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A composite indicator to measure universal health care coverage in India: way forward for post-2015 health system performance monitoring framework

Shankar Prinja[1,*], Rakesh Gupta[2], Pankaj Bahuguna[1], Atul Sharma[1], Arun Kumar Aggarwal[1], Amit Phogat[3] and Rajesh Kumar[1]

[1]School of Public Health, Post Graduate Institute of Medical Education and Research, Chandigarh 160012, India, [2]Office of Chief Minister, Government of Haryana, Chandigarh 160012, India and [3]National Rural Health Mission, Department of Health and Family Welfare, Panchkula - 134109, Haryana, India

*Corresponding author. School of Public Health, Post Graduate Institute of Medical Education and Research, Sector-12, Chandigarh 160012, India. E-mail: shankarprinja@gmail.com

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Abstract

Background There is limited work done on developing methods for measurement of universal health coverage. We undertook a study to develop a methodology and demonstrate the practical application of empirically measuring the extent of universal health coverage at district level. Additionally, we also develop a composite indicator to measure UHC.

Methods A cross-sectional survey was undertaken among 51 656 households across 21 districts of Haryana state in India. Using the WHO framework for UHC, we identified indicators of service coverage, financial risk protection, equity and quality based on the Government of India and the Haryana Government's proposed UHC benefit package. Geometric mean approach was used to compute a composite UHC index (CUHCI). Various statistical approaches to aggregate input indicators with or without weighting, along with various incremental combinations of input indicators were tested in a comprehensive sensitivity analysis.

Findings The population coverage for preventive and curative services is presented. Adjusting for inequality, the coverage for all the indicators were less than the unadjusted coverage by 0.1–6.7% in absolute term and 0.1–27% in relative term. There was low unmet need for curative care. However, about 11% outpatient consultations were from unqualified providers. About 30% households incurred catastrophic health expenditures, which rose to 38% among the poorest 20% population. Summary index (CUHCI) for UHC varied from 12% in Mewat district to 71% in Kurukshetra district. The inequality unadjusted coverage for UHC correlates highly with adjusted coverage.

Conclusion Our paper is an attempt to develop a methodology to measure UHC. However, careful inclusion of others indicators of service coverage is recommended for a comprehensive measurement which captures the spirit of universality. Further, more work needs to be done to incorporate quality in the measurement framework.

Key words: Universal Health Care, Financial Risk Protection, Out-of-pocket expenditure, catastrophic health expenditure, Performance Measurement, Health Services Research, Health System

Key Messages

- Measurement of universal health care should be an integral part of post millennium development goals sustainable development framework, besides national monitoring framework for health system in countries.
- The measurement of universal health care should encompass coverage of services extent of equity in delivery of these services and financial risk protection.
- Composite indicator should be developed and used along with descriptive analysis for each specific indicator.
- Countries should attempt to include information on indicators for UHC monitoring in their routine management information system.

Introduction

Achieving universal health coverage (UHC) is now increasingly being recognized as a major development agenda goal at the global and national levels. The passage of the UN General Assembly resolution in December 2012 is an example of building momentum (Zarocostas 2007). The resolution urged the member states to strengthen health systems such that there is no financial hardship for accessing health care to the population. Coming close to the heels of the global call, many national Governments in low- and middle-income countries have increasingly turned attention towards the need for inclusion of UHC as a primary goal (GoI 2012). Several authors advocated for inclusion of universal health coverage as the overarching goal for monitoring Post 2015-Millennium Development Goal framework (Vega 2013). Finally, the Sustainable Development Goals call for 'achieving universal health coverage, including financial risk protection, access to quality essential healthcare services and access to safe, effective, quality and affordable essential medicines and vaccines for all' (Osborn *et al.* 2015). While it does include achieving the goal of universal health coverage, measurement of the same is not *the* leading monitorable health indicator.

Lack of a global consensus on measurement metrics for UHC has been a major limitation to its inclusion as the major health system performance goal during post-2015 era (A position paper by the International Epidemiological Association 2013). The question of what is UHC remains central to any attempt at measuring its coverage. UHC is the goal that all people obtain the health services they need without risking financial hardship from unaffordable out-of-pocket payments (WHO 2010). It involves coverage with good quality health services—from health promotion to prevention, treatment, rehabilitation and palliation—as well as coverage with a form of financial risk protection. A third feature is universality—coverage should be for everyone. A lot of research is being done on what could be the path towards achieving UHC and how does it affect the goals of the health system (Tancharoensathien *et al.* 2006). Some estimates on how much it would cost are also available (Prinja *et al.* 2012).

The World Health Report of 2013 identified measuring the progress of UHC at country and sub-national level as a major research priority (WHO 2013). This report identifies attempts at. Recently, the World Bank and the WHO produced a framework for measuring progress of universal health coverage (WHO-WB 2014). This framework uses the definition of universal health coverage espoused in the World Health Report 2010 (WHO 2010). As a result, it calls for measurement of service coverage, population coverage and financial risk protection. Several indicators have been suggested as part of this framework for measurement of UHC.

Some multi-country, national or sub-national attempts at measuring universal health coverage exist in the literature. Most of these attempts measure the ability of health system to provide financial risk protection, i.e. protecting the households from high out-of-pocket expenditures which lead to catastrophic outcomes or impoverishment (Akinkugbe, *et al.* ; Karan, *et al.* Akinkugbe *et al.* 2011; Ghosh 2011; Raban *et al.* 2013; Karan *et al.* 2014). Alternatively, previous studies have measured health service coverage and financial risk protection (UNICEF 2009; Berman *et al.* 2010; Selvaraj and Karan 2012; GAVI 2014; Prinja *et al.* 2015). However, in most instances, the health service coverage has traditionally been measured by type of health condition or type of intervention (Prinja *et al.* 2015). Given the profusion of health conditions and interventions, there have been some efforts to create composite indicators. For example, Millennium Development Goals (MDG) Countdown Research Group constructed composite indices by compiling a selection of service coverage indicators representing various strengths or intervention areas of the maternal and child health (MCH) service delivery system (Countdown 2008; Equity Analysis Group 2008; Barros *et al.* 2012). However, most of these attempts have had a narrow MCH-centric focus. On the contrary, the concept of UHC goes well beyond the MCH domain and includes other preventive services, curative services—including both the outpatient and the inpatient, as well as financial risk protection.

From Indian point of view, a recent study evaluated the extent of universal health coverage in India (Devadasan *et al.* 2014). While the study is the first attempt, authors do include a range of indicators including preventive and curative services coverage, population coverage and financial risk protection. They also suggest several implications of such a framework for more sustainable measurement. However, authors concede that the findings are limited in terms of use of a rather decade-old data on financial coverage. Further, while the findings paint a descriptive picture in terms of each of these domains of UHC and there is no attempt at generating a composite indicator which could then be used to monitor progress. Finally, the choice of indicators does not reflect on the quality of care provided as part of service provision.

One multi-country study which aims at generating a composite indicator uses crude arithmetic methods to aggregate individual indicators into a single composite coverage indicator (CCI) (Sherri, *et al.* 2012). Another more recent study used robust statistical methods to aggregate individual indicators and to generate a composite indicator to measure UHC (Leegwater *et al.* 2015). Although the authors use data from >100 countries to assess a service coverage indicator, the study is limited in terms of not including an indicator of financial risk protection or population coverage. Both achievements of financial protection and equity are at the heart of the concept of UHC, hence any attempt which does not address the same remains relatively incomplete.

The most robust attempt at generating a composite UHC index was recently published in a World Bank report (Wagstaff *et al.* 2015). The authors used service coverage and financial risk protection indicators which were clubbed to a summary index using

geometric average approach as used in the United Nation's Human Development Index. The service coverage and the financial risk protection were weighted for the extent of inequality. However, the authors used arbitrary weights to compute the service coverage indicator, rather than application of statistical methods. Further, there was no measure of 'quality' in computation of service coverage.

