A Transparent Universal Health Coverage Index with Decomposition by Socioeconomic Groups: Application in Asian and African Settings

Running title: A Transparent Universal Health Coverage Index

Jahangir A. M. Khan\*,1,2,3

Sayem Ahmed1,2,4

Tao Chen1

Ewan Tomeny1

Louis W. Niessen1,5

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\*) Corresponding author

1. Liverpool School of Tropical Medicine, Pembroke Place, L3 5QA, Liverpool, United Kingdom.
2. Karolinska Institutet, Department of Learning, Informatics, Management and Ethics, Solna Campus, S-171 77, Stockholm, Sweden.
3. James P Grant School of Public Health, Brac University, 68, Shahid Tajuddin Ahmed Sharani, Mohakhali, Dhaka-1212, Bangladesh
4. icddr,b, 68, Shahid Tajuddin Ahmed Sharani, Mohakhali, Dhaka-1212, Bangladesh
5. Department of International Health, Johns Hopkins SPH, Baltimore, USA.

**ABSTRACT**

Background: Health and Wellbeing as one of the Sustainable Development Goals require all countries to achieve Universal Health Coverage (UHC). That is, all people must have access to healthcare when needed at an affordable price. While several indices were developed recently to assess UHC status, these indices appeared to be difficult for practitioners to apply without statistical knowledge.

Objective: This paper presents a transparent and step-by-step practical calculation method of such an index using Excel spreadsheets, applying in some Asian and African countries. We further intend to decompose the contribution of socioeconomic groups to the UHC index values.

Methods: We utilized the well-known UHC illustration (three-dimensional box, showing population coverage, service coverage and financial protection) to calculate the UHC index. We also decomposed the index into socioeconomic groups. For validation, correlation coefficients between our index and other UHC indices were calculated and the relationship of our index with out-of-pocket payments was estimated.

Results: World Bank data from 6 Asian and 15 African countries on health service coverage of people in five socioeconomic quintiles with financial protection were used to calculate our UHC index. Among Asian countries, indices ranged between 26.0% (Nepal) and 58.7% (Kazakhstan), while in African countries indices ranged between 8.9% (Chad) and 55.3% (Namibia). Decomposition of the UHC index showed a higher contribution to the index by richer socioeconomic groups. The correlation coefficients between our estimated UHC index values and those of others ranged between 0.774 and 0.900. Our index reduced by 1.4 percent in response to a one percent increase in OOP payments.

Conclusions: This spreadsheet approach for calculating the UHC index appeared to be useful, where the interrelation of UHC dimensions was easily observed. Decomposition of the index could be useful for policy-makers to identify the sub-populations and health services with need for further interventions towards UHC achievement.

Keywords: Africa, Asia, decomposition of UHC index, Econometric models, Out-of-pocket payments, Universal health coverage, UHC index

KEY POINTS FOR POLICY MAKERS

* This transparent Universal Health Coverage index is convenient to calculate using Excel spreadsheet and without advance statistical knowledge. It thus can be useful for Ministry of Health and other relevant stakeholders in the respective countries to monitor and assess the status of universal health coverage, which is an important indicator of the journey towards sustainable development goals.
* The index specifically quantifies the contribution of population coverage, service coverage and financial protection to the achieved UHC status of a country.
* Decomposition of the UHC index shows how each socioeconomic group of populations contribute to the UHC status. Such decomposition is useful to identify the population groups with higher need of health interventions for achieving UHC.

INTRODUCTION

Health and Wellbeing as one of the Sustainable Development Goals (SDGs) require achieving Universal Health Coverage (UHC), meaning that all people must have access to health care when needed, and at an affordable price [1]. In response to the UHC objective, several countries have developed monitoring and evaluation tools to measure their progress in achieving UHC [2,3] . Such tools often include a large number of indicators, causing difficulty in comparing the status of UHC across countries over different time periods [2] . Furthermore, even the same country can perform differently in different indicators over a given period. The benefit of having a composite index of UHC attainment thus becomes apparent. In recent years, several researchers have developed and validated such composite indices [4,5]. Despite the usefulness of these indices, they too are methodologically challenging to apply in empirical analyses by UHC practitioners without statistical knowledge, such as health service organizers (Governments, NGOs), stakeholders and policy-makers.

