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Inequity in health care sector in India: A case study of district level in four Indian states

Brijesh C. PUROHIT
Madras School of Economics, Chennai, India
brijeshpurohit@gmail.com

Abstract. *Across the nations, national health policies, including that of India, have emphasised a preference for equitable health care facilities. Keeping this emphasis on equity in mind we explored four Indian states using sub-state level (or district level) data. We applied mainly three well established indicators, namely Gini coefficient and Thiel's T and L indices to gauge magnitudes of inequity. We compared our results between two periods for the same state which included one high income and another low income Indian state. Also we compared across four states, namely, Punjab, Karnataka, Madhya Pradesh and West Bengal using the information for latest available year. Our results indicate that government investment in three tier health facilities expansion indeed has resulted in low inequities in terms of health facilities available. However, private health facilities or certain specific public health facilities do not seem to be much equitable particularly at the sub-state level. Our results focus on availability aspects and thus necessarily do not indicate equitable utilisation of health care facilities or health care outcomes at the district levels.*

Keywords: inequity; Indian states; district level; health care sector; Gini coefficient.

JEL Classification: I11; I18; R58

Introduction

Health care inequalities are considered to be unfair. It is presumed that differences in people's health care access and utilization across different population groups are avoidable by proper health policies. Preference for equity is emphasised in most of the health policy documents of different countries. In India, for instance, the National Health Policy 2015 (GOI, 2014)(1) has mentioned that there is a mismatch between the health system ability and delivery of health services to those in greatest need. Being merit public good basic health facilities should be available to all despite differences in socio-economic differences. This emphasis on equity is also notable ever since the National Health Policy of 1983 and further with the National Health Policy of 2002. The major impetus globally for equity came through the World Health Organization (WHO) in 1985 by highlighting differences across different continents (WHO, 1985).(2)

In this paper we deal with inter and intra state dimensions of health care inequities in India. The following section provides brief review of relevant studies carried out in different countries including India. This is followed by a description of our methodology and data bases used. Sections 4 and 5 provide our analysis relating to different dimensions of equity mainly in terms of access and utilization. Conclusions and policy implications are discussed in the last section.

Inequity in healthcare can be considered in terms of three main variables, namely health related outcomes, service use and finance (Roberts, 2004; O'Donnell et al., 2008; Yang, 2013). These variables provide a view to evaluate health system inequity. Various ways in which inequity is focused include age, gender standardized health inequality, socioeconomic variation, etc. Inequity in health use between people with the same healthcare needs has been called as horizontal inequity. For health financing, measures like catastrophic health payment and health payment-induced poverty are used(3). Different methods have been used to quantify inequity. Mostly these have been based on concentration index (CI). These are being widely used by international organizations, government bodies, and academic institutions to measure equity in health and healthcare (Watanabe and Hashimoto, 2012; Wagstaff, 2005; Somkotra and Lagrada, 2008, Allin et al., 2010). Advantage of an approach using CI lies in Concentration Curve, which gives an easy visual of the distribution across income groups pertaining to health related variable. Among studies for countries other than India one could, for instance include Teresa, Andrew and Doorslaer (2009), Allin et al. (2009), Doorslaer, Masseria and Koolman (2006), Leu and Schellhorn (2004), Balsa, Rossi and Triunfo (2011), Winetrobe et al. (2015), Steele et al. (2006), Chao Shu Yao and Michael I. MacEntee (2014), Levy et al. (2013), Naomi (2005), King (2014), Barnett and Barnett (2004) which relate to European, American, Canadian, Australian or New Zealand context. In the context of Asian continent one could mention Shinjo and Aramak (2012), Ryo Watanabe and Hideki Hashimoto (2012) (for Japan), Peltzer et al. (2014) (for China, Ghana, India, Mexico, the Russian Federation, and South Africa). Saito et al. (2016) (for Nepal), Trani and Cecile (2012) (for Afghanistan) Hassanzadeh et al. (2013), Mohammadbeigi et al. (2015), Babaie (2012) (for Iran),Kim, Kwon and Xu (2013) (for China), Wagstaff and van Doorslaer, Lee and Shaw (2014) (for Korea), Kien et al. (2014)(for Vietnam), Leander and García-Gómez (2015)

(for South Africa), Mutangadura et al. (2007) (for selected African countries namely Ethiopia, Kenya, Ghana, Senegal, Zambia, Malawi, Egypt, Morocco and Cameroon), Odaga (2004) (for Uganda), Phiri and Ataguba (2014) (for Zambia), Hyun (2009) (for Philippines), Anwar et al. (2015) (for Bangladesh), Baru et al. (2010), Mondal (2014), Bose and Dutta (2015) and Purohit (2017) (for India), Flato and Zhang (2016), Lam (2014) (for China), Boccolini and Borges de Souza Junior (2016), Lopes et al. (2016), Szwarcwald et al. (2016), Lima-Costa et al. (2016) (for Brazil). Among others these studies have focused on different dimensions including regions, socio-economic criteria, access, utilization, finance and methodological issues.

Our methodology and data base

There are as many as ten measures of inequity which can be used. These include relative Mean Deviation, coefficient of variation, Standard Deviation of Logs, Gini Coefficient, Mehran Measure, Piesch Measure, Kakwani Measure, Theil Entropy Measure and Theil Mean Log Deviation Measure and Erreyger index.(4) From time to time, there are some modifications suggested and applied by researchers to account for income or socio-economic status. However, among these popular indicators remain Lorentz curve and Gini coefficient or its modifications. The major disadvantages of Gini coefficient is its shortcoming that the within group component cannot be neatly added to the between group component. This weakness of Gini coefficient is overcome by the entropy based measures of inequality which are known as Theil's T and L coefficients(5). In this paper, we use two main indicators of inequity which include Gini index and Theil's T and L measures.

The most widely used single measure of inequality is the Gini coefficient. It is based on the Lorenz curve, a cumulative frequency curve that compares the distribution of a specific variable (for example, income) with the uniform distribution that represents equality. To construct the Gini coefficient, graph the cumulative percentage of households (from poor to rich) on the horizontal axis and the cumulative percentage of expenditure (or health expenditure or household income) on the vertical axis. The Lorenz curve is shown in figure 1. The diagonal line represents perfect equality. The Gini coefficient is defined as A / (A + B), where A and B are the areas shown in the figure. If A = 0, the Gini coefficient becomes 0, which means perfect equality, whereas if B = 0, the Gini coefficient becomes 1, which means complete inequality. In this example, the Gini coefficient is about 0.35. If we multiply this number by 100, in which case it would be reported as 35.

