Equity in Child Survival, Health, and Nutrition 2

The comparative cost-effectiveness of an equity-focused approach to child survival, health, and nutrition: a modelling approach

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Progress on child mortality and undernutrition has seen widening inequities and a concentration of child deaths and undernutrition in the most deprived communities, threatening the achievement of the Millennium Development Goals. Conversely, a series of recent process and technological innovations have provided effective and efficient options to reach the most deprived populations. These trends raise the possibility that the perceived trade-off between equity and efficiency no longer applies for child health—that prioritising services for the poorest and most marginalised is now more effective and cost effective than mainstream approaches. We tested this hypothesis with a mathematical-modelling approach by comparing the cost-effectiveness in terms of child deaths and stunting events averted between two approaches (from 2011–15 in 14 countries and one province): an equity-focused approach that prioritises the most deprived communities, and a mainstream approach that is representative of current strategies. We combined some existing models, notably the Marginal Budgeting for Bottlenecks Toolkit and the Lives Saved Tool, to do our analysis. We showed that, with the same level of investment, disproportionately higher effects are possible by prioritising the poorest and most marginalised populations, for averting both child mortality and stunting. Our results suggest that an equity-focused approach could result in sharper decreases in child mortality and stunting and higher cost-effectiveness than mainstream approaches, while reducing inequities in effective intervention coverage, health outcomes, and out-of-pocket spending between the most and least deprived groups and geographic areas within countries. Our findings should be interpreted with caution due to uncertainties around some of the model parameters and baseline data. Further research is needed to address some of these gaps in the evidence base. Strategies for improving child nutrition and survival, however, should account for an increasing prioritisation of the most deprived communities and the increased use of community-based interventions.

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This is the second in a **Series** of two papers about equity in child survival, health, and nutrition

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Introduction

Substantial recent global progress in reducing childhood mortality and undernutrition has been accompanied by increasing within-country inequities.[1] For example, 18 of 26 countries with the largest decreases in under-5 mortality show a simultaneous widening of the mortality gap between the least and most deprived wealth quintiles.[1,2] The global burden of childhood mortality, morbidity, and undernutrition is now increasingly concentrated in the most deprived and underserved populations within countries,[1–3] partly as a result of inequitable coverage of key maternal and child health and nutrition interventions.[4,5]

Much of the encouraging progress in reducing childhood mortality and undernutrition can be attributed to the identification and roll out of highly effective evidence-based interventions over the past decades.[6] Failing to ensure that marginalised communities benefit from these improvements in knowledge threatens the achievement of the fourth Millennium Development Goal (MDG). Yet countries as diverse as Brazil,[7,8] Chile,[9] Mozambique,[10,11] Niger,[12,13] and Thailand[14] have shown that a reduction of both overall child mortality and inequities is possible. Advances in technology and community-based programming have generated innovative strategies with the potential to reach the underserved in a cost-effective manner.[15,16] The convergence of these trends raises the possibility that the perceived trade-off between equity and efficiency no longer applies for child nutrition and survival—that an equity-focused approach that prioritises services for the poorest and most marginalised can be more effective and cost effective than mainstream approaches that incrementally increase coverage from the easier to the more difficult to reach populations.

We aimed to build a case for this hypothesis using a mathematical modelling approach,[17] noting its use to predict the effect and cost-effectiveness of several maternal and child-health strategies.[18–22]

Modelling methods

Study design

We compared two strategic approaches to reducing under-5 mortality and malnutrition across 14 countries and one province: one approach that we have labelled a mainstream approach to delivering services and the other, labelled as an equity-focused approach that prioritised operational strategies to reach the most deprived populations. Figure 1 provides a schematic description of the main factors we assessed that affect

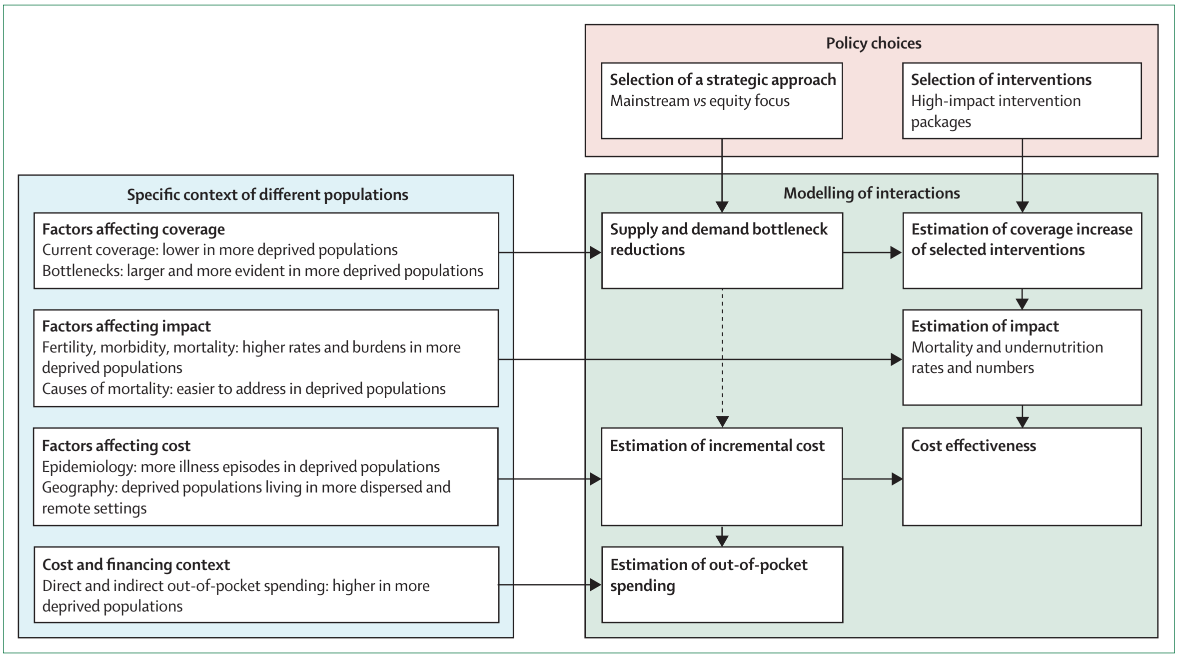

Figure 1: **Modelling the cost and impact of strategic approaches in different population contexts**

