Trends in, and projections of, indicators of universal health coverage in Bangladesh, 1995–2030: a Bayesian analysis of population-based household data

Md Shafiur Rahman, Md Mizanur Rahman, Stuart Gilmour, Khin Thet Swe, Sarah Krull Abe, Kenji Shibuya

Summary

Background Many countries are implementing health system reforms to achieve universal health coverage (UHC) by 2030. To understand the progress towards UHC in Bangladesh, we estimated trends in indicators of the health service and of financial risk protection. We also estimated the probability of Bangladesh's achieving of UHC targets of 80% essential health-service coverage and 100% financial risk protection by 2030.

Methods We estimated the coverage of UHC indicators—13 prevention indicators and four treatment indicators—from 19 nationally representative population-based household surveys done in Bangladesh from Jan 1, 1991, to Dec 31, 2014. We used a Bayesian regression model to estimate the trend and to predict the coverage of UHC indicators along with the probabilities of achieving UHC targets of 80% coverage of health services and 100% coverage of financial risk protection from catastrophic and impoverishing health payments by 2030. We used the concentration index and relative index of inequality to assess wealth-based inequality in UHC indicators.

Findings If the current trends remain unchanged, we estimated that coverage of childhood vaccinations, improved water, oral rehydration treatment, satisfaction with family planning, and non-use of tobacco will achieve the 80% target by 2030. However, coverage of four antenatal care visits, facility-based delivery, skilled birth attendance, postnatal checkups, care seeking for pneumonia, exclusive breastfeeding, non-overweight, and adequate sanitation were not projected to achieve the target. Quintile-specific projections showed wide wealth-based inequality in access to antenatal care, postnatal care, delivery care, adequate sanitation, and care seeking for pneumonia, and this inequality was projected to continue for all indicators. The incidence of catastrophic health expenditure and impoverishment were projected to increase from 17% and 4%, respectively, in 2015, to 20% and 9%, respectively, by 2030. Inequality analysis suggested that wealthiest households would disproportionately face more financial catastrophe than the most disadvantaged households.

Interpretation Despite progress, Bangladesh will not achieve the 2030 UHC targets unless the country scales up interventions related to maternal and child health services, and reforms health financing systems to avoid high dependency on out-of-pocket payments. The introduction of a national health insurance system, increased public funding for health care, and expansion of community-based clinics in rural areas could help to move the country towards UHC.

Funding Japan Ministry of Health, Labour, and Welfare.

Introduction

Universal health coverage (UHC) is a global health priority and one of the major targets of the Sustainable Development Goals (SDGs).[1] UHC ensures that all citizens have access to high-quality health services when needed without financial risk.[1,2] Under SDG3, WHO has defined a set of UHC targets that member countries need to achieve by 2030 as part of their progress towards health financing reform,[3,4] and every UN member state has committed to these goals.[1,5] The targets are to achieve at least 80% essential health-service coverage for the entire population of the country irrespective of their economic status, gender, or place of residence, and 100% protection from catastrophic and impoverishing payment for health services by 2030.[2,3]

South Asian countries, especially Bangladesh, have made progress towards reductions in mortality and increases in life expectancy, but face many barriers to continuing this progress. Inequity in access to health care,[6] a growing burden of non-communicable diseases,[7] high dependency on out-of-pocket (OOP) health payments,[8] and the absence of risk-pooling mechanisms (health insurance schemes used to minimise financial burden due to health-care expenditure, such as state-funded national health insurance systems) in the health financing system[9] could hinder progress towards UHC in resource-limited countries such as Bangladesh. The Bangladeshi Government has committed to achievement of UHC, and took an initial step in 2012 by developing health-financing strategies to raise funds through taxation

Research in context

Evidence before this study

We systematically searched PubMed, CINHAL, and the Web of Science database with a combination of MeSH heading terms and the keywords "universal health coverage", "progress", "movement"," assessment", "catastrophic", "out-of-pocket", "impoverish", "financial risk", "cost of illness", "expenditure", "household financial", "household economic", "economic impact", "health insurance", and "Bangladesh" for articles published in any language before Nov 1, 2016, to identify work about assessment of progress towards universal health coverage (UHC) in Bangladesh. Of the 307 records identified by our search, we established—after screening of titles, abstracts, and full texts—that five studies assessed UHC in Bangladesh. None of the previous studies assessed the progress of Bangladesh towards UHC in terms of WHO-recommended dimensions (ie, health-service coverage, financial risk protection, and equity) and indicators. In the previous studies, only specific health indicators were assessed, or equity or financial risk protection were not considered. None provided trends and projections of UHC indicators in the past 10 years.

Added value of this study

To our knowledge, this study is the first comprehensive assessment of UHC in Bangladesh. We used the most up-to-date data sources, a wide range of indicators, and Bayesian analysis to provide model-based estimates of trends in, and projections

of, UHC, health-service coverage, and financial risk protection indicators, with a focus on equity. The projections of indicators helped us to assess the likelihood of achievement of UHC through a probabilistic approach. This process also enabled us to quantify the probability of achieving UHC targets for each indicator. Our results showed that, although overall prevention and treatment coverage are increasing nationally and across wealth quintiles, financial risk protection is decreasing. Several indicators related to maternal and child health services are not on track to meet 2030 targets. Projections to 2030 also suggest continued wealth-based inequality in health indicators and access to health services, except for exclusive breastfeeding and non-overweight. By using Bayesian models, we estimated that 23% of households would incur financial hardship by 2030.

Implications of all the available evidence

By use of a probabilistic Bayesian models, we provided projections of selected UHC indicators up to 2030. These projections showed that Bangladesh is unlikely to reach the targets of 80% health-service coverage and 100% financial risk protection. The low coverage of specific health services, existing pro-rich inequality in the health service, and increasing trends of financial burden as a result of health-care expenses emphasise the need for stable policies, cost-effective interventions, and urgent implementation of risk pooling mechanisms in Bangladesh.

and donor contributions.[10] Therefore, assessment of the country's progress towards UHC goals is necessary through a broad range of UHC indicators that provide an assessment of the practical effect of the strategy on ordinary users of health services.[11] Projections for these indicators to inform future planning are also needed.

Although trends and projections are very useful for policy makers to identify areas in which further policies and interventions are required, none of the previous studies in Bangladesh included projections of the coverage of UHC indicators to quantify the probability of achieving targets by 2030.[8,12–15] We aimed to investigate trends in the coverage of health services and financial risk protection in Bangladesh with a focus on equity, and to obtain projections of coverage of health services and financial risk protection by 2030. We also aimed to estimate the probability of achieving the UHC targets of 80% coverage of health services and 100% financial risk protection from catastrophic and impoverishing health payments by 2030.