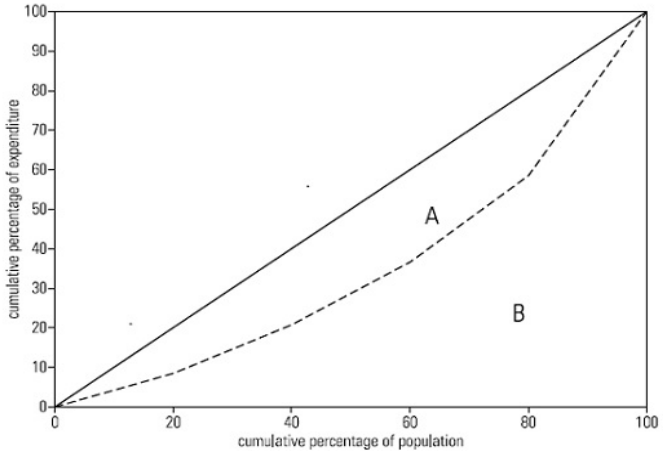
Formally, let xi be a point on the x-axis, and yi a point on the y-axis. Then

$$\text{Gini} = 1-\sum_{i=1}^{N} (x_i-x_{i-1}) (y_i + y_{i-1}) \quad (1)$$

When there are N equal intervals on the x-axis, equation (1) simplifies to

$$\text{Gini} = 1- 1/N \sum_{i=1}^{N} (y_i + y_{i-1}) \quad (2)$$

Figure 1. *Lorentz curve and Gini coefficient*



Source: Haughton and Khandker, 2009.

The Gini coefficient is not entirely satisfactory. Although it does satisfy some of the criteria that makes a good measure of income inequality[6]. The Gini index is not easily decomposable or additive across groups or the total Gini of society is not equal to the sum of the Gini coefficients of its subgroups. In the latter (namely statistical testability) one should be able to test for the significance of changes in the index over time. Partly this problem is overcome by confidence intervals and it can typically be generated using bootstrap techniques.

Generalized Entropy Measures (Theil's T and L measures)

There are a number of measures of inequality that satisfy all six criteria. Among the most widely used are the Theil indexes and the mean log deviation measure. Both belong to the family of generalized entropy (GE) inequality measures. The general formula is given by

$$GE(\alpha) = 1/\alpha(\alpha-1)\left[1/N\sum_{i=1}^{N}(y_i/\bar{y})^{\alpha}-1\right] \quad (3)$$

Here $\bar{y}$ is the mean income per person (or expenditure per capita). The values of GE measures vary between zero and infinity, with zero representing an equal distribution and higher values representing higher levels of inequality. The parameter α in the GE class represents the weight given to distances between incomes at different parts of the income distribution, and can take any real value. For lower values of α, GE is more sensitive to changes in the lower tail of the distribution, and for higher values GE is more sensitive to changes that affect the upper tail. The most common values of α used are 0, 1, and 2. GE (1) is Theil's T index, which may be written

$$GE(1) = 1/N\sum_{i=1}^{N}(y_i/\bar{y})\ln(yi/\bar{y}) \quad (3.1)$$

GE (0), also known as Theil's L, and sometimes referred to as the mean log deviation measure, is given by

$$GE(0) = 1/N\sum_{i=1}^{N}\ln(\bar{y}/yi) \quad (3.2)$$

Data base

We focus on district level inequity for health care availability, utilisation and outcomes for four Indian states namely Madhya Pradesh, West Bengal, Punjab and Karnataka. Based on their per capita average income compared to al India average, both Madhya Pradesh and West Bengal belong to lower income states and other two states belong to higher income states(7). We also compare change in district level inequity between two periods for West Bengal and Punjab. Data have been collected from various government publications. These include District Level Household and Facility Survey (DLHS-4), 2012-13: India. Madhya Pradesh (IIPS 2014), Estimates of State Domestic Product Madhya Pradesh; 2004-2005 to 2012-2013 (RBI, 2017), Annual Health Survey 2012-2013 (GOI, 2014), Karnataka at Glance (Government of Karnataka, 2018), Punjab-At-A-Glance (District Wise), Publication No. 936(Government of Punjab, 2012), Statistical Abstract West Bengal 2015 (Government of West Bengal, 2017) and others.

Results

Madhya Pradesh

Results for four states using district level data are presented in Tables 1-11 (and Figures 1-13). Results for Madhya Pradesh presented in Table 1 depict a range of unequal distribution of different health care facilities. For instance minimum population covered by a sub-centre is 4136 in contrast to 10255 in maximum coverage (Table 1). Likewise difference between minimum and maximum per capita income (PCI) is nearly four times. Similar disparities could be observed in terms of population coverage by PHCs and CHCs. Except for ANMs, for most of other manpower like MHW, medical officer, lady medical officer, AYUSH doctors and Pharmacist, the percentage SHCs having these types of manpower is much higher for maximum value districts relative to their minimum value districts (Table 1, columns 3-10). This observation also holds for facilities like regular electricity and water supply (columns 12-13, Table 1), toilet facilities, labour room availability and usage and sub-centres with govt. buildings (columns 14-17, Table 1). Such differentials in health inputs are also reflected in minimum and maximum IMR (37-85, column 18) in the districts of MP.

Keeping in mind these variations across districts, inequity coefficients, namely, Gini coefficient, Thiel's mean log deviations and Thiel's entropy measure (Thiel's T) are depicted in Figures 1a-2. As presented in Figure 1a, it could be observed that lowest inequity coefficient remains for ANMMP and very high inequity in terms of three inequity coefficients is for AYUSH doctors (AYUSHMP). Likewise in terms of facilities including regular water supply, electricity, availability and use of labour rooms and sub-centres with govt. buildings, the lowest and highest inequity pertains to toilet facilities and labour rooms used respectively.

Table 1. *District level maximum and minimum values relating to health facilities' average population coverage, percentage of health facilities having requisite medical manpower (or a particular facility) and Per Capita Income (PCI) in MP*

MP Total Districts 45	sub-Centre	PHC	CHC	ANM (%)	MHW (%)	Addi-tional ANM (%)	Medical officer (%)	Lady Medical Officer (%)	AYUSH Doctor (%)	Phar-macist (%)	PCI
minimum	4136	13538	47924	83.3	14.3	0	30	0	0	0	12892
maximum	10255	95591	229374	100	85.7	59.1	100	71.4	100	81.8	49327

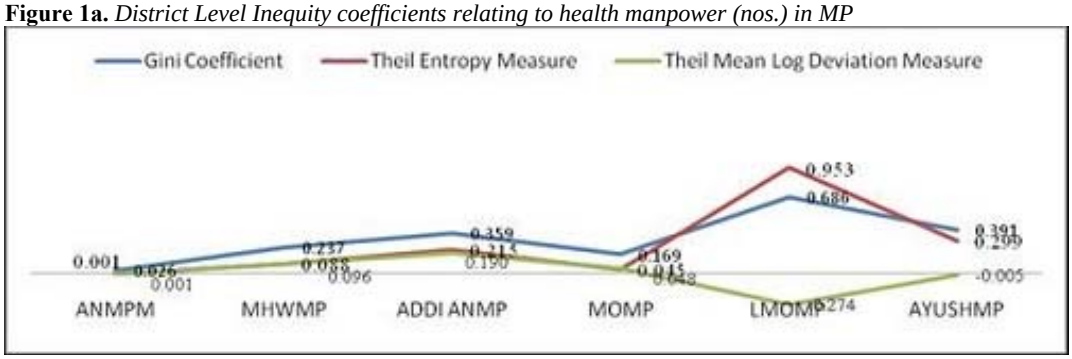
Source: Estimated; PHC = Primary Health Centres, CHC = Community Health Centre, ANM-Auxiliary Nurse Midwife, MHW = Male health Worke, SHC = Sub Health Centre, PCI = Per Capita Income at District level.