This paper has three specific objectives: firstly, to develop a methodology for the calculation of a composite UHC index within an Excel spreadsheet; secondly, within the same spreadsheet to decompose these index values into population groups; and thirdly, to validate the index. The relative advantage with this spreadsheet approach is that the contributions of UHC dimensions (population coverage, service coverage and financial protection) to the index are directly measurable and transparent to the audiences.

METHODS

**Concept of Universal Health Coverage**

A spreadsheet approach was undertaken to calculate the UHC index of a number of countries in Asia and Africa, using World Bank data and a formula, based upon the well-known illustration of UHC (Figure 1) [6]. The volume of the inner-box (actual health coverage) as a proportion of the outer-box (highest achievable health coverage) was expressed as a percentage, giving a UHC index ranging between 0 and 100 percent with higher index values corresponding to better UHC achievement.

Figure 1 to be inserted here

We describe below three dimensions of UHC, i.e. population coverage (length), service coverage (depth), and financial protection (height) of the UHC illustration.

*Population coverage*

Striving for Universal Health Coverage is tied to the belief that all people in need, irrespective of their socioeconomic position, should be covered by all health services, whether they be promotive, preventive, curative, rehabilitative or palliative. The population in a country can be divided into socioeconomic quintiles, based on an asset/wealth index [7]. Populations can be further classified into sub-groups using other parameters, like geographic locations (urban, rural, suburb, hard-to-reach), gender, age (children, working-age, elderly), and occupational attainment (blue- and white-collar workers). Since UHC promotes equal health care irrespective of socioeconomic status, in our index we give the same weight to all socioeconomic groups.

*Service coverage*

In principle, promotive, preventive, curative, rehabilitative and palliative health services should be available in order to achieve UHC in a given country. Practically, countries have different health priorities; many countries, for example, require priority services for malaria, HIV/AIDS and tuberculosis. However, some services are commonly found in all countries, including, out-patient and inpatient services and immunization. Despite differences between countries, UHC puts emphasis on the utilization of health services by people in need, rather than the availability of different services [5,8].

*Financial risk protection*

Financial risk protection (FRP) means that payment for healthcare is not a barrier to utilizing health services and people do not get poorer by paying for healthcare. An essential component of UHC is to ensure FRP for all people in need of health services, once again, irrespective of socioeconomic status. It is well documented that households affected by disease and illness often face ‘catastrophic’ health expenditure, becoming impoverished economically [9–11] . We measured the FRP situation in a country using the proxy of the proportion of households that did not face catastrophic health expenditure for utilizing health care. Like Wagstaff et al., we define a household to have experienced *catastrophic* health expenditure (CHE) if their health expenditure in a given year is 25% or more of their total household consumption expenditure. Those with expenditure below 25% are therefore considered as protected from financial risk while utilizing health care [5,8].

DATA AND UHC INDEX ESTIMATION

We used data from 21 countries to calculate the index of universal health coverage (UHC) and the impact of OOP payments on the UHC indices.

Calculation of UHC index reflected “the proportion of defined health services actually utilized by people in five socioeconomic quintiles in comparison to full utilization of all these services by all people”, which quantified the boxes in Figure 1. The following equation was used for calculating UHC indices:

UHC index = Total volume of actual health service utilization by all people without facing financial hardship ÷ Total volume of potential health service utilization by all people without facing financial hardship

= (Length of service arm indicating actual utilization x Length of population arm who utilized the services x Length of financial risk protection arm indicating user without facing financial hardship) ÷ (Maximum achievable length of service arm x Maximum achievable length of population arm x Maximum achievable length of financial risk protection arm indicating no financial hardship) … … … (1)[[1]](#endnote-1)