Several low- and middle-income countries are undertaking pilot to large-scale programs for universalizing health coverage in their countries. From Indian point of view, the 12th Five Year Plan places significant importance on developing strategies to achieve UHC. It lays emphasis on increasing tax-funding for public health system in order to finance heath care. In order to develop operational plans for 'how' to universalize care, it calls for undertaking district-level pilot programs which could be implemented, tested and then scaled-up if found successful (GoI 2012). Similarly, the draft Indian National Health Policy of 2015 highlights the failure of previous policies in terms of their inadequate MCH-centric focus, thereby neglecting the provision of a universal coverage (GoI 2014). As a result, it calls for achieving UHC, and providing financial risk protection. Following the national policy discourse, several state governments such as Kerala, Tamil Nadu and Punjab have developed plans and implemented programs for UHC in 1–2 districts in these states. In Kerala, one of the southern states in India, UHC was piloted in Malappuram and Palakkad districts. A situational analysis was done as a part of this UHC pilot project in order to assess the shortfall in the institutional capacities at district and state level to undertake UHC. Using the information provided by situational analysis, a stakeholders' assembly lead to the development of evidence based essential health package for rolling out UHC in two districts of state (SHSRCK).

Given the current policy directions, measuring the coverage of UHC has become even more important. Hence, it becomes important to address the existing gaps in the literature in terms of methodology and findings for measuring UHC. We undertook this study in a north Indian state of Haryana to develop a methodology and empirically measure the extent of universal health coverage at the district level.

Methods

Study setting

Haryana is one of the northern states of India, which falls in top bracket in terms of per capita gross domestic product (GDP). In 2013–14, the per capita GDP for the state was INR 133 427 as compared with India's per capita GDP of INR 74 380 (MoSPI 2015). Further, the state recorded a population of 25.35 million in 2011 census, 65% of which lives in rural areas (Health Services 2014). Average life expectancy of 68.9 years for males and 71.3 years for females is higher than the rest of the country (67.3 years and 69.6 years, respectively). However, the state lags behind in many health and healthcare service indicators. In terms of infant mortality rate (42 per thousand live births in 2013), Haryana ranks 27 among 35 states and Union Territories in India, which is poor considering human and economic development in the state. The state has 56 secondary and tertiary care hospitals, 110 Community health centres (CHCs), 356 Primary Health Centres (PHCs) and 2630 Sub-centres (SCs) for provision of health services (Health Services 2014). A sub-centre is the lowest level of health facility where auxiliary nurse midwife provides primary care, predominantly reproductive and child health services, to a population of 5000. A PHC and CHC which are staffed by medical doctor and other paramedical staff cater to a population of 30 000 and 100 000, respectively, providing preventive and curative services. While a PHC and CHC serve primary level curative care, a district hospital is the hub for provision of specialist secondary care in a district. Public health expenditure in the state was USD 14.26 per capita in 2012–13 as compared with the national average of USD 31 in 2011 (MOHFW 2009; Tandon and Cashin 2010). The ratio of public doctors to private providers in the state is on the higher side, i.e. 1:11 as compared with India's ratio of 1:10 (CFPR 2011).

Data collection

We undertook a multi-stage stratified random sample survey in rural and urban Haryana—the Concurrent Evaluation of National Health Mission: Haryana Health Survey in order to determine the extent of universal health coverage. Thirty field investigators (with graduate level qualification) who were given prior training collected household level data on health service utilization: both preventive and curative, and out-of-pocket (OOP) expenditures for health care. Data collection was done in the period from September 2012 to December 2013.

Six different categories of clients were interviewed: women who had delivered in last 1 year (for assessing maternal and child health service utilization), women with a child in the age group of 12–23 months (to assess immunization coverage), women with a child <5 years (child health services assessment), eligible couple (family planning service assessment), those with an illness during the last two weeks (treatment seeking behaviour and OOP for outpatient consultation) and any hospitalization during last 365 days (utilization of inpatient services and OOP expenditure during hospitalization). Only one member out of the eligible couple was interviewed for family-planning service assessment and, in $>95\%$ cases, respondent was a female due to non-availability of spouse in the house. Detailed description of sample selection, stratification, sample size and different methods used for the development of composite index is given in the Supplementary material (pp. 2–7).

Development of a metric for measuring UHC

We used the framework of UHC envisioned in the WHO's World Health Report 2010 to develop a metric for measuring the extent of UHC (WHO 2010). The report suggests three broad domains of UHC: i.e. service coverage (the range of services that are covered), financial coverage (the proportion of the total costs covered through insurance or other risk pooling mechanisms) and population coverage (proportion of the population covered).

Input indicators

Choice of the indicators was influenced by multiple factors. In principle, universal health coverage envisages provision of quality health care of all types (preventive, curative and rehabilitative) and at all levels (primary, secondary and tertiary), without any financial hardship as a result of out-of-pocket expenditures at the time of service use. However, in practice, countries need to prioritize which services can be provided to entire population at a cost which they can afford. This stems from the inherent resource constraint for providing anything and everything. Hence, each country has a defined benefit package which is based on some explicit or implicit priority setting exercise. The measurement of UHC for a given country should begin with an assessment of the extent of provision of benefit package services without financial hardship.

It was in this light that we chose the indicators to measure UHC. First, we included indicators which measured the coverage of services outlined by Government of India for inclusion in the benefit package of various state-specific UHC pilots (MOHFW 2013). Second, we considered those indicators on which data is routinely available through either routine management information systems or other routine health surveys. The latter would ensure replication of study methodology in other states of India and similar low- and middle-income country settings. Finally, we also consulted the policy makers and program managers in Haryana state (Das *et al.* 2012). In line with the UHC framework, we selected indicators from each of the domain. For service coverage, we selected the following indicators: iron–folic acid (IFA) prophylaxis during pregnancy, two TT injections during pregnancy, >3 antenatal care (ANC) visits, institutional delivery, six postnatal visits by an accredited social health activist (ASHA), full immunization (coverage against six vaccine preventable diseases under universal immunization program [UIP]), oral rehydration solution (ORS) use during a diarrhoeal episode among children under 5 years of age, contraceptive prevalence rate, met need for family planning, met need for curative care during an illness episode in last 2 weeks and met curative need specifically for non-communicable disease (Table 1). Met need for non-communicable disease was assessed specifically among those who reported having a non-communicable disease during the last 15 days prior to survey. These service indicators served three requirements. First, these include an element of preventive and curative care. For the latter, we used institutional delivery, ORS use for diarrhoea, met need for outpatient care, and met need for NCD treatment. Second, the indicators cover the lifespan of the individuals representing the health care needs of children, reproductive age population and the elderly age group. Finally, the indicators also included needs for variety of health services—maternal and child health, curative care for infectious disease and non-communicable diseases, and various forms of care—outreach services, facility level outpatient care and hospitalizations.

For including a component of quality in the service coverage we included two indicators. This first indicator is 'full effective ANC care' and the second indicator is 'care by qualified provider'. ANC is traditionally considered as complete or 'full' if the pregnant woman undergoes three antenatal checkups, receives 100 iron folic acid tablets and gets immunized with two doses of tetanus toxoid. However, what the traditional coverage indicator does not reflect is the quality of care provided during those three ANC visits. Women were interviewed during our survey as to whether during the ANC check-up: weight and height were measured, blood pressure and abdomen examined, blood and urine tested, and whether advice was given for nutrition and place of delivery. Several past surveys report that while women do report three ANC check-ups during pregnancy, these contacts to not result in provision of necessary quality care in terms of examinations, testing and counselling. In our study, only a woman who reported having had three check-ups during pregnancy, consumed full iron folic acid supplementation, had TT vaccination and received appropriate care in terms of previously defined criteria was considered as full *effective* ANC care. This indicator of *effective* ANC care includes the quality component over and above the traditional coverage indicator alone. The second quality indicator which was included was provision of curative care by a qualified health care provider. 'Qualified' health provider is not in the strict 'medical' term, but implies anyone with a formal training to provide the care which he/she is providing. This could include an auxiliary nurse midwife who provides treatment for a diarrhoeal episode among children under 5 years of age; but excludes care by unqualified 'quacks'. Hence the indicators for quality are more than the simple service coverage indicators.

