

Health System Reform in China 7



China's health system performance

Yuanli Liu, Keqin Rao, Jing Wu, Emmanuela Gakidou

We created a comprehensive set of health-system performance measurements for China nationally and regionally, with health-system coverage and catastrophic medical spending as major indicators. With respect to performance of health-care delivery, China has done well in provision of maternal and child health services, but poorly in addressing non-communicable diseases. For example, coverage of hospital delivery increased from 20% in 1993 to 62% in 2003 for women living in rural areas. However, effective coverage of hypertension treatment was only 12% for patients living in urban areas and 7% for those in rural areas in 2004. With respect to performance of health-care financing, 14% of urban and 16% of rural households incurred catastrophic medical expenditure in 2003. Furthermore, 15% of urban and 22% of rural residents had affordability difficulties when accessing health care. Although health-system coverage improved for both urban and rural areas from 1993 to 2003, affordability difficulties had worsened in rural areas. Additionally, substantial inter-regional and intra-regional inequalities in health-system coverage and health-care affordability measures exist. People with low income not only receive lower health-system coverage than those with high income, but also have an increased probability of either not seeking health care when ill or undergoing catastrophic medical spending. China's current health-system reform efforts need to be assessed for their effect on performance indicators, for which substantial data gaps exist.

Introduction

Is China's health system doing well? Existing published work has been mixed so far. On the one hand, with China's economy growing at an annual rate of 9.7% from 1978 to 2006 and lifting more than 210 million people from poverty, Chinese people now have improved nutrition, drinking water, housing conditions, and health care.¹ Not surprisingly, the health status of China's people, measured by broad population health indicators, has continuously improved. Life expectancy at birth increased from 67.9 years in 1981 to 71.4 years in 2000. From 1991 to 2005, the infant mortality rate fell from 50.2 to 19.0 per 1000 livebirths, and the maternal mortality rate declined from 88.9 to 47.7 per 100 000.²

On the other hand, self-reported morbidity rate and bedridden days increased remarkably from 1993 to 2003, according to China's three national household health surveys done in 1993, 1998, and 2003.³ Furthermore, the mismatch between increasing demand for and inadequate supply of safe and effective health care, escalating medical costs, and absence of insurance coverage made the general public identify the problem of "too difficult to see a doctor" and "too expensive to see a doctor" as one of the key public policy issues in China's opinion polls.^{4,5} In 1998, for example, only 12% of patients living in urban areas and 7% of those living in rural areas were dissatisfied with the inpatient services they received. By 2003, hospital dissatisfaction rate in patients living in urban and rural areas increased to 61% and 54%, respectively.³ To answer people's mounting demand for policy actions to reform China's health system, the State Council Health-Care Reform Leading Group, involving 14 ministries, was formed in September, 2006, to develop new policies aiming to establish a more effective and equitable health-care

system. The package of new health-system reform policies is likely to be announced late 2008.⁶⁻⁸

However, because health-care reform is a means to an end and not an end in itself, several crucial questions can be raised: how has China's overall health-system performance been? In what particular areas has China done well or not well? Will China's reform efforts improve health-system performance nationally and sub-nationally? How can we assess health-system performance? Despite vigorous discussions among China's major stakeholders about different reform strategies and approaches, little attention has been paid to the issue of how to monitor health-system reform initiatives and to measure their success and failures in China.⁹ Comprehensive analysis of health-system performance sub-nationally (eg, in provinces) is absent. This is a crucially important unit of analysis, if not more important than the country-wide analysis, because of China's decentralised fiscal system.¹⁰ Furthermore, because substantial disparities exist in China's many socioeconomic dimensions, the issue of how China's health system performs differently for different groups of people needs to be addressed. Therefore, as indicated by experiences in Mexico and other countries, the measurement of a country's (or region's) performance of health-care system is crucially important for monitoring progress, providing evidence-based assessment of reform policies, identifying determinants of success and failure, and fostering a culture of accountability.^{11,12}

Measurement issues

Initiatives by WHO, Organisation of Economic Co-operation and Development, World Bank, and other organisations in the past 15 years have generated worldwide interests in performance measurement of

Published Online
October 20, 2008
DOI:10.1016/S0140-
6736(08)61362-8

This is the seventh in a *Series* of seven papers on health system reform in China

Harvard School of Public Health, Boston, MA, USA (Y Liu PhD); Ministry of Health, Beijing, China (K Rao MD, J Wu MD); and Institute for Health Metrics and Evaluation, University of Washington, Seattle, WA, USA (E Gakidou PhD)

Correspondence to:
Dr Yuanli Liu, Harvard School of Public Health, Boston, MA 02115, USA
yuanliu@hsph.harvard.edu

health systems between countries and within countries.^{13–16} Even though health systems can be defined in many ways, a consensus that has emerged is on the two fundamental approaches to measurement of how a health system performs.

First is the measurement of health-system coverage. The defining goal of any health system is generally accepted to be to improve health. However, because health is determined by many factors, including non-health-care factors such as environmental pollution, we cannot merely attribute changes in health status to the performance of a health system. Therefore, a measure of health-system performance should focus on the delivery of health interventions to individuals in need, because it is a key process through which health systems can contribute to improvement of population health and reduction of health inequalities. Shengelia and colleagues¹⁷ argued that provision of health services can be assessed more comprehensively through the measure of coverage, which they defined as the probability of people in need to receive services. Furthermore, effective coverage takes into account the quality of interventions delivered and aims to measure the estimated health gain associated with every health intervention.

Second is the measurement of health-care affordability. Besides improvement of health, another intrinsic goal of a health system is to reduce financial barriers to health

care, especially protection of households from incurring catastrophic medical expenditures. Financial hardship caused by out-of-pocket payments has been measured in different ways in published studies. Measurement of the impoverishing effect: if the income of a household has fallen below the poverty line after out-of-pocket payments for health care, then this household would be defined as being medically impoverished.^{18,19} Measurement of so-called catastrophic spending: if household's out-of-pocket payments for health care are equal or greater than 30–40% of the household's capacity to pay (disposable income minus food expenditure),^{20–22} or 10% of the household's income,²³ then that household would be defined as having undergone catastrophic spending.

Here, we mainly adopt WHO's framework of effective coverage and catastrophic spending (30% of household capacity to pay) to measure China's health-system performance. We also measure people's foregone health care due to cost concerns.

