Background

Estimating the impact of scaling up the coverage of maternal, neonatal and child health interventions is important in evaluating progress towards national and global health goals, strategic program planning, and supporting advocacy at local, national, and global levels. The Lives Saved Tool ( ) is a linear deterministic model used to estimate the impact of changes in coverage of key interventions on cause-specific maternal, neonatal, and child mortality in low and middle-income countries [1]. To model the health impact of intervention scale-up in three primary inputs are required: estimates of intervention effectiveness, measures of health and mortality status, and estimates of baseline intervention

scenarios projecting toward an absolute target (e.g. an increase up to 90% as the target as used in [12] would produce impact estimates which are biased upwards, if proxy estimates for coverage are overly conservative. Conversely, if proxy estimates for coverage are overestimates of true levels of coverage, then the impact of intervention scale up determined by would be inadvertently minimized.

Reliable and accurate estimates of intervention coverage are critical inputs to the model, and as the availability, validity and reliability of coverage data are strengthened, impact estimates generated by will improve. Coverage data may be available in some low and middle income countries, but concerns about the data quality, timeliness and reliability still persist. As part of the broader agenda to end preventable maternal, neonatal and child deaths, calls have been made for improved coverage measurement to track population coverage for life-saving maternal, newborn and child health interventions [3, 13]. Technical work is ongoing to harmonize survey tools and increase the validity and reliability of a core set of indicators used for global monitoring of intervention coverage [6, 9, 14]. One promising approach to improve coverage measurement relies on linking self-reported care-seeking data collected through household surveys to data on service availability and readiness from health facility assessments. There is increasing recognition that this strategy- hereafter referred to as the 'linking approach' - may be a feasible option for estimating coverage of interventions not amenable to tracking by household surveys alone [15, 16].

Although the linking of household and health facility surveys represents improved estimates of intervention coverage when no routine coverage data exists, the linking approach depends on the availability and temporal alignment of household and health facility surveys. Although many health facility assessment tools have been developed, nationally representative health facility assessments are not yet routinely conducted and survey data available in many low and middle income countries [17]. For the purposes of modeling, it remains crucial to estimate intervention coverage for all low and middle income countries using the available data to inform the process. The objective of this study was to use estimates of intervention coverage derived from the linking approach to guide the development of formulas to calculate new estimates for intervention coverage in

For a subset of ANC interventions, we estimated population-level coverage based on the linking approach, then compared these to the existing proxies in the most recent version of the model (Spectrum version 5.55, released April 14, 2017). By applying a simple predictive modeling framework, we developed updated estimates for coverage of syphilis detection and treatment, case management of diabetes, hypertensive disorders, malaria infection, and pre-eclampsia. Lastly, we provided recommendations to guide the inclusion of improved estimates of coverage of maternal, newborn and child health interventions in . This study underscores the need for continued efforts to improve coverage measurement, and highlights the importance of health facility assessments as valuable data sources.

Methods

We used a five step process to develop updated estimates of baseline intervention coverage for syphilis detection and treatment, case management of diabetes, hypertensive disorders, malaria infection, and pre-eclampsia (Fig. 1). First, we used data collected from two large-scale nationally representative health facility assessments, the Service Provision Assessment (SPA) and the Service Availability and Readiness Assessment (SARA), to calculate health facility 'readiness' to deliver each intervention. 'Readiness' was defined by the availability of the relevant drugs, equipment, supplies, guidelines and trained staff necessary to deliver a specific intervention. Facility-level indicators were summarized at the stratum level as the proportion of health facilities ready to deliver the intervention in that stratum. Strata were defined by health facility type (hospital, health center, health post, etc.), managing authority (public, non-public) and location (rural, urban).

Second, we estimated coverage of ANC4+ within each stratum, using data on care-seeking from the DHS. The woman's questionnaire of the DHS collects information on pregnancy-related care for the most recent live births occurring within 5 years prior to the survey. To reduce recall bias, this analysis was restricted to reports about ANC received for live births occurring only within the 3 years prior. The analysis was also restricted to the sample of women who reported attending at least four ANC visits, as most ANC interventions we considered require more than one ANC visit to be delivered at sufficient quality to have an impact on the intended health outcomes. Also, ANC4+ coverage is a standard indicator used in . Based on the reported source of ANC (managing authority and health facility type) and residence (urban/rural), we computed the distribution of ANC4+ coverage by stratum (health facility type, managing authority and residence).

