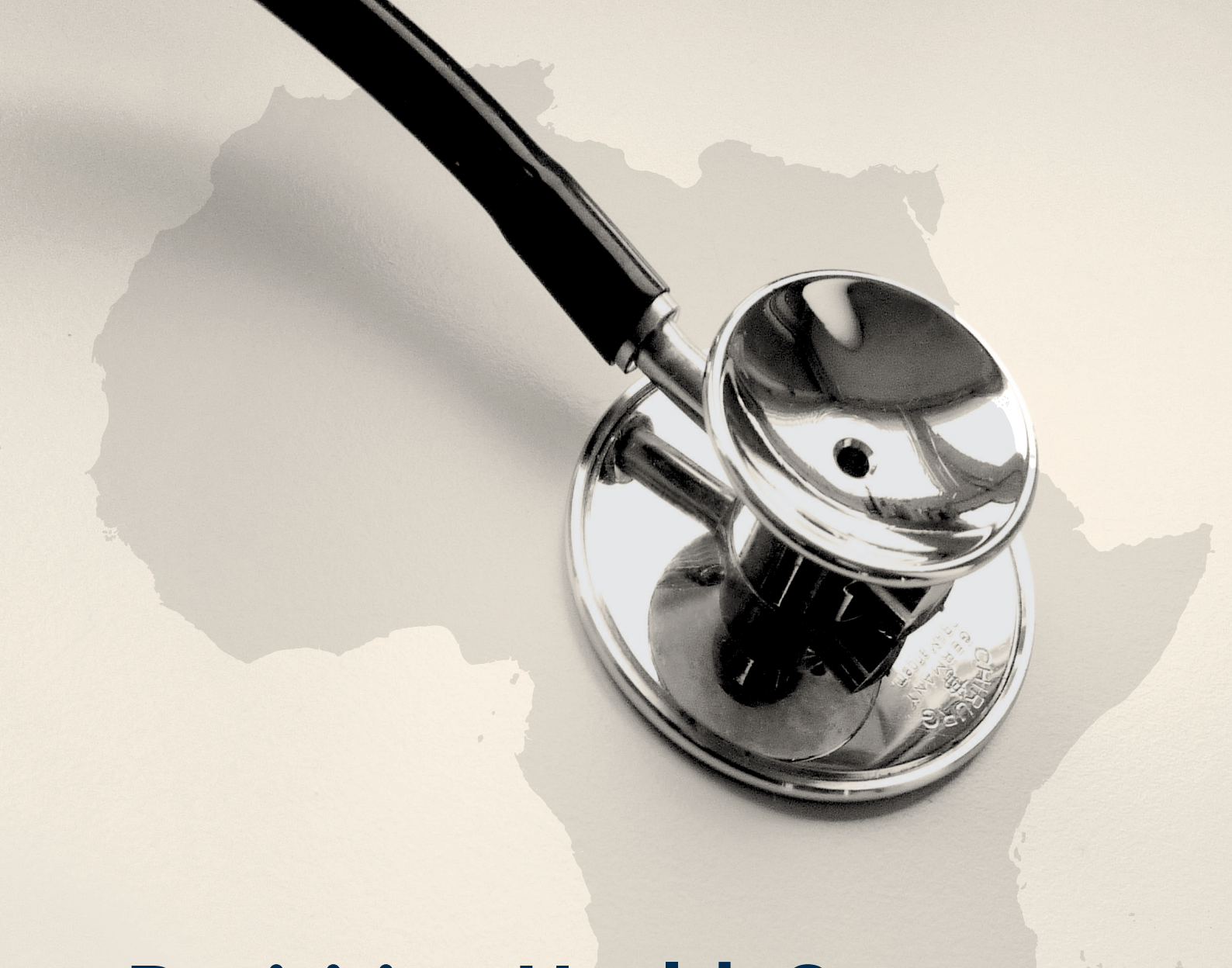

Revisiting Health System Performance Assessment in Africa

A landscape in transition

Tom Achoki

REVISITING HEALTH SYSTEM PERFORMANCE ASSESSMENT IN AFRICA

Tom Nyandega Achoki

The research as presented in this PhD thesis was conducted under the umbrella of the Utrecht World Health Organization (WHO) Collaborating Centre for Pharmaceutical Policy and Regulation, which is based at the Division of Pharmacoepidemiology and Clinical Pharmacology, Utrecht Institute for Pharmaceutical Sciences, Utrecht University, The Netherlands. The Collaborating Centre aims to develop new methods for independent pharmaceutical policy research, evidence based policy analysis and conceptual innovation in the area of policy making and evaluation in general.

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door

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CHAPTER 1

INTRODUCTION

INTRODUCTION

The African continent continues to face many population health challenges, characterized by a vicious cycle of high disease burden, weak health systems and limited resources for effective health service delivery [1]. Recently, this cycle came to bear when the Ebola epidemic ravaged most of the western Africa region, exposing severe inadequacies in some of the health systems with limited capacity to mount an effective response [2]. Furthermore, in many countries within the sub-Saharan Africa region, communicable disease conditions such malaria, maternal and childhood illnesses, which could easily be controlled using simple and inexpensive health technologies, still continue to be significant contributors to health loss in the region [1,3]. This is in the backdrop of an emerging epidemic of non-communicable diseases and injuries, which are exerting further pressure on the already vulnerable health systems [3,4,5].

However, amidst these pressing challenges and grim outlook, many health systems across the region are still striving to improve population health. There are some encouraging trends from various countries within the region. For example, Zambia has recently scaled up some of the priority maternal and child health interventions, to great success, evidenced by steady declines of under-5 mortality over the past two decades [6]. Botswana, which is faced with a huge burden of HIV/AIDS has consistently recorded high population coverage with key interventions such as antiretroviral treatment (ART) and prevention of mother to child transmission (PMTCT) of HIV [7]. Overall, a similar trend is observed in many countries within the sub-Saharan Africa region, which have managed to register improvements in child survival and reduced mortality due to common communicable diseases, including HIV/AIDS with varying degrees of success [8].