Table 1. contd

	Mpregelectr (%)	mpWater (%)	Mptoilet (%)	Mplaborroom (%)	Mplbinuse (%)	Mpscgbuil (%)	total imr mp
minimum	0	24	35.7	0	0	5	37
maximum	50	91.7	100	81.3	100	59	85

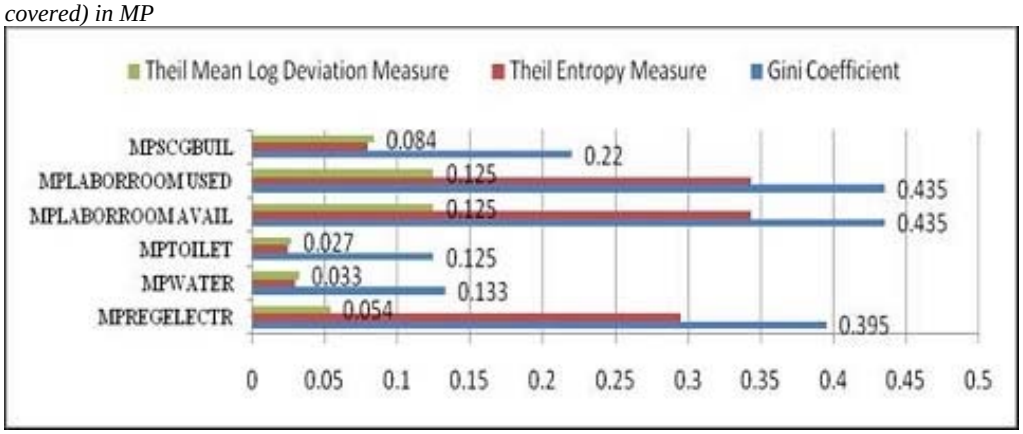
Source: Estimated; Number of sub-centres with regular electricity (mpregelectr), water supply (mpWater), toilet facilities (mptoilet), labour room (mplaborroom), labour room in current use (mplbinuse), sub-centres with govt. buildings (mpscgbuil), imr = infant mortality rates.

Figure 1a. *District Level Inequity coefficients relating to health manpower (nos.) in MP*



Source: Estimated; ANM-Auxiliary Nurse Midwife, MHW = Male health Worker, MOMP = Medical officer, LMOMP = Lady Medical Officer, AYUSHMP = AYUSH Doctor.

Figure 2. *District level inequity coefficients relating to health facilities (in terms of average population covered) in MP*

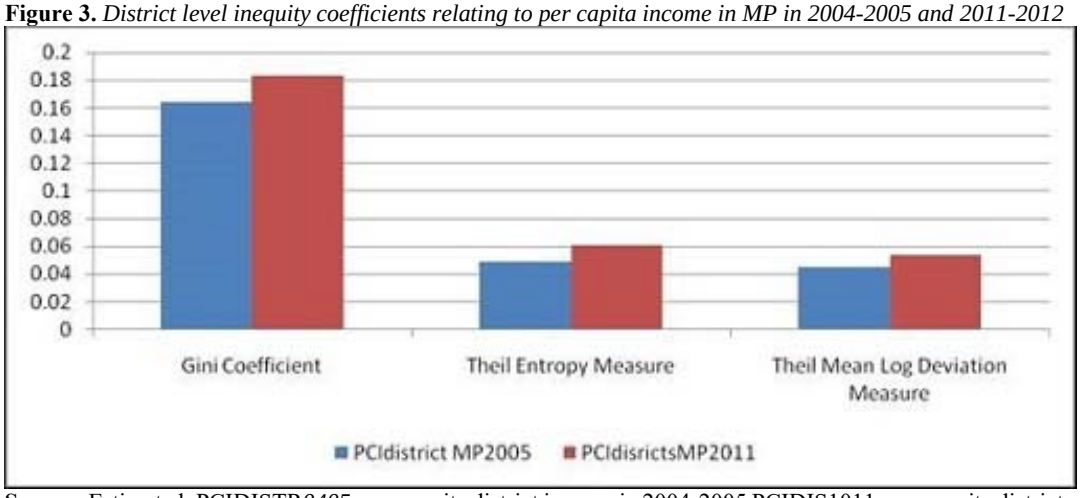


Source: Estimated; Number of sub-centres with regular electricity (MPREGELECTR), water supply (MPWATER), toilet facilities (MPTOILET), labour room (MPLABORROOM), labour room in current use (MPLBINUSE), sub-centres with govt. buildings (MPSCGBUIL).

However, as presented in Figure 3 and Table 2 inequity coefficients at district level per capita income and infant mortality rates for MP seem to be quite low. Thus there does not seem to be any pattern that a low income State has higher inequality. To explore any possible correlation between some selected health care facility variables and per capita income (PCI), we looked into correlations among selected variables and PCI which are depicted in Table 3.

The Pearson correlation between PCI and CHC population coverage is positive and significant at 5 percent level (Table 3). Also it is significant between percentages of Primary health centres having medical officer and PCI (Table 3). Thus possibly the better off areas might have attracted more medical manpower's posting and presence. Yet health system of this low income states has been largely guided by requirements of the norm to be satisfied under three tier health systems existing in Indian set up.

Figure 3. *District level inequity coefficients relating to per capita income in MP in 2004-2005 and 2011-2012*



Source: Estimated; PCIDISTR*0405* = per capita district income in 2004-2005 PCIDIS1011 = per capita district income in 2010-2011.

Table 2. *District level inequity coefficients relating to total infant mortality rate for MP*

inequality measures of totalimrmp	
Gini coefficient	0.076
Theil entropy measure	0.010
Theil mean log deviation measure	0.010

Source: Estimated; totalimrmp = total infant mortality rate district level for MP.

Table 3. *Pearson correlation for selected variables: Madhya Pradesh*

Per capita income	1				
chc pop covered	0.3746*	1			
Medical officer	0.3439*	0.015	1		
Lady medical officer	-0.2179	0.073	0.1918	1	
pharmacist	-0.0766	0.1234	-0.0239	-0.0527	1

Source: Estimated. * significant at 5% level.

Punjab

The maximum and minimum values for Punjab health care facilities are presented in Table 4 below. In case of Punjab the available information pertains to average population

coverage in hospitals (Hosp), Primary health centres (Phc), dispensaries (Dis) and community health centres (Chc), Ayurvedic, Unani and Homeopathic institutions (Aurv, Una and Homeo). Unlike other states the government publications provide us comparable data for two years namely 2001 and 2011. The comparison between two years facilitates inequity contrast after a decade. Indeed as seen in Table 4 below, maximum and minimum values gap has rather reduced for almost all the health facilities depicted here. This suggests that in some districts these health care facilities were not available in 2001(the minimum value being zero) and the same have been established by the year 2011. Also as presented in Table 5, we can observe that per capita income gap between maximum and minimum which was 1.86 times in 2004-2005 has reduced to 1.68 times in 2010-2011.

