Funding and services needed to achieve universal health coverage: Applications of global, regional, and national estimates of utilisation of outpatient visits and inpatient admissions from 1990 to 2016, and unit costs from 1995 to 2016

Mark Moses, MHS, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Ave, Suite 600, Seattle WA 98121

Paola Pedroza, MPH, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Ave, Suite 600, Seattle WA 98121

Ranju Baral, PhD, PATH, 2201 Westlake Ave, Seattle, WA 98121

Sabina Bloom, BA, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Ave, Suite 600, Seattle WA 98121

Jonathan Brown, MAIS, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Ave, Suite 600, Seattle WA 98121

Abby Chapin, BA, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Ave, Suite 600, Seattle WA 98121

Kelly Compton, BS, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Ave, Suite 600, Seattle WA 98121

Erika Eldrenkamp, BA, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Ave, Suite 600, Seattle WA 98121

Nancy Fullman, MPH, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Ave, Suite 600, Seattle WA 98121

John Everett Mumford, BA, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Ave, Suite 600, Seattle WA 98121

Vishnu Nandakumar, BS, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Ave, Suite 600, Seattle WA 98121

Katherine Rosettie, MPH, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Ave, Suite 600, Seattle WA 98121

Nafis Sadat, MA, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Ave, Suite 600, Seattle WA 98121

Tom Shonka, BA, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Ave, Suite 600, Seattle WA 98121

Abraham Flaxman, PhD, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Ave, Suite 600, Seattle WA 98121

Theo Vos, PhD, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Ave, Suite 600, Seattle WA 98121

Chris JL Murray, DPhil, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Ave, Suite 600, Seattle WA 98121

Marcia R Weaver, PhD, Institute for Health Metrics and Evaluation, University of Washington, 2301 Fifth Ave, Suite 600, Seattle WA 98121
mweaver@uw.edu
office phone: 206-897-2861
mobile phone: 206-708-0773

Word count = 4916

Summary

Background: To inform plans to achieve Universal Health Coverage (UHC), we estimated utilisation and unit cost of outpatient visits and inpatient admissions, conducted a decomposition analysis of utilisation, and estimated additional services and funds needed to meet a UHC standard for utilisation.

Methods: We collated 1175 country-years of outpatient, and 2068 of inpatient data on utilisation. We performed metaregression analyses of annual visits and admissions per capita by sex, age, location, and year. We decomposed changes in total number of services from 1990 to 2016. We used data from 795 National Health Accounts to estimate shares of outpatient and inpatient services in total health expenditure by location and year and estimated unit costs as expenditure divided by utilisation. We identified standards of utilisation per disability-adjusted-life-year and estimated additional services and funds needed.

Findings: In 2016, the global age-standardised outpatient utilisation rate was 5·42 (95% uncertainty interval [UI] 4·88—5·99) visits per capita, and inpatient utilisation rate was 0·10 (95%UI 0·09—0·11) admissions. Globally, 39·29 (95%UI 35·37—43·58) billion visits, and 0·71 (95%UI 0·65—0·77) billion admissions were provided in 2016; 58·65% and 67·96% increases, respectively, since 1990. Population growth accounted for 42·95% increase in visits over 27 years, population ageing for 8·09%, and higher utilisation rates for 7·63%; results for admissions were 44·33%, 9·99%, and 13·5%, respectively. 2016 Unit cost estimates ranged from 2017 international $2 to I$478 for visits or 2017 United States $1 to US$537, and I$87 to I$22 543 for admissions or US$2 to US$22 543. Annual cost of 8·2 billion additional visits (95%UI 6·24-9·95) and 0·28 billion (95%UI 0·25-0·30) admissions in low and lower-middle income countries in 2016 was I$503 billion (95%UI I$404—I$606) or US$158 billion (95%UI US$127—US$190).

Interpretation: UHC plans can be based on utilisation and unit costs of current health systems.

Funding
Bill & Melinda Gates Foundation

Word count = 299

Research in context

Evidence before this study

Prospects of expanding access to quality essential health services are improving, as the World Health Organization seeks to expand health coverage to one billion people by 2023, and countries prepare to meet this target of the Sustainable Development Goals by 2030. Researchers have made progress towards measuring Universal Health Coverage (UHC), but far less is known about the utilisation and unit cost of services of health systems that will expand coverage. Utilisation of outpatient visits and inpatient admissions has not been estimated globally, and global estimates of unit costs are ten years old.

Generating a time-series of utilisation and updating unit cost estimates were needed for two reasons. Utilisation estimates could describe how the volume of visits and admissions changed in response to changes in population size, age structure, and health policies that affected utilisation rates. These dynamics of health systems have never been reported globally. We also quantified the volume of services needed to expand access for a given population, and the costs to supply those services. Other researchers have used different methods to estimate the cost of UHC for selected countries, but not globally. No one has quantified the additional services needed.

Added value of this study

For the first time, health researchers and advocates can describe health systems by utilisation, in addition to inputs such as number of health professionals, and outcomes such as the global burden of disease (GBD). Building on the strengths of GBD methods that account for age, sex, spatial, and temporal patterns in health outcomes, and adjusting for differences across heterogeneous data sources, we produced estimates of utilisation per person for visits and admissions by age, and sex for 195 countries from 1990 to 2016. We also decomposed changes in the volume of services over time into changes in population size, age and sex structure, and utilisation rates for every location.

