Modeling the Effects of Health Systems Strengthening Investments

July 2022

Background

To support the development of strong health systems, it can help to ***quantify*** the potential impact of health systems strengthening (HSS) investments. With such estimates, stakeholders can better understand the expected returns on their investments, can better advocate for and justify investments, and can better prioritize among different investment options. For future investments, and when empirical measurement of past investments is impractical, quantification typically involves ***mathematical modeling***.

Models have their limitations and often rely on assumptions, especially for estimating the complex dynamics of a health system. But an imperfect model, when well understood, at least gives some information on which to base decision making. The process of developing a model can be helpful in and of itself, as an articulation of beliefs and assumptions about what is expected to arise from HSS efforts.

In this brief we ***articulate the challenges of modeling HSS investments*** and ***propose one approach*** for estimating the effects of HSS investments on health outcomes. We believe this approach is adaptable, comprehensible, and fits the way we think about health systems.

Existing models and their limitations for modeling HSS investments

Given the interest in HSS, why do we not already have a model to estimate the effect of HSS investments? Various models do exist to model aspects of HSS, but no existing individual model can readily be used to estimate the impact of multiple HSS activities on health outcomes. These models fall short for the following reasons:

- Starting too far "downstream": Models such as the Lives Saved Tool (LiST) estimate the impact of improving coverage of interventions on health outcomes, but for HSS our starting point is further "upstream"; we need a model where the inputs are HSS activities, not coverage of interventions.
- "Black box" associations: Models such as those used for WHO's workforce requirements analyses show an association between HRH density and mortality, for example, but do not explain the causal mechanism by which investments improve health. They also cannot easily include multiple HS components, given the limited data to fit such models (with countries as the unit of analysis).
- Overly specific: Studies have modeled the impact of certain types of HSS activities on HS functioning (e.g., the effect of HRH strategies on health worker performance), but the nature and effect of these activities is often program-specific and context-specific, and the studies typically do not go all the way to health outcomes.
- Overly complex: Systems dynamics models show promise for capturing the complexity of health systems, and fit with "systems thinking" approaches, but such models are difficult to implement and can be hard to reason about.

The challenge is to develop a HSS model that: (1) ***is causal*** (with pathways that are explicit, interrogatable, and match our conceptual thinking on health systems), (2) ***goes all the way from HSS activities to health outcomes*** (starting sufficiently "upstream" and ending sufficiently "downstream"), and (3) ***captures a meaningful number of factors without becoming prohibitively complex***. In the remainder of this brief we propose an approach to modeling HSS investments that meets these criteria by combining aspects of existing modeling approaches.