Table 4. *District level maximum and minimum values relating to health facilities (in terms of average population covered) in Punjab for 2001 and 2011*

punjab health facility (20 districts)	Hosp 2001	Hosp 2011	Phc 2001	Phc 2011	Dis 2001	Dis 2011	Chc 2001	Chc 2011
minimum	0	154502	0	36139	0	11815	0	124452
maximum	223714	992289	91904	105693	22954	26870	303283	622723

...contd

health facility	Aurv 2001	Aurv 2011	Una 2001	Una 2011	Homeo 2001	Homeo 2011
minimum	0	25598	0	0	0	98615
maximum	127836	141756	1183295	1388859	894854	992289

Source: Estimated; Hosp2001 and Hosp2011 = Hospitals in 2001 and 2011, Phc2001 and Phc2011= Primary Health Centres in 2001 and 2011, Dis2001 and Dis2011 = Government dispensaries in 2001 and 2011, Chc2001 and Chc2011 = Community health centres in 2001 and 2011, Aurv2001 and Aurv2011 = Ayurvedic Institutions in 2001 and 2011, Una2001 and Una2011 = Unani Institutions in 2001 and 2011 Homeo2001 and Homeo2011 = Homeopathic Institutions in 2001 and 2011.

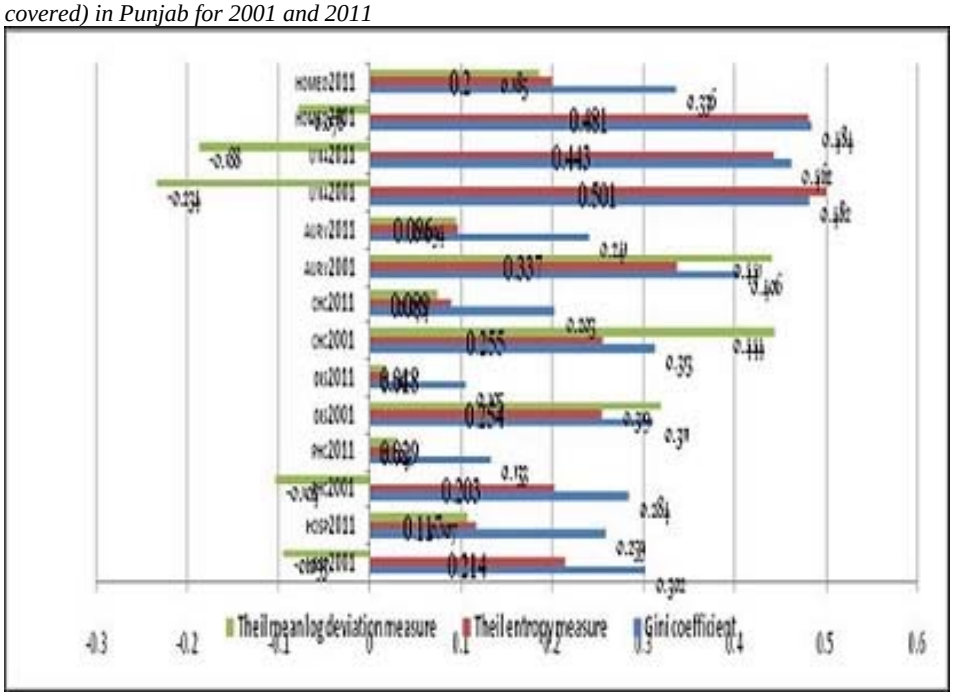
Table 5. *District level maximum and minimum values relating to per capita income in Punjab in 2004-2005 and 2010-2011*

	PCIpun0405distr	PCIpun 1011disr
minimum	26790	56429
maximum	49976	94798

Source: Estimated; Pcipun0405distr and Pcipun1011disr = per capita district income in Punjab in 2004-2005 and 2010-2011.

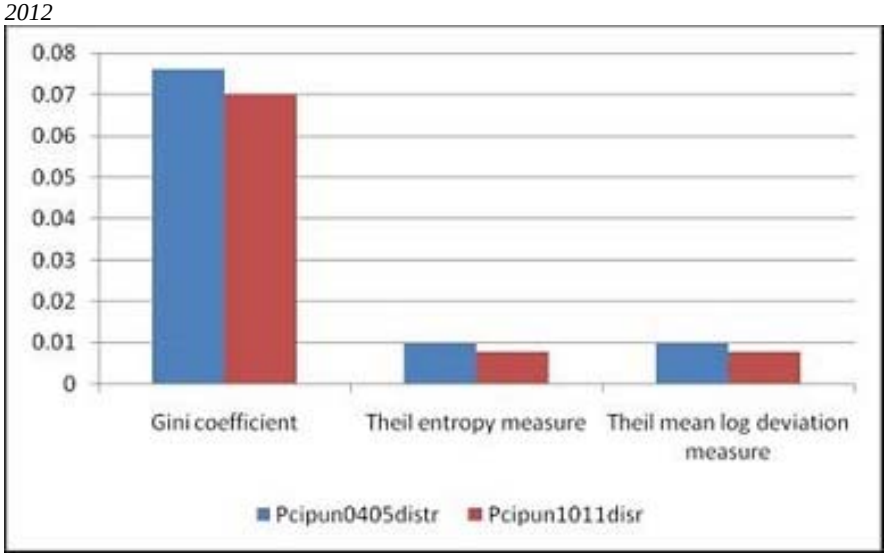
Further as depicted in Figure 4, the inequity coefficients pertaining to hospitals, PHCs, Dispensaries, CHCs, ayurvedic, unani and homeopathic institutions have reduced in magnitude for all these facilities in Punjab between 2001 to 2011. For instance, Gini coefficient which was highest in 2001 for homeopathic institutions (.484) and Thiel's entropy measure which was highest for unani institutions (.501) came down to .336 and .443 respectively in 2011. Also by and large the patterns of all the three inequity coefficients remain in tune with each other. However among homeopathic and unani institutions the highest was different for Gini in 2011 which was unani institutions and it was unani institutions for Thiels entropy measure in both the periods. Also as presented in Figure 5, the inequity across per capita incomes in the districts of Punjab has come down and thus a similarity between downward movements of inequity values relating to health facilities and per capita incomes is observed for Punjab.

Figure 4. *District level inequity coefficients relating to health facilities (in terms of average population covered) in Punjab for 2001 and 2011*



Source: Estimated; Hosp2001 and Hosp2011 = Hospitals in 2001 and 2011, Phc2001 and Phc2011 = Primary Health Centres in 2001 and 2011, Dis2001 and Dis2011 = Government dispensaries in 2001 and 2011, Chc2001 and Chc2011 = Community health centres in 2001 and 2011, Aurv2001 and Aurv2011 = Ayurvedic Institutions in 2001 and 2011, Una2001 and Una2011 = Unani Institutions in 2001 and 2011 Homeo2001 and Homeo2011 = Homeopathic Institutions in 2001 and 2011.

Figure 5. *District level inequity coefficients relating to per capita income in Punjab in 2004-2005 and 2011-2012*



Source: Estimated; Pcipun0405distr and Pcipun1011disr = per capita district income in Punjab in 2004-2005 and 2010-2011.