the ability of health services to reduce child deaths and undernutrition. On the basis of these factors, and by estimating associated reductions in bottlenecks and subsequent increases in intervention coverage, we developed a mathematical model that uses disaggregated data to estimate the costs and effect of the two strategic approaches (mainstream versus equity-focused). Our comparison included measuring the specific bottlenecks faced by different segments of the population, estimating the differential effectiveness of strategies to overcome their specific bottlenecks and translating these data into increases in coverage and corresponding mortality and stunting events averted.

We estimated incremental costs incurred and reductions of deaths and stunting in children younger than 5 years of age resulting from implementation of effective preventive, promotive, and curative interventions, as identified in the Lives Saved Tool (LiST),[23–36] through the two proposed strategic approaches (table 1). Baseline was defined as the current situation. The simulation was modelled for the 5-year period of 2011 to 2015, coinciding with the years remaining to meet the MDGs.

The mainstream approach modelled in this report is representative of the current investment strategies in health and nutrition programming in many countries. The primary focus of this approach is to use additional investment to increase the training and deployment of professional health workers, expand building infrastructure, and use mass communication to encourage excluded populations to seek care. The predominant delivery mode for preventive interventions in the mainstream approach is through outreach activities or health-care facilities. Curative interventions are mostly assumed to be dispensed in these facilities. In this approach, community delivery of services is almost exclusively related to promotive interventions, such as early and exclusive breastfeeding, complementary infant feeding, and improved water, sanitation, and hygiene practices. Attempts to eliminate user fees at point of service for all groups are also included in this approach.

The equity-focused approach that we modelled is representative of a strategy for additional investment in primary health care, focused strongly on preventive and primary care that specifically targets the most deprived communities. A key feature of this approach is a stronger focus on community-based interventions, through task shifting, and expanding universal outreach through the systematic use of campaigns. In particular, the approach emphasises the use of community-based case management whenever possible for the treatment of pneumonia, diarrhoea, severe acute malnutrition, malaria, and measles. The approach also seeks to maximise outreach through mobile service delivery and the use of new technologies; expand access to a selected package of life-saving maternal and neonatal clinical interventions by shifting their provision to a selected district hospital; use performance-related pay and enhanced supervision to retain and motivate health workers; provide social assistance in the form of subsidies and conditional cash transfers, in addition to selectively waiving user fees for the poor; and promote care-seeking and health practices by intensifying the roll out of community mobilisation and partnerships and media-based information, education, and communication initiatives.

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	Mainstream	Equity-focused
Service delivery modes and options		
Family-based and community-based care	Moderate focus: maintaining services at current level	Strong focus: community health workers deployed to reach 100% of villages. Task shifting to integrated maternal, newborn, and childhood community-based management of childhood illnesses. Human-resources strategy to improve performance, retention, and deployment of community health workers
Population-oriented, schedulable services	Strong focus: salaries, preservice training, and supply management for outreach. Universal access through standard outreach services (eg, child health days)	Strong focus: universal access through campaigns. Targeted cash transfers and fee waivers, comprehensive social mobilisation, performance incentives, enhanced supervision, and monitoring
Individually oriented clinical services	Strong focus: strengthen supply and logistics systems, increase infrastructure and staffing, and provide in-service training and supervision, to reach all populations at primary and referral clinics	Moderate focus: limited infrastructure investment, mostly rehabilitation, and upgrading. Performance incentives and hardship allowances for key workers at primary and referral levels
Basic services	Strong focus: additional in-service training and supervision of all workers	Strong focus: aims for universal access to skilled birth attendants. Full maternity services at primary levels including waiting homes
Clinical services	Strong focus: universal expansion of supply (eg, human resources, facilities, etc) coverage	Moderate focus: maintaining current facilities plus upgrading of one hospital per district for complicated emergency obstetric care
Financing options		
Direct costs	Strong focus: elimination of user fees for all quintiles. Contracting out to non-government providers	Strong focus: targeted elimination of user fees. Contracting out to non-government providers
Indirect costs	Weak focus: no conditional cash transfers	Strong focus: targeted conditional cash transfers
Sustainability options		
Information, communication, and education	Strong focus: mass media and social marketing to increase awareness and demand for services and health practices	Strong focus: emphasises community empowerment and demand promotion and continuity in partnership with community-based enablers and promoters

Table 1: **Comparison of two strategic approaches to service delivery and financing**

Figure 2 shows the main elements of the model used to formulate and test the strategic approaches. For each of the dimensions analysed—coverage, impact, cost, and out-of-pocket spending—the figure presents the explanatory factors (independent variables), the modelling of interactions, and the results (dependent variables) in more deprived groups and areas as compared with less deprived groups and areas. The model combines the use of two methods that have been applied in a number of contexts. The Marginal Budgeting for Bottlenecks Toolkit (MBB, version 5.5.1), a results-based planning and budgeting method developed jointly by the World Bank and UNICEF (appendix) based on the Tanahashi model of coverage of health services,[37] was used to estimate expected coverage increases, incremental costs, and sources of financing. LiST (version 4.23 beta 15),[38–41] was used to estimate the effect of different intervention packages and coverage levels on under-5 mortality and undernutrition.

