%	9.19%	9.59%	8.00%	7.94%	8.64
7	10.18%	10.43%	10.62%	10.08%	9.06%	9.80
8	11.84%	11.92%	10.08%	12.33%	11.25%	11.18
9	14.45%	14.25%	10.37%	9.58%	15.62%	13.84
10 (richest)	24.74%	23.86%	9.03%	19.78%	27.06%	21.79
total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
g		0.004744	0.002764	0.012405	0.129908	0.149821
V		−0.000035	−0.000864	−0.001599	0.004933	0.002138
H		0.000019	0.000003	0.000770	0.004951	0.005788
R		0.000000	0.000000	0.000962	0.009306	0.011943
RE		−0.000053	−0.000867	−0.003331	−0.009323	−0.015593
RE / RE		100.00%	100.00%	100.00%	100.00%	100.00%
V / RE		64.58%	99.64%	47.99%	−52.92%	−13.71%
H / RE		−35.42%	−0.36%	−23.13%	−53.10%	−37.12%
R / RE		0.00%	0.00%	−28.88%	−99.82%	−76.59%

g: Payments as fraction of income

V: Vertical effect

H: Horizontal inequity

R: Reranking

RE: Redistributive effect

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9
Bias	9	Describe any efforts to address potential sources of bias	9, 10
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10, 11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10, 11
		(*b*) Describe any methods used to examine subgroups and interactions	10
		(*c*) Explain how missing data were addressed	11
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed	8

		eligible, included in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9, 10
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers of outcome events or summary measures	12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	26, 27, 28, 29
		(*b*) Report category boundaries when continuous variables were categorized	26, 27, 28, 29
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18, 19
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	19
Generalisability	21	Discuss the generalisability (external validity) of the study results	19
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	20

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Did expansion of health insurance coverage reduce horizontal inequity in health care finance? A decomposition analysis for China

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Manuscripts

1   **Did expansion of health insurance coverage reduce horizontal inequity in health**

2   **care finance? A decomposition analysis for China**

3

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22

1   **Abstract**

2   **Objectives** 'Horizontal inequity' in health care finance occurs when people with

3   equal income contribute unequally to health care payments. Prior research is lacking

4   on horizontal inequity in China. Accordingly, this study set out to examine horizontal

5   inequity in the Chinese health care financing system in 2002 and 2007 through two

6   rounds of national household health surveys.

7   **Design** Two rounds of cross-sectional study.

8   **Setting** Heilongjiang Province, China.

9   **Participants** Adopting a multi-stage stratified random sampling, 3,841 households

10   with 11,572 individuals in 2003 and 5530 households with 15,817 individuals in 2008

11   were selected.

12   **Methods** The decomposition method of Aronson *et al*. (1994) was used in the present

13   study to measure the redistributive effects and horizontal inequity in health care

14   finance.

15   **Findings** Over the period 2002–2007, the absolute value of horizontal inequity in

16   total health care payments decreased from 93.85 percentage points to 35.50

17   percentage points in urban areas, and from 113.19 percentage points to 37.12

18   percentage points in rural areas. For public health insurance, it increased from 17.84

19   percentage points to 28.02 percentage points in urban areas, and decreased from

20   127.93 percentage points to 0.36 percentage points in rural areas. Horizontal inequity

21   in out-of-pocket payments decreased from 79.92 percentage points to 24.83

22   percentage points in urban areas, and from 127.71 percentage points to 53.10

23   percentage points in rural areas.

24   **Conclusions** Our results show that horizontal inequity in total health care financing

25   decreased over the period 2002–2007 in China. In addition, out-of-pocket payments

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contributed most to the extent of horizontal inequity, which were reduced both in

urban and rural areas over the period 2002–2007.

Keywords: horizontal inequity; redistributive effect; health insurance; payment; financing

Strengths and limitations of this study

- This study was the first to evaluate the horizontal inequity in health care finance in China.

- The study was the first to explore the relationship between vertical and horizontal equity in health care financing system in China.

- Our study demonstrates that horizontal inequity also contributed to the overall inequity in health care finance, and that it should be simultaneously considered with vertical inequity when renovating the health care financing system.

3

1   **INTRODUCTION**

2   Apart from securing access to health care, contributions toward financing health

3   care may redistribute the disposable income of households. This redistribution can be

4   assessed on vertical and horizontal levels: 'vertical redistribution' occurs when health

5   care payments are disproportionately related to 'ability to pay' (ATP); 'horizontal

6   redistribution' occurs when people with equal ATP contribute unequally to health

7   care payments. Vertical redistribution and horizontal redistribution are generally

8   defined as a 'redistributive effect' (RE). An RE can be quantitatively decomposed

9   into three aspects: 'vertical', 'horizontal' and 'reranking'. The vertical effect shows

10   how households with different incomes are affected by the financing, the horizontal

11   effect measures the inequity generated among households with the same pre-financing

12   income, while the reranking effect quantifies the change in the order of income

13   distribution.