We pioneered in estimating the share of Total Health Expenditure on each service using mutually exclusive and collectively exhaustive National Health Account data, and the cost per outpatient visit and per inpatient admission for 188 countries from 1995 to 2016. Our macro-costing approach reflected current expenditures and efficiency. We also created UHC standards of utilisation per disability-adjusted-life-year (DALY) based on existing health systems rather than ideals to estimate the additional services and funding needed annually to expand health coverage in 2016 for 188 countries.

Implications of all the available evidence

The decomposition analysis showed both encouraging and cautionary evidence about the dynamics of health systems. In countries such as China, Indonesia, Thailand, and Turkey, the analysis showed the effects of policies to expand coverage on utilisation rates. In several

countries in the sub-Saharan Africa super-regions, most of the change in volume of services has been from population growth rather than changes in utilisation rates. The volume of services increased just to keep pace with population growth among countries with low scores on the GBD's UHC Index of personal health services.

The cost estimates for a UHC standard for utilisation of personal health services complemented earlier estimates by producing estimates in the context of each country's current health system. Three research groups estimated the cost of UHC with different methods and groups of countries. Our global estimates made it possible to show that the estimates were similar for the same groups of countries. We provided the first evidence on the additional services needed to meet a UHC standard for utilisation represented by the Netherlands. Although both primary and specialty services were essential, the gap in services was larger for admissions than for visits. We also identified Portugal as an intermediate UHC standard for utilisation with a smaller increase in admissions.

Background

Universal health coverage (UHC) is a global priority. It is one of three strategic priorities of the World Health Organization's General Programme of Work for 2019-2023.[1] It is also target 3.8 of the Sustainable Development Goals aimed at achieving "financial risk protection, access to quality essential health-care services, and access to safe, effective, quality and affordable essential medicines and vaccines for all."[2] Meeting the target will require improvements in population-level interventions, and personal health services to promote health and provide preventive and curative care.[3] Indicator 3.8.1 on coverage of essential health services, and 3.8.2 on financial risk protection will monitor progress towards the target. Researchers have proposed indices of essential health service coverage.[4,5] The Global Burden of Disease (GBD) 2016 Sustainable Development Goal collaborators calculated a UHC index of personal health services with 41 items, including coverage of nine tracer interventions and mortality from 32 causes that are amenable to care.[4] The items represented essential services such as reproductive, maternal, newborn, and child health care, and access to care for infectious diseases, non-communicable diseases, and injuries. More research is needed however, on utilisation and unit costs of personal health services in the health systems that will expand coverage over the next 12 years.

Although previous researchers have reported on utilisation for multiple countries, none reported on all countries over time. The Organisation of Economic Cooperation and Development (OECD) reports the annual number of outpatient visits per person and inpatient discharges for 35 member countries (with the exception of inpatient admissions for Canada and the United States), and five non-member countries for selected years.[6] The probabilities of having general practitioner and specialist doctor visits in the past year were estimated for 18 OECD countries using the European Health Interview Survey or the most recent national health survey.[7] The number of outpatient visits in the past four weeks and inpatient admissions in the past year were estimated for 39 countries outside of OECD using World Health Survey data.[8] Systematic estimates have not been reported for more than half of countries globally, most of which have low scores on the UHC indices.

The World Health Organization's Choosing Interventions that are Cost-Effective (WHO-CHOICE) researchers estimated unit costs of outpatient visits and inpatient bed-days for 191 countries in 2007 and 2008 based on facility-level data from 30 countries.[9] Although the WHO-CHOICE estimates were standardised to reflect health systems performing at high levels of efficiency, they have been used extensively in cost-effectiveness analyses when more exact micro-costing estimates were neither practical nor appropriate.[10,11] The estimates are due for an update, based on nationally representative samples, and bounded by a national health expenditure envelope.

The aim of the study was to support progress towards UHC. The objectives were to produce global estimates of outpatient visits and inpatient admissions by age and sex for 27 years and unit costs for these services for 22 years, and to demonstrate two applications of the estimates to inform expansion of coverage of essential personal health services. We decomposed changes in volume of services by location from 1990 to 2016 into changes in utilisation rates, population size, and age and sex structure of the population to show the role of each factor in every country over time. We estimated the services and funding needed to expand utilisation for the 2016 population size and structure to meet a UHC standard for utilisation per disability-adjusted-life-year (DALY) using counterfactual DALY estimates from GBD 2016.

Methods

Definition of utilisation

We defined outpatient utilisation rate as the annual number of visits per capita to a health facility that did not result in admission, and inpatient utilisation rate as the annual number of admissions per capita for one night or more into a health facility. We included preventive, rehabilitative, and curative care, and adhered as closely as possible to the International Classification for Health Accounts' categories for Health-Care Functions (denoted as HC) so that the utilisation rate would be consistent with expenditure data based on the System of Health Accounts 2011.[12] For outpatient visits, our definition mapped to four categories: outpatient curative and rehabilitative care (HC 1.3 and HC 2.3, respectively), facility-based preventive maternal and child care (HC 6.4), and vaccinations (HC 6.2). For inpatient admissions, our definition mapped to two categories: inpatient curative and rehabilitative care (HC 1.1 and HC 2.1, respectively). Our estimates excluded day-patient admissions (HC 1.2 and HC 2.2), and long-term care (HC 3), because data on their utilisation and expenditures were not available globally.

Data sources for utilisation estimates

We compiled data sources from a systematic review of surveys and administrative data within the Global Health Data Exchange.[13] All data sources were nationally or subnationally representative. In compliance with the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER),[14] we documented the methods of the systematic review, data sources for each country, data processing, and estimation (appendix, p 6).

We compiled outpatient utilisation data from 130 countries, spanning 1175 country-years, and inpatient data from 128 unique countries, spanning 2068 country-years (appendix, p11).

