Universal health coverage in China: a serial national cross-sectional study of surveys from 2003 to 2018

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Summary

Background Achieving universal health coverage (UHC) is one crucial target of the Sustainable Development Goals. However, consistent trends data for UHC evaluation in China are still scarce. The aim of our study was to provide a comprehensive assessment of UHC in China.

Methods In this serial cross-sectional study, we collected nationally representative data from the latest four rounds (2003, 2008, 2013, and 2018) of the National Health Service Surveys, with the aim of evaluating UHC in China. These surveys used multistage stratified cluster sampling covering all 31 provinces, autonomous regions, and municipalities in mainland China. Within each household, all members aged 15 years and older were interviewed. For children and adolescents aged younger than 15 years, their adult family members answered the questions for them. We constructed a UHC index following the WHO-recommended framework that included service coverage (nine prevention indicators and five treatment indicators) and financial protection (three indicators) dimensions. Bayesian regression models were done to investigate the trends in and projections of UHC index and indicators, with average annual percentage change (AAPC) and probabilities of achieving the 2030 WHO targets. Based on trends and projections, we counted population equivalents with UHC coverage. To examine the potential efficiency of financial investment, we quantified UHC performance based on government health expenditure (GHE) per capita. Finally, we explored the association between each UHC indicator and macroeconomic and health systems characteristics by using multiple regression.

Findings We sampled 57 023 households from 95 counties between September and October, 2003; 56 456 households from 94 counties between June and July, 2008; 93 613 households from 156 counties between August and October, 2013; and 94 076 households from 156 counties in September, 2018. A total of 901 182 individuals were involved in this study (193 689 in 2003, 177 501 in 2008, 273 688 in 2013, and 256 304 in 2018). Although the overall UHC increased from 44·0% (95% CI 43·0–44·9) in 2003 to 79·8% (79·2–80·3) in 2018 and is predicted to meet the 80% global target by 2030, the progress towards UHC has steadily slowed down nationally. Based on current projections, an estimated 105·8 (95% CI 27·3–189·1) million population equivalents would still not have UHC coverage in 2030. The treatment index showed a large increase over time from 2003 to 2018 (AAPC 4·9%, 2·9–7·2), with minimal disparities and all subgroups will achieve the target in the treatment domain by 2030 (possibilities higher than 90%). However, the prevention index presented poor performance with a small increase over time from 2003 to 2018 (AAPC 1·4%, 0·3–2·5) and sizable disparities across regions, urban–rural areas, and income (all p<0·0001). To achieve at least 80% UHC coverage, provinces would need to reach at least ¥445 in GHE per capita per year under maximum efficiency. However, large gaps between the observed and frontier UHC index, especially in several western provinces, indicated inefficiency. Furthermore, we found that primary health-care institutions were closely and positively related to UHC indicators especially in the prevention domain.

Interpretation Although considerable achievements have been made, the progress towards UHC is not keeping pace with the rapid society development in China. Considering an increased burden in non-communicable diseases and an ageing population, prioritising the efficacy of financial investment and optimising resource allocation by strengthening primary health care are necessary to achieve UHC in China.

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Introduction

Universal health coverage (UHC) includes access to essential health care without suffering from financial hardship and is a global policy priority and one central target of the Sustainable Development Goals (SDGs).[1,2] Under the SDGs, WHO has defined a set of UHC targets, in which at least 80% of the population will be covered for basic health services by 2030 in each country, irrespective of their place of residence or economic status.[3,4] In 2014, WHO and The World Bank developed a

Research in context

Evidence before this study

We searched PubMed for articles published in any language from inception to August 24, 2022, using the search terms ((public health) OR (national health)) AND ((health service) OR (service coverage)) AND (financ* risk), to identify work about universal health coverage (UHC) assessment in China. Of the 19 051 papers identified, 634 were about China. We identified 104 papers that assessed UHC in China after screening the titles and abstracts, and 81 papers were finally identified after screening the full text. Several studies have tried to provide information about the progress towards UHC in China but they each have various limitations. Four studies were based on multiple different databases or used small sample data restricted to specific regions or groups, which were not consistent and nationally representative. One study used national data but was restricted to lags in data availability for understanding up-to-date trends. One paper published in *PLoS Medicine* did a systematic analysis of progress towards the health-related Sustainable Development Goals using multiple data from China, which included UHC projections by 2030. This article used nine tracer interventions and risk-standardised death rates from 32 causes amenable to personal health care (scale of 0 to 100) to assess and predict UHC in China. Although very important, as the authors pointed out, this study still had a limitation related to data availability and quality due to using multiple different databases. Another paper published in *BMJ Global Health* assessed 10-year impacts of China's rural health scheme to inform UHC promotion, which made important evaluations of the health sector reform in China. However, this study focused on the New Cooperative Medical Scheme in China, and used a subsample of the National Health Service Surveys' respondents who were enrolled in this scheme in 2003, 2008, and 2013, which only accounted for 8·8%, 68·7%, and 51·7% of the survey's total sample in the three waves, respectively, and was not nationally representative. Moreover, work about UHC evaluation to date in China has only examined each dimension of UHC in isolation.

Added value of this study

Our study provides a comprehensive and up-to-date assessment of UHC in China, using a composite index with service coverage and financial protection as major indicators. Importantly, it focused on the least covered indicators and hard-to-reach populations. We showed that China could achieve the 80% UHC target by 2030 at the national level, with substantial improvements from 2003 to 2018. Important advances have been mainly made in achieving equal access to maternal and child health services (eg, full immunisation and hospital delivery) and insurance coverage. China has done well in provision of equitable treatment services but poorly in prevention performance, especially related to basic health facilities. We also found notable inefficiencies when transforming government health expenditure into UHC performance. By quantifying the associations between health resources and UHC indicators, our study provides solid evidence of the essential role that primary health care could have in UHC promotion, especially in the prevention domain.

Implications of all the available evidence

China still faces challenges in achieving UHC for all. More attention should be paid to the prevention domain, especially for the rural and central populations who have a low income. Improving efficacy of financial investment and promoting high-quality primary health care should be prioritised to help China achieve UHC.

UHC monitoring framework to track UHC progress, which requires simultaneous measurement on both service coverage and financial protection dimensions.[3,4] In the past decades, many countries have embarked on health reforms and have made great progress in UHC.[5,6] However, many countries, in particular low-income and middle-income countries (LMICs), still struggle to deliver UHC.[7–9] In this context, it is essential to monitor progress towards UHC. As the most populous LMIC in the world, data from China is important for a comprehensive evaluation of UHC worldwide.

China's health-care reforms largely started in the early 2000s, and were then followed by a more comprehensive health reform in 2009 that focused on public health, essential medicines, service delivery, insurance, and public hospitals.[10,11] The efficacy of these reforms in China remains to be elucidated. Although several studies have tried to report progress towards UHC in China and have shown major advances, they each have prevailing data limitations.[12–19] Previous studies were either lagging in data availability for understanding recent trends or based on merged databases that indicated inconsistencies.[12–19] Moreover, previous studies did not measure overall UHC using the comprehensive index from WHO-recommended health services and financial protection dimensions. Previous studies have not provided projections with quantifying probabilities and, therefore, whether China can achieve the 2030 global target of UHC is also unclear. Additionally, although UHC progress was reported in multi-country analyses, previous studies did not focus on problems specific to China.[20–24]

Monitoring current levels and trends of UHC is essential to track progress towards UHC targets, identify indicators and populations in most need, assess the effectiveness of policies, and align future programme planning in China. The aim of our study was to provide a comprehensive assessment of UHC, including trends, projections, and disparities using an index measuring both health services and financial protection based on serial national surveys from 2003 to 2018 in China. Additionally, we considered applications of UHC index

for current national priorities by translating index performance to the number of people covered by UHC coverage and investigating the efficiency of government health expenditure (GHE) on UHC. Finally, to better understand underlying factors in achieving UHC, we explored the association between UHC indicators and macroeconomic and health systems characteristics, which would be important for informing stakeholders to make effective health strategies.

