

Inequality and inequity in access to health care and treatment for chronic conditions in China: the Guangzhou Biobank Cohort Study

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Non-communicable diseases (NCDs) are a large and rapidly-growing problem in China and other middle-income countries. Clinical treatment of NCDs is long-term and expensive, so it may present particular problems for equality and horizontal equity (equal treatment for equal need) in access to health care, although little is known about this at present in low- and middle-income countries. To address this gap, and inform policy for a substantial proportion of the global population, we examined inequality and inequity in general health care utilization (doctor consultations and hospital admissions) and in treatment of chronic conditions (hypertension, hyperglycaemia and dyslipidaemia), in 30499 Chinese adults aged ≥ 50 years from one of China's richest provinces, using the Guangzhou Biobank Cohort Study (2003–2008).

We used concentration indices to test for inequality and inequity in utilization by household income per head. Inequality was decomposed to show the contributions of income, indicators of 'need for health care' (age, sex, self-rated health, coronary heart disease risk and chronic obstructive pulmonary disease) and non-need factors (education, occupation, out-of-pocket health care payments and health insurance).

We found inequality and inequity in treatment of chronic conditions but not in general health care utilization. Using more objective and specific measures of 'need for health care' increased estimates of inequity for treatment of chronic conditions. Income and non-need factors (especially health insurance, education and occupation) made the largest contributions to inequality. Further work is needed on why access to treatment for chronic conditions in China is restricted for those on low incomes and how these inequities can be mitigated.

Keywords Inequity, inequality, chronic illness, access to care, China

KEY MESSAGES

- We examined inequality and inequity in general health care utilization and in treatment of chronic conditions in adults aged ≥ 50 years in Guangzhou, one of China's richest provinces.
- Inequality and inequity was found in treatment of chronic conditions but not in general health care utilization.
- Income and non-need factors such as health insurance, education and occupation made the largest contributions to inequality.

Introduction

Since the establishment of the People's Republic of China in 1949, life expectancy in China has almost doubled from around 40 to 74 years (Banister 1987; World Health Organization 2010b). Market-oriented economic reforms beginning in 1978 brought rapid economic growth but also rising health inequalities (Liu *et al.* 1999) and a shift in the burden of disease. Non-communicable diseases (NCDs) now account for over 80% of deaths and 70% of disability-adjusted life years in China (Wang *et al.* 2005). The World Health Organization (WHO) has estimated that US\$558 billion will be lost from the Chinese economy between 2005 and 2015 as a result of NCDs (World Health Organization 2005). Whilst there is a growing body of work quantifying the magnitude of the NCD burden in China (Wang *et al.* 2006), to our knowledge there has been little recognition of the implications for access to health care.

The use of clinical prevention and treatment strategies is part of a mix of population-level and individual-level interventions needed to meet the challenge of NCDs in low- and middle-income countries (e.g. Beaglehole and Horton 2010; World Health Organization 2010a). Even where effective and cost-effective clinical interventions exist, however, it is far from clear that a health system organized as China's is can deliver them effectively to those in greatest need (Samb *et al.* 2010). This raises the prospect of widening inequalities in access to health care between rich and poor, since NCDs are known to be associated with socio-economic deprivation (Elwell-Sutton *et al.* 2011). Currently, socio-economic inequalities in NCDs may not be as strong in China, or other middle-income countries, as in high-income countries (Fleischer *et al.* 2008; Le *et al.* 2011), yet there is a real risk that continued inequity in access to care may generate or exacerbate such inequalities in future.

China's economic liberalization, beginning in 1978, greatly reduced health care coverage, especially in rural areas where communes collapsed along with their associated health insurance schemes (Wagstaff *et al.* 2009). In urban areas too, health insurance coverage fell (Gao *et al.* 2001). Despite more recent efforts to increase insurance coverage, in 2003 only 56% of people in China had any health insurance (Yip and Mahal 2008). Since China's current health care financing relies heavily on out-of-pocket payments (Yip and Hsiao 2008), one might expect the wealthy to have better access to health care. Hence, we might expect wealthier people to utilize more health care (inequality) or to utilize more health care for a given level of health need (horizontal inequity).

Previous studies of inequality and inequity in utilization of health care in China have focused on the effects of economic liberalization, finding increased overall utilization but also bigger gaps in utilization between urban and rural areas (Liu *et al.* 1999; Gao *et al.* 2002). This contrasts with studies from high-income countries in Europe, which generally show an equitable, or slightly pro-poor, distribution of primary care consultations, with pro-rich inequity in specialist consultations, though this pattern is reversed in Hong Kong (van Doorslaer *et al.* 2000; van Doorslaer and Masseria 2004; van Doorslaer *et al.* 2004; Lu *et al.* 2007).

To our knowledge, no previous studies have considered the effects of the epidemiological transition and the rise of NCDs on inequality and inequity in access to health care in China or

elsewhere. Since most NCDs are chronic, effective clinical treatment and prevention often requires long-term use of medication, contact with multiple health care professionals, and high, long-term costs. Thus, we might expect access to effective treatment of NCDs to be more inequitable than access to general health care in China.

Using utilization as a proxy for access to health care, we examined the idea that NCDs present particular challenges for equal and equitable access to health care in an urban population of older people from Guangzhou, southern China. We tested the hypothesis that there is greater inequality and inequity in utilization of treatment for chronic conditions than in general health care utilization. This hypothesis was tested by comparing observed inequality and inequity in general utilization of health care (doctor consultations and hospital admissions) with inequality and inequity in treatment for three chronic conditions which are major risk factors for NCDs: hypertension, hyperglycaemia and dyslipidaemia. We also examined utilization of Traditional Chinese medicines and minerals/vitamins. To understand the sources of income-related differences in utilization, we used decomposition techniques to estimate the contributions of other factors to observed inequalities in utilization.