West Bengal

The results for another low income state namely West Bengal are presented below. As depicted in Table 6, there is one district (which is largely urban and it is the capital Kolkata) which is not having any sub-centre and sub-centre beds in both the years and thus the minimum population coverage is zero in these years. It should be noted that more population coverage actually denotes that a health facility is catering in a more populated district and thus in year 2014 due to increase in number of health facilities we see a decline in total population coverage for all the health facilities depicted in Table 7. Also the difference in terms of gap between maximum and minimum which was highest for private beds (40.62 times in 2011) and the lowest (2.329 times in 2011) for total health units has not altered in 2014 thus indicating probably no change in inequity between the two years. This pattern of no change is in contrast to Punjab where a decline was indicated. However we also underline that the gap between contrasting years is only three years in West Bengal and in case of Punjab it is 7 years. Further the figures for minimum and maximum for per capita disposable income (in 2004-2005 and 2011-2012) and the population served per bed (in 2016) are presented in Table 8 which suggest that the gap between minimum and maximum income levels (less than three times in 2004-2005) increased in 2011-2012 to more than three times. Also as shown in Table 8, the population served per bed in 2016 in terms of maximum and minimum populations was nearly 18 times.

The inequity coefficients are presented for different health facilities variables and per capita incomes for the similar periods as discussed above. These indicate actually inequity increase for West Bengal (figures 6 and 7). For instance Gini coefficient value which was the lowest for total health units (.122) in the year 2011 went up to .141 (in 2014). Likewise the maximum Gini value which was .412 for private hospitals in 2011 increased to .438 (in 2014) (figure 6). Even the per capita income has also shown an increase in inequality from 2004 to 2011-12 with the Gini values as being .135 and .165 in the respective years (Figure 7). Keeping in view the highest level of inequity pertaining to private hospitals and hospital beds we also looked into Pearsons correlation coefficients across Per capita incomes and different health facilities. Presented in Table 9 below these indicated a very high positive and significant correlations between both the government and private hospitals (as well as beds in them) and Per capita incomes. Probably part of increase in inequality in the latter period could also be attributed to these high correlations.

Table 6. *District level maximum and minimum values relating to health facilities (in terms of average population covered) in West Bengal for 2011*

per health facility population covered WB 2011									
	wbg bhos	wbgh osbed	wbpv thos	wbpvth osbed	wbhcent	wbhecentbed	wbscent	wbtothltunit	wbtothltbed
minimum	87716	275	12259	395	0	0	0	4652	162
maximum	849040	4227	243997	16047	136255	9761	13589	10837	2450

Source: Estimated; wbgbhos = Government hospitals in WB, wbghosbed = beds in Government hospitals in WB, wbpvthos = private hospitals in WB, wbpvthosbed = beds in private hospitals in WB, wbhcen = health centres in WB, wbhecentbed = beds in health centres in WB, wbscent = sub-centres in WB, wbtothltunit = total health units in WB, wbtothltbed = beds in total health units in WB.

Table 7. *District level maximum and minimum values relating to health facilities (in terms of average population covered) in West Bengal for 2014*

per health facility population covered WB 2014								
wbgbhos	wbghosbed	wbpvthos	wbpvthosbed	wbhcent	wbhecentbed	wbscent	wbtothltunit	wbto thltbed
87716	268	12259	395	0	0	0	4652	160
750212	4168	243997	16047	136255	9548	13589	10864	2422

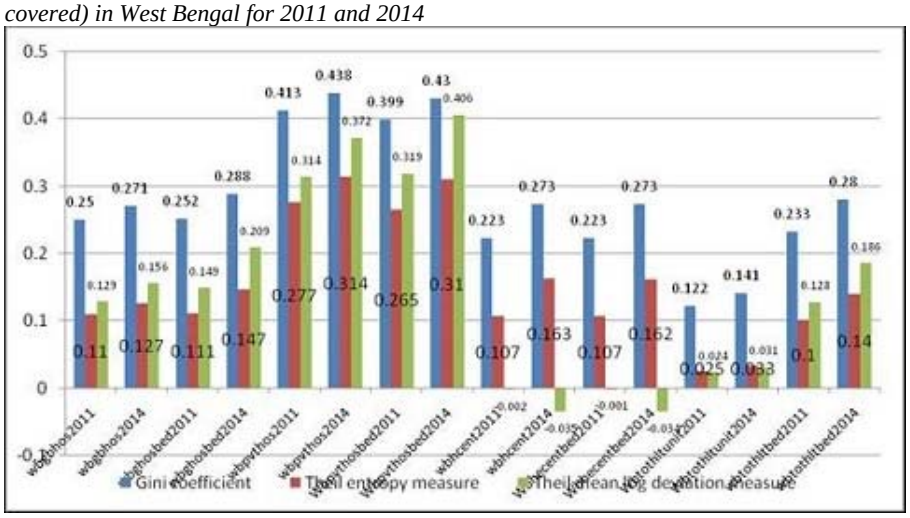
Source: Estimated.

Table 8. *District level maximum and minimum values relating to per capita income in 2004-2005 and 2011-2012 and population served per bed in West Bengal*

	Pcidiswb 0405	Pcidis Wb1112	Popserperbed Totwb 2016
minimum	13684.03	17465.64	138
maximum	38393.62	57907.11	2477

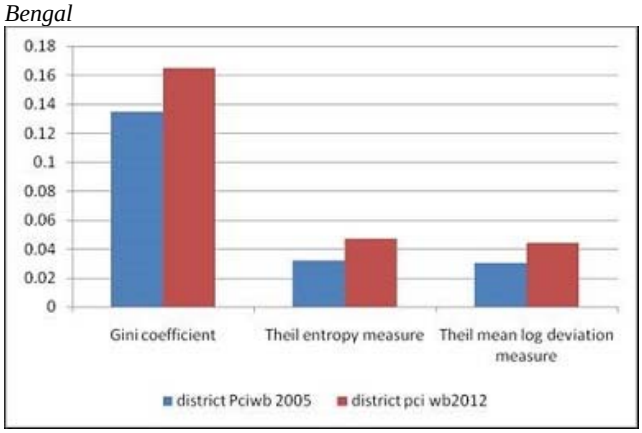
Source: Estimated.

Figure 6. *District level inequity coefficients relating to health facilities (in terms of average population covered) in West Bengal for 2011 and 2014*



Source: Estimated; wbgbhos = Government hospitals in WB, wbghosbed = beds in Government hospitals in WB, wbpvthos = private hospitals in WB, wbpvthosbed = beds in private hospitals in WB, wbhcen = health centres in WB, wbhecentbed = beds in health centres in WB, wbscent = sub-centres in WB, wbtothltunit = total health units in WB, wbtothltbed = beds in total health units in WB, suffix 2011 and 2014 refers to values of these variables in the respective years.

Figure 7. *District level inequity coefficients relating to per capita income in 2004-2005 and 2011-2012 in West Bengal*



Source: Estimated.