Methods

Study design and data sources

We used data from nationally representative cross-sectional household surveys in Bangladesh to estimate trends in, and projections of, UHC coverage. Study data came from surveys, which we obtained from the Bangladesh

Demographic Health Survey and Bangladesh Bureau of Statistics. Surveys were included if they were done nationally, sampled on the basis of a defined framework, and had high response rates. We identified 19 surveys that were done from Jan 1, 1991, to Dec 31, 2014, in all of which multistage cluster sampling methods were used to gather data from nationally representative probability samples of households (appendix p 3). Ethical approval was not required for this study, because we used publicly available secondary datasets.

Measurement of UHC indicators

We followed the joint WHO and World Bank framework for assessment of progress towards UHC.[3] We measured both coverage of essential health services and protection from financial risk due to health-care costs. To establish whether these components provided benefits to the whole population irrespective of socioeconomic status,[3] we measured them both nationally and by household consumption quintiles.

Health-service interventions are classified into two broad categories: prevention services and treatment services.[11] Because various prevention and treatment indicators are used to monitor progress towards UHC, the selection of indicators depends on a country's health system, epidemiology, and availability of data sources.[11] On the basis of these selection criteria and previous studies,[8,11,16] we

See **Online** for appendix

	Definition*	Data sources
Prevention indicators		
At least four antenatal care visits	The proportion of women aged 15–49 years in the 3 years preceding the survey who received at least four visits from a skilled health provider (ie, doctor, nurse, or midwife) during their last pregnancy	BDHS 1993–94, 1996–97, 1999–2000, 2004, 2007, 2011, 2014; MICS 2012–13
At least one antenatal care visit	The proportion of women aged 15–49 years in the 3 years preceding the survey who received at least one visit from a skilled health provider during their last pregnancy	BDHS 1993–94, 1995–96, 1999–2000, 2004, 2007, 2011, 2014; MICS 2012–13
Postnatal care of mother	The proportion of women giving birth in the 3 years preceding the survey who received their first postnatal checkup in the first 2 days after birth by a medically trained provider (ie, doctor, nurse, midwife, paramedic, family welfare visitor, community skilled birth attendant)	BDHS 2004, 2007, 2011, 2014
Postnatal care of newborn infant	The proportion of last births in the 3 years preceding the survey who received their first postnatal checkup in the first 2 days after birth by a medically trained provider	BDHS 2004, 2007, 2011, 2014
Exclusive breastfeeding	The proportion of youngest children younger than 6 months living with their mother who are exclusively breastfed (based on a 24 h recall period)	BDHS 1993–94, 1996–97, 1999–2000, 2007, 2011, 2014
Needs for family planning satisfied	The proportion of married women aged 15–49 who do not want any more children or want to wait 2 or more years before having another child and are using modern contraception	BDHS 1993–94, 1996–97, 1999–2000, 2004, 2007, 2011, 2014
BCG immunisation	The proportion of children aged 12–23 months who received one dose of the BCG vaccine	BDHS 1993–94, 1996–97, 1999–2000, 2004, 2007, 2011, 2014
DPT3 immunisation	The proportion of children aged 12–23 months who received three doses of the DPT vaccine	BDHS 1993–94, 1996–97, 1999–2000, 2004, 2007, 2011, 2014
Polio3 immunisation	The proportion of children aged 12–23 months who received three doses of polio vaccine	BDHS 1993–94, 1996–97, 1999–2000, 2004, 2007, 2011, 2014
Measles immunisation	The proportion of children aged 12–23 months vaccinated against measles	BDHS 1993–94, 1996–97, 1999–2000, 2004, 2007, 2011, 2014
Non-use of tobacco	The proportion of men and boys aged 15 years or older who do not use tobacco	BDHS 2007, GATS 2009; HMSS 2012, 2014
Non-overweight	The proportion of women and girls aged 15–49 years who are not overweight (ie, body-mass index <25·0 kg/m²)	BDHS 1996–97, 1999–2000, 2004, 2007, 2011, 2014
Improved or safe water	The proportion of households whose main source of drinking water is an improved source (which includes tube well, piped water, rain water, protected well, and bottled water)	BDHS 1993–94, 1996–97, 1999–2000, 2004, 2007, 2011, 2014; MICS 2012–13
Adequate sanitation	The proportion of households with improved toilet facilities (which includes flush toilets piped to sewer system, septic tank, or pit latrines, ventilated improved pit latrines, and pit latrine with slabs)	BDHS 1993–94, 1996–97, 1999–2000, 2004, 2007, 2011, 2014
Treatment indicators		
Institutional delivery	The proportion of livebirths delivered at a health facility in the 3 years preceding the survey	BDHS 1993–94, 1996–97, 1999–2000, 2004, 2007, 2011, 2014; MICS 2006, 2012–13
Skilled birth attendance	The proportion of livebirths assisted by a skilled health provider (ie, a doctor, nurse, midwife, or auxiliary nurse or midwife) in the 3 years preceding the survey	BDHS 1993–94, 1996–97, 1999–2000, 2004, 2007, 2011, 2014; MICS 2006, 2012–13
Oral rehydration therapy	The proportion of children younger than 5 years with diarrhoea who received oral rehydration therapy (ie, oral rehydration salts, recommended home solution, or increased fluids) in the previous 2 weeks	BDHS 1993–94, 1996–97, 1999–2000, 2004, 2007, 2011, 2014
Care seeking for pneumonia	The proportion of children younger than 5 years with suspected pneumonia who sought care from an appropriate health provider in the previous 2 weeks	BDHS 1993–94, 1996–97, 1999–2000, 2004, 2007, 2011, 2014; MICS 2006, 2012–13
Treatment of diabetes†	The proportion of patients with diabetes taking drugs to control the disease	BDHS 2011
Treatment of hypertension†	The proportion of patients with hypertension taking drugs to control the disease	BDHS 2011
Financial risk protection indicators		
Catastrophic health expenditure	The proportion of households for which out-of-pocket payments for health care exceed 10% of the household's total consumption	HES 1991–92, 1995–96; HIES 2000, 2005, 2010; UHES 2011; BIHS 2011–12
Impoverishing health expenditure	The proportion of households for which total household expenditure was greater than household subsistence expenditure, but household expenditure without out-of-pocket health payment was lower than subsistence expenditure	HES 1991–92, 1995–96; HIES 2000, 2005, 2010; UHES 2011; BIHS 2011–12

BDHS=Bangladesh Demographic and Health Survey. MICS=Bangladesh Multiple Indicator Cluster Survey. DPT=three doses of diphtheria, pertussis, and tetanus vaccine. Polio3=three doses of polio vaccine. GATS=Global Adult Tobacco Survey—Bangladesh. HMSS=Bangladesh Health and Morbidity Status Survey. HES=Household Expenditure Survey. HIES=Household Income and Expenditure Survey. UHES=Urban Health Expenditure Survey. BIHS=Bangladesh Integrated Household Survey. *Adapted from the global monitoring report on universal health coverage.[8,11,16] †Not projected for the year 2030 because data were insufficient.