Methods

Setting and study design

The rapid epidemiological transition in Guangzhou over the past 60 years has produced social patterning of chronic disease somewhat different to that currently found in western countries (Schooling *et al.* 2008; Elwell-Sutton *et al.* 2011). As in many Chinese cities, health care in Guangzhou is largely hospital-based, with inpatient and outpatient clinics providing care on a fee-for-service basis.

The Guangzhou Biobank Cohort Study (GBCS) is a collaboration between Guangzhou No. 12 Hospital, the University of Hong Kong and the University of Birmingham in the UK, and has been described in detail elsewhere (Jiang *et al.* 2006). Recruitment of participants draws from 'The Guangzhou Health and Happiness Association for the Respectable Elders' (GHHARE), a community social and welfare organization which is unofficially aligned with the municipal government and where membership is open to Guangzhou residents aged 50 years or older for a nominal fee of US\$0.5 (4 Yuan) per month.

Participants were recruited to the study in three phases and were included if they were capable of consenting, ambulatory, and not receiving treatments which, if omitted, might result in immediate life-threatening risk. Therefore, some patients with severe hypertension or diabetes may have been excluded. The Guangzhou Medical Ethics Committee of the Chinese Medical Association approved the study and all participants gave written, informed consent before participation.

Sample description

About 7% (~95 000 of ~1.5 million) of permanent Guangzhou residents aged over 50 were members of GHHARE. This study uses phases 1–3 of the GBCS collected during 2003–08 and involving 30 499 participants. Participants underwent a

half-day detailed interview, including medical history and a physical examination. Participation in the study was free and results from physical examinations were given back to participants. To account for the fact that our sampling frame did not encompass the entire population of the city, we used post-stratification adjustment to weight our data (Biemer and Christ 2008). Weights were constructed by comparing cross-classification tables (by age, sex and education) from our sample with similar tables from census data for Guangzhou residents (National Bureau of Statistics 2000).

Variables

Table 1 shows a summary of the variables used in our analysis. Our measure of income was household income per head. Household income was recorded in six categories (<5000 Yuan, 5000–9999 Yuan, 10 000–19 999 Yuan, 20 000–29 999 Yuan, 30 000–49 999 Yuan and $\geq 50 000$ Yuan). As in previous studies of inequality and inequity in health care utilization where income was recorded in categories (e.g. van Doorslaer *et al.* 2000), we used the mid-point of each income category and we assumed that those in the highest category had an annual household income of 75 000 Yuan.

We used measures of health care utilization as outcomes (see Table 1). Measures of general utilization include doctor consultations and hospital admissions. Measures of utilization of treatment for chronic conditions include regular use of treatment for hypertension, hyperglycaemia and dyslipidaemia in the last month. We also considered use of Traditional Chinese medicines and mineral/vitamin supplements. The number of doctor consultations and hospital admissions were recorded but due to the predominance of zeros these have been dichotomized into binary variables ('used' or 'not used'). Other outcomes were recorded as 'used' or 'not used' only.

Need for health care was assessed using age (in five-year age groups); sex; self-rated health (in four categories: 'very good', 'good', 'poor' and 'very poor'); coronary heart disease (CHD) risk [based on the Framingham CHD risk score and calculated according to Wilson *et al.* (1998), incorporating age, sex, diabetes, smoking status, blood pressure, LDL-C and HDL-C]; and chronic obstructive pulmonary disease (COPD) assessed by spirometry and recorded in five categories ('no COPD', 'mild COPD', 'moderate COPD', 'severe COPD' and 'very severe COPD') according to GOLD guidelines (Rabe *et al.* 2007). Spirometry measurement and checking procedures have been described in detail elsewhere (Yin *et al.* 2007).

We also controlled for other 'non-need' factors which could influence health care utilization. These were: highest education level (less than primary school, primary school, junior middle school, senior middle school, junior college, senior college); longest-held occupation (manual, non-manual, other); out-of-pocket spending on consultations or prescriptions in last 14 days (in quintiles); out-of-pocket spending on admissions to hospital in last 6 months (in quintiles); and type of health insurance coverage. Our questionnaire recorded several types of health insurance which are common in China (Wagstaff *et al.* 2009): Government Insurance Scheme (GIS) covering civil servants and direct government employees; Basic Medical Insurance (BMI) covering urban workers combining contributions from government, employers and employees; full or partial coverage provided by employers; Co-operative Medical Scheme covering mainly agricultural workers; and private medical insurance.

In descriptive tables we used the following definitions of chronic conditions: hypertension was defined as blood pressure $>140/90$ mmHg or use of blood pressure-lowering drugs; diabetes was defined as fasting blood glucose >7.0 mmol/l, use of glucose-lowering drugs or previous diagnosis of diabetes; and dyslipidaemia was defined, as in previous work on this sample, as fasting plasma triglycerides ≥ 2.3 mmol/l, and/or total cholesterol ≥ 6.2 mmol/l, or total cholesterol ≥ 5 , <6.2 with total cholesterol–HDL ratio >5 , or using lipid-lowering drugs (Thomas *et al.* 2006).

Measuring inequality and inequity

We tested our hypothesis that there is greater inequality and inequity in utilization of treatment for chronic conditions than in general health care utilization by measuring inequality and inequity in a range of health care utilization measures. The concentration index (C_M) was used to measure inequality (Kakwani *et al.* 1997). C_M was calculated along with its robust standard error using ordinary least squares (OLS) regression (O'Donnell *et al.* 2008b) with individuals ranked according to their income (see Appendix A for details).