14   In the literature, a considerable number of studies have been published on vertical

15   equity. [1-5] Horizontal inequity and reranking, by contrast, were not reported in great

16   detail until 1994. In that year, Aronson, Johnson and Lambert (hereafter, AJL)

17   provided a decomposition method to measure the RE of income tax through pre- and

18   post-Gini coefficients, and revealed the separate contributions to the RE of income tax

19   of (a) the effective schedule (the 'vertical effect'), (b) the unequal treatment of equals

20   arising from departures from this effective schedule (the 'horizontal effect') and (c)

21   the reranking of unequals as a result of such departures (the 'reranking effect').[6]

22   Later, in 1997, Wagstaff and van Doorslaer applied the AJL method to decompose the

23   change in income inequality caused by health care finance into vertical, horizontal

24   and reranking effects in the Netherlands, with each effect corresponding to a different

25   dimension of equity: vertical equity, horizontal inequity and reranking. [7] By

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1   simultaneously revealing these three different dimensions of equity, the AJL

2   decomposition constitutes a useful tool for assessing the fairness of health care

3   financing. Consequently, horizontal inequity has since been measured and evaluated

4   in empirical studies using the AJL decomposition method. The findings of these

5   studies indicated that factors such as social status, geographic distribution,

6   employment type, insurance type, income composition, urban–rural classification,

7   health condition, and race or ethnicity may contribute to horizontal inequity and

8   reranking.[7-9] However, only three papers have conducted empirical evaluations of

9   horizontal inequity in health care finance – for the Netherlands, Switzerland, and

10   Sweden, respectively.[7-9] Moreover, until now, no such empirical assessments have

11   been conducted in China. Since China launched new and extended the established

12   health insurance schemes, a greater proportion of the population has been covered by

13   health insurance. However, the impact on horizontal inequity in health care finance is

14   uncertain. Little is known about the extent of horizontal inequity in health care

15   finance during the reform of China's health care insurance in the past decades.

16   China has established new types of health insurance since 1998. Health insurance

17   coverage has been expanded to include individuals with different socioeconomic

18   statuses. In each socioeconomic group, individuals with diverse social statuses,

19   urban–rural classifications, and geographic access to health care joined health

20   insurance schemes. Until recently, though, there has been no reliable evidence with

21   which to evaluate whether China's expansion of health insurance coverage has been

22   successful in reducing horizontal inequity in health care finance. The present study

23   examines the RE and horizontal inequity in the Chinese health care financing system

24   in 2002 and 2007 for four different sources of financing; namely, general taxes, public

25   health insurance, private health insurance and out-of-pocket (OOP) payments.

5

1   The remainder of the paper proceeds as follows: Section 2 provides a brief

2   overview of Chinese health insurance reform. Section 3 outlines our data sources and

3   describes the computational methods used in this study. Section 4 presents the

4   findings of the study, and delineates how empirical results in different financing

5   sources, areas and times may be compared. Finally, Sections 5 and 6 discuss the

6   empirical results and attempt to draw some conclusions in relation to broad lessons

7   from the Chinese experience.

8   **CHINA'S HEALTH INSURANCE REFORM**

9   Influenced by social and economic transitions since the early 1980s, China's health

10   care system was reformed to transit from one based on a planned economic model to a

11   market-based system. Government health input rapidly decreased with the

12   decentralization of health care financing.[10-12] Subsequently, the share of public

13   funding in the health care system decreased and the proportion of private financing

14   increased.[13 14] For instance, under China's planned economy, health care in urban

15   areas had been financed primarily through the Government Welfare Insurance

16   Scheme and the Labor Insurance Scheme. The former covered mainly civil servants

17   and government employees, college students, and veterans, whereas the latter was for

18   workers and their dependents across all formal sectors of the economy.[10 15] However,

19   these schemes faced challenges during the market-oriented economic reforms, which

20   resulted in huge changes in health care financing patterns. Along with the higher

21   demand by employees for quality care, and corresponding financial pressures making

22   these demands unaffordable, financing from the Government Welfare Insurance

23   Scheme and the Labor Insurance Scheme decreased markedly and citizens had to pay

24   much higher OOP expenses for health care.[16] Meanwhile, for the majority of the rural

25   population, and the poor in particular, the Cooperative Medical Scheme (CMS)

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1 played a key role in guaranteeing access to basic health services.[17] [18] However, the

2 CMS began to collapse after the initiation of China's Household Contract

3 Responsibility System in the early 1980s, which decreed that health care would be

4 funded at the household level. Only 9.3% of rural farmers were still enrolled in the

5 CMS, and over 80% had no health insurance coverage by 2002.[19] Rural residents

6 without health insurance had to pay for their health care by direct payment, which

7 created barriers to basic health services and made medical expenses unaffordable to

8 the poor and vulnerable groups, especially in respect of health services that had

9 become more expensive.[20]

10 Such transformations greatly changed China's health care financing structure.

11 Between 1980 and 2002, the percentage of government spending for health care

12 dropped from 36.24% to 15.69% and the percentage of citizens covered by public

13 health insurance plummeted from 42.57% to 15.64%. Conversely, the share of health

14 care spending as OOP payments increased from 21.19% to 57.72%.[21] Such a heavy

15 dependence on OOP payments resulted in a segmented and tiered health care

16 financing system.[22] Results from China's third National Health Services Survey

17 showed that, in 2002, 48.9% of outpatients (57.0% and 45.8% in urban and rural

18 areas, respectively) did not visit any health institution. Among those who were

19 admitted but did not use inpatient services, 75.4% could not afford hospital

20 expenses.[19]