Financial coverage was assessed using two indicators: prevalence of catastrophic health care expenditures and the impoverishment as a result of out-of-pocket (OOP) health care expenditures (Table 1). Both the indicators of financial coverage were estimated for any OOP expenditure incurred on hospitalization in the household during the last 365 days. Out of the total individuals who reported an episode of hospitalization in the last 1 year, percent households who incurred out-of-pocket health expenditure in excess of 40% of the household's annual non-food consumption expenditure was considered as the prevalence of catastrophic health care expenditure. Impoverishment as a result of OOP expenditures was measured as relative increase in percent households below poverty line for the period from September 2012 to December 2013. Poverty estimations were done at $2 and $1.25 (purchasing power parity [PPP]) per capita per day.

The third element of UHC is distributional aspect population coverage. In order to account for inequalities across population groups ranked by wealth status, we compared service and financial coverage indicators across different wealth quintiles in the districts (O'Donnell *et al.* 2008). All households in the state were divided into wealth quintile groups based on monthly per capita consumption expenditure (MPCE). Consumption expenditure was adjusted for age and household composition using the OECD equivalence scale (OECD 1982). Concentration index was computed to assess the extent and direction of inequity in various service and financial indicators. Concentration index ranges from +1 to −1; with positive (negative) value suggesting pro-rich (poor) distribution. Finally, an inequality adjusted coverage of these indicators, i.e. achievement index was calculated (Wagstaff 2002; O'Donnell *et al.* 2008). This was estimated at the first-level aversion for inequality (for details refer to Supplementary materialp. 12). The 'achievement' index so constructed is equal to the population mean multiplied by the complement of the 'concentration' index (Kakwani *et al.* 1997); the latter captures the inequality between the poor and less poor. The achievement index falls below the population mean in state, districts or regions that achieve high service coverage rates by disproportionately covering the better-off. This is similar to the inequality adjustment performed in the UN's Human Development Index (HDI). However, the Atkinson inequality index which is used for HDI does not capture whether it is the rich or poor who are disproportionately covered, something which we consider is very important in the context of UHC measurement.

Besides analyzing service coverage from an equity lens using the wealth status, we also computed coverage of each of the input indicators according to education status, religion, caste or social group and occupation. Besides, we present the coverage of the composite UHC indicator, as described in next section, by districts, thereby presenting geographical inequities.

Composite UHC Index

First, all the indicators included for the development of Composite UHC Index (CUHCI) were coverage estimates with a value ranging from 0 to 100%. Second, each of them was arranged in the same direction. For this, we converted the catastrophic expenditure and impoverishment rates into percent hospitalization episodes in which the household did not incur any catastrophic expenditure or impoverishment. Doing so, all the indicators had the same direction, i.e. a higher value of the indicator reflected positive picture. This was necessary to align it in the same direction as the population coverage

Table 1. Operational definition for indicators of Universal Health Care coverage (UHC)

	Coverage indicators	Definition	Numerator	Denominator
Maternal and Child Health	Iron and folic acid (≥100)	Percent pregnant women taking minimum 100 tablets of Iron and folic acid supplementation	Number of women who took 100 tablets of Iron and folic acid during pregnancy	Total number of women who delivered in last 1 year
	TT (2 injections)	Percent pregnant women immunized with two injections of Tetanus Toxoid	Number of women immunized with 2 TT injections during pregnancy	Total number of women who delivered in last 1 year
	≥ 3 Antenatal check ups	Percent pregnant women with at least 3 antenatal checkups during pregnancy	Number of pregnant women with at least 3 antenatal checkups during pregnancy	Total number of women who delivered in last 1 year
	Institutional delivery	Percent pregnant women delivering in any level of public or private institution	Number of women delivering in any level of public or private institution	Total number of women who delivered in last 1 year
	Postnatal care (6 visits by ASHA)	Percent women visited at least 6 times by ASHA within 42 days after delivery	Number of women visited at least 6 times by ASHA within 42 days after delivery	Total number of live births
	Full immunization	Percent 11–23 months children immunized with 1 dose of BCG, 3 doses of DPT, oral polio vaccine and 1 dose of measles within 1 year of birth	Number of 11–23 months children immunized with 1 dose of BCG, 3 doses of DPT, oral polio vaccine and 1 dose of measles within 1 year of birth	Total number of 11–23 months children
	ORS use rate	Percent children below 5 years age who received ORS for diarrhoea episode in the last 2 weeks	Number of children below 5 years age given ORS for diarrhoea in the last 2 weeks	Total number of children below 5 years age having episode of diarrhoea in last 2 weeks
Family planning	Contraceptive prevalence rate	Percent couples using any method of contraception	Number of couples using any method of contraception	Total number of eligible couples
Curative care	Overall met need for any illness	Percent population sought care from any level of health facility (public or private) for any illness	Number of individuals who sought care from any level of health facility (public or private) for any illness	Total number of individuals with any illness during last 2 weeks
	Met need for non-communicable diseases	Percent population sought care from any level of health facility (public or private) for any non-communicable disease	Number of individuals sought care from any level of health facility (public or private) for any non-communicable disease	Total number of individuals with any non-communicable disease during last 2 weeks
Financial risk protection	Pre-payment poverty headcount (@$1.25 PPP)	Percent households with per capita per day non-food expenditure less than $1.25	Number of households with per capita per day non-food expenditure less than $1.25	Total number of households
	Pre-payment poverty headcount (@$2 PPP)	Percent households with per capita per day non-food expenditure less than $2	Number of households with per capita per day non-food expenditure less than $2	Total number of households
	Post-payment Poverty headcount (@$1.25 PPP)	Percent households with per capita per day non-food expenditure after subtracting the hospitalization expenditure in family less than $1.25	Number of households with per capita per day non-food expenditure subtracting the hospitalization expenditure in family is less than $1.25	Total number of households
	Postpayment Poverty headcount (@$2 PPP)	Percent households with per capita per day non-food expenditure after subtracting the hospitalization expenditure in family is less than $2	Number of households with per capita per day non-food expenditure subtracting the hospitalization expenditure in family less than $2	Total number of households
	Catastrophic Hospitalization Expenditure	Percent households with hospitalization expenditure more than the 40% of the annual non-food household expenditure	Number of households with hospitalization expenditure more than the 40% of the annual non-food household expenditure	Total number of households with a family member hospitalized in the last one year
Quality of care	Full effective ANC	Percent pregnant women with 100 IFA, 2 TT, 3ANC, Weight measurement, Height measurement, BP measurement, blood test, urine test, abdominal examination, birth preparedness advice, nutritional advice given during ANCs	Number of pregnant women with 100 IFA, 2 TT, 3 ANC, weight measurement, height measurement, BP measurement, blood test, urine test, abdominal examination, birth preparedness advice, nutritional advice given during ANCs	Number of pregnant women with at least 3 antenatal checkups during pregnancy
	Care from qualified provider	Percent population sought care from any qualified health provider (public or private)	Number of individuals sought care from any qualified health provider (public or private)	Total number of individuals with any illness in population

indicators for service utilization, where a higher coverage implies that services are being utilized by a higher proportion of those in need. Similarly, the rescaled indicators—protection from catastrophic expenditure and impoverishment—reflect higher financial protection.

In order to aggregate individual input indictors and compute a summary CUHCI, we used multiple methodologies. There are four generic classes of scales that can be applied to variables: interval-scale non-comparability (INC), interval-scale full comparability (IFC), ratio-scale non-comparability (RNC) and ratio-scale full comparability (Ebert and Welsch 2004). Our inputs indicators demonstrate properties of ratio scale and are non-comparable. Hence, we used the geometric average approach to aggregate input indicators and compute the CUHCI (Ebert and Welsch 2004) (Supplementary materialp. 14). Prior to this, rescaling of each indicator was done calculating dimension index resulting in coverage vary between 0 and unity (for details refer to Supplementary material, p. 13). The purpose of rescaling was to standardize the multi-dimensional indicator values on same scale (0–1) making them suitable for aggregation. This is considered as the base case analysis, and is similar to the methodology used for computation of the human development index (UNDP 2013). In this base case analysis, we aggregated the coverage levels of input indicators which were not weighted for extent of inequalities in service utilization across wealth groups.