With this mixed picture of isolated successes and challenges, it becomes clearly apparent that a comprehensive assessment strategy is vital in order to fully appreciate how specific health systems are meeting the prevailing population health needs. This cannot be accomplished satisfactorily by narrowly focusing on a specific part of the health system or disease area, but rather by appreciating the health system as an assemblage of many moving parts, all working together to improve population health [9]. It is only through this approach that health system performance assessment would become an important policy tool to guide decision makers in pinpointing progress, stagnation as well as regression in health service delivery and the resultant population health trends [9,10].

The World Health Organization (WHO) in its seminal work has provided a clear basis for health system performance assessment, by elaborating a logical framework that outlines the key components and objectives of the health system [11,12]. As shown in Fig. 1, the framework is underpinned by the core functions of the health system, namely; health service delivery; development and deployment of human resources for health; collection, analysis and utilization of critical health information; promoting access to essential medical products, vaccines and other health technologies; ensuring adequate health financing; and effective leadership and governance [12]. According to the authors of the framework, all these six components are supposed to interact closely in the production process aimed at meeting the prevailing population health needs and improve health.

In addition to improving population health, the health system is supposed to ensure equitable distribution and utilization of health goods and services. It is also expected to be responsive to the legitimate non-health expectations of those seeking healthcare; ensure

fairness in financial contribution across the population; and embrace efficient and cost-effective delivery. As an intermediate objective towards improving health, the health system is responsible for ensuring that the population has both physical and financial access to the essential health goods and services. Effective population health coverage can only be attained once those in need of a specific health good or service have access, utilize and derive health benefits as a result [12,13].

Therefore, any comprehensive effort towards measuring the performance of any health system, must be anchored on the health system framework and seek to understand how the different components are working together in the effort to meet the population health needs and improve health. More so, in seeking to tackle the various health system challenges, it is fundamentally vital for the health system stewards to carefully examine trends across the different components and levels of the health system such that a consistent and instructive story emerges. For example, if decision-makers only focus on the national aggregate estimates of performance, they might miss out on important subnational trends that could reveal geographical inequalities, requiring closer policy attention. This is illustrated by Colson et al. [6], who demonstrated that national estimates masked substantial variation across districts in the levels and trends of all health indicators in Zambia.

In addition, paying attention to only one component of the health system without accounting for trends and interactions with the other related parts might also lead to spurious conclusions. For instance, a number of studies have repeatedly demonstrated that, despite the fact that many health systems in Africa often cite resource constraints as a major hindrance to progress in service delivery, there are still significant levels of inefficiency when considering both inputs and outputs [14,15]. According to a recent paper from the Institute for Health Metrics and Evaluation (IHME), which assessed the technical efficiency of health facilities in the delivery of antiretroviral treatment in three African countries; Kenya, Uganda and Zambia; more health services could be provided with the available resources [16]. Di Giorgio et al. [16], emphasize that all the three countries, demonstrated massive levels of inefficiency, at 34%, 40% and 39% respectively, in the utilization of available resources to provide health services in general. This is also consistent with the findings of Masiye [17], which established that a significant proportion of hospitals in Zambia were technically inefficient.

Still, health systems do not operate in a vacuum, but within an eco-system where they continually interact with various political, socio-economic and socio-cultural factors. Therefore, population health outcomes are the result of many complex factors inside and outside the health system [9,12]. For example, Gakidou et al. [18] point out the fact that increased educational attainment among women of reproductive age, was significantly associated with declines in under-5 mortality across many countries. The role of poverty, indoor pollution, access to clean water and sanitation on population health have also been extensively documented [19, 20]. Therefore, strategies to assess and improve the performance of health systems also need to appreciate such contextual factors in order to fully account for the observed trends. It is only such comprehensive assessment that decision-makers would be equipped with sufficient evidence to appropriately direct policy attention and utilize the scarce resources effectively.

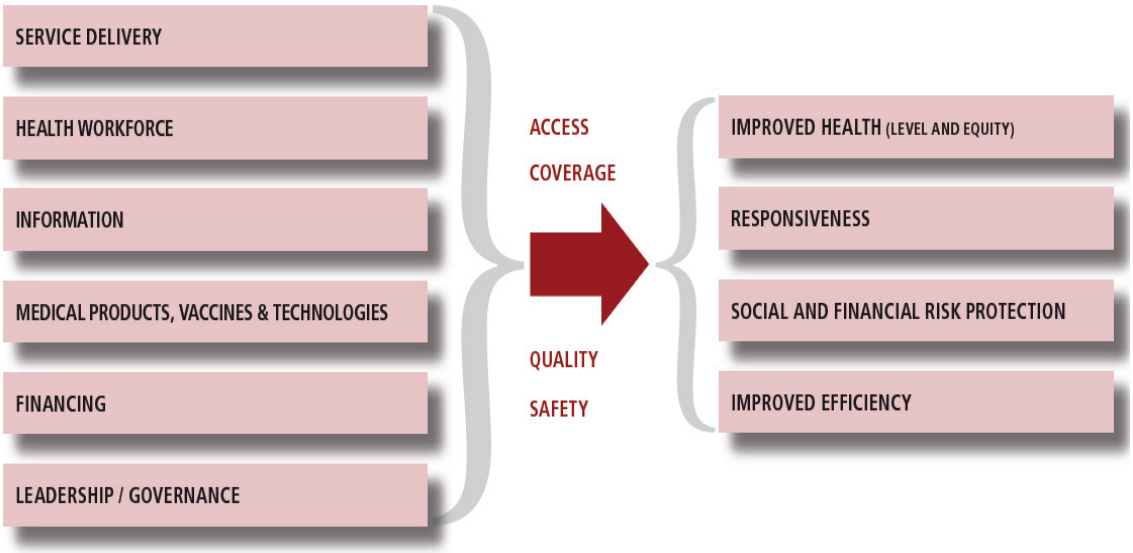

Figure 1: *Health System Framework*

AIMS

With many health systems across low and middle income countries facing difficult options characterized by diminishing resources and competing health priorities, this thesis builds a solid case for decision-makers to embrace health system performance assessment as a policy directing tool to guide efforts towards improving population health. We seek to illustrate how to assess the performance of health systems using different resources that are readily available to health system stewards and researchers in most of the low- and middle- income countries.