21 In order to decrease OOP and provide basic health insurance to the general

22 population, China's government took steps to establish and extend insurance

23 coverage. In 1998, Urban Employee Basic Medical Insurance (UEBMI) was

24 introduced to cover urban workers in the formal sector. UEBMI coverage was

25 gradually extended from covering employees in the larger formal sector to those

7

1 working in all forms of organizations, such as government institutions, state-owned

2 and collective enterprises, private enterprises, enterprises with foreign investment,

3 social organizations and private non-profit units.[23] However, only providing coverage

4 to urban workers raised equity concern in relation to the remaining urban residents

5 who were not covered by the UEBMI scheme. Thus, in 2007, the Urban Residents'

6 Basic Medical Insurance (URBMI) scheme was launched to extend urban health

7 insurance coverage to an additional 155 million uninsured citizens, including the

8 unemployed, children, students and elderly persons without pensions.[24] Meanwhile, in

9 rural areas, the New Rural Cooperative Medical Scheme (NCMS) had been initiated

10 in 2003 with the purpose of rebuilding rural health insurance coverage. Since its

11 formation, China's authorities have provided additional public spending on NCMS,

12 which has achieved a high coverage level for rural residents, with the insured rate

13 increasing from 9.64% in 2002 to 94.44% in 2007.[25]

14 **METHODS**

15 **Data source**

16 The data for the analysis were drawn from two rounds of the National Health

17 Services Survey conducted in Heilongjiang Province, China. The two rounds were

18 conducted between August and October in 2003 and 2008 in the sample regions, with

19 the information recorded in 2002 and 2007, respectively. Heilongjiang Province,

20 located in the northeast of China, is a middle-income province in terms of per capita

21 gross domestic product and has a population of more than 20 million people.[26] The

22 per capita gross domestic product was 1,152.72 US dollars (USD) and 2,943.37 USD

23 in Heilongjiang Province in 2002 and 2007, respectively. Adopting a multi-stage

24 stratified random sampling method, the survey randomly selected 13 cities or

25 counties. In every city or county, eight communities or villages were randomly

8

1 selected. Then, about 30 households were randomly selected from each community or

2 village. Finally, 3,841 households with 11,572 individuals in 2003 and 5,530

3 households with 15,817 individuals in 2008, respectively, were selected in the survey.

4 Tables 1 2 present detailed data about the descriptive and socioeconomic

5 characteristics for the urban and rural samples, respectively.

9

Table 1 Descriptive statistics and socioeconomic characteristics for the urban sample

Variable	2002			2007		
	Obs	Mean	Std. dev.	Obs	Mean	Std. dev.
Gender (female)	2,613	0.50		3,140	0.51	
Age (years)	5,265	38.86	18.96	6,188	43.25	19.11
0–14	699	8.41	4.14	579	8.13	4.11
14–59	3,738	38.07	11.41	4,332	40.36	11.74
60+	828	68.14	6.43	1,277	68.99	6.65
No. of household members (average)	1,923	2.74	0.91	2,433	2.67	0.97
Equivalent household income	1,923	806.33	1,031.35	2,433	1,285.26	1,061.11
1st quintile	383	197.22	46.95	485	492.12	108.42
2nd quintile	385	344.72	42.55	489	772.76	68.33
3rd quintile	385	511.15	58.14	486	1,038.58	87.83
4th quintile	385	787.23	108.75	487	1,412.04	128.86
5th quintile	385	2,188.16	1,648.92	486	2,712.05	1,610.68
Equivalent OOP expenditure	1,923	107.49	345.85	2,433	172.81	290.63
Incidence of catastrophic health expenditure	513	26.68%		869	35.72%	
Health insurance						
None	3,120	59.26%		2,909	47.01%	
Any	2,145	40.74%		3,279	52.99%	
Public health insurance types	1,922	36.51%		2,988	48.29%	
UEBMI	1,374	26.10%		2,100	33.94%	

10

URBMI	0	0.00%		273	4.41%
CMS (NCMS)	6	0.11%		50	0.81%
Other insurance	542	10.29%		565	9.13%
None	3,343	63.49%		3,200	51.71%
Private health insurance types	359	6.82%		297	4.80%

Source: Authors' calculations from 2003–2008 National Health Services Survey data.

OOP, out-of-pocket; UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban Residents' Basic Medical Insurance; NCMS, New Rural Cooperative Medical Scheme.

All expenditures are presented in USD.

The threshold of the catastrophic health expenditure is 25% of nonfood household expenditure in this study.

11

Table 2 Descriptive statistics and socioeconomic characteristics for the rural sample

Variable	2002			2007		
	Obs	Mean	Std dev	Obs	Mean	Std dev
Gender (female)	3,063	0.49		4,808	0.50	
Age (years)	6,307	33.39	18.02	9,638	36.57	19.17
0–14	1,133	8.22	4.42	1,497	7.33	4.22
14–59	4,704	35.92	11.91	7,080	37.95	12.33
60+	470	68.70	7.06	1,061	68.57	7.46
No. of household members (average)	1,918	3.29	1.12	3,097	3.25	1.16
Equivalent household income	1,918	408.49	334.99	3,097	975.97	708.17
1st quintile	383	155.97	35.45	619	426.42	87.44
2nd quintile	385	243.28	23.37	620	640.02	49.12
3rd quintile	383	326.94	27.49	620	826.73	57.68
4th quintile	384	443.90	45.74	619	1,075.66	93.17
5th quintile	383	873.13	492.62	619	1,911.79	1,079.40
Equivalent OOP expenditure	1,918	56.28	153.78	3,097	126.78	296.75
Incidence of catastrophic health expenditure	485	25.29%		694	22.41%	
Health insurance						
None	5,311	84.21%		905	9.39%	
Any	996	15.79%		8,733	90.61%	
Public health insurance types	597	9.47%		8,627	89.50%	
UEBMI	71	1.13%		34	0.35%	
URBMI	0	0.00%		4	0.04%	

