scientific reports

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Inequalities and trends in access to health insurance and essential public health services among internal migrants in china: 2013 to 2018

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China launched a major health-care reform in 2009 aimed to provide all citizens with equal access to basic health care with reasonable quality and financial risk protection. Since then, China has made substantial progress toward Universal Health Coverage (UHC). However, the access of UHC among internal migrants might be disadvantaged compared with local residents. This study aimed to provide an assessment of inequalities and trends in internal migrants' access to Universal Health Coverage. Six rounds (2013–2018) of the China Migrants Dynamic Survey were used including 976,430 respondents. Financial protection was measured using the basic medical insurance enrollment proportion (BMIEP) and hospital reimbursement rate (HRB). Essential health services were measured using the standardized health record establishment proportion (SHREP) and standardized health education intervention coverage (SHEIC). The Erreyers Index (EI) and Wagstaff Index (WI) were used to measure socio-economic related UHC inequalities. The process of the Recentered Influence Function (RIF)-Ordinary Least Squares (OLS) method was used to decompose risk factors of the EI and WI. The average coverage rate of SHREP and SHEIC were 24.3% and 75.7%, respectively. The average coverage rate of BMIEP and the percentage of HRB were 87.4% and 58.3% respectively. Regarding inequalities, it was found that for SHREP and SHEIC, the general trends of inequalities raised while for BMIEP, the general trends decreased. Regarding HRB, it was less inequalities in 2018 compared with 2014. RIF-OLS regression showed that both individual factors and regional factors contributed to the inequalities in UHC among China's internal migrants. Progress has been made in financial protection of migrants as the high coverage of BMIEP and its decrease in inequalities as well as lower inequalities in 2014 of HRB compared with 2018. While challenges remained in the lower coverage rate of SHEIC and increasing inequalities of SHREP and SHEIC. Policy efforts on narrowing down both individual and regional inequalities should be put forward.

Keywords Internal migrants, Inequalities, Trends, Universal health coverage, Socioeconomic status

The pursuit of Universal Health Coverage (UHC) – defined as equitable access to quality services without financial hardship[1] – stands as a cornerstone of the United Nations' 2030 Sustainable Development Agenda[2]. China's 2009 health-care reform marked a pivotal step toward this goal, prioritizing nationwide social health insurance expansion and financial risk protection[3]. By 2023, this reform had significantly improved healthcare accessibility for the general population[4]. However, a critical unresolve challenge persists: systemic disparities in UHC access for internal migrants, a population exceeding 374 million (26% of China's total population) as of 2020[5].

China's UHC implementation remains constrained by the *hukou* system, an administrative framework tying social service entitlements to one's registered birth place[6]. While reforms have expanded coverage to local residents, migrants face persistent institutional barriers including limited probability of insurance benefits

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across regions[7], elevated out-of-pocket expenditures and underutilization of urban health facilities compared to local residents[8].

The evidence regarding the impact of these reforms on trends and equity in the context of UHC is rather limited. Although a nationwide cross-sectional survey focusing on health insurance and financial protection among internal migrants in China has recently been published[9], it lacks a historical perspective. Moreover, the existing literature on internal migrants in China and their access to health services has predominantly concentrated on specific health issues, such as maternal health or mental health[10,11], with a notable absence of comprehensive studies on access to public health services. Previous research tracking China's progress towards UHC has primarily targeted the general population and centered on hospital-based care and financial risk protection[4,12]. There is a significant gap in research assessing China's recent trends towards UHC among vulnerable populations, particularly in terms of preventive services[13]. Therefore, measuring the trends of UHC among China's internal migrants and incorporating preventive services coverage trends would greatly enhance the current body of knowledge. Additionally, analyzing the trends of UHC among migrants could offer valuable insights to the international community regarding the issue of migrants.

The present study aims to provide a more accurate assessment of trends and inequalities in access to health protection schemes and essential public health services (EPHSs) among China's internal migrants over time. Additionally, risk factors of presenting inequalities would also be explored.

Methods

Study design and data sources

Six rounds (2013–2018) of the China Migrants Dynamic Survey (CMDS: https://www.chinaldrk.org.cn/wjw/#/home) were used in this study. The CMDS is an annual, national cross-sectional survey conducted by the National Health Commission of the People's Republic of China, covering 31 provinces (districts and cities) and the Xinjiang Production and Construction Corps in China using a stratified, multi-stage, and proportionate-to-size (PPS) method for sampling. The study focuses on the status and access of migrants to health insurance and EPHSs in China. The respondents were internal migrants aged 15–59 years, who have lived outside their registered place of residence (county or city) for at least 1 months. Figure 1 presents data cleaning procedure of the sample. In total, 1,075,279 respondents completed the survey in six rounds of CMDS. As we focus on internal migration, cross-border migration was excluded from the analysis. And because the EPHSs cover population who reside in current place for at least 6 months, migrants with migration duration of less than 6 months were also excluded from the analysis. After excluding cross-border migration and within 6 months of migration duration, 978,152 respondents were included. Excluding 1722 respondents without reporting socio-economic status, there were 976,430 respondents included in descriptive analysis. After excluding 154 respondents who did not report marital status or migration scope, 976,276 respondents were included in equity analysis. All

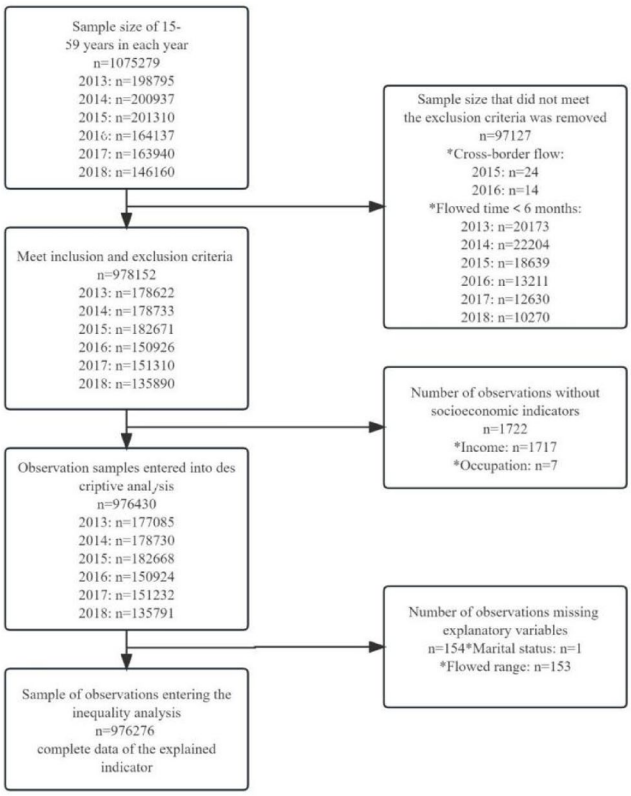

Fig. 1. Data cleaning procedure of the sample.

methods were carried out in accordance with relevant guidelines and regulations. We confirm that the informed consent was obtained from all subjects and/or their legal guardians.

Measurements

Following the WHO and World Bank framework[14] we measured UHC progress from two dimensions: coverage of essential health services and financial protection due to health-care costs. We chose two fundamental health services focused on prevention which targeted the whole population : the standardized health record establishment proportion (SHREP) and the standardized health education intervention coverage (SHEIC). The financial protection was measured using two indicators due to the essence of protecting population under health insurance coverage and reducing cost sharing: the basic medical insurance enrollment proportion (BMIEP) and the hospitalization reimbursement rate (HRB) (Table 1).

SES index generation

To analyze equity in UHC, we generate a socio-economic indicator (SES). The concept of SES refers to an individual's relative material and social standing compared to others[15]. Using a single indicator to measure socioeconomic status may not adequately reflect an individual's complex socioeconomic circumstances or situation. Integrating various socioeconomic factors into a single index provides valuable insights to a comprehensive socioeconomic gradient of inequities in UHC. In this study, SES was quantified by combining income condition, educational level, and occupation status. Income condition was measured using per capita monthly household income, calculated as follows:

Average Indexed Monthly Earnings (AIME) = individual's per capita monthly income/national per capita monthly income.

The data for "national per capita monthly income" were obtained from the Statistical Yearbook[16] published by the National Bureau of Statistics of China.

Actual per capita monthly household income = total monthly household income/number of household members.

Subsequently, the AIME was divided into six equal categories numerically, ranked from 1 to 6 representing the lowest to highest income groups.

Education was categorized into six levels: illiteracy = 1, primary school = 2, junior high school = 3, senior high school or technical secondary school = 4, junior college = 5, and undergraduate or above = 6.

According to the occupation classification from China's State Statistics Bureau, the 8 general categories of occupation were consistently used throughout 1999 to 2022, which was classification used in the CMDS questionnaire. Our study used the occupational reputation developed by a previous study based on the 8 general categories[17]. Occupations were then rated on a 5-level scale: domestic helpers/agriculture/no fixed job/unemployed = 1, employees/self-employed = 2, middle class (employers) = 3, white-collar workers = 4, leaders = 5.