Indicators of health-system coverage

We identified four major types of health interventions: (1) curative interventions to treat different diseases (eg, tuberculosis treatment and hypertension control); (2) preventive interventions (eg, immunisations); (3) behavioural interventions (eg, smoking cessation); and (4) intersector public-health interventions (eg, safe

	Intervention	Population in need	Definition of indicator	Year of survey
Water	Access to safe drinking water	All households	Percentage of households with access to safe drinking water	1993, 1998, 2003
Toilet	Access to sanitary toilets	All households	Percentage of households with access to a sanitary toilet	1993, 1998, 2003
Cessation	Smoking cessation	Smokers	Percentage of smokers who either quit smoking or tried to quit in the year before the survey	1993, 1998, 2003
Antenatal	Antenatal care	Expectant mothers	Percentage of expectant mothers who received any antenatal visit in the year before the survey	1993, 1998, 2003
Delivery	Hospital delivery	Women who gave birth in a specific period	Percentage of women who gave birth, delivering their baby in a hospital in the year before the survey	1993, 1998, 2003
Postnatal	Postnatal care	Women who gave birth in a specific period	Percentage of women who gave birth in the year before the survey, who received any postnatal visit by medical staff	1993, 1998, 2003
Vaccine	Immunisation	Children aged 0–1 years	Percentage of children younger than 1 year who were immunised for all of the following: BCG, DTP3, Hep B, measles, and OPV	1993, 1998, 2003
TB examination	Examination of suspected TB cases	Population with self-reported symptoms of TB (coughing or coughing up blood for 3 weeks)	Ratio of people who reported having gone through formal clinical examination to people who reported having TB-like symptoms	2003
TB DOTS	Treatment of confirmed TB cases	TB patients	Percentage of confirmed TB patients who self-reported having completed the whole treatment protocol	2003
Hypertension treatment	Treatment of hypertension	Hypertension patients	Percentage of hypertensive people who reported having taken control measures in the past year	2004
Hypertension effectiveness	Effective treatment of hypertension	Hypertension patients	Percentage of hypertensive people who reported having taken control measures and whose blood pressure was normal during the survey period	2004

BCG=Bacille Calmette Guérin. DOTS=directly observed treatment, short-course. DTP3=diphtheria-tetanus-pertussis vaccine. Hep B= Hepatitis B. OPV=oral polio vaccine. TB=tuberculosis.

Table 1: Indicators and associated measurement strategies

Panel: Data sources**China National Health Services Survey³**

Since 1993, the Chinese Ministry of Health has done a national household interview survey every 5 years. A four-stage stratified random sampling procedure was used to select the households for interview to represent China's urban and rural populations. In the first stage, urban cities and rural provinces were selected after they were grouped into three urban types (big, middle-sized, and small cities) and four rural types (ranging from the richest to the poorest counties). In the second stage, five streets in every city and five towns in every county were randomly chosen. In the third stage, two residential committees and villages in every selected street and town were chosen. Finally, 60 households were randomly identified in every residential committee and village. The total number of households sampled in 1993, 1998, and 2003 were 50 700, 50 690, and 57 023, respectively. In addition to demographic and socioeconomic data (including self-reported income and expenditure), the interviewers, who are trained medical professionals, also obtained comprehensive information about self-reported health status, health-care utilisation, and behavioural factors, such as smoking and drinking. Informed consent was obtained from every person before being interviewed. The response rate has been on average more than 90%.

2004 China Adult Chronic Diseases Risk Factors Surveillance Survey

Because of the increasing prevalence of chronic diseases, China did the first Adult Chronic Diseases Risk Factors Surveillance Survey in 2004, and is planning to do one every 3 years. The survey is done by the China Centre for Disease Control, which is in the process of completing the second survey. The sample was selected on the basis of the adjusted National Disease Surveillance Points (DSPs), which included 154 counties, representing China in terms of, for example, geographical and demographic distribution, and socioeconomic development status. The survey adopted a multistage stratified random sampling framework, with a final sample size of 32 760 households. From every household, an adult (18–69 years of age) was randomly selected. The contents of the survey included two parts: a structured questionnaire and a physical examination. The structured questionnaire asked questions about the person's demographic characteristics, self-reported health status, chronic diseases, and relative risk factors (such as smoking, drinking, diet, and exercise), and health-service utilisation. The physical examination included measurement of height, weight, waist and sternum, and blood pressure.

China Statistics Digest

The State Statistics Bureau publishes a China Statistics Digest every year, which gives a comprehensive set of information about China's demographic, economic, and social characteristics nationally and provincially. We drew from this dataset information about province variables that might explain variations in effective coverage and occurrence of household catastrophic health-care spending.

drinking water). To measure the effective coverage of health interventions in China, we selected those that represent these four major types of interventions and that are relevant for China's major health problems. Ideally, we should have a comprehensive list of indicators for all the major interventions that target the most common diseases and their risk factors in China. On the basis of a review of all available data, only 11 interventions could be measured for all provinces for at least one period during the 10 years of investigation (from 1993 to 2003) (table 1).

A composite measure of coverage was constructed with simple averages from the 11 interventions to help to summarise the overall pattern of service delivery at national and provincial levels. This set of interventions, even though not exhaustive or ideal, is the basis of the first generation of measurements of health-system coverage in China. The panel shows in detail China's most important data sources. Although data collectors (ie, the Chinese Ministry of Health) assessed data validity and reliability, no independent evaluation exists.

On the basis of these data, table 2 shows the latest national and provincial benchmarks for measurement of health-system coverage. We have taken advantage of the recently completed 2004 China Adult Chronic Diseases

Risk Factors Surveillance Survey (panel) to measure effective coverage of treatment of hypertension—the only intervention for which information about quality is available. For other interventions, we used crude coverage—ie, the proportion of those in need of the intervention who reported having obtained the intervention. Table 2 also shows catastrophic medical spending by region.

In 2003, China's health system seemed to do well in terms of access to safe drinking water, antenatal care, hospital delivery, and childhood vaccinations, as indicated by the high coverage of these interventions. Coverages of these interventions were 99%, 96%, 93%, and 95% for urban areas, and 80%, 86%, 62%, and 85% for rural areas, respectively. However, concerns may arise about access to sanitary toilets for rural households (only 21%), the low rate of examination of suspected tuberculosis (36% for urban and 28% for rural areas), and low effective coverage of hypertension in 2004 (only 12% and 7% for urban and rural areas, respectively). Because China's high rate of cigarette smoking (45% of urban and 50% of rural male adults were regular smokers in 2003) and the associated disease burden, we find it particularly troublesome to see such a low smoking cessation rate (only about 6% of the smokers have tried to quit).

Furthermore, we noticed remarkable inter-regional inequalities in health-system coverage. Except for the effective coverage of tuberculosis treatment, differences between urban and rural coverage rates and inter-provincial differences were all significant. On average, coverage in urban areas (61%) was 15% higher than in rural areas (46%) (table 2). Figure 1 maps composite coverage of different provinces. The geographical

distribution of health-system coverage is remarkable, with the southeast regions having the best performance indicator, followed by the northern, central, and western regions. This pattern corresponds almost perfectly with China's different economic development in these regions (China's eastern provinces tend to have higher economic development level than the central provinces, which in turn are better than their western counterparts).¹⁰