We have sought to apply different research methods employing both quantitative and qualitative techniques, such that a consistent and instructive story emerges. Specifically, in our quantitative analysis, we have relied on secondary data sources that are readily available in many countries through population based surveys, routine health information systems and other administrative data systems. In addition, we have made efforts to access information from various databases that are freely available such as the Global Burden of Disease Study (GBD) and Health Action International (HAI), to buttress our assessment.

By innovatively combining different data sources that are readily available to answer some of the priority questions that face many health system stewards, we hope to encourage and mainstream the culture of health system performance assessment in low- and middle- income countries. The approaches of performance assessment that we have employed in this thesis can be easily adopted and applied by health system managers operating with limited resources.

OUTLINE OF THE THESIS

In **chapter 2,** we use data from the Global Burden of Disease Study (GBD) to provide an overview of the burden of disease in the sub-Saharan Africa region. Here we seek to illustrate some of the challenges health systems in the region are facing as basis for defining the population health needs. We make policy relevant comparisons across the four sub-regions; central, eastern, southern and western, that made up the region.

In **chapter 3.1,** we drill down to Zambia, a low-income country in Africa and provide information on maternal and child health intervention coverage trends between 1990 and 2010, in benchmarking performance across the 72 districts in the country. The interventions that we have considered are critical for addressing childhood illnesses that contribute significantly to the burden of disease in the sub-Saharan Africa region. These interventions include childhood vaccinations such as Bacillus Calmette-Guérin (BCG); diphtheria-pertussis-tetanus (DPT); measles, polio, and pentavalent vaccines; as well as health technologies for malaria prevention such as insecticide treated nets and intermittent prevention of malaria in pregnancy. In total 17 health interventions that are closely tied to child survival were considered.

We aggregate 9 key health interventions into a composite coverage metric at the district level as a measure of the overall health system output in chapter 3.2. We then explore how financial resource disbursement to districts in Zambia could affect progress in the efforts to scale up health intervention coverage. Specifically, we assess the impact of different funding scenarios and channels through which the very funds are disbursed as a determinant of coverage.

In **chapter 4.1,** we assess the technical and scale efficiency across the 72 districts on how the available resources are utilized to improve under-5 survival. In this analysis various components of the health system, such as human resources for health, financial resources and health technologies are considered in a joint analytical framework with under-5 survival as a primary health system outcome. In this case, health technologies comprised of measles and DPT vaccination, malaria prevention and skilled birth attendance (SBA), which are all critical for child survival in many low- and middle- income settings. Further, health system productivity change in reducing under-5 mortality in Zambia is covered in chapter 4.2. This analysis, covers the period between 2004 and 2009, when the Zambian health system saw the introduction and rapid scale up of medicines, vaccines and other health technologies targeting child survival.

Chapter 5, changes focus from the maternal and child health landscape, and focuses on diabetes mellitus. In this analysis we assess how health systems in sub-Sahara Africa are responding to the rising burden of diabetes mellitus and its risk factors. We consider availability and affordability of the some of the essential medicines used to treat diabetes mellitus. In chapter 6, we present the perspectives of health systems stewards in Botswana. In this qualitative study we explore the health financing situation in the country, and assess how a proposed policy reform could impact progress towards universal health coverage, paying specific attention to access to medicines, efficiency and cost effectiveness of health service delivery.

Chapter 7 is a brief report from Botswana that demonstrates the country's progress towards eliminating mother to child transmission of HIV, by embracing cost effective health interventions. Lastly in chapter 8, we conclude the thesis and offer perspectives on health policy implications of this work.

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CHAPTER 2

THE EVOLVING BURDEN OF DISEASE IN AFRICA: HEALTH POLICY IMPLICATIONS FOR DECISION-MAKERS

Currently in press: Health Policy and Planning

Tom Achoki, Lauren Hashiguchi, Martin O. Ota, Uzma Alam, Temesgen Awoke, Abaleng Lesego, Pierre Ongolo-Zogo, Anke Hovels, Charles S. Wiysonge

ABSTRACT

Introduction

National health systems within sub-Saharan Africa are faced with disparate epidemiological challenges and often operate under diverse socio-economic and socio-political circumstances. Health decision-makers are expected to draw important lessons from a careful examination of population health trends and their determinants.

Methods

We used data from the Global Burden of Disease Study 2013, which employed standard methodology for estimating population health loss across time, geographies, sex and age groups. This measured spatial and temporal trends for important population health indicators for the various sub-regions and countries within the sub-Saharan Africa region, for the period between 1990 and 2013.