Administrative sources contributed 59·1% of outpatient country-years and 80·3% of inpatient country-years. More data were available from administrative records in High Income and in Central Europe, Eastern Europe, and Central Asia due to their well-established reporting systems. More than half of the data sources were surveys for the other super-regions, except for inpatient data for North Africa and the Middle East.

Methods for utilisation estimates

The unit of analysis was average utilisation by sex and age categories, where the 23 age categories were: early neonatal (0-6 days), neonatal (7-27 days), infants (28-364 days), 1-4 years, five-year intervals from 5-9 to 90-94, and 95+ years. We estimated the age-sex specific rates of utilisation for visits and admissions with DisMod-MR, version 2.1. DisMod-MR is a Bayesian hierarchal metaregression method and an established method to estimate age-sex specific incidence and prevalence rates of diseases by location.[15,16]

Measures of utilisation and recall periods were not consistent across surveys (appendix, p19), and we used two methods to adjust for inconsistencies. When inconsistencies across data sources did not differ by age category, we included dichotomous covariates in the Dismod-MR models. The reference category was annually reported, administrative records from either national sources or facility-level health information system data. For the outpatient utilisation model, we created four covariates for recall periods, and two for inconsistent phrasing of the utilisation questions. For the inpatient utilisation model, we created two covariates for survey series such as the World Health Survey. When inconsistencies differed by age category such as one-year recall of inpatient admissions, we used age-spline regressions to adjust for the differences before estimating the DisMod-MR models (appendix, pages 23-27).

Additional covariates were the Socio-demographic index in the outpatient model, and hospital beds per 1000 population in the inpatient model. The rationale for including each covariate, their definition, and estimated coefficients were reported in the appendix, pages 28-29. To account for geographic variation, we used random effects to nest GBD super-regions, regions and countries (appendix, pages 13-18).

Decomposition of changes in utilisation

The total volume of outpatient visits and inpatient admissions was calculated by multiplying age-sex specific utilisation rates for each location by the population for each category sourced from GBD 2016 national estimates.[17] Age-sex specific utilisation rates by GBD super-region are in appendix, pages 34-36. We decomposed changes in total volume of services from 1990 to

2016 into changes in four factors: utilisation rates by age and sex, population growth, population ageing, and sex composition. Decomposition of these factors followed the method in Das Gupta[18] to estimate the average marginal effect of changing one factor across all combinations of changes in the other factors.

Unit cost estimates

We estimated unit costs as expenditure per capita on each service divided by utilisation per capita. Expenditure per capita was the product of total health expenditures (THE) per capita in 2017 international dollars, and the share of outpatient services in THE for visits or share of inpatient services for admissions. THE estimates from 1995 to 2015,[19] and projections for 2016[20] were available for 188 countries. The shares were estimated with 795 country-years of National Health Accounts data, which provided a mutually exclusive and collectively exhaustive account of the flow of THE through a health system (appendix, pages 53-54). The sample represented 108 of 188 (57%) countries, but fewer than half of the countries in three super-regions: Southeast Asia, East Asia, and Oceania, Latin America and Caribbean, and North Africa and the Middle East. Outpatient spending was estimated as the share of outpatient curative and rehabilitative care (HC 1.3 and HC 2.3, respectively), and inpatient as the share of inpatient curative and rehabilitative care (HC 1.1 and 2.1, respectively).

Cost estimates to meet a UHC standard for utilisation

We estimated the additional services and funds needed to meet a UHC standard for utilisation. The metric for the units of service was the 2016 volume of services per DALY, using a counterfactual estimate of DALY from GBD 2016. A country's burden of disease was endogenous to health service utilisation, because improved access and quality of services reduced the burden. We standardised the burden of disease across countries by removing the effects of access and quality of services using age-specific estimates of the GBD 2016 Health Access and Quality (HAQ) index.[21] We regressed 2016 DALYs for each age and sex category on the Socio-demographic index and HAQ index; counterfactual DALYs were predicted with the HAQ index set to zero (appendix, pages 63-64).

Our UHC standard for utilisation, services per counterfactual DALY, was based on an existing health system. For each country, we calculated the additional units of service needed, and multiplied the total by their unit cost. Units of service needed for each age and sex category was the difference between the standard and the country's 2016 volume per counterfactual DALY, and multiplied by those DALYs to get an estimate in units of services.

To identify the standard, we calculated the global cost to reach the UHC standard for utilisation using each country as the standard (see 188 global estimates on appendix, p 66). Six countries formed a frontier with high value on the GBD 2016 UHC index and lowest global cost for their value. We selected the Netherlands, ranked ninth on the UHC index, and in the middle of the frontier as the UHC standard for the main analysis, and conducted a sensitivity analysis with Portugal, ranked 34th on the UHC index as an intermediate UHC standard. The aggregate ratio of total volume to counterfactual DALYs was 7·25 for visits and 0·17 for admissions for the Netherlands (age-sex specific ratios on appendix, pages 69-70), and 7·01 and 0·14, respectively, for Portugal.

Health systems differed in the quality and type of services they provided, as well as volume of services. We estimated that the unit costs in the Netherlands were 28% higher for visits than predicted by cost-of-living differences in gross domestic product per capita, and 24% higher for admissions (appendix, p 81). We conducted a sensitivity analysis with unit costs increased by these percentages as a measure of improvements.