Table 1: Indicators of universal health coverage

chose 13 prevention indicators and four treatment indicators (table 1). These interventions help to improve population health and prevent premature death and disability.[17] We estimated a composite prevention index and a composite treatment index as the weighted mean of prevention and treatment indicators, respectively, to trace the progress of overall prevention and treatment coverage.

Because the composite prevention index was estimated from survey data and information for all 13 prevention indicators was not available for the same survey year, only nine prevention indicators (four antenatal care visits; exclusive breastfeeding; family planning demand satisfaction; improved water; adequate sanitation; BCG immunisation; measles immunisation; three doses of diphtheria, pertussis, and tetanus immunisation (DPT3); and three polio immunisations) were included to estimate the composite prevention index. Additionally, we estimated a composite coverage index—a weighted mean of eight reproductive, maternal, and child health services indicators from four intervention areas—on the basis of the formula developed by Boerma and colleagues.[16]

Incidence of catastrophic health expenditure and impoverishment due to OOP health payments were used for assessment of financial hardship.[3] We used a 10% threshold of household total consumption to define catastrophic health payment.[18] Health expenditure was defined as impoverishing when a non-poor household became poor because of OOP payments for health care[18]— ie, health expenditure was deemed impoverishing when total household expenditure (including OOP payment) was greater than household subsistence expenditure, but household expenditure without OOP payment was lower than the subsistence expenditure. A poverty line based on food share was used for the estimation of household subsistence expenditure. We defined financial hardship as the incidence of either catastrophic health expenditure or impoverishment, or both. Details of the measurement procedure for catastrophic and impoverishing health expenditure are in the appendix (pp 5–6).

Statistical analysis

Coverage of prevention, treatment, and financial hardship indicators were estimated as proportions with 95% CIs from the original survey data. The socioeconomic status of households was determined either according to the asset-based wealth index or on the basis of total consumption (appendix p 6). Because the included health surveys had no information about the income or expenditure of sampled households, we used the wealth index as a proxy measure of household socioeconomic status.[19] Household wealth index was constructed on the basis of household characteristics and ownership of assets by principal component analysis with the standard method from the Demographic and Health Surveys.[20] We then ranked households on the basis of wealth scores and divided them into quintiles, from poorest quintile (lowest 20%

of the index) to the richest quintile (highest 20% of the index). Consistent with previous studies,[21,22] household consumption expenditure quintiles were used to measure socioeconomic status of households for household health expenditure survey data (appendix p 6).

We used a regression-based relative index of inequality to measure the relative socioeconomic inequalities between poor and rich households for the included indicators for the years 2007, 2011, and 2014 to see changes in inequalities in recent years. The regression approach takes into account the whole population distribution of wealth and quantifies the degree of inequity between the top and bottom quintiles. The value of the relative index of inequality indicates the increased risk of experiencing an outcome among the rich quintile compared to the poor quintile. Additionally, we constructed a concentration curve to show the socioeconomic inequality in the indicators graphically and calculated a concentration index to measure the extent of socioeconomic inequality in each of the indicators (appendix p 6).[18]

Composite prevention and treatment indices were developed based on random-effects meta-analysis by use of the Freeman-Tukey transformation method.[23] Because the proportion of some of the indicators in our study was close to the boundary values (such as 0 or 1) we preferred to apply meta-analysis on the basis of the Freeman-Tukey method. The Freeman-Tukey method applies a double arcsine transformation to the proportions. We applied the meta-analysis to the transformed values and their variance, and then transformed the values and their confidence intervals back to the original proportion scale to obtain accurate estimates of the pooled means.

We used a Bayesian linear regression model with non-informative prior to estimate the trends in indicators with time and the posterior predictive distribution of the indicators. We used Bayesian regression models because we were interested in computation of target achievement probability. Bayesian linear regression specifies a sampling distribution of the data with specification of a prior distribution of the regression coefficients. Time was a covariate in each model (appendix p 29).