Results

Over the 23-year period, the sub-Saharan Africa region, made progress in reducing mortality and overall health loss. However, performance was heterogeneous across age-groups, countries and sub-regions. Regional under-5 mortality rates registered progress, dropping from 4138.5 deaths per 100, 000 (95% UI: 4087.7- 4192.4) in 1990 to 2129.5 deaths per 100, 000 (95% UI: 2000.9- 2280.0) in 2013. The fastest drop averaging -5.1% per annum was registered in Benin, in the western sub-region. Age standardized mortality rates also declined in the region, albeit at a slower rate, declining from 1674.7 deaths per 100,000 (95% UI: 1651.4- 1700.7) in 1990, to 1454.9 deaths per 100,000 (95% UI: 1424.6- 1487.7) in 2013. Age standardized DALYs also followed a similar trend, with the eastern sub-region as the best performing. However, the contribution of non-communicable diseases and their risk factors to overall health loss also became more significant.

Discussion

The sub-Saharan Africa region has made significant progress in reducing mortality and overall health loss. However, the progress within and between the four sub-regions was highly variable. Therefore, health systems stewards in the region must be aware of these trends and seek to adapt and innovate appropriate measures in their quest to improve population health.

Key words

Burden of Disease; Sub- Sahara Africa; Health System Performance

INTRODUCTION

Sub-Saharan Africa is a vast region which carries a huge and rapidly growing population [1]. Though it is often viewed as a homogenous entity, the region hosts an extraordinary diversity of cultures, climatic and environmental conditions. Countries within the region also operate across a wide spectrum in terms of the socio-economic and socio-political development scale [1,2]. Amid this rich cultural, environmental, and economic diversity, there are also important similarities that cut across the sub-regional blocks. For instance, many neighboring countries not only share similar ethnic profiles, but also unique cultural identities and socio-economic characteristics [1].

Cultural, climatic, and environmental factors influence health, so it is logical to expect that population health outcomes in the sub-Saharan region would exhibit not only diverse trends, but also a level of shared characteristics that mirror the wide distribution of some of the key drivers and determinants of health [2,3]. By carefully examining population health trends and their determinants, the decision-makers operating in the region's health systems might more easily collaborate on shared health challenges. For example, benchmarking population health outcomes and their determinants across time and space, could allow national (and sub-national) health system stewards to learn from their better performing peers and be empowered to assess progress, stagnation and regression of performance, in order to institute appropriate measures in a timely fashion [3,4].

In addition, by having an in-depth understanding of the level and magnitude of population health challenges, decision-makers could be better placed to objectively set priorities and select the best ways to intervene [3]. For instance, by linking information on specific causes of burden of disease with the costs and effectiveness of the different options and interventions available, health systems decision makers would be empowered to objectively allocate resources and assess the performance of their health systems. This is particularly relevant to the sub-Saharan Africa region, which is faced with a multitude of competing health priorities in the backdrop of limited resources [5,6].

The Global Burden of Disease Study (GBD) is the largest and most comprehensive effort to measure epidemiological levels and trends of diseases, injuries and their risk factors across the world [7]. By providing standardized information on key population indicators across different geographies and time periods, GBD facilitates objective comparison between countries and regions of the world [7,8]. This information is not only highly useful to benchmark performance, but is also a vital policy directing tool to pinpoint decision-makers to areas where further attention is needed in order to effectively respond to population health needs.

The focus of this paper is to provide an overview of the burden of disease trends across the sub-Saharan Africa region and make comparisons across the four geographical sub-regions; the eastern, central, southern and western that make up the region. We further pay specific attention on the priority risk factors that are associated with the observed burden of disease and injuries across the four regions in focus. Based on the observed trends, we seek to highlight some of the priority areas where respective health systems decision-makers could focus on in their attempts to tackle some of the prevailing population health challenges facing the region.

METHODS

The GBD methodology has been adequately described elsewhere [7-9] So far, it is the most comprehensive global study to collect, analyze and produce comparable estimates of health loss and their risk factors for regions and countries across the world.In summary, this entails the identification of all available data sources, evaluation of the quality and correction for known

bias in each data source, consistent statistical estimation including uncertainty analysis, and cross-validation analysis to assess model performance. Specifically, on propagation of sampling and non- sampling error as well as model uncertainty, all the reported estimates are obtained by repeating all the steps in the calculations 1000 times. From these draws, the 95% Uncertainty Intervals (UI), are represented by the values in the 2.5 percentile and 97.5 percentile [7,8].

A comprehensive list of causes of disease and injuries, organized into a hierarchy comprising of four levels of disaggregation is used in the GBD analytical framework. At every level the causes are mutually exclusive and collectively exhaustive [9]. For GBD 2013, this comprised of 306 causes, and the first level of disaggregation broadly grouped into 3 categories, namely, communicable, maternal, neonatal, and nutritional (CMNN) disorders; non-communicable diseases (NCDs); and injuries. Drilling down from these three broad categories, finer categories of causes of health loss and their sequelae (clinical outcomes resulting from a specific cause) are defined in a comprehensive and consistent manner. Estimates, were produced for all geographies, age groups and sex categories, from 1990 to 2013, to facilitate useful comparisons that are informative to health system policy making and performance assessment [7-9].

GBD uses a number of related metrics to measure population health loss in a comparable and consistent manner. These include, number of deaths and mortality rates, years of life lost due to premature death (YLLs), years of life lived with disability (YLDs) and disability adjusted life years (DALYs). YLLs are a function of deaths observed at a specific age group and the reference life expectancy at the age of death. Meanwhile, YLDs are obtained by multiplying the prevalence of a sequela and its disability weight. Specific weights attributed to different sequela are derived from large population surveys across the world [7,10]. The DALY concept has been developed and refined as a measure of overall health loss, and is obtained as the sum of YLDs and YLLs [7-9].

