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Measuring Catastrophic Health Expenditures and its Inequality: Evidence from Iran's Health Transformation Program

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Abstract

One of the important goals of Iran's health transformation programme (HTP) is to improve financial protection for households against health expenditure. This study aimed to investigate the occurrence, intensity and inequality in distribution of catastrophic health expenditure (CHE) using the WHO and the World Bank (WB) methodologies with different thresholds in the years before and after HTP. We used data from seven annual national repeated cross-sectional surveys on households' income and expenditures from 2011 to 2017. The intensity to CHE was calculated using overshoot and mean positive overshoot (MPO) indices. Finally, the inequality in distribution of exposure to CHE was calculated using the concentration index (CI), and the dominance test of concentration curves was used to inference about the significant changes in inequality of the years before and after HTP. The exposure rate to CHE in the total population and at 40% threshold of the WHO methodology changed from 1.99% in 2011 to 3.46% in 2017. Additionally, at 20% threshold of the WB methodology, it was changed from 5.14% to 8.68%. Overshoot and MPO indices increased on average based on two methodologies in urban and rural areas during seven years. The CIs for all the years show a negative value in both methodologies, indicating that CHE occurrence is higher among the poor households. In 2017, at 40% threshold of the WHO, the numerical values of the CIs were −0.15 and −0.14 in urban and rural populations, respectively. These values were −0.07 and −0.05 for the 20% threshold of WB, respectively. Results of dominance test showed no significant change in inequality for the years after than before HTP with two exceptions for total and rural populations based on the WB methodology. Generally, HTP had no considerable success in financial protection, requiring a review in actions to support pro-poor adaptation strategies.

Keywords: Catastrophic health expenditure, health inequalities, Iran's health transformation programme, health policy

Introduction

One of the sustainable development goals of the United Nations is the access of all countries to universal health coverage (UHC) by 2030 (WHO, 2015). WHO has defined the UHC as to ensure that all people have access to necessary health services without any financial constraints during receiving the services (WHO, 2010). Existence of financial barriers causes some difficulties in need-based access to therapeutic interventions especially for

Key Messages

- We found that generally the exposure rate to CHE and intensity during the study years has increased and the Iran's health transformation programme (HTP) only has reduced the rate of growth of exposure to catastrophic health expenditure (CHE) based on WHO methodology results, but overall, compared with the before HTP, there has been no significant decrease in any of WHO and World Bank (WB) methodologies results.
- In all the years studied, the results of the CHE occurrence with the target set out in Iran's development plans were significantly different.
- The numerical value of concentration index was negative in all urban and rural populations during all the study years, which means that exposure to CHE has more concentration on low socio-economic status households.
- Reducing inequality in the years after the HTP was not significant exception in the two sub analyses (i.e. total and rural popluation) in the WB methodology results, and it seems to be necessary to review and redeveloping the targeted mechanisms and interventions in favour of the poor people and disadvantaged groups with chronic, severe and high-cost illnesses.

disadvantaged and at-risk people. In this regard, equitable financial protection against health expenditures plays a pivotal role in achieving UHC (WHO, 2013), and is one of the goals and policies of health systems (Filmer *et al.*, 2002). As, lack of financial protection in health is recognized as an illness of the health system (Knaul *et al.*, 2006).

The rate of households' exposure to catastrophic health expenditures (CHE) is one of the indices used to evaluate and control the status of financial protection in health systems which had globally received considerable critical attention. Evidence reveals that the high contribution of out-of-pocket (OOP) for health services results in inappropriate coverage of social protection of health and economic hardships especially in developing countries (McIntyre *et al.*, 2006; Van Doorslaer *et al.*, 2006). Despite the accomplished actions in the field of improving global health financing, developing countries still suffer from the barriers to providing health financing resources, and ultimately, high level of OOP payments should be paid, and it would lead to imposition of CHE (Van Lerberghe, 2008).

There are different methods for CHE occurrence considering the household's income and capacity to pay (CtP); paying more than a certain percentage of their income or CtP for health has been reported in various studies (Berki, 1986; Pannarunothai and Mills, 1997; Frenk and Knaul, 2002; Merlis, 2002; Waters *et al.*, 2004). The WHO defines CHE as when household's health expenditure is equal or >40% of household's income after paying for essential expenditure, that household is exposed to CHE (Xu *et al.*, 2003). Furthermore, the World Bank (WB) is one of the organizations that has its own standard in this scope, and the threshold of 20% of total household's expenditure is considered a criterion for catastrophic expenditure (Van Lerberghe, 2008). Countries may have different agreed and non-agreed thresholds in their national health policies to estimate the amount of their CHE, and different sources have considered different thresholds (Murray *et al.*, 2003; Xu *et al.*, 2003; Kavosi *et al.*, 2009).

Given that health financial protection indices are expressed as rates and proportions, and according to this issue that these indices represent a moderate amount in population, they cannot comprehensively explain the status in the different subgroups of society, such as income deciles. Therefore, surveying the status of inequality in the distribution of these indicators is highly important for proactive and forward-looking policymaking. Health inequality is a general term used to indicate the existing differences, changes and inconsistencies in access to the health care of individuals or groups (Norheim and Asada, 2009).