Methods

Study design and participants

In this serial cross-sectional study, we collected data from the latest four rounds (done in 2003, 2008, 2013, and 2018) of the National Health Services Survey (NHSS), which had been carried out by the National Health Commission every fifth year since 1993, with the aim of specifically evaluating UHC in China.[13,25] The NHSS is one of the largest nationally representative cross-sectional household surveys of Chinese residents' demographic and socioeconomic status, health insurance enrolment, health needs, health service access and utilisation, medical expenditures, and health. The NHSS covers all 31 provinces, autonomous regions, and municipalities in the mainland of China (appendix p 2) and uses a multistage stratified cluster sampling method (appendix pp 3–4), which has been reported elsewhere.[13,25]

Within each household, all members aged 15 years and older were interviewed. For the children and adolescents aged younger than 15 years, their adult family members answered the questions for them.

The institutional review board of the Chinese National Bureau of Statistics provided ethical approval for the survey. Oral consent was obtained from all participants before the interview. More details about the survey protocol are available in the appendix (p 3).

Procedures

Previous reports have described the interview procedures in details.[13,25] Face-to-face interviews based on a structured questionnaire were administered by locally trained health-care workers (appendix pp 5–9). The response rate of each survey round was 98·3% in 2003, 95·0% in 2008, 95·5% in 2013, and 97·8% in 2018 respectively. The questionnaire was designed and implemented every 5 years since 1993 and presented reliability and consistency over time.

Measurement of UHC indicators

Following the WHO and World Bank framework,[3,4] we measured UHC progress from two dimensions: coverage of essential health services and financial protection due to health-care costs (appendix pp 10–13). Health services are divided into two domains: prevention services and treatment services. Due to varieties in indicators monitoring UHC progress, a country's health system, epidemiology, and data availability should be considered to select indicators. Five broad principles underpinned our choice of UHC indicators (appendix p 10). We chose nine prevention indicators (breast or cervical cancer screening, four or more antenatal visits, postnatal care, full immunisation, exclusive breastfeeding, safe drinking water, adequate sanitation, physical access to a health facility, and non-use of tobacco) and five treatment indicators (caesarean section, hospital delivery, skilled birth attendance, use of outpatient care, and hospital admissions) covering all major principal indicators in assessing health services based on the selection criteria and previous studies (appendix pp 11–13). The financial protection included three indicators that can reflect the ability to respond to health financial risks (appendix pp 11–13). All selected indicators were measured in the same way in each survey round presenting reliability and consistency across surveys (appendix p 14).

To track the progress of overall prevention and treatment coverage, we calculated a composite prevention index and a composite treatment index as the weighted geometric average of prevention and treatment indicators, respectively. Service coverage was weighted unequally via a geometric average for prevention and treatment domains.[22] The UHC index is a geometric average of service coverage and financial protection (appendix pp 15–16).[22]

See Online for appendix

Statistical analysis

Data were disaggregated by geographical regions (east, central, or west), residence (urban or rural), and household annual income (quartile 1 [Q1, the poorest] to quartile 4 [Q4, the wealthiest]). The coverages of UHC and indicators were calculated for the overall population and subgroups. As the missing data of most UHC indicators were lower than 1%, individuals with missing values about UHC indicators were not included in the final analysis. Bayesian linear regression models with non-informative priors were used to investigate trends in and projections of UHC indicators with time (appendix p 17).[26–28] The logit transformed proportions of UHC indicators were the dependent variables and survey year was the covariate. Posterior predictive distributions were extracted from the fitted Bayesian models to calculate the probability of achieving targets for UHC indicators and the average annual percentage of change (AAPC) over time. According to the UHC targets defined by WHO under SDG 3, a threshold of 80% coverage by 2030 was applied.[3] Additionally, we used a WHO-recommended approach to count population equivalents (the number of people covered by UHC in correspondence to its performance index) with UHC coverage.[29] We applied index estimates as fractional metrics and multiplied these values by populations to approximate population equivalents with UHC coverage.[21,30]

To evaluate the degree of income disparity, the ratio difference of an indicator between households in the top and bottom of income status (Q4:Q1) was

calculated.[13] The ratio suggests the difference between the two groups of people, where 1 implies no difference; any ratio higher or lower than 1 indicated differences between the two groups. Pearson χ^2 tests were used to test statistical significance of differences. The same analysis was done to assess regional (east or west) and urban versus rural disparities.

We did a stochastic frontier meta-regression analysis to estimate UHC frontier.[31–33] To better understand potential drivers of UHC coverage, we did a multiple regression to investigate the association between each UHC indicator and macroeconomic and health systems characteristics (health financing and resources; appendix p 18).[22] The macroeconomic and health systems characteristics data of each province in each survey year (2003, 2008, 2013, and 2018) were collected from the statistical yearbook of the National Bureau of Statistics of China.[34] Explanatory variables included: gross domestic product (GDP) per capita, GHE (as a % of GDP), large hospitals, primary health-care (PHC) institutions, doctors (per 1000 capita), and medical beds (per 1000 capita). The coefficients are interpreted as effects relative to the omitted category. We did all the analyses using Stata (version 16.0) or R (version 3.5.1).

Role of the funding source

The funders of the study had no role in the study design, data collection, data analysis, data interpretation, or writing of the report.

Results

We sampled 57 023 households from 95 counties between September and October, 2003; 56 456 households from 94 counties between June and July, 2008; 93 613 households from 156 counties between August and October, 2013; and 94 076 households from 156 counties in September, 2018. A total of 901 182 individuals, including 193 689 in 2003, 177 501 in 2008, 273 688 in 2013, and 256 304 in 2018, were analysed in the study (appendix p 19). Individuals involved were comparable in most sociodemographic factors across survey years, which were well balanced (appendix p 19).

Overall, the composite UHC index increased substantially from 44·0% (95% CI 43·0–44·9) in 2003 to 79·8% (79·2–80·3) in 2018 with a 3·4% AAPC and was projected to reach 94·2% (85·2–98·3) in 2030, which would meet the 80% target by 2030 at the national level with 99·2% probability (table 1). The number of people with UHC increased by 544·4 (95% CI 540·3–549·2) million from 2003 to 2018 (appendix p 20). However, based on current projections, an estimated 105·8 (27·3–189·1) million population equivalents would not have UHC in 2030 (appendix p 20). Improvements occurred during 2003–08; however the progress slowed down after 2008 (appendix p 21). For different domains, accelerated increase was observed in the treatment index (4·9%, 95% CI 2·9–7·2), but very slow rate of progress was found in the prevention index (1·4%, 0·3 to 2·5), which was only one-fourth that of the treatment index.