Uncertainty

We captured and propagated uncertainty in the analysis, including all three steps of the utilisation estimates: sampling uncertainty from extracted data, uncertainty from adjustments to inconsistently reported data, and uncertainty estimated as part of DisMod-MR. For all reported estimates, we took 1000 draws from the posterior distributions. The mean of the 1000 draws was the point estimate and the 2·5th and 97·5th percentile of the draws were the uncertainty interval. Applications using modelled outputs were done at the draw level.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had complete access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

Global, regional, and national utilisation rates

The global age-standardised utilisation rates were 5·42 outpatient visits (95% uncertainty interval: 4·88—5·99), and 0·10 (95%UI 0·09—0·11) inpatient admissions per capita in 2016. The age-standardised utilisation rate for outpatient visits (Figure 1) was highest in the High-income

Asia-Pacific (15·46, 95%UI 14·02 –17·06), and Eastern European (10·29, 95%UI 9·78– 17·06) regions, and lowest in the Southern sub-Saharan Africa (3·53, 95%UI 3·03–4·08), and Caribbean (3·37, 95%UI 2·89–3·88). Taiwan had the highest outpatient utilisation rate (19·61, 95%UI 17·04–22·44), and Burkina Faso had the lowest (2·00, 95%UI 1·17–2·32). The age-standardised utilisation rates for inpatient admissions (Figure 2) was highest in the Eastern Europe (0·23, 95%UI 0·22–0·24), and Central Europe (0·18, 95%UI 0·17–0·20) regions, and lowest in Southeast Asia (0·03, 95%UI 0·02 – 0·04), and Eastern sub-Saharan Africa (0·05, 95%UI 0·05 – 0·06). Bulgaria had the highest inpatient utilisation rate (0·27, 95%UI 0·26 – 0·28), and Cambodia had the lowest (0·02, 95%UI 0·02 – 0·03).

Many countries were exceptions to the regional patterns, and the range of estimates within some regions was broad. In Western Europe where the age-standardised outpatient rate was 7·33 (95%UI 6·68–8·12), the rates were below the global average in Scandinavia, England, Greece, Netherlands, and Portugal. In Central Latin America where the outpatient rate was 4·6 (95%UI 3·99 – 5·27), the rates were above the global average in Colombia, Nicaragua, and Panama.

Decomposing changes in outpatient and inpatient volume from 1990 to 2016

From 1990 to 2016, outpatient volume increased from 24·80 (95%UI 21·81 – 28·17) to 39·35 (95%UI 35·38–43·58) billion visits globally. Of the 58·65% increase in visits, 42·95% was from population growth, 8·09% from population ageing, and 7·63% from increases in utilisation rates. (Small changes in the sex composition of the population account for the difference between the total change from 1990 to 2016 and the sum of three factors reported here.) Changes over time in the age-sex specific outpatient utilisation rates increased volume in six super-regions (Figure 3A), the exception being High Income. Inpatient volume increased from 0·42 (95%UI 0·38 – 0·47) to 0·71 (95%UI 0·65–0·77) billion admissions. Of the 67·96% increase in admissions, 44·33% was from population growth, 10·0% from population ageing, and 13·55% from increases in utilisation rates. Changes in inpatient utilisation rates decreased volume in five super-regions, the exceptions being Southeast Asia, East Asia, and Oceania, and North Africa and Middle East.

Increases in China's age-sex specific utilisation rates accounted for most of their sizable increase in volume of services from 1990 to 2016 (Figure 3E). The 114·41% increase in outpatient visits decomposed into a 69·13% increase from utilisation rates, 27·94% from population growth, and 17·26% from population ageing. The 497·00% increase in inpatient admissions decomposed into a 403·85% increase from utilisation rates, 59·80% from population growth, and 32·73% from population ageing. Increases in age-sex specific utilisation rates also

accounted for large increases in outpatient visits in Thailand (19·44% of a 63·85% increase) and inpatient admissions in Indonesia (62·35 % of a 141·01 % increase), and Turkey (202·22% of a 302·87% increase) (Figure 3F).

Central Europe, Eastern Europe, and Central Asia was the only super-region with a decrease, albeit small, in the volume of inpatient admissions (Figure 3C). In the Central Asia region, the 9·00% decrease in inpatient admissions decomposed into a 35·30% decrease from utilisation rates, offset by a 24·24% increase from population growth, and 2·00% increase from population ageing. In Eastern Europe, the 7·96% decrease in inpatient admissions decomposed into a 4·40% decrease from utilisation rates, and 4·44 % from population decline, offset by a 0·66% increase from population ageing.

Unit cost estimates

In 2016, the cost per outpatient visit ranged from 2017 international $2 (Burundi, Eritrea, Central African Republic) to I$478 (United States). (Table 1, United States dollar estimates are in appendix, pages 74-80). The cost per inpatient admission ranged from I$87 (Central African Republic) to I$22 543 (United States). Unit cost estimates generally followed patterns of THE per capita. Spearman rank correlation coefficients for THE per capita were 0·93 and 0·89 for outpatient and inpatient costs, respectively. Coefficients for share of expenditure were 0·39 and 0·67, and for utilisation per capita were 0·26 and 0·25.

We compared our unit cost estimates to the WHO-CHOICE estimates in 2008, the year of their most recent estimates. Our estimates were generally higher (Figure 4); cost per outpatient visit at any health facility was 103% higher on average than the WHO-CHOICE estimates for secondary hospitals, and cost per admission to any hospital was 3% higher on average than WHO-CHOICE estimates for teaching hospitals (appendix, p 55).