To create a composite SES index, Principal Components Analysis (PCA) was utilized. This method has been validated as a robust approach for describing SES differentiation within a population[18]. Factor scores were computed by weighting the raw responses with the factor loadings of the PCA. Bartlett's Test of Sphericity showed: $\chi^{23} = 225046.177$, $p < 0.001$, rejecting the null hypothesis that the variables are uncorrelated. Meanwhile, the KMO measure of sampling adequacy was 0.619 (> 0.6), indicating that the data are suitable for factor analysis. The PCA extracts common factor variance percentage of 52.653%. Higher scores indicate higher levels of SES.

Statistical analysis

We did statistical analyses in STATA software 17.0. Descriptive analysis of basic demographic characteristics and UHC indicators were conducted.

Measuring socioeconomic-related UHC inequalities

Traditional measurement of inequalities, like the conventional concentration index (CI) has two drawbacks as below. Firstly, for bounded variables, the CI may depend on the mean of the health variable, making comparisons of populations with different mean health levels problematic[19]. Therefore, it is not suitable for tracking longitudinal inequalities with different mean health levels. Secondly, the CI does not satisfy the "mirror property", that is, inequalities in health do not "mirror" those in ill-health[20].

Wagstaff[21] and Erreygers[19] proposed different correction mechanisms to deal with these problems. In this study, we focused on Erreygers' Index (EI) since it is the only one that measures quasi-absolute inequalities, i.e., it is insensitive to any feasible equal addition to the health variable. The Wagstaff Index (WI) measures relative differences and hence, it is possible that it gives larger inequalities than the Erreygers index when prevalence is low, as is the case for the prevalence in some unhealthy lifestyles. Thus, the EI and WI together could complement each other and provide better measures for longitudinal data to measure changes of inequalities over time.

Indicator	Definition
SHREP (%)	The proportion of population who have established standardized health records at community level within a defined administrative area and time period
SHEIC (%)	The proportion of a defined population that ever receives standardized health education interventions
BMIEP (%)	The proportion of a population enrolled in standardized health insurance programs that provide essential medical expense reimbursement
HRB (%)	The proportion of costs covered by insurers for inpatient care

Table 1. Definition of key indicators.

The EI and WI can be written as.

$$E(a|y) = \frac{1}{n}\sum_{i=1}^{n}\left\{\frac{4a_i}{(a^{\max} - a^{\min})}(2R_i - 1)\right\}$$

$$W(a|y) = \frac{1}{n}\sum_{i=1}^{n}\left\{\frac{(a^{\max} - a^{\min})a_i}{(a^{\max} - \overline{a})(\overline{a} - a^{\min})}(2R_i - 1)\right\}$$

where a_i is the range of bounded variables, $a_i \in [a^{min}, a^{max}]$. R_i is the relative rank of the i^{th} individual in the socioeconomic status distribution. Bounded variable can be retransformed into an indicator of the proportional deviation from the minimum value: b_i. This lies on the range [0, 1] and records only "real" changes in the underlying attribute, not "nominal" ones due to the choice of measurement scale. Under this transformation, the Erreygers and Wagstaff indices simplify, respectively, to.

$$E\,(b\,|y\,) = (1/n)\sum_{i=1}^{n}\{4b_i\,(2R_i - 1)\}$$

$$W\,(b\,|y\,) = (1/n)\sum_{i=1}^{n}[\{b_i/(1-\bar{b})\}\bar{b}(2R_i - 1)]$$

The range of both the Wagstaff Index (WI) and Erreygers Index (EI) is −1 to + 1. When the value falls within the range of [−1,0) or (0,1], it indicates the presence of inequalities in UHC that favors either low or high socioeconomic status (SES) groups. If the value is negative (−1 < WI/EI < 0), it suggests the existence of UHC inequalities in favor of the lower SES group. Conversely, if the value is positive (0 < WI/EI < 1), it indicates UHC inequalities in favor of the higher SES group. The magnitude of the WI and EI values reflects the depth or extent of inequality. The larger the absolute value of WI or EI, the greater the level of inequality in health outcomes between different socioeconomic groups.

Decomposition of risk factors of inequalities in UHC

The process of the Recentered Influence Function (RIF)- Ordinary Least Squares (OLS) method is to use the recentered influence function (RIF) estimates of the UHC inequality index to find the relationship between the RIF and the explanatory variables and establish the regression function between the UHC inequality index and the explanatory variables to achieve causal recognition. The method is mainly divided into two steps. The first step is to estimate the RIF value of the WI and EI, and the second step is to use the RIF estimation value of the health inequality index as the explanatory variable and various factors X as explanatory variables to implement the OLS regression process[22].

Results

Trends in access to health insurance and essential services

Individuals involved were comparable in most socio-demographic factors across survey years, but we observed an increasing trend education level and age, which was consistent to recent migration trends in China (Table 2). The average SHREP between 2013 and 2018 was 24.3%, indicating a less optimistic situation regarding documentation. During the period from 2013 to 2016, the SHREP showed an increasing trend, particularly between 2015 and 2016. However, from 2017 to 2018, the rate sharply declined. The average SHEIC between 2014 and 2018 was 78.4%, indicating a higher proportion of the population receiving health education. The years 2015 had the highest rates of SHEIC. For BMIEP, it remained consistently high (> 80%) with minimal fluctuations and peaked at 93.4% at 2018. Compared to 2014, the number of individuals receiving reimbursement for hospitalization significantly increased in 2018 (Table 3; Fig. 2). Probit regression showed that after controlling other factors, BMIEP experienced a general increase during the observation period while the SHEIC witnessed a general reduction. The SHREP increased at the beginning but decreased in later period. Compared with 2014, the HRB was higher in 2018 (Table 4; Fig. 3).

Inequalities in access to health insurance and essential services

Regarding the trends of inequalities in coverage of SHREP, from 2013 to 2015, it was the lower SES group was in better situation than the higher SES group. Nevertheless, from 2016 onwards, the lower SES group was in worse situation than the higher counterpart and the inequalities continued to enlarge. For inequalities in SHEIC, the relative terms (WI) witnessed an increasing trend from 2014 to 2018 with number larger than 0, indicating enlarging inequalities favor higher SES group. While for absolute terms (EI), the year 2015 had largest decreasing rate of inequalities and afterwards, the inequalities increased until 2017. In terms of BMIEP, as it was a binary indicator, we mainly consider the results of EI. EI in BMIEP showed that the inequalities remained in favor of

the higher SES group with fluctuation over time and had the lowest level in 2018. For HRB, due to limits to the data, we can only compare the 2018 situation with the 2014 one. It indicated that inequalities that favor higher SES groups decreased.

Decomposition of risk factors of inequalities

Results of RIF-OLS showed that age exaggerated inequalities in SHREP. Compared to males, females were more likely to experience inequalities. Compared to illiteracy, higher education groups had less inequalities in SHREP. Single migrants had lower risk of experiencing inequalities in SHREP. Larger migration scope increased inequalities in SHREP. Migrants with longer migration duration experienced lower levels of inequalities in SHREP. Higher income groups enjoyed higher level of equitable SHREP compared with lower ones. In terms of region, a negative coefficient indicating the Western region has a lower level of inequalities in SHREP while a positive coefficient representing that the Central and Eastern region has higher level of inequalities (both compared to the Northeastern region). For the economic zones, the Yangtze River Delta and Circum-bohai Sea economic zones enjoyed higher level of equitable HR coverage while the Pearl River Delta enjoyed less level. Compared with the initial year of 2013, the inequalities in SHREP decreased in 2014 and 2015 then increased in the following two years then dropped downed in 2018 again. Except for the 1 st level of occupation as babysitting and agricultural occupations and 5th level as leading groups, all the other occupation groups experienced lower level of inequalities in the SHREP (Table 5).

Results of RIF-OLS regression in SHEIC inequality index showed that younger, women, higher education level, marital status as not single, larger migration scope, shorter migration duration, lower income level suffered more from inequalities in SHEIC. Compared to Northeastern region, Western region had the largest inequalities in SHEIC. Compared to other regions, Pearl River Delta, Yangtze River Delta and Circum-bohai Sea experienced lower level of inequalities in HE coverage. For occupation, the 5th occupation levels showed higher inequalities in SHEIC whereas the 2nd to 4th levels presented lower inequalities compared with the 1 st level. Regarding year, the year 2014 experience the lowest inequalities compared with year 2015 to 2018 (Table 6).

RIF-OLS regression results in BMIEP inequality index found that higher age, female, primary school education or above, higer income level, economic zones than others, 2014 (compared with 2013) had less inequalities. Married, cross-provinces and cross cities (compared with cross counties), longer migration duration, living outside Northeastern regions, had higher inequalities in BMIEP. For occupation, compared with the 1 st level, the 2nd to the 3rd level had showed less inequalities while the 4th and the 5th presented higher inequalities in BMIEP (Table 7).