	Water	Toilet	Cessation	Antenatal	Delivery	Postnatal	Vaccine	TB examination	TB DOTS	Hypertension treatment	Hypertension effectiveness	Catastrophic medical expenditures
National	85.8 (0.2)	40.1 (0.2)	6.1 (0.2)	87.7 (0.3)	68.2 (0.5)	53.2 (0.5)	86.3 (0.8)	30.6 (0.8)	57.0 (3.3)	26.7 (0.5)	8.9 (0.3)	15.3 (0.2)
Urban	99.2 (0.1)	86.5 (0.3)	6.9 (0.5)	96.5 (0.4)	92.7 (0.6)	59.6 (1.1)	94.5 (1.3)	36.3 (1.5)	48.9 (7.3)	33.6 (0.8)	11.7 (0.6)	13.8 (0.3)
Rural	80.2 (0.2)	20.7 (0.2)	5.8 (0.3)	85.5 (0.4)	61.9 (0.6)	51.5 (0.6)	84.7 (0.9)	28.2 (0.9)	59.1 (3.7)	21.8 (0.6)	7.0 (0.4)	15.8 (0.2)
Urban vs rural p value	<0.0001	<0.0001	<0.05	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	>0.10	<0.0001	<0.0001	<0.0001
Beijing	98.6 (0.3)	46.1 (1.4)	8.4 (1.9)	96.9 (1.8)	97.9 (1.5)	80.2 (4.1)	100.0 (0.0)	38.6 (6.5)	..	40.0 (3.6)	11.6 (2.3)	27.5 (1.4)
Tianjin	85.7 (1.0)	54.8 (1.4)	3.1 (1.1)	95.5 (2.0)	95.2 (2.1)	69.1 (4.4)	100.0 (0.0)	36.8 (7.8)	66.7(27.2)	37.6 (4.2)	17.3 (3.3)	14.7 (1.1)
Hebei	68.5 (0.9)	28.5 (0.9)	3.90 (0.9)	94.1 (1.1)	75.0 (2.1)	43.43 (2.4)	85.5 (4.0)	22.9 (3.4)	83.3(15.2)	33.5 (2.5)	9.6 (1.6)	17.7 (0.8)
Shanxi	98.3 (0.3)	12.3 (0.8)	6.2 (1.3)	92.8 (1.5)	60.1 (2.8)	40.9 (2.8)	83.3 (5.1)	19.7 (4.6)	71.4(17.1)	26.1 (2.2)	8.2 (1.4)	16.7 (1.2)
Neimeng	87.3 (0.8)	1.7 (0.3)	2.3 (0.9)	91.4 (1.5)	53.0 (2.6)	55.4 (2.6)	86.8 (4.1)	29.5 (3.5)	80.0(17.9)	21.7 (2.7)	4.8 (1.4)	23.8 (1.0)
Liaoning	98.8 (0.3)	48.2 (1.4)	3.8 (1.2)	98.7 (0.9)	80.1 (3.3)	68.9 (3.8)	100.0 (0.0)	34.0 (6.7)	100.0 (0.0)	24.6 (2.2)	6.0 (1.2)	15.0 (1.1)
Jilin	96.2 (0.4)	54.8 (1.2)	4.5 (1.3)	98.1 (0.9)	97.7 (1.0)	43.3 (3.4)	100.0 (0.0)	17.2 (3.9)	100.0 (0.0)	27.3 (2.5)	6.8 (1.4)	19.9 (1.0)
Heilongjiang	99.4 (0.2)	14.1 (0.8)	6.3 (1.4)	98.2 (0.7)	82.1 (2.1)	50.0 (2.8)	100.0 (0.0)	24.8 (4.0)	66.7(19.2)	20.9 (1.8)	5.7 (1.0)	17.2 (0.9)
Shanghai	100.0 (0.0)	86.7 (1.0)	6.2 (1.5)	98.9 (1.1)	98.9 (1.1)	68.9 (4.9)	85.7 (9.4)	38.0 (4.9)	..	54.4 (4.1)	18.8 (3.2)	18.4±0.8
Jiangsu	90.8 (0.6)	50.7 (1.0)	7.4 (1.2)	93.0 (1.6)	98.8 (0.7)	58.2 (3.2)	95.7 (2.4)	34.5 (4.0)	55.6(16.6)	46.7 (3.1)	22.2 (2.6)	14.2±0.8
Zhejiang	98.4 (0.3)	68.5 (1.1)	9.9 (1.5)	100.0 (0.4)	99.5 (0.4)	69.7 (3.0)	95.0 (3.5)	39.0 (4.5)	100.0 (0.0)	22.9 (2.4)	6.0 (1.3)	15.0±0.9
Anhui	96.8 (0.4)	29.2 (0.9)	8.5 (1.5)	90.4 (1.7)	72.4 (2.5)	39.0 (2.8)	88.0 (3.8)	27.2 (4.0)	28.6(12.1)	33.6 (2.8)	11.2 (1.9)	15.4 (0.8)
Fujian	76.4 (1.0)	46.4 (1.2)	10.1 (1.7)	96.9 (1.0)	90.8 (1.7)	78.1 (2.4)	94.1 (2.6)	30.9 (4.8)	75.0(21.7)	15.9 (2.4)	3.1 (1.2)	11.2 (0.8)
Jiangxi	88.5 (0.7)	26.6 (1.0)	10.4 (1.6)	72.5 (3.2)	48.3 (3.4)	60.7 (3.4)	61.8 (6.5)	31.9 (4.0)	58.3(14.2)	33.3 (3.8)	15.0 (2.9)	12.0 (0.8)
Shandong	98.7 (0.2)	39.1 (1.0)	4.5 (1.0)	96.6 (1.0)	95.2 (1.1)	62.8 (2.6)	91.7 (4.0)	27.9 (5.0)	50.0(35.4)	25.3 (2.4)	8.1 (1.5)	14.9 (0.9)
Henan	91.3 (0.6)	32.0 (1.0)	5.1 (1.0)	88.8 (1.4)	70.0 (2.1)	21.0 (1.8)	75.8 (4.5)	32.1 (4.5)	50.0(17.7)	24.1 (2.6)	5.0 (1.3)	18.4 (0.8)
Hubei	91.3 (0.6)	53.7 (1.0)	5.2 (1.1)	91.2 (1.7)	70.5 (2.8)	63.4 (2.9)	83.3 (4.8)	22.4 (3.7)	55.6(16.6)	34.6 (2.6)	11.5 (1.8)	9.3 (0.6)
Hunan	80.9 (0.8)	75.1 (0.9)	5.2 (1.1)	88.5 (1.9)	60.7 (2.9)	59.9 (2.9)	89.4 (3.8)	25.6 (3.7)	33.3(19.2)	21.7 (2.5)	8.3 (1.7)	14.4 (0.7)
Guangdong	97.2 (0.3)	72.9 (0.9)	8.6 (1.3)	92.1 (1.4)	89.6 (1.6)	54.6 (2.6)	98.7 (1.3)	30.4 (4.0)	12.5(11.7)	39.0 (3.8)	14.0 (2.7)	11.1 (0.8)
Guangxi	73.7 (1.0)	25.5 (1.0)	6.7 (1.4)	81.8(2.3)	68.6 (2.7)	43.3 (2.9)	79.0 (4.7)	32.1 (4.5)	71.4(17.1)	25.6 (2.8)	10.9 (2.0)	8.4 (0.7)
Hainan	98.9 (0.3)	65.9 (1.4)	6.6 (1.9)	95.0 (1.5)	98.6 (0.8)	63.4 (3.2)	100.0 (0.0)	45.1 (7.0)	57.1(18.7)	31.2 (4.8)	9.7 (3.1)	16.3 (1.1)
Chongqing	84.5 (0.8)	54.5 (1.2)	5.4 (1.2)	9.8 (2.1)	67.6 (3.4)	54.6 (3.7)	89.2 (5.1)	37.9 (3.1)	64.7(11.6)	19.2 (3.5)	4.8 (1.9)	18.5 (0.9)
Sichuan	81.3 (0.9)	41.3 (1.2)	8.5 (1.6)	91.4 (2.8)	73.8 (4.3)	59.6 (4.8)	86.4 (7.3)	35.7 (4.5)	100.0 (0.0)	18.0 (2.4)	6.3 (1.5)	15.9 (0.9)
Guizhou	63.8 (1.1)	7.6 (0.6)	1.4 (0.6)	66.8 (2.3)	29.8 (2.2)	56.1 (2.4)	68.2 (5.1)	30.9 (4.2)	66.7(12.2)	12.4 (2.1)	4.9 (1.4)	17.0 (0.8)
Yunan	82.2 (0.9)	34.0 (1.1)	7.1 (1.4)	72.4 (2.2)	38.2 (2.4)	47.8 (2.5)	72.5 (5.4)	28.6 (3.6)	63.6(14.5)	17.8 (2.7)	6.1 (1.7)	17.8 (0.9)
Tibet	65.4 (1.4)	48.3 (1.4)	7.1 (2.3)	75.6 (2.3)	38.2 (2.7)	33.0 (2.6)	97.7 (1.6)	43.5 (5.4)	52.2(10.4)	29.2 (3.1)	16.7 (2.5)	10.2 (0.9)
Shanxi	78.3 (1.0)	48.9 (1.2)	7.7 (1.4)	88.3 (2.1)	77.4 (2.8)	68.0 (3.1)	78.4 (6.8)	24.5 (4.2)	50.0(25.0)	25.1 (2.9)	12.1 (2.2)	13.0 (0.8)
Gansu	46.9 (1.2)	5.7 (0.5)	5.7 (1.4)	86.5 (1.8)	47.5 (2.6)	58.8 (2.6)	93.7 (3.1)	36.4 (6.5)	69.2(12.8)	15.8 (2.03)	2.8 (0.9)	12.7 (0.8)
Qinghai	53.0 (1.4)	2.9 (0.5)	2.5 (1.1)	84.8 (1.8)	34.4 (2.4)	54.9 (2.5)	80.3 (4.7)	13.6 (3.7)	80.0(17.9)	29.6 (5.4)	8.5 (3.3)	22.9 (1.2)
Ningxia	90.0 (0.6)	33.4 (1.0)	4.1 (1.1)	97.1 (0.7)	92.8 (1.1)	85.0 (1.6)	98.0 (1.4)	39.0 (4.2)	28.6(17.1)	18.0 (4.4)	1.3 (1.3)	16.8 (0.8)
Xinjiang	88.1 (0.8)	40.9 (1.2)	2.5 (1.2)	60.7 (2.4)	36.0 (2.4)	16.0 (1.8)	61.9 (5.3)	28.0 (4.7)	22.2(13.9)	25.5 (2.1)	10.8 (1.5)	16.2 (0.9)
Inter-province p value	<0.0001	<0.0001	<0.005	<0.0001	<0.0001	<0.0001	<0.0001	<0.005	>0.10	<0.005	<0.005	<0.005