Description of variables

We defined effective coverage as the provision of a service or practice of a behaviour that includes the minimum required conditions to attain its full effectiveness (including timeliness, completion, and compliance with quality standards). The explanatory factors that determine potential increases in effective coverage of interventions are the current levels of coverage, the specific determinants of coverage (availability of commodities, availability of human resources, geographic access, initial use, continued use, and effective coverage),[16] and the choice and effect size of the operational strategies selected. Data related to demand-side determinants (including effective coverage) were gathered from systematic household surveys such as the Demographic and Health Surveys (DHS) and the Multiple Indicator Cluster Surveys (MICS). Data related to supply-side determinants (availability of commodities, availability of human resources, and geographical access) were obtained or derived from different World Health Surveys, service delivery assessments, health system assessments and, in some cases, from the most recent publicly available national administrative data and other national sources (appendix). For the effect size of the operational strategies we developed estimates based on those derived from the literature review described in the accompanying report in this series[16] and summarised in the appendix.

See Online for appendix

The impact in terms of child deaths or undernutrition cases averted for any change in coverage of a given intervention will depend on its proven efficacy, the current rates of mortality, undernutrition, and fertility and other epidemiological conditions of the target population, and the distribution of the causes of under-5 mortality and undernutrition. The epidemiological parameters used were extracted mostly from standard population surveys (such as DHS and MICS) and published estimates from global disease programmes, complemented with data from national disease programmes. Baseline estimates of births and death rates were extracted from UN databases and national censuses and surveys.

Additional costs are determined by the input prices, the quantities of inputs required per delivery site or service production unit (SPU); the strategies used and the resulting bottleneck reductions in the target population; the number of illness episodes affecting this group; and their geographic context (remoteness and degree of urbanisation).

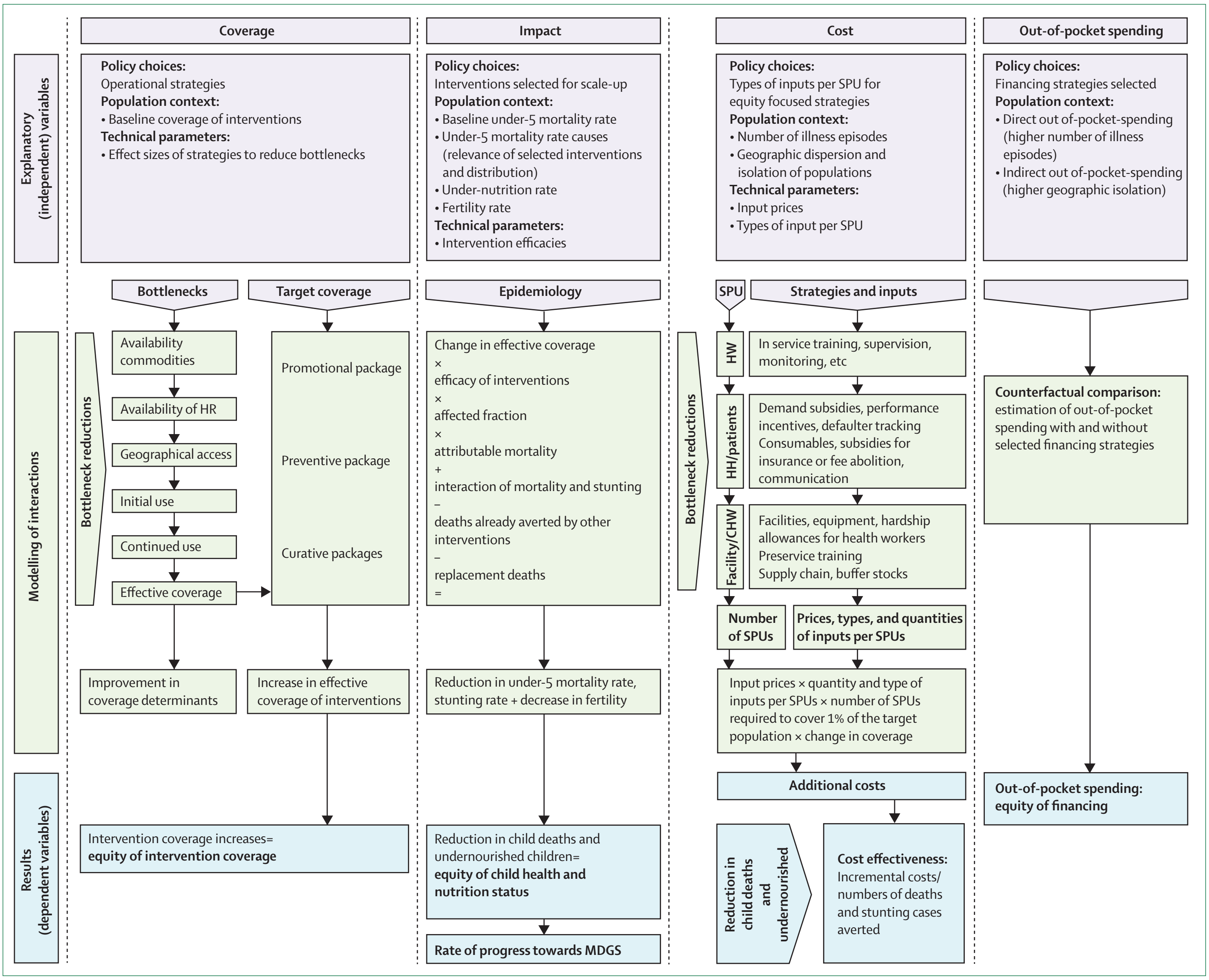

Figure 2: **Model used to formulate and test the strategic approaches**
HR=human resources. MDG=Millennium Development Goal. SPU=service production unit. HW=health worker. HH=household. CHW=community health worker.

SPUs are defined as cost centres to which individual cost items are assigned in the MBB. The SPU reflects the point of the service provision chain where bottlenecks are located and to which corrective strategies must be targeted—and, therefore, where the cost of the inputs required for their implementation must be allocated. For example, the SPUs for supply-side bottlenecks consist of primary, secondary, and tertiary-level health facilities and community health workers. On the other hand, as strategies to overcome demand-side bottlenecks are oriented towards the target population (and not the health system per se), the SPUs for demand-side determinants are the individuals or households served (table 2).