For risk factors of HRB inequalities index, higher age, female, higher income group, the Bohai Rim, they Year of 2018 had lower inequalities while higher education group, married, larger migration scope, regions outside the Western region faced higher inequalities. For occupation, compared with the 1 st category, the 2nd and the 3rd enjoyed lower inequalities whereas the 4th and the 5th had higher inequalities (Table 8).

Discussion

To the best of our knowledge, the current study is the first to measure inequalities and trends in UHC among China's internal migrants with focus on preventive services. Our data for indicators were taken from the latest six rounds of nationally representative household surveys, including a large-scale sample of 976,430 individuals, in China. Notable progress has been made in the BMIEP with general steady increase and in the SHEIC with comparatively high coverage rate while the SHREP experienced fluctuations with relatively low rate. The HRB had significant improvements in 2018 compared with 2014 (Figs. 2 and 3). Inequalities in the SHREP, the SHEIC increased in general trends over time while the BMIEP generally decreased over time. Inequalities in the HRB dropped down in 2018 compared with 2014 (Fig. 5). Risk factors of the inequities included individual level factors: gender, education, income, marital status, occupation, migration duration, migration scope and contextual factors: region, economic zone.

Our study highlights potential drivers for UHC promotion, mainly policy efforts. The steady increase of BMIEP and improvements in HRB together with decrease in inequities of BMEIP and HRB might be associated with efforts in financial protection put forward by the 2009 healthcare reform and the 2016 reform of health insurance to merge the Urban Residents Basic Medical Insurance and the New Rural Cooperative Medical Scheme, which both increased health insurance coverage among the whole population including migrants and prevented them from financial risks to some extents. For the increase in SHEIC, it coincided with the policy efforts in equalization of EPHSs (2014) among internal migrants with 1 year time-lag indicating the SHEIC increased one year after (2015) these policy efforts. These indicated to achieve UHC among the vulnerable groups such as migrants, sustained and targeting policy efforts are needed.

Though progresses have been made, this study also reveal that challenges remained in UHC among migrants, including the low rate of SHREP and HRB and the intensified inequities in SHREP and SHEIC. According to the goals set up by the National Commission of Health and Family Planning in 2017, the SHREP and the SHEIC among migrants should reach 80% and 95%, respectively by 2020[23]. The current SHREP was 24.3% averagely from 2013 to 2018, indicating the process toward the target was far left behind. For SHEIC, the average coverage rate was 78.4% with the maximum coverage rate of 91.5% in 2015, which seems much closer to the target compared to the SHEIC. However, the inequities in SHEIC intensified (Fig. 5). The higher SES groups enjoyed increasingly higher probability of receiving health education services in the observation period. This was consistent with a study measuring health inequalities among China's population which found that there was "pro-rich" health inequality in 2012–2016 and the extent of health inequality was the biggest in 2016[24]. This might due to the higher SES group might have better health literacy and knowledge on EPHSs so they utilized more.

Variables	2013		2014		2015		2016		2017		2018	
	n	%(95% CI)	n	%(95% CI)	n	%(95% CI)	n	%(95% CI)	n	%(95% CI)	n	%(95% CI)
Individuals interviewed	175147	18.2 (18.1-18.3)	175571	18.3 (18.1-18.4)	178945	18.6 (18.5-18.7)	148859	15.5 (15.4-15.6)	148933	15.5 (15.4-15.6)	134384	14.0 (13.9-14.1)
Gender												
Male	90244	51.5 (51.1-51.9)	88918	50.6 (50.2-51.1)	92337	51.6 (51.2-52.0)	76438	51.3 (50.9-51.8)	76149	51.1 (50.7-51.6)	68754	51.2 (50.7-51.6)
Female	84903	48.5 (48.1-48.9)	86653	49.4 (48.9-49.8)	86608	48.4 (48.0-48.8)	72421	48.7 (48.2-49.1)	72785	48.9 (48.4-49.3)	65630	48.8 (48.4-49.3)
Education												
Illiteracy	2668	1.5 (1.4-1.6)	2864	1.6 (1.5-1.7)	3217	1.8 (1.7-1.9)	2357	1.6 (1.5-1.7)	3121	2.1 (2.0-2.2)	2924	2.2 (2.0-2.3)
Primary school	22524	12.9 (12.6-13.1)	22438	12.8 (12.5-13.0)	23593	13.2 (12.9-13.5)	18443	12.4 (12.1-12.7)	20261	13.6 (13.3-13.9)	18522	13.8 (13.5-14.1)
Junior high school	94025	53.7 (53.3-54.1)	90097	51.3 (50.9-51.7)	88433	49.4 (49.0-49.8)	70120	47.1 (46.7-47.5)	65930	44.3 (43.8-44.7)	57770	43.0 (42.5-43.4)
Senior high school or technical secondary school	49265	28.1 (27.8-28.5)	36343	20.7 (20.4-21.1)	39169	21.9 (21.5-22.2)	32974	22.2 (21.8-22.5)	33033	22.2 (21.8-22.6)	30247	22.5 (22.1-22.9)
Junior college	6177	3.5 (3.4-3.7)	14860	8.5 (8.2-8.7)	15183	8.5 (8.2-8.7)	14640	9.8 (9.6-10.1)	15307	10.3 (10.0-10.5)	14336	10.7 (10.4-11.0)
Undergraduate or above	486	0.3 (0.2-0.3)	8969	5.1 (4.9-5.3)	9350	5.2 (5.0-5.4)	10325	6.9 (6.7-7.1)	11282	7.6 (7.4-7.8)	10585	7.9 (7.6-8.1)
Marital status*												
Single	36819	21.0 (20.7-21.3)	32968	18.8 (18.5-19.1)	29137	16.3 (16.0-16.6)	22459	15.1 (14.8-15.4)	22685	15.2 (14.9-15.5)	20429	15.2 (14.9-15.5)
Not single	138327	79.0 (78.7-79.3)	142603	81.2 (80.9-81.5)	149808	83.7 (83.4-84.0)	126400	84.9 (84.6-85.2)	126248	84.8 (84.5-85.1)	113955	84.8 (84.5-85.1)
Migration scope												
Cross-province	117892	67.3 (67.0-67.6)	118308	67.4 (67.0-67.7)	116963	65.4 (65.0-65.7)	95995	64.5 (64.1-64.9)	96436	64.8 (64.4-65.1)	87217	64.9 (64.5-65.3)
Cross-city	40737	23.3 (22.9-23.6)	40733	23.2 (22.9-23.5)	44278	24.7 (24.4-25.1)	39496	26.6 (26.2-26.9)	39195	26.3 (25.9-26.7)	35841	26.7 (26.3-27.1)
Cross-county	16517	9.4 (9.3-9.6)	16530	9.4 (9.3-9.6)	17704	9.9 (9.7-10.1)	13269	8.9 (8.8-9.1)	13302	8.9 (8.8-9.1)	11326	8.4 (8.3-8.6)
Average Indexed Monthly Earnings(AIME)**												
0.00-60.07	18516	10.6 (10.4-10.8)	15161	8.6 (8.4-8.8)	12098	6.8 (6.6-6.9)	17905	12.0 (11.8-12.3)	24487	16.4 (16.2-16.7)	22234	16.5 (16.2-16.9)
60.07-81.92	30526	17.4 (17.2-17.7)	15944	9.1 (8.9-9.3)	15228	8.5 (8.3-8.7)	25825	17.3 (17.0-17.7)	27058	18.2 (17.8-18.5)	20170	15.0 (14.7-15.3)
81.92-106.26	24910	14.2 (14.0-14.5)	23808	13.6 (13.3-13.8)	24715	13.8 (13.5-14.1)	31080	20.9 (20.5-21.2)	21999	14.8 (14.5-15.1)	22454	16.7 (16.4-17.1)
106.26-136.58	38242	21.8 (21.5-22.1)	26243	14.9 (14.7-15.2)	39653	22.2 (21.8-22.5)	25976	17.5 (17.1-17.8)	23564	15.8 (15.5-16.1)	25782	19.2 (18.8-19.6)
136.58-191.21	28236	16.1 (15.8-16.4)	45374	25.8 (25.5-26.2)	41869	23.4 (23.0-23.8)	22934	15.4 (15.1-15.7)	28221	18.9 (18.6-19.3)	20971	15.6 (15.3-16.0)
＞191.21	34717	19.8 (19.5-20.1)	49039	27.9 (27.6-28.3)	45382	25.4 (25.0-25.7)	25139	16.9 (16.6-17.2)	23604	15.8 (15.5-16.2)	22774	16.9 (16.6-17.3)
Region												
Eastern	133285	76.1 (75.9-76.3)	135082	76.9 (76.7-77.2)	134069	74.9 (74.7-75.2)	111234	74.7 (74.5-75.0)	112496	75.5 (75.3-75.8)	102707	76.4 (76.2-76.7)