12

CMS (NCMS)	347	5.50%		8,401	87.16%
Other insurance	179	2.84%		188	1.95%
None	5,710	90.53%		1,012	10.50%
Private health insurance types	402	6.37%		773	8.02%

Source: Authors' calculations from 2003–2008 National Health Services Survey data.

OOP, out-of-pocket; UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban Residents' Basic Medical Insurance; NCMS, New Rural Cooperative Medical Scheme.

All expenditures are presented in USD.

The threshold of the catastrophic health expenditure is 25% of nonfood household expenditure in this study.

13

1   We adopted the same questionnaire in the two rounds of the survey. The national

2   survey gathers extensive information about households' socioeconomic and

3   demographic characteristics, including urban–rural classification, number of

4   household members, age, gender, educational attainment, professions of household

5   members, and household expenditures. Monthly household expenditures on food,

6   housing, clothing, traffic, electricity, water, fuel, communication, education, exercise,

7   entertainment, medical care and other types of expenditure were queried through the

8   household head or the member most familiar with the home's affairs. Unexpected

9   expenditures during the previous year were also recorded. Regarding health care

10   payments, information was obtained through two sources of data: one was the survey

11   above, while other data were taken mainly from the local statistic yearbook of tariffs,

12   taxes and contribution rates for public health insurance. With regard to general taxes,

13   specific taxes that were considered included taxes on the purchase of cigarettes,

14   alcohol, entertainment, electricity, gas and any excise taxes on restaurants, bars,

15   lodging, and other consumption taxes. Taxes were approximated by applying specific

16   tax rates to the corresponding expenditures. The proportion of government

17   expenditure on health was 4.12% and 5.19% of government expenditure in 2002 and

18   2007, respectively.[27] Since the government expenditure mainly came from general

19   taxes, we assumed that the health financing took 4.12% and 5.19% of the total general

20   taxes in 2002 and 2007, respectively. With regard to public health insurance, flat rate

21   contributions were recorded directly in household interviews with respondents

22   covered by the URBMI, CMS and NCMS. For respondents covered by the UEBMI,

23   the contribution was estimated by applying contribution rates to the earnings of

24   covered workers. Private health insurance premiums were obtained directly via

25   household interviews. Information about OOP payments included health care

14

1   expenditures on outpatient care and prescriptions that were paid by individuals during

2   the two weeks prior to the household interview. Inpatient OOP expenditures during

3   the preceding 12 months were also recorded.[28]

4   **Data analysis**

5   **Measurement of ATP**

6   The unit of health care finance was on the household level, based on which

7   expenditures and health care payments were aggregated. The amount of household

8   expenditure was used as the measurement of ATP.[28] Adjustment was made according

9   to the size and age structure of the household to both ATP and each component of

10   health care financing. The scale of 'adult equivalents' (*AE*) in the household was

11   calculated as:

12   $$AE = (A + 0.5K)^{0.75} \tag{1}$$

13   where A was the number of adults in the household and K the number of children (0–

14   14 years old).

15   **AJL decomposition**

16   An AJL decomposition that measured the RE of health care payments on income

17   distribution was used to compare the inequality – as measured by the Gini coefficient

18   – of pre-payment income with that in post-payment incomes.[7] The 'redistributive

19   impact' can be defined as the reduction in the Gini coefficient caused by the health

20   care payments.[6] Thus:

21   $$RE \equiv G^X - G^{X-P} \tag{2}$$

22   where G^X and G^{X-P} are the pre-payment and post-payment Gini coefficients,

23   respectively, wherein X denotes pre-payment income, or, more generally, some

24   measure of ATP, and P denotes health care payments. The AJL approach

25   demonstrated that the RE can be decomposed as:

15

1 $$RE = V - H - R \tag{3}$$

2 The first term, which AJL refer to as V, measures the inequality reduction that would

3 have been obtained if there had been no differential health care payment. The second

4 term, which AJL refer to as H, measures the extent of classical horizontal inequity –

5 the unequal treatment of equals. The third term, which AJL refer to as R, measures the

6 extent of reranking in the move from the pre-payment income distribution to the

7 post-payment income distribution.[7] To distinguish and compute these components,

8 groups of pre-payment equals are required to be artificially created. This is done by

9 defining certain pre-payment income intervals, and then labelling all households with

10 incomes in that range as equals. All households within an interval are attributed the

11 mean within-interval income, x_j; V itself can be decomposed into a 'payment rate

12 effect' and a 'progressivity effect',

13 $$V = \left(\frac{g}{1-g} \right) K_E \tag{4}$$

14 with g the sample average health care payment rate (as a proportion of income) and

15 K_E being the Kakwani index of payments computed under the assumption of

16 within-group equality – that is, in all households in the same (pre-defined) bandwidth

17 of (equal) pre-payment income, everyone pays the same amount (i.e. under horizontal

18 equity conditions).