Cost estimates to meet a UHC standard for utilisation

Globally, 10·45 billion additional outpatient visits (95%UI 7·83—12·79) per year in 161 countries at a cost of 2017 I$362 billion (95%UI I$212—I$527) were needed in 2016 to meet the UHC standard for utilisation, and 0·35 billion additional inpatient admissions (95%UI 0·31—0·38) in 184 countries at a cost of I$816 billion (95%UI I$584—I$1056). Additional services in each country can be calculated with results in Tables 1, S10, and S11. Low income countries for I$47billion (95%UI I$37—I$56) (4%; [I$47 billion/I$1177 billion]) of the total additional cost for reaching the UHC standard, lower-middle for I$456 billion (95%UI I$366—I$551) (39%; [I$456 billion/I$1177 billion]), upper-middle for I$408 billion (95%UI I$314—I$500) (35%; [I$408

billion/I$1177 billion]), and high for I$266 billion (95%UI I$152—I$381) (23%; [I$266 billion/I$1177 billion]).

Four of 21 regions each accounted for ten percent or more of additional cost of reaching the UHC standard for utilisation: Southeast Asia (25·48%; [I$300.05 billion /I$1177.69 billion]), High Income North America (14·17%; [I$166.93 billion /I$1177.69 billion]), South Asia (12·34%; [I$145.30 billion /I$1177.69 billion]), and North Africa and the Middle East (10·01%; [I$119.28 billion /I$1177.69 billion]). Much of the additional cost in Southeast Asia was due to high unit costs and large gaps in admissions per DALY in Indonesia and the Philippines, as well as large populations. In South Asia it was due to the large gaps in utilisation per DALY and population in India, whereas in High Income North America it was due to high unit costs and large population in the United States. For North Africa and the Middle East, much of the additional cost was driven by Iran's large gap in inpatient utilisation, high inpatient costs, and large population. The share of High Income North America increased to 28·97% (I$166·71 billion/I$575·57 billion) in the United States dollar estimates (appendix, pages 74-80).

In sensitivity analysis, the additional cost to meet an intermediate UHC standard for utilisation was 63.3% (745.58 billion/1177.69 billion] of the full standard (appendix, pages 83-89). It was 25·2% (1474·8 billion/1177·69 billion) higher with higher unit costs to reflect the cost of improving the quality and types of services offered (appendix, pages 91-97).

Discussion

We reported the first global estimates of utilisation of outpatient visits and inpatient admissions, and unit costs for these services where the cost estimates were based on expenditures from the National Health Account. In our decompositions analysis, we highlighted examples of countries with substantial changes in utilisation rates, and showed results for countries where increased volume was driven by population growth. Using the population and age structure in 2016, we estimated the additional services and funds needed to meet a UHC standard for utilisation.

The decomposition analysis captured the effects of known trends in UHC, as well as other changes in health systems since 1990. China's increase in visits and admissions due to changes in utilisation rates was consistent with the expansion of insurance coverage to hospital services in 2003 and comprehensive care in 2008.[22] Similarly, the increase in admissions in Indonesia due to changes in utilisation rates was consistent with a social security law in 2004 that included national health coverage.[23] Although Indonesia's comprehensive health insurance

scheme was not finalised until 2014, coverage of inpatient services expanded for some populations beginning in 2003. The increase in visits in Thailand due to changes in the utilisation rates was consistent with their UHC Scheme that extended coverage in 2002 to the 30% of population who previously was uninsured.[24] The increase in services in Turkey reflected the additional primary health care teams and hospital beds from their Health Transformation Program.[25] Age-sex specific inpatient utilisation rates decreased in 21 of 29 countries in the Central Europe, Eastern Europe, and Central Asia super-region, reflecting the decline in hospital beds in Central Europe and Eastern Europe from 1990 to 2005.[26]

The unit cost results for 188 countries were higher than the upper range of the widely-referenced WHO-CHOICE estimates in 2008.[9] The WHO-CHOICE researchers estimated cost functions with available unit cost estimates from 30 countries, where the unit of analysis was a facility-year.[9] Our expenditure estimates included ancillary services such as diagnostic exams and medical supplies such as drugs provided during the visit or admission, consistent with the National Health Account categories,[12] whereas the WHO-CHOICE estimates excluded them. Our unit costs estimates used utilisation as the denominator and reflected current efficiency. The WHO-CHOICE researchers sought to compare interventions across WHO locations and countries at a standard level of efficiency where all facilities operated at the 80th percentile of measured capacity. In the absence of estimates of actual unit costs however, many researchers relied on the WHO-CHOICE estimates as if they represented actual health systems, and underestimated the cost of interventions in the majority of countries.[10,11] Health facilities in Kenya, Uganda, and Zambia operated at 40% of capacity or less.[27]

To our knowledge, only two other studies estimated comprehensive unit costs at the national level. Dieleman and colleagues reconciled the data from multiple sources with the United States' National Health Expenditure Account.[28] Their 2013 cost per visit was 2017 US$557 compared to our estimate of US$457 (95% UI: US$397-US$525), and per admission was US$18,626 compared to our estimate of US$21,000 (US$19,303-US$ 22,721). The Australian Independent Pricing Authority reported a 2016 cost per overnight admission of 2017 US$7429 compared to our estimate of US$8050 (95% UI: US$7310-US$8865).[29]

Our unit cost estimates were macro-costing estimates, which the second United States Panel on Cost-Effectiveness and Medicine (Panel) referred to as "gross costing."[30] Approaches to estimating unit costs ranged from our unit costs per visit and admission to micro-costing estimates that directly enumerate and cost every input, and neither approach is always more accurate or precise. The Panel recommended the macro-costing approach for some analyses, because of its "simplicity, practicality, and if data are obtained broadly, robustness to geographic, institutional, and other sources of variation." For example, a macro-costing

estimate may be appropriate for an intervention that changed the quantity of services,[10,11] or when its effect on the cost of services was known. Our macro-costing estimates were average costs, which would be the same as the marginal costs in stable health systems. Average costs may be less than marginal costs when initiating interventions or serving remote locations or populations. Researchers should consider the nature of the interventions, locations, and populations in their analyses and adjust the average costs as appropriate. Macro-costing estimates can be adjusted for specific diagnoses, using a country's weights for service intensity or other representative weights.[31]