Table 9. *Pearson correlation for selected variables: West Bengal*

Pcidis 11-12	1					
wbgbhos	0.7851*	1				
wbghosbed	0.7780*	0.8519*	1			
wbpvthos	0.8702*	0.9085*	0.8054*	1		
wbpvthosbed	0.8556*	0.9004*	0.9569*	0.8961*	1	
wbtothltbed	0.8199*	0.8933*	0.9903*	0.8687*	0.9828*	1

Source: Estimated.

Karnataka

For Karnataka, the detailed information for 28 health related variables are presented below. Among others, these include the number of units and number of beds in various categories of hospitals covering: taluk, district, health and family welfare and teaching hospitals, PHCs, CHCs, government hospitals, private hospitals, nursing homes, allopathic, and ISM hospitals. Also details include variables relating to numbers of govt. doctors and other facilities like blood banks and medical shops. Table 10 depicts the maximum and minimum values for these variables. We can observe from it that gap between maximum and minimum is lowest (2.208 times) for total health institutions and beds therein. The largest gap between minimum and maximum (22.319 times) pertains to beds in Taluka hospitals. Also as given in the same table, the gap between maximum and minimum for total number of infant deaths is nearly 80 times.

Table 10. *District level maximum and minimum values relating to health facilities (in terms of average population covered) in Karnataka for 2016*

Karnataka Total Districts 30	taluk hospno	taluk beds	Distrhospno	Dhosp bed	hfwhosp	Hfw bed	Teach hospi	Tea hospi bed	Total hosp	Tot hosp bed
minimum	143717	1437	0	0	0	0	0	0	50411	377
maximum	3207184	32072	2678980	12551	3001127	60023	4779661	6459	356354	2446

Source: Estimated; talukhospno = number of TalukaHq Hospitals, talukbeds = number of beds inTalukaHq Hospitals, Distrhospno = number of District Hospitals, Dhospbed = number of District Hospitals beds, hfwhosp = Other Hospitals under HFW, Hfwbed = beds in Other Hospitals under HFW, Teachhospi = Number of teaching hospitals, Teahospibed = Number of beds in teaching hospitals, chc = Number of community health centres, Chcbed = Number of beds in community health centres, Totalhosp = total number of hospitals, Tothospbed = total number of beds in all hospitals.

Table 10. contd
population covered by health facility

Karnataka Total Districts 30	Govtho spino	Nurs Homno	Total	Govt Doctors	beds Govt Hospi	Med Shops	Blood Banks	Allo pathy hospi	allo beds	ism hosp	ism Beds
minimum	10635	11262	7967	6161	323	959	152723	11156	329	184840	10037
maximum	68238	115827	17594	29696	1553	5130	1703300	73447	1581	1044825	165154

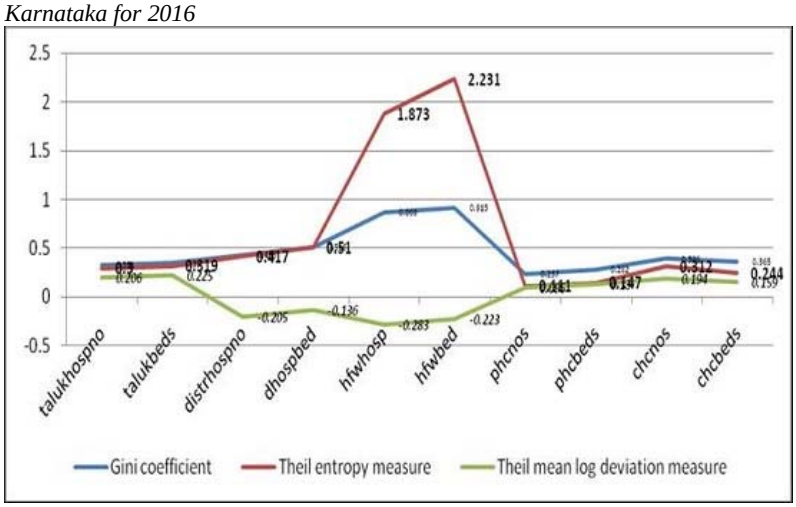
Source: Estimated.
Govthospino = total number of government hospitals, NursHomno = total number of nursing homes, Total = total number of health institutions, Govt Doctors = total number of Govt Doctors, beds Govt Hospi = total number of beds in Govt Hospitals, Med Shops = total number of Medical Shops, Blood Banks = total number of Blood Bank, Allopathy hospi = total number of Allopathy hospitals, allobeds = total number of beds in Allopathy hospitals, ismhosp = total number of Indian system of medicines(ISM) hospitals, ismBeds = total number of beds in Indian system of medicines(ISM) hospitals.

Table 10. contd
population covered by health facility

Karnataka Total Districts 30	pvthosp	phcNos.	phcBeds	chcNos.	chcBeds	pcidistrkantka0910	Infantdeaths karntka
minimum	11262	12644	1704	0	0	25078	16
maximum	115827	92515	15930	1924310	43734	140369	1289

Source: Estimated.
Pvthosp = total number of private hospitals, phcNos. = total number of primary health centres, phcBeds = total number of beds in primary health centres, chcNos. = total number of community health centres, chcBeds = total number of beds in community health centres, pcidistrkantka0910 = per capita district income in Karnataka in 2009-10, Infantdeaths karntka = number of infant deaths in districts of Karnataka in 2011.

Figure 8. *District Level Inequity values relating to Health Facilities (taluk, district, health and family welfare hospitals, primary and community health centres and beds (in terms of Average Population Covered) in Karnataka for 2016*

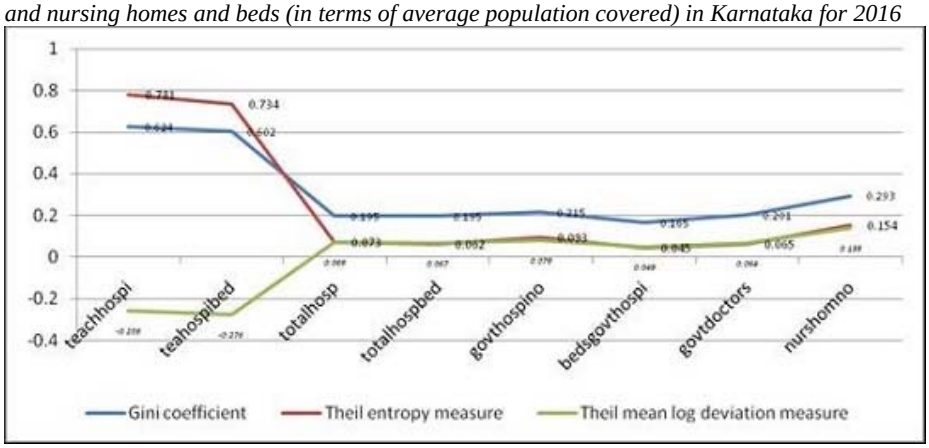


Source: Estimated; talukhospno = number of TalukaHq Hospitals, talukbeds = number of beds inTalukaHq Hospitals, Distrhospno = number of District Hospitals, Dhospbed = number of District Hospitals beds, hfwhosp = Other Hospitals under HFW, Hfwbed = beds in Other Hospitals under HFW, chc = Number of community health centres, Chcbed = Number of beds in community health centres.