For calculating the indices, we used data available from the Health Equity and Financial Protection (HEFP) datasheets provided by The World Bank [7]. These data-sheets provide information on health care service utilization, key health outcome indicators, health financing sources, the incidence of catastrophic health expenditure, and impoverishment due to OOP health payments, disaggregated into socioeconomic groups in low- and middle-income countries (LMICs). The World Bank extracted this information from the Demographic and Health Surveys, World Health Surveys, Multiple Indicator Cluster Surveys, Living Standards and Measurement Surveys and other available surveys of the LMICs [19]. During extraction, a common set of health indicators were used for all the LMICs. We, therefore, got the opportunity to employ this data for analysing UHC status of 21 countries. However, data on service indicators, related to rehabilitative and palliative care were unavailable in the countries under investigation [7].

**Step-by-step calculation of UHC index**

We assessed the volume of inner- and outer-box of UHC illustration (figure 1) for calculating the UHC index values using equation (1). The outer-box captured the volume indicated by the maximum possible achievable volume, meaning that all the population in all socioeconomic quintiles utilized all health services without any financial hardship. We assumed that a socioeconomic quintile could achieve maximum 1.00 cm for 1.00 health service where all people (100% or 1.00) utilized such a service without any financial hardship. It implied that the maximum achievable volume of the outer-box would cover 5 quintiles for 6 health services with full financial protection for all people, i.e. length 5.00 cm x depth 6.00 cm x height 1.00 cm = 30.0 cubic cm. The inner-box, on the other hand, captured the actually achieved length for all health services by the proportion of the population who had full financial protection. For instance, if a population actually achieved 3.0 cm by all socioeconomic quintiles for 6.00 health services with full financial protection of 90% people, the inner-box would capture a total volume of 16.2 cubic cm (length 3.00 cm x depth 6.00 cm x height 0.90 cm). The UHC index could then capture the share of the inner-box as a percentage of the outer-box (length 5.00 cm x depth 6.00 cm x height 1.00 cm). We followed a step-by-step approach for calculating the index using real-life data from a number of Asian and African low- and middle-income countries. We described below, accompanied with Figure 2, how we calculated the UHC index value for Ghana step-by-step.

*Step 1: Country and variable selection*

We targeted countries in Asia and Africa which had data on the largest common number of health services. We found that 6 Asian and 15 African countries had data on 6 health services (utilization rate by socioeconomic quintiles). The services were Immunization, Skilled antenatal care (4 visits), Treatment of diarrhoea, Medical treatment of Acute Respiratory Infection (ARI), Skilled birth attendance (SBA) and Inpatient (in last 12 months). These services reflected the status of preventive and curative health services in each country. In principle, all types of health services (promotive, preventive, curative, rehabilitative and palliative) should be considered in the index calculation. Due to data services constraints, like missing data on promotive, rehabilitative, and palliative care as well as unavailability of data on same health services across countries, we could not capture the complete scenario of UHC status. Our method, however, allows for the inclusion of as many health services as possible if data are available. Additionally, we were aware that there were inpatient services related to the treatment of diarrhoea, ARI, skilled birth attendance etc. But it was very likely that inpatient services included many other health conditions or diseases, for instance cancer, diabetes, cardiovascular diseases, injuries and so forth. Inclusion of inpatient services thus might be justifiable even if it might have overlapped with some services, like skilled birth attendance. Keeping data limitation in mind, we put the emphasis on utilizing the available and comparable data from Asian and African countries for calculating the UHC index and the validation of the index values. The HEFP datasheets of the World Bank provide data for the years 1993 to 2006. We used data on any health services available between 2002 and 2006 for this analysis. Since data on financial risk related to every single health service was not available, we applied financial risk for countries across all services, except immunization which often was funded by government and its development partners (like, GAVI Alliance).