In order to understand the impact of important determinants of health, the GBD framework, also embraces a systematic approach, which selects risk factors according to their relevance in policy making [9,11]. First, using meta-analysis from published literature, the relative risk of a specific risk factor on mortality or morbidity is determined. The next step entails, determining the distribution (from published and unpublished sources) of the specific risk factor of interest- across, different geographies, sex and age groups. Lastly the attributable health loss to a specific risk factor is determined by counterfactual analysis, whereby a comparison is made between the observed distribution and the theoretical minimum risk [7,12]. In a similar analytical approach to the causes of health loss, risk factors are organized in a hierarchical structure that includes different levels of aggregation [12]. These are also mutually exclusive and collectively exhaustive at every level of aggregation.

In summary, this approach confers a common currency to understating health loss and its determinants, and hence facilitates appropriate comparisons across diseases, geographies and age groups [7,9,12]. We have used estimates from this comprehensive and rich data source to make comparisons across the sub-Saharan Africa region that are policy relevant to health system stewards and other decision makers. In this paper, we focus on the four sub-regions that make up the region, namely, central, eastern, southern and western. Here, we interrogate trends for three important areas covered by GBD, namely; mortality, DALYs and risk factors.

RESULTS

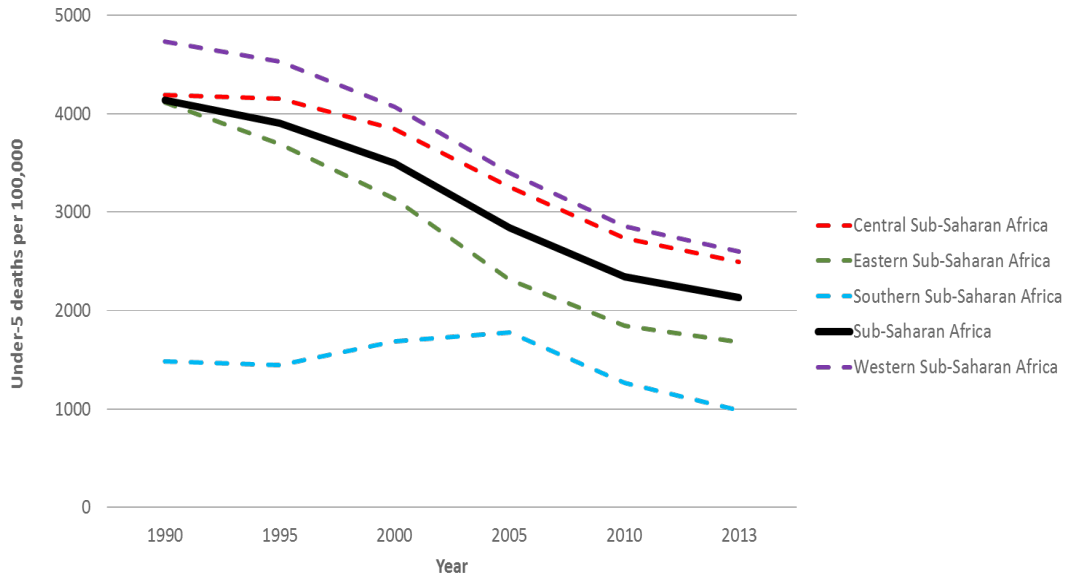

Figure 1: *Trends of under 5 mortality rates, 1990 to 2013*

Figure 1 shows that all sub-regions within sub-Saharan Africa, registered a reduction in under-5 mortality rates between 1990 and 2013. On average, under-5 mortality declined, from 4138.5 deaths per 100, 000 (95% UI: 4087.7- 4192.4) in 1990 to 2129.5 deaths per 100, 000 (95% UI: 2000.9- 2280.0) in 2013. In the early 1990s there was a wide gap across the sub-regions, with the southern as the best performing while the rest lagged behind. However, this performance gap gradually narrowed as the central, eastern and western sub-regions registered a rapid decline in under-5 mortality while the southern stagnated or registered an increase in mortality until 2005.

Despite the progress, by the year 2013, there was still a significant performance gap across the four sub-regions. With the regional average under-5 mortality rate at 2129.5 deaths per 100, 000 (95% UI: 2000.9- 2280.0) in 2013, the eastern and southern were better performers, at 1678.3 deaths per 100, 000 (95% UI: 1557.4- 1813.4) and 987.5 deaths per 100,000 (95% UI: 838.8- 1148.0) respectively, while the central and western sub-regions lagged behind, at 2491.4 deaths per 100,000 (95% UI: 2088.7- 2957.4) and 2601.2 deaths per 100,000 (95% UI: 2429.5-2778.6) respectively. Over the 23-year period, the largest progress was registered in the eastern sub-region, which registered a decline from 4112.8 deaths per 100,000 (95% UI: 4041.9- 4187.5) to 1678.3 deaths per 100, 000 (95% UI: 1557.4- 1813.4) between 1990 and 2013.