19 Horizontal inequity H is measured by the weighted sum of the group (j) specific

20 post-payment Gini coefficients, G_j^{X-P}, where weights are given by the product of the

21 group's population share and its post-payment income share, a_j:

22 $$H = \sum_j a_j G_j^{X-P} \tag{5}$$

23 R captures the extent of reranking of households that occurs in the move from

16

1 pre-payment to post-payment income distributions. It is measured as the difference

2 between the post-payment Gini coefficient G^{X-P} and the post-payment concentration

3 index C^{X-P}. The latter differs from the former in that households are ranked by their

4 pre-payment income, not their post-payment income. If there is no reranking, R is

5 zero.

6   $R = G^{X-P} - C^{X-P}$ (6)

7 In sum, the total RE can be decomposed into four components: an average rate

8 effect (g), the departure-from-proportionality or progressivity effect (K_E), a horizontal

9 inequity effect H and a reranking effect R.

Patient and public involvement

11 All data in this study were derived from the household survey, so no patients and

12 the public were involved in the study design, the outcome measures, data analysis or

13 interpretation of the results. Results will be disseminated to study participants via this

14 publication. This study was approved by the Academic Research Ethics Committee of

15 Nanjing Medical University.

RESULTS

17 Decompositions of the RE of health care financing sources are presented in Tables

18 3 to 6. The distribution of health care financing sources across equivalent income

19 deciles, along with the corresponding values of g, V, H, R and RE. V, H and R, are

20 also presented as a percentage of RE.

RE of urban areas in 2002

22 In urban areas in 2002, payments to health care accounted for 15.70% of the total

23 household expenditures (g for Total payments in Table 3). The RE value was positive,

24 indicating health care financing had a pro-poor redistribution. The V/RE ratio was

25 359.42%, which indicated that the positive RE would be 259.42% greater in the

17

1 absence of horizontal inequity (that is, H + R). In terms of specific health care

2 financing source, general taxes and private health insurance exhibited pro-rich

3 redistribution, while public health insurance and OOP payment showed the opposite

4 effect. In addition, the negative *RE* of general tax and private health insurance would

5 be 24.68% and 50.60% smaller in the absence of horizontal inequity, while the

6 positive *RE* of public health insurance and OOP payment would be 19.77% and

7 231.53% greater in the absence of horizontal inequity.

18

Table 3 Decomposition of the REs of the Chinese urban health care financing system in 2002

Decile	Per capital household expenditure	General taxes	Public health insurance	Private health insurance	OOP	Total payments
1 (poorest)	1.97%	2.07%	0.52%	1.01%	1.53%	1.44%
2	2.95%	3.12%	0.81%	4.92%	2.19%	2.18%
3	3.86%	4.08%	1.33%	6.00%	2.83%	2.86%
4	4.76%	4.97%	2.83%	3.65%	3.94%	3.92%
5	5.74%	5.89%	3.82%	4.54%	5.28%	5.12%
6	6.98%	7.22%	4.91%	6.45%	5.87%	5.95%
7	8.64%	9.09%	8.40%	14.02%	6.91%	7.70%
8	10.86%	11.33%	17.03%	9.31%	8.70%	10.60%
9	14.60%	14.85%	34.95%	28.02%	13.24%	17.58%
10 (richest)	39.64%	37.38%	25.40%	22.10%	49.51%	42.66%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
g		0.003789	0.011082	0.008820	0.133309	0.157001
V		−0.000063	0.001162	−0.000666	0.014464	0.015376
H		0.000021	0.000173	0.000382	0.003487	0.004015
R		0.000000	0.000019	0.000301	0.006615	0.007083
RE		−0.000084	0.000970	−0.001349	0.004363	0.004278
RE/RE		100.00%	100.00%	100.00%	100.00%	100.00%
V/RE		75.32%	119.77%	49.40%	331.53%	359.42%
H/RE		−24.68%	17.84%	−28.32%	79.92%	93.85%
R/RE		0.00%	1.93%	−22.28%	151.62%	165.57%

OOP, out-of-pocket.

g = payments as fraction of income; V = vertical effect; H = horizontal inequity; R = reranking; RE = redistributive effect.

19

1 **RE of rural areas in 2002**

2   In rural areas in 2002, payments to health care accounted for 14.61% of the total

3 household expenditures (g for Total payments in Table 4). The *RE* value was

4 negative, indicating health care financing had a pro-rich redistribution. The *V/RE* ratio

5 was −311.62%, which indicated that the negative *RE* would be 411.62% smaller in the

6 absence of horizontal inequity. In terms of specific health care financing source, all

7 health care payments were pro-rich distributed. The negative *RE* of general taxes,

8 public and private health insurance and OOP payment would be 15.41%, 215.17%,

9 124.18% and 462.90% smaller in the absence of horizontal inequity.