Continued

Variables	2013		2014		2015		2016		2017		2018	
	n	%(95% CI)	n	%(95% CI)	n	%(95% CI)	n	%(95% CI)	n	%(95% CI)	n	%(95% CI)
Central	12647	7.2 (7.1-7.3)	12606	7.2 (7.1-7.3)	12545	7.0 (6.9-7.1)	10671	7.2 (7.1-7.3)	10309	6.9 (6.8-7.0)	8557	6.4 (6.3-6.5)
Western	25715	14.7 (14.5-14.9)	24528	14.0 (13.8-14.1)	29312	16.4 (16.2-16.6)	24331	16.3 (16.1-16.5)	23712	15.9 (15.7-16.1)	20943	15.6 (15.4-15.8)
Northeastern	3500	2.0 (2.0-2.0)	3354	1.9 (1.9-2.0)	3018	1.7 (1.6-1.7)	2622	1.8 (1.7-1.8)	2416	1.6 (1.6-1.7)	2178	1.6 (1.6-1.7)
Economic belt area												
Pearl River Delta	43139	24.6 (24.2-25.1)	46983	26.8 (26.3-27.2)	48146	26.9 (26.4-27.4)	39777	26.7 (26.2-27.2)	41717	28.0 (27.5-28.5)	40066	29.8 (29.3-30.3)
Yangtze River Delta	59400	33.9 (33.6-34.3)	59352	33.8 (33.4-34.2)	58799	32.9 (32.5-33.2)	49052	33.0 (32.6-33.3)	50063	33.6 (33.2-34.0)	46564	34.7 (34.2-35.1)
Circum-bohai Sea	22469	12.8 (12.6-13.0)	20819	11.9 (11.7-12.1)	18989	10.6 (10.4-10.8)	15930	10.7 (10.5-10.9)	15038	10.1 (9.9-10.3)	10722	8.0 (7.8-8.1)
Others	50138	28.6 (28.4-28.9)	48418	27.6 (27.3-27.8)	53012	29.6 (29.3-29.9)	44100	29.6 (29.3-29.9)	42116	28.3 (28.0-28.6)	37032	27.6 (27.3-27.9)
Occupation												
Babysitting/Agricultural/Irregular employed/Unemployed	27087	15.5 (15.2-15.7)	29305	16.7 (16.4-17.0)	32358	18.1 (17.8-18.4)	26128	17.6 (17.2-17.9)	24819	16.7 (16.4-17.0)	21840	16.3 (15.9-16.6)
Employee/Individual household	121913	69.6 (69.3-70.0)	116956	66.6 (66.2-67.0)	118259	66.1 (65.7-66.5)	97328	65.4 (65.0-65.8)	99242	66.6 (66.2-67.0)	87190	64.9 (64.4-65.3)
Middle-class employers	11929	6.8 (6.6-7.0)	12631	7.2 (7.0-7.4)	11083	6.2 (6.0-6.4)	10044	6.7 (6.5-7.0)	8217	5.5 (5.3-5.7)	9056	6.7 (6.5-7.0)
White-collar worker	13535	7.7 (7.5-7.9)	15818	9.0 (8.8-9.3)	16564	9.3 (9.0-9.5)	14714	9.9 (9.6-10.1)	15980	10.7 (10.5-11.0)	15723	11.7 (11.4-12.0)
Leading groups	683	0.4 (0.3-0.4)	861	0.5 (0.4-0.6)	681	0.4 (0.3-0.4)	645	0.4 (0.4-0.5)	676	0.5 (0.4-0.5)	575	0.4 (0.4-0.5)
Age (years- mean-95CI)	175147	33.1 (33.0-33.1)	175571	34.2 (34.2-34.3)	178945	35.0 (34.9-35.1)	148859	35.0 (35.0-35.1)	148933	35.9 (35.8-35.9)	134384	36.2 (36.1-36.3)
Migration duration (years- mean-95CI)	175147	33.1 (33.0-33.1)	175571	34.2 (34.2-34.3)	178945	35.0 (34.9-35.1)	148859	35.0 (35.0-35.1)	148933	35.9 (35.8-35.9)	134384	36.2 (36.1-36.3)

Table 2. Characteristics of survey respondents. Note: * indicates missing values- where the missing value of marital status is 1 and the missing value of migration scope is 153. ** AIME = (Current Monthly Wage) / Standard Wage × 100%

Item	2013		2014		2015		2016		2017		2018		Total	
	n	%(95% CI)	*n*	%(95% CI)	*n*	%(95% CI)	*n*	%(95% CI)	*n*	%(95% CI)	*n*	%(95% CI)	*n*	%(95% CI)
Standardized health record establishment proportion														
Yes	30,721	17.5 (17.3–17.8)	32,333	18.4 (18.1–18.7)	43,367	24.2 (23.9–24.6)	52,817	35.5 (35.1–35.9)	39,987	35.5 (35.1–35.9)	33,582	25.5 (25.1–25.9)	232,807	24.3 (24.2–24.5)
No	144,425	82.5 (82.2–82.7)	143,210	81.6 (81.3–81.9)	135,577	75.8 (75.4–76.1)	96,043	64.5 (64.1–64.9)	106,384	64.5 (64.1–64.9)	98,296	74.5 (74.1–74.9)	723,935	75.7 (75.5–75.8)
Total	175,147	100.0	175,544	100.0	178,943	100.0	148,859	100.0	146,370	100.0	131,878	100.0	956,742	100.0
Standardized health education intervention coverage														
Yes	–	–	110,692	63.0 (62.6–63.5)	163,789	91.5 (91.3–91.8)	128,565	86.4 (86.1–86.7)	105,915	86.4 (86.1–86.7)	106,155	79.0 (78.6–79.4)	615,115	78.4 (78.3–78.6)
No	–	–	64,879	37.0 (36.5–37.4)	15,155	8.5 (8.2–8.7)	20,295	13.6 (13.3–13.9)	40,456	13.6 (13.3–13.9)	28,229	21.0 (20.6–21.4)	169,012	21.6 (21.4–21.7)
Total	–	–	175,571	100.0	178,943	100.0	148,859	100.0	146,370	100.0	134,384	100.0	784,128	100.0
Basic medical insurance enrollment proportion														
Yes	140,388	80.2 (79.8–80.5)	146,646	83.5 (83.2–83.9)	163,846	91.6 (91.3–91.8)	127,589	85.7 (85.4–86.0)	136,413	85.7 (85.4–86.0)	125,460	93.4 (93.1–93.6)	840,343	87.4 (87.2–87.5)
No	34,758	19.8 (19.5–20.2)	28,923	16.5 (16.1–16.8)	15,096	8.4 (8.2–8.7)	21,270	14.3 (14.0-14.6)	12,520	14.3 (14.0-14.6)	8924	6.6 (6.4–6.9)	121,492	12.6 (12.5–12.8)
Total	175,147	100.0	175,569	100.0	178,943	100.0	148,859	100.0	148,933	100.0	134,384	100.0	961,835	100.0
Hospitalization reimbursement rate														
Yes	–	–	3456	50.2 (48.0-52.4)	–	–	–	–	–	–	2916	72.0 (69.6–74.3)	6372	58.3 (56.6–60.0)
No	–	–	3429	49.8 (47.6–52.0)	–	–	–	–	–	–	1133	28.0 (25.7–30.4)	4562	41.7 (40.0-43.4)
Total	–	–	6885	100.0	–	–	–	–	–	–	4049	100.0	10,934	100.0

Table 3. Coverage rate of essential health service and health insurance.

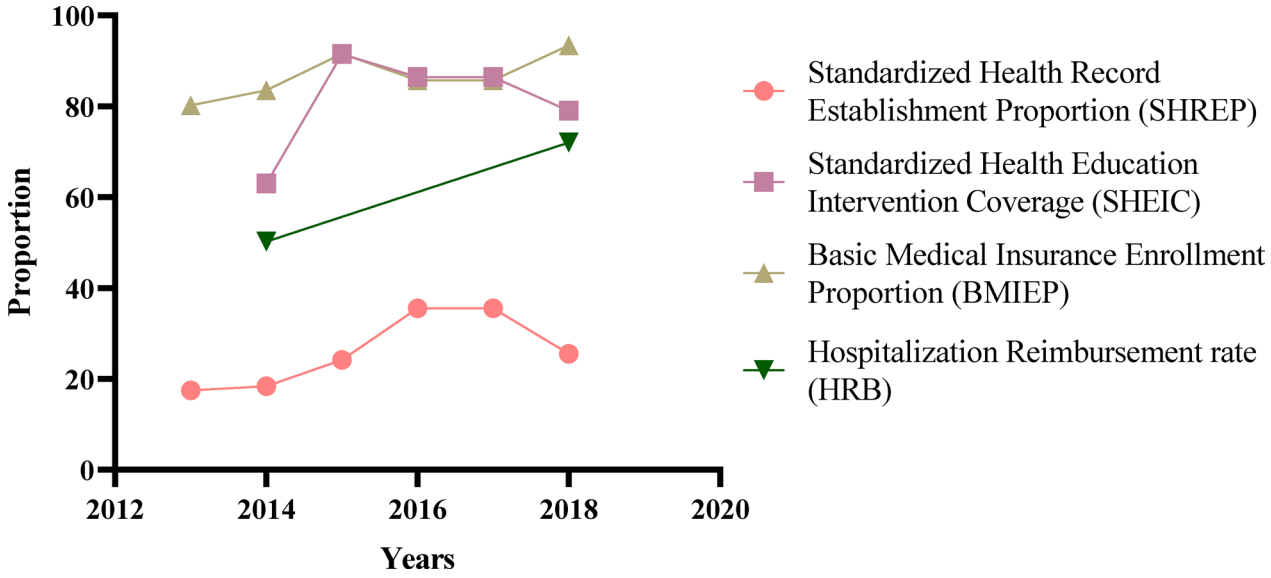

Fig. 2. Trends of coverage of standardized health record establishment proportion, standardized health education intervention coverage, basic medical insurance enrollment proportion and hospitalization reimbursement rate.