*Step 2: Data compiling*

In step 2, data were compiled in columns A-D which were later used for calculating the index. These four columns included health service types, population groups (socioeconomic quintiles), utilization rates of services and proportion population without financial hardship respectively. Column A indicated 6 types of health services and column B showed classification of the services into five socioeconomic quintiles. Health service utilization rate of all six types across five socioeconomic quintiles were inserted in column C. For instance, 53.9% of total population in the poorest quintile utilized immunization in Ghana. In column D, the proportion of the population who did not face any catastrophic expenditure due to the specific healthcare utilization was inserted. For example, 100% of the population who utilized immunization service did not face catastrophic expenditure i.e. had financial protection. We applied 100% protection since immunization service in low- and middle-income countries was often funded by the government and international development partner (like, GAVI alliance) and no out-of-pocket payment was required for such a service. For all other health services (like, skilled birth attendant, inpatient care), we applied the proportion of people with financial protection in general in the reported country. For instance, 8.8% population faced catastrophic expenditure in Ghana for any health services, meaning that 91.2% population had financial protection [18], which was inserted in column D.

Figure 2 to be inserted here

Step 3: Data analysis

Columns E-I were calculated in step 3. By multiplying columns C and D, we found the service utilization rate of people with financial protection. While 20.5% of the poorest people in Ghana utilized SBA service (in column C), 18.7% utilized this service without facing any catastrophic expenditure (column E). Column F summed up the total arm length for each health service. For instance, the total volume attributable to immunization was 3.55 cubic cm out of a maximum possible 5.00 cubic cm. Volumes for each service were calculated accordingly. Column G then summed up the total volume of all 6 services, accounted for 14.06 cubic cm. Column H showed the maximum possible achievable volume by multiplying the number of services across all socioeconomic quintiles with full financial protection of all the population, i.e. 6.00 cm x 5.00 cm x 1.00 cm =30.00 cubic cm. Finally, the UHC index was calculated in column I, applying equation (1), i.e. (G/H) x 100 or (14.06 ÷ 30.00)x100 = 46.9%. The step-by-step calculation of UHC index is available in an Excel spreadsheet (Electronic supplementary material, Excel sheet 1).

**Decomposition of UHC-index by population groups with an example**

In any country, each socioeconomic quintile contributes to the UHC-index values in connection with their healthcare utilization. Table 1 presents the method of decomposition of UHC index using Ghana as a case study. In Ghana, the UHC index was 0.469 (or 46.9%) (column A). The socioeconomic quintiles were indicated in column B. When we put utilization rate of ‘0’ in the poorest quintile across all six health services, the UHC index reduced to 0.403 (column C). The absolute contribution of socioeconomic quintile was thus 0.469 - 0.403 or 0.065 (column D). In the same way, the absolute contribution of the 2nd, 3rd, 4th and 5th quintiles were calculated to 0.081, 0.090, 0.106 and 0.126 respectively. The relative contribution was calculated by dividing the absolute contribution of each quintile with the total UHC index value multiplied by 100 in column E. The poorest quintile’s relative contribution was thus calculated as (0.065/0.469) x 100 or 14.0%. Similarly, we found the relative contribution of 2nd, 3rd, 4th and 5th quintile as 17.3%, 19.3%, 22.6% and 26.9% respectively.

Table 1 to be inserted here

**Excel spreadsheet with Ghana country case: UHC index calculation and decomposition step by step**

Electronic supplementary material (Excel spreadsheet) contains 7 Excel sheets. Excel sheet 1 shows the calculation of UHC index step by step. For calculating the decomposition of the index, we used Excel sheet 2-7. In sheet 2-6, the health service utilization rates in socioeconomic quintiles (Q1-Q5) were assumed to be ‘0’ (one quintile at a time in each sheet). In sheet 7, UHC value in total was calculated (column A). Column B represented the socioeconomic quintiles and UHC values assuming ‘0’ in each quintile was captured in column C. Column D calculated the absolute contribution (A-C) and column E captured the relative contribution (D/A\*100) of the socioeconomic quintiles.