Data are percentages (SD). DOTS=directly observed treatment, short-course. TB=tuberculosis. Data sources: reference 3 and 2004 China Adult Chronic Risk Diseases Factors Surveillance Survey (unpublished).

Table 2: Performance indicators of health-system coverage in 2003 and 2004 by region

With respect to the income-related inequality in coverage, the rate difference in composite coverage between the highest and lowest income quintile groups ranged from 12% to 27%. For urban populations, the greatest income-related inequality was in access to sanitary toilets, with the rate difference between rich and poor groups being as high as 40% in 1998. For rural populations, income-related inequality was most pronounced in hospital delivery rate, with the rate difference between the highest and the poorest income quintile being as high as 43% in 1998. The hospital delivery rate for the poorest women living in urban areas was 88%, which was even higher than that for the richest women living in rural areas (78%). China's urban health-care system has done better than the rural system on almost all the coverage indicators, except for coverage of tuberculosis treatment. A small percentage (36% for the urban and 28% for the rural samples) of interviewed people, who reported tuberculosis-like symptoms, underwent formal testing for tuberculosis (including radiographic and smear examination). Therefore, China's ability to detect tuberculosis cases remains questionable despite recent progress in tuberculosis control.²⁴ Once diagnosed, however, a high percentage of patients received treatment, which was provided free of charge at government-run facilities. The overall percentage of confirmed patients with tuberculosis who received treatment was 90% for urban and 97% for rural patients in 2003. A higher percentage of tuberculosis patients living in rural areas (59% vs 49% of patients living in urban areas) completed the whole treatment episode. The higher effective coverage of tuberculosis treatment in rural China might be explained, in part, by the fact that rural populations are less mobile than their urban counterparts, and thus patient compliance issues in rural areas may be easier to manage. Other studies showed that, although tuberculosis drugs are free in China, patients still had to pay for other related medicines and diagnostic tests during the course of their treatment, a reason that may also explain why many patients failed to complete the appropriate treatment.^{25,26}

How did coverage and its distribution change between 1993 and 2003? Both urban and rural sectors have overall improved coverage of all major interventions (table 3). However, changes seemed to have been non-linear and unstable during the 10 years.

Although inter-provincial inequalities in coverage seemed reduced between 1993 and 2003, as indicated by the decreased coefficient of variation, income-related inequality in composite coverage in terms of rate difference between the lowest and highest income quintile increased only slightly in the rural and urban areas between 1993 and 2003 (table 3). Even though coverage of hospital delivery for women living in rural areas increased from 1993 to 2003, income-related inequality also increased (table 3), showing that serious inequity problems persisted in China, especially in rural China.