All the proportions were logit transformed before the analysis, and all calculations were done in the logit-transformed variables and then transformed back to probabilities to ensure all predicted and projected probabilities lay between 0 and 1. A Markov chain Monte Carlo (MCMC) algorithm was used to obtain 1000 samples from the posterior distributions of the parameter of interest with two chains. For each model, the first 5000 iterations were discarded as burn-in and the number of iterations was increased until the output diagnosed as converged. These posterior predictive distributions were used to obtain projections and credible intervals (CrI) up to the year 2030. They were also used to calculate the annual rate of change, and the probability of achieving the target for all included indicators.
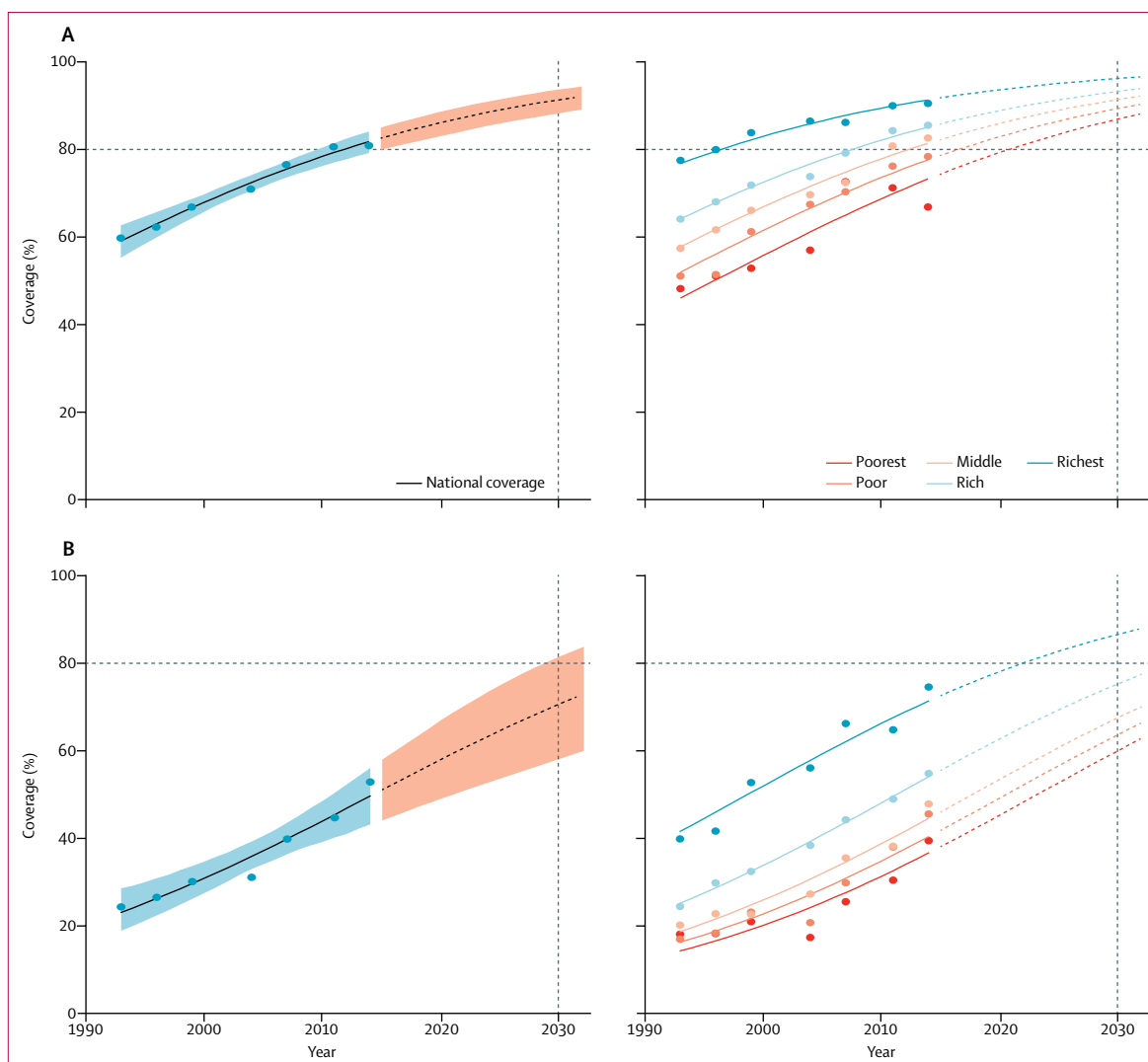
Figure 1: **Trends in, and projections of, composite indices nationally (left) and by wealth quintile (right), in Bangladesh, 1993–2030**
Dots represented recorded mean estimates. Lines show the posterior mean estimates (dashed lines represent projected future values). The shaded area represents the 95% credible intervals. The dotted line represents the 80% coverage target for universal health coverage indicators.

We considered an indicator to have met the UHC target by 2030 if the target achievement probability was 90% or above. We used trends for 1993–2014 to obtain projections of health service indicators. For financial risk protection indicators, Bayesian models included survey data from the year 2000 and later because of differences in data collection before 2000. Additionally, for the quintile-specific models, we included quintile as a categorical covariate and tested for an interaction between quintile and year in every model with the deviance information criterion (appendix p 7). Finally, we did sensitivity analyses for indicators with trends from 2000 and later whenever possible. Trace plots were checked visually to assess convergence of MCMC output for each of the models. When the outputs from two chains become alike, posterior samples were considered to have converged.[24] Additionally,

Gelman-Rubin diagnostic statistics were used as a quantitative measure of convergence. A potential scale reduction factor is used in this diagnostic, in which a value close to 1 diagnosed convergence, and a value less than 1·02 identified convergence failure.[24] Bayesian models were developed in JAGS (version 4·2·0) and implemented in R (version 3·2·4). Example JAGS and R codes for the antenatal care visit indicator, and the final data set used for analysis, are in the appendix (pp 30–34).