According to our findings, both individual factors and contextual factors were identified as risk factor of inequalities in UHC indicators. This was consistent with the Anderson Model[25] which identified age, gender, education, occupation and income as individual factors and region related factors as contextual factors. In other words, the driver of inequalities of UHC consisted of both individual level socio-economic status and migration characteristics as well as regional socio-economic status. China's decentralized and fragmented health system bring regional differences in resource preparation and service delivery. More developed regions are therefore having more service provision. However, internal migrants normally migrate from less developed region to more developed region which have heavy burdens providing services to enlarging population. In addition, the

Variable	Standardized health record establishment proportion		Standardized health education intervention coverage		Basic medical insurance enrollment proportion		Hospitalization reimbursement rate	
	β(95%CI)	*P*	β(95%CI)	*P*	β(95%CI)	*P*	β(95%CI)	*P*
Age	<0.001 (−0.001-<0.001)	0.229	−0.004 (−0.005–0.004)	<0.001	0.004 (0.003–0.005)	<0.001	0.017 (0.011–0.023)	<0.001
Gender								
Male	0(ref)	..	0(ref)	..	0(ref)	..	0(ref)	..
Female	0.095 (0.085–0.105)	<0.001	0.092 (0.080–0.104)	<0.001	−0.011 (−0.023–0.001)	0.083	−0.003 (−0.116–0.109)	0.954
Education								
Illiteracy	0(ref)	..	0(ref)	..	0(ref)	..	0(ref)	..
Primary school	0.180 (0.141–0.219)	<0.001	0.238 (0.196–0.280)	<0.001	0.117 (0.072–0.163)	<0.001	0.021 (−0.267–0.309)	0.886
Junior high school	0.271 (0.233–0.309)	<0.001	0.405 (0.364–0.446)	<0.001	0.174 (0.130–0.218)	<0.001	0.072 (−0.210–0.355)	0.616
Senior high school or technical secondary school	0.361 (0.322–0.401)	<0.001	0.500 (0.457–0.543)	<0.001	0.190 (0.144–0.236)	<0.001	0.229 (−0.067–0.524)	0.129
Junior college	0.401 (0.359–0.443)	<0.001	0.536 (0.490–0.582)	<0.001	0.191 (0.142–0.241)	<0.001	0.404 (0.091–0.716)	0.011
Undergraduate or above	0.397 (0.353–0.442)	<0.001	0.494 (0.446–0.543)	<0.001	0.233 (0.179–0.287)	<0.001	0.689 (0.351–1.027)	<0.001
Marital status								
Single	0(ref)	..	0(ref)	..	0(ref)	..	0(ref)	..
Not single	0.158 (0.144–0.173)	<0.001	0.160 (0.143–0.177)	<0.001	0.259 (0.242–0.276)	<0.001	0.183 (−0.010–0.377)	0.063
Migration scope								
Cross-province	−0.139 (−0.152–0.127)	<0.001	−0.085 (−0.101–0.069)	<0.001	−0.375 (−0.393–0.357)	<0.001	−0.540 (−0.657–0.422)	<0.001
Cross-city	−0.038 (−0.050–0.025)	<0.001	0.017 (0.001–0.034)	0.042	−0.261 (−0.280–0.243)	<0.001	−0.223 (−0.338–0.108)	<0.001
Cross-county	0(ref)	..	0(ref)	..	0(ref)	..	0(ref)	..
Migration duration	0.006 (0.005–0.007)	<0.001	−0.001 (−0.002–0.	0.019	−0.002 (−0.003–0.001)	<0.001	0.003 (−0.007–0.014)	0.535
Average Indexed Monthly Earnings (AIME)								
0.00-60.07	0(ref)	..	0(ref)	..	0(ref)	..	0(ref)	..
60.07–81.92	0.024 (0.007–0.041)	0.005	0.075 (0.054–0.096)	<0.001	0.057 (0.034–0.079)	<0.001	0.149 (0.007–0.290)	0.040
81.92-106.26	0.036 (0.019–0.053)	<0.001	0.092 (0.071–0.113)	<0.001	0.089 (0.066–0.110)	<0.001	0.124 (−0.025–0.273)	0.102
106.26-136.58	0.044 (0.027–0.061)	<0.001	0.102 (0.081–0.123)	<0.001	0.080 (0.059–0.102)	<0.001	0.233 (0.079–0.387)	0.003
136.58-191.21	0.040 (0.022–0.058)	<0.001	0.101 (0.079–0.122)	<0.001	0.119 (0.097–0.142)	<0.001	0.248 (0.089–0.406)	0.002
>191.21	0.018 (−0.001–0.037)	0.062	0.059 (0.036–0.081)	<0.001	0.142 (0.118–0.166)	<0.001	0.251 (0.084–0.419)	0.003
Region								
Eastern	−0.134 (−0.148–0.120)	<0.001	0.0316 (0.014–0.050)	0.001	0.141 (0.123–0.160)	<0.001	−0.090 (−0.233–0.053)	0.217
Central	0.085 (0.076–0.095)	<0.001	−0.030 (−0.043–0.016)	<0.001	0.118 (0.104–0.133)	<0.001	−0.087 (−0.184–0.011)	0.082
Western	0.050 (0.036–0.065)	<0.001	−0.220 (−0.239–0.202)	<0.001	−0.371 (−0.389–0.353)	<0.001	−0.195 (−0.355–0.034)	0.017
Northeastern	0(ref)	..	0(ref)	..	0(ref)	..	0(ref)	..
Economic belt area								
Pearl River Delta	0.018 (<0.001–0.035)	0.049	−0.300 (−0.322–0.278)	<0.001	−0.471 (−0.493–0.448)	<0.001	0.077 (−0.095–0.249)	0.379
Yangtze River Delta	−0.575 (−0.591–0.559)	<0.001	−0.527 (−0.545–0.508)	<0.001	−0.365 (−0.384–0.345)	<0.001	0.075 (−0.075–0.226)	0.327
Circum-bohai Sea	−0.391 (−0.406–0.376)	<0.001	−0.346 (−0.365–0.327)	<0.001	−0.221 (−0.240–0.202)	<0.001	0.154 (−0.020–0.328)	0.083
Others	0(ref)	..	0(ref)	..	0(ref)	..	0(ref)	..
Year								
2013	0(ref)	..	..	..	0(ref)	..	..	..
2014	0.020 (0.003–0.037)	0.018	0(ref)	..	0.118 (0.100-0.136)	<0.001	0(ref)	..
Continued								

Variable	Standardized health record establishment proportion		Standardized health education intervention coverage		Basic medical insurance enrollment proportion		Hospitalization reimbursement rate	
	β(95%CI)	*P*	β(95%CI)	*P*	β(95%CI)	*P*	β(95%CI)	*P*
2015	0.204 (0.188–0.219)	<0.001	1.065 (1.046–1.083)	<0.001	0.519 (0.499–0.539)	<0.001	..	..
2016	0.537 (0.521–0.553)	<0.001	0.772 (0.754–0.790)	<0.001	0.204 (0.185–0.223)	<0.001	..	..
2017	0.297 (0.280–0.313)	<0.001	0.271 (0.254–0.287)	<0.001	0.530 (0.509–0.550)	<0.001	..	..
2018	0.233 (0.216–0.251)	<0.001	0.489 (0.472–0.507)	<0.001	0.663 (0.641–0.685)	<0.001	0.551 (0.453–0.648)	<0.001
Occupation								
Babysitting/Agricultural/ Irregular employed/Unemployed	0(ref)	..	0(ref)	..	0(ref)	..	0(ref)	..
Employee/Individual household	0.014 (<0.001–0.028)	0.045	0.109 (0.093–0.126)	<0.001	0.285 (0.268–0.301)	<0.001	0.280 (0.178–0.382)	<0.001
Middle-class employers	−0.016 (−0.040–0.007)	0.176	0.129 (0.100-0.157)	<0.001	0.139 (0.111–0.167)	<0.001	−0.006 (−0.213–0.202)	0.958
White-collar worker	0.111 (0.089–0.133)	<0.001	0.197 (0.171–0.223)	<0.001	0.576 (0.547–0.606)	<0.001	0.608 (0.410–0.807)	<0.001
Leading groups	0.274 (0.201–0.346)	<0.001	0.314 (0.220–0.407)	<0.001	0.530 (0.415–0.645)	<0.001	1.005 (0.479–1.532)	<0.001

Table 4. Probit regression of risk factors of the utilization of standardized health record establishment proportion, standardized health education intervention coverage, basic medical insurance enrollment proportion and hospitalization reimbursement rate.