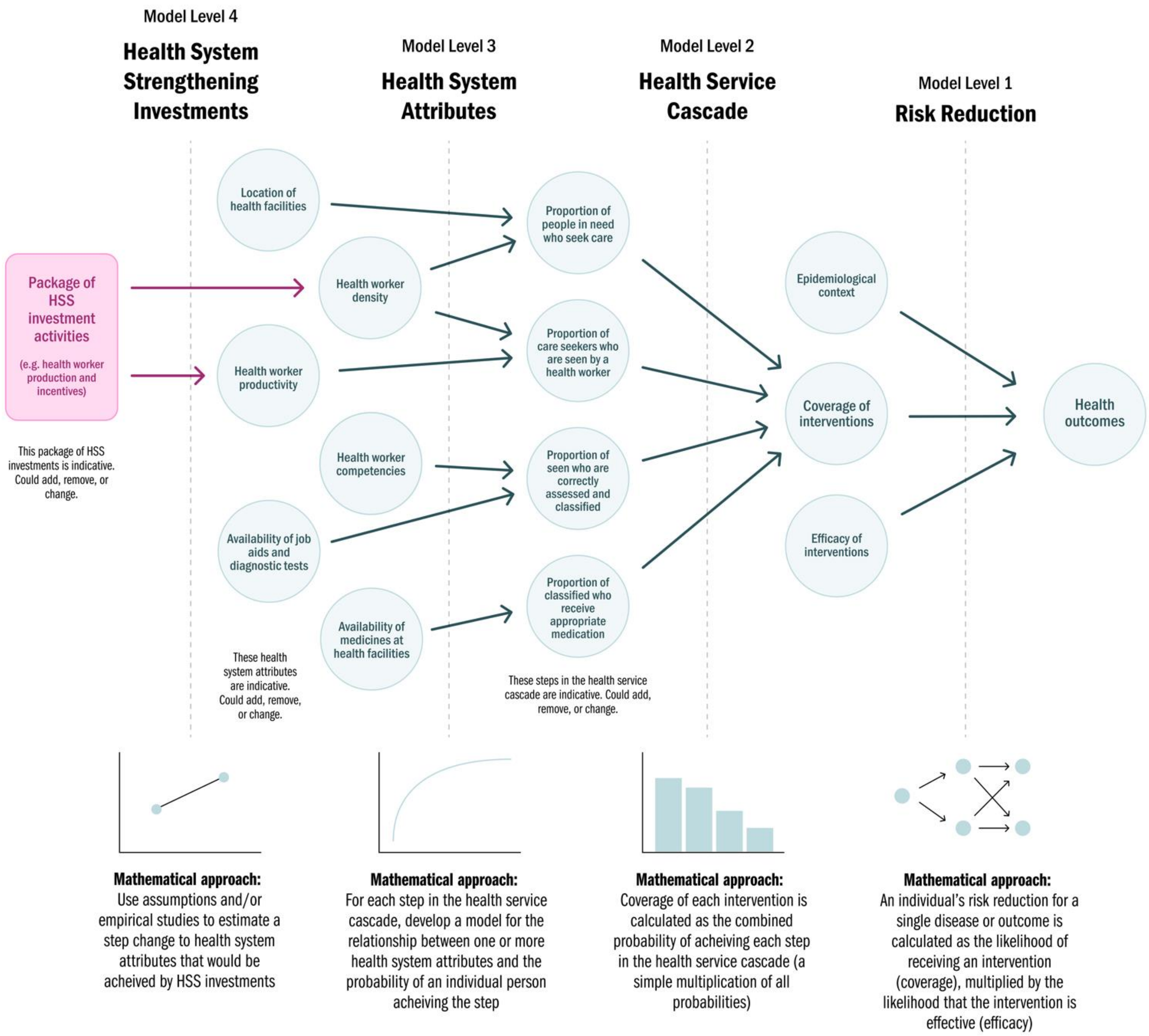
A proposed approach for an adaptable and comprehensible HSS model

What we propose here represents only an ***approach*** to modeling the effects of HSS investments. It is a mathematical framework, not a definitive model. It allows for developing different specific models depending on (a) the HSS activities of interest, (b) the availability of data, (c) the desired complexity, and (d) the assumptions made about impact pathways.

We propose a causal model with four levels. The first level establishes health outcomes as a function of coverage of interventions, using the same approach taken by LiST and similar models. The second level sees coverage as a function of a service delivery cascade, as conceptualized by Tanahashi and in the more recent commentary on effective coverage. The third level links each step in the service delivery cascade to a set of health system attributes. The fourth level describes how health system attributes are improved by HSS investments.

Figure 1 explains the approach with some indicative examples of HSS investment activities, health system attributes, and steps in a health service cascade. In this approach, HSS improves population health outcomes by increasing coverage of interventions; in other words, by *increasing the proportion of people who receive prevention and treatment interventions*. The factors in levels 2-4 can be interchanged with other factors, but the methodology for estimating the factors in each level from the preceding level is always the same.

Figure 1. Conceptual model



Illustrative example

To illustrate the proposed modeling approach, we imagine a scenario in which a Ministry of Health (MoH) wants to know how improving different aspects of the health system will impact neonatal and maternal mortality. Table 1 shows the input data that might be available to use (parameters that would appear in the first column of the conceptual model, Figure 1). Table 2 lists three investment scenarios. The MoH wants to estimate how many additional lives saved might be achieved by each of these scenarios.