Concentration indices show whether health care utilization was evenly distributed by income. The range of C_M is -1 to 1 . A value of 0 indicates that people of all incomes use the same amount of health care. Positive values indicate a pro-rich distribution: that is, that utilization is concentrated amongst wealthier people. At its extreme, a C_M value of 1 would indicate that all health care was used by the single wealthiest individual

Table 1 Variables used in analysis

Income (ranking)	Health care utilization	Need for health care	Non-need
<ul style="list-style-type: none"> Household income per head 	<ul style="list-style-type: none"> Western doctor consultations in last 14 days. Traditional Chinese doctor consultations in last 14 days. Hospital admissions in last 6 months. <p>In the last month regular use of:</p> <ul style="list-style-type: none"> Treatment for hypertension (blood pressure lowering drugs). Treatment for hyperglycaemia (glucose lowering drugs). Treatment for dyslipidaemia (lipid lowering drugs). Traditional Chinese medicines (tonics/teas/herbal medicines). Minerals/vitamins 	<ul style="list-style-type: none"> Age Sex Self-rated health CHD risk score COPD 	<ul style="list-style-type: none"> Highest education Longest-held occupation Out-of-pocket payments for consultations/prescriptions in last 14 days. Out-of-pocket payments for admissions to hospital in last 6 months. Health insurance coverage

Notes: CHD = coronary heart disease; COPD = chronic obstructive pulmonary disease.

in the population. Similarly, negative values indicate a pro-poor distribution, with poorer people utilizing more health care than wealthy people.

Horizontal inequity—deviation from the principle of ‘equal treatment for equal need’—was assessed from the horizontal inequity index (HI_{WV}) (Wagstaff and van Doorslaer 2000), which is the difference between the concentration index for observed utilization (C_M) and the index of need-expected utilization (C_N). First we used indirect standardization to predict need-expected utilization rates. To illustrate the effect of measuring ‘need for health care’ in different ways, we include three models of need-expected utilization. Model 1 measures need using age, sex and self-rated health, whilst Model 2 additionally includes the CHD risk score, and Model 3 additionally includes COPD. A range of ‘non-need’ factors (see Table 1), which may also influence health care utilization, are included in the standardization to avoid confounding (O’Donnell *et al.* 2008b). The horizontal inequity index (HI_{WV}), then, is a measure of inequality in the utilization of health care after standardizing for differences in need. HI_{WV} lies within the range of -2 to 2 with positive (negative) values indicating pro-rich (pro-poor) inequity.

By comparing the extent of inequality and inequity in different types of health care utilization, we were able to test our hypothesis that there would be greater inequality and inequity in treatment of chronic conditions than in general health care utilization.

Explaining inequality

To explain inequalities in health care utilization, we used decomposition analysis. Since the concentration index is estimated using a linear regression model, it is possible to decompose it into the contributions of different factors such that the sources of income-related inequality are identified (Wagstaff *et al.* 2003) (see Appendix A for details). In this way we estimated the independent contributions to inequality of income, need and non-need factors along with a residual term, which approaches zero in well-specified models.

Contributions to inequality may be positive (indicating a pro-rich contribution) or negative (a pro-poor contribution). The sum of all contributions would be zero if utilization was equal across the income distribution. If total equity existed, only the ‘need’ variables would contribute to overall inequality whereas other factors contribute when inequity exists (van Doorslaer and Koolman 2004).

Missing data

Across all the variables used in our analysis, 6.8% of data points were missing. Variables with the largest amount of missing data were COPD status (44.7% missing), regular use of blood pressure lowering treatment in the past month (34.4% missing) and household income per head (24% missing). All other variables had less than 10% of data missing. Multiple imputation (10 imputations) was used for all missing data in income, need and non-need variables (Schafer 1999; Harrell 2001) with missing values predicted based on a flexible additive regression model with predictive mean matching (Harrell 2001), which also incorporated personal income and all outcomes (Moons *et al.* 2006). We summarized results from the 10 imputed data

sets into single estimates of the concentration index (C_M), the horizontal inequity index (HI_{WV}) and decomposition contributions, with standard errors and P -values adjusted for missing data uncertainty (Schafer 1999).

Sensitivity tests

Since our outcomes are binary, the use of OLS regression models to estimate the concentration index (C_M) and the horizontal inequity index (HI_{WV}) may not be appropriate. However, it has been found previously that measures of inequality and inequity, as well as decomposition of inequality, differ little between OLS and non-linear models (van Doorslaer *et al.* 2000; van Doorslaer and Masseria 2004). Moreover, decomposition can be applied to non-linear models only by using approximation techniques that introduce errors (van Doorslaer *et al.* 2004), making it more appropriate to use a linear approximation. For consistency with decomposition analysis and with previous publications (e.g. Lu *et al.* 2007) we used OLS regression for our main analysis, though we also estimated C_M and HI_{WV} using logit models as a sensitivity test. Since we used multiple imputation for all missing data, a complete case analysis was also carried out as a sensitivity test.

Misreporting of health care utilization is a common phenomenon when self-reports are used. Although both under- and over-reporting are possible, the net effect tends to be under-reporting, which increases with longer recall periods (Bhandari and Wagner 2006). To investigate the potential influence of misreporting, we conducted a sensitivity test comparing results based on varying recall periods for hypertension treatment (in the last 2 days, last month and ever) and for dyslipidaemia treatment (in the last month and ever).

Results

Table 2a shows the demographic characteristics of our sample by household income group. Higher household income was associated with younger age, more education, non-manual longest-held occupation and having health insurance. Table 2b shows that higher household income was associated with Traditional Chinese doctor consultations and, amongst those with chronic conditions, with treatment of chronic conditions; for example, in the lowest income group 33% of people with hypertension were on hypertension treatment compared with 46.9% in the highest income group ($P < 0.01$).