In Iran, equity in health financing and usage has been emphasized in national plans and upper-level documents, and it has been considered one of the social preferences. One of the most important objectives in the fifth and sixth 5-year development plans in Iran was decreasing the rate of households' exposure to CHE to 1% (IPI, 2011, 2017). Also In 2014, a programme named health transformation programme (HTP) was launched in Iran. This programme encompassed a series of interventions in a stepwise process. The HTP package in the treatment sector followed several main interventions. One main intervention was to expand access to healthcare services through increasing population covered by basic health insurance. In this regard, non-insured people were covered by health insurance with no premium. According to the report of the National Institute of Health Research of Iran (NIHR), insurance coverage increased to 96% after implementing HTP (NIHR, 2015), while based on Iran's Multiple-Indicator Demographic and Health Survey (IrMIDHS) report in 2010, the level of population covered by basic health insurance was 83.15% (Rashidian *et al.*, 2010). Another intervention was decreasing co-insurance for hospital services (reducing to 5% and 10% for rural and urban residents, respectively) in public hospitals affiliated with the Ministry of Health (MOH). Furthermore, HTP obliged these hospitals to provide all necessary medicines, consumables and services inside the hospitals and to reduce the number of unnecessary referrals to private centres. It also focused on improving the quality of care with a primary emphasis on the public hospitals affiliated with the MOH (Moradi-Lakeh and Vosoogh-Moghaddam, 2015; Aghajani *et al.*, 2017). In case of medical services pricing, it revises and updates the medical tariffs based on the relative value units of treatment procedures aiming at more balanced and realistic values among different specialties. Another goal of HTP was to redistribute physicians in hospitals in less-developed areas, to encourage them to stay and work in deprived areas, thereby increasing equity in access to health services and reducing disparities between different regions of the country. In addition, another goal of the programme was to increase the duration of the presence of specialist physicians in hospitals affiliated with the MOH (Olyaeemanesh *et al.*, 2018). This programme also encompassed some interventions in primary health care, which primarily focused on developing physical infrastructure, expanding access to and improving quality of PHC in slum and suburban populations as well as introducing and strengthening self-care and surveillance programmes to control non-communicable diseases (NCD). This programme relied on two main financial sources, including allocating a 10% proportion of the targeted subsidies

initiative resources and 1% of the income earned by value-added tax; this was carried out by increasing the public budget and insurances contribution in health payments.

Nevertheless, the amount of achievement of the goals of the plans especially in financial protection is ambiguous.

Based on the given explanations on the importance of the subject, this study aims to survey three main objectives: first, estimating the amount of occurrence and intensity of households facing CHE based on the different thresholds of the two standard methodologies of the WHO and the WB from 2011 to 2017 to provide more comprehensive evidence as well as sensitivity analysis at various thresholds. Secondly, we aimed to estimate the inequality status in distribution of households' exposure rate to CHE from 2011 to 2017, and finally, comparing the amount of occurrence and intensity of CHE and its inequality level during the two different periods, which are before HTP (2011–13) and after HTP (2014–17).

Materials and methods

This article is a retrospective descriptive study that used data from seven annual national repeated cross-sectional surveys on households' income and expenditure from 2011 to 2017 in Iran (ISC, 2017). The study sample size varied from 38 434 in 2011 to 37 866 in 2017 after removing specimens in which no food expenditure was reported. It also varied from 18 695 in 2011 to 18 559 in 2017 in urban populations and from 19 739 to 19 207 in rural populations.

Calculations

Occurrence and intensity of exposure to CHE

In this study, two common methodologies attributed to the WHO and the WB has been used to estimate the occurrence and intensity of exposure to CHE. Overshoot and Mean Positive Overshoot (MPO) are among the indicators used to estimate the intensity of exposure to CHE. These calculations were performed over two periods, i.e. 3 years before HTP (2011–13) and 4 years after HTP (2014–17) in all three sample frames, including urban and rural segments and in four thresholds of each methodology. Details of the calculation of occurrence and intensity of CHE based on two methodologies are explained in Supplementary Data.

Calculation the inequality status in distribution of exposure to CHE

One of the methodologies for calculating the inequality status in the distribution of health variables is using the concentration index (CI). The CI was first introduced by Wagstaff *et al.* (1989) and is widely used to measure inequalities in various variables of health and health services utilization (Zhong, 2010; Amini Rarani *et al.*, 2018; Omani-Samani *et al.*, 2018). This index shows the degree of inequality at the income distribution level of a health variable and is defined by reference to the concentration curve (CC). The CC on the *x*-axis represents the cumulative percentage of people ranked based on income or socio-economic status and in the *y*-axis, it represents the cumulative percentage of the health variable (O'Donnell *et al.*, 2008; Zhong, 2010). The basis for estimating the CI and CC is the Lorenz curve. If the curve is below the equality line, it indicates that the concentration of the health status variable is in the high socio-economic strata and conversely. The torsion of the Lorenz curve with the equality line indicates the absence of inequality. The level of inequality is twice the area between the CC and the equality line (O'Donnell *et al.*, 2008).

In this study, the CI estimation has been used to measure the level of inequality of the distribution of exposure to CHE, based on the following equation:

$$CI = \frac{2}{\mathrm{H}}\ cov(H, R)$$

In this equation, H is equal to the percentage of exposure rate to CHE, and Cov (H, R) represents the covariance between the variable of exposure to CHE and the relative ranking of households by the asset index. Here, the *y*-axis is cumulative exposure rate to CHE, and the *x*-axis is the cumulative percentage of households' socio-economic status by the asset index. Principle component analysis (PCA) methodology was used to estimate the asset index. In this method, the variables in a correlated multistate space are summed up to a set of uncorrelated components, which each of them is a linear combination of the main variables. The uncorrelated components are called principle components derived from special covariance matrices or correlation matrices of the main variables. In general, the main application of the PCA methodology is to reduce the number of variables and find the structure of the relationship between the variables, which is in fact the same as the classification of variables (Jolliffe, 2002). The process was as follows that initially PCA was carried out on 34 items of household assets, then based on its results and obtaining a new variable as an asset index, households in each sample were divided into five groups and formed economic quintiles. Calculations of CI have been performed for all thresholds of both the WHO and the WB methodologies in all years of the study and all the samples.