As presented in Figure 8, the highest values of Gini (.915) is for hfw beds and lowest (.237) is for PHC numbers. Other inequity coefficients namely Thiel's entropy and mean log deviations follow nearly the same order of values as that of Gini. This indicates that most

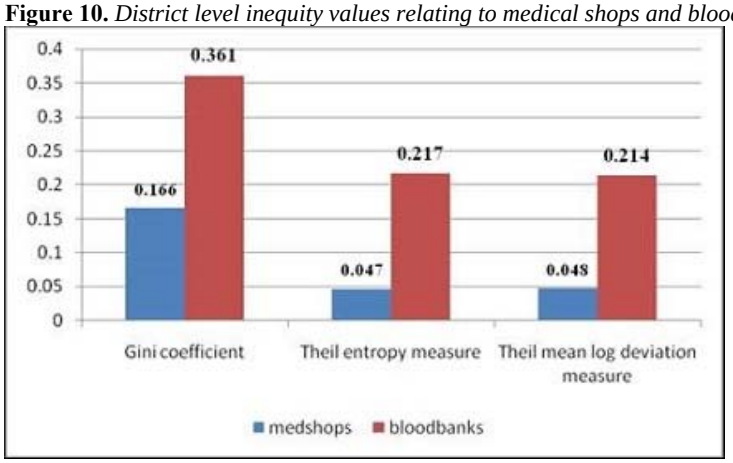
other government established health facilities except HFW hospitals are more equitably distributed across the districts in Karnataka. Likewise the highest inequity as observed from Gini coefficients in Figure 9 depicts more inequitable distribution of teaching hospitals since the coefficient for this category of health facilities (.624) is the highest. The lowest inequity in this group (.165) (as presented in Figure 9) is for beds in government hospitals which denotes a better health facility planning in the state. However, if we compare other kind of facilities like blood banks or medical shops, we find that the absolute values are not high (Figure 10) yet relative to medical shops; blood banks are less equitably distributed across the districts of the state. Further as presented in Figure 11, broadly two systems of medicines, namely allopathic and Indian systems of medicines, the latter is more inequitably distributed both in terms of numbers of hospitals (Gini .266) and beds (Gini .338). Even the inequity in numbers of private hospitals (.293) is also higher than in numbers of ISM hospitals (Gini .266). A similar lower value (.201) for Gini coefficient is observed for distribution of government doctors in the districts (Figure 12). Thus keeping in view in general lower values of government established institutions, we looked into inequity pertaining to Per capita income (for 2009-10) and a variable which was available from the published data as a broad indicator of health system output namely infant mortality at district level. These are presented in Figure 13. Although the per capita income inequity is very low but infant deaths inequity seemed to quite high with Gini and other inequity coefficients nearing towards 0.50 magnitudes (Figure 13). Further with a presumption that per capita income may have a significant correlation mostly with private health facilities like nursing homes and private hospitals, we looked into Pearson's correlation coefficients among per capita incomes, public and private health facilities (Table 11). However, as observed from Table 11, this correlation with per capita incomes was high and significant for public as well as private health facilities probably indicating an overall influence of the economic development of the state on health sector.

Figure 9. *District level inequity values relating to health facilities (teaching, govt. and total hospitals, and beds and nursing homes and beds (in terms of average population covered) in Karnataka for 2016*



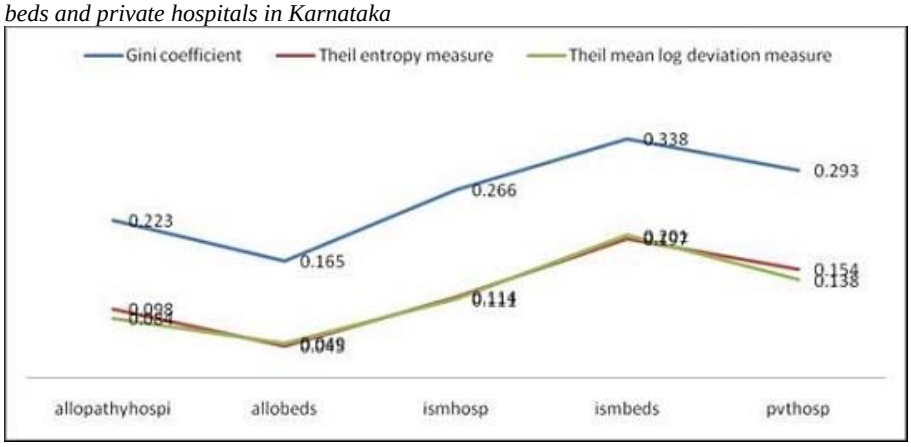
Source: Estimated. Teachhospi = Number of teaching hospitals, Teahospibed = Number of beds in teaching hospital, Totalhosp = total number of hospitals, Tothospbed = total number of beds in all hospitals
Govthospino = total number of government hospitals, bedsGovt Hospi = total number of beds in Govt Hospitals GovtDoctors = total number of Govt. Doctors, beds, NursHomno = total number of nursing homes.

Figure 10. *District level inequity values relating to medical shops and blood banks*



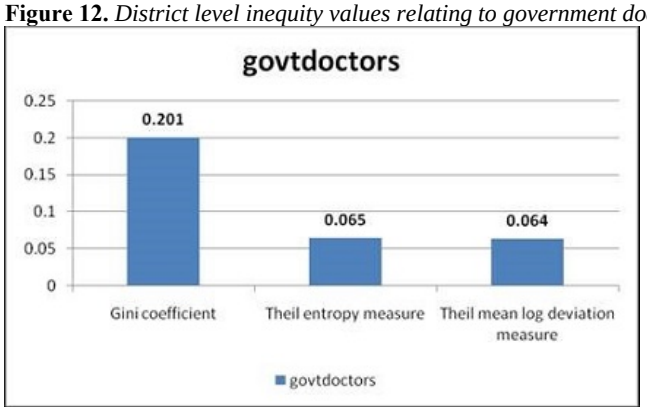
Source: Estimated.

Figure 11. *District Level Inequity values relating to Allopathic, Indian system of medicine (ISM) hospitals and beds and private hospitals in Karnataka*



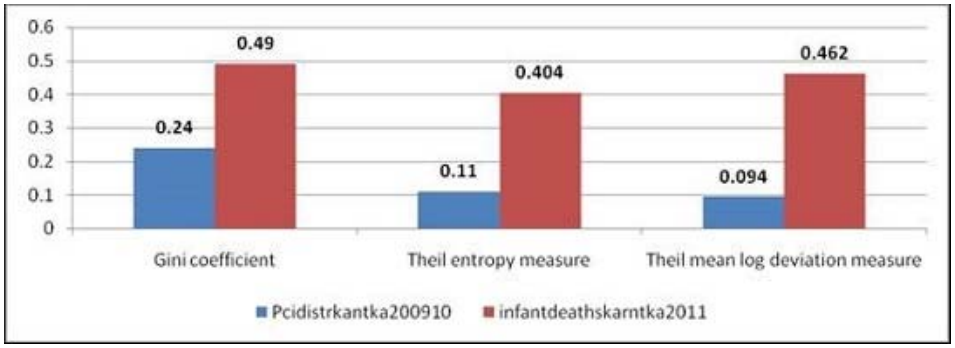
Source: Estimated. Allopathy hospi = total number of Allopathy hospitals, allobeds = total number of beds in Allopathy hospitals, ismhosp = total number of Indian system of medicines(ISM) hospitals, ismBeds = total number of beds in Indian system of medicines(ISM) hospitals, pvthosp = total number of private hospitals.