Third, we computed the product of ANC coverage and health facility readiness for each stratum, then summed across all strata. The resulting estimates represented the proportion of women who attended ANC at least four times and sought care at a health facility 'ready' to deliver the specific intervention. Of note, these estimates represent the proportion of women for whom

an intervention was available (also referred to 'availability coverage') [18], but several factors related to clinical practice could hinder women from actually receiving the intervention [19]. Country-specific coverage values for each intervention were available for 20 SPAs or SARAs conducted in 13 sub-Saharan African countries with a DHS conducted 2 years prior or after the SPA/SARA. The full list of countries where coverage could be estimated based on the linking approach were Benin, Burkina Faso, Democratic Republic of Congo, Ghana, Kenya, Namibia, Rwanda, Senegal, Sierra Leone, Tanzania, Togo, Uganda, and Zimbabwe. Further details on the indicator definitions and exclusion criteria can be found in Additional files 1, 2 and 3.

Fourth, we developed simple predictive models for intervention coverage, with the goal to use these in to estimate intervention coverage for all low and middle income countries. The pool of candidate independent variables was drawn from existing DHS data characterizing ANC, specifically the number of ANC visits, timing of ANC visits, and receipt of ANC components: measurement of blood pressure, height and weight, and collection of urine and blood samples. These variables were selected based on both the availability in the DHS and the plausibility of an association with intervention coverage, as they represent elements of ANC essential for the delivery of key ANC interventions. For example, measurement of blood pressure is used to screen pregnant women for hypertensive disorders.

Using the country-level estimates of coverage from the linking approach as the outcomes, we specified fractional logit models, with a logit link and binomial error

the perfect prediction line, with several outliers far from the perfect prediction line, and very little agreement.

The measures assessing model fit and accuracy of the five prediction models are summarized in Table 3. Correlation coefficients ranged from 0.5–0.83 indicating moderate to strong agreement between updated esti-

Unfortunately, given the current challenges it will be necessary to rely on linking household and health facility surveys for the foreseeable future [3, 16, 21]. The combination of two surveys – household surveys to assess care-seeking and health facility assessments to assess the availability and readiness of the health system – will provide more reliable data to track progress towards ending preventable maternal, neonatal and child deaths. The linking approach is a promising strategy, but further research to develop and validate the methods is warranted. Such studies should assess the accuracy and validate estimates of coverage derived from the linking approach. It is important to determine whether linking methods at aggregate levels are sufficiently reliable to determine level of intervention coverage quantitatively and thus, able to be used to track progress over time. Further standardization of health facility assessments and standard definitions of readiness are needed.

Conclusions

In summary, we updated estimates of coverage for syphilis detection and treatment, case management of diabetes, hypertensive disorders, malaria infection, and pre-eclampsia for use in . Work is ongoing to use linking methods to improve estimation of coverage of other interventions along the continuum, where currently uses proxy assumptions. While more work is needed to improve coverage measurement for maternal, neonatal and child health interventions more generally, our updated estimates facilitate the establishment of baseline coverage in By balancing the desire for robust estimates of intervention coverage with the limitations of sparse data availability in low and middle income countries, we accomplished the task of improving proxy estimates of intervention coverage, a critical input in

Additional files

Additional file 1: Table: Indicator definitions. (DOCX 17 kb)

Additional file 2: Table: List of Service Provision Assessments (SPA) and Service Availability and Readiness Assessments (SARA) identified. (DOCX 19 kb)

Additional file 3: Figure: Flow chart of exclusion criteria. (DOCX 28 kb)

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ANC: Antenatal care; FASQ: Facility Audit of Service Quality; HFC: Health Facility Census; LiST: Lives Saved Tool; RMSE: Root mean square error; SAM: Service Availability Mapping; SARA: Service Availability and Readiness Assessment; SPA: Service provision assessment

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