The input prices used in the costing exercise were based on data gathered from administrative sources in the countries analysed (such as salary levels and building costs), complemented by global databases of prices for tradable commodities (such as vaccines and essential commodities from UNICEF supply division). In each country, the same item prices were used to calculate the costs for different subnational populations and different strategies. Nonetheless, transport and maintenance costs for physical inputs were calculated separately for different populations within each country taking into account their relative dispersion and remoteness (measured through population density and urbanisation rate) and status of transportation infrastructure (appendix).

Out-of–pocket spending includes all the direct expenditures borne by households to pay for health services and products (such as user fees and purchase of

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drugs) as well as indirect expenditures required to use the services (including transportation and time). This spending is a function of total direct and indirect costs; the policies put in place to reduce their effect on families (such as user-fee abolition and cash transfers); and the relative level of household income (since means-tested subsidies are normally linked to income).

Conceptualisation and measurement of deprivation and inequity

We adopted an operational definition of deprivation on the basis of lack of coverage of effective health and nutrition interventions, in line with the Countdown to 2015 approach (appendix).[42] In our model, inequity of coverage was determined by geographical, economic, and sociocultural factors. For practical reasons (notably the fact that the supply of services is geographically organised), changes in inequities across geographical areas were used as the basic tracer of equity to assess the effect of the approaches modelled. However, inequities within each geographical grouping were also assessed. Income-based deprivation was explicitly assessed by identifying the populations in each region for whom financial barriers represent a significant bottleneck to the use of services and adoption of practices. These bottlenecks were addressed through modelling the effect of specific strategies (such as subsidies and fee abolition). The outcomes of these strategies were assessed by estimating changes in use of services and out-of-pocket spending for different populations living within the same service coverage area. Coverage bottlenecks associated with sociocultural barriers in each region were also measured and addressed through specific strategies (such as social mobilisation and incentives for providers).

Country selection and typologies

Table 3 shows the 14 countries and one province (Punjab province in Pakistan) selected for the analysis. These geographical units were selected on the basis of having a completed and nationally validated MBB application within the preceding 5 years; and availability of subnational disaggregated information for health facilities, health staff, and procurement capacities.

The countries selected represented a wide range of patterns of inequity that we grouped into four types. In type A countries, most of the population experience high levels of deprivation (low coverage of services) while a minority is relatively advantaged. Type C countries represent the exact opposite—in general, low levels of deprivation with an excluded minority. Type B countries represent an intermediate case with different levels of deprivation. Type B was further divided into 2 subtypes: type B1 grouping African countries and type B2 grouping Asian countries (appendix).

Estimating changes in effective coverage

The first step in the modelling process was to estimate the changes in coverage of interventions resulting from implementation of the two approaches using the MBB. This estimate was done initially by identifying the present distribution of the interventions according to the three main modes of delivery: individually-oriented clinical services delivered at fixed sites; population-oriented, schedulable services; and family-based and community-based care.

The next step consisted of grouping interventions within each service delivery mode in different subpackages. An assumption of the model is that all the interventions grouped in a given subpackage face the same bottlenecks. For example, all the interventions related to immunisation are grouped into a subpackage; this subpackage also includes other interventions delivered along with vaccines, such as vitamin A supplementation, all of which are assumed to be subject to the same bottlenecks. Hence, we selected a tracer intervention as representative of each subpackage. Indicators for the six main coverage determinants were identified and data were gathered to measure them for each tracer intervention. This approach allowed us to identify the bottlenecks for each subpackage for any given population.

As stated previously, we then determined the effect of implementing the operational strategies contained in the

	Individually oriented clinical services (curative)	Population-oriented, schedulable services (preventive)	Family-based and community-based care	
			Promotion	Curative
Availability of commodities	Facility (primary, first, or second referral)	Outreach point	Community health workers	Community health workers
Availability of human resources	Facility (primary, first, or second referral)	Outreach point	Community health workers	Community health workers
Geographical access	Facility (primary, first, or second referral)	Outreach point	Community health workers	Community health workers
Initial utilisation	Patients	Pregnant women and children	Households	Patients
Continued utilisation	Patients	Pregnant women and children	Households	Patients
Effective coverage	Health workers	Health workers	Community health workers	Community health workers

Table 2: **Service production unit by service delivery mode and coverage determinant**

	Countries
Type A*	Ethiopia, Mali, Niger, Rwanda, Uganda
Type B†	
Type B1‡	Benin, Ghana, Kenya, Nigeria, South Africa, Zimbabwe
Type B2§	Bangladesh, Punjab (Pakistan)
Type C¶	Philippines, Vietnam

*Deprivation affects most of the population and institutional capacities to manage and control targeting mechanisms are generally weak. †Deprivation affects large groups of the population and institutional capacities are limited. ‡African countries with relatively higher deprivation and mortality levels. §Asian countries with relatively lower mortality and deprivation. ¶Deprivation is concentrated in some specific groups and institutional capacities are sufficiently developed.

Table 3: **Countries selected for analysis and typologies**

Panel 1: Modelling the interactions of different strategies

When different strategies address the same bottleneck, their combined effect is not a simple addition of the individual effects of each. To address this challenge, we estimated the net effect of each strategy in a residual approach. The effect of the first strategy applied was calculated for the main bottleneck, and assumed to solve only part of it, leaving a residual bottleneck. Then the effect of the second strategy was estimated for that unsolved residual bottleneck, and so forth.

When different strategies are applied to solve different bottlenecks of the same subpackage, they can have synergistic effects. In our model, this combined effect is estimated in a cascading manner. In view of the fact that, within the conceptual framework adopted, the different coverage determinants follow a hierarchical and logical order, when a certain bottleneck is reduced, the resulting increase in the coverage determinant will affect the subsequent (dependent) coverage determinants. We assume that this cascading effect is proportional to the original level.