Most maternal and child health indicators improved largely and are projected to meet the 2030 target, such as full immunisation (AAPC 2·5%, 95% CI 1·0 to 4·8, probability 100%) and hospital delivery (4·0%, 2·4 to 5·8, 100%). However, breast or cervical cancer screening (0·4%, –2·4 to 3·5, 2%) and exclusive breastfeeding (–0·8%, –1·6 to –0·3; 7%) did not increase and were projected to be far below the 2030 target. For health facility indicators, adequate sanitation still presented wide urban–rural disparity (ratio 1·41, 95% CI 1·40 to 1·41; table 1) with the gap between urban and rural households being as high as 25·6% in 2018 (88·6% [95% CI 88·4 to 88·9] in urban *vs* 63·0% [62·5 to 63·4] in rural). Besides, consistent decreasing trends were observed in physical access to a health facility especially in urban China during survey periods from 2003 to 2018 (AAPC –0·6%, 95% CI –1·2 to –0·1). Within the financial protection domain, health insurance coverage improved by more than three times during these survey periods and had already met the target (97·5%, 97·5 to 97·6 in 2018). Nevertheless, the coverage of no catastrophic health expenses presented decreasing trends, especially in poor households from 60·7% (95% CI 60·2 to 61·3) in 2013 to 38·7% (38·1 to 39·3) in 2018, which will not achieve the target (probability 0%). And 23·3% of people still face the risk of self-discharge from hospitals for financial reason. Sensitivity analyses of weighting indicators equally were done, which suggested the robustness of the main results (appendix p 38). Trace plots and density plots of Markov chain Monte Carlo diagnostics suggested the Bayesian models were converged (appendix p 39).

UHC indexes and indicators presented different patterns and trends in urban–rural, regional, and income disparities (figure 1; appendix pp 22–35). For overall UHC index, the urban–rural and regional disparities were substantially narrowing over time (ratio 1·50 [95% CI 1·49–1·51] in 2003 to 1·04 [1·03–1·04] in 2018 for urban–rural disparities; and 1·20 [1·20–1·20] in 2003 to 1·05 [1·05–1·05] in 2018 for regional disparities), whereas the income disparity was still large (ratio 1·21, 95% CI 1·20–1·22, coverage gap 15·2% in 2018; figure 1; appendix p 26). The treatment index presented consistently narrowed disparities with a small difference between urban–rural (ratio 1·01, 95% CI 1·01–1·02), regional (1·05,1·04–1·05), and income-based (1·02, 1·02–1·03) subgroups. By contrast, the prevention index still showed sizeable interactive urban–rural (1·17, 1·16–1·18, p<0·0001), regional (1·17, 1·16–1·19, p<0·0001), and income-based (1·21, 1·19–1·23, p<0·0001) disparities (appendix pp 28, 31, 34). Individuals from rural and central areas with low income had a prevention index far below the 80% target and were projected not to achieve the target by 2030 (probabilities less than 60%). The

	Observed coverage				AAPC, 2003–18	Predicted coverage, 2030	Probability of reaching target*	Disparity†					
	2003	2008	2013	2018				Urban–rural		Regional		Income	
								2003	2018	2003	2018	2003	2018
Universal health coverage index	44·0% (43·0 to 44·9)	67·9% (67·0 to 68·9)	79·7% (79·0 to 80·4)	79·8% (79·2 to 80·3)	3·4% (1·4 to 5·7)	94·2% (85·2 to 98·3)	99·2%	1·50‡	1·04‡	1·20‡	1·05‡	1·48‡	1·21‡
Service coverage index	44·2% (43·1 to 45·1)	60·4% (59·3 to 61·5)	76·0% (75·1 to 76·8)	82·2% (81·8 to 82·7)	4·0% (2·4 to 5·9)	95·3% (89·0 to 98·2)	100·0%	1·42‡	1·03‡	1·21‡	1·06‡	1·19‡	1·04‡
Prevention index	63·7% (63·0 to 64·4)	68·3% (67·6 to 69·0)	72·5% (72·0 to 73·0)	78·8% (78·4 to 79·1)	1·4% (0·3 to 2·5)	86·0% (75·7 to 93·6)	91·6%	1·41‡	1·10‡	1·24‡	1·08‡	1·14‡	1·09‡