Validation of UHC Index (CUHCI)

We validated the CUHCI score and district rank by using a variety of sensitivity and scenario analyses. First, we used three different statistical methods for aggregating input indicators into CUHCI. These included the geometric mean aggregation, principal component analysis (PCA) and regression methods. In order to run the analysis, we used data on a subset of 137 subcentres, for which the data on all input indicators was available as a non-zero value.

For the PCA analysis, we included first four components covering all the input indicators. The four components included were composed of all the 10 original indicators as different combinations. In the next step, component loadings were used as weight in the linear equation with corresponding variables. A second set of weights were also estimated for each principal component based on the variability in the observed data explained by them. Final weights for each input indicator were derived by multiplying the two set of weights, i.e. component loadings multiplied by component weight (Nicoletti *et al.* 2000; OECD 2008; Sharpe and Andrews 2012). These weights were finally applied to district level coverage of inputs indicators to compute CUHCI (Supplementary materialp. 14).

Second, we used the same subset subcentre data to run a multiple linear regression where input indicators were considered as independent variables and the base CUHCI derived using geometric mean approach was used as dependent variable. The coefficients of the regression equation yielded weights corresponding to each independent variable that were used for prediction of CUHCI. These regression-based weights were applied to district level coverage of inputs indicators to compute CUHCI (Supplementary material p. 15). Third, we aggregated the inequality-adjusted coverage for various input indicators to compute CUHCI using geometric average approach.

In the second set of scenario analysis, we used four incremental combinations of input variables to compute CUHCI. These included indicators for maternal health; maternal and child health; maternal, child and family planning and; maternal, child, family planning and curative care. Thus, seven different methods of computation of CUHCI were tested. Degree of correlation and kappa statistic between the district-wise scores and ranks, respectively, was obtained by comparing each of the seven methods with the base case analysis, i.e. geometric mean approach.

Ethical considerations

The authors received ethical approval from their institution.

Results

Sample population characteristics

Our analysis is based on data collected from >500 primary sampling units, covering 51 656 households and 275 550 individuals, of which 71.5% belonged to rural area. This sample included 9281 women who had delivered during last 1 year, 7676 women with a child in the age group of 11–23 months, 26 033 women with a child under 5 years of age, 33 425 eligible couples, 20 912 individuals with a self-reported illness episode during last 2 weeks and 8655 individuals with a hospitalization during last 365 days (Supplementary material Table 4).

Service and population coverage

Nearly, 82% women in Haryana received two doses of TT injection during pregnancy and delivered in an institution (Table 2 and Figure 1). Despite about 68% women receiving at least three antenatal check-ups, the overall full antenatal coverage was only 26%, which was low on account of poor coverage of iron–folic acid (IFA) supplementation. Accounting for provision of desired clinical and health education services which should be part of ANC care, less than one-fifth (18%) women received quality ANC care.

Although 71% children in Haryana were fully immunized according to India's UIP, ORS use was reported in less than one-third (32%) episodes of diarrhoea among under-fives. Unmet need for curative care (any illness) and non-communicable disease specifically was 1.3% and 2%, respectively. However, in about 11% of these illness episodes, care was sought from unqualified providers.

All the services, preventive and curative, were utilized at a higher rate by the wealthy population groups (Figure 2). Inequalities were much more marked for services such as ANC care (concentration index [CI] 0.133), iron–folic acid supplementation during pregnancy (CI = 0.172) and ORS use during diarrhoea (CI = 0.177) (Table 2). As a result, the inequality adjusted coverage for all the indicators were less than the unadjusted coverage by 0.1–6.7% in absolute term and 0.1–27% in relative term.

Coverage of key service coverage indicators among population groups defined by social group, education, occupation and religion is shown in Table 3. Coverage of services is lowest among the disadvantaged groups including those belonging to Muslim community, SC/ST caste and illiterate or literate without formal education. There was no significant effect of occupation.

Financial risk protection

Among those who had a hospitalization during last 1 year, 30% households incurred catastrophic health expenditures (Table 2). Prevalence of catastrophic health expenditure was almost same (i.e. 28.5%) for those who consulted outpatient departments, for any illness in last 1 month. Among the poorest 20% households, the prevalence of catastrophic health expenditures was 38% (Table 2 and Figure 2). In Haryana, 7% and 23% households have a per capita per day consumption expenditure of below $1.25 and $2 per capita per day (PPP), respectively. Nearly 16% households were

Table 2. Coverage of health services, equity, quality and its risk protection in Haryana, India, 2012–13

Indicators	Mean coverage	95% Confidence interval		Percent coverage by wealth quintile (SE)		Concentration Index (SE)	Inequality adjusted coverage
		LL	UL	Poorest	Richest		
Maternal and child Health							
Iron and folic acid (≥100)	36.4	35.6	37.2	30.1 (1.6)	44.1 (1.9)	0.172 (0.012)	30.1
TT (2 injections)	82.3	81.7	83.0	76.7 (1.6)	84.1 (1.6)	0.05 (0.005)	78.2
≥ 3 Antenatal check ups	68.2	67.4	69.1	56.6 (1.9)	80.2 (1.7)	0.133 (0.007)	59.2
Full ANC	26.2	25.5	27.0	20.2 (1.4)	36.4 (1.8)	0.24 (0.016)	20.0
Institutional delivery	82.2	81.5	82.8	74.6 (1.6)	87.8 (1.4)	0.067 (0.005)	76.7
Postnatal care (6 visits by ASHA)	12.4	11.9	13.0	12.2 (1.2)	14.6 (1.4)	0.228 (0.025)	9.6
Full immunization	70.9	70.1	71.7	62.3 (1.9)	75.6 (1.8)	0.095 (0.01)	64.2
ORS use rate	32.4	30.8	34.0	31.6 (3.5)	37.4 (4)	0.177 (0.03)	26.7
Family planning							
Contraceptive prevalence rate	58.1	57.7	58.5	56.9 (0.9)	57.4 (0.9)	0.083 (0.004)	53.3
Curative care							
Overall met need for any illness	98.7	98.6	98.8	99.1 (0.3)	98.3 (0.2)	0.001 (0.001)	98.6
Met need for non-communicable diseases	98	97.6	98.3	98.1 (1)	98.2 (0.5)	0.003 (0.003)	97.7
Financial risk protection							
Prepayment poverty headcount (@$1.25 PPP)	7.1	6.6	7.6	12.2 (1.6)	3.1 (0.7)	−0.008 (0.04)	7.2
Prepayment poverty headcount (@$2 PPP)	28.6	27.7	29.5	45.4 (2.5)	12.1 (1.4)	−0.076 (0.02)	30.8
Postpayment poverty headcount (@$1.25 PPP)	23.2	22.4	24.1	27.1 (2.1)	18.7 (1.8)	0.077 (0.02)	21.4
Postpayment poverty headcount (@$2 PPP)	44.8	43.8	45.8	57.5 (2.5)	31 (2.1)	−0.011 (0.01)	45.3
Poverty impact headcount (@$1.25 PPP)	16.1	15.7	16.4				
Poverty impact headcount (@$2 PPP)	16.2	16.1	16.3				
Catastrophic health expenditure	30.3	29.3	31.2	37.7 (2.5)	27.1 (2.1)	0.045 (0.02)	28.9
Quality of care							
Full effective ANC	18.5	17.8	19.1	18 (1.4)	27.1 (1.7)	0.027 (0.021)	13.5
Care from qualified provider	89.1	88.8	89.4	90.5 (0.7)	89.4 (0.6)	0.024 (0.002)	87

Figures in the table are percentages (except concentration index) i.e. percentage (standard error).

additionally pushed below poverty line as a result of health care expenditures. Financial risk protection was poorest for those belonging to the SC/ST caste, wage labourers and illiterate or those without a formal education (Table 3).