In the example in figure 3, a first strategy is introduced that is aimed at improving geographic access (eg, building new facilities in underserved areas), which increases its coverage from 60% to 80% (a 33% relative increase). The subsequent coverage determinants (initial use, continued use, and effective coverage) were then assumed to increase by the same proportion (33%). This cascading effect is shown in figure 3.

A second strategy aimed at improving initial use of an intervention (eg, elimination of user fees) is then applied. This strategy is expected to improve initial use further from 53% to 63% (a 19% relative increase). Therefore, the subsequent coverage determinants will be expected to further increase by a similar proportion (ie, increasing continued use from 32% to 38% and effective coverage from 20% to 24%). Finally, an additional strategy is introduced to improve effective quality coverage (eg, refresher training for providers to improve quality of care); this operational strategy is expected to have an additional effect of 10% on effective coverage, increasing effective coverage from 24% to 34%.

The effect of any strategy will be constrained by any remaining bottlenecks that exist on previous coverage determinants. For example, if geographic access is 40% and initial use is 35%, the maximum possible level of initial use with any combination of strategies (eg, abolishing user fees, mobilising communities) that do not address geographic access, is 40%. The rationale behind this modelling assumption is clear: unless we resolve an existing constraint in the system (in this case reaching the 60% of the population currently excluded from geographic access) any other efforts will have a limited effect.

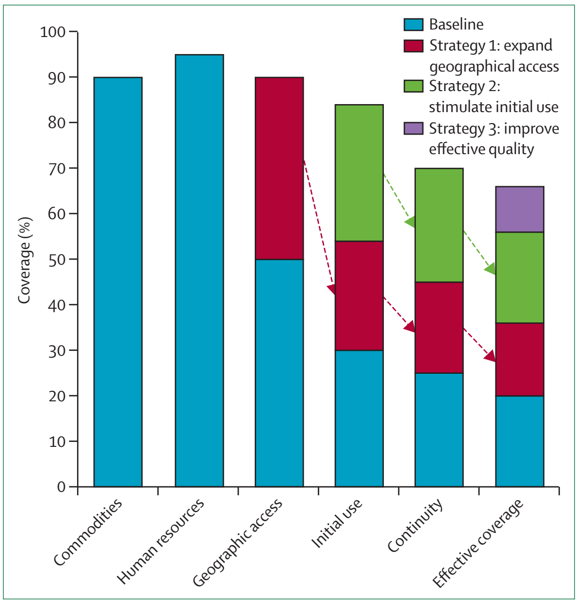

Figure 3: Modelling increases in coverage of interventions

two approaches on the specific bottlenecks and hence coverage (appendix).

Once a bottleneck was identified and addressed, the model estimated how other aspects of service delivery will subsequently improve up to the point where the next weakest link in the chain imposes a new bottleneck. The model also took into account the dynamic relation among the different determinants and the combined effect of different sets of bottlenecks. For example, evidence shows that the removal of user fees increases use of services, although the observed effect size varies widely across studies as it depends on contextual factors such as the physical availability of services.[43,44] The effect size will change as other interventions address each of the main bottlenecks (ranging from availability of commodities through to quality of care). The model takes into account such interactions for each of the different ways of delivering the services (individually oriented clinical services; population-oriented, schedulable services; and family-based and community-based care; panel 1). The first type of interaction refers to the combined effect of different strategies in addressing the same bottleneck. The second is the combined effect of different strategies applied to solve different bottlenecks of the same subpackage. The final interaction is how the effect of any given strategy is constrained by other remaining bottlenecks.

Estimating effect of coverage changes on mortality and undernutrition

The next step involved assessing the effect of the changes of coverage on key dependent variables: rates and absolute levels of under-5 mortality, stunting, and fertility. The effect of the changes in coverage of the package of essential interventions for under-5 mortality and stunting was estimated with the LiST software.[38,41,45] LiST projects the reduction in the rates of mortality and stunting that could be achieved if the coverage levels of specific interventions were increased on the basis of baseline characteristics, demographic characteristics, and coverage targets. LiST was applied independently for each of the different population groups within the sampled countries.

Assuming a fixed level of efficacy of an intervention such as measles vaccination, a much higher reduction in incidence of morbidity and mortality will be achieved in a more deprived population with higher current levels of measles. Disaggregated estimates for causes of under-5 and neonatal mortality for each subnational population group were estimated with the model developed by the Child Health Epidemiological Reference Group.[46,47] We then applied the effect of changes in coverage levels to the specific disease burden of the different population groups within a country.

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Because family planning was included in the package of interventions, birth rates are also expected to change over the 5-year estimation period. The estimations of changes in fertility and birth rates were calculated with the Reproductive Health Costing Tool developed by the UN Population Fund.[48] This method estimates changes in fertility on the basis of the interaction of all relevant parameters: the total and unmet demand for family planning; the current and projected coverage of contraceptive methods; the current and projected mix of contraceptive methods; the population structure (particularly the distribution, by age, of women of reproductive age); and the fecundity rate.

Estimating incremental costs

MBB was used to estimate the incremental costs for the application of the mainstream and equity-focused approaches in the selected countries. As opposed to the unit cost or health systems approaches, which estimate incremental costs directly as a function of the number of people reached by a given intervention, MBB estimates the costs required to overcome the bottlenecks associated with each coverage determinant independently (appendix).