20

Table 4 Decomposition of REs of Chinese rural health care financing system in 2002

Decile	Per capital household expenditure	General taxes	Public health insurance	Private health insurance	OOP	Total payments
1 (poorest)	3.09%	3.43%	1.35%	0.89%	2.17%	2.22%
2	4.53%	4.80%	1.46%	3.23%	4.43%	3.96%
3	5.46%	5.86%	3.26%	3.35%	4.58%	4.55%
4	6.46%	6.86%	6.37%	4.59%	5.34%	5.76%
5	7.38%	7.75%	14.62%	11.23%	6.07%	7.95%
6	8.59%	8.74%	13.18%	10.80%	8.90%	9.65%
7	9.93%	10.29%	8.46%	8.14%	7.91%	8.42%
8	11.81%	11.73%	12.11%	20.12%	12.55%	12.51%
9	14.97%	15.08%	7.19%	17.32%	13.22%	12.60%
10 (richest)	27.78%	25.46%	31.99%	20.33%	34.83%	32.39%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
g		0.003705	0.001190	0.003403	0.137787	0.146085
V		−0.000094	0.000038	0.000104	0.013238	0.013424
H		0.000017	0.000043	0.000163	0.004659	0.004876
R		0.000000	0.000029	0.000371	0.012227	0.012856
RE		−0.000111	−0.000033	−0.000431	−0.003648	−0.004308
$RE–RE$		100.00%	100.00%	100.00%	100.00%	100.00%
$V–RE$		84.58%	−115.17%	−24.18%	−362.90%	−311.62%
$H–RE$		−15.41%	−127.93%	−37.94%	−127.71%	−113.19%
$R–RE$		0.00%	−87.24%	−86.25%	−335.18%	−298.43%

OOP, out-of-pocket.

g = payments as fraction of income; V = vertical effect; H = horizontal inequity; R = reranking; RE = redistributive effect.

21

RE of urban areas in 2007

In urban areas in 2007, 19.30% of household expenditure was paid to health care (*g* for Total payments in Table 5). The *RE* value was negative, indicating health care financing had a pro-rich redistribution. The *V/RE* ratio was −21.70%, which indicated that the negative *RE* would be 121.70% smaller in the absence of horizontal inequity. In terms of specific health care financing source, general taxes, private health insurance and OOP payment were pro-rich redistributed, while public health insurance was pro-poor redistributed. In addition, the negative *RE* of general taxes, private health insurance and OOP payment would be 52.60%, 306.03% and 88.42% smaller in the absence of horizontal inequity, while the positive *RE* of public health insurance would be 40.92% greater in the absence of horizontal inequity.

22

Table 5 Decomposition of REs of Chinese urban health care financing system in 2007

Decile	Per capital household expenditure	General taxes	Public health insurance	Private health insurance	OOP	Total payments
1 (poorest)	3.14%	3.49%	1.05%	5.17%	2.68%	2.59%
2	4.52%	4.80%	2.36%	2.82%	4.16%	3.85%
3	5.55%	5.66%	4.07%	4.49%	5.91%	5.37%
4	6.49%	6.59%	5.30%	6.46%	6.75%	6.36%
5	7.47%	7.46%	6.82%	5.56%	8.02%	7.51%
6	8.66%	8.57%	9.01%	4.27%	9.10%	8.77%
7	10.16%	9.95%	10.59%	10.31%	11.43%	10.83%
8	11.82%	11.48%	12.68%	15.70%	13.55%	12.92%
9	14.54%	14.62%	17.35%	16.01%	13.35%	14.70%
10 (richest)	27.66%	27.39%	30.77%	29.20%	25.04%	27.11%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
g		0.004710	0.045590	0.008282	0.134454	0.193035
V		−0.000022	0.005007	0.000428	−0.002364	0.003885
H		0.000024	0.000995	0.000352	0.005067	0.006355
R		0.000000	0.000459	0.000284	0.012975	0.015431
RE		−0.000046	0.003553	−0.000208	−0.020406	−0.017901
RE–RE		100.00%	100.00%	100.00%	100.00%	100.00%
V–RE		47.40%	140.92%	−206.03%	11.58%	−21.70%
H–RE		−52.60%	28.02%	−169.28%	−24.83%	−35.50%
R–RE		0.00%	12.91%	−136.75%	−63.59%	−86.20%

OOP, out-of-pocket.

g = payments as fraction of income; V = vertical effect; H = horizontal inequity; R = reranking; RE = redistributive effect.

1 **RE of rural areas in 2007**

2   In rural areas in 2007, 14.98% of household expenditure was paid to health care (g

3 for Total payments in Table 6). The *RE* value was negative, indicating health care

4 financing had a pro-rich redistribution. The *V/RE* ratio was −13.71%, which indicated

5 that the negative *RE* would be 113.71% smaller in the absence of horizontal inequity.

6 In terms of specific health care financing source, all health care payments were

7 pro-rich distributed. The negative *RE* of general taxes, public and private health

8 insurance and OOP payment would be 35.42%, 0.36%, 52.01% and 152.92% smaller

9 in the absence of horizontal inequity.