Table 1. Input data / model parameters

Health worker numbers and distribution	78% of facilities have at least one trained nurse or midwife
Demand for health services	81% of pregnant women seek at least one antenatal care visit (ANC 1+) 57% of pregnant women deliver at a health facility
Availability of supplies and equipment	84% of facilities have iron tablets or combined iron/folic acid tablets 89% of facilities have tetanus toxoid vaccine 79% of facilities have broad-spectrum antibiotics 56% of facilities have uterotonics (oxytocin) 62% of facilities have anticonvulsants (MgSO4)

Table 2. Three investment scenarios

1	Health workforce investments	Increase the number of health workers, so that 95% of facilities have at least one nurse or midwife
2	Demand-side investments	Invest in community-based education programs to increase demand for maternal health services (increasing ANC 1+ and facility delivery to 90% and 80% respectively)
3	Supply chain investments	Ensure that at least 95% of facilities have supplies of iron/folic acid, tetanus toxoid vaccine, antibiotics, oxytocin, and MgSO4

This example is intentionally kept simple for illustration purposes. In addition to the parameters in Table 1, the model would include other empirical and assumed values. In our example, these values would be held constant and would not change across scenarios, so we do not show them here.

Using the proposed modeling approach, we can estimate how the three different scenarios would alter the health service cascade for different interventions. Figure 2 shows how the cascade might change for the intervention of iron supplementation during pregnancy. In this example, health workforce investments would increase coverage of iron supplementation from 53% to 65%, demand-side investments would increase coverage from 53% to 59%, and supply chain investments would increase coverage from 53% to 60%.

Figure 2. Health service cascade for iron supplementation, under three investment scenarios

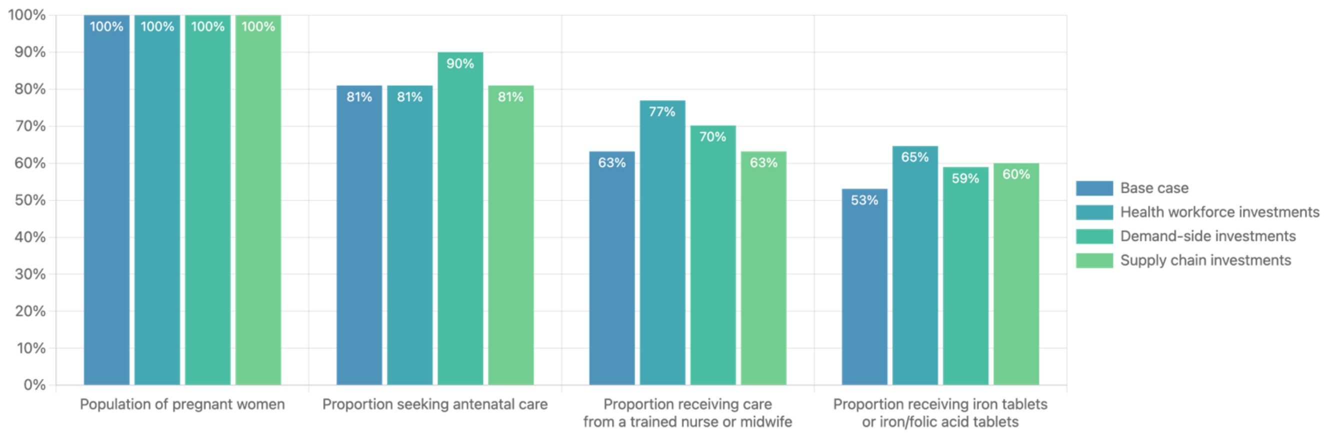


Figure 3 shows how the three investment scenarios might increase the coverage of five maternal health interventions. In this example, the biggest increase to iron supplementation would come from health workforce investments, increasing coverage from 53% to 65%. The biggest increase to anticonvulsants for eclampsia would come from supply chain investments, increasing coverage from 28% to 42%.