Extent of universal health coverage: composite UHC index

At the district level, we found large geographic variation in the population coverage of services, its equitable distribution and the prevalence of catastrophic expenditures (Table 4). On the equity front, however, all districts had a pro-rich utilization of key preventive and curative services. There were wide differences among districts in the extent of universal health coverage in Haryana (Figure 3). While districts like Kurukshetra (CUHCI= 71%), Jhajjar (CUHCI = 64%) and Kaithal (CUHCI= 60%) perform well on the scale of UHC, others like Mewat (CUHCI= 12%), Palwal (CUHCI= 18%) and Fatehabad (CUHCI= 28%) are very low in terms of performance on delivery of UHC (Figure 3).

Validation of composite UHC index

We found strong correlation ($r > 0.75$, $P < 0.01$) between CUHCI values obtained using the base method, and that obtained using various scenario and sensitivity analyses (Table 5). In terms of agreement on district rank, we find that there is only average agreement if we do not include indicators pertaining to curative care utilization and financial risk protection (kappa =0.4). Hence, inclusion of curative care and financial risk protection is imperative to make a comprehensive judgment on universality of health care provision. Finally, there is high degree of correlation ($r = 0.95$, 95% CI = 0.83, 0.99) for CUHCI and agreement in district rank (kappa = 0.85), with or without inequality adjustment in input indicators.

Discussion

In this paper, we present a methodology to compute a composite indicator for measuring the extent of universal health coverage. Further we use a large-scale household survey data on 275 550 individuals to empirically apply the methodology to measure UHC. Finally, we test the robustness of our methodology by applying various sensitivity and scenario analyses. Our results show that it is possible to measure UHC using a composite index which can be used at district level. The weights generated by us can be useful for replication in other states of India and other similar low- and middle-income country settings (Supplementary material, Table 7). The inequality unadjusted coverage for UHC correlates highly with adjusted coverage. So, for the ease of computation, policy makers can continue to use the unadjusted input indicators, as long as the setting is similar to present study in terms of the distributional aspect of population coverage. Another important conclusion from the present paper is that measurement of universal health coverage improves the way we assess health system performance and hence should be incorporated in country frameworks for performance measurement.

Measurement of UHC is complex as a result of a number of issues. First, it requires a clear definition of UHC which varies from one to the other setting, and hence the difficulty in identifying services which should be included for measuring UHC. Second, there can be a difference in opinion on what is the goal of UHC, which creates numerous measurement frameworks and domains. Finally, creation of a composite indicator is fraught with problems which could be normative and

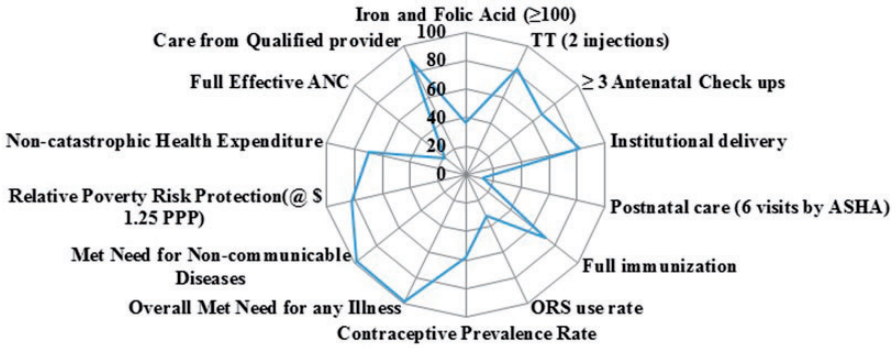

Figure 1. Extent of Universal Health Coverage in Haryana state, India, 2012–13

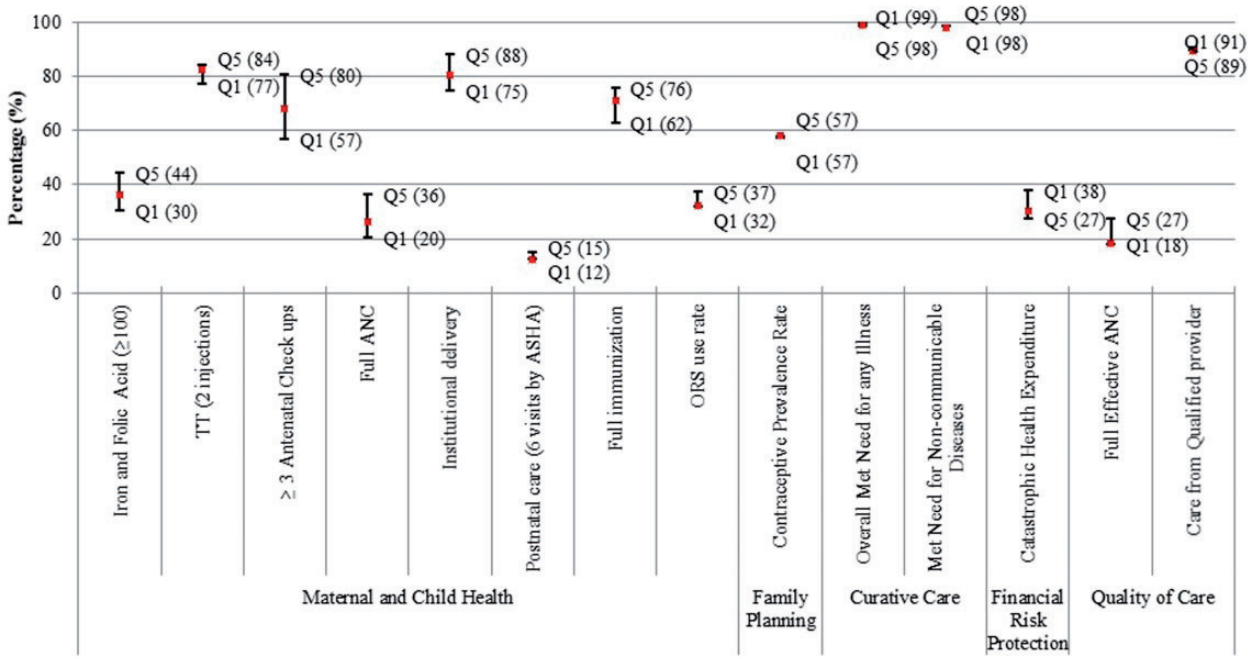

Figure 2. Inequalities based on wealth status in provision of health care in Haryana, India, 2012–13

statistical in nature. There could be multiple ways in which one can combine a given set of individual indicators: with or without weighting, with one statistical method versus another, etc.

Strengths

Our methodology for measuring UHC is similar to the framework proposed by WHO and World Bank (WHO-WB 2014). Briefly, we measured UHC in terms of service coverage, financial risk protection and the distributional aspects of service coverage. Service coverage was measured across the full life cycle of population including indicators which cover heath needs of all ages and gender. We attempted to include indicators for both preventive and curative services which could be delivered at all levels of the health system. In addition, we chose to include those indicators which are collected as part of other routine national and sub-national surveys or as part of routine health information system. All the indicators are relevant and are based on the list of essential services outlined by Government of India (MOHFW 2013) for inclusion in the benefit package for UHC district pilots. Moreover, as an extension to WHO framework, we included curative care from a qualified health care provider and full effective ANC care to incorporate an aspect of quality. Some proposed frameworks give emphasis on inclusion of detailed indicators to monitor country progress on the provision of services for non-communicable diseases (NCD) (Sherri *et al.* 2012; WHO-WB 2014). We included one indicator specifically on the met need of curative care for NCDs. As an output of our analysis, we present the weights which could be used by others to derive a composite weighted index. The inclusion of quality indicators and more robust statistical analysis to generate weights and the sensitivity analysis to validate the use of statistical methods are advancement over the previous attempts made in earlier papers, including the World Bank report (Wagstaff *et al.* 2015).