The absolute contributions of the socioeconomic quintiles to the UHC index were later used for calculating the concentration index, which was reported in Table 3 using a method applied by Yao (1999) [12] .

**UHC Index Validation**

For index validation, we calculated the correlation coefficients between our index values and those of other authors’ who estimated the UHC index or index of universal health service coverage. We estimated the effects of OOP payments on UHC achievement for further validation by employing data from the World Bank [13]. Data of explanatory variables were OOP payments as a percentage of total health expenditure, GDP per capita, gender (proportion female), the proportion of the elderly in the population, and the population of the country.

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Since the values of UHC indices ranged between 0% and 100%, we transformed them into the logit function, which is the inverse of the logistic transform. When the function's variable represents a probability p, the logit function gives the log-odds, that is, the logarithm of the odds p/(1 − p). We predicted the log-odds with OOP payments as a share of total health expenditure in each country. Equation (2) below was used in this estimation.

Logit … … (2)]

Where denotes the probability of incurring a specific UHC index, a constant, the OOP payments as a percentage of total health expenditure, logged GDP per capita, , , demographic structure and is the error term.

RESULTS

Based on available data, we calculated the indices of Universal Health Coverage (UHC-Index) for 6 Asian and 15 African countries (Table 2). Among the reported Asian countries, Kazakhstan achieved the largest UHC index value (58.7%), followed by the Philippines (52.2%). Nepal achieved the lowest index value (26.0%). The average UHC index value in Asian countries was 39.9% with only Kazakhstan and the Philippines achieving a higher value than this average. In Nepal, the best utilization of health care was observed for immunization (54.2% and 82.8% in the poorest and richest quintile) while all other services were utilized at a lower rate. For instance, Medical treatment of ARI and inpatient care was utilized by only 38.0% and 7.5% respectively of the population in the richest quintile.

Table 2 to be inserted here

Among the 15 African countries we considered, the highest UHC-index was observed in Namibia (55.3%), followed by Zimbabwe (54.0%). The average index value among the African countries was 35.9%, with seven countries achieving higher than this average. The lowest index in Africa was observed in Chad (8.9%); other countries with low indices were Ethiopia (13.2%), Burkina Faso (27.0%) and Mali (27.8%).

In India, 20.3% of people who utilized health care faced financial hardship in terms of CHE. It was further noticeable that India had the highest rate of OOP payments (68.5%) among all reported countries in Asia. We found that countries with higher GDP per capita appeared to be more successful in achieving UHC. For instance, Kazakhstan and the Philippines were at higher economic levels in Asia with 14,259 and 3,770 USD per capita (PPP adjusted). African countries showed a similar pattern, meaning that the countries with higher economic level like Namibia (GDP per capita 6,815 USD PPP) and Morocco (GDP per capita 5,164 USD PPP) had higher UHC indices of 55.3% and 40.7% respectively. However, we observed exceptions in some countries, meaning that Zimbabwe (GDP per capita 1,893 USD PPP) achieved a UHC index of 54.0% i.e. the second largest among the African countries.

Decomposition of UHC index generally showed a higher contribution from richer socioeconomic groups than the poorer ones. The richest quintile (Q5) contributed more than 20% towards the index values across all countries (Table 3). The highest contributions of the richest quintile to UHC index values were observed in Asia in Nepal (31.9%) and in Africa in Ethiopia (40.1%) and reached concentration indices of 0.161 and 0.237, showing large inequality across socioeconomic groups. Both countries also scored a low UHC index: 26.0% in Nepal and 13.2% in Ethiopia.