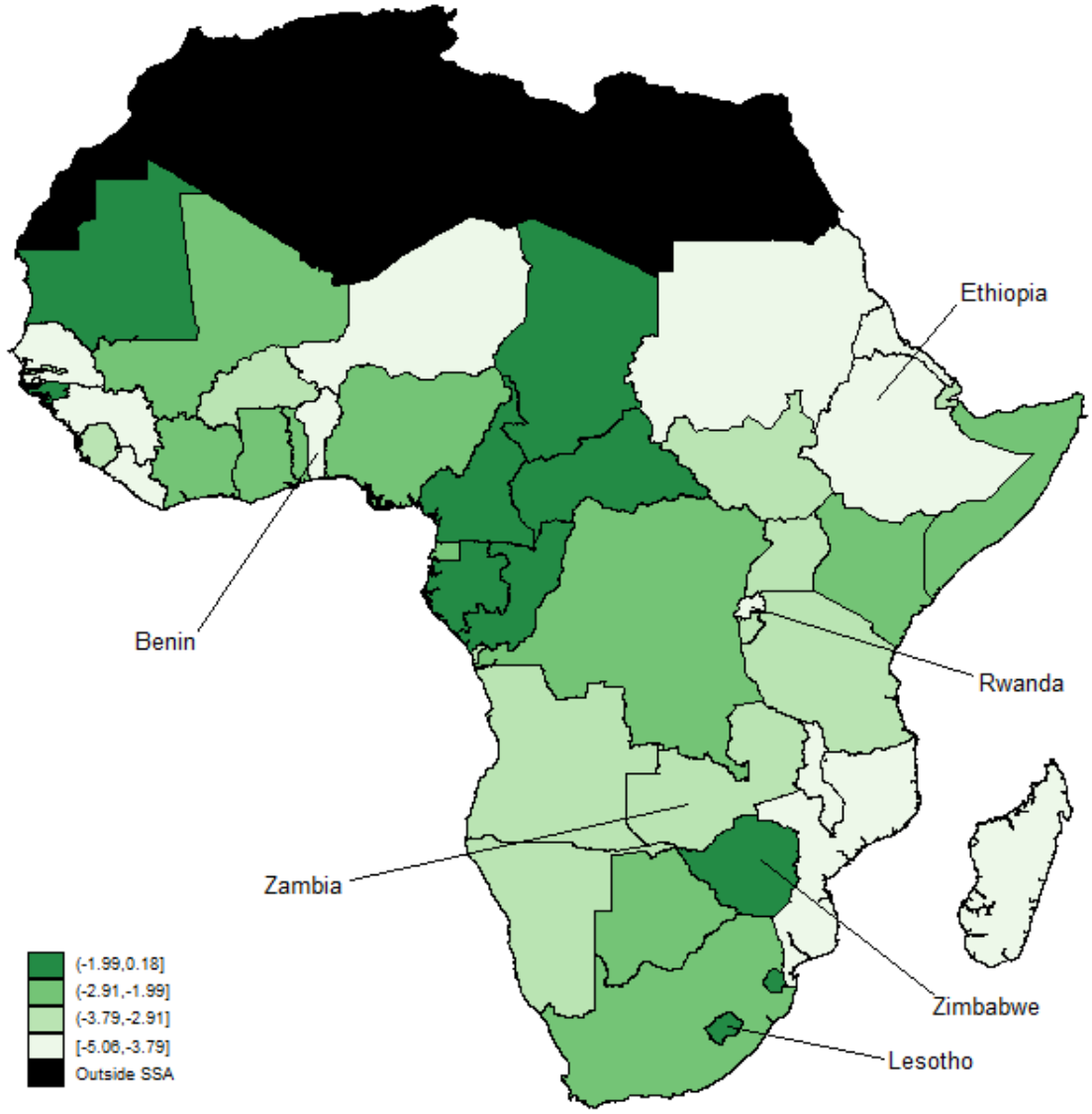

Figure 2: *Annual percentage change in under 5 mortality, 1990 to 2013*

Figure 2 drills down to the country level, and shows the annual percentage change in under-5 mortality over the course of 23 years. Performance across the sub-Saharan Africa region was very heterogeneous, with countries such as Benin and Ethiopia, registering a faster decline in mortality averaging -5.1% and -5.0% per annum respectively, while Swaziland and Lesotho registered a slower decline averaging -0.11% and -0.04% per annum respectively. The heterogeneous performance is further evidenced by the fact that, despite the southern sub-region performing well in reducing under-5 mortality, Zimbabwe, a country within the sub-region, registered an annual increase of under-5 mortality averaging 0.18% over the course of 23 years. In comparison to the other countries in the region, Zambia was an average performer, with an annual decline in under-5 mortality averaging -3.6%.