Over the preceding 14 days, 9.4% of participants consulted a western doctor and 7.4% consulted a Traditional Chinese doctor. Table 3 shows the results of our inequality and inequity analysis. The concentration index (C_M), our measure of inequality, was positive for all measures of health care utilization, indicating that in all cases utilization was pro-rich (i.e. more common amongst wealthier people) though in many cases the standard errors are large. Thus, we found no evidence of income-related inequality in doctor consultations (western or Traditional Chinese) or in hospital admissions (Table 3). However, we did find pro-rich inequality in treatment for two chronic conditions (hypertension and dyslipidaemia) and in the use of Traditional Chinese medicines and minerals/vitamins.

Table 2a Characteristics of 30 499 Chinese adults aged ≥ 50 in the Guangzhou Biobank Cohort Study by annual household income group

	All (N) Col %	Annual household income group						Unknown	P ^a
		<¥5000 (493)	¥5000 –¥9999 (1257)	¥10 000 –¥19 999 (3976)	¥20 000 –¥29 000 (5847)	¥30 000 –¥49 000 (6455)	¥50 000+ (5164)		
N	(30 499)	(493)	(1257)	(3976)	(5847)	(6455)	(5164)	(7307)	
Sex									
Male	27.7	30.8	19.9	27.3	30.4	28.8	30	24.3	
Female	72.3	69.2	80.1	72.7	69.6	71.2	70	75.7	<0.01
Age									
50–54	19	6.5	8.7	15	19.3	28.2	26	10.6	
55–59	24.9	17.4	17.4	20.7	23.2	28	30.8	23.3	
60–64	20.7	20.3	17.2	17.8	21.2	19.4	21.2	23.2	
65–69	19.8	28	26.7	23.4	20.3	14.7	14.2	24.2	
70–74	12.1	18.9	22.6	17.5	12.6	7.6	6.1	14.8	
75–79	2.8	6.7	6.2	4.1	2.8	1.7	1.3	3.2	
80+	0.7	2.2	1.3	1.4	0.6	0.4	0.4	0.7	<0.01
Self-rated health									
Very good	1.3	1	1.2	1.1	1.3	1.5	1.6	1.2	
Good	78.4	70	75.9	75.8	77.5	80	80.9	78.5	
Poor	17.1	25.4	20.7	20.4	18.7	15.1	13.4	17.1	
Very Poor	0.2	0.8	0.4	0.2	0.2	0.2	0.2	0.2	
Unknown	2.9	2.8	1.8	2.5	2.3	3.3	3.8	2.9	<0.01
COPD									
No COPD	86.5	82.6	81.9	83.4	86	89.2	90.2	84.4	
Mild COPD	10.2	11.8	13.1	11.7	10.6	8.2	7.4	12.4	
Moderate COPD	2.5	3.7	3.3	3.6	2.6	2.2	1.9	2.3	
Severe COPD	0.7	1.2	1.4	1.2	0.6	0.4	0.4	0.6	
Very severe COPD	0.2	0.8	0.2	0.2	0.2	0	0.1	0.2	<0.01
Education									
Less than primary	10	34.5	25.3	15.3	8	4	2.5	15.2	
Primary	32.8	48.1	45.3	40.4	34.8	25	17.8	41.5	
Junior Middle	26.5	11.8	19.5	24.5	29	31.8	25.9	23.4	
Senior Middle above	21.6	4.7	7.6	15.1	20.8	28.5	34.4	14.2	
Junior College	5.6	0.8	1.4	3	4.4	6.9	12	3.1	
College	3.4	0.2	0.9	1.5	2.9	3.8	7.4	2.3	
Unknown	0.1	0	0.1	0.2	0	0	0	0.2	<0.01
Longest-held occupation									
Manual	62.9	87.2	80.5	71.8	63	56.6	46.2	70.8	
Non-manual	23.7	4.3	10.4	17.3	23.3	27.4	36.4	18.7	
Other	12.9	7.9	9.1	10.6	13.2	15.2	16.3	10.3	
Unknown	0.6	0.6	0	0.4	0.5	0.7	1.1	0.3	<0.01
Health insurance coverage									
No insurance	16.7	50.1	28.7	22.1	13.7	10.8	9.1	22.5	
GIS	4.2	0.8	0.6	1.7	2.8	4.8	9.7	3.2	
BMI	70.3	9.9	56.4	65.6	77.4	77.8	76	63	
Full employer cover	1	0.4	1	1.1	1	1.3	0.8	1	
CMS	4.7	34.1	10.3	5.7	3	2.6	2.1	6.3	
Partial employer cover	2.1	3.9	2.3	2.7	1.3	1.6	1.5	3	
Private insurance	0.3	0.2	0.2	0.3	0.2	0.4	0.5	0.2	
Others	0.3	0.6	0.3	0.6	0.1	0.2	0.1	0.4	
Unknown	0.3	0	0.2	0.3	0.3	0.5	0.2	0.3	<0.01

Notes: COPD = chronic obstructive pulmonary disease; GIS = Government Insurance Scheme; BMI = Basic Medical Insurance; CMS = Co-operative Medical Scheme.

^aP-value from chi-squared test.

¥1 = US\$0.16.

Table 2b Health care utilization, chronic conditions and treatments for 30 499 Chinese adults aged ≥ 50 in the Guangzhou Biobank Cohort Study by annual household income group