Breast or cervical cancer screening	34·8% (34·4 to 35·3)	46·6% (46·1 to 47·1)	37·6% (37·3 to 37·9)	40·3% (39·9 to 40·6)	0·4% (–2·4 to 3·5)	43·3% (21·1 to 67·9)	2·0%	1·62‡	1·13‡	1·38‡	1·09‡	1·28‡	1·40‡
Four or more antenatal visits	55·1% (53·6 to 56·6)	68·4% (67·0 to 69·8)	84·0% (83·1 to 84·8)	94·4% (93·9 to 94·9)	4·0% (2·4 to 5·9)	99·1% (97·8 to 99·7)	100·0%	1·73‡	1·06‡	1·49‡	1·05‡	1·25‡	1·05‡
Postnatal care	54·3% (52·8 to 55·8)	56·6% (55·1 to 58·1)	65·1% (64·0 to 66·3)	78·1% (77·2 to 79·1)	2·6% (0·9 to 4·4)	87·2% (71·2 to 95·6)	90·1%	1·16‡	1·09‡	1·17‡	1·13‡	1·11‡	1·07‡
Full immunisation	83·1% (82·3 to 83·9)	81·0% (80·2 to 81·8)	87·5% (87·0 to 88·0)	99·5% (99·4 to 99·6)	2·5% (1·0 to 4·8)	99·9% (99·4 to 100·0)	100·0%	1·08‡	1·00	1·05‡	1·00	1·05‡	1·00
Exclusive breastfeeding	97·5% (97·2 to 97·8)	91·9% (91·4 to 92·5)	84·7% (84·1 to 85·2)	88·9% (88·4 to 89·3)	–0·8% (–1·6 to –0·3)	58·1% (25·6 to 85·3)	7·0%	0·99‡	1·03‡	1·00	1·00	1·00	1·02‡
Safe drinking water	83·3% (83·0 to 83·6)	88·5% (88·2 to 88·7)	93·4% (93·2 to 93·6)	93·7% (93·6 to 93·9)	0·8% (0·2 to 1·4)	97·4% (93·8 to 99·1)	100·0%	1·29‡	1·08‡	1·27‡	1·05‡	1·09‡	1·03‡
Adequate sanitation	40·1% (39·7 to 40·5)	44·5% (44·0 to 44·9)	64·7% (64·4 to 65·0)	76·8% (76·5 to 77·1)	4·8% (2·6 to 7·1)	91·6% (82·3 to 96·8)	98·7%	4·18‡	1·41‡	1·84‡	1·27‡	1·37‡	1·18‡
Physical access to health facility	83·1% (82·8 to 83·4)	81·2% (80·8 to 81·5)	80·6% (80·3 to 80·8)	80·3% (80·0 to 80·5)	–0·2% (–0·9 to 0·4)	76·8% (62·0 to 87·1)	23·3%	1·16‡	1·12‡	1·17‡	1·12‡	1·06‡	1·07‡
Non-use of tobacco	74·0% (73·8 to 74·2)	75·1% (74·9 to 75·3)	74·3% (74·2 to 74·5)	76·7% (76·6 to 76·9)	0·2% (–0·8 to 1·0)	77·2% (62·7 to 87·6)	27·9%	1·04‡	1·04‡	1·01‡	1·04‡	1·05‡	1·03‡
Treatment index	39·1% (38·0 to 40·1)	58·0% (56·8 to 59·2)	77·2% (76·2 to 78·1)	83·4% (83·0 to 83·9)	4·9% (2·9 to 7·2)	96·5% (91·8 to 98·8)	99·9%	1·42‡	1·01‡	1·20‡	1·05‡	1·21‡	1·02‡
Caesarean section	18·9% (17·7 to 20·0)	30·1% (28·7 to 31·5)	40·9% (39·8 to 42·1)	44·1% (43·0 to 45·3)	5·4% (2·1 to 8·7)	69·9% (49·5 to 86·2)	11·7%	3·59‡	1·14‡	2·93‡	1·28‡	1·38‡	1·10‡
Hospital delivery	47·7% (46·2 to 49·2)	64·3% (62·8 to 65·7)	82·1% (81·2 to 83·0)	87·7% (87·0 to 88·5)	4·0% (2·4 to 5·8)	97·4% (94·1 to 99·2)	100·0%	2·21‡	1·03‡	1·59‡	1·00	1·36‡	1·04‡
Skilled birth attendance	87·2% (86·2 to 88·2)	93·4% (92·6 to 94·2)	96·1% (95·6 to 96·5)	99·0% (98·8 to 99·2)	1·0% (0·5 to 1·5)	99·8% (99·5 to 99·9)	100·0%	1·13‡	1·00	1·27‡	1·01‡	1·06‡	1·01
Use of outpatient care§	51·1% (50·6 to 51·7)	51·6% (51·0 to 52·2)	70·6% (70·1 to 71·0)	61·2% (60·9 to 61·6)	1·7 % (–0·6 to 4·1)	74·7% (49·9 to 91·2)	33·8%	0·79‡	0·95‡	1·02	1·14‡	1·15‡	1·05‡
Hospital admissions¶	34·1% (33·2 to 34·9)	60·8% (59·7 to 62·0)	86·2% (85·1 to 87·3)	100·0% (100·0 to 100·0)	7·3% (4·8 to 9·8)	99·6% (98·5 to 99·9)	100·0%	1·23‡	1·00	0·92‡	1·00	1·20‡	1·00
Financial protection index	43·8% (42·9 to 44·7)	76·5% (75·7 to 77·2)	83·7% (83·2 to 84·2)	77·4% (76·7 to 78·0)	2·8% (0·7 to 5·6)	93·5% (81·3 to 98·7)	98·1%	1·59‡	1·04‡	1·18‡	1·05‡	1·82‡	1·41‡
Health insurance coverage	29·7% (29·5 to 29·9)	87·9% (87·8 to 88·1)	96·3% (96·2 to 96·4)	97·5% (97·5 to 97·6)	5·5% (3·0 to 8·9)	99·9% (99·8 to 100·0)	100·0%	2·63‡	0·99‡	1·43‡	0·99‡	1·69‡	1·01‡
No self-discharge for financial reasons	36·5% (34·6 to 38·3)	64·9% (63·4 to 66·5)	76·5% (75·4 to 77·6)	76·7% (75·3 to 78·2)	4·1% (1·7 to 6·9)	93·6% (83·1 to 98·4)	98·5%	1·42‡	0·99	1·13	1·02	2·42‡	1·31‡
No catastrophic health expenses	77·5% (77·2 to 77·8)	78·3% (77·9 to 78·6)	79·6% (79·3 to 79·9)	62·0% (61·6 to 62·3)	–1·0% (–2·4 to 0·4)	55·6% (26·9 to 79·6)	2·3%	1·07‡	1·13‡	1·03‡	1·14‡	1·49‡	2·15‡