Testing CC dominance

The CC dominance test was conducted to investigate if CCs for years before and after HTP were significantly different from each other(Amini Rarani *et al.*, 2018). There are two rules to make inferences about the dominance. The first rule is named intersection union principle (iup), which requires a significant difference between ordinates at all quantile points to accept dominance. The second rule, namely multiple comparison approach (mca) indicates if there is at least one significant difference between curves in one direction and no significant difference in the other. In other words, iup rule is stricter than mca one (Dardanoni and Forcina, 1999).

Dominance test in this study was conducted in all three subset analyses, including urban, rural and total populations in the standard thresholds of the two WHO and WB methodologies based on both rules.

Data analysis

Exposure rate to CHE, overshoot, MPO, PCA and CI in all urban, rural and total samples in the 3 years before and after HTP has been calculated. Additionally, all steps of data preparation and analysis and plotting graphs, curves and CC dominance testing were performed using Excel 2013 and STATA 12 software. Sampling weight was also entered in all analyses based on the initial sampling method.

Results

The results of the study are presented in two parts. The first part is related to the results of the households' exposure rate to CHE (the occurrence of CHE) and the intensity of exposure to CHE based on

the two overshoot and MPO indices using both WHO and WB methodologies. The second part is concerned with the results of estimating distribution inequality status regarding exposure rate to the CHE based on the CI.

Occurrence and intensity of exposure to CHE

Tables 1 and 2 present the study results regarding the exposure rate to CHE and intensity of exposure to the CHE for the WHO and WB methodologies, respectively. Generally, the exposure rate to CHE in both WHO and WB methodologies has increased in total urban and rural populations during the study years. This amount in the total population and at the standard threshold of 40% of the WHO methodology, it changes from 1.99 in 2011 to 3.46 in 2017, and in the standard threshold of 20% of the WB methodology, it changes from 5.14 to 8.68. This growth is more in the urban population than in the rural one. Based on the WHO methodology results, the highest amount is related to the year 2017 for the rural population and the year 2016 for the urban population, and the lowest amount is related to the year 2011 for both populations. In general, the exposure rate to CHE in the WHO methodology has been estimated lower for both urban and rural areas in all years compared with the WB method (Tables 1 and 2).

The exposure rate to CHE has generally increased in all the thresholds of both WHO and WB methodologies, and in total, urban and rural populations during all 7 years. This growth is more in the urban population than in the rural one, and it has a less swinging trend relative to the rural population. Generally, based on the both methodologies and in all years (except the year 2016 in WB methodology), the exposure rate to CHE was estimated lower for the urban population compared with the rural population. In the WHO methodology, since 2014, this index for the urban population has increased, but it has decreased in the rural population. The noticeable point is the high growth and steep slope of exposure rate to CHE from 2011 to 2013 in both urban and rural populations. Another important point is that despite the reduction in this rate in 2014 and beyond in the rural population, this index has not yet reached its initial level in 2011; therefore, this issue shows that from 2011 to 2013, the growth had a steep slope. The increase rate after

Table 1. Catastrophic health expenditures headcount and intensity before and after HTP based on standard threshold (40%) of the WHO methodology

Year		WHO methodology in threshold of 40%											
		Urban				Rural				Total			
		Prevalence (%)		Intensity (%)		Prevalence (%)		Intensity (%)		Prevalence (%)		Intensity (%)	
		H[a]	SE	O	MPO	H	SE	O	MPO	H	SE	O	MPO
Before HTP	2011	1.55	0.12	0.22	14.02	3.13	0.15	0.4	12.81	1.99	0.09	0.27	13.51
	2012	1.94	0.14	0.25	12.77	3.53	0.16	0.49	13.81	2.36	0.11	0.31	13.22
	2013	2.61	0.15	0.36	13.73	4.59	0.19	0.66	14.28	3.15	0.12	0.44	13.96
	Mean	2.03	0.14	0.28	13.51	3.75	0.17	0.52	13.63	2.5	0.11	0.34	13.56
After HTP	2014	2.69	0.16	0.36	13.36	4.37	0.18	0.66	15.07	3.15	0.13	0.44	13.96
	2015	2.81	0.16	0.35	12.44	4.38	0.18	0.59	13.57	3.25	0.13	0.42	12.89
	2016	3.06	0.17	0.39	12.62	4.02	0.17	0.56	13.91	3.34	0.14	0.44	13.03
	2017	3.02	0.16	0.36	12.12	4.65	0.19	0.6	12.91	3.46	0.13	0.42	12.35
	Mean	2.89	0.16	0.36	12.63	4.35	0.18	0.60	13.86	3.3	0.13	0.43	13.06

[a]CHE headcount ratio.

SE, standard error; O, overshoot; MPO, mean positive overshoot.