	All (N) Col %	Annual household income group							<i>P</i> ^a
		<¥5000	¥5000–¥9999	¥10 000–¥19 999	¥20 000–¥29 000	¥30 000–¥49 000	¥50 000+	Unknown	
N	(30 499)	(493)	(1257)	(3976)	(5847)	(6455)	(5164)	(7307)	
Western doctor consultation in last 14 days									
No	90.6	89.7	89.9	90.7	90.9	91.4	90.5	90	
Yes	9.4	10.3	10.1	9.3	9.1	8.6	9.5	10	0.43
Traditional Chinese doctor consultations in last 14 days									
No	92.6	94.3	93.6	92.1	92.5	93.3	92.2	92.5	
Yes	7.4	5.7	6.4	7.9	7.5	6.7	7.8	7.5	0.04
Hospital admissions in last 6 months									
No	95.6	93.7	95.4	95.7	95.8	95.9	95.5	95.3	
Yes	3.3	5.1	3.3	3.4	3.5	3	3.4	3.4	
Unknown	1.1	1.2	1.3	0.9	0.8	1.2	1.2	1.3	0.17
Hypertension^b									
No	57.4	54.4	54	54.1	56.9	61.2	61.6	54	
Yes	42.4	45.4	45.7	45.7	43	38.6	38.2	45.7	
Unknown	0.2	0.2	0.3	0.2	0.1	0.2	0.2	0.3	<0.01
Hypertension treatment (% of those with hypertension)									
No	26.8	41.1	21.6	26.6	25.2	29.2	30.1	24.2	
Yes	36.7	33	28.9	31.3	38.7	43.1	46.9	29	
Unknown	36.5	25.9	49.5	42.1	36.2	27.7	23	46.8	<0.01
Diabetes^c									
No	87.1	85.8	86.6	85.6	85.9	88.7	88.7	86.3	
Yes	12.4	11.6	12.6	14	13.6	10.8	10.7	13.1	
Unknown	0.6	2.6	0.8	0.4	0.5	0.5	0.6	0.6	<0.01
Hyperglycaemia treatment (% of those with diabetes)									
No	43.2	54.4	52.5	41.4	40.8	42.7	44.7	43.8	
Yes	53.5	42.1	44.9	56.1	55.3	53.3	52.6	53.3	
Unknown	3.2	3.5	2.5	2.5	3.9	4	2.7	2.9	0.04
Dyslipidaemia^d									
No	50.4	55.8	52.3	51.4	49.2	49.7	48.6	51.9	
Yes	49.6	44.2	47.7	48.6	50.8	50.3	51.4	48.1	<0.01
Dyslipidaemia treatment (% of those with dyslipidaemia)									
No	82.4	86.2	88.1	82.9	80.7	82.5	80.2	84	
Yes	9.9	6.9	6	10.1	10.7	9.5	11.4	9.3	
Unknown	7.7	6.9	5.8	6.9	8.7	8	8.4	6.7	<0.01

Notes: ^a*P*-value from chi-squared test. ^bHypertension defined as: blood pressure >140/90 mmHg or on blood pressure-lowering drugs. ^cDiabetes defined as: fasting blood glucose >7.0 mmol/l or on glucose-lowering drugs. ^dDyslipidaemia defined as: fasting plasma triglycerides ≥ 2.3 mmol/L, and/or total cholesterol ≥ 6.2 mmol/l, or total cholesterol ≥ 5 , <6.2 with total cholesterol–HDL-C ratio >5, or using lipid-lowering drugs.

¥1 = US\$0.16.

The health inequity index (HI_{WV}) in Table 3 shows inequality in health care utilization after standardization for measures of need for health care and can be interpreted in a similar way to the concentration index. In Model 1 (standardized for age, sex, self-rated health) we found no inequity in doctor consultations (western or Traditional Chinese) or hospital admissions, but there was pro-rich inequity in treatment of hypertension, hyperglycaemia and dyslipidaemia, indicating that wealthier people used these treatments more often than would be

expected given their level of need, compared with poorer people.

Comparing Model 1 with Model 2 shows that the degree of pro-rich inequity in treatment of chronic conditions was greater after additional standardization for CHD risk score, though this did not affect estimates of inequity in utilization of other health care. Comparing Model 2 and Model 3 shows that additional standardization for COPD as a measure of need for health care made little difference.

Table 3 Income-related inequality and inequity in health care utilization for 30 499 Chinese adults aged ≥ 50 in the Guangzhou Biobank Cohort Study

	N	Percentage utilization	C_M	(SE)	Model 1 ^a		Model 2 ^b		Model 3 ^c	
					HI _{WV}	(SE)	HI _{WV}	(SE)	HI _{WV}	(SE)
Western doctor consultations (any in last 14 days)	30 496	9.4	0.006	(0.022)	-0.013	(0.022)	-0.012	(0.022)	-0.012	(0.022)
Traditional Chinese doctor consultations (any in last 14 days)	30 499	7.4	0.015	(0.027)	0.024	(0.025)	0.022	(0.025)	0.021	(0.025)
Hospital admissions (any in last 6 months)	30 169	3.4	0.019	(0.038)	0.008	(0.037)	0.006	(0.037)	0.007	(0.037)
Hypertension treatment (regular use in last month)	20 020	24.0	0.048	(0.016)	0.076	(0.014)	0.092	(0.014)	0.091	(0.014)
Hyperglycaemia treatment (regular use in last month)	28 155	7.2	0.039	(0.025)	0.051	(0.023)	0.085	(0.023)	0.084	(0.023)
Dyslipidaemia treatment (regular use in last month)	28 164	5.3	0.159	(0.034)	0.148	(0.031)	0.161	(0.031)	0.159	(0.031)
Traditional Chinese medicines (regular use in last month)	27 552	30.8	0.132	(0.012)	0.098	(0.011)	0.098	(0.011)	0.098	(0.011)
Minerals/vitamins (regular use in last month)	27 775	28.8	0.142	(0.013)	0.133	(0.011)	0.132	(0.011)	0.132	(0.011)

Notes: C_M = Concentration Index for inequality; HI_{WV} = Healthy Inequity Index; SE = robust Standard Error.

^aModel 1 is standardized for sex, age and self-rated health; ^bModel 2 is standardized for sex, age, self-rated health and CHD risk score; ^cModel 3 is standardized for sex, age, self-rated health, CHD risk score, and COPD.

Bold figures are significant at $P < 0.05$ level.