Findings in context of previous evidence

Our results in individual domains are similar to the findings reported previously from India. The coverage of services reported in our study is similar to previously reported estimates in terms of antenatal services, postnatal services, immunization, institutional

Table 3. Coverage of key health care services and financial risk protection in Haryana by socio-demographic characteristics

		Full ANC	Full immunization	Contraceptive prevalence rate	ORS use rate during diarrhoea	Met need for non-communicable diseases	Overall met need for any illness	Catastrophic health expenditure
		Coverage (LL–UL)	Coverage (LL–UL)	Coverage (LL–UL)	Coverage (LL–UL)	Coverage (LL–UL)	Coverage (LL–UL)	Coverage (LL–UL)
Religion	Hindu	30.0(28.7–31.2)	79.5(78.6–80.4)	63.4(62.9–63.9)	42.7(40.4–45.1)	96.8(96.6–97.0)	97.0(96.6–97.4)	28.3(26.9–29.8)
	Muslim	8.4(6.2–10.7)	41.1(36.7–45.5)	21.9(20.6–23.1)	29.7(23.6–35.9)	96.9(96.3–97.6)	97.7(96.6–98.9)	25.9(21.2–30.7)
	Sikh/Buddhism	27.7(21.5–33.9)	77.6(74.6–80.6)	60.1(58.6–61.5)	40.2(29.9–50.5)	97.0(96.3–97.6)	97.7(96.6–98.7)	23.9(21.4–26.5)
Social group	SC/ST	26.8(25.0–28.6)	77.7(76.3–79.1)	62.1(61.4–62.8)	38.3(35.1–41.5)	97.2(96.9–97.5)	97.4(96.8–97.9)	33.0(30.9–35.0)
	OBC	26.7(24.8–28.7)	69.9(68.2–71.7)	55.0(54.3–55.8)	41.5(37.9–45.2)	96.6(96.3–97.0)	97.2(96.6–97.8)	24.2(22.1–26.3)
	Other/General	31.4(29.0–33.7)	80.1(78.5–81.7)	62.7(61.9–63.5)	47.5(42.6–52.4)	96.5(96.1–96.9)	96.7(96.0–97.4)	23.4(21.4–25.5)
Occupation	Self Employed	25.9(24.6–27.3)	73.0(71.8–74.1)	59.4(58.8–59.9)	40.9(38.1–43.6)	96.8(96.6–97.0)	97.1(96.6–97.5)	28.9(27.4–30.4)
	Wages	32.3(26.9–37.7)	77.2(73.4–81.1)	62.1(60.1–64.1)	38.9(30.4–47.4)	98.3(97.6–99.0)	99.7(99.0–100)	46.9(37.1–56.8)
	Unemployed	33.3(30.0–36.5)	82.0(80.0–84.0)	59.7(58.6–60.9)	41.7(36.0–47.4)	96.4(95.9–96.9)	96.6(95.8–97.3)	27.3(24.5–30.1)
	Regular salaried	30.1(26.9–33.3)	78.4(76.1–80.8)	58.8(57.7–60.0)	43.9(38.3–49.5)	97.1(96.6–97.7)	97.4(96.4–98.4)	18.7(16.1–21.4)
Education	Illiterate/literate without formal	25.2(23.3–27.1)	71.9(70.2–73.6)	54.6(53.8–55.4)	33.6(29.8–37.4)	97.3(96.9–97.6)	96.7(96.1–97.3)	33.8(31.5–36.0)
	Primary/below primary	25.3(22.8–27.7)	70.5(68.2–72.7)	56.5(55.6–57.5)	41.2(36.8–45.6)	96.9(96.4–97.3)	97.9(97.2–98.6)	29.2(26.4–32.0)
	Matric/below matric	29.9(27.9–32.0)	75.8(73.5–78.0)	61.9(60.8–63.0)	40.0(34.8–45.2)	96.7(96.4–97.1)	97.4(96.8–98)	25.7(23.7–27.8)
	Senior secondary	34.4(30.2–38.7)	82.4(79.7–85.1)	64.7(63.8–65.7)	48.2(42.9–53.5)	95.9(95.1–96.7)	96.2(94.7–97.7)	18.8(15.1–22.5)
	Graduate and above	37.5(32.4–42.6)	81.9(80.3–83.5)	63.1(61.5–64.7)	59.1(49.1–69.1)	96.1(95.2–97.0)	96.6(95.2–98)	15.0(11.7–18.3)

delivery, ORS use rate and met need for curative care (IIPS 2007; UNICEF 2009; RGI 2012; Prinja *et al.* 2015). Similarly, the findings of our study on financial risk protection and equity in delivery of services are also similar to what has been reported previously (Ghosh 2011; Prinja *et al.* 2013; Balasubramanian *et al.* 2015). The World Bank reported overall UHC coverage varying from 51% to 57% from 1998 to 2006, respectively (Wagstaff *et al.* 2015). We reported an overall UHC coverage of 53% in Haryana.

Implications: policy and future research

Our analysis shows that the overall rank of performance of a district in terms of UHC performance varies considerably if only the traditional reproductive, maternal and child health indicators are measured versus if all indicators which are part of UHC framework are used. Inclusion of curative care and financial risk protection in the performance measurement framework improves the scope of health system performance assessment. The ranking of districts in terms of health system performance changes significantly once the provision of curative care and financial risk protection are also considered. Districts which are considered well performing based on traditional indicators become average or poor performing, and vice versa. This merits inclusion of UHC as a major indicator for post-2015 monitoring framework. Besides a global monitoring indicator, our findings also provide empirical basis for inclusion of UHC as a major health system-monitoring framework at individual country level.

Second, as highlighted earlier, countries around the world are developing strategies or models to achieve universal health coverage. In order to do so, it will be important to measure the performance of each of these strategies. This will be important not only from the point of view of individual countries or states or districts to map their progress as these go along but also to compare the relative successes and limitations of each of these strategies. Monitoring progress will also be able to highlight the differences in impact which each of these strategies or models to universalize health care can have on overall index as well as on the individual domains such as service coverage and financial risk protection.

Third, it is important to mention that the measurement of UHC should not be done in an isolated fashion using either service coverage or financial risk protection alone (Akinkugbe *et al.* 2011; Raban *et al.* 2013; Karan *et al.* 2014; Leegwater *et al.* 2015). Focus on service coverage alone hides the economic burden which it imposes on households, especially the poorer households. Similarly, evaluating FRP alone does not give any idea of unmet need for services. Poor households who have higher unmet need for service may not spend on health care and, as a result, have low OOP expenditure, and, as a result, low catastrophic spending. Similarly, poorer households may also substitute costlier forms of appropriate care with cheaper form of inappropriate care, which may also reflect is lower OOP expenditure. These issues have been highlighted by others also (Prinja *et al.* 2012; Prinja *et al.* 2012).

An important point to highlight is the measurement of financial risk protection (FRP) and its implications. We used two indicators for assessing FRP—protection from catastrophic health spending and protection from impoverishment. We recommend using both the indicators for measuring FRP. While the former offers precise protection from consumption, the latter does not explicitly measure the same. However, the latter does measure the impact of even small amounts of OOP expenditure among those who are just above poverty line, and for whom even small OOP expenditures can push the household below poverty line. Moreover, impoverishment is generally seen to be a very effective indicator to convince policy makers

Table 4. Coverage of key health care services and financial risk protection at district level in Haryana, India, 2012–13