Specific costs associated with overcoming supply bottlenecks included all items related to expanding or enhancing commodities, infrastructure and equipment, strengthening the supply management system and personnel costs (including preservice training). Demand-side expenses include the direct costs needed to provide the service (drugs, supplies, consumables); and the costs of specific complementary initiatives to increase use (eg, information, education, and communication), increase completion and continuity (such as cash transfers) and effective quality (eg, in-service training). The mode of service delivery influences both the demand-side and supply-side costs associated with overcoming bottlenecks. The model combined all the elements explained in the following paragraphs with this general equation to estimate incremental costs.

$$\text{Incremental costs} = \text{increase in coverage} \times \text{number of additional SPUs required to cover 1\% of the target population} \times \text{quantity and type of inputs per SPU} \times \text{input prices}$$

Estimating the additional number of SPUs required to cover the targeted population

The number of SPUs required to cover a target population varies across countries and population groups as a function of demography, geography, configuration of the health system, and epidemiology (appendix).

For populations living in less dense, more remote areas and experiencing higher levels of fertility and morbidity, the number of SPUs required will be higher than in more densely populated populations with lower fertility and morbidity (appendix). This information is used in the model to account for the heterogeneous nature of the populations within each of the countries analysed, and to reflect the relatively higher costs required to reach deprived populations.

Additionally, the model accounted for the decrease in number of SPUs required as a result of preventive interventions that decrease fertility and the burden of disease. For example, by increasing the coverage of insecticide-treated nets, the number of children requiring treatment for malaria will decrease (appendix).

Estimating the quantity and type of inputs per SPU

The amount and type of inputs required for a given SPU are determined by two key factors. First, the national norms of the health system, such as the number of health workers required per point of provision (eg, nurses required per primary-care centre as per national norms) and the number of inputs required per each unit of service provided (eg, number of doses of diphtheria, pertussis, and tetanus vaccine required per child). Second, the operational strategies and service delivery modes selected, which might require either incorporating new inputs or adjusting existing norms (eg, increasing the number of nurses per health centre).

Cost-effectiveness

Cost-effectiveness—defined here as the number of under-5 deaths and stunting cases averted per US$1 million invested—was estimated by dividing the number of deaths and stunting cases averted in the last year of the period analysed (2015) by the incremental costs incurred in that same year.

Out-of-pocket spending

We also estimated how much of the incremental costs would need to be borne by households. We estimated the effect of strategies to decrease direct and indirect out-of-pocket expenditures separately. Different targeting approaches were modelled for financial strategies reflecting the institutional capacity and pattern of inequality. This typology is shown in table 3.

In type A countries, subsidies were targeted to the whole population. In type B countries, a geographical targeting approach was modelled, meaning that subsidies were applied to the entire population living in the most deprived districts of each region (note that type B countries are divided into two subcategories; table 3). For type C countries, the poorest population was targeted, simulating a means-testing scheme.

As no sufficiently robust data are available for the current share of out-of-pocket expenditure covered by different subnational groups, the modelling exercise estimated the relative decrease in out-of-pocket spending by comparing the projected level of such spending with and without the application of fee abolition and cash transfers (appendix).

Unit of analysis

The smallest subnational unit used for all countries in the analysis was a region except for Punjab province in Pakistan and Bangladesh, where districts were used as the basic unit. We ranked the areas from the most deprived to the least deprived. Areas were then grouped into three categories: most, medium, and least deprived (appendix). Each of these three groups or categories included about a third of the population of each country to allow for cross-country comparisons.

In each country, these subgroups (the most, medium, and least deprived areas) were then used as the main unit of analysis: the levels of mortality and coverage, the epidemiological and geographical conditions, and the bottlenecks were assessed and analysed separately for each subgroup. The same package of interventions and strategies were applied to each subgroup separately and results were modelled independently for each group (for cost, impact of each strategic approach, and cost-effectiveness). This exercise facilitated comparison of the cost-effectiveness of specific policies in different groups, as well as the expected outcomes in improving equity across the groups. Finally, results were reaggregated to assess the overall progress for the country. Even though these geographical groups were used as main units of analysis, these were not classed as homogeneous groups. The diverse financial and sociocultural barriers affecting subpopulations within each of these geographical units were addressed through specific strategies and compounded in the aggregate result.