Summary results of our decomposition analysis are shown in Figure 1, giving the aggregate contributions of all need factors, all non-need factors and income. The direct contribution of income across nearly all measures of utilization is in the pro-rich direction. The largest contribution to observed pro-rich inequality in treatment of chronic conditions was made by non-need factors.

Since positive and negative contributions within the aggregated categories of 'need' and 'non-need' may cancel each other out, Table 4 shows disaggregated decomposition results. In the need category, CHD risk score made pro-poor contributions to the treatment for chronic conditions. In the non-need category, health insurance, education and, to a lesser extent, longest-held occupation made the largest pro-rich contributions.

The results of our sensitivity tests are shown in appendices. The complete case analysis gave very similar results to the main analysis (data not shown). Using logit regression instead of OLS to calculate C_M and HI_{WV} also produced similar results (Appendix B). Results for hypertension treatment and dyslipidaemia treatment in Appendix C show that varying lengths of recall period made little difference to estimates of C_M and HI_{WV}.

Discussion

In one of the first studies to consider equality and equity in access to treatment for chronic conditions, we found pro-rich inequality and inequity in the treatment of three major chronic conditions: hypertension, hyperglycaemia and dyslipidaemia. By contrast, general health care utilization (doctor consultations and hospital admissions) was equally and equitably distributed across different levels of income in our setting.

By considering the distribution of treatment for specific conditions whilst controlling for objectively assessed measures of need for health care, we were able to show that apparent equality and equity in the amount of contact people have with health care professionals can mask inequalities and inequities in the type of care they receive. Moreover, this study was conducted amongst older people in Guangzhou, one of the most developed of China's rapidly expanding mega-cities, giving our observations immediate public health relevance. As China and other middle-income countries undergo rapid epidemiological and demographic transition, Guangzhou can be seen as a sentinel population for the effects of NCDs on access to health care.

One previous study of access to health care in Italy found pro-rich inequity in utilization of specialist care and pro-poor inequity for GP care in sub-groups of patients with chronic diseases (Sigfrid *et al.* 2006). However, the study was limited by lack of information on income, with all income data being imputed. Most previous studies of equality and equity of access to health care in China have focused on rural-urban comparisons (e.g. Yip 2010) and/or the effects of health reform (e.g. Liu *et al.* 2002; Akin *et al.* 2005). Few studies have specifically considered access to treatment for chronic conditions though a recent study of diabetes prevalence and treatment in rural areas of China found that income and education were positively associated with treatment among diabetic patients (Le *et al.* 2011). Another study found that hospital admission for chronic conditions was more common in urban areas and early self-discharge was more common in rural areas, though these figures were not adjusted for need (Jian *et al.* 2010).

In contrast to previous studies in China, we found no evidence of pro-rich inequality or inequity in general health

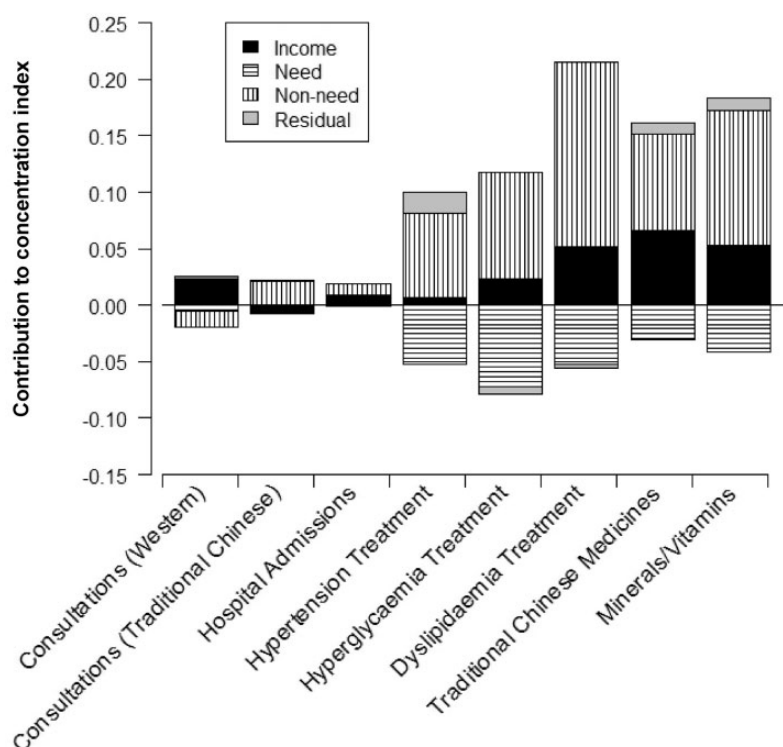


Figure 1 Summary contributions to inequality in health care utilization and treatments in 30 499 Chinese adults aged ≥ 50 in the Guangzhou Biobank Cohort Study

Table 4 Detailed contributions^a to inequality in health care utilization in 30 499 Chinese adults aged ≥ 50 in the Guangzhou Biobank Cohort Study

	Consults (Western)	Consults (Traditional Chinese)	Hospital admissions	Hypertension treatment	Hyperglycaemia treatment	Dyslipidaemia treatment	Traditional Chinese medicines	Minerals/vitamins
Income	0.023	-0.006	0.009	0.007	0.023	0.051	0.066	0.053
Need								
Sex	0.002	-0.005	<0.001	-0.009	-0.023	-0.011	-0.010	-0.021
Age	-0.001	<0.001	-0.001	0.008	0.061	0.007	-0.016	-0.020
Self-rated health	-0.003	-0.004	<0.001	-0.011	-0.018	-0.015	-0.003	-0.004
CHD risk score	-0.002	0.006	<0.001	-0.043	-0.094	-0.038	-0.001	0.002
COPD	-0.001	0.001	<0.001	0.003	0.003	0.005	<0.001	0.001
Non-need								
Health insurance	0.004	0.015	0.002	0.036	0.038	0.049	0.016	0.016
Education	0.002	0.003	0.001	0.021	0.036	0.087	0.032	0.065
Longest-held occupation	-0.009	0.011	-0.003	0.019	0.021	0.029	0.038	0.039
OPP consultations ^b	-0.011	-0.008	<0.001	-0.001	-0.001	-0.002	<0.001	-0.001
OPP admissions ^c	<0.001	<0.001	0.010	<0.001	0.001	0.001	<0.001	<0.001
Residual	0.002	0.001	<0.001	0.019	-0.007	-0.004	0.010	0.011
Cm	0.006	0.015	0.019	0.048	0.039	0.159	0.132	0.142

Notes: CHD=coronary heart disease; COPD=chronic obstructive pulmonary disease.