Table 2. Catastrophic health expenditures headcount and intensity before and after HTP based on standard threshold (20%) of the WB methodology

Year		WB methodology in threshold of 20%											
		Urban				Rural				Total			
		Prevalence (%)		Intensity (%)		Prevalence (%)		Intensity (%)		Prevalence (%)		Intensity (%)	
		H[a]	SE	O	MPO	H	SE	O	MPO	H	SE	O	MPO
Before HTP	2011	4.93	0.21	0.56	11.28	5.69	0.2	0.69	12.04	5.14	0.17	0.59	11.51
	2012	4.72	0.21	0.59	12.59	6	0.21	0.74	12.32	5.05	0.16	0.63	12.51
	2013	7.11	0.26	0.87	12.28	7.29	0.23	0.96	13.21	7.16	0.2	0.9	12.53
	Mean	5.59	0.23	0.67	12.05	6.33	0.21	0.8	12.52	5.78	0.18	0.71	12.18
After HTP	2014	7.05	0.25	0.9	12.8	7.57	0.23	0.99	13.12	7.19	0.2	0.93	12.89
	2015	7.84	0.27	0.94	12.05	7.96	0.24	1.03	12.95	7.87	0.21	0.97	12.29
	2016	8	0.27	1.02	12.81	7.66	0.23	0.98	12.83	7.91	0.21	1.01	12.82
	2017	8.51	0.27	1.02	12.02	9.22	0.26	1.13	12.26	8.68	0.22	1.04	12.08
	Mean	7.85	0.26	0.97	12.42	8.10	0.24	1.03	12.79	7.91	0.21	0.99	12.52

[a]CHE headcount ratio.

SE, standard error; O, overshoot; MPO, mean positive overshoot.

HTP is much slower than that before HTP based on the WHO methodology results (Figures 1, 2).

Supplementary Tables A1 and A2 present more detailed results under heading of *sensitivity analysis* regarding exposure rate to CHE for the years before and after HTP and in four thresholds for each methodology.

The intensity of CHE has increased on average based on the overshoot index using the WHO methodology in total urban and rural populations during 7 years. According to the study results, the overshoot index has increased from 0.22% and 0.40% in 2011 to 0.36% and 0.60% in 2017 for urban and rural populations, respectively, based on the 40% threshold of the WHO methodology. Furthermore, this index has increased from 0.56% and 0.69% in 2011 to 1.02% and 1.13% in 2017, respectively, based on the 20% threshold of the WB methodology. This amount is on average higher for the rural population, and only in 2016, it is lower for the rural population than for the urban population. In the WHO methodology, the highest amount for urban and rural populations is in 2016 and 2014, respectively. In the WB methodology, the highest amount for urban and rural populations is in 2017. The lowest amount was related to year 2011 for both urban and rural populations and in both methodologies.

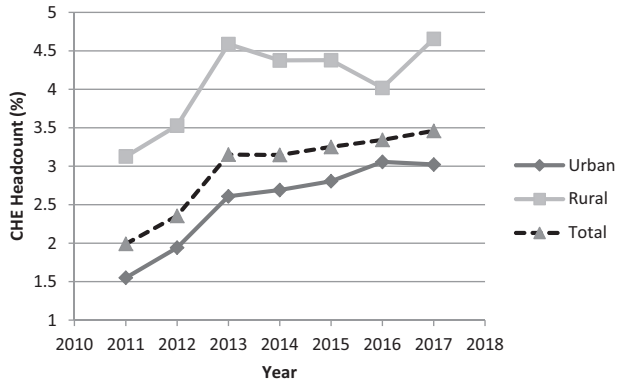

Figure 1 CHE headcount (%) in Iran by residence area from 2011 to 2016 based on standard threshold of the WHO methodology.

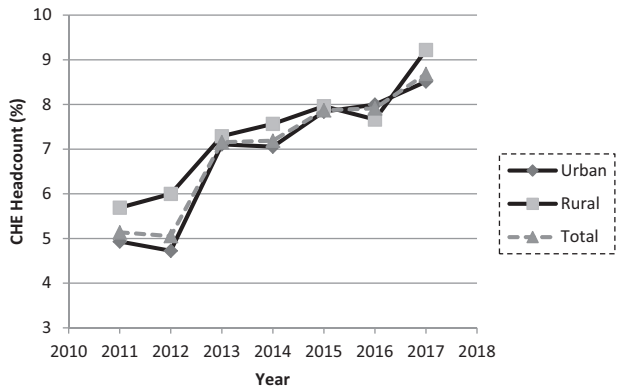

Figure 2. CHE headcount (%) in Iran by residence area from 2011 to 2016 based on standard threshold of the WB methodology.

MPO index as another index of the intensity of CHE has fluctuated during the study years and in both methodologies. The amount of this index varies from 14.02% and 12.81% in 2011 to 12.12% and 12.91% in 2017 for urban and rural populations, respectively, based on the WHO methodology. This index varies from 11.28% and 12.04% in 2011 to 12.02% and 12.26% in 2017, respectively, based on the WB methodology. According to the WHO methodology, the amount of this index was higher for the urban population than for the rural population in 2011, but in its following years, the index has had a reverse trend. The amount of this index was higher for the rural population than for the urban population in all study years based on the WB methodology. Tables 1 and 2 present other information and details of the study results regarding the CHE for the years before and after HTP. Furthermore, Supplementary Table A3 presents the results of other thresholds of both methodologies.