Figure 12. *District level inequity values relating to government doctors in Karnataka*



Source: Estimated.

Figure 13. *District level inequity values relating to district per capita income (2010) and infant deaths (2011) in Karnataka*



Source: Estimated.

Table 11. *Pearson correlation for selected variables: Karnataka*

	pcidist~0910	teach hospi	teahos pibed	tothospbed	nurshomno	pvthosp	medshops	bedsgov thospi
Pcidist 2009-2010	1							
teachhospi	0.7145*	1						
teahospibed	0.7060*	0.9818*	1					
tothospbed	0.6990*	0.9387*	0.9496*	1				
nurshomno	0.6412*	0.8146*	0.8252*	0.8678*	1			
pvthosp	0.6412*	0.8146*	0.8252*	0.8678*	1.0000*	1		
medshops	0.7272*	0.9471*	0.9249*	0.9337*	0.9136*	0.9136*	1	
bedsgovthospi	0.6462*	0.9084*	0.9271*	0.9878*	0.8428*	0.8428*	0.9088*	1

Source: Estimated.

Conclusions

Our results for inequity at district levels relating to health system variables, per capita incomes and a proxy for health system output covering two low income and two high income Indian states indicated that: i) it is not necessary that a low income state or high income state may have high intra state disparity either in health care facilities, health care output and per capita incomes; ii) comparing two periods for intra state inequity for a high income state like

Punjab and low income state like West Bengal, we observed that in the high income state there is generally a decline in inequity. By contrast in low income state, between two periods with a shorter gap of three years, in general for health system variables the inequity seemed to be on rise; iii) despite being a high income state (like Karnataka) with low magnitudes of inequity for health system variables (in general) and per capita incomes, due to some other reasons a broad health system output indicator, infant deaths, could show a large magnitude of inequity; iv) the results across all the four states covered by us indicate that overall three tiers of health facilities expansion by the central and state governments in India has led in general to more equitable public health facilities, yet private health facilities are less equitable and per capita incomes at district levels seemed to have some influence for creating demand and thus establishment of private health facilities within the state; v) our results are more indicative rather than conclusive since we have restricted to correlations and not explored causation through more elaborate models.

Notes

(1) Government of India (2014), National Health Policy 2015, Ministry of Health and Family Welfare, December, 2014.

(2) *Targets for health for all*. Copenhagen, WHO Regional Office for Europe, 1985 (European Health for All Series No. 1). The extent of differentials in health in European nations including UK, France, Spain and Hungary in terms of mortality across income and occupation groups, employed vs. unemployed, rural-urban areas, gender, type of locality, disease specific incidences and disability has been nicely highlighted by a WHO document in 1985 (WHO, 1985).

(3) For a detailed review of literature, see Purohit (2017).

(4) See for instance, Haughton, Jonathan; Khandker, Shahidur R. 2009. Handbook on poverty and inequality. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/488081468157174849/ Handbook-on-poverty-and-inequality
Alicja Krol and Judy Maan Miedema (2009), Measuring Income Inequality: an Exploratory Review, Document #: 451158 Region of Waterloo Public Health Health Determinants, Planning and Evaluation Division June. Yang Wei (2013), An analysis of inequities and inefficiencies in health and healthcare in China, thesis submitted to the Department of Social Policy of the London School of Economics for the degree of Doctor of Philosophy London.

(5) Some measures have focus on welfare and income orientation these include Atkinson's index, Mehran measure, Piesch measure and Kakwani measure.

(6) For instance it satisfies mean independence (If all incomes were doubled, the measure would not change), Population size independence (If the population were to change, the measure of inequality should not change, all else equal), Symmetry (If any two people swap incomes, there should be no change in the measure of inequality), Pigou-Dalton Transfer sensitivity (Under this criterion, the transfer of income from rich to poor reduces measured inequality). However, it does not satisfy two other criteria including decomposability and statistical testability. In the former (namely decomposability) inequality may be broken down by population groups or income sources or in other dimensions.

(7) See, Annexure Table A1.

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Annexure 1

Table A1. *Per capita incomes of Indian states*

S. No.	State/*Union territory*	GRDP per capita (nominal)	Data-year
1	*Andaman and Nicobar Islands*	₹121,954 (US$1,800)	2014–15
2	Andhra Pradesh	₹142,054 (US$2,100)	2017–18
3	Arunachal Pradesh	₹113,645 (US$1,700)	2015–16
4	Assam	₹60,952 (US$910)	2015–16
5	Bihar	₹34,168 (US$510)	2015–16
6	*Chandigarh*	₹242,386 (US$3,600)	2015–16
7	Chhattisgarh	₹91,772 (US$1,400)	2016–17
8	*Delhi*	₹303,073 (US$4,500)	2016–17
9	Goa	₹270,150 (US$4,000)	2015–16
10	Gujarat	₹138,023 (US$2,100)	2015–16
11	Haryana	₹180,174 (US$2,700)	2016–17
12	Himachal Pradesh	₹158,462 (US$2,400)	2017–18
13	Jammu and Kashmir	₹72,958 (US$1,100)	2015–16
14	Jharkhand	₹62,816 (US$940)	2015–16
15	Karnataka	₹146,416 (US$2,200)	2015–16
16	Kerala	₹155,516 (US$2,300)	2015–16
17	Madhya Pradesh	₹72,599 (US$1,100)	2016–17
18	Maharashtra	₹134,081 (US$2,000)	2014–15
19	Manipur	₹52,436 (US$780)	2014–15
20	Meghalaya	₹79,332 (US$1,200)	2016–17
21	Mizoram	₹85,659 (US$1,300)	2014–15
22	Nagaland	₹78,526 (US$1,200)	2014–15
23	Odisha	₹75,223 (US$1,100)	2016–17
24	*Puducherry*	₹190,384 (US$2,800)	2016–17
25	Punjab	₹114,561 (US$1,700)	2014–15
26	Rajasthan	₹76,881 (US$1,100)	2014–15
27	Sikkim	₹227,465 (US$3,400)	2015–16
28	Tamil Nadu	₹157,116 (US$2,300)	2016–17
29	Telangana	₹175,534 (US$2,600)	2017–18
30	Tripura	₹71,666 (US$1,100)	2014–15
31	Uttar Pradesh	₹48,520 (US$720)	2015–16
32	Uttarakhand	₹151,219 (US$2,300)	2015–16
33	West Bengal	₹78,903 (US$1,200)	2014–15
	India	₹112,764 (US$1,700)	2017–18

Source: Reserve Bank of India (2017); State Wise Data, *rbi.org.in*, New Delhi, pp. 29-33.