The total cost of meeting a UHC standard for utilisation was 2017 I$1178 billion or 2017 US$576 billion and similar to previous UHC cost estimates for the same countries,[32,33] but our methods differed. Stenberg and colleagues estimated that progress towards UHC in 67 low-income and middle-income countries would cost 2017 US$287 billion per year by 2030, and I$391 billion for an ambitious scenario.[32] Our total cost for the same 67 countries was 2017 US$297 billion in 2016. They used benchmarks such as the numbers of facilities and laboratories per person, and human resource targets to estimate the cost of platforms, rather than the WHO-CHOICE unit costs, and added the commodity costs for 187 interventions. Jamison and colleagues estimated that a high priority package of interventions in 83 low income and lower-middle income countries would cost 2017 US$113 billion in 2015 and US$223 billion for essential UHC.[33] Our total cost for the same 83 countries was 2017US$158 billion in 2016. They produced unit cost estimates for 218 interventions, using the best unit cost estimates in the literature with adjustments for health professional salaries across countries. Both previous estimates included the cost of population and community platforms, which was 15%[32] and from 12·6 to 18·6%[33] of cost. Our estimates of the additional cost of personal health services did not include these platforms.

We reported the first estimate of the additional services needed to meet a UHC standard. Using the Netherlands as the standard, the gaps in inpatient services were larger than outpatient, with a 49% (0·35 billion/0·71 billion) increase in admissions, and 26% (10·42 billion/39·35 billion) increase in visits. Equally important, our metric of utilisation per counterfactual DALY made it possible to compare health systems with different combinations of visits and admissions. We identified countries such as the Netherlands and Portugal whose combination achieved high values on GBD's UHC index at lower costs than other combinations. In our sensitivity analysis using Portugal as the standard, the gap in admissions was 33·0% (0·23 billion/0·71 billion) and in visits was 19·5% (7·67 billion/39·33 billion), providing an intermediate UHC standard requiring relatively fewer admissions.

Our cost estimate was based on additional services at the current quality and type of service, and was 25.2% (I$1474.8 billion/I$1177.69 billion) higher in the sensitivity analysis with higher unit costs to reflect improvements, similar to the additional cost of commodities in previous estimates.[32] Like previous estimates, ours was the starting point for national assessments that would benefit from country-specific information; quality improvement would be substantially more in some countries, and minimal in others. When improvements in the quality of essential personal health services are delivered during visits and admissions, the additional cost of diagnostic exams and medical goods would be calculated using data on the country's burden of disease, current purchases, and lowest available prices available, and then added to total expenditure for a service to calculate a country-specific estimate of higher unit costs.

To put our estimates in perspective, we used Dieleman and colleagues estimate of pooled resources for health,[20] which were prepaid revenues through government financing, social health insurance, private insurance, or development assistance for health (DAH). Pooled resources were THE minus out-of-pocket spending. The additional cost of reaching the UHC standard for utilisation in 2016 was 105.97% (2017 I$71 of I$67 per capita) of pooled resources for low income countries, 129.66% (I$153 of I$118 per capita) for lower-middle, 23.59% (I$159 of I$674 per capita) for upper-middle, and 4.66%, (I$227 of I$4876 per capita) for high. As they reported, some expansion of coverage in low and lower-middle income countries may be possible with improvements in efficiency as well as additional funds.

Future directions

Health systems need to expand to accommodate population growth and ageing at the same time that they expand coverage. Population growth accounted for the majority of the increase in the volume of services from 1990 to 2016 globally, and among four super-regions where the GBD's UHC index in many countries was low: Latin America and the Caribbean, North Africa and the Middle East, South Asia, and Sub-Saharan Africa. Our cost of meeting a UHC standard for utilisation was based on population in 2016, but future estimates could include the additional cost associated with population growth and ageing.

Our methods for estimating utilisation and unit costs lend themselves to calculating the costs of future changes in health policy such as expansion in coverage. Utilisation could be forecast with global projections of population growth and age structure,[34] and forecasts of the Socio-demographic index,[35] which are available, as well as hospital capacity. Our analysis from 1990 to 2016 showed that hospital capacity was relatively stable over-time in the absence of changes in health policy, and could be forecast. Health expenditures on services could be forecast with available forecasts of THE and gross domestic product per capita,[20] and the share of

expenditures on each service. Again, the shares were relatively stable, and could be forecast. Estimates of the costs of changes in health policy would be modelled in this context.

Limitations

A major limitation was the availability, quality, and scope of the data. Our systematic search for utilisation data revealed gaps, particularly before the year 2000 in countries outside of the High Income, and Central Europe, Eastern Europe, and Central Asia super-regions. Further, the data sources for the other super-regions were primarily surveys, and utilisation questionnaires were not standardised. Despite the gaps, 330 of 1175 country-years of outpatient data, and 275 of 2068 country-years of inpatient data were from countries in the other super-regions, and our estimates adjusted for inconsistencies across questionnaires. In countries that continue to rely on surveys, it is important to standardise utilisation questions, as well as collect additional data (appendix, p 10). Second, some of the decrease in inpatient admissions in the High Income super-region may have been associated with an increase in day hospital admissions, but these services were not included in our analysis. Utilisation and expenditure data for these services were not generally available, even though Day curative (HC 1.2) and rehabilitative care (HC 2.2) were categories of the System of Health Accounts. Third, although the utilisation estimates included facility-based preventive maternal and child care (HC 6.4), and vaccinations (HC6.2), the expenditure shares did not, because they were not reported in 649 of 795 (81%) of National Health Accounts. Their omission may have underestimated the unit cost of outpatient visits, but the effects would have been substantial for only 16 country-years in which these categories exceeded 3% of THE.