The inequality status in distribution of exposure to CHE

Table 3 shows the calculation results related to the CI of exposure rate to CHE in different thresholds of the WHO and WB methodologies, respectively. The CI shows a negative number in both methodologies. For example, in 2016, at 40% threshold of the WHO, the numerical value of the CI was −0.12 and −0.14 for urban and rural populations, respectively. This value was −0.04 and −0.05 based on the 20% threshold of the WB. Generally, the results indicate that the exposure to CHE has a higher level of concentration in households with low socio-economic status based on two methodologies and in both urban and rural populations in all the years before and after HTP. Also CI based on the WB methodology show a lower value than the WHO methodology. Table 3 shows other calculations and details. Moreover, Supplementary Tables A4 and A5 present the results of other thresholds of both methodologies.

Table 3. Concentration index of distribution of exposure to CHE before and after HTP based on standard thresholds of the WHO and the WB methodologies

Year		WHO methodology in threshold of 40%						WB methodology in threshold of 20%					
		Urban		Rural		Total		Urban		Rural		Total	
		CI*	SE**	CI	SE	CI	SE	CI	SE	CI	SE	CI	SE
Before HTP	2011	−0.23	0.04	−0.21	0.03	−0.28	0.03	−0.06	0.03	−0.08	0.02	−0.09	0.02
	2012	−0.12	0.04	−0.17	0.03	−0.2	0.03	−0.1	0.03	−0.09	0.02	−0.12	0.02
	2013	−0.14	0.03	−0.16	0.02	−0.21	0.02	−0.05	0.02	−0.06	0.02	−0.06	0.02
	Mean	−0.16	0.04	−0.18	0.03	−0.23	0.03	−0.07	0.03	−0.08	0.02	−0.09	0.02
After HTP	2014	−0.07	0.03	−0.23	0.02	−0.16	0.02	−0.05	0.02	−0.1	0.02	−0.06	0.02
	2015	−0.2	0.03	−0.15	0.02	−0.21	0.02	−0.07	0.02	−0.06	0.02	−0.07	0.01
	2016	−0.12	0.03	−0.14	0.02	−0.15	0.02	−0.04	0.02	−0.05	0.02	−0.04	0.02
	2017	−0.15	0.03	−0.14	0.02	−0.2	0.02	−0.07	0.02	−0.05	0.02	−0.08	0.01
	Mean	−0.13	0.03	−0.16	0.02	−0.18	0.02	−0.06	0.02	−0.06	0.02	−0.06	0.01

CI, concentration index; SE, standard error.

The inequality status of the exposure rate to CHE based on the CI in both methodologies does not show regular changes during the years; however, the CI on average has a lower negative value during the years after HTP. The CCs of the distribution of exposure to CHE for comparison before and after HTP inequality status are presented based on both methodologies in all urban, rural and total study population (Figures 3–8). CI and CC results indicate that the average amount of inequalities in the exposure to CHE after HTP has been reduced. The CI of the urban population after HTP on average reduced 17% and 18% based on the WHO and WB methodologies, respectively. However, the testing dominance of exposure to CHE CCs revealed that CC before HTP did not dominate CC after HTP; in other words, change of inequality in exposure to CHE before and after HTP was no statistically significant in both WHO and WB methodologies.

In addition, the CI of the rural population after HTP on average reduced 8% and 15% based on the WHO and WB methodologies, respectively. However, the testing dominance of exposure to CHE CCs revealed that CC before HTP did not dominate CC after HTP based on the WHO methodology; In other words, change of inequality in exposure to CHE before and after HTP was no statistically significant. However, the dominance test showed that CC before HTP dominated CC after HTP in the rural population based on the WB methodology, i.e. reduction in exposure to CHE inequality was statistically significant according to the mca criterion.

The CI of total population after HTP on average reduced 22% and 30% based on the WHO and WB methodologies, respectively.

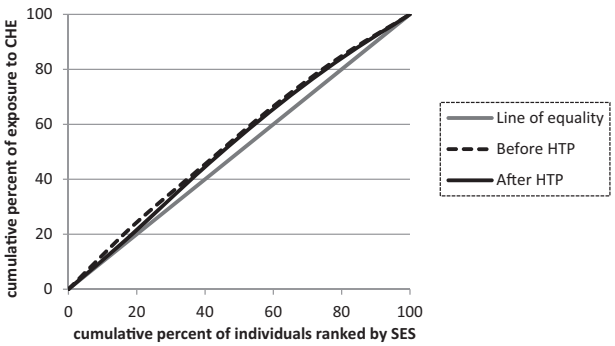

Figure 3. CCs of exposure to CHE before and after HTP (total population based on WHO methodology).

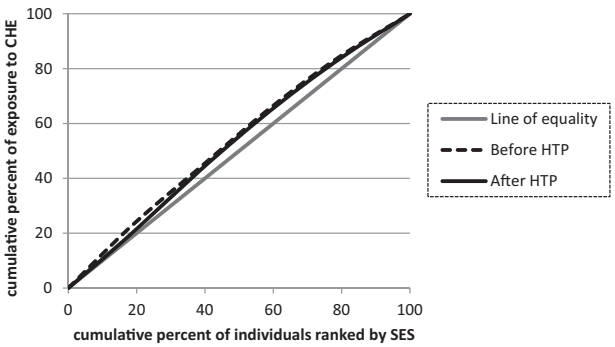

Figure 4. CCs of exposure to CHE before and after HTP (urban population based on WHO Methodology).