Data are % (95% CI), %, or ratio. AAPC=average annual percentage change. *WHO's targets for universal health coverage are by 2030 at least 80% health services coverage for the entire population, irrespective of economic status, gender, or place of residence. †Disparity was expressed by the ratio between comparison groups. ‡p values test indicates significant differences (p<0·05). §The coverage of use of outpatient care is calculated and reported in effective coverage. ¶For the hospital admissions indicator, WHO has proposed a benchmark of 0·1 inpatient admissions per capita, equivalent to 9·03% of the population with an inpatient admission in the past 12 months. Rate is expressed as percent of this benchmark or 100% if the rate is above 9·03%.

Table 1: **Trends in, projections of, and disparities of national universal health coverage in China from 2003 to 2030**

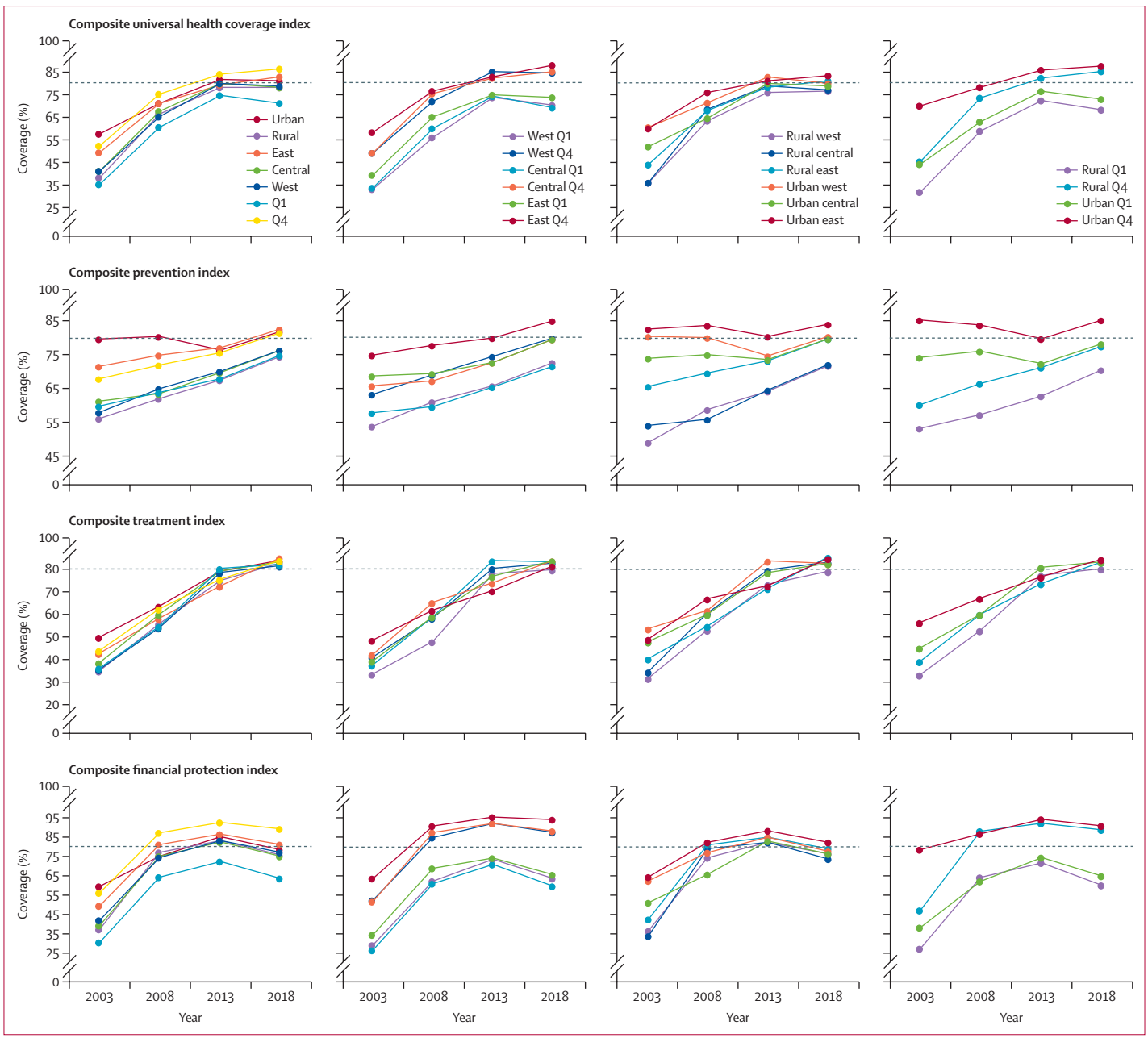
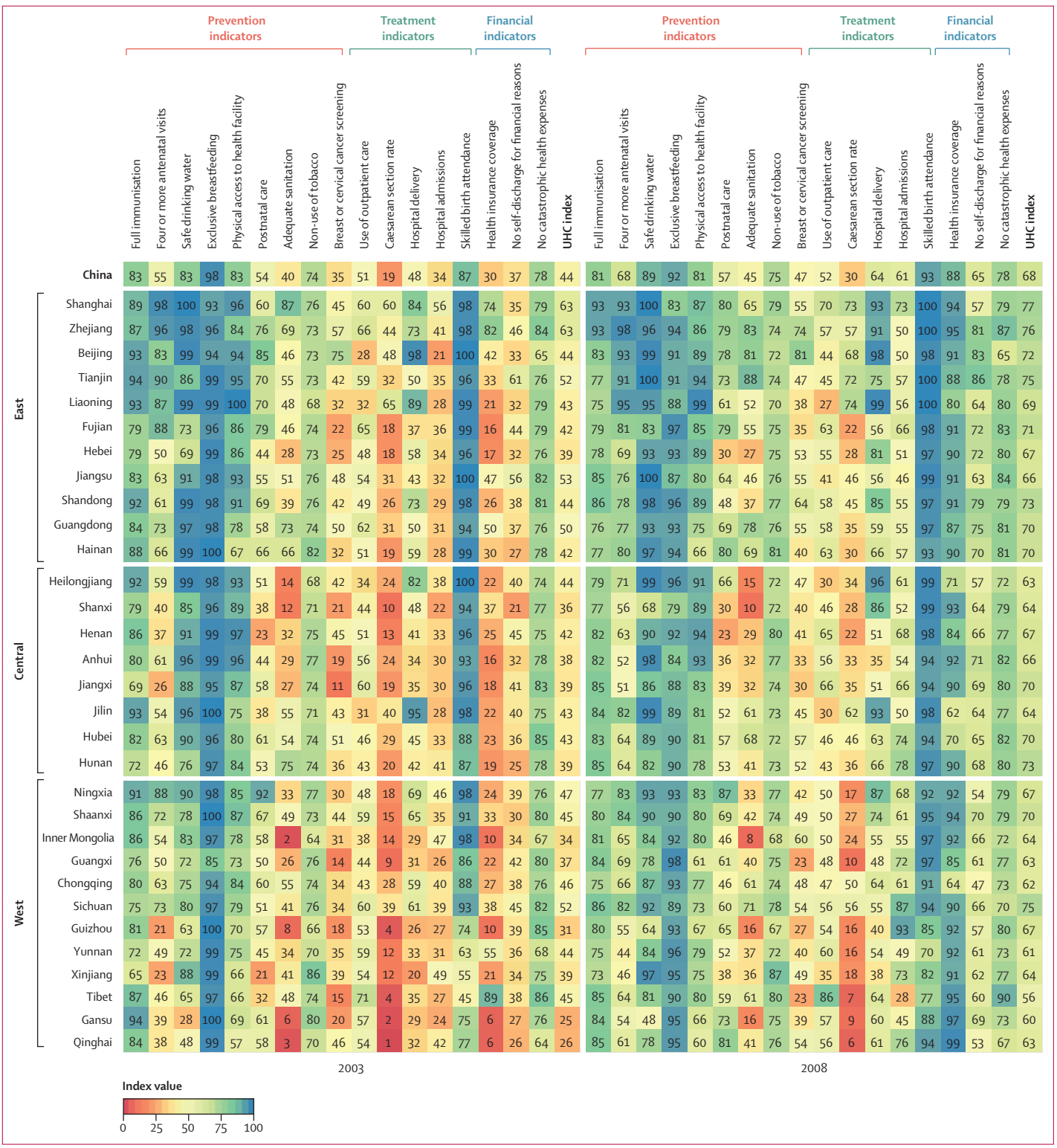


Figure 1: **Trends in urban–rural, regional, and income disparities of composite universal health coverage indices in China from 2003 to 2018**
The dotted line represents the 80% coverage target for universal health coverage indicators. Q1 represents the poorest household annual income and Q4 represents the wealthiest household annual income. Q1=quartile 1. Q4=quartile 4.

financial index showed large income disparities across region (1·47, 1·45–1·49) and urban–rural (1·51, 1·50–1·53) areas, and the coverage of no catastrophic health expenses in urban (richest) households was nearly three times that in rural (poorest) households (2·75, 2·69–2·80; appendix p 35). For individuals of different age groups, adults aged 55 years or older used outpatient care less, no self-discharge for financial reasons, and higher hospital admissions compared with children aged younger than 15 years (appendix p 36).

The overall UHC index often corresponded with levels achieved of each indicator (figure 2). Provinces with high UHC index values generally had high values of most indicators, whereas provinces with low UHC index scored similarly low across most indicators (figure 2). The overall UHC index and its components showed strong regional patterns and substantial variations mirroring populations' different health needs (figure 2). Remote western and central regions had remarkable increases in most maternal and child health indicators,

such as antenatal care and full immunisation, but still had comparatively lower scores on health facilities-related indicators such as adequate sanitation (figure 2). Compared with high coverage in health service, poor performance in no catastrophic health expenses was the core issue in wealthier eastern regions (figure 2).



(Figure 2 continues on next page)