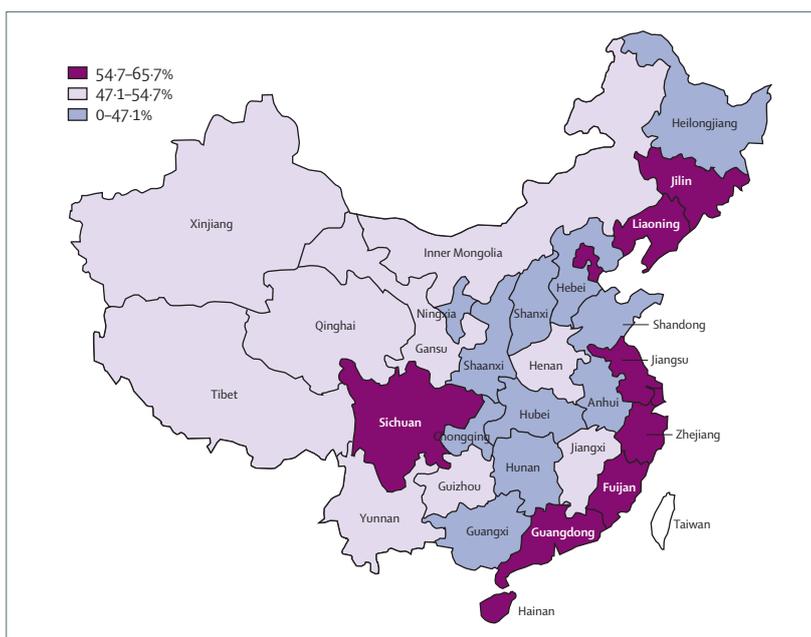


Figure 1: Health-system coverage in Chinese provinces in 2003

Moreover, our findings strongly suggest that attention should be paid to China's inadequate disease prevention programmes. Rates of coverage of immunisation in children aged 0–1 years living in urban and rural areas fell between 1998 and 2003 (table 3), mainly because of rate reduction in the poorest populations. This finding shows a widespread challenge to China's public-health system in terms of how to provide equitable access to those health interventions that are cost effective, yet non-profitable, to the fee-for-service health-care providers.^{27,28} Furthermore, the rate of smoking cessation is low and the rate of smoking in men living in rural areas remains high, especially in the poor population. As previously shown,²⁹ smoking control is not only an important public-health issue for China, but also a poverty-reduction issue. The fact that, in 2004, only 42% and 27% of individuals living in urban and rural areas, respectively, with high blood pressure were aware of their condition draws attention to the absence of health literacy.

We did a multivariate regression analysis to understand which provincial characteristics could explain the differences across provinces in terms of coverage. Explanatory variables included population size, gross domestic product (GDP) per head, dependency ratio (ie, the ratio of the number of dependants [aged 0–14 years and >65 years] to the total working-age population [aged 15–64 years]), urbanisation index, illiteracy rate, health-care supply, and insurance coverage. We showed that only GDP per head was a significant predictor of both hospital delivery and composite coverage. Another significant predictor (of composite coverage only) was insurance coverage. Figure 2 illustrates the relation between a province's GDP per head and its hospital

	Water	Toilet	Prenatal	Hospital delivery	Postnatal	Vaccines	Composite
Urban*							
1993	97.15 (96.89-97.41)	69.39 (68.67-70.11)	82.85 (81.98-83.72)	85.85 (85.05-86.66)	41.88 (40.74-43.02)	84.86 (81.54-88.17)	77%
1998	96.98 (96.72-97.24)	68.63 (67.93-69.33)	96.59 (95.24-97.93)	92.32 (92.30-92.34)	61.59 (58.00-65.19)	95.26 (92.39-98.13)	85%
2003	99.19 (99.06-99.33)	86.55 (86.03-87.06)	96.46 (95.62-97.30)	92.65 (91.46-93.84)	59.63 (59.61-59.66)	94.50 (94.49-94.55)	88%
Rural*							
1993	52.49 (52.00-52.99)	5.20 (4.98-5.42)	31.34 (30.77-31.90)	19.97 (19.49-20.46)	48.99 (48.38-49.59)	48.05 (45.93-50.17)	34%
1998	58.78 (58.30-59.26)	8.23 (7.96-8.50)	81.04 (79.69-82.38)	41.43 (41.41-41.45)	50.41 (48.70-52.12)	89.34 (87.54-91.13)	55%
2003	80.24 (79.85-80.62)	20.71 (20.31-21.10)	85.48 (84.66-86.29)	61.92 (60.8-63.05)	51.52 (51.51-51.53)	84.70 (84.72-84.76)	64%
Urban inequity[†]							
1993	1.40 (1.39-1.41)†	34.36 (34.33-34.39)†	15.28 (15.23-15.33)†	14.05 (14.00-14.10)†	2.05 (2.03-2.07)†	5.68 (5.13-6.23)†	12%
1998	7.48 (7.46-7.49)†	39.61 (39.58-39.64)†	8.13 (7.75-8.50)†	17.34 (16.82-17.86)†	22.74 (22.16-23.32)†	7.75 (6.59-8.91)†	17%
2003	1.31 (1.31-1.32)†	24.95 (24.93-24.98)†	10.50 (10.33-10.68)†	13.12 (12.93-13.31)†	24.17 (23.93-24.41)†	11.54 (10.47-12.61)†	13%
Rural inequity[†]							
1993	17.35 (17.34-17.36)†	5.16 (5.15-5.16)†	19.36 (19.34-19.37)†	20.04 (20.03-20.06)†	19.27 (19.25-19.28)†	17.66 (17.48-17.85)†	16%
1998	32.49 (32.47-32.50)†	18.61 (18.60-18.62)†	30.30 (30.16-30.45)†	43.22 (43.06-43.37)†	29.22 (29.08-29.36)†	8.08 (7.84-8.32)†	27%
2003	18.69 (18.68-18.70)†	19.73 (19.72-19.74)†	20.82 (20.76-20.88)†	36.27 (36.20-36.34)†	21.65 (21.59-21.70)†	9.33 (9.12-9.53)†	20%
Inequity[‡]							
1993	0.34†	0.70†	0.40†	0.59†	0.36†	0.43†	0.47
1998	0.09†	0.52†	0.16†	0.48†	0.36†	0.07†	0.28
2003	0.17†	0.55†	0.11†	0.31†	0.28†	0.13†	0.26

Data are percentages (95% CI), unless otherwise stated. Inequity[†]=rate difference between the income quintile 1 and 5. *Urban-rural difference in the same year is significant at p<0.0001, except for vaccines in 1998 where p value <0.01. †Intertemporal difference of the same indicator is significant at p<0.0001. ‡Inequity[‡]=coefficient of variation for provincial indicators.

Table 3: Health-system coverage in 1993, 1998, and 2003

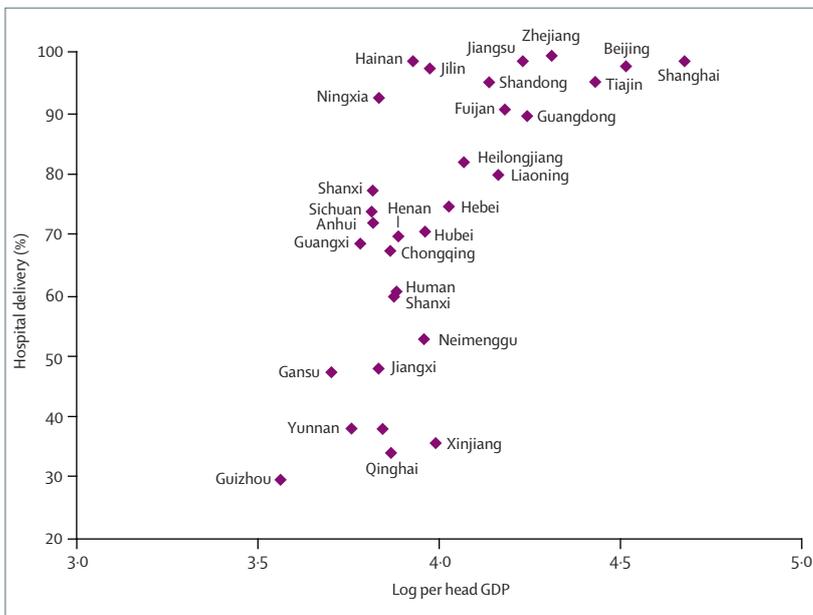


Figure 2: Hospital delivery in Chinese provinces and log per head gross domestic product (GDP) in 2003

delivery. These results support the claim that a strong relation between economic development of a province and its health system coverage exists, which clearly suggests China's absence of transfer payments to provinces by central government. An article in this *Lancet* Series by Hu and colleagues³⁰ provides a detailed

discussion about the inadequate and inequitable government financing in China.