Role of the funding source

	Predicted coverage in year (95% credible interval)				Annual % change 1993–2030 (95% credible interval)	Probability of reaching target	Relative index of inequality (95% CI), 2014
	1995	2005	2015	2030			
Prevention indicators							
At least four antenatal care visits	6·9 (5·4 to 9·0)	14·4 (12·5 to 16·7)	27·9 (22·1 to 34·1)	57·1 (41·8 to 70·9)	6·2 (4·7 to 7·5)	0%	10·84 (7·30 to 14·38)
Postnatal care of mother	5·8 (2·8 to 10·7)	16·1 (12·7 to 20·4)	38·6 (31·0 to 47·4)	77·9 (56·5 to 91·8)	7·9 (5·0 to 10·5)	39·3%	6·56 (5·12 to 8·05)
Postnatal care of newborn infant	5·4 (1·8 to 12·8)	15·0 (10·5 to 20·8)	37·5 (26·4 to 50·6)	76·8 (44·4 to 94·8)	8·2 (3·6 to 12·0)	46·4%	7·82 (5·90 to 9·73)
Exclusive breastfeeding	44·9 (36·1 to 54·1)	51·2 (45·0 to 57·7)	57·4 (46·5 to 67·6)	65·7 (44·5 to 82·3)	1·1 (–0·3 to 2·3)	5·3%	1·05 (0·69 to 1·42)
Needs for family planning satisfied	57·7 (54·9 to 60·3)	65·4 (63·7 to 67·3)	72·5 (69·5 to 75·6)	81·1 (76·2 to 85·5)	1·0 (0·7 to 1·2)	73·3%	1·02 (0·93 to 1·10)
BCG immunisation	86·4 (82·9 to 89·1)	95·2 (94·2 to 96·0)	98·4 (97·8 to 98·9)	99·7 (99·4 to 99·9)	0·5 (0·3 to 0·6)	100%	1·04 (1·01 to 1·07)
DPT3 immunisation	67·9 (59·4 to 75·4)	85·3 (82·1 to 88·1)	94·0 (90·9 to 96·2)	98·5 (96·7 to 99·4)	1·2 (0·8 to 1·7)	100%	1·22 (1·08 to 1·36)
Polio3 immunisation	65·9 (56·9 to 74·1)	84·9 (81·9 to 88·0)	94·1 (91·0 to 96·3)	98·7 (96·9 to 99·5)	1·3 (0·9 to 1·8)	100%	1·19 (1·06 to 1·32)
Measles immunisation	68·8 (63·2 to 74·5)	80·0 (76·9 to 82·9)	87·7 (83·9 to 90·9)	94·9 (90·0 to 97·0)	0·9 (0·6 to 1·3)	100%	1·35 (1·18 to 1·51)
Non-use of tobacco	8·8 (1·5 to 26·6)	26·4 (15·8 to 40·4)	61·9 (49·4 to 4·5)	91·9 (69·8 to 99·2)	7·9 (2·8 to 13·1)	93·9%	1·01 (0·96 to 1·05)
Non-overweight	97·3 (96·5 to 98·0)	91·0 (89·6 to 92·0)	75·9 (71·2 to 79·9)	28·8 (18·7 to 40·8)	–3·2 (–4·3 to –2·2)	0%	0·52 (0·49 to 0·55)
Improved or safe water	94·5 (92·7 to 96·0)	97·0 (96·4 to 97·6)	98·4 (97·6 to 99·0)	99·3 (98·5 to 99·8)	0·2 (0·1 to 0·2)	100%	1·07 (0·99 to 1·14)
Adequate sanitation	25·6 (18·3 to 34·5)	41·7 (34·7 to 48·8)	59·7 (45·1 to 71·4)	80·5 (58·9 to 92·8)	1·0 (1·0 to 1·0)	58·4%	3·20 (2·67 to 3·72)
Composite prevention index	58·8 (54·6 to 63·0)	71·5 (69·3 to 74·0)	81·5 (78·5 to 84·4)	91·1 (87·4 to 93·8)	1·3 (1·0 to 1·6)	100%	..
Treatment indicators							
Institutional delivery	4·4 (3·7 to 5·2)	14·6 (13·4 to 16·1)	38·8 (34·6 to 43·6)	81·6 (75·0 to 86·8)	8·9 (8·0 to 9·4)	73·8%	6·76 (5·17 to 8·34)
Skilled birth attendance	8·8 (6·7 to 11·4)	20·8 (18·0 to 24·0)	41·9 (35·0 to 49·9)	76·1 (63·3 to 86·4)	6·4 (5·1 to 7·5)	25·1%	5·63 (4·45 to 6·82)
Oral rehydration therapy	75·6 (70·4 to 80·4)	82·1 (79·7 to 84·5)	87·0 (82·9 to 90·3)	92·0 (85·8 to 95·8)	0·5 (0·2 to 0·9)	99·9%	0·99 (0·84 to 1·15)
Care seeking for pneumonia	27·0 (20·2 to 34·0)	31·6 (27·4 to 36·2)	36·7 (28·4 to 45·7)	44·8 (27·3 to 63·9)	1·4 (–0·5 to 3·2)	0·0%	1·36 (0·44 to 2·27)
Composite treatment index	25·1 (21·1 to 29·9)	37·1 (34·0 to 40·5)	51·0 (44·0 to 57·9)	70·7 (58·1 to 81·5)	3·0 (2·0 to 3·8)	3·9%	..
Composite coverage index	50·1 (47·8 to 52·8)	60·7 (59·1 to 62·4)	70·4 (68·0 to 72·9)	81·9 (78·1 to 85·2)	1·4 (1·2 to 1·7)	90·0%	..

WHO's universal health coverage target is to have at least 80% health-services coverage by 2030 for the entire population of the country, irrespective of economic status, gender, or place of residence. Predicted coverage of all indicators were estimated from Bayesian models. Quintile specific values (pp 8–12), the observed coverage of health services during 1993–2014 (pp 13–14), and predicted coverage of health services nationally and by wealth quintiles during 1995–2030 (pp 18–27) are presented in the appendix. DPT3=three doses of diphtheria, pertussis, and tetanus vaccine. Polio3=three doses of polio vaccine.

Table 2: Health-service coverage 1995–2030, and probability of achieving the target of 80% coverage in Bangladesh by 2030

Results

12 nationwide population-based surveys of 276 608 households were included in our study to estimate health-service coverage. Figure 1 shows the trend in UHC composite indices from 1993, and projection to 2030. Overall, we projected that prevention coverage both at the national level and across wealth quintiles will meet targets by 2020 if current trends continue (figure 1). Overall, treatment coverage is increasing but was projected to fail to meet the target, with only the richest quintile on track to meet the target (figure 1). The composite coverage index was projected to be more than 80% by 2030 at the national level and among the three wealthiest quintiles but not among the two poorest quintiles (appendix p 8).

Among prevention indicators, national coverage of four childhood vaccinations (ie, the BCG, DPT3, polio, and measles) and access to improved water had already reached the target by 2015 (table 2). Even though coverage of at least four antenatal care visits and postnatal checkups are increasing with a high annual rate of change (more than 6% per year), these indicators were not projected to meet the target by 2030 if present trends continue (table 2). The target achievement probability for at least four

antenatal care visits was 0% (table 2), suggesting that there is zero probability of achieving at least 80% coverage of at least four antenatal care visits by 2030. The proportion of non-overweight women was projected to decrease from 75·9% (95% CrI 71·2–79·9) in 2015, to 28·8% (18·7 to 40·8) by 2030, but the proportion of non-tobacco users was projected to achieve the target before 2030 (table 2). Of the four treatment indicators, coverage of oral rehydration therapy only was projected to meet the target by 2030 with a high (ie, ≥90%) probability (table 2). The proportion of care seeking for treatment of pneumonia was projected to increase to 44·8% (95% CrI 27·3–63·9), the lowest proportion of the treatment indicators (table 2). The coverage of institutional delivery was projected to increase from 38·8% (95% CrI 34·6–43·6) in 2015, to 81·6% (75·0–86·8) in 2030 at the national level (table 2), but some quintiles will not achieve the target (appendix p 12). Coverage of treatment for non-communicable diseases was quite low in Bangladesh: only 38% of patients with diabetes and 42% of patients with hypertension received treatment in 2011 (appendix p 17).

Sensitivity analysis of health-service indicators produced similar results for all but a few indicators (appendix

p 4). In these analyses, coverage of at least four antenatal care visits was projected to increase to only 48·0% (CrI 31·0–65·6) by 2030 if the trends from 2000 and later continue, whereas the estimated coverages of adequate sanitation, skilled birth attendance, and care seeking for pneumonia treatment were higher than those in the standard analysis (appendix p 4).