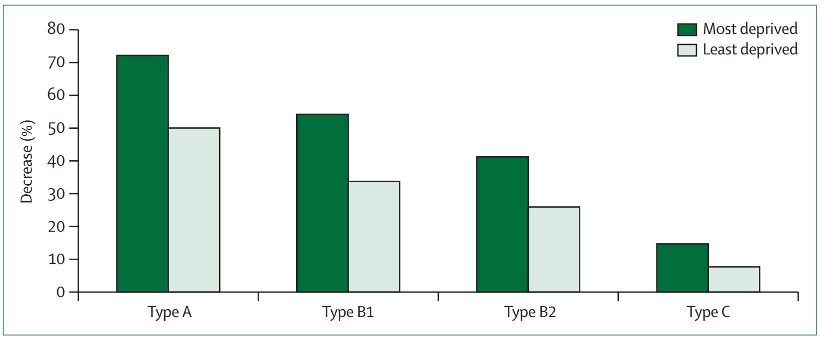

Figure 4: **Decrease in under-5 mortality rate per 1000 livebirths**

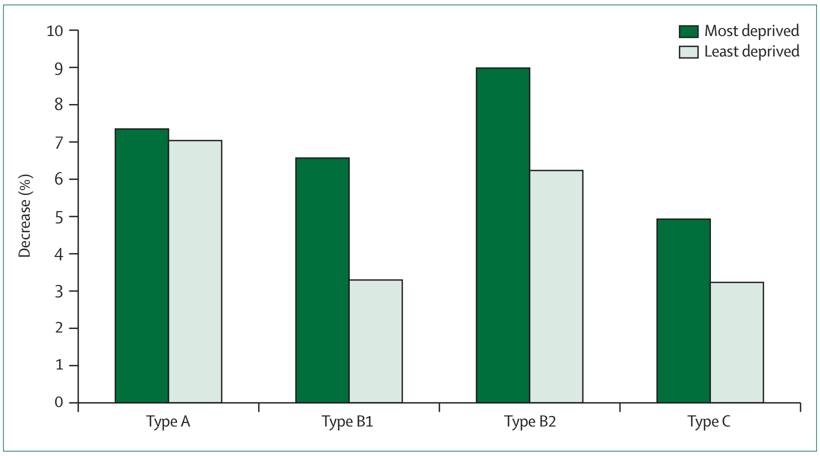

Figure 5: **Decrease in stunting rate at 12–23 months of age**

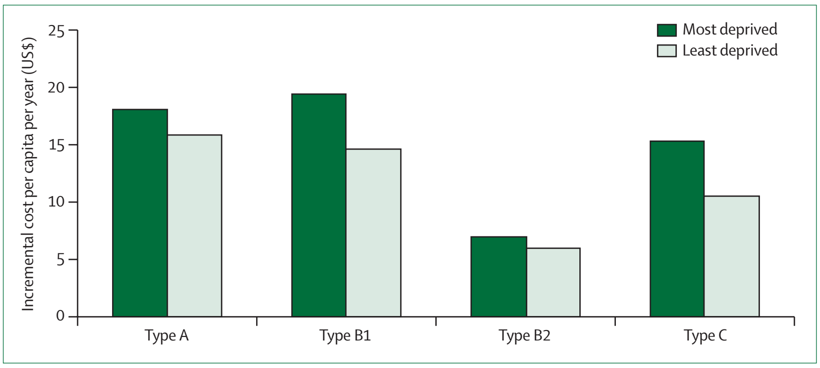

Figure 6: **Incremental cost per capita per year**

Modelling outcomes

The model suggests that the equity-focused approach results in higher increases in coverage of high-impact interventions among the most deprived populations, as compared with the least deprived. These findings were consistent across different country typologies with increased coverage ranging from 104% in the most deprived areas versus 75% in the least deprived areas in type A countries to 100% in the most deprived areas versus 57% in the least deprived areas in type C countries.

Figure 4 shows that the model projects this increased coverage to lead to relatively greater mortality declines for the most deprived communities compared with the least deprived communities. In type C countries, mortality rates are lower and a smaller proportion of deaths are due to easily preventable or treatable disorders such as diarrhoea or measles. Thus, the impact of the intervention package is less than in type A countries.

The comparatively modest declines in stunting reflect the limited efficacy of the intervention package, on the basis of existing evidence. While type C countries have lower under-5 mortality rates, they still face relatively high stunting rates and, in view of their greater capacity for implementation, the equity-focused strategy is projected to yield comparable stunting reductions in these countries (figure 5).

The calculated incremental cost required to achieve these gains was higher for reaching the most deprived communities across all the countries (figure 6). Nevertheless, investing in these communities is estimated to be more cost effective in averting under-5 deaths and stunting than investing the same amount of resources on the least deprived. The model suggests that for each $1 million invested in providing equity-focused services, approximately 97 children's lives could be saved in the most deprived populations, versus 61 lives in the least deprived populations across the 15 settings included in the analysis. In type A countries, the results showed

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160 lives saved in the most deprived populations versus 84 in the least deprived populations, and in type C countries, the results showed 16 in the many deprived populations versus ten in the least deprived populations.

The difference was even greater for chronic malnutrition (stunting): each $1 million invested in the most deprived populations through an equity-focused approach could avert approximately 279 cases of stunting compared with 188 in least deprived populations, on average in all countries.

Across all 15 settings, the model also estimated that for each $1 million invested in equity-focused national health programmes, 81 under-5 deaths and 244 cases of stunting could be averted. By comparison, for each $1 million invested in current approaches 49 under-5 deaths and 84 cases of stunting could be averted. The potential mortality reductions are higher in the poorest countries (type A; figure 7). However, the countries that have the least to gain from equity-driven health strategies in terms of child mortality reduction do seem to have more to gain in terms of reducing chronic malnutrition (figure 8).

The proportion of expenditure borne by families would decrease twice as much with the equity-focused approach than with the mainstream approach (24 percentage points *vs* 13 percentage points).

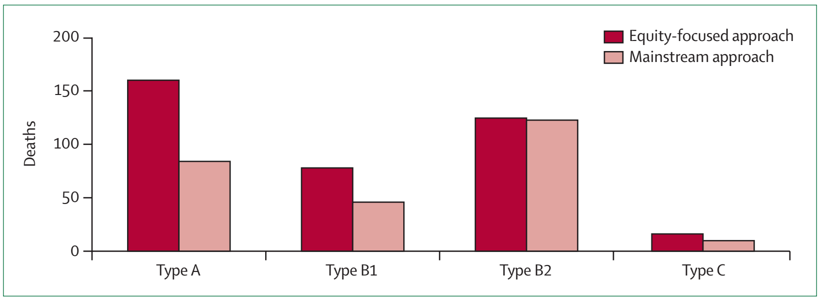

Figure 7: **Number of under-5 deaths averted in 2015 per $1 million investment**

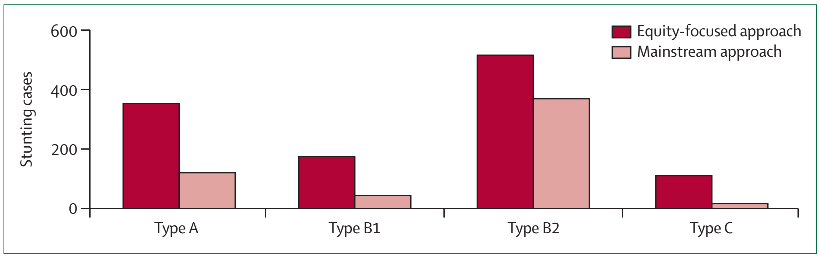

Figure 8: **Stunting cases at 12–23 months of age averted in 2015 per $1 million investment**

Conclusions

Even though substantial gains in survival can be made through increased investments with existing delivery strategies, our model supports the contention that across a wide range of countries, a focus on reaching the most deprived populations will save more lives and avert more episodes of stunting and decrease health inequities within countries. Our model also suggests that focusing on the most deprived is the most cost-effective way to deliver services to both narrow the gaps in access to services and health status between the most and least deprived population groups and accelerate progress towards health-related MDGs.