Conclusions

Plans to expand health coverage can be based on utilisation and unit costs of current health systems and guided by standards of performance of actual health systems.

Table 1: National unit costs of outpatient visits and inpatient admissions, utilisation per counterfactual disability-adjusted-life-year, and additional visits, admissions, and funds needed to achieve a Universal Health Coverage standard for utilisation in 2016 in 2017 international dollars

Table displays four sets of national estimates organised by GBD region: 1) cost per outpatient visit and inpatient admission by country, 2) ratio of total inpatient admissions to counterfactual DALYs, where the counterfactual DALYs standardised the burden of disease across countries by removing the effects of access and quality of health care, 3) estimates of additional services needed to achieve the UHC standard for utilisation calculated by age and sex category, and 4) total cost of additional services in 2017 international dollars and as a percentage of 2016 gross domestic product. For each result, the mean of 1000 draws is reported, and in parenthesis the uncertainty interval defined as the $2{\cdot}5^{th}$ and $97{\cdot}5^{th}$ percentile of draws. DALY = disability-adjusted-life-year. GBD= Global Burden of Disease, UHC = Universal Health Coverage.

Figure 1: Annual outpatient visits per capita, age-standardised, and both sexes combined by country in 2016

Map displays the age-standardised estimated annual number of outpatient visits per person in 2016 for all ages and both sexes combined. The rate ranged from 2·5 to 7·0 visits per person for the majority of countries, and the key shows 0·5 visit increments in this range to present differences among these countries. ATG = Antigua and Barbuda. VCT = Saint Vincent and the Grenadines. TTO = Trinidad and Tobago. FSM = Federated States of Micronesia.

Figure 2: Annual inpatient admissions per capita, age-standardised, and both sexes combined by country in 2016

Map displays the age-standardised estimated annual number of inpatient admissions per capita in 2016 for all ages and both sexes combined. ATG = Antigua and Barbuda. VCT = Saint Vincent and the Grenadines. TTO = Trinidad and Tobago. FSM = Federated States of Micronesia.

Figure 3: Decomposition of the percentage change in volume of outpatient visits and inpatient admissions from 1990 to 2016 for all ages and both sexes summarised by GBD super-region (A) and by region and country in GBD high Income (B), Central Europe, Eastern Europe, and Central Asia (C), Latin America and Caribbean (D), South East Asia, East Asia, and Oceania (E), North Africa and Middle East (F). South Asia (G), and Sub-Saharan Africa (H)

Changes in the volume of outpatient visits and inpatient admissions from 1990 to 2016 were decomposed into changes in four factors: age-sex specific utilisation rates, total population, the share of the population in each age category, and the share of the population of each sex

within each age category. The black dots represent the overall percentage change in volume of each service. Colours represent the percentage that each factor contributed to overall percentage change. Bars to the left of zero show that the factor contributed to a decrease and bars to the right show an increase. GBD = Global Burden of Disease

Figure 4: Comparison of 2008 IHME unit cost estimates to 2008 WHO-CHOICE estimates for (A) outpatients, and (B) inpatients

Figure 4a is a scatter plot of the unit costs by country, where the vertical axis reports the WHO-CHOICE estimate and the horizontal reports our estimates. The solid diagonal line represents where the points would lie if the two estimates were identical. The majority of points were lower and to the right of the line, showing that our estimates were higher. All unit costs are in 2010 international dollars. IHME= Institute for Health Metrics and Evaluation. WHO-CHOICE= World Health Organization Choosing Interventions that are Cost-Effective.

References

1 Horton R. Offline: WHO—a roadmap to renewal? *The Lancet* 2017; **390**: 2230.

2 Goal 3 : Sustainable Development Knowledge Platform. https://sustainabledevelopment.un.org/sdg3 (accessed April 29, 2017).

3 Schmidt H, Gostin LO, Emanuel EJ. Public health, universal health coverage, and Sustainable Development Goals: can they coexist? *The Lancet* 2015; **386**: 928–30.

4 GBD 2016 SDG Collaborators. Measuring progress and projecting attainment on the basis of past trends of the health-related Sustainable Development Goals in 188 countries: an analysis from the Global Burden of Disease Study 2016. *Lancet* 2017; **390**: 1423–59.

5 Hogan DR, Stevens GA, Hosseinpoor AR, Boerma T. Monitoring universal health coverage within the Sustainable Development Goals: development and baseline data for an index of essential health services. *The Lancet Global Health* 2018; **6**: e152–68.

6 OECD Statistics. http://stats.oecd.org/# (accessed June 24, 2017).

7 Devaux Marion. Income-related inequalities and inequities in health care services utilizsation in 18 selected OECD countries. *European Journal of Health Economics* 2015; **16**: 21–33.

8 Saksena P, Xu K, Elovainio R, Perrot J. Utilization and expenditure at public and private facilities in 39 low-income countries. *Trop Med Int Health* 2012; **17**: 23–35.

9 Stenberg K, Lauer JA, Gkountouras G, Fitzpatrick C, Stanciole A. Econometric estimation of WHO-CHOICE country-specific costs for inpatient and outpatient health service delivery. *Cost Effectiveness and Resource Allocation* 2018; **16**: 11.