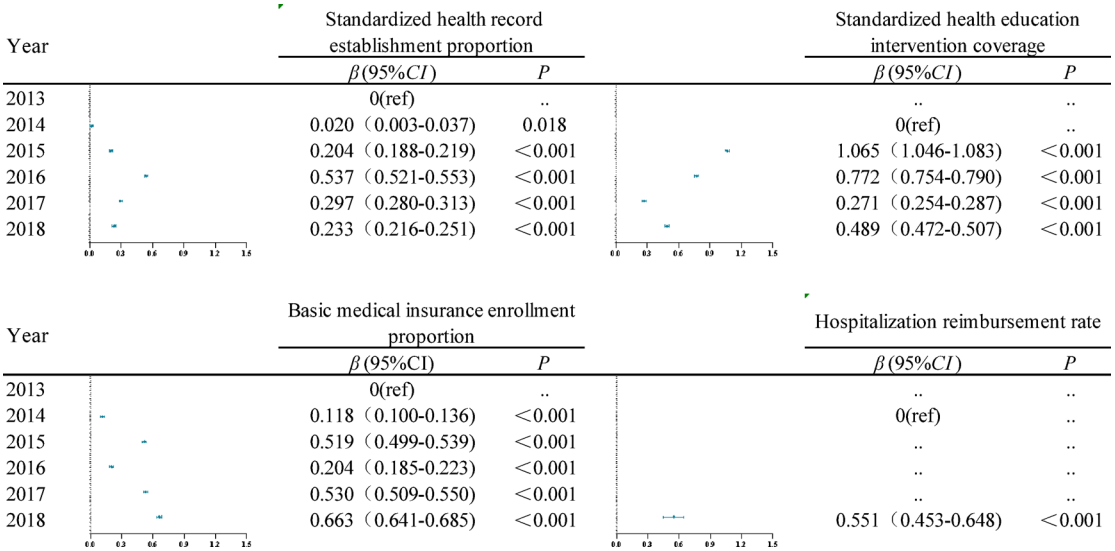

Fig. 3. Adjusted trends of coverage of standardized health record establishment proportion, standardized health education intervention coverage, basic medical insurance enrollment proportion and hospitalization reimbursement rate. Note: Age, gender, education, marital status, migration scope, migration duration, indexed average monthly wage, region, economic belt area, occupation were adjusted.

enjoyment of local public services is currently based on the hukou system indicating migrants cannot benefit in local areas.

The purpose of UHC is to ensure that all people have accessible, affordable and quality health provision, regardless of their wealth, gender or other circumstances[26]. It is therefore of great importance to measuring UHC progress from an equity perspective. Previous studies have discussed UHC progress among different education levels, income groups and regions[12,27], the current study employed a SES approach which comprehensively reflect individual's socio-economic status, providing adding value to the current knowledge. The current study focused on the vulnerable population- internal migrants in China, revealing that vulnerable groups need more attention in the way toward UHC and there might be further inequities in access to UHC within these groups. To compete these challenges, policy should incline to the "poor among the vulnerable". Additionally, by employing WI and EI, the current study measuring inequalities in both absolute and relative terms, adding new approaches

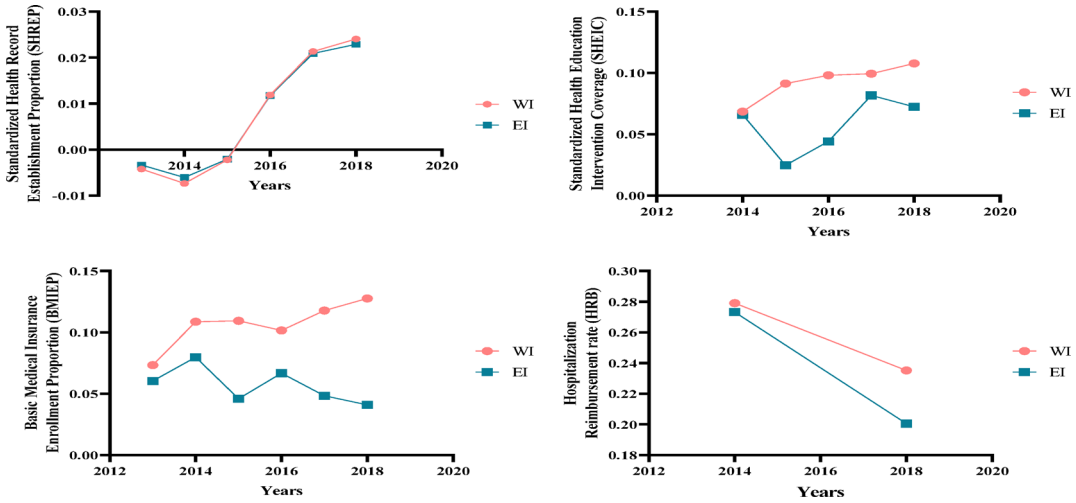

Fig. 4. Trends of inequality index of coverage of standardized health record establishment proportion, standardized health education intervention coverage, basic medical insurance enrollment proportion and hospitalization reimbursement rate. Note: WI: Wagstaff Inde, EI: Erreygers Index.

to current studies which mainly adopted the concentration index[28,29], the slope index of inequalities and the relative index of inequalities[30]. The WI and EI satisfied the mirror conditions as they exhibit a property where the conclusions drawn from longitudinal analysis remain symmetry in analyzing changes in health inequality over time, therefore they are suitable for current longitudinal study.

The current study was the first attempt to analyze the inequalities and trends of migrants' access to health insurance and EPHSs from a horizontal perspective using a national representative sample. Previously, migrants were under representative in national studies measuring progress toward UHC[12]. However, there were also two limitations. Firstly, due to the data availability, we did not include the catastrophic health expenditure to measuring financial protection and other EPHSs service coverage data to measuring essential health services. Secondly, data were based on self-reports and are therefore subject to bias, which could be especially problematic for questions about the utilization of essential health services.

In conclusion, remarkable and steady increases in BMIEP accompanied by the decreases in OOP and the decreases in inequalities in BMEIP and HRB proportion. Major advances were made in achieving financial protection against risk while greater attention is needed to improve the utilization of EPHSs among internal migrants. Firstly, there is a need of a shared digital health record integration across regions to address the current fragmented status. Secondly, more attractive and vivid policy propaganda on EPHSs should be provided to migrants to increase their awareness and further their utilization. Thirdly, targeted subsidies for health education programs in underserved areas should be provided to narrow down the inequalities in SHEIC at regional level. Lastly, the "poor of the vulnerable"-migrants with the lower SES status need to be the focus of policy targets to achieve the equalization of EPHSs among migrants as well as UHC.

Variable	Standardized health record establishment proportion			
	WI		EI	
	β(95% CI)	*P*	β(95% CI)	*P*
Age	0.00082(0.00076–0.00088)	<0.001	0.00077(0.00071–0.00083)	<0.001
Gender				
Male	0(ref)	..	0(ref)	..
Female	0.011(0.010–0.012)	<0.001	0.010(0.009–0.011)	<0.001
Education				
Illiteracy	0(ref)	..	0(ref)	..
Primary school	−0.078(−0.081–0.074)	<0.001	−0.073(−0.076–0.070)	<0.001
Junior high school	−0.159(−0.162–0.156)	<0.001	−0.149(−0.152–0.147)	<0.001
Senior high school or technical secondary school	−0.162(−0.165–0.159)	<0.001	−0.152(−0.155–0.149)	<0.001
Junior college	−0.117(−0.121–0.114)	<0.001	−0.110(−0.113–0.107)	<0.001
Undergraduate or above	−0.122(−0.126–0.118)	<0.001	−0.114(−0.118–0.111)	<0.001
Marital status				
Single	0(ref)	..	0(ref)	..
Not single	0.036(0.035–0.038)	<0.001	0.034(0.033–0.036)	<0.001
Migration scope				
Cross-province	0.057(0.055–0.060)	<0.001	0.054(0.051–0.057)	<0.001
Cross-city	0.058(0.055–0.061)	<0.001	0.054(0.052–0.057)	<0.001
Cross-county	0(ref)	..	0(ref)	..
Migration duration	−0.00078(−0.00088 - −0.00068)	<0.001	−0.00073(−0.00082 - −0.00064)	<0.001
Average Indexed Monthly Earnings (AIME)				
0.00-60.07	0(ref)	..	0(ref)	..
60.07–81.92	0.0297(0.028–0.032)	<0.001	0.028(0.026–0.030)	<0.001
81.92-106.26	0.024(0.022–0.026)	<0.001	0.022(0.020–0.024)	<0.001
106.26-136.58	0.0102(0.008–0.012)	<0.001	0.010(0.008–0.012)	<0.001
136.58-191.21	−0.016(−0.018–0.014	<0.001	−0.015(−0.017–0.013)	<0.001
>191.21	−0.061(−0.063–0.059)	<0.001	−0.058(−0.060–0.056)	<0.001
Region				
Eastern	0.051(0.047–0.055)	<0.001	0.048(0.044–0.052)	<0.001
Central	0.109(0.104–0.114)	<0.001	0.102(0.098–0.107)	<0.001
Western	−0.032(−0.044–0.021)	<0.001	−0.030(−0.041–0.020)	<0.001
Northeastern	0(ref)	..	0(ref)	..
Economic belt area				
Pearl River Delta	0.006(0.003–0.010)	<0.001	0.006(0.003–0.009)	<0.001
Yangtze River Delta	−0.038(−0.041–0.034)	<0.001	−0.036(−0.039–0.032)	<0.001
Circum-bohai Sea	−0.067(−0.072–0.064)	<0.001	−0.064(−0.068–0.060)	<0.001
Others	0(ref)	..	0(ref)	..
Year				
2013	0(ref)	..	0(ref)	..
2014	−0.018(−0.020–0.016)	<0.001	−0.017(−0.019–0.015)	<0.001
2015	−0.006(−0.007–0.004)	<0.001	−0.005(−0.007–0.004)	<0.001
2016	0.010(0.008–0.012)	<0.001	0.010(0.008–0.012)	<0.001
2017	0.003(0.001–0.005)	0.001	0.003(0.001–0.005)	<0.001
2018	−0.004(−0.005–0.002)	<0.001	−0.0031(−0.005–0.001)	<0.001
Occupation				
Babysitting/Agricultural/Irregular employed/Unemployed	0(ref)	..	0(ref)	..
Employee/Individual household	−0.013(−0.014–0.012)	<0.001	−0.012(−0.013–0.011)	<0.001
Middle-class employers	−0.031(−0.034–0.029)	<0.001	−0.0230(−0.032–0.027)	<0.001
White-collar worker	−0.002(−0.004–0.00001)	0.049	−0.002(−0.004–0.00002)	0.053
Leading groups	0.159(0.151–0.166)	<0.001	0.149(0.142–0.156)	<0.001