Indicators of health-care affordability in China

On the basis of Xu and colleagues' publications,^{20,21} we defined a household as having incurred catastrophic medical spending if the family's total reported out-of-pocket medical expenditure in the past year exceeded 30% of the family's yearly non-subsistence spending, which equals total household spending minus subsistence food expenditure. Unfortunately, the national health-service survey in 1993 did not obtain information on total household expenditures. Therefore, we were not able to include the data from 1993 in our time analysis on financial risks.

Financial effect of out-of-pocket payments for households cannot be fully captured by measuring catastrophic spending. Because of inability to pay, some people may choose not to seek health care when ill. To identify those individuals who cannot afford health care, we used questions from the China Health Services Survey in 1998 and 2003 on the reasons for: (1) not seeking health care when ill; (2) foregoing admission to hospital recommended by doctors; and (3) self-discharging from the hospital against medical advice. Here, we classify individuals as having affordability problems if they cited inability to pay as the major reason for not seeking health care.

We showed variation of the rate of catastrophic medical spending between rural and urban settings (table 2).

Besides the difference in income, the urban–rural rate difference is also related to the differential insurance coverage of the two populations, with the urban populations having a substantially higher insurance coverage than their rural counterparts.³ We also showed a wide variation of the rate of catastrophic medical spending in different provinces (table 2). Notably, poor provinces do not always have higher rates of catastrophic medical spending, as one might expect. For example, in Beijing, despite being a high-income city, the rate of catastrophic medical spending is high, whereas in Guizhou, despite being a low-income province, the rate is low. This result is not wholly unexpected, because the extent of catastrophic medical spending is dependent on utilisation rate and price, in addition to income. Low-income regions may have low health-care utilisation rates and low average medical prices, both of which might cause a low probability of catastrophic medical spending.

How did catastrophic medical spending change between 1998 and 2003 in China? The average rate of catastrophic medical spending increased but this rise is entirely attributable to the increased rural rate, because the rate in urban households declined (table 4). Although all income groups in rural China had an increasing rate of catastrophic medical spending, the poorest rural group was the hardest hit. The fraction of rural households in the lowest income quintile that incurred catastrophic medical spending increased from 21.5% in 1998 to 25.7% in 2003.

Although the inter-province inequality in catastrophic spending seemed to have narrowed from 1998 to 2003 (the coefficient of variation decreased), the income-related inequality for rural households increased. Therefore, all indicators point to a worsening financial risk protection for the rural population.

Table 5 shows rates of foregone medical care (outpatient and inpatient) and early hospital discharge due to cost concerns. In 1998, less than 1% of urban and rural residents reported feeling ill during the 2 weeks before interview but did not seek health care because of cost concerns. This trend leads to an estimated yearly rate of 14% for urban and 19% for rural populations. Furthermore, around 1% of the interviewed urban and rural residents reported having refused to be admitted to hospital against medical advice in the year before the interview because of cost concerns. Inability to pay was cited by less than 1% of urban and rural residents for their decision to discharge themselves ahead of schedule in 1998. Overall, 16% of urban and 20% of rural residents reportedly had financial difficulties in accessing health care in 1998. Although urban rate of foregone medical care decreased to 15% in 2003, the rural rate rose to 22% in the same year, explained by 5% increase in foregone outpatient care and 25% rise in early hospital discharge from the rural rate in 1998.

We also showed that the poorest income groups had not only a higher rate of foregone medical care than their

better-off counterparts, but also a higher probability of attributing their decision to inability to pay. For example, in 2003, 75% and 83% of poor urban and rural patients who refused to be admitted cited inability to pay as the

Households with medical expenditure higher than 30% of the capacity to pay	
Urban*	
1998	16.42 (15.74–17.10)
2003	13.77 (13.21–14.33)
Rural*	
1998	12.78 (12.42–13.14)
2003	15.83 (15.47–16.19)
Urban inequity¹	
1998	17.29 (16.73–17.85)†
2003	11.25 (10.86–11.64)†
Rural inequity¹	
1998	13.93 (13.60–14.26)†
2003	14.81 (14.53–15.09)†
Inequity^{2,‡}	
1998	0.35†
2003	0.28†

Data are percentages (95% CI), unless stated otherwise. Inequity¹=rate difference between the income quintile 1 and 5. *Urban–rural difference in the same year is significant at p<0.0001. †Intertemporal difference of the same indicator is significant at p<0.0001. ‡Inequity²=coefficient of variation for provincial indicators.

Table 4: Rate of catastrophic medical spending in 1998 and 2003

	Foregone outpatient care due to cost	Foregone inpatient care due to cost	Early discharge due to cost
Urban*			
1998	14.36 (14.03–14.69)	1.01 (0.92–1.11)	0.74 (0.66–0.82)
2003	13.61 (13.31–13.91)	0.78 (0.70–0.86)	0.69 (0.62–0.77)
Rural*			
1998	18.69 (18.48–18.89)	0.97 (0.93–1.02)	0.74 (0.70–0.79)
2003	19.73 (19.52–19.93)	0.9 (0.85–0.95)	0.93 (0.88–0.98)
Urban inequity¹			
1998	28.86 (28.23–29.49)†	1.36 (1.21–1.51)†	0.91 (0.78–1.04)†
2003	33.80 (33.08–34.52)†	1.39 (1.24–1.54)†	1.03 (0.90–1.16)†
Rural inequity¹			
1998	28.86 (28.58–29.14)†	1.10 (1.03–1.17)†	0.58 (0.54–0.62)†
2003	29.12 (28.86–29.38)†	0.96 (0.90–1.20)†	0.36 (0.34–0.38)†
Inequity^{2,‡}			
1998	0.53†	0.49†	0.52†
2003	0.57†	0.61†	0.41†

Data are percentages (95% CI), unless stated otherwise. Inequity¹=rate difference between the income quintile 1 and 5. *Urban–rural difference in the same year is significant at p<0.0001. †Intertemporal difference of the same indicator is significant at p<0.0001. ‡Inequity²=coefficient of variation for provincial indicators.