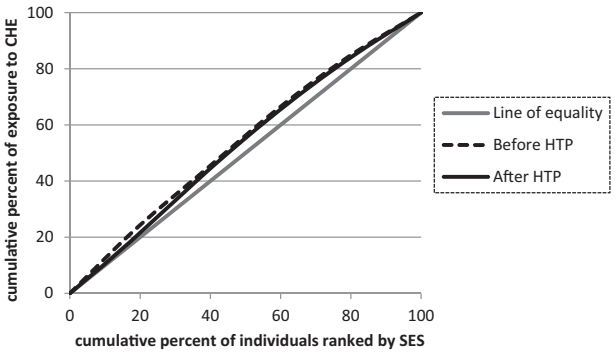

Figure 5. CCs of exposure to CHE before and after HTP (rural population based on WHO methodology).

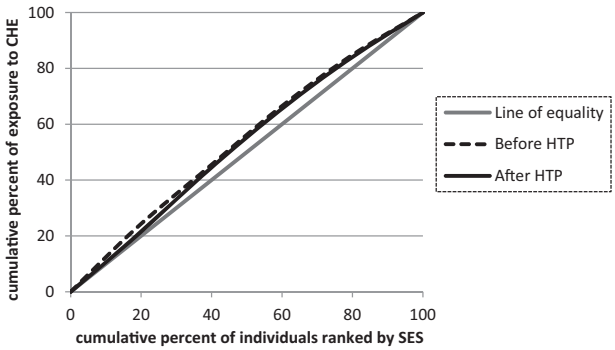

Figure 6. CCs of exposure to CHE before and after HTP (total population based on WB methodology).

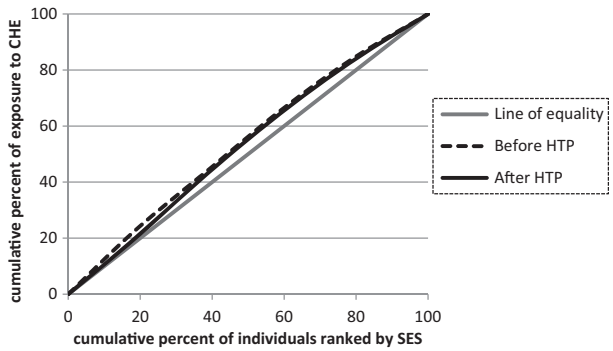

Figure 7. **CC**s of exposure to CHE before and after HTP (urban population based on WB methodology).

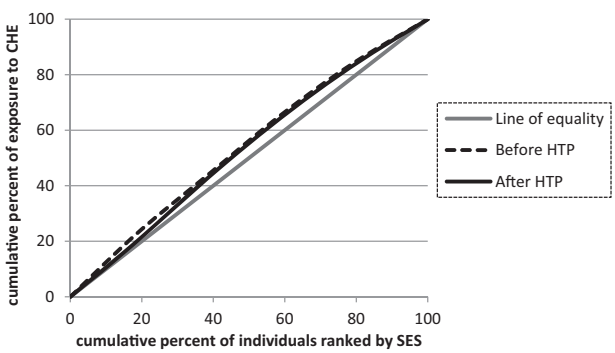

Figure 8. CCs of exposure to CHE before and after HTP (rural population based on WB methodology).

However, the testing dominance of exposure to CHE CCs revealed that CC before HTP did not dominate CC after HTP based on the WHO methodology; in other words, change of inequality in exposure to CHE before and after HTP was not statistically significant. However, on the contrary, the dominance test showed that CC before HTP dominated CC after HTP in the total population based on the WB methodology, i.e. reduction in exposure to CHE inequality was statistically significant according to the mca criterion.

Discussion

The purpose of the present study was to estimate the occurrence and intensity of exposure to CHE as well as the inequality status in exposure distribution to CHE over two periods before and after implementing HTP in urban, rural and total populations. The aforementioned items are separately discussed in the two parts of the study results.

Occurrence and intensity of exposure to CHE

Generally, the exposure rate to CHE during the study years has increased based on both methodologies with average annual growth of 10%. The average amount of exposure rate to CHE during 7 years was 2.9% and 6.9% based on the WHO and WB methodologies, respectively. Similar to the present study, in another study conducted in Iran and on national data by using the WHO methodology from 2008 to 2015, the average exposure rate to CHE was 2.5% (Yazdi-Feyzabadi, 2018).

The study results at 40% threshold of the WHO revealed that the exposure rate on average changed from 2.03 and 3.75 for urban and rural populations, respectively, during 3 years before HTP to 2.89 and 4.35 during the 4 years after HTP. For the WB methodology, the results show an increase in the occurrence of CHE after implementation of HTP. At 20% threshold, the exposure rate on average changes from 5.63 and 6.33 for urban and rural populations, respectively, during 3 years before implementation of HTP to 7.85 and 8.10 during the 4 years after HTP. Many studies have been conducted about the years before implementation of HTP, which have reported different amounts for the exposure rate to CHE. According to the study conducted by Ghiasvand *et al.* (2015) on the national data of 2013, the exposure rate to CHE was 2.9% and 2.43% based on the WHO methodology, and 0.48% and 0.5% based on the WB methodology for urban and rural populations, respectively. The study conducted by Yazdi-Feyzabadi *et al.* (2017) has reported the average exposure rate to CHE as 2.3% and 3.5% for urban and rural populations, respectively; their study was conducted using the WHO methodology, and it surveyed the results from 2008 to 2013. One study was conducted in Iran using the WHO methodology to measure the exposure rate to CHE after HTP, based on the data of 2015 (Moradi *et al.*, 2018). The results of the above-mentioned study support the present study results showing that the exposure rate to CHE has increased after HTP. This study has reported the rates 4.58 and 5.65 for urban and rural populations, respectively (Moradi *et al.*, 2018). According to this issue that one of the most important objectives of HTP in Iran is to financially protect citizens against health expenditure, the present study results revealed that at least until 2017, reduction of the exposure rate to CHE as one of the indices of households' financial protection against the health expenditure has not occurred, and the exposure to CHE has increased after HTP. However, similar reforms in other countries' health systems such as those in Turkey and Thailand, have been relatively successful with the goal of households' financial protection.