Table 5. RIF-OLS regression of determinants of inequality in standardized health record establishment proportion.

Variable	Standardized health education intervention coverage			
	WI		EI	
	β(95% CI)	*P*	β(95% CI)	*P*
Age	0.0011(0.0010–0.0012)	<0.001	0.00090(0.00085–0.00096)	<0.001
Gender				
Male	0(ref)	..	0(ref)	..
Female	0.015(0.014–0.016)	<0.001	0.008(0.008–0.009)	<0.001
Education				
Illiteracy	0(ref)	..	0(ref)	..
Primary school	−0.129(−0.133–0.125)	<0.001	−0.089(−0.092–0.086)	<0.001
Junior high school	−0.222(−0.225–0.218)	<0.001	−0.156(−0.159–0.154)	<0.001
Senior high school or technical secondary school	−0.212(−0.216–0.209)	<0.001	−0.152(−0.154–0.149)	<0.001
Junior college	−0.185(−0.189–0.181)	<0.001	−0.133(−0.136–0.130)	<0.001
Undergraduate or above	−0.213(−0.218–0.208)	<0.001	−0.152(−0.156–0.149)	<0.001
Marital status				
Single	0(ref)	..	0(ref)	..
Not single	0.036(0.034–0.038)	<0.001	0.022(0.021–0.023)	<0.001
Migration scope				
Cross-province	0.066(0.062–0.069)	<0.001	0.050(0.048–0.052)	<0.001
Cross-city	0.069(0.065–0.073)	<0.001	0.050(0.048–0.053)	<0.001
Cross-county	0(ref)	..	0(ref)	..
Migration duration	−0.00029(−0.00041 - −0.00017)	<0.001	−0.00017(−0.00026–0.000089)	<0.001
Average Indexed Monthly Earnings (AIME)				
0.00-60.07	0(ref)	..	0(ref)	..
60.07–81.92	−0.035(−0.038–0.032)	<0.001	−0.026(−0.028–0.024)	<0.001
81.92-106.26	−0.048(−0.051–0.045)	<0.001	−0.035(−0.037–0.033)	<0.001
106.26-136.58	−0.059(−0.061–0.056)	<0.001	−0.043(−0.044–0.041)	<0.001
136.58-191.21	−0.075(−0.078–0.073)	<0.001	−0.054(−0.056–0.052)	<0.001
>191.21	−0.111(−0.114–0.109)	<0.001	−0.078(−0.080–0.076)	<0.001
Region				
Eastern	0.095(0.090–0.100)	<0.001	0.069(0.065–0.072)	<0.001
Central	0.094(0.087-0.100)	<0.001	0.060(0.056–0.065)	<0.001
Western	0.203(0.188–0.218)	<0.001	0.192(0.182–0.203)	<0.001
Northeastern	0(ref)	..	0(ref)	..
Economic belt area				
Pearl River Delta	−0.007(−0.012–0.003)	0.002	0.005(0.001–0.008)	0.004
Yangtze River Delta	−0.037(−0.042–0.033)	<0.001	−0.010(−0.013–0.007)	<0.001
Circum-bohai Sea	−0.045(−0.050–0.040)	<0.001	−0.017(−0.020–0.013)	<0.001
Others	0(ref)	..	0(ref)	..
Year				
2013	.	..	..	..
2014	0(ref)	..	0(ref)	..
2015	0.099(0.097–0.101)	<0.001	0.049(0.048–0.050)	<0.001
2016	0.070(0.068–0.072)	<0.001	0.032(0.031–0.033)	<0.001
2017	0.059(0.057–0.061)	<0.001	0.035(0.033–0.036)	<0.001
2018	0.061(0.059–0.063)	<0.001	0.031(0.030–0.032)	<0.001
Occupation				
Babysitting/Agricultural/Irregular employed/Unemployed	0(ref)	..	0(ref)	..
Employee/Individual household	−0.029(−0.031–0.028)	<0.001	−0.022(−0.023–0.021)	<0.001
Middle-class employers	−0.042(−0.045–0.040)	<0.001	−0.032(−0.034–0.030)	<0.001
White-collar worker	−0.015(−0.018–0.012)	<0.001	−0.013(−0.015–0.012)	<0.001
Leading groups	0.068(0.058–0.077)	<0.001	0.041(0.034–0.048)	<0.001

Table 6. RIF-OLS regression of determinants of inequality in standardized health education intervention coverage.

Variable	Basic medical insurance enrollment proportion			
	WI		EI	
	β(95%CI)	*P*	β(95%CI)	*P*
Age	−0.000017(−0.000083–0.000048)	0.605	−0.00008(−0.00011–0.00004)	<0.001
Gender				
Male	0(ref)	..	0(ref)	..
Female	−0.004(−0.005–0.003)	<0.001	−0.002(−0.002–0.001)	<0.001
Education				
Illiteracy	0(ref)	..	0(ref)	..
Primary school	−0.050(−0.053–0.046)	<0.001	−0.026(−0.028–0.024)	<0.001
Junior high school	−0.076(−0.079–0.073)	<0.001	−0.043(−0.045–0.041)	<0.001
Senior high school or technical secondary school	−0.101(−0.104–0.098)	<0.001	−0.058(−0.060–0.056)	<0.001
Junior college	−0.0721(−0.076–0.068)	<0.001	−0.041(−0.043–0.039)	<0.001
Undergraduate or above	−0.009(−0.013–0.005)	<0.001	−0.005(−0.007–0.002)	<0.001
Marital status				
Single	0(ref)	..	0(ref)	..
Not single	0.090(0.088–0.092)	<0.001	0.044(0.043–0.045)	<0.001
Migration scope				
Cross-province	0.0385(0.035–0.042)	<0.001	0.045(0.043–0.046)	<0.001
Cross-city	0.052(0.049–0.055)	<0.001	0.049(0.048–0.051)	<0.001
Cross-county				
Migration duration	0.00036(0.00025–0.00046)	<0.001	0.00030(0.00024–0.00037)	<0.001
Average Indexed Monthly Earnings (AIME)				
0.00-60.07	0(ref)	..	0(ref)	..
60.07–81.92	−0.006(−0.008–0.003)	<0.001	−0.005(−0.006–0.003)	<0.001
81.92-106.26	−0.028(−0.030–0.026)	<0.001	−0.019(−0.021–0.018)	<0.001
106.26-136.58	−0.043(−0.045–0.041)	<0.001	−0.028(−0.029–0.027)	<0.001
136.58-191.21	−0.055(−0.057–0.053)	<0.001	−0.036(−0.038–0.035)	<0.001
>191.21	−0.073(−0.076–0.071)	<0.001	−0.048(−0.050–0.047)	<0.001
Region				
Eastern	0.0865(0.082–0.091)	<0.001	0.049(0.046–0.052)	<0.001
Central	0.040(0.034–0.045)	<0.001	0.002(−0.001–0.006)	0.163
Western	0.232(0.220–0.245)	<0.001	0.266(0.259–0.274)	<0.001
Northeastern	0(ref)	..	0(ref)	..
Economic belt area				
Pearl River Delta	−0.037(−0.041–0.033)	<0.001	−0.008(−0.010–0.005)	<0.001
Yangtze River Delta	−0.033(−0.037–0.030)	<0.001	−0.004(−0.007–0.002)	<0.001
Circum-bohai Sea	−0.037(−0.042–0.033)	<0.001	−0.013(−0.015–0.010)	<0.001
Others	0(ref)	..	0(ref)	..
Year				
2013	0(ref)	..	0(ref)	..
2014	−0.005(−0.007–0.003)	<0.001	−0.009(−0.010–0.008)	<0.001
2015	0.034(0.032–0.035)	<0.001	0.003(0.002–0.004)	<0.001
2016	0.005(0.003–0.007)	<0.001	−0.006(−0.007–0.005)	<0.001
2017	0.015(0.013–0.017)	<0.001	−0.009(−0.010–0.008)	<0.001
2018	0.019(0.017–0.021)	<0.001	−0.009(−0.011–0.008)	<0.001
Occupation				
Babysitting/Agricultural/Irregular employed/Unemployed	0(ref)	..	0(ref)	..
Employee/Individual household	−0.109(−0.111–0.108)	<0.001	−0.073(−0.074–0.072)	<0.001
Middle-class employers	−0.157(−0.159–0.154)	<0.001	−0.097(−0.099–0.096)	<0.001
White-collar worker	0.0285(0.026–0.031)	<0.001	0.002(0.001–0.004)	<0.001
Leading groups	0.049(0.040–0.057)	<0.001	0.015(0.010–0.020)	<0.001