By 2030, the predicted coverage of postnatal checkups, institutional delivery, and skilled birth attendance among the richest quintile was projected to be more than the 80% target; coverage of such health services was projected to be much lower than the target among the poorest quintile (appendix pp 9–12). Coverage of child vaccinations, oral rehydration therapy, access to improved water, proportion of non-tobacco users, and family planning satisfaction will be above 80% by 2030 across all the quintiles, but coverage of exclusive breastfeeding, non-overweight, and care seeking for treatment of pneumonia will be far from the target among all wealth quintiles (appendix pp 9–12).

The results of inequality analyses for health-service coverage across different years are in the appendix (p 16). The concentration index suggested that most included health services were more concentrated among the wealthier than among the poorer households, whereas exclusive breastfeeding and non-overweight were more concentrated among the poor households (figure 2). The least equitable indicators were four antenatal visits, post-natal checkups, institutional delivery, skilled birth attendance, and access to adequate sanitation (figure 2). The relative index of inequality suggested that women in the richest group were about six times more likely to have four antenatal visits, institutional delivery, deliver babies with the assistance of a skilled birth attendant, and receive a postnatal checkup than were their counterparts in the poorest group in 2014 (table 1). The wealthiest households had 3·2 times higher access to adequate sanitation than did the poorest households (table 1). Treatment of diabetes and hypertension was also more concentrated among the wealthiest than the poorest groups (appendix p 17).

Expenditure data from 49 606 households from seven nationwide population-based surveys showed that the incidence of catastrophic health expenditure and impoverishment as a result of OOP health expenditure increased over time, and was projected to continue to increase (table 3). About 23% of households were projected to incur financial hardship due to OOP by 2030 (table 3). Bangladesh will not achieve the target of financial protection from catastrophic payment or impoverishment, or both, by 2030.

If post-2000 trends continue, around 12% of the poorest and 29% of the richest households were projected to incur financial catastrophe by 2030 (table 4). The concentration curves for each year are below the line of equality, suggesting that the wealthiest households were facing disproportionately more financial catastrophe compared with the poorest households (figure 3).
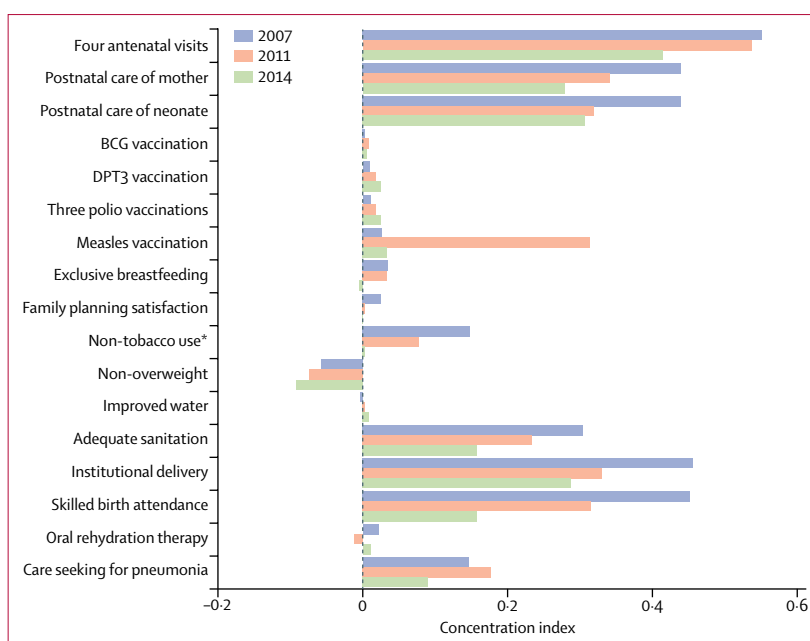
Figure 2: **Concentration index for the coverage of preventive and treatment services in 2007, 2011, and 2014**
Concentration indices with 95% CIs for all included indicators are in the appendix (p 16). DPT3=three doses of diphtheria, pertussis, and tetanus immunisation. *The concentration index for non-tobacco use is presented for the year 2012 instead of 2011.

	Catastrophic health expenditure (95% credible interval)	Impoverishment (95% credible interval)	Financial hardship (95% credible interval)
1991	4·2% (3·7 to 4·8)*	1·8% (1·5 to 2·2)*	5·5% (4·9 to 6·1)*
1995	3·6% (3·2 to 4·0)*	1·5% (1·3 to 1·8)*	4·7% (4·2 to 5·2)*
2000	14·8% (11·0 to 19·2)	2·2% (1·2 to 3·6)	15·7% (13·3 to 17·8)
2005	15·4% (13·3 to 18·0)	2·6% (1·9 to 3·6)	16·7% (15·2 to 18·4)
2010	16·2% (13·3 to 19·3)	3·3% (2·1 to 4·8)	17·8% (16·1 to 19·7)
2015	17·0% (12·4 to 22·8)	4·2% (2·0 to 7·9)	18·9% (16·4 to 22·5)
2020	17·9% (11·1 to 26·9)	5·4% (1·8 to 13·0)	20·1% (16·4 to 26·0)
2030	20·0% (8·8 to 36·3)	9·4% (1·3 to 32·3)	22·8% (16·3 to 34·8)
Annual rate of change 2000–30	0·82% (–2·6 to 3·7)	4·0% (–2·9 to 10·6)	1·2% (–0·1 to 3·0)
Probability of reaching target†	0·6%	29·4%	0·1%

Catastrophic health expenditure was calculated on the basis of the 10% threshold of household total consumption. Predicted incidences of all the indicators were estimated from Bayesian models unless mentioned. Observed incidences of catastrophic health expenditure (based on different thresholds) and impoverishment are presented in the appendix (p 28). *Observed estimates from survey data; numbers in parentheses are 95% CIs. †Target is 95% protection by 2030 (the universal health coverage target is 100%, but by design, the logit-transformation model does not predict 100%).