Districts	Full ANC			Institutional delivery			Full immunization			Catastrophic Health Expenditure		
	Coverage (SE)	Concentration Index (SE)	Inequality adjusted coverage	Coverage (SE)	Concentration Index (SE)	Inequality adjusted coverage	Coverage (SE)	Concentration Index (SE)	Inequality adjusted coverage	Coverage (SE)	Concentration Index (SE)	Inequality adjusted coverage
Ambala	35.5 (3.9)	0.272 (0.04)	25.9	94.7 (1.6)	0.017 (0.02)	93.1	84.1 (2.9)	0.08 (0.02)	77.3	16.6 (2.9)	0.070 (0.11)	15.4
Bhiwani	9.4 (1.8)	0.421 (0.09)	5.5	90.7 (1.5)	0.04 (0.01)	87.1	84.5 (2.4)	0.028 (0.01)	82.1	21.5 (3.2)	0.202 (0.08)	17.2
Faridabad	17.8 (2.1)	0.514 (0.06)	8.7	77.4 (2.5)	0.1 (0.06)	69.7	67.1 (2.5)	0.074 (0.02)	62.1	23.3 (2.5)	0.261 (0.06)	17.2
Fatehabad	24.3 (3.6)	0.212 (0.08)	19.1	76.8 (3.5)	0.096 (0.03)	69.4	72.6 (3.2)	0.103 (0.02)	65.1	33.3 (3.9)	0.085 (0.07)	30.5
Gurgaon	51.6 (3.3)	0.261 (0.04)	38.2	76.7 (2.8)	0.159 (0.03)	64.5	49.1 (3.1)	0.313 (0.04)	33.7	7.8 (1.6)	−0.233 (0.08)	9.6
Hisar	39.4 (4)	0.285 (0.05)	28.2	83.3 (3)	0.051 (0.02)	79.0	67.7 (3.6)	0.157 (0.03)	57.1	30.7 (4)	0.098 (0.07)	27.7
Jhajjar	42.2 (2.6)	0.262 (0.03)	31.1	87.7 (1.7)	0.068 (0.01)	81.8	72.9 (2)	0.097 (0.02)	65.8	32 (2.5)	−0.026 (0.05)	32.8
Jind	46.1 (3.5)	0.264 (0.04)	33.9	89.4 (2)	0.069 (0.02)	83.2	84.3 (2.2)	0.025 (0.01)	82.2	35.8 (3.5)	0.04 (0.06)	34.3
Kaithal	40.2 (3.3)	0.215 (0.04)	31.6	84.4 (2.2)	0.082 (0.02)	77.5	75.6 (2.7)	0.14 (0.02)	65.0	36.5 (3.6)	0.049 (0.06)	34.7
Karnal	12.8 (2.3)	0.265 (0.11)	9.4	80.9 (2.6)	0.1 (0.02)	72.7	75.3 (2.9)	0.121 (0.03)	66.2	21.2 (3.1)	0.103 (0.09)	19.0
Kurukshetra	57.8 (3.4)	0.190 (0.03)	46.8	93.4 (1.7)	0.031 (0.01)	90.4	94.3 (1.7)	0.033 (0.01)	91.3	34.2 (4.1)	−0.069 (0.07)	36.6
Mahendergarh	30.9 (3)	0.210 (0.06)	24.4	91.1 (1.7)	0.046 (0.01)	86.8	82.3 (1.9)	0.048 (0.01)	78.4	23.6 (3.5)	0.198 (0.09)	18.9
Mewat	3.2 (1)	0.626 (0.14)	1.2	57 (3)	0.186 (0.03)	46.4	28.9 (2.4)	0.337 (0.04)	19.2	25.8 (2.7)	0.127 (0.06)	22.5
Palwal	10.9 (1.5)	0.607 (0.06)	4.3	52 (2.4)	0.245 (0.03)	39.3	59.6 (2.4)	0.123 (0.02)	52.3	9 (1.4)	0.046 (0.12)	8.5
Panchkula	39.2 (5)	0.253 (0.06)	29.3	91.1 (3.9)	0.056 (0.03)	86.0	93.5 (1.6)	0.043 (0.01)	89.5	28 (6.3)	0.188 (0.13)	22.8
Panipat	30.5 (3.3)	0.524 (0.05)	14.5	72.3 (2.9)	0.117 (0.03)	63.9	57.9 (3)	0.072 (0.03)	53.7	37.1 (3.1)	0.051 (0.05)	35.2
Rewari	32.9 (2.6)	0.356 (0.04)	21.2	98.2 (0.5)	0.014 (0.00)	96.8	86.8 (1.6)	0.038 (0.01)	83.6	18.8 (2.3)	0.046 (0.08)	17.9
Rohtak	37 (3.6)	0.511 (0.05)	18.1	91.5 (1.9)	0.065 (0.02)	85.6	93.2 (1.8)	0.039 (0.01)	89.6	16.3 (2.9)	0.268 (0.13)	11.9
Sirsa	13.9 (2.3)	0.325 (0.09)	9.4	84.7 (2.4)	0.095 (0.02)	76.6	75 (3)	0.1 (0.02)	67.5	49.1 (3.9)	−0.045 (0.05)	51.4
Sonipat	29.1 (3.2)	0.156 (0.06)	24.6	77 (3)	0.074 (0.02)	71.3	68.9 (3.3)	0.155 (0.03)	58.2	24.1 (3.7)	−0.017 (0.09)	24.5
Yamunanagar	32.7 (3.6)	0.192 (0.06)	26.4	79.7 (3.2)	0.108 (0.03)	71.1	73.4 (2.9)	0.107 (0.02)	65.6	42.2 (3.5)	−0.009 (0.05)	42.5
Haryana	26.2 (0.7)	0.24 (0.016)	20.0	82.2 (0.7)	0.07 (0.005)	76.7	70.9 (0.8)	0.095 (0.01)	64.2	30.3 (0.9)	0.045 (0.02)	28.9

Figures in the table are percentages (except concentration index) i.e. percentage (standard error).

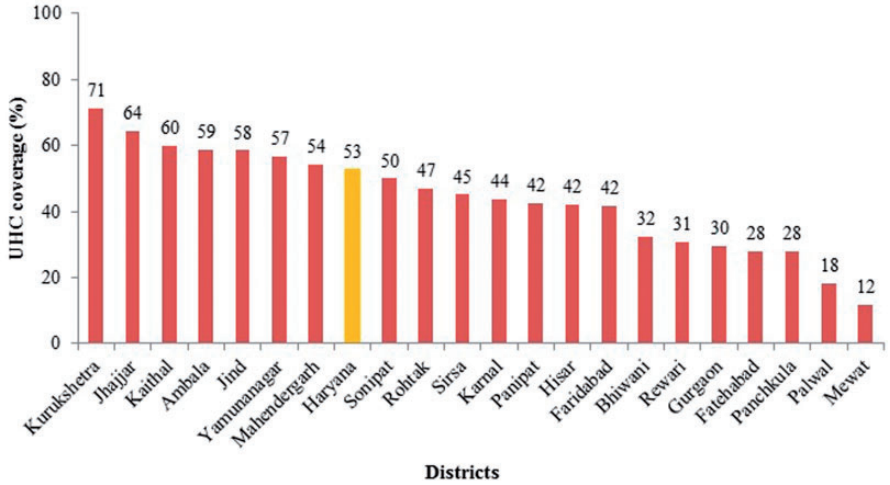

Figure 3. Extent of Universal Health Coverage in the 21 districts of Haryana state, India, 2012–13

Table 5. Comparative UHC coverages and rankings using different methods for constructing composite index