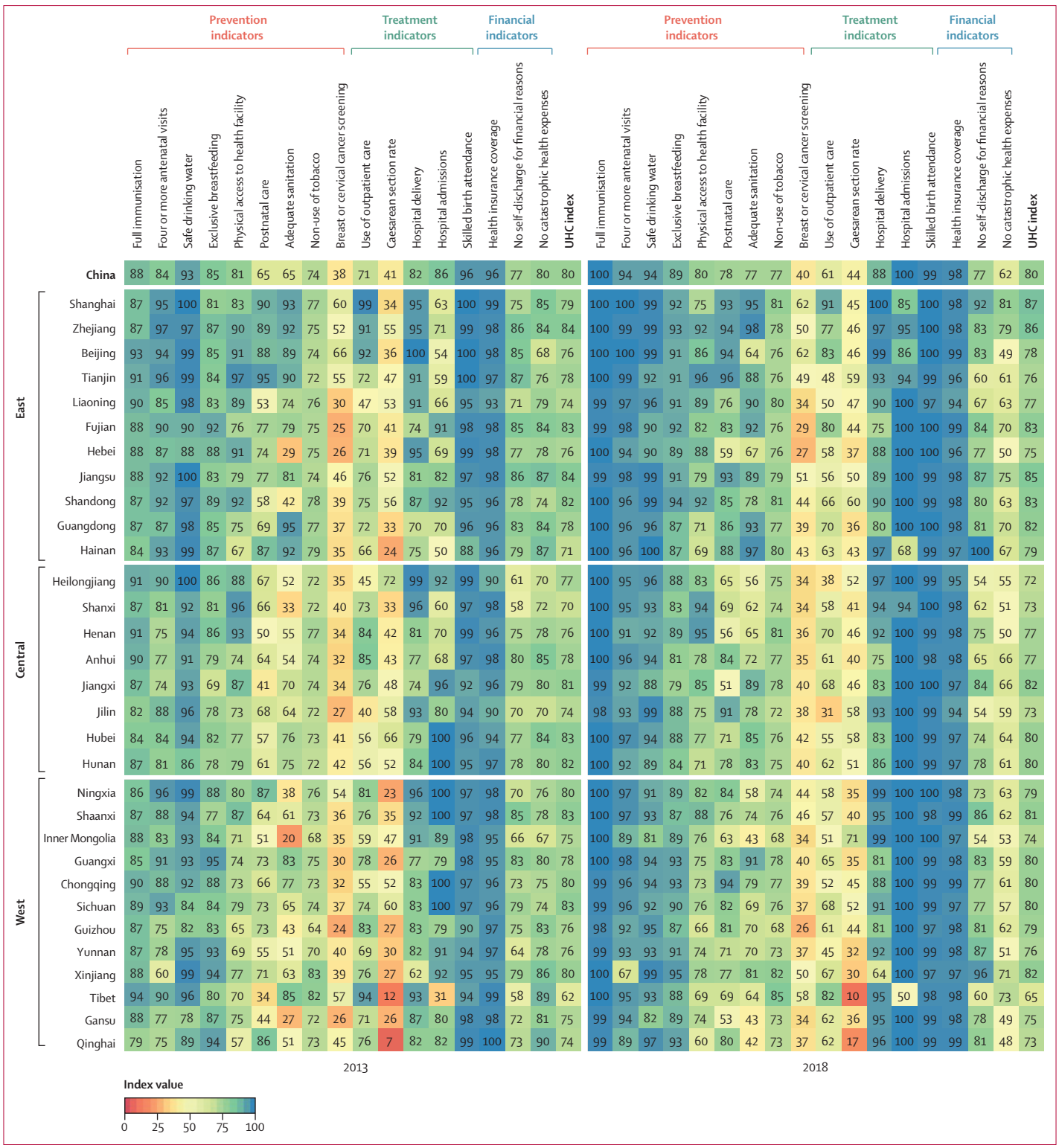


Figure 2: **Province-level performance indicators of UHC from 2003 to 2018**
The values (%s) shown in boxes represent the coverages of the indicators in each year. UHC=universal health coverage.

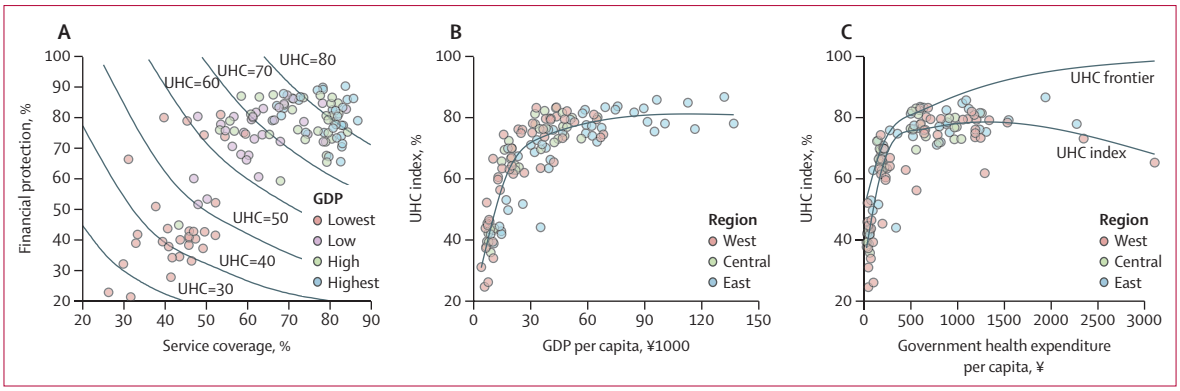


***Figure 3*: UHC index relative to pooled GDP per capita and government health expenditure per capita**
Data are based on the four rounds of surveys. Data points represent each province. (A) The UHC index of different provinces with different GDP levels. Contours show the combinations of service coverage and financial protection that produce the same value of UHC index. Data points are colour-coded by the level of GDP per capita divided by quartile. (B) Relationship between UHC index and GDP per capita. The grey line represents the fitted value of the UHC index. Data points are colour-coded by region. (C) UHC index frontier based on government health spending per capita. The upper grey line represents the frontier value for UHC index indicting potentially achievable level at any given amount of government health spending per capita. The grey line below represents the fitted value of the observed UHC index. Data points are colour-coded by region. UHC=universal health coverage. GDP=gross domestic product.

Additionally, the UHC index varied in different regions and provinces of China, ranging from 24·6% in Gansu (western) to 65·5% in Shanghai (eastern) in 2003, and 63·5% in Xinjiang (western) to 86·9% in Shanghai (eastern) in 2018 (figure 2).

We identified four major patterns of change in UHC index from 2003 to 2018 (figure 2; appendix p 37). The first pattern was characterised by a constantly low UHC index below the national average of China, such as the coverage seen in most provinces in the western and central regions (Qinghai [western] ranged from a low UHC index of 26·1% in 2003 to a high UHC index of 73·4% in 2018; Henan [central] ranged from 42·2% in 2003 to 77·0% in 2018). The second pattern included provinces with a UHC index consistently above the national average level, such as the coverage seen in most eastern provinces (Zhejiang from 62·9% in 2003 to 85·9% in 2018; Jiangsu from 53·1% in 2003 to 85·0% in 2018). The third pattern was provinces with a UHC index that changed from above to below the national average, such as that seen in Tianjin in the east, ranging from 7·7% above average in 2003 to 3·4% below average in 2018. A fourth pattern showed the opposite trend whereby the UHC index changed from below to above national average, as seen in Fujian, where it changed from 2·1% below average in 2003 to 3·3% above average in 2018.

Figure 3 presents the UHC index relative to pooled GDP per capita and GHE per capita. Generally, a province's UHC index score is higher the higher the province's income (GDP per capita), and provinces doing the best are those at the top right-hand corner of figure 3A of the high-income group, which have both high rates of service coverage and financial protection (figure 3A). Nevertheless, some provinces in the east did worse than others at the same or even lower income level in the west (figure 3B). Additionally, the UHC index was associated with GHE per capita (R^2=0·79, p<0·0001), but this relationship varied at different spending levels (figure 3C). Up to about ¥1235 in GHE per capita per year, increasingly higher spending generally paralleled higher performance on UHC index; beyond that, higher spending did not correspond as consistently with further improvements in UHC performance (figure 3C). To achieve at least 80% on the UHC index, provinces would need to reach ¥445 in GHE per capita per year, and do so under maximum efficiency. However, large gaps were found between potentially achievable UHC frontier and estimated UHC index performance especially in several western provinces, with a maximum difference of 34·0% (figure 3C).

The results of the regression analysis suggested potential correlates of the UHC index components (table 2). For health economics, GDP per capita and government health expenditure as a share of GDP was positively associated with most UHC indicators, such as four or more antenatal visits (10·2, 95% CI 4·8–15·5, p<0·0001 for GDP per capita; 10·5, 5·9–15·1, p<0·0001 for government health expenditure as a share of GDP). The associations between different health resources (large hospitals, primary health-care institutions, doctors, and medical beds) and UHC indicators vary (table 2). Importantly, establishment of PHC institutions were positively associated with three prevention indicators as well as two treatment indicators while building large hospitals were only positively associated with one service indicator (table 2).