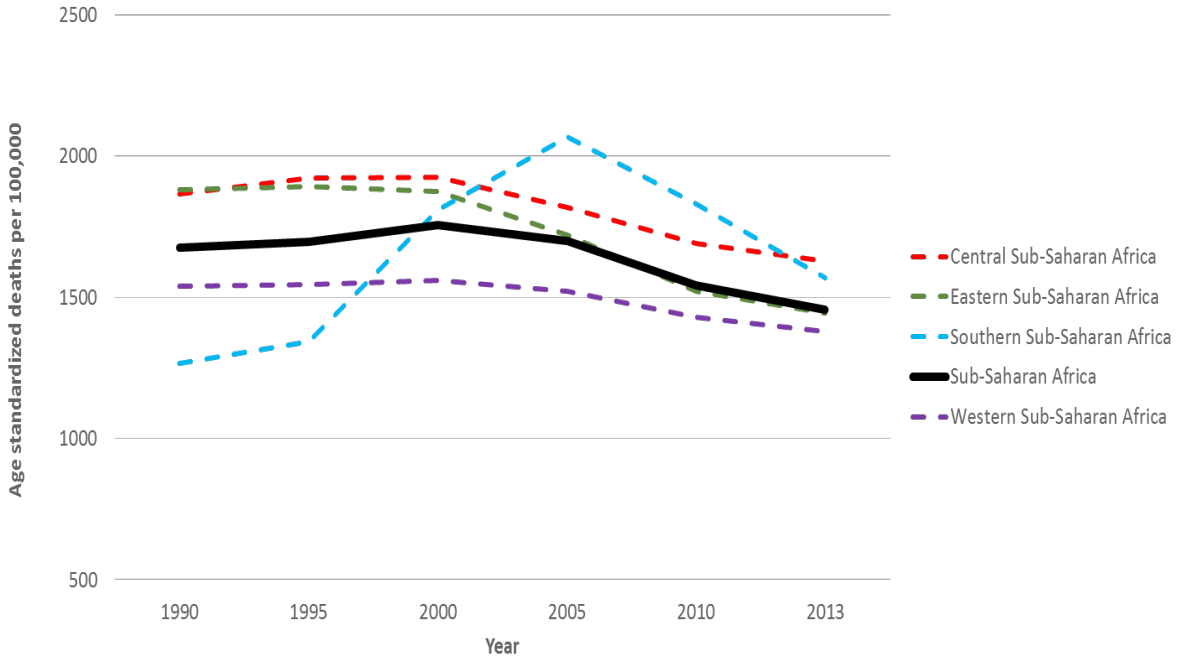

Figure 3: *Trends of age standardized mortality rates, 1990 to 2013*

Figure 3 shows that the average age-standardized mortality rates (ASMR) across the sub-Saharan Africa region, declined from 1674.7 deaths per 100,000 (95% UI: 1651.4- 1700.7) in 1990, to 1454.9 deaths per 100,000 (95% UI: 1424.6- 1487.7) in 2013. Performance across the region also varied widely, although there was a convergence in trends towards the year 2013. The most dramatic trends were observed in the southern sub-region, which had the lowest ASMR in 1990, at 1266.0 deaths per 100,000 (95% UI: 1206.0-1336.3), and then surpassed all the other sub-regions to average2068.8 deaths per 100,000 (95% UI: 1987.0-2163.9) in 2005, only to drop to 1567.4 deaths per 100,000 (95% UI: 1494.4- 1638.0) in the year 2013. Apart from the accelerated drop in mortality observed in the southern sub-region from the peak of 2005, all the other sub-regions show a gradual decline over the 23-year period.

DISABILITY-ADJUSTED LIFE YEARS

In tandem with ASMR, Figure 4 shows that the age-standardized DALY rates (ASDR) declined over time, with some significant heterogeneity across the region. However, all the sub-regional averages remained above 50,000 DALYs for every 100,000 people, pointing to the fact the region still experienced substantive health loss, despite the progress. The regional average was 77886.2 DALYs per 100, 000 (95% UI: 74342.6- 81983.1) in 1990, but this had dropped to 61117.0 DALYs per 100,000 (95% UI: 57468.0- 65104.7) by 2013. In contrast to the other parts of the region, the southern sub-region registered a consistent increase in ASDR from 1990 onwards, that peaked in 2005 at 86601.9 DALYs per 100, 000 (95% UI: 81339.8-91980.7) only to decline to 64195.1 DALYs per 100,000 (95% UI: 60212.5- 68466.5) in the year 2013, which was closer to the regional average. The eastern sub-region registered the fastest progress in reducing ASDR that averaged, -1.4% per annum in contrast to the southern sub-

region that registered a 1.1% annual increase. Despite these trends, the central sub-region still lagged behind the other three sub-regions with 67192.5 DALYs per 100,000 (95% UI: 61173.8-73872.0).