^aContributions sum to value of the concentration index (Cm) and indicate the size and direction of the contribution made by each factor to overall inequality. Positive (negative) contributions indicate a pro-rich (pro-poor) contribution. ^bOut-of-pocket payments for consultations/prescriptions in the last 14 days per consultation episode. ^cOut-of-pocket payments for admissions to hospital in the last 6 months per admission.

care utilization, perhaps due to the setting of our study. Previous studies concerned some of China's poorest provinces (Luo *et al.* 2009) where the supply of health care may be less adequate than in relatively prosperous Guangzhou. Also,

previous studies date from the 1990s (Gao *et al.* 2002; Liu *et al.* 2002), a period during which health insurance coverage fell in urban areas resulting in reduced access to care for many poorer people. Since then, urban insurance coverage has

increased (Yip and Hsiao 2008) and coverage was high in our sample, with 83% of participants having insurance of some kind.

Given that there was no evidence of inequality or inequity in the utilization of doctor consultations and hospital admissions, it is notable that we found inequalities and inequities in the treatment of chronic conditions. This is consistent with our hypothesis, that we should expect greater inequality and inequity in treatment of chronic conditions than in general health care utilization. Our findings suggest that even people on low incomes were able to access treatment for acute conditions whilst their access to treatment of chronic conditions was restricted.

We have also shown how different methods of measuring 'need' for health care can affect measurement of inequity. Most previous studies of inequity have used age, sex and self-rated health as the primary measures of need, sometimes combined with self-reported chronic disease (e.g. Lu *et al.* 2007; van Doorslaer *et al.* 2000). Our results show the effect of measuring 'need' for care in more objective and more specific ways. Using CHD risk score as a measure of relative need for health care, we observed greater inequity in the treatment of chronic conditions though it did not affect the estimates of inequity for other types of health care utilization. Previous studies may have underestimated the extent of inequity in health care utilization because of the practical and theoretical difficulties involved in measuring 'need for health care' accurately.

In this study, the unequal distribution of income accounted for only part of observed inequality in treatment of NCDs with factors such as health insurance, education and longest-held occupation also making contributions. The difference in insurance coverage rates between income groups in our sample was dramatic; over 50% of those in the lowest household income group had no insurance at all compared with less than 10% in the highest income group. We expected, therefore, that insurance coverage would contribute to income-related inequalities in health care utilization. We found, however, that the contribution of insurance coverage to inequalities in utilization was limited to treatment for chronic conditions, and did not apply to general health care utilization. Thus, whilst a lack of health insurance did not, in general, prevent poorer people from consulting doctors or being admitted to hospital, it did make them less likely to be treated for chronic conditions.

Increasing health insurance coverage has been a major focus of government health policy in China in recent years with ambitious targets set to achieve 90% population coverage by 2010 and 100% coverage by 2020 (Guo *et al.* 2010). Coverage in our sample (83%) fell short of this target and there was no evidence that coverage rates increased across the 5 years during which subjects were recruited (data not shown). The national drive to increase coverage has been part of a package of health reform policies, which have the explicit goals of 'equalization of access to public services' and providing everyone with 'basic health care' (Cheng 2008). Our study suggests that higher insurance coverage rates should improve equity of access to care for chronic conditions, although, crucially, a previous study found that insurance models geared towards acute care costs may not adequately protect people against the long-term outpatient costs associated with chronic disease (Yip and

Hsiao 2009). Thus, it is important that future reform of health financing and service delivery systems take full account of the growing burden of NCDs in China and the need to integrate care for these increasingly common conditions into basic health care services.

This study had a number of strengths and weaknesses. One strength was that, whereas most previous studies of inequality and inequity considered only general measures of health care utilization (such as doctor consultations and hospital admissions), we considered the distribution of treatment for specific conditions. Moreover, we were able to relate that to clinically assessed measures of need for health care rather than relying on general, self-reported measures. We also used a large sample with detailed, individual-level data on medical and demographic characteristics.

This study also had some limitations. First, this was not a fully population-representative sample. The membership fee of the recruiting welfare organization was US\$0.5 (4 Yuan) per month, which is very low compared with the per capita monthly disposable income in Guangzhou (US\$220–310) (Guangdong Statistical Bureau 2010), so we think it was not likely to bias membership, and prevalence of conditions such as hypertension and diabetes in our sample are similar to those in a nationally representative sample (Gu *et al.* 2003; Reynolds *et al.* 2003). Moreover, to account for the fact that our sampling frame did not encompass the entire population of the city, we weighted our sample to the Guangzhou population of this age group by age, sex and education. Thus, the patterns we observed—i.e. the differences in inequality and inequity between different measures of health care utilization—are unlikely to have been the result of selection bias. Nevertheless, caution should be applied in generalizing our results to other populations, especially as our sample did not include migrants to Guangzhou and some severely sick patients were excluded.