Table 3 to be inserted here

The experience of countries with high UHC values was the opposite. Kazakhstan (UHC index 58.7%) and Namibia (UHC index 55.3%) with largest of the UHC indices in Asia and Africa respectively had a much more equitable distribution of contribution to their UHC index across socioeconomic groups. The richest group in Kazakhstan contributed with 20.6% and the poorest with 18.5% to UHC index, giving a concentration index of 0.021, which showed much more equality in healthcare utilization across socioeconomic groups. Similar experience was observed in Namibia (concentration index = 0.066) and Zambia (concentration index = 0.089). Nevertheless, some countries with a high UHC index did also show high inequality. For instance, the Philippines and Ghana had UHC indices of 52.2% and 46.9%, but also experienced high concentration indices of 0.106 and 0.125 respectively. Overall, however, there is a strong and significant correlation (-0.7519, p = 0.0001) between a country’s UHC index and their concentration index.

For validation of our UHC index, we estimated correlation coefficients between our index values with the index values estimated by other researchers [5,6]. The correlation coefficients between our estimated UHC index values and Wagstaff’s and Hogan’s were 0.900 (p-value 0.037) and 0.774 (p-value 0.000) respectively. It should be noted here that we found 5 common countries with Wagstaff and all 21 countries with Hogan. It implied that our spreadsheet approach to UHC index calculation reflected the UHC status of the reported countries similarly. Further, we fitted two models for explaining UHC indices by the level of out-of-pocket payments (Table 4). In Model 1, we controlled for both economic level (GDP per capita) and population size of the countries, while Model 2 additionally controlled for variations in demographic structure i.e. the proportion of female and elderly in the total population. Both regression equations explained the models well, i.e. by 70.7% (Model 1) and 69.2% (Model 2). Neither significant multicollinearity nor misspecification was found in the estimations.

Table 4 to be inserted here

Both models showed a negative significant relationship between the share of out-of-pocket payment and the UHC index. Our estimation of the recommended model (Model 2), which controlled for both economic level and demographic variations, showed that a 1 percent increase in OOP health care payments reduced the UHC index values by 1.4 percentage points. These estimations supported our hypothesis that reliance on out-of-pocket payments for health care reduces the probability of achieving Universal Health Coverage.

DISCUSSION

The composite index of UHC presented here has quantified three dimensions of UHC as other developed indices have [4,5] , The presentation of the index in this paper has provided a transparent relationship among the dimensions and their contribution to the index. We further decomposed the index into sub-populations (socioeconomic groups) by calculating the absolute and relative contribution of each socioeconomic group to the index value of each country under investigation. Using the same method of decomposition, we could also calculate the contribution of individual health services on the index, which was not shown in this paper.

Our calculated index values were strongly correlated to those of Wagstaff’s and Hogan’s [5,14]. Further validation of our index was reflected in the estimated coefficient of out-of-pocket payments on UHC index values using equation (2). This econometric estimation (Model 2 in Table 4) found that a one-percent increase in OOP payments reduced our UHC index by 1.4 percent when accounting for the economic level and demographic structure of the countries. This finding was in line with a generally acceptable negative relation between OOP payments and UHC achievement.

In this paper, decomposition of the index showed that in general health benefits are considerably concentrated on the richer segment of society and these inequalities were, in fact, more pronounced in counties with a lower UHC achievement. We found that a higher prevalence of OOP payments for healthcare within a country contributed to inequity favouring the richer people, in line with previous studies of benefit incidence analysis of health care[15,16]. In Bangladesh, both in- and outpatient care benefits together through private providers had a concentration index of 0.237, while that through public providers was 0.044 [16]. Akazili and colleagues found concentration indices of out-patient care benefits of 0.1807 in private and 0.1166 in public facilities, where the inpatient care benefits showed concentration indices of 0.4086 in private and 0.0784 in public facilities[15]. Experience of both countries demonstrated that private health care benefits fostered inequalities in health care to a much larger extent. The UHC mission aims to guarantee the need-based health coverage for all people irrespective of their socioeconomic position, but the current nature of health service provision through the private sector suggests this mission is far from being achieved.