Discussion

To the best of our knowledge, this study is the first comprehensive assessment of UHC in China using a composite index with service coverage and financial protection as major indicators, following the WHO and World Bank framework. Our data for indicators were taken from the latest four rounds of nationally

	Macroeconomy		Health financing		Health resources							
	GDP per capita	p value	Government health expenditure (as % of gross domestic product)	p value	Large hospitals	p value	Primary health-care institutions	p value	Doctors (per 1000 capita)	p value	Medical beds (per 1000 capita)	p value
Universal health coverage index	20·4 (18·1 to 22·8)	<0·0001	2·1 (0·8 to 3·3)	0·0010	1·3 (0·0 to 2·6)	0·044	0·7 (0·1 to 1·4)	0·032	−7·4 (−10·0 to −4·9)	<0·0001	0·6 (−1·3 to 2·5)	0·52
Service coverage index	14·1 (11·8 to 16·3)	<0·0001	0·1 (−1·1 to 1·3)	0·90	1·6 (0·3 to 2·8)	0·013	1·2 (0·6 to 1·8)	<0·0001	−5·7 (−8·2 to −3·3)	<0·0001	4·4 (2·6 to 6·1)	<0·0001
Prevention index	10·1 (7·6 to 12·6)	<0·0001	0·0 (−1·3 to 1·3)	1·0	1·0 (−0·4 to 2·3)	0·16	−0·5 (−1·2 to 0·2)	0·15	1·6 (−1·1 to 4·4)	0·23	−0·4 (−2·4 to 1·5)	0·65
Breast or cervical cancer screening	7·8 (2·3 to 13·4)	0·0070	4·4 (−3·3 to 12·1)	0·25	1·7 (−2·4 to 5·8)	0·39	−1·9 (−3·4 to −0·5)	0·010	−5·1 (−9·8 to −0·4)	0·036	−2·2 (−6·4 to 2·1)	0·30
Four or more antenatal visits	10·2 (4·9 to 15·5)	<0·0001	10·5 (5·9 to 15·1)	<0·0001	3·7 (−0·6 to 8·0)	0·090	2·7 (1·0 to 4·5)	0·0040	−3·8 (−9·0 to 1·4)	0·14	1·2 (−1·2 to 3·6)	0·31
Postnatal care	6·7 (1 to 12·4)	0·021	0·4 (−2·5 to 3·2)	0·79	−1·1 (−4·9 to 2·8)	0·59	−0·4 (−1·3 to 0·6)	0·42	6·8 (2·0 to 11·7)	0·0060	−1·0 (−4·2 to 2·2)	0·54
Full immunisation	2·4 (0·1 to 4·7)	0·042	2·0 (0·8 to 3·2)	0·0010	0·0 (−1·2 to 1·3)	0·98	0·9 (0·3 to 1·6)	0·0050	0·6 (−1·9 to 3·1)	0·62	2·2 (0·4 to 4·0)	0·019
Exclusive breastfeeding	−6·2 (−8·3 to −4·0)	<0·0001	−1·1 (−2·1 to −0·1)	0·034	0·6 (−0·6 to 1·8)	0·35	−0·5 (−1·0 to −0·1)	0·021	0·8 (−1·6 to 3·3)	0·49	2·2 (1·2 to 3·3)	<0·0001
Safe drinking water	3·0 (−0·7 to 6·8)	0·10	7·5 (1·9 to 13·1)	0·010	−0·3 (−4·1 to 3·4)	0·86	−0·3 (−1·9 to 1·2)	0·67	−1·9 (−4·8 to 0·9)	0·17	−0·9 (−3·3 to 1·4)	0·41
Adequate sanitation	12·6 (6·3 to 18·8)	<0·0001	2·5 (−1·5 to 6·4)	0·22	1·4 (−2·3 to 5·1)	0·46	1·1 (−0·4 to 2·6)	0·14	8·1 (3·8 to 12·4)	<0·0001	−0·1 (−3·4 to 3·3)	0·96
Physical access to health facility	−3·9 (−6·6 to −1·2)	0·0060	2·5 (0·2 to 4·8)	0·032	0·0 (−2·8 to 2·9)	0·97	0·5 (−0·6 to 1·6)	0·32	0·0 (−2·7 to 2·6)	0·98	−0·6 (−2·2 to 1·1)	0·48
Non-use of tobacco	1·3 (0·3 to 2·2)	0·0080	0·4 (−1·3 to 2·2)	0·64	0·2 (−0·3 to 0·8)	0·42	0·2 (0·0 to 0·5)	0·059	0·7 (−0·3 to 1·6)	0·18	−1·1 (−2·1 to −0·2)	0·021
Treatment index	14·5 (11·8 to 17·1)	<0·0001	0·2 (−1·2 to 1·6)	0·81	1·6 (0·2 to 3·1)	0·024	1·6 (0·9 to 2·3)	<0·0001	−7·3 (−10·1 to −4·4)	<0·0001	5·4 (3·4 to 7·5)	<0·0001
Caesarean section	12·3 (7·7 to 16·9)	<0·0001	−5·6 (−7·9 to −3·2)	<0·0001	1·2 (−2·3 to 4·6)	0·51	1·0 (0·1 to 1·9)	0·025	−5·2 (−8·3 to −2·0)	0·0020	5·6 (1·1 to 10·0)	0·015
Hospital delivery	17·3 (11·8 to 22·8)	<0·0001	4·9 (2·7 to 7·0)	<0·0001	−0·7 (−3·6 to 2·3)	0·66	0·2 (−0·9 to 1·3)	0·68	0·1 (−3·9 to 4·1)	0·96	0·1 (−2·7 to 2·8)	0·94
Skilled birth attendance	1·4 (−2·1 to 4·9)	0·42	8·3 (4·2 to 12·4)	<0·0001	0·7 (−0·7 to 2·1)	0·32	−0·3 (−1·4 to 0·7)	0·52	−2·4 (−6·2 to 1·4)	0·20	−0·4 (−2·7 to 1·8)	0·69
Use of outpatient care	11·6 (5·2 to 18·0)	0·0010	−0·7 (−4·5 to 3·1)	0·70	−3·8 (−8·6 to 0·9)	0·10	0·3 (−1·2 to 1·7)	0·72	11·9 (5·1 to 18·7)	0·0010	−10·4 (−14·4 to −6·4)	<0·0001
Hospital admissions*	1·7 (1·1 to 2·4)	<0·0001	0·4 (0·0 to 0·7)	0·048	0·1 (−0·3 to 0·4)	0·78	0·4 (0·3 to 0·6)	<0·0001	−2·5 (−3·2 to −1·7)	<0·0001	2·0 (1·4 to 2·5)	<0·0001
Financial protection index	28·7 (24·5 to 32·9)	<0·0001	6·0 (3·8 to 8·2)	<0·0001	2·6 (0·4 to 4·9)	0·022	−0·2 (−1·3 to 1·0)	0·78	−9·1 (−13·6 to −4·6)	<0·0001	−2·0 (−5·3 to 1·2)	0·22
Health insurance coverage	36·6 (30·7 to 42·5)	<0·0001	10·2 (7·1 to 13·3)	<0·0001	3·5 (0·4 to 6·7)	0·029	0·0 (−1·6 to 1·6)	0·98	−11·9 (−18·2 to −5·5)	<0·0001	−1·3 (−5·8 to 3·3)	0·58
No self-discharge for financial reasons	22·9 (18·9 to 26·9)	<0·0001	3·6 (1·4 to 5·7)	0·0010	1·6 (−0·5 to 3·8)	0·13	0·7 (−0·4 to 1·8)	0·22	−5·7 (−10·1 to −1·4)	0·010	−1·9 (−5·0 to 1·2)	0·23
No catastrophic health expenses	6·3 (1·6 to 11·0)	0·011	−5·1 (−7·3 to −2·8)	<0·0001	−4·4 (−8·0 to −0·9)	0·017	−1·8 (−3·2 to −0·4)	0·016	−2·5 (−5·2 to 0·2)	0·068	−6·6 (−9·1 to −4·1)	<0·0001

Data are regression coefficient (95% CI) or p value, unless otherwise stated. GDP=gross domestic product. *The hospital admission data were not normalised by the WHO benchmark in the regression analysis.