Table 5: Rate of foregone medical care due to cost concerns in 1998 and 2003

	Population ($\times 10^7$) in 2005	Gross national income per head (PPP int \$) in 2005	Male life expectancy at birth (years) in 2005	Infant mortality rate (per 1000 livebirths) in 2005	Maternal mortality ratio (per 100 000 livebirths) in 2005	Immunisation coverage among children aged 1 year (DTP3) in 2005*	TB detection rate under DOTS in 2005	TB treatment success under DOTS in 2004	Access to improved drinking water sources (urban) in 2004*	Access to improved drinking water sources (rural) in 2004*	Access to improved sanitation (urban) in 2004*	Access to improved sanitation (rural) in 2004*
Vietnam	84 238	3010 (111)	69 (72)	16 (117)	130 (77)	95% (70)	84% (34)	93% (12)	99% (56)	80% (83)	92% (75)	50% (91)
India	1103 371	3460 (107)	62 (126)	56 (55)	540 (42)	59% (180)	61% (87)	86% (43)	95% (100)	83% (75)	59% (129)	22% (141)
Indonesia	222 781	3720 (105)	66 (103)	28 (83)	230 (61)	70% (170)	66% (71)	90% (21)	87% (133)	69% (109)	73% (109)	40% (111)
Egypt	74 033	4440 (98)	66 (103)	28 (83)	84 (96)	98% (26)	63% (84)	70% (123)	99% (56)	97% (41)	86% (91)	58% (79)
Philippines	83 054	5300 (90)	64 (118)	25 (92)	200 (66)	79% (152)	75% (50)	87% (38)	87% (133)	82% (77)	80% (99)	59% (78)
China	1323 345	6600 (78)	71 (50)	23 (96)	56 (108)	87% (121)	80% (43)	94% (9)	93% (114)	67% (114)	69% (116)	28% (132)
Brazil	186 405	8230 (61)	68 (83)	28 (83)	260 (58)	96% (55)	53% (105)	81% (78)	96% (96)	57% (129)	83% (96)	37% (115)
Thailand	64 233	8440 (59)	67 (95)	18 (107)	44 (113)	98% (26)	73% (52)	74% (103)	98% (72)	100% (1)	98% (46)	99% (27)
USA	298 213	41 950 (2)	75 (33)	7 (152)	14 (140)	96% (55)	85% (30)	61% (148)	100% (1)	100% (1)	100% (1)	100% (1)
Southeast Asia	1 656 529	3557	62	51	460	66%	64%	87%	92%	81%	64%	31%

Data are numbers (indicator ranking in all WHO member states), unless otherwise stated. PPP=purchasing power parity. Int \$=the international dollar is a hypothetical unit of currency that has the same purchasing power that the US dollar has in the USA at a specific time. DTP3=diphtheria-tetanus-pertussis vaccine. DOTS=directly observed therapy. TB=tuberculosis. *Data are percentages (indicator ranking among all WHO member states). Data source: 2007 World Health Statistics.

Table 6: Indicators of health and coverage in selected countries and areas in WHO member states

major reason for foregone inpatient care. The income-related inequality in foregone health care and early hospital discharge due to inability to pay had increased for urban residents from 1998 to 2003, whereas it increased only for foregone outpatient care for rural residents during the same period. During 1998 and 2003, however, the rural rate was consistently higher than the urban one.

Discussion

We have done a comprehensive measurement of China's health-system performance, considering two major variables: health-care delivery (addressing the basic question of whether people in need of certain health interventions receive them), and health-care financing (addressing the basic issue of whether households can afford to pay for the health care they need).

We showed that China's health system did well for some indicators (eg, delivering maternal and child health services), but not so well for others. For example, the increases in antenatal visit and hospital delivery rates for women living in urban areas between 1993 and 2003 approached the performance of Mexico for skilled birth attendance.³¹ These rates also increased for women living in rural areas; however, indicators that capture specific quality measures showed that big gaps exist between crude and effective coverage. For example, even though most urban and rural confirmed tuberculosis cases underwent some treatment, only about half of urban and almost 60% of rural patients completed the treatment protocol. Effective control rate of patients with hypertension is even lower: only 12% and 7% of patients with hypertension living in urban and rural areas had their blood pressure lowered to normal values as a result of treatment. China's future health-system reform

programmes should not only aim to expand access to more health-care services, but also ensure and enhance quality of these services.

Indicators of both China's health status and health-system coverage are not international outliers because of their income (table 6). However, according to a recent study of 23 selected countries that account for around 80% of the total burden of chronic-disease mortality in developing countries, death rates for chronic respiratory disease are highest in China.³² Increasing evidence exists about the cost-effectiveness of tobacco control measures, salt reduction, and use of multidrug regimens for patients at high risk of cardiovascular diseases.³³ In this respect, China's health system seems to be far less advanced than that of other developing countries. For example, in the examination survey only 42% and 27% of people living in urban and rural areas, respectively, with high blood pressure knew about their condition. Moreover, although 45% and 50% of men living in urban and rural areas were regular smokers in 2003, only 5–6% of them tried to quit. Therefore, the biggest challenge for the future is to scale up cost-effective interventions for chronic disease prevention and to use measurement of effective coverage to monitor progress in China.

Irrespective of specific indicators, remarkable inequalities in health-system coverage exist in China. According to our analysis, these inequalities are mainly related to income differentials. Indeed, our multiple regression analysis showed that the only significant predictor of provincial health-system coverage is GDP per head. This finding not only emphasises the fundamental role of wealth in health development, but also indicates a serious absence of effective transfer payment mechanisms between provinces in the health sector on the part of the central government.

With respect to affordability, we measured the rate of both catastrophic medical spending and foregone health care due to inability to pay. According to WHO's definition (ie, 30% of a household's capacity to pay), 14% of urban and 16% of rural households incurred catastrophic medical spending in 2003. In other words, catastrophic medical spending affected about 184 million Chinese people—a record that puts China's health-system performance for financial risk protection among the poorest in the world. A recent study of 89 countries showed that the rate of catastrophic medical spending ranged from zero in the Czech Republic, Slovakia, and the UK to more than 10% in Brazil and Vietnam.²⁰

Furthermore, on the basis of the proportion of residents reported having either foregone medical care (outpatient or inpatient) or early hospital discharge due to cost concerns in 2003, we can extrapolate that about 438 million Chinese people had affordability difficulties in 2003. The fact that many people were affected by financial access difficulties might explain both people's high dissatisfaction rate with the services they received and erosion of trust in the system, as Tang and colleagues³⁴ discussed in a report about health equity in China. Moreover, the low-income groups were the hardest hit because they had a higher probability not only of not seeking health care when ill, but also of incurring catastrophic medical spending when seeking medical care.

Our analysis has several limitations, which need to be taken into consideration in the interpretation of the findings. First, analysis of the provincial health-system performance is based on four sets of nationally representative survey data, which, although large in terms of sample size, are not always representative of every province. Therefore, our results on benchmarking provinces should be interpreted with caution, and considered as an illustrative example of what can and should be done if more data were available. Second, in most cases we are able to provide only crude rather than effective coverage indicators. For many indicators in this analysis, either no information or only proxies were available to capture the quality of the intervention being delivered. Third, our analysis is based on cross-sectional surveys that are done only every 5 years. Finally, the selection of indicators used in the coverage estimation is opportunistic and does not mirror the changing epidemiological profile of the Chinese population. No information exists on the coverage of interventions for most chronic diseases. Therefore, our measure of coverage is only the first step towards benchmarking performance and needs to be re-estimated once information about coverage of other important interventions becomes available.