Furthermore, the difference of the change rate of exposure to CHE before and after HTP years could be the key to represent the effect of HTP, since based on the WHO methodology results, the increase rate after HTP is much slower than that before HTP, which may show some evidence to indicate that HTP has had a positive effect to slow growth speed of CHE occurrence. However, this change is not seen in the results of the WB methodology which for this reason and that the evidence in this regard is not comprehensive, it seems that it cannot be meaningful and significant.

According to the results of the studies following the implementation of the programme, the OOP has been reduced (Mehrolhassani *et al.*, 2017; Aghajani *et al.*, 2017); however, this has not diminished significantly enough to reduce the CHE. However, according to the WHO report (2010), for the negligible CHE in a country, the OOP is expected to drop by 15%.

One of the reasons that can contribute to increase exposure rate to CHE is that HTP focuses on services of hospitals that are the subset of MOH, and other outpatient services and hospitalization of other hospitals and the private sector having high contribution in providing healthcare services are not considered. In addition, in spite of existing some clinical guidelines in different sectors, treatment services are not offered based on these guidelines, and this issue can increase the treatment expenditure and the amount of OOP payments. Another point is that according to HTP, the contribution of OOP payments for health expenditures has decreased while based on the presentation of relative value book and increasing relative tariffs for different medical services in this plan, the absolute amount of OOP payments for households has increased. One of the other main reasons contributing to increase of CHE after HTP is the fee-for-service payment system that naturally increases the provider's induced demands, then potentially increases the health service utilizations not covered by HTP, and consequently increases CHE. Furthermore, due to an increase in the level of basic insurance coverage, and therefore demand stimulation in the public sector and lack of growth in services supply, many of the patients are inevitably referred to the private sectors with much higher expenditure, which is likely to be effective in increase of OOP and exposure rate to CHE. In this regard, it seems that HTP requires a serious review in its targeting, coverage and actions after 4 years of its start.

The intensity of exposure to CHE has been measured using overshoot and MPO indices. The value of overshoot index in the 40% threshold of the WHO and 20% threshold of the WB has changed from 0.27% and 0.59% in 2011 to 0.44% and 1.01% in 2016 (the average of 0.39% and 0.86%). In other words, households pay on average 0.39% and 0.86% more than the threshold for their health expenditure. Moreover, the value of the MPO index was on average 13.28% and 12.27% for two methodologies, which means that households encountering CHE, pay on average 13.28% and 12.27% more than the threshold for health services. In fact, e.g. at 40% of the WHO, the households encountering CHE, pay on average 53.28% (40 + 13.28) of their CtP as OOP payment for their health expenditure. Different national studies in Iran have reported different numbers for the intensity of health expenditure. In the study conducted by Yazdi-Feyzabadi *et al.* (2018), the value of overshoot and MPO indices was reported 0.34% and 15.44%, respectively, based on the data from 2008 to 2015. According to a study conducted based on the data of Egypt, Palestine and Jordan, the value of both overshoot and MPO indices increased during the study years (2000–10) (Rashad, 2015). The overshoot and MPO indices have increased during the 4 years after implementation of HTP compared with the 3 years before HTP. According to the WHO and WB methodologies, the value of the overshoot index increased from

0.34% and 0.71% before implementation of the programme to 0.43% and 0.99% after implementation of the programme, respectively. In addition, the value of the MPO index changed from 13.56 and 12.18 to 13.06 and 12.52, showing that this index has an increase in the WHO methodology and a decrease in the WB method.

Comparing the overshoot index before and after implementation of HTP in both methodologies indicates that this index has on average a higher value during the years after HTP. In case of MPO, the intensity of exposure to CHE based on the WB methodology has increased during the years after HTP. However, based on the WHO methodology, the intensity of exposure to CHE by considering the MPO index increased for the rural population after HTP, but has decreased for the urban population after HTP. There are several possible explanations for increase of intensity after HTP. A possible explanation for this might be that the basic health insurance and increase in population coverage as a part of interventions conducted by HTP did not significantly affect the intensity of CHE in households, particularly rural ones having CtP and income lower than the urban population. Furthermore, another possible explanation for this is that although public budget and insurer contributions were increased, the medical tariffs for different medical specialties were also increased, limiting the financial protection against CHE. Furthermore, HTP was primarily focused on hospital services, particularly public hospitals, while other sectors were neglected and less focused for interventions. This programme was dependent on two main sources, including targeted subsides initiative and value-added tax, which economic and political instability impaired the sustainability in financing during the implementation years. Generally, in conclusion, the results of the present study on intensity of exposure to CHE showed that HTP was not successful; therefore, it requires a serious review in the future.