24

Table 6 Decomposition of REs of Chinese rural health care financing system in 2007

Decile	Per capital household expenditure	General taxes	Public health insurance	Private health insurance	OOP	Total payments
1 (poorest)	3.63%	3.75%	11.08%	4.30%	3.36%	5.29
2	5.10%	5.20%	9.74%	10.25%	4.97%	6.33
3	6.13%	6.27%	9.70%	5.94%	5.81%	6.84
4	6.97%	7.04%	10.05%	10.28%	7.15%	7.92
5	7.97%	8.08%	9.74%	9.46%	7.77%	8.37
6	8.98%	9.19%	9.59%	8.00%	7.94%	8.64
7	10.18%	10.43%	10.62%	10.08%	9.06%	9.80
8	11.84%	11.92%	10.08%	12.33%	11.25%	11.18
9	14.45%	14.25%	10.37%	9.58%	15.62%	13.84
10 (richest)	24.74%	23.86%	9.03%	19.78%	27.06%	21.79
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
g		0.004744	0.002764	0.012405	0.129908	0.149821
V		−0.000035	−0.000864	−0.001599	0.004933	0.002138
H		0.000019	0.000003	0.000770	0.004951	0.005788
R		0.000000	0.000000	0.000962	0.009306	0.011943
RE		−0.000053	−0.000867	−0.003331	−0.009323	−0.015593
RE–RE		100.00%	100.00%	100.00%	100.00%	100.00%
V–RE		64.58%	99.64%	47.99%	−52.92%	−13.71%
H–RE		−35.42%	−0.36%	−23.13%	−53.10%	−37.12%
R–RE		0.00%	0.00%	−28.88%	−99.82%	−76.59%

OOP, out-of-pocket.

g = payments as fraction of income; V = vertical effect; H = horizontal inequity; R = reranking; RE = redistributive effect.

25

1 **DISCUSSION**

2 Horizontal inequity decreased over the period 2002–2007 in both urban and rural

3 areas. Meanwhile, the extent of reranking also reduced over the same period in both

4 urban and rural areas, indicating that the impact of health care finance on

5 impoverishment was lessened.

6 The biggest challenge for horizontal equity in China's health care finance

7 originated from OOP payments. OOP payments as fraction of income (g) were far

8 larger than all other health care financing sources. This implied that the RE of total

9 health care payment was largely dominated by OOP payments in China. Although

10 OOP has been found to be the main reason for the pro-rich redistribution in other

11 countries, the impact was much smaller than that in China.[7] [9] For example, in

12 Switzerland, horizontal inequity of OOP accounted for 12.4 percentage points of the

13 RE, whereas reranking accounted for 9.8 percentage points of the RE.[9] Our study has

14 shown that horizontal inequity in OOP payments has been reduced both in urban and

15 rural areas over the period 2002–2007. The horizontal inequity in OOP payments had

16 mainly stemmed from the different health conditions and health insurance schemes

17 among individuals with the same income level. As the distribution of health

18 conditions among the population was unlikely to have changed markedly during a

19 relatively short time period, the reduction of horizontal inequity was more likely

20 largely attributable to the reform and establishment of the new health insurance

21 programmes. This finding agrees with a study from the Netherlands, in which vertical

22 and horizontal inequity were both found to be largely attributable to the different

23 choices of benefit packages of health insurance schemes.[7] The extent of reranking of

24 OOP payments was much larger than other health care payments, and it was found

25 that the rank order of individuals who financed health care through OOP payments

26

1   decreased markedly.

2   In 2002, urban public health insurance was the UEBMI scheme, and it covered

3   mainly workers in the public sector. In 2007, the UEBMI and URBMI schemes were

4   both in effect, with the former covering workers in both the public and private sectors,

5   while the latter covered citizens who were ineligible to enroll in the UEBMI scheme,

6   such as students, the elderly and the unemployed. China's public health insurance was

7   managed and run at the city level and UEBMI premiums were different between

8   cities. This was the main reason for the horizontal inequity in public health insurance

9   in urban areas in 2002. Excluding this reason, in 2007, the different financing

10   schemes between the UEBMI and the URBMI, as well as the disparity in financing

11   contribution to the UEBMI between public and private sectors, also resulted in

12   horizontal inequity. This explains why horizontal inequity in urban public health

13   insurance increased over the period 2002–2007. In 2002, CMS provided rural public

14   health insurance, covering less than 10% of rural residents. In 2007, NCMS covered

15   over 90% of rural residents. Both CMS and NCMS were based on flat rate

16   contributions. Thus, the horizontal inequity in rural health insurance came from the

17   different financing contribution between different cities, and came from the covered

18   and the uncovered parties. Since almost all rural residents were covered by NCMS in

19   2007, the horizontal inequity in rural public health insurance was dramatically

20   reduced over the period. Private health insurance did not play an important role in

21   China's health insurance reform because the government decided to achieve Universal

22   Health Coverage through public health insurance. Currently, only about 5% of the

23   population is enrolled in private health insurance.[29] The insurees purchase different

24   types of insurance from different insurance companies. Therefore, the horizontal

25   inequities are comparatively high.

27

1   Our findings demonstrated that horizontal inequity in general taxes increased from

2   2002 to 2007, and that horizontal inequity was higher in urban areas than in rural

3   areas. The main income source for households in China in our sample was wages.

4   Taxes for households consisted primarily of personal income tax. Because of

5   economic development, individuals – and especially those in urban areas – earned

6   their income from a variety of sources, and people with the same income levels had a

7   much greater variety of income compositions than in the past. Different income types

8   were subject to different tax rates, which resulted in increased horizontal inequity.