While the other researchers used geometric mean of health service tracers [5,14] for calculating the index, we utilized a transparent step-by-step spreadsheet approach which should be useful for the potential users (like, health managers of Ministries and local government, international health observers) without a statistical background and research skills. It should be emphasized here that our spreadsheet approach can even be used for monitoring the service coverage status in local (sub-districts) and regional (provinces) as well as in any health service catchment areas by customising the spreadsheet to local conditions.

In principal, any number of possible service indicators and population stratum, as well as the indicator of financial protection, can be accommodated in constructing the proposed index. Though we have put an equal weight across all services and population groups, it is possible to assign different weights considering the priority of services and sub-populations in calculating the index. If the service utilization rates change over time in sub-populations in a way that the total length of coverage remains same, our index value will not be sensitive to these changes while equal weights are applied. The index values will, however, be sensitive if different weights are applied for different services and in different population sub-groups. Use of sex- and age-standardized service utilization rates might be more useful for comparing the index values across countries. In this initial phase of the developing the index, we give focus on actual values reflecting three dimensions of UHC (population coverage, service coverage and financial protection). Since we do not find any priority in specific health services and population groups by any global health policy for achieving UHC, we assumed same weight across services and sub-populations. It, however, is technically simple to add weights in the analysis.

In the practical context, data on utilization of services like, rehabilitative and palliative care are often missing in most of the low- and middle-income countries. We, however, expect that through ongoing research on UHC, more data will be available in the near future which will be useful to calculate more robust UHC index values using this current method. We expect that more robust and frequent data on health care utilization and financial risk protection will be more useful to observe the UHC status of the countries and their progress over periods. We would also benefit by quantifying the effects of any changes in service utilization by any socioeconomic groups. It is also possible to classify the populations with demographic characteristics (age group, male-female), residence (urban, rural, semi-urban, hard-to-reach area) etc. for observing the population coverage of health care. The countries then will be able to identify their under-developed areas of health services for future intervention for achieving universal health coverage.

CONCLUSION

A spreadsheet approach for calculating a UHC index worked well for our analyses, where the interrelation of UHC dimensions to the index values could easily be observed. Decomposition of the index into socioeconomic groups was useful for identifying the target population for further intervention towards UHC. The index was validated by estimating the correlation coefficients with other relevant UHC indices and also by estimating the effect of OOP payments on our index values. The proposed UHC index is expected to be used by UHC practitioners without any advanced knowledge in statistics and they can simply observe the efforts of their work towards UHC as the index is sensitive to any changes in health coverage by any sub-populations and for any health services in the country. This index can also be useful for observing affordable health service coverage in local and regional levels in any countries.

DATA AVAILABILITY STATEMENT

Data used in this study are available for the readers with the journal as supplementary data in an Excel file.

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COMPLIANCE WITH ETHICAL STANDARD

None of the authors (Jahangir A.M. Khan, Sayem Ahmed, Tao Chen and Louis W. Niessen) declared conflict of interest in this paper.

This paper entirely used publicly available secondary data and consequently was not subject to ethical approval.

CONTRIBUTION OF THE AUTHORS

Jahangir Khan generated the idea, developed methods and analysis technique, identified data requirements, analysed data, interpreted results, wrote the first draft of the manuscript. Sayem Ahmed identified relevant literature and data, analysed data and interpreted results. Tao Chen specified models for statistical inference tests and interpreted the results in the context of Universal Health Coverage. Ewan Tomeny contributed to the concept and quantifying the index values, interpreted the results and revised the manuscript. Louis Niessen contributed to the concept development, interpreted the results and put the study into the context of Universal Health Coverage and Sustainable Development Goals. All authors contributed to writing the manuscript, responded to reviewers’ comments and approved the final version of the manuscript.

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1. ) Mathematical expression for technical readers:

   = Utilization rate of health service *i* in socioeconomic quintile *j*, = proportion of population (ranges between 0 and 1) faced financial risk (hardship) for utilizing any health service, = Full utilization of health service *i* in socioeconomic quintile *j* and = no financial risk faced by any people (value 1). [↑](#endnote-ref-1)