Figure 3. Intervention coverage for five interventions, under three investment scenarios

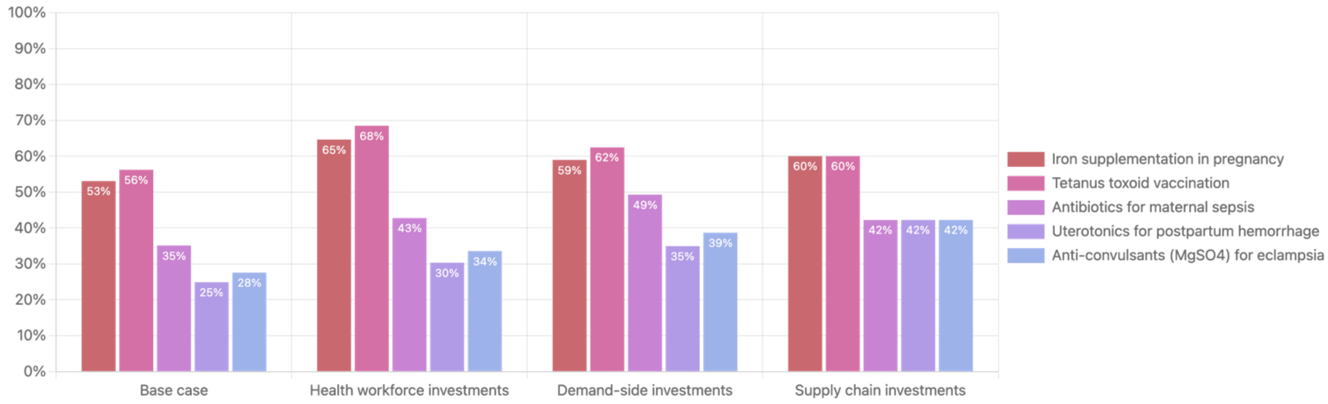
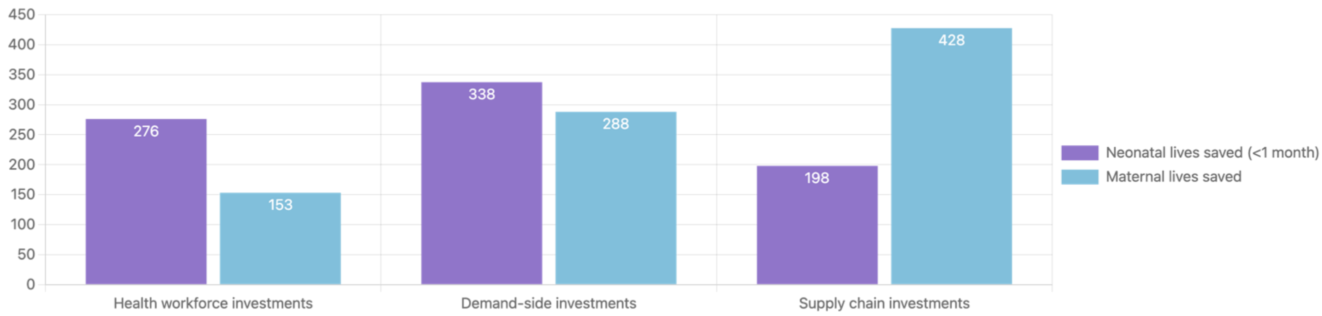


Figure 4 shows the number of neonatal and maternal lives per year that would be saved by each investment scenario. In the first two scenarios (health workforce and demand-side investments), more neonatal lives are saved, due to the larger coverage improvements to tetanus toxoid vaccine. In the third scenario (supply chain investments), more maternal lives are saved, because tetanus toxoid vaccine does not increase by as much, and there are larger increases to the other four interventions, which predominantly affect maternal mortality.

Figure 4. Lives saved per year due to the five interventions, under three investment scenarios



Summary

Health systems are highly complex, and any effort to model their functioning is bound to have limitations. In this brief, we proposed a modeling approach that is causal, goes all the way from health systems attributes to health outcomes, and captures a meaningful number of factors without becoming prohibitively complex. This approach stands in contrast to systems thinking and systems dynamics modeling in that it lacks the ability to capture feedback loops and other interactions. The advantage we see, however, is that it is more easily understood and fits the way many practitioners already think, being similar to a logic model or theory of change and incorporating the idea a service delivery cascade. We encourage others to consider this approach and seek opportunities to apply the ideas presented here to real-world scenarios and policy questions.