The inequality status in distribution of exposure to CHE

As the results of the study showed, the numerical value of CI was negative in all thresholds of both methodologies and in all urban and rural populations during all the study years. This issue indicates that exposure to CHE has more concentration among the households with a lower socio-economic status. The value of CI based on the 40% threshold of the WHO decreased from −0.28 in 2011 to −0.20 in 2017; it means that in spite of existing greater concentration on exposure to CHE, this amount of inequality decreased during the years. Based on the 20% threshold of the WB, the results are also similar; CI decreased from −0.09 to −0.08. The study conducted by Moradi *et al.* (2018) based on the WHO method, reported the CI of exposure to CHE as a negative number in the urban population and a positive number in the rural population in 2015. The study of Ghiasvand *et al.* (2015), which its calculations were conducted based on both WHO and WB methodologies in 2014 data, showed different results from our results in the urban population and similar results in the rural population. In the mentioned study, the value of CI was 0.078 and −0.086 in the WHO methodology and 0.027 and −0.176 in the WB methodology in urban and rural populations, respectively. The other studies conducted in the world show different results; in some of these studies such as a study in Ghana, the greater concentration of exposure to CHE was on low-income households (Akazili *et al.*, 2017); however, in other studies such as a study in Thailand, the greater concentration of exposure to CHE was on high-income households (Somkotra and Lagrada, 2008; Ghosh, 2010; Akazili *et al.*, 2017). The existing point in calculating the CI is the choice of households ranking variable, which is considered different in various studies. Various studies use different variables such as income variable, socio-economic status index, expenditures and asset index. Due to this reason, different results for CI may be obtained from two identical studies in one context.

It is worth mentioning that inequality in distribution of exposure to CHE has been generally estimated lower in the WB methodology compared with the WHO methodology, which is due to the different nature of calculation based on two methodologies. The inequality status of exposure to CHE based on CI does not show regular changes during the years in urban and rural populations, as in some years, this index has a higher value in the urban population, while in other years, it has a higher value in the rural population.

The inequality status of exposure to CHE based on CI in different thresholds of both methodologies does not show regular changes during the years. However, on average the years after implementation of HTP have more appropriate conditions, and CI shows a lower level of inequality in the distribution of exposure to CHE in the years after HTP. According to the dominance test of the results, this reduction in inequality in the distribution of exposure to CHE is not significant based on the results of the WHO methodology. Reduction of inequality was only significant in the WB methodology and in rural and total populations. In this regard, if judged based on the WB methodology results, it seems that HTP had hopeful performance in the target rural population that should continue, but in the urban population, significant changes did not occur in terms of inequality.

Limitations

The data used in this study were gathered by the self-reporting methodology that due to different existing issues, this possibility exists that in some cases, the income and expenditure data do not have enough accuracy. In addition, due to the existing different items in patients' payment bills and this issue that in each item, the patient's and insurance's contributions are different, this possibility exists that health expenditure data in hospitalization may not be accurate. Furthermore, as a result of this issue, the patient is not aware about his or her actual OOP payment. Another limitation is related to lack of communication between the data source of ISC and the data of other relevant organizations, such as the MOH and insurance organizations. Another point is that the common methodologies of estimating CHE only consider direct medical expenditure, while indirect expenditures related to illnesses such as transportation, residency and distant from work place are also extremely important. All of these limitations should be considered when using and interpreting the results.

The strength and weakness of the study

The present study is very comprehensive in terms of the number of the study years and different methodologies and thresholds estimated in this study as well as attention to details. In addition, it can provide complete and comprehensive evidence about the current status of Iran in terms of CHE for its readers and users of its results.

Conclusion

In general, the results of the study provide comprehensive and appropriate evidence about the status of exposure to CHE based on different methodologies and thresholds. The study results showed an increase in exposure rate to CHE and its intensity during the years before and after implementation of HTP. In addition, the results showed that HTP did not succeed much in reducing CHE, and there

was only some evidence that its growth rate was declining, which could not be significant as it only occurred in the results of the WHO methodology. Based on the targeting of upper-level documents and 5-year development plans in Iran for reducing the exposure rate to CHE to 1%, two points are highly important. First, it is not obvious that the mentioned targeting was carried out based on which methodology and threshold, while the results based on different methodologies have significant differences with each other. Secondly, it seems that this targeting was conducted completely far from the realities of society. The calculations related to the inequality in distribution of exposure to CHE showed that values of CI were negative for all years in both methodologies and different thresholds, indicating that CHE occurrence has a disproportionate concentration on the poor people. In other words, CHE occurrence is higher among the poor households. Furthermore, although the inequality status improved in the years after implementation of HTP, these results are not statistically significant with two exceptions for total and rural populations based on the WB methodology. Currently, one main challenge of HTP is to provide sustainable financial sources to continue it. Given the recent instability in the HTP sources, it seems necessary to review and redevelop the targeted mechanisms and interventions in favour of the poor people and disadvantaged groups with chronic, severe and high-cost illnesses. In general, the use of financial and single-sector policies in the public sector in HTP, regardless of attention to development of physical infrastructures and other provided sectors, cannot realize UHC and equal access to health services without financial problems. To improve the performance of HTP, some targeted supporting interventions should be implemented through definition of essential health services packages for low-income households.

Ethical approval

This research was approved by ethics committee of Kerman University of Medical Sciences with ID number IR.KMU.REC.1398.026.

Supplementary data

Supplementary data are available at *Health Policy and Planning* online

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Conflict of interest statement. None declared.

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