Table 7. RIF-OLS regression of determinants of inequality in basic medical insurance enrollment proportion.

Variable	Hospitalization reimbursement rate			
	WI		EI	
	β(95%CI)	*P*	β(95%CI)	*P*
Age	−0.0026(−0.0032 - −0.0020)	<0.001	−0.0028(−0.0034 - −0.0022)	<0.001
Gender				
Male	0(ref)	..	0(ref)	..
Female	−0.005(−0.018–0.008)	0.429	−0.005(−0.018–0.008)	0.472
Education				
Illiteracy	0(ref)	..	0(ref)	..
Primary school	−0.026(−0.059–0.008)	0.133	−0.024(−0.057–0.010)	0.161
Junior high school	−0.008(−0.039–0.023)	0.605	−0.007(−0.038–0.023)	0.642
Senior high school or technical secondary school	−0.021(−0.052–0.011)	0.204	−0.022(−0.053–0.010)	0.179
Junior college	0.004(−0.030–0.037)	0.826	0.001(−0.032–0.034)	0.950
Undergraduate or above	0.136(0.101–0.172)	<0.001	0.131(0.095–0.166)	<0.001
Marital status				
Single	0(ref)	..	0(ref)	..
Not single	0.0470(0.021–0.072)	<0.001	0.044(0.019–0.069)	0.001
Migration scope				
Cross-province	0.023(−0.006–0.052)	0.116	0.033(0.004–0.062)	0.024
Cross-city	0.033(0.004–0.062)	0.028	0.040(0.011–0.069)	0.008
Cross-county	0(ref)	..	0(ref)	..
Migration duration	−0.00043(−0.0015–0.00060)	0.413	−0.00043(−0.0014–0.00059)	0.412
Average Indexed Monthly Earnings (AIME)				
0.00-60.07	0(ref)	..	0(ref)	..
60.07–81.92	−0.038(−0.056–0.020)	<0.001	−0.037(−0.055–0.020)	<0.001
81.92-106.26	−0.030(−0.047–0.013)	0.001	−0.029(−0.046–0.013)	0.001
106.26-136.58	−0.040(−0.058–0.023)	<0.001	−0.040(−0.058–0.023)	<0.001
136.58-191.21	−0.069(−0.086–0.052)	<0.001	−0.069(−0.086–0.052)	<0.001
>191.21	−0.091(−0.109–0.074)	<0.001	−0.091(−0.109–0.074)	<0.001
Region				
Eastern	0.059(0.020–0.098)	0.003	0.064(0.026–0.103)	0.001
Central	0.036(−0.016–0.087)	0.179	0.033(−0.018–0.085)	0.203
Western	−0.163(−0.309–0.017)	0.029	−0.144(−0.289–0.001)	0.052
Northeastern	0(ref)	..	0(ref)	..
Economic belt area				
Pearl River Delta	0.010(−0.025–0.044)	0.578	0.006(−0.028–0.040)	0.711
Yangtze River Delta	0.025(−0.009–0.059)	0.147	0.022(−0.012–0.056)	0.201
Circum-bohai Sea	−0.026(−0.066–0.014)	0.206	−0.031(−0.071–0.010)	0.135
Others	0(ref)	..	0(ref)	..
Year				
2013	..	..	..	..
2014	0(ref)	..	0(ref)	..
2015	..	..	..	..
2016	..	..	..	..
2017	..	..	..	..
2018	−0.004(−0.005–0.003)	<0.001	0.005(−0.006–0.015)	0.371
Occupation				
Babysitting/Agricultural/Irregular employed/Unemployed	0(ref)	..	0(ref)	..
Employee/Individual household	−0.073(−0.074–0.072)	<0.001	−0.033(−0.044–0.023)	<0.001
Middle-class employers	−0.097(−0.099–0.096)	<0.001	−0.080(−0.106–0.054)	<0.001
White-collar worker	0.003(0.001–0.004)	<0.001	0.156(0.135–0.176)	<0.001
Leading groups	0.015(0.010–0.020)	<0.001	0.486(0.385–0.586)	<0.001

Table 8. RIF-OLS regression of determinants of inequality in hospitalization reimbursement rate.

A Standardized health record establishment proportion

Year	WI β(95%CI)	WI P	EI β(95%CI)	EI P
2013	0(ref)	..	0(ref)	..
2014	-0.018（-0.020--0.016）	<0.001	-0.017（-0.019--0.015）	<0.001
2015	-0.006（-0.007--0.004）	<0.001	-0.005（-0.007--0.004）	<0.001
2016	0.010（0.008-0.012）	<0.001	0.010（0.008-0.012）	<0.001
2017	0.003（0.001-0.005）	0.001	0.003（0.001-0.005）	<0.001
2018	-0.004（-0.005--0.002）	<0.001	-0.0031（-0.005--0.001）	<0.001

B Standardized health education intervention coverage

Year	WI β(95%CI)	WI P	EI β(95%CI)	EI P
2013	..	..	..	..
2014	0(ref)	..	0(ref)	..
2015	0.099（0.097-0.101）	<0.001	0.049（0.048-0.050）	<0.001
2016	0.070（0.068-0.072）	<0.001	0.032（0.031-0.033）	<0.001
2017	0.059（0.057-0.061）	<0.001	0.035（0.033-0.036）	<0.001
2018	0.061（0.059-0.063）	<0.001	0.031（0.030-0.032）	<0.001

C Basic medical insurance enrollment proportion

Year	WI β(95%CI)	WI P	EI β(95%CI)	EI P
2013	0(ref)	..	0(ref)	..
2014	-0.005（-0.007--0.003）	<0.001	-0.009（-0.010--0.008）	<0.001
2015	0.034（0.032-0.035）	<0.001	0.003（0.002-0.004）	<0.001
2016	0.005（0.003-0.007）	<0.001	-0.006（-0.007--0.005）	<0.001
2017	0.015（0.013-0.017）	<0.001	-0.009（-0.010--0.008）	<0.001
2018	0.019（0.017-0.021）	<0.001	-0.009（-0.011--0.008）	<0.001

D Hospitalization reimbursement rate

Year	WI β(95%CI)	WI P	EI β(95%CI)	EI P
2013	..	..	..	..
2014	0(ref)	..	0(ref)	..
2015	..	..	..	..
2016	..	..	..	..
2017	..	..	..	..
2018	-0.004（-0.005--0.003）	<0.001	0.005（-0.006-0.015）	0.371

Fig. 5. Adjusted trends of inequality index of standardized health record establishment proportion, standardized health education intervention Coverage, basic medical insurance enrollment proportion and hospitalization reimbursement rate.

Data availability

The data that support the findings of this study are available from National Commission of Health and Family Planning, People's Republic of China. Restrictions apply to the availability of the data.

Received: 28 January 2025; Accepted: 22 August 2025
Published online: 29 August 2025

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Author contributions
YJ, YZ and CC contributed to the conception and the design of the work. KW, XQ, XK, TC, XW, YD contributed to the data analysis and interpretation of data. YZ drafted the work. All authors have approved the submitted version and have agreed both to be personally accountable for the author's own constitutions and to ensure the questions related to the accuracy and integrity of any part of the work.

Funding
No funding.

Declarations

Competing interests
The authors declare no competing interests.

Ethical approval and consent to participate
This was secondary analysis of publicly available data, and no participant consent forms were required to access this data set. This study was exempted from ethical review by Peking University Institutional Review Board (No. IRB00001052–16011).

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