Table 2: **Association between macroeconomic and health systems characteristics with universal health coverage indicators**

representative household surveys, including a large-scale sample of 901 182 individuals, in China. Overall, despite notable improvements, an estimated 105 million people would still lack coverage in 2030. Moreover, China showed a lagging performance on the prevention domain relative to the treatment domain, and households without catastrophic health expenses showed a decreasing trend, suggesting that the progress towards UHC is not keeping pace with the society's development and associated population health needs.

Importantly, our study highlights potential drivers of UHC promotion, which could help identify and shape

policies. Continued efforts to develop effective policies and programmes in UHC promotion will be needed to achieve the SDG 2030 target. China has already made some important efforts and launched a major health-care reform in 2009 with multiple policies aiming to achieve UHC for all.[10,11] In 2016, China launched the Healthy China 2030 plan, followed in 2022 by the National Economic and Social Development plan and the 14th Five-Year Plan. These plans detail the country's targets for 2030 and 2035.[35,36] Previous studies suggested that these initiatives have already had some effects at the initial stage of health reform from 2003 to 2011·[12,13] During the survey periods from 2003 to 2018, we found that substantial achievements and minimal disparities were mainly observed in the treatment domain, and China's population will achieve the 2030 target in this domain. Additionally, China has done well in the provision of maternal and child health services such as full immunisation and antenatal and postnatal care, especially in remote western and central regions, which was in line with the Millennium Development Goals.[37,38] Our results further revealed that an estimated 544 million additional people obtained UHC in the past 15 years, which can be interpreted as a reflection of the overarching reform effort rather than of individual policies in China. Based on past trends, we estimate that UHC will meet the target of 80% coverage by 2030 at the national level. Underpinning such progress was China's strong commitment to long-term strategies and efforts to ensure equitable coverage with financial protection for all.[39–41]

However, challenges exist in achieving the ambitious targets of UHC in China. We noted the slow increasing rate in achieving UHC in China, indicating that progress towards this target had slowed down—an estimated 105·8 million population equivalents would be lacking UHC coverage in 2030. A possible reason for this is that prevention services are not advancing at a similar rate as treatment services. As our results indicate, prevention services presented constantly lagging performance with only a one-fourth rate of treatment progress and showed wide urban–rural, regional, and income disparities. With the rapid rise of the burden of non-communicable diseases (NCDs), China has tried to shift the focus of the health-care principle from treatment first to prevention first.[42–44] However, due to a poorly functioning PHC system, the health-care delivery system continues to be hospital-centric and treatment-based.[14,45] Moreover, rural and central populations with low income were left behind with little chance of reaching the 2030 targets in prevention, indicating that China struggles to ensure quality care and access to effective prevention services for all.

Of particular concern were several main issues in the prevention domain, including basic health facilities and two maternal and child health indicators. The rural population had low coverage of adequate sanitation, whereas the urban population had insufficient health facilities. This phenomenon suggests that the development of health facilities is not keeping pace with the rapid urbanisation process.[46,47] Therefore, enhancing the establishment of supportive health facilities to improve optimal health-care access for the urban population should be a priority and might be beneficial in the future. Moreover, prevention services were not progressing as quickly as demographic transitions such as accelerated ageing coupled with declining fertility. For maternal and child health in the prevention domain, there was a constant decreasing trend in exclusive breastfeeding and the coverage was much lower than the 80% target for breast or cervical cancer screening, which might not provide a positive and supportive social environment for the three-child policy implementation.[37,48] Notably, the Healthy China 2030 plan emphasises building a robust public health system to ensure equal access to basic health services for all.[35] However, findings in our study indicated that there is still a long way to go to achieve UHC in China. More efforts should be made in the prevention domain by focusing on those who are vulnerable and providing effective financial protection against health shocks.

There is a growing global consensus on UHC and its ability to promote health outcomes for all in a sustainable and equitable way.[22,30,49] Consistent with previous work,[22] our results suggest that a substantial increase in income (GDP) and GHE is necessary for UHC promotion. Moreover, we further estimated a threshold of ¥445 GHE per capita per year to achieve 80% UHC index in China. The Chinese Government injected massive funding into the health-care sector from 2008 to 2017— the GHE tripled from ¥343 to ¥1086 and the GHE as a share of the overall GDP rose from 1·1% to 1·8% in the same timeframe.[14] We observed large gaps between observed and frontier UHC values, especially in several western provinces, which indicated widespread inefficiency of transfer payment mechanism in health services.[11] Simply increasing spending, without fixing inefficiencies, would not result in lasting change. It is important to increase efficiency when increasing GHE.

Our study provides solid evidence for the various relationships between health resources and different UHC indicators, highlighting that reasonable health resource allocation could be another viable route to promote UHC performance. Importantly, our results showed that establishment of primary health-care institutions was positively associated with service indicators such as four or more antenatal visits and full immunisation in the prevention domain. This finding emphasises the essential role that PHC could have in health promotion, especially in the prevention domain. However, resources are currently not well allocated; health systems are still hospital-centric and weak in PHC in China. In 2017, approximately 58% of resources were concentrated at tertiary hospitals especially in large cities and major urban areas, whereas only

18% of resources were devoted to PHC facilities.[14] One-third of PHC professionals received no continuing medical education.[14,50] Considering the increasing burden of NCDs and population ageing, allocating more resources towards PHC and enhancing the training of the workforce would probably make for a more efficient way to achieve the UHC target for all people.

Our study had several strengths. First, we used high-quality population-based household survey data, which was nationally representative and consistent across survey years. Second, we included all major WHO-recommended indicators in our analysis and used a well accepted framework. Third, this study provides reliable evidence of trends, projections, and disparities in UHC indicators, which can inform future policies in the least covered indicators and hard-to-reach populations. Finally, we quantified the association between health system characteristics and UHC indicators that can inform policy makers and the government in tailoring plans for future programmes.

Our study also had some limitations. All our models were on the assumption of unchanging future polices and were based on current trends, which might be too strict. Nevertheless, we aimed to predict coverage based on recent trends to inform future policy making, and thus the assumption that policy will not change was important to the goals of this study.[26] Besides, the association between the health systems characteristics and UHC performance does not represent causality. Future work is needed to investigate the other possible mechanisms driving this relationship. Finally, China, like many other countries, has complex health insurance schemes, and the coverage of health care by each scheme could vary. Putting all these schemes from different regions of China into the same indicator could be a limitation. Varieties of specific health programmes across different places should be considered in future work.

Despite substantial progress, China is facing daunting challenges in achieving UHC. Weak performance in the prevention domain and low efficiency during financial investment transformation indicates that the progress towards UHC is not keeping pace with rapid society development and changing population health needs. Therefore, in response to China's ageing population and an increased NCD burden, the country must prioritise PHC, especially in the prevention domain. Optimising resource allocation and elevating efficacy of financial investment are essential for China to achieve the UHC target for the entire population by 2030.

Contributors

WW and LD conceived the idea for the study and managed the project. YZ, CL, MW, SX, LD, and WW designed the study. YZ, CL, MW, and SX collected the data. YZ, CL, and LW did the statistical analyses and wrote the statistical analysis plan. YZ and CL drafted and edited the manuscript. MW edited the manuscript. WW and JH had full access to all the data in the study and take full responsibility for the integrity of the data and the accuracy of the analyses. WW, JH, and LD have the final responsibility for the decision to submit for publication. All authors read and approved the final manuscript.

Declaration of interests

We declare no competing interests.

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