District	Base case		Alternative Scenarios													
			Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5: PCA		Scenario 6: REG		Scenario 7: HDI	
	Coverage (%)	Rank	Coverage (%)	Rank	Coverage (%)	Rank	Coverage (%)	Rank	Coverage (%)	Rank	Coverage (%)	Rank	Coverage (%)	Rank	Coverage (%)	Rank
Ambala	58.7	4	62.0	5	57.7	5	63.3	5	66.6	2	51.3	9	42.4	5	57.3	6
Bhiwani	32.5	15	32.5	14	23.9	18	26.2	18	32.4	16	41.6	20	22.1	18	27.3	18
Faridabad	41.7	14	20.2	18	30.0	16	33.0	15	42.2	12	46.3	15	26.0	14	32.4	15
Fatehabad	28.0	18	38.2	8	32.5	14	36.2	13	25.3	19	43.5	18	21.7	19	26.2	19
Gurgaon	29.7	17	31.4	15	37.2	13	35.3	14	45.3	11	46.2	16	22.4	17	30.8	17
Hisar	42.0	13	37.1	10	39.1	11	42.3	12	40.6	14	47.1	14	25.9	15	40.6	13
Jhajjar	64.2	2	77.5	3	73.8	3	70.2	3	65.0	3	55.2	3	51.7	2	63.1	2
Jind	58.4	5	70.5	4	71.4	4	69.9	4	57.4	5	55.7	2	48.4	4	57.6	5
Kaithal	60.0	3	37.6	9	44.1	10	49.4	8	58.9	4	53.5	5	41.3	7	59.9	3
Karnal	43.7	11	33.2	13	38.7	12	43.1	11	45.3	10	45.8	17	25.2	16	45.0	9
Kurukshetra	71.2	1	87.1	1	77.1	2	74.9	1	72.1	1	57.2	1	52.9	1	73.7	1
Mahendergarh	54.3	7	41.6	6	51.0	6	55.2	6	56.8	6	52.6	7	35.1	9	51.1	8
Mewat	11.8	21	8.7	20	7.6	21	5.4	21	10.0	21	37.6	21	18.6	20	10.7	21
Palwal	18.3	20	5.4	21	14.9	19	16.6	20	23.0	20	43.3	19	12.0	21	14.1	20
Panchkula	27.7	19	17.7	19	14.1	20	18.6	19	25.8	18	47.8	12	31.4	11	32.5	14
Panipat	42.4	12	26.7	16	32.4	15	31.9	16	39.7	15	48.5	10	31.6	10	41.6	12
Rewari	30.6	16	34.1	11	48.9	7	52.2	7	31.1	17	53.2	6	36.2	8	42.7	11
Rohtak	46.8	9	80.9	2	77.9	1	74.8	2	51.8	8	52.2	8	50.6	3	31.6	16
Sirsa	45.1	10	23.3	17	27.0	17	30.5	17	40.8	13	47.2	13	31.2	12	42.7	10
Sonipat	50.0	8	39.5	7	47.6	8	47.2	10	51.5	9	48.2	11	28.7	13	51.7	7
Yamunanagar	56.7	6	33.5	12	44.2	9	47.6	9	54.0	7	54.9	4	41.6	6	57.9	4
Correlation coeff. (r)			0.76 (0.44,0.89)		0.81 (0.56,0.93)		0.84 (0.66,0.95)		0.96 (0.91,0.99)		0.85 (0.58,0.96)		0.83 (0.61,0.95)		0.95 (0.83,0.99)	
Kappa (*P*-value)			0.4 (0.011)		0.4 (0.011)		0.4 (0.011)		0.7 (<0.0001)		0.55 (<0.0001)		0.7 (<0.0001)		0.85 (<0.0001)	

Note: Base case and Scenarios 1, 2, 3, 4, and 7 use 'Human Development Index' (HDI) methodology, scenario 5 uses PCA and scenario 6 use Regression weighting method to calculate composite index.

Base case: All indicators, Scenario 1: only maternal health indicators included, Scenario 2: maternal health and child health indicators included, Scenario 3: maternal health, child health and family planning indicators included, Scenario 4: maternal health, child health, family planning and curative care indicators included, Scenario 5: all indicators using 'Principle Component Analysis' (PCA) method, Scenario 6: all indicators using Regression weighting method, Scenario 7: all indicators using 'Human Development Index' (HDI) method and inequality adjusted coverages.

Correlation coefficient and Cohen's Kappa as validation measure are calculated to see the concordance between base case and different scenarios.

on the effects of the OOP expenditures. However, as a note of caution, FRP '*alone*' should not be used to measure the extent of universal health coverage. This is especially relevant in low-income country settings, where high unmet need for health care services could be observed. As a result of high-unmet need, a large number of poor households may not be accessing treatment for an illness, and may be perceived to be protected from financial risk as they do not spend any OOP. Further, in such cases, high-cost hospitalization is avoided and replaced with low-cost treatment in outpatient setting. However, the same is not desirable. As a result, financial risk protection should be viewed along with service coverage to comment on the extent of universal health coverage. Finally, we also recommend exclusion of indirect costs, such as productivity losses, in the economic burden of health care as universal health coverage does not address the same.

Limitations

We would like to acknowledge three important limitations in terms of the choice of indicators used for UHC measurement in our analysis. First, the services included in our measurement framework for coverage estimation do not measure UHC in the most comprehensive way. Several important indicators which could be included were left out—for example coverage of ART treatment for HIV patients, or DOTS treatment for TB patients. Similarly, although we estimate the coverage of preventive and curative care, our indicators do not capture the coverage of services for rehabilitation, palliation or long-term care due to lack of reliable data. Further, the health goal is closely linked to many of the other social, economic and environmental Sustainable Development Goals (SDGs). Enhanced and expanded monitoring of health under the SDGs should seek to build on this premise by including coverage of other social determinants. Subsequent attempts at measuring UHC should incorporate these additional services in the measurement matrix.

Second, in terms of financial risk protection measurement, two other indicators that are sometimes used to measure the 'depth of poverty,' i.e. the extent to which out-of-pocket health payments worsen a household's pre-existing level of poverty, and the 'mean catastrophic positive overshoot,' the average amount by which households affected by catastrophic expenditures pay more than the threshold used to define catastrophic health spending. Subsequent attempts at UHC measurement could include these indicators of financial risk protection.

Third, our attempt at measuring quality of care is still rudimentary. Measurement of quality of health care to render 'effective' coverage is a difficult task. Several measures of quality of care have been suggested in the literature which could be used to evaluate the quality in terms of structures, processes, health outcomes and lastly patient experiences. Another approach towards measuring quality could be the level of entity where quality is being measured, i.e. health plan/insurance, provider/facility and finally the health care professional. Structural indicators measure the infrastructure of the facility or provider in terms of delivering care. However, it has to be used in conjunction with the process indicators as the ability of a facility to provide a particular function does not necessarily imply that the function or service is being delivered. Our indicator of quality was essentially a process indicator which described whether a pregnant woman received the set of services which she was supposed to receive. Measuring the outcomes indicators requires detailed collection of data from medical records on the condition of the user. Finally, the patient experiences provide feedback on patient experiences on care, including the inter-personal aspect of care.

Conclusion

Composite indicators are good tools for easy communication of performance as a snapshot. However, we acknowledge that the creation of a single composite indicator does not take away the merit of closely reviewing the individual input indicators. Moreover, policy actions for improving UHC coverage can be undertaken when the situation is assessed in totality. Hence, we recommend the use of a composite indicator supplemented with a spider diagram. The latter would be useful to identify gaps in service provision, its distribution among population groups, financial risk protection and quality of care. On the contrary, a composite indicator presents a snapshot picture and ranking of districts, states or countries in terms of UHC performance. The composite indicator should be kept relatively simple in construction to assist its replication and to minimize suspicion on its validity (as a result of too much weighting). So, we recommend the use of un-weighted composite indicator for use in routine monitoring. Our sensitivity analyses show that interpretation and direction of un-weighted CUHCI are robust to the application of weights. Such assessments of UHC rely on good quality data. As a result countries need to invest in generation of quality data, either by strengthening the quality of routine MIS or undertaking representative surveys. To conclude, we present an attempt to develop a methodology to measure UHC and empirically demonstrate its application. The present measurement matrix provides a useful contribution towards analysing health system performance for delivery of equitably delivered health care which does not impose financial burden on utilization of health care. However, it is also important to acknowledge that the current measurement matrix needs to be further improved upon by including other important services for coverage estimation. This would further enhance the universality of measurement. Further, more indicators of financial risk protection and improvements in the way quality is measured are recommended as future areas of research in this important area of performance measurement.

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Contributors

All authors contributed substantially to the design and undertaking of the study, its analysis, and in the writing of this manuscript. All authors approved the final manuscript. Shankar Prinja is the guarantor. Specific roles of authors are as follows:

S.P., R.G. and R.K.: conceived the study and designed the experiment.

R.K., A.K.A., S.P. and A.S.: prepared study tools.

A.S., P.B., A.K.A., A.P. and S.P.: supervised data collection.

P.B., S.P. and A.S.: analyzed the data.

S.P. and P.B.: wrote the first draft of paper.

All authors: Critically reviewed paper and revised the manuscript. All authors approve the final version of manuscript submitted. All authors had full access to all of the data in the study and take responsibility for the integrity of the data and accuracy of the data analysis and their presentation.

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Ethical approval

The authors received ethical approval from their institution.

Conflict of interest statement. None declared.

Supplementary Data

Supplementary data are available at *HEAPOL* online.

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