We have shown the urgent need for China to construct a more comprehensive nationally and regionally representative dataset (whether a cohort or repeated cross-sections) to be able to monitor and assess health-policy changes properly. In particular, China needs to

obtain information on non-personal, public-health interventions, such as seatbelt use and mental-health services. Future studies should also establish a more comprehensive understanding of the major underlying determinants of the health-system performance.

Contributors

YL conceptualised and coordinated analyses and preparation of the paper. EG was mainly responsible for methods and accurate interpretation of data analysis results. KR and JW were primarily responsible for data analysis and tabulation of results. All authors contributed to the final version of the manuscript.

Conflict of interest statement

We declare that we have no conflict of interest. JW served as a Takemi fellow at Harvard School of Public Health (HSPH, MA, USA), funded by the HSPH China Initiative.

Acknowledgments

We thank the editors and reviewers for their comprehensive comments that helped revision of our manuscript. Comments from participants of *The Lancet*–CMB Authors Workshop in October, 2007, in Beijing were also appreciated.

References

- 1 Wen J. Keynote speech presented at Summer Davos, Dalian, China. http://www.gov.cn/english/2007-09/07/content_741508.htm (accessed April 18, 2008).
- 2 The Chinese Ministry of Health. *China Health Statistics Digest*. Beijing: the Peking Union Medical College Press, 2007.
- 3 Centre for Health Statistics and Information, MOH. *An Analysis Report of National Health Services Survey in 2003*. Beijing: the Peking Union Medical College Press, 2004.
- 4 Ma K. Implementation of the central government's economic work conference for the benefit of 2007 development and reform. *Macroeconomic Management* 2007; 1: 8–13.
- 5 The Chinese Social Sciences Academy. *2007 Social Development Report*. Beijing: the Chinese Social Sciences Academy Press, 2006.
- 6 Gao Q. Using creative system mechanisms to stimulate health reform and development. *China Development Observation* 2007; 4: 44–47.
- 7 Wen J. Keynote speech presented at the National Urban Residents Basic Medical Insurance Pilot Study Conference in Beijing, P. R. China, July, 23, 2007.
- 8 Chen Z, Gao Q. Health reform and development with Chinese characteristics: ensuring medical and health care services for each and every citizen. *Qiu Shi* 2008; 1: 35–38.
- 9 Yip W, Hsiao WC. The Chinese health system at a crossroads. *Health Affairs* 2008; 27: 460–68.
- 10 Dollar D. Poverty, inequality and social disparities during China's economic reform. World Bank Policy research Working Paper 4253, 2007. http://econ.worldbank.org/external/default/main?pagePK=64165259&piPK=64165421&theSitePK=469372&menuPK=64166093&entityID=000016406_20070613095018 (accessed Aug 26, 2008).
- 11 Gakidou E, Lozano R, Gonzalez-Pier E, et al. Assessing the effect of the 2001–06 Mexican health reform: an interim report card. *Lancet* 2006; 368: 1920–35.
- 12 Frenk J. Bridging the divide: global lessons from evidence-based health policy in Mexico. *Lancet* 2006; 368: 954–61.
- 13 WHO. *The World Health Report 2000: Health Systems: Improving Performance*. Geneva: World Health Organization, 2000.
- 14 World Bank. *Technical Note No 5: Assessing health sector performance*. Washington, DC: World Bank, 2001. http://www.healthsystems.org/Pdfs/HNP_tecnote5a.pdf (accessed May 1, 2008).
- 15 Roberts MJ, Hsiao WC, Berman P, Reich MR. *Getting health reform right—a guide to improving performance and equity*. Oxford: Oxford University Press, 2004.
- 16 Liu Y. What is wrong with China's health system? *Harvard China Review* 2006; 3: 14–18.
- 17 Shengelia B, Murray CJL, Adams OB. Beyond access and utilization: defining and measuring health system coverage. In: Murray CJL, Evans DB eds. *Health systems performance assessment: debates, methods and empiricism*. Geneva: World Health Organization, 2003: 221–34.

- 18 Liu Y, Rao K, Hsiao WC. Medical spending and rural impoverishment in rural China. *JHPN* 2003; **21**: 216–22.
- 19 Wagstaff A, Yu S. Do health sector reforms have their intended impacts? The World Bank's Health VIII project in Gansu province, China. *J Health Econ* 2007; **26**: 505–35.
- 20 Xu K, Evans D, Carrin G, et al. Protecting households from catastrophic health spending. *Health Aff* 2007; **26**: 972–83.
- 21 Xu K, Evans B, Kawabata K, Zeramdini R, Klavus J, Murray CJL. Household catastrophic health expenditure: a multi-country analysis. *Lancet* 2003; **362**: 111–17.
- 22 Murray CJL. Assessing the Distribution of Household Financial Contributions to the Health System: Concepts and Empirical Application. In: Murray CJL, Evans DB eds. Health systems performance assessment: debates, methods and empiricism. Geneva: World Health Organization, 2003: 513–31.
- 23 Wagstaff A, van Doorslaer E. Catastrophe and impoverishment in paying for health care with applications to Vietnam, 1993–98. *Health Econ* 2003; **12**: 921–34.
- 24 Wang L, Liu J, Chin DP. Progress in tuberculosis control and the evolving public-health system in China. *Lancet* 2007; **369**: 691–96.
- 25 Zhang T, Tang S, Jun G, Whitehead, M. Persistent problems of access to appropriate, affordable TB services in rural China: experiences of different socio-economic groups. *BMC Public Health* 2007; **7**: 19.
- 26 Meng Q, Li R, Cheng G, Blas E. Provision and financial burden of TB services in a financially decentralized system: a case study from Shandong, China. *Int J Health Planning Management* 2004; **19** (suppl 1): S45–S62.
- 27 Blumenthal D, Hsiao W. Privatization and its discontents—the evolving Chinese health care system. *N Engl J Med* 2005; **353**: 1165–70.
- 28 Liu Y. China's public health-care system: facing the challenges. *World Health Organ Bull* 2004; **82**: 532–37.
- 29 Liu Y, Rao K, Hu T, Sun Q, Mao Z. Cigarette smoking and poverty in China. *Soc Sci Med* 2006; **63**: 2784–90.
- 30 Hu S, Tang S, Liu Y, Zhao Y, Escobar ML, de Ferranti D. Reform of how health care is paid for in China: challenges and opportunities. *Lancet* 2008; published online October 20, 2008. DOI:10.1016/S0140-6736(08)61368-9.
- 31 Lozano R, Soliz P, Gakidou E, et al. Benchmarking of performance of Mexican states with effective coverage. *Lancet* 2006; **368**: 1729–41.
- 32 Abegunde DO, Mathers CD, Adam T, Ortegon M, Strong K. The burden and costs of chronic diseases in low-income and middle-income countries. *Lancet* 2008; **370**: 1929–38.
- 33 Gaziano TA, Galea G, Reddy KS. Scaling up interventions for chronic disease prevention: the evidence. *Lancet* 2008; **370**: 1939–46.
- 34 Tang S, Meng Q, Chen L, Bekedam H, Whitehead M. Health equity in China: tackling the “perfect storm”. *Lancet* 2008; published online October 20, 2008. DOI:10.1016/S0140-6736(08)61364-1.