Second, the data used were not sufficiently detailed to measure directly all aspects of access to health care. Thus, as in previous studies of inequality and inequity in access to health care (van Doorslaer *et al.* 2000; Lu *et al.* 2007; O'Donnell *et al.* 2008a), we used probability of health care utilization as a proxy measure of access to care. Our data and methodology do not, therefore, allow any conclusions to be drawn about whether the mean level of health care utilization is appropriate, nor does the study consider differences in the quality of health care provided. Our intention here was only to consider whether existing health care utilization is distributed equally by income (equality), taking into account health needs (equity).

Third, as in most other studies of health care utilization, we relied on self-reports of health care utilization and treatment. Like any self-reported measure, these were potentially unreliable, though misreporting would only bias results if it was also associated with income. We cannot rule out the possibility that inequality and inequity was observed for treatment of chronic conditions due to under-reporting in low-income groups, through previous studies have found no association between under-reporting and demographic characteristics other than age (Tsui *et al.* 2005; Bhandari and Wagner 2006). Moreover, if our results had been influenced by under-reporting, we would have expected them to be sensitive to length of recall period, which they were not (see Appendix C) (Clarke *et al.* 2008).

Fourth, in studies of this kind, there are potential problems with endogeneity since participants need to access health care facilities in order to have their need for access to health care assessed. However, this was a research study with no provision of health care, where the major barrier to routine access to health care (cost) was removed. Therefore, participation in this study and routine access to health care can be regarded as largely independent of one another.

Conclusions

Along with other low- and middle-income countries, China faces a large and growing burden from non-communicable disease. Clinical treatment of chronic conditions is only part of the response, but it presents particular challenges for equality and equity of access to health care. In China and other middle-income countries, a window of opportunity exists to avert a build-up of socio-economic inequalities in non-communicable disease. As health reforms aimed at equity of access continue in China, more work needs to be done to understand why access to treatment for chronic conditions appears to be restricted for those on low incomes and how these inequities can be mitigated.

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Conflict of interest

None declared.

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Appendix A

Statistical techniques

The Concentration Index

The concentration (C_M) can be estimated, along with its robust standard error, using the following 'convenient regression':

$$\frac{2\sigma_R^2}{y} y_i = \alpha + \beta R_i + \varepsilon_i, \quad (1)$$

where σ_R^2 is the variance of individual fractional ranks based on income, y is health care utilization, \bar{y} is its mean, and R_i is the fractional rank of the i th individual in the income distribution. The ordinary least squares (OLS) estimate of β is the estimate of C_M (Kakwani *et al.* 1997).

Fractional ranking

The fractional rank of individuals was calculated as:

$$\frac{\sum_{k=1}^{j-1} n_k + 0.5n_j}{n} \quad (2)$$

where k is the number of income categories, n_j is the number of individuals in income category j , and n is the sample size, which is suitable for income data recorded in categories (Clarke and Van Ourti 2010).

Decomposition analysis

A linear model of health care utilization (y) can be written as:

$$y = \alpha + \sum_k \beta_k x_k + \varepsilon, \quad (3)$$

where β_k are coefficients of explanatory variables x_k which may include income, 'need' variables and 'non-need' variables. For the purposes of decomposition, the concentration index for health care utilization can then be written as:

$$C = \sum_k (\beta_k \bar{x}_k / \bar{y}) C_k + GC_\varepsilon / \bar{y}, \quad (4)$$

where \bar{y} is the mean of health utilization, \bar{x}_k is the mean of x_k , and C_k is the concentration index for \bar{x}_k (defined analogously to C). The residual term (GC_ε / μ) is the generalized concentration index for the regression error ε (O'Donnell *et al.* 2008b).

Appendix B

Sensitivity test using logit regression

Income-related inequality and inequity in health care utilization for 30 499 Chinese adults aged ≥ 50 in the Guangzhou Biobank Cohort Study using logit regression.

	N	Percentage utilization	Cm	(SE)	Model 1 ^a		Model 2 ^b		Model 3 ^c	
					HIwv	(SE)	HIwv	(SE)	HIwv	(SE)
Western doctor consultations (any in last 14 days)	30 496	9.4	0.006	(0.022)	-0.030	(0.023)	-0.029	(0.023)	-0.028	(0.023)
Traditional Chinese doctor consultations (any in last 14 days)	30 499	7.4	0.015	(0.027)	0.025	(0.026)	0.022	(0.026)	0.020	(0.026)
Hospital admissions (any in last 6 months)	30 169	3.4	0.019	(0.038)	-0.001	(0.039)	-0.005	(0.039)	-0.004	(0.039)
Hypertension treatment (regular use in last month)	20 020	24.0	0.048	(0.016)	0.080	(0.014)	0.095	(0.014)	0.094	(0.014)
Hyperglycaemia treatment (regular use in last month)	28 155	7.2	0.039	(0.025)	0.054	(0.023)	0.088	(0.022)	0.087	(0.022)
Dyslipidaemia treatment (regular use in last month)	28 164	5.3	0.159	(0.034)	0.153	(0.031)	0.166	(0.031)	0.164	(0.031)
Traditional Chinese medicines (regular use in last month)	27 552	30.8	0.132	(0.012)	0.099	(0.011)	0.099	(0.011)	0.099	(0.011)
Minerals/vitamins (regular use in last month)	27 775	28.8	0.142	(0.013)	0.136	(0.011)	0.135	(0.011)	0.135	(0.011)

Notes: Cm = Concentration Index; HIwv = Healthy Inequity Index for inequality; SE = robust Standard Error.

^aModel 1 is standardized for sex, age and self-rated health; ^bModel 2 is standardized for sex, age, self-rated health and CHD risk score; ^cModel 3 is standardized for sex, age, self-rated health, CHD risk score and COPD; ^dProbability of utilisation over the recall periods specified in Table 1. **Bold** figures are significant at $P < 0.05$ level.

Appendix C

Concentration Indices (Cm) and Health Inequity Indices (HI_{wv}) with 95% confidence intervals for hypertension

treatment and dyslipidaemia treatment for different recall periods.