Table 3: **Incidence of catastrophic health expenditure and impoverishment in Bangladesh, 1991–2030**

Discussion

In this study, we estimated trends, projections, and the probability of target achievement for each of the included UHC indicators by 2030. Of the 17 included health-service indicators, targets for national coverage of child vaccinations and access to improved water have already been met. Three other health-service indicators—oral rehydration therapy, family planning, and non-use of tobacco—are on track to meet the UHC target by 2030,

	Catastrophic health expenditure (95% credible interval)		Inequality in catastrophic health expenditure	
	Poorest quintile	Richest quintile	Relative index of inequality (95% CI)	Concentration index (95% CI)
1991	3·1 (2·1 to 4·1)*	5·2 (3·9 to 6·5)*	1·6 (1·0 to 2·3)	0·29 (0·22 to 0·37)
1995	2·3 (1·5 to 3·1)*	4·9 (3·8 to 6·0)*	1·7 (1·2 to 2·3)	0·11 (0·04 to 0·18)
2000	8·6 (7·7 to 9·6)	22·4 (20·5 to 24·9)	3·9 (3·0 to 4·9)	0·22 (0·19 to 0·27)
2005	9·1 (8·3 to 9·9)	23·5 (21·6 to 25·4)	0·8 (0·7 to 0·9)	−0·05 (−0·07 to −0·02)
2010	9·6 (8·7 to 10·5)	24·6 (22·7 to 26·6)	2·5 (1·9 to 3·0)	0·15 (0·12 to 0·18)
2015	10·1 (9·0 to 11·3)	25·7 (23·3 to 28·2)	..	..
2020	10·7 (9·2 to 12·3)	26·9 (23·6 to 30·1)	..	..
2030	12·0 (9·3 to 14·8)	29·4 (24·3 to 34·7)	..	..

Catastrophic health expenditure was calculated on the basis of the 10% threshold of total consumption. Predicted incidences of all the indicators were estimated from Bayesian models, unless mentioned. The probability of meeting the target of 95% protection from catastrophic health expenditure by 2030 is 0% in both the richest and the poorest quintile. *Observed estimates from survey data; numbers in parentheses are 95% CIs.

Table 4: Inequality in catastrophic health expenditure in Bangladesh, 1991–2030
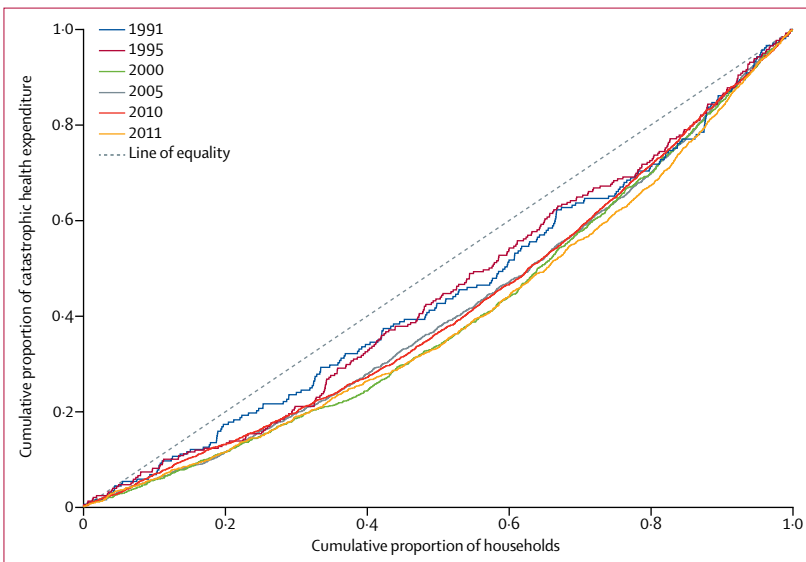
Figure 3: Concentration curves for the proportion of households experiencing catastrophic health expenditure in Bangladesh, 1991–2010
Catastrophic health expenditure was calculated on the basis of a 10% threshold of household total consumption.

whereas indicators related to maternal pregnancy care, pneumonia treatment, nutrition, and sanitation were projected not to achieve the target. Although overall prevention coverage was projected to reach the target by 2030, the progress of overall treatment coverage is slow and will be far below the 80% coverage target by 2030, especially among the poorest quintile.

Bangladesh has made impressive gains in the coverage of maternal health interventions, including antenatal care, institutional delivery, skilled birth attendance, and postnatal checkups at the national level, but progress was still projected to be insufficient to achieve the target of 80% coverage for all people by 2030. The pluralistic health system,[25] community-based approaches,[26] establishment of community clinics, and implementation of sector-wide approaches might have helped to improve coverage of reproductive, maternal, and child health interventions, and especially of child vaccination, during the past two decades.[27] Additionally, with the help of donor agencies, the Government of Bangladesh has been implementing a demand-side financing scheme since 2007, which includes free antenatal care, delivery care, postnatal checkups, and treatment of pregnancy complications (including caesarean delivery), and covers costs for laboratory tests and transportation to the health facility from home.[28] Despite these reforms, the coverage of these interventions still unequally favours rich people, and these socioeconomic disparities are likely to continue in the future. Even though public health facilities are accessible to everyone, lack of awareness, unavailability of specific services, and high OOP payment related to health care could be the main barriers to improvement of access to maternal health services among disadvantaged populations in Bangladesh.[29]

Bangladesh has made significant progress in the coverage of child vaccinations. Our projections suggest that national and quintile-specific coverage of child vaccinations increased rapidly over the past decades, especially after the nationwide implementation of the Expanded Programme on Immunization. If trends continue, Bangladesh will achieve UHC immunisation targets by 2030. For the management of childhood illnesses, coverage of oral rehydration therapy both nationally and across all wealth quintiles was projected to meet the target with high probability. However, care seeking for pneumonia treatment was projected to fall far short of the target by 2030, and the poorest households were projected to have a much lower chance of receiving care for pneumonia than the richest households. Although exclusive breastfeeding has been identified as a key intervention to improve infant and maternal health[30] and is a recognised health inequality reduction strategy,[31] the coverage of exclusive breastfeeding is low in Bangladesh and was projected not to meet the 80% target. This low level of exclusive breastfeeding could be a result of increasing participation of women in the formal and non-formal employment sectors, inadequate maternal leave, maternal undernutrition, increasing caesarean deliveries, lack of awareness among mothers, and rapid urbanisation.[32,33] The national health policy of Bangladesh should be strengthened to increase the coverage of child health indicators and to reduce inequality in access to care, especially access to pneumonia treatment.

In SDG3, prevention and promotion of non-communicable disease are recognised as imporatant.[1] Many studies[34,35] have shown that the burden of non-communicable diseases could be prevented by decreasing the prevalence of tobacco smoking, high body-mass index, and indoor use of solid fuel. We noted an increasing trend in overweight among Bangladeshi adults, which will increase the burden of non-communicable diseases,

despite projected decreases in the proportion of tobacco users.[36] We showed that roughly half of people with hypertension and diabetes in Bangladesh were not taking appropriate medication. This poor treatment coverage might be because of high treatment costs. Another study[37] showed that about 12% of households that included someone with hypertension or diabetes implemented distress financing to cope with treatment costs. Another study[38] in Bangladesh showed that about 5% of households were pushed into poverty because of the high cost of treatment for non-communicable diseases and chronic diseases. A rising burden of high treatment costs will also increase national health expenditure and put a substantial burden on the health system unless the Bangladeshi Government can incorporate an effective strategy to protect households from such high-cost diseases.[39] Funding a cap on the maximum amount of OOP expenditure per individual based on income is a potential strategy. Additionally, welfare programmes and subsidy systems could be incorporated for selected high-cost diseases (eg, cancer).