10 Floyd J, Wu L, Hay Burgess D, Izadnegahdar R, Mukanga D, Ghani AC. Evaluating the impact of pulse oximetry on childhood pneumonia mortality in resource-poor settings. *Nature* 2015; **528**: S53-59.

11 Gu D, He J, Coxson PG, *et al.* The Cost-Effectiveness of Low-Cost Essential Antihypertensive Medicines for Hypertension Control in China: A Modelling Study. *PLOS Medicine* 2015; **12**: e1001860.

12 OECD, WHO, Eurostat. A System of Health Accounts. Paris: Organisation for Economic Co-operation and Development, 2011 http://www.oecd-ilibrary.org/content/book/9789264116016-en (accessed April 29, 2017).

13 Global Health Data Exchange | GHDx. 2017; published online April 29. http://ghdx.healthdata.org/ (accessed April 29, 2017).

14 Stevens GA, Alkema L, Black RE, *et al.* [Guidelines for Accurate and Transparent Health Estimates Reporting: the GATHER Statement]. *Epidemiol Serv Saude* 2017; **26**: 215–22.

15 Flaxman AD, Vos T, Murray CJL, Kiyono P, editors. An Integrative Metaregression Framework for Descriptive Epidemiology, 1 edition. Seattle: University of Washington Press, 2015.

16 GBD 2016 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet* 2017; **390**: 1211–59.

17 GBD 2016 Mortality Collaborators. Global, regional, and national under-5 mortality, adult mortality, age-specific mortality, and life expectancy, 1970-2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet* 2017; **390**: 1084–150.

18 Das Gupta Prithwis. Decomposition of the difference between two rates and its consistency when more than two populations are involved. *Mathematical Population Studies* 1991; **3**: 105–25.

19 Dieleman JL, Haakenstad A, Micah A, *et al.* Spending on health and HIV/AIDS: domestic health spending and development assistance in 188 countries, 1995–2015. *The Lancet* 2018; **391**: 1799–829.

20 Dieleman JL, Sadat N, Chang AY, *et al.* Trends in future health financing and coverage: future health spending and universal health coverage in 188 countries, 2016–40. *The Lancet* 2018; **391**: 1783–98.

21 GBD 2016 Healthcare Access and Quality Collaborators. Measuring performance on the Healthcare Access and Quality Index for 195 countries and territories and selected subnational locations: a systematic analysis from the Global Burden of Disease Study 2016. *Lancet* 2018; **391**: 2236–71.

22 Blumenthal D, Hsiao W. Lessons from the East — China's Rapidly Evolving Health Care System. *New England Journal of Medicine* 2015; **372**: 1281–5.

23 Pisani E, Olivier Kok M, Nugroho K. Indonesia's road to universal health coverage: a political journey. *Health Policy Plan* 2017; **32**: 267–76.

24 Tangcharoensathien V, Witthayapipopsakul W, Panichkriangkrai W, Patcharanarumol W, Mills A. Health systems development in Thailand: a solid platform for successful implementation of universal health coverage. *Lancet* 2018; published online Jan 31. DOI:10.1016/S0140-6736(18)30198-3.

25 Atun R. Transforming Turkey's Health System — Lessons for Universal Coverage. *New England Journal of Medicine* 2015; **373**: 1285–9.

26 Healy J, McKee M. Implementing hospital reform in central and eastern Europe. *Health Policy* 2002; **61**: 1–19.

27 Di Giorgio L, Moses MW, Fullman N, *et al.* The potential to expand antiretroviral therapy by improving health facility efficiency: evidence from Kenya, Uganda, and Zambia. *BMC Medicine* 2016; **14**: 108.

28 US Spending on Personal Health Care and Public Health, 1996-2013 | Health Care Economics, Insurance, Payment | JAMA | JAMA Network. https://jamanetwork.com/journals/jama/fullarticle/2594716 (accessed July 26, 2018).

29 IHPA. National Hospital Cost Data Collection, Public Hospitals Cost Report, Round 20 (Financial year 2015-16). 2018; published online April 23. https://www.ihpa.gov.au/publications/national-hospital-cost-data-collection-public-hospitals-cost-report-round-20-0 (accessed July 26, 2018).

30 Cost-Effectiveness in Health and Medicine, Second Edition, New to this Edition: Oxford, New York: Oxford University Press, 2016.

31 Reed SD, Friedman JY, Gnanasakthy A, Schulman KA. Comparison of hospital costing methods in an economic evaluation of a multinational clinical trial. *Int J Technol Assess Health Care* 2003; **19**: 396–406.

32 Stenberg K, Hanssen O, Edejer TT-T, *et al.* Financing transformative health systems towards achievement of the health Sustainable Development Goals: a model for projected resource needs in 67 low-income and middle-income countries. *The Lancet Global Health* 2017; **5**: e875–87.

33 Jamison DT, Alwan A, Mock CN, *et al.* Universal health coverage and intersectoral action for health: key messages from Disease Control Priorities, 3rd edition. *Lancet* 2017; published online Nov 24. DOI:10.1016/S0140-6736(17)32906-9.

34 World Population Prospects - Population Division - United Nations. 2018; published online Jan 15. https://esa.un.org/unpd/wpp/Download/Standard/Population/ (accessed Jan 15, 2018).

35 Foreman, Kyle, et. al. Forecasting life expectancy, years of life lost, all-cause and cause-specific mortality for 250 causes of death: reference and alternative scenarios 2016-2040 for 195 countries and territories. *The Lancet*; **forthcoming**.