Our analysis was subject to many assumptions. The (non-econometric) modelling approach used did not allow for calculation of confidence intervals. We were conscious that many of the parameters and assumptions in the model were subject to interpretation. However, the most important parameters on which the conclusions are based—namely, the lower levels of coverage of deprived populations; their higher levels of mortality, morbidity, and fertility; and the specific bottlenecks faced by these populations—are well established in published works.

Other parameters are based on a more recent and evolving body of evidence especially the effectiveness and costs of alternative operational strategies and service delivery modes to reach the most deprived. To minimise bias resulting from the uncertainties around these data, we used analyses from a broad range of country contexts. We also conservatively interpreted the evidence on effect size—applying in our model sizes close to the lower end—because the range of effectiveness documented in the literature is broad for most strategies, precluding the possibility of undertaking sensitivity analyses. The identification of data sources to analyse supply bottlenecks, disaggregated by social group and subnational geographical region, was also a substantial challenge. We used the best available evidence on this specific aspect, although knowledge and understanding of these issues needs to be improved.

As with any modelling exercise, caution should be taken not to over-interpret the findings, in view of these uncertainties. We also appreciate that the two approaches compared are not mutually exclusive in practice—mainstream strategies do often incorporate some of the equity-focused measures we have highlighted. Yet the broader significance of the results of our model lies in the suggestion that much greater impetus needs to be given to prioritising the delivery of services to the most deprived communities, including increased use of community-based interventions.

The question, therefore, might no longer be whether to prioritise deprived populations when designing health and nutrition policies, programmes, and projects, but rather to examine and explore how to reach them in the most effective and efficient way in each specific context.

This assertion raises several policy considerations. First, identification of the most deprived children and communities at the most disaggregated level possible is necessary. A more comprehensive understanding of inequity is required when analysing a situation or designing policies and programmes that combine

Panel 2: Some areas requiring additional research

Operational strategies and service delivery modes

Even though an increasing body of evidence shows the effectiveness of the operational strategies, more research to understand mediating factors impacting this effectiveness and more precise measurement is needed. This research might require, in turn, more standardised definitions and common monitoring and assessment platforms that permit the comparison of diverse settings. Additionally, since public policy rarely offers quasiexperimental environments, adequate methods need to be further refined for this aim.

Costs

Although the costs of main inputs into the health system and operational strategies are reasonably well known, the factors determining incremental costs of reaching remote, deprived populations need to be more accurately measured and understood.

Impact

While the past decade has seen a fundamental improvement in our understanding of the effectiveness of high-impact interventions on the most prevalent and common causes of child mortality and malnutrition, a number of challenges remain:

- Obtaining a more accurate estimation of the causes of mortality that affect different population groups within each country.
- Understanding the divergences in effectiveness of any given intervention due to the delivery channels through which it is applied (eg, the effectiveness of providing antibiotics for pneumonia through community health workers might differ from the effectiveness of providing antibiotics through health professionals in clinics) and the divergences in effectiveness due to differences in quality (in our model, the concept of effective coverage explicitly includes minimum quality standards, but more information is required to assess the impact on the effectiveness of proven interventions when delivered through poor-quality services commonly encountered by most deprived communities).
- Understanding how the impact of an intervention is affected by individual conditions of the beneficiary (such as nutrition status and comorbidity).
- Assessing possible synergies and interactions that occur when a package of interventions is provided simultaneously to the same population group.
- Understanding the interactive effect of factors beyond the health sector, such as parental education levels and household income, on health outcomes, and stimulating the design and implementation of interventions to address these effects.

geographical disparities with other measures such as wealth, gender, and ethnic origin.

A second consideration is to identify the specific operational strategies and service delivery modes that are required to improve coverage deficits of essential services. The most effective interventions in health and nutrition are already known; deeper understanding of the proximate causes of mortality, morbidity, and undernutrition at the subnational level enables a better formulation of the packages required to overcome coverage deficits for those most deprived populations.

Once the most deprived populations are identified and adequate intervention packages are selected, a dedicated analysis is needed to detect the specific systemic bottlenecks that prevent those children and their communities from enjoying basic services—examining both the delivery of those services (supply-side), financial, and cultural barriers (demand-side), as well as quality deficits. Additionally, the broader social determinants of health that act across multiple bottlenecks need to be assessed, alongside the development of innovative structural interventions that address this wider context. This approach will require more granularity and heterogeneity in data collection and analysis, bottleneck identification, indicator selection, policy design, and monitoring methods.

Deepening our knowledge of the efficacy of specific interventions to prevent disease, death, and malnutrition, while necessary, is insufficient to accelerate progress and reach the poorest and most marginalised communities. A better understanding of the effectiveness, impact, and costs of the operational strategies and service delivery modes that can be used to overcome existing bottlenecks (especially those faced by people living in low-income and lower-middle-income countries) is required to ensure that deprived populations receive low cost, high-impact interventions (panel 2).

Contributors

CC, RK, and GB conceptualised the report and model. CC, RK, GB, AA, MC, and JP designed the study and participated in data collection, analysis, quality checking, and drafting the report. PD, AS, and KR analysed the data and participated in drafting the report. LP undertook data validation and documentation of the methodology. TO'C reviewed the literature, participated in data collection, analysis, and interpretation, developed analysis on out-of-pocket spending, and participated in drafting the report. ER participated in the modelling exercise, data analysis and interpretation for African countries, and drafting the report. KMA participated in data collection, analysis, validation, and modelling for Vietnam, Philippines, and South Africa.

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Conflicts of interest

We declare that we have no conflicts of interest.

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