We projected an upward trend in financial risk indicators, including catastrophic payment and impoverishment. By 2030, more than 9% of non-poor households will become poor as a result of OOP payment for health care in Bangladesh. We also found that rich households are facing more financial catastrophe than poor households, and that this scenario is likely to continue. Poor people have lower coverage of all health services than rich people, which might be because of an inability to pay, and as a result financial risk is also low. Another reason for this counterintuitive finding is that poor people use public facilities, whereas rich people often use private facilities, which increases health expenditure.[40] This high burden (across wealth strata) could also be due to the lack of formal risk pooling mechanisms in the health financing system,[41] low government spending on health,[42] and ineffective subsidy programmes in public health facilities in Bangladesh.[43] Even though basic medicines are available for free in public facilities, patients often need to buy other medicines from pharmacies, and also need to purchase diagnostic tests from private facilities and make other unofficial payments.[44]

In resource-limited countries such as Bangladesh, where public health expenditure is less than 3% of the gross domestic product and has remained almost stagnant in the past few years,[45] governments should increase spending on health at a minimum rate of 0·3% of gross domestic product per year to reduce inequalities in health outcomes and avoid financial burdens related to health-care costs.[46] The Government of Bangladesh developed a 20-year strategy in 2012 to reduce the level of financial risk from health-care payments to achieve UHC. However, the effect of this plan on UHC is unclear.[10] In 2016, a pilot social health scheme, *Shasthyo Shurokhsha Karmasuchi*, has been implemented in three subdistricts of Dhaka division for populations

below the poverty line. Each household receives one health card. The benefits package is restricted to free treatment and medicines for only 50 diseases, and covers up to a maximum of 50 000 Bangladeshi Taka per health card per year, irrespective of the number of household members. The health financing strategy also includes a social health protection scheme to cover both the formal and informal sectors through mandatory social protection schemes and tax-based financing. However, this scheme could be quite a challenge, because a large proportion of the population is engaged in the informal sector, and their inclusion in the tax system will be difficult.

According to a study[45] published in 2017, per-person health expenditure in Bangladesh is expected to increase from US$92 in 2014, to $173 by 2030. The proportion of total health expenditure that OOP payments account for is expected to remain stagnant between 2014 to 2030 (65·6% to 65·3%),[45] although the aim of the health financing strategy was to halve the proportion of total health expenditure that OOP payments comprise (from 63·3% in 2012) within 20 years through raising funds from taxation and donor contributions.[47,48] This goal might be challenging to achieve unless the Bangladeshi Government prioritises health in budget allocations. Some Asian countries—eg, Japan, Thailand, Vietnam—increased and maintained their budget allocation for health and introduced health insurance schemes to achieve UHC.[49] Thailand introduced a tax-financed universal coverage scheme for uninsured people in 2002, and this scheme reduced the level of financial hardship.[50] To move towards UHC targets for financial risk protection, the Government of Bangladesh could adopt the strategies of other developing countries, including Vietnam and Thailand.[49] Of course, health financing alone is not sufficient to achieve Bangladesh's health goals, because social determinants of health also have a large effect on the prevalence of disease, especially non-communicable diseases. Although non-communicable diseases were identified as major public health problems in the Health, Population and Nutrition Sector Development Programme (HPNSDP), the implementation of programmes related to prevention of these diseases has been insufficient, and skilled human resources to address them are lacking. The Bangladeshi Government could prioritise prevention programmes for non-communicable diseases by strengthening the capacity of human resources and health facilities to provide prevention and risk reduction services and promoting key interventions, such as reduction of salt intake and adoption of health lifestyles.[51] The effects of social determinants of health are a growing problem associated with the epidemiological transition, and all countries heading to UHC should consider the essential role of social determinants in health.

Our study had several strengths. First, our study provided reliable estimates of trends in the indicators along with the corresponding rate of change in different

periods. Second, because we used a Bayesian regression model to generate credible intervals of projected estimates of future coverage, we could use these credible intervals to estimate target achievement probabilities for each indicator, which would have been impossible with a standard regression model.[24] Third, we included WHO-recommended indicators, which were based on available data. Fourth, we used a large amount of high-quality population-based household health and expenditure survey data to estimate trends and projections of UHC indicators, and provided disaggregated estimates for different socioeconomic groups. Finally, the study provided an overview of the progress of Bangladesh towards UHC and will help policy makers to reform policies for indicators with the least coverage and to increase coverage among marginalised and hard-to-reach populations.

Our study also had some limitations. We could not make a projection of control of diabetes and hypertension because of scarce datapoints. We also had fewer data points for some indicators—eg, non-tobacco use, postnatal care of mothers and neonates—which resulted in wide credible intervals for projection of those indicators. Wide credible intervals are normal for projections outside the available data range, and they still enable calculation of realistic probability estimates. All our models were based on current trends and on the assumption that future policy will not change, which might be too strict. However, we aimed to estimate the projected coverage on the basis of recent trends, so that policy makers can develop appropriate policy, and thus the assumption of unchanging policy was important to the study goals.

Overall, coverage of health services is increasing in Bangladesh, but insufficient progress in antenatal, delivery, and postnatal care, and care seeking for pneumonia, coupled with an increased prevalence of overweight and persistent wealth-based inequality will impede progress towards UHC. The country needs to develop stable and effective policies to implement cost-effective interventions to minimise the coverage gap and reduce inequalities in health services. Adequate supplies of drugs for non-communicable diseases, increased human resources for health, improved quality of care, and the establishment of more community clinics and other public health facilities in rural areas could help marginalised people to access health services. Strengthening of the health financing system, increasing public funding for health care, and incorporation of risk pooling mechanisms are necessary for Bangladesh to achieve UHC by 2030.

Contributors
MSR, MMR, SG, and KS conceived the study. MSR did the statistical analysis in consultation with MMR and SG. MSR and KTS managed health expenditure data. MSR wrote the first draft. MMR and SG checked the consistency of the analysis results and data interpretation. MMR, SG, SKA, and KS critically revised the Article for important intellectual content. All authors have reviewed and approved the final draft.

Declaration of interests
We declare no competing interests.

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