9   Horizontal inequity in relation to personal income tax was found to have decreased

10   between 1980 and 1990 in Sweden, where the ceiling of taxable income range was

11   abolished following economic development. Overall, such a policy ensures that the

12   tax is largely borne by the rich.[8]

13   Despite the fact that horizontal, vertical and reranking effects are usually expressed

14   and explained as a percentage of the total RE, some results need to be interpreted with

15   caution. Whilst the horizontal inequity of OOP and total payments in relative terms

16   decreased over the period 2002–2007, in absolute terms, horizontal inequity increased

17   over during that period in both urban and rural areas. As horizontal inequity was

18   measured by the weighted sum of Gini coefficients in each income quintile group,[7 8]

19   the increase of horizontal inequity in the absolute term indicates a more inequitable

20   distribution within the income quintile group. Furthermore, the RE decreased both in

21   urban and rural areas from 2002 to 2007 in our study, indicating that the health care

22   financing system had become more pro-rich over the period. In a previous study in the

23   same area, Chen *et al.* found that the Kakwani index of the total health care payments

24   decreased from 2002 to 2007.[29] This is consistent with our study's finding that

25   vertical equity (*V*) decreased over the period 2002–2007. We have also found that

28

1 horizontal inequity (H) increased in both urban and rural areas over the same time

2 period. In addition, reranking (R) decreased in rural areas but increased in urban areas

3 from 2002 to 2007. When considering V, H and R together, RE decreased in both

4 urban and rural areas. This finding indicates that improving both vertical and

5 horizontal equity in health care financing system could improve pro-poor

6 redistribution to a large extent in the study population. However, equitable vertical

7 and horizontal distributions are hard to achieve simultaneously. Taking NCMS as an

8 example, a flat rate premium could result in an equitable horizontal distribution, but at

9 the cost of worsened vertical equity, as all insured individuals would pay the same

10 premium, irrespective of their incomes. In addition, some public insurance schemes

11 are financed at the county level and it is also important to consider other amenable

12 factors such as sex, age and location in policy interventions. Therefore, we should

13 weigh horizontal equity against vertical equity in health care financing system reform.

14 Future work is warranted to investigate the optimal trade-off between horizontal and

15 vertical equity to achieve a more pro-poor redistribution in the health care financing

16 system.

17 Health care financing has changed dramatically since the initiation of health

18 insurance reform within the study region. The proportion of general taxes in the health

19 care financing system increased from 15.15% in 2002 to 27.26% in 2015.[27] During

20 this time, with the help of information technology, a strict tax supervision policy was

21 implemented and tax avoidance was hard to achieve. This resulted in the reduction of

22 horizontal inequity in respect of general tax. Meanwhile, the proportion of public

23 health insurance in the health care financing system increased from 19.12% in 2002 to

24 36.76% in 2015.[27] However, due to the policy goal of universal health coverage and

25 an increasing rate of urbanization, the URBMI and NCMS schemes were gradually

29

1 integrated. This suggests that many more individuals with different natural and social

2 characteristics were covered in the same insurance schemes, which in turn brought

3 about an increase of horizontal inequity. On the contrary, the proportion of OOP

4 payments notably decreased from 65.73% in 2002 to 35.98% in 2015.[27]

5 Consequently, the horizontal inequity in respect of total health care finance was

6 reduced by the decreasing impact of OOP payments.

7 The current study has only examined data from one province in China, which is

8 unlikely to fully represent horizontal equity in China's health care financing system

9 overall. Studies using nationally representative data are warranted to evaluate

10 horizontal equity following the national health insurance reforms in China.

11 **CONCLUSIONS**

12 Overall, horizontal inequity in China's total health care financing has decreased

13 during the period 2002–2007. In addition, OOP payments were found to have

14 contributed most to the overall health care payments and horizontal inequity in OOP

15 payments has decreased. These findings have important implications for future health

16 care financing reforms: China's further health insurance reform should target cost and

17 service coverage in order to decrease the impact of OOP payments.

18

19 **Ethics approval and consent to participate**

20 This study was approved by the Academic Research Ethics Committee of Nanjing

21 Medical University. All procedures were undertaken in accordance with the ethical

22 standards of the Helsinki Declaration. Participants provided informed consent prior to

23 data collection.

24 **Acknowledgements**

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Authors' contributions

ZW led the study; he designed the study and led the data analysis and interpretation. MC contributed to the study design and wrote the manuscript. XZ analyzed the data and helped in the writing of the final draft of the manuscript. YG contributed to the study design and analyzed the data. LS supervised the study, contributed to the study design and wrote the manuscript. AP contributed to the study design, reviewed the manuscript and helped in the writing of the final draft of the manuscript. All authors read and approved the final manuscript.

Competing interests

None

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Data sharing statement

The datasets used in this study are not publicly available due to a confidentiality policy, but they are available from the corresponding author on reasonable request.

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9
Bias	9	Describe any efforts to address potential sources of bias	9, 10
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10, 11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10, 11
		(*b*) Describe any methods used to examine subgroups and interactions	10
		(*c*) Explain how missing data were addressed	11
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed	8

		eligible, included in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9, 10
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers of outcome events or summary measures	12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	26, 27, 28, 29
		(*b*) Report category boundaries when continuous variables were categorized	26, 27, 28, 29
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18, 19
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	19
Generalisability	21	Discuss the generalisability (external validity) of the study results	19
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	20

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.