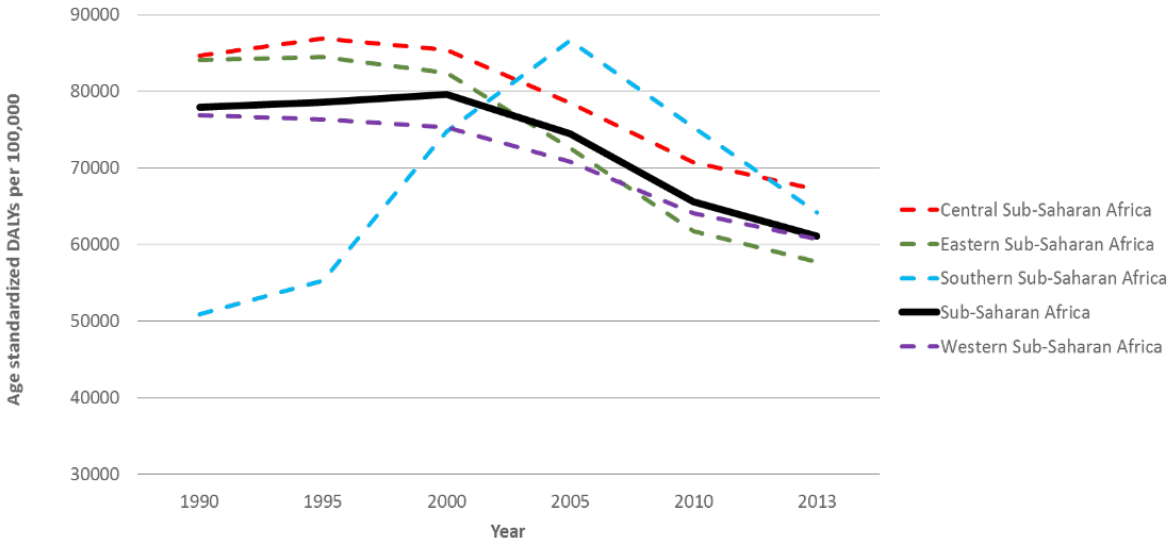

Figure 4: *Trends of age standardized DALY rates, 1990 to 2013*

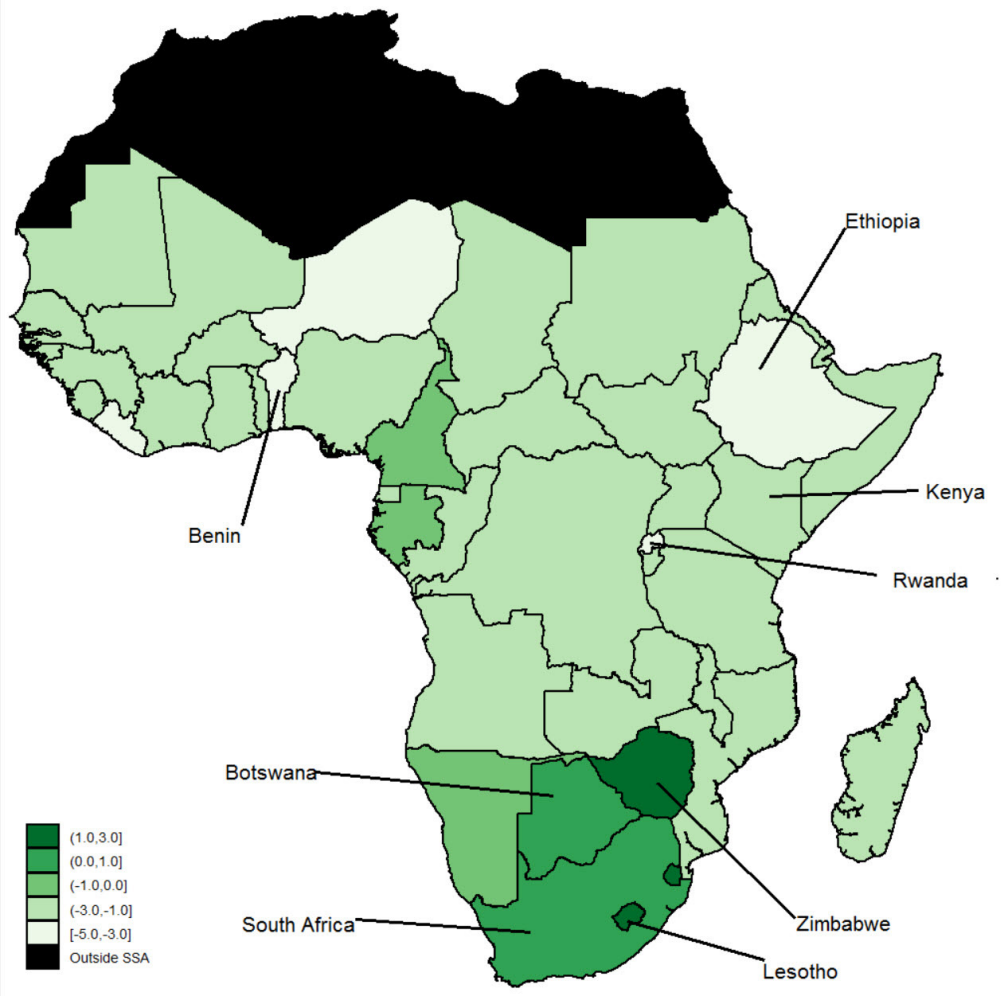

Figure 5: *Annual percentage change in age standardized DALY rates, 1990 and 2013*

Drilling down to the country levels, figure 5, reveals deep differences in the average annual rate of decline of ASDR over the 23-year period. Ethiopia, a country in the eastern sub-region registered the fastest average reduction in ASDR of – 4.1% per annum, while the Lesotho a country in the southern sub-region registered an average increase of 1.9 % per annum over the same period. Other countries within the southern sub-region such as Swaziland, Botswana and Zimbabwe also registered an average annual increase in the ASDR at 1.6%, 0.6% and 1.0% respectively. On the other hand, Rwanda, Benin and Niger registered fast average annual rates of decline at -3.6%, -3.7% and -3.8% respectively.

Table 1: The contribution of different disease categories to health loss, between 1990 and 2013

Region	Communicable, maternal, neonatal, and nutritional diseases			Non-communicable diseases			Injuries		
	Percent of total DALYs 1990	Percent of total DALYs 2013	Trend	Percent of total DALYs 1990	Percent of total DALYs 2013	Trend	Percent of total DALYs 1990	Percent of total DALYs 2013	Trend
Central Sub-Saharan Africa	60.8% (57.0, 64.1)	51.9% (48.3, 55.4)	Decrease	32.7% (29.9, 36.2)	40.8% (37.5, 44.4)	Increase	6.5% (5.6, 7.5)	7.2% (6.4, 8.1)	Increase
Eastern Sub-Saharan Africa	61.6% (59.1, 64.1)	53.6% (51.2, 55.9)	Decrease	30.8% (28.6, 33.3)	39.5% (37.3, 41.8)	Increase	7.5% (6.6, 8.9)	6.8% (6.2%, 7.6)	Decrease
Southern Sub-Saharan Africa	39.3% (37.3, 41.6)	58.7% (55.9, 61.5)	Increase	51.9% (48.4, 54.1)	34.4% (31.6, 37.0)	Decrease	8.8% (7.7, 11.3)	6.9% (6.1, 7.9)	Decrease
Western Sub-Saharan Africa	62.0% (57.1, 65.5)	52.2% (48.7, 55.6)	Decrease	31.8% (28.3, 36.7)	40.1% (36.6, 44.1)	Increase	6.2% (5.4, 6.8)	7.7% (6.6, 8.8)	Increase
Sub-Saharan Africa	60.1% (56.7, 62.7)	53.6% (50.9, 56.0)	Decrease	32.9% (30.2, 36.3)	39.2% (36.6, 42.1)	Increase	6.9% (6.4, 7.7)	7.2% (6.6, 7.8)	Increase

Table 1 shows the contribution of different disease categories to the observed ASDR between 1990 and 2013 across the sub-Saharan Africa region. Overall, the region witnessed the contribution of CMNN, reduce from 60.1% (95% UI: 56.7- 62.7) to 53.6% (95% UI: 50.9-56.0), while the contribution of NCDs increased from 32.9% (95%UI: 30.2-36.3) to 39.2% (95% UI: 36.6-42.1) during the same period. In general, this trend was evident across the region, except in the southern sub-region, where the contribution of CMNN to the overall health loss increased, while the contribution of NCDs declined. At the same time, the contribution of injuries to the overall health loss showed a mixed picture across the four sub-regions of sub-Saharan Africa, but the changes over the 23-year period, were not statistically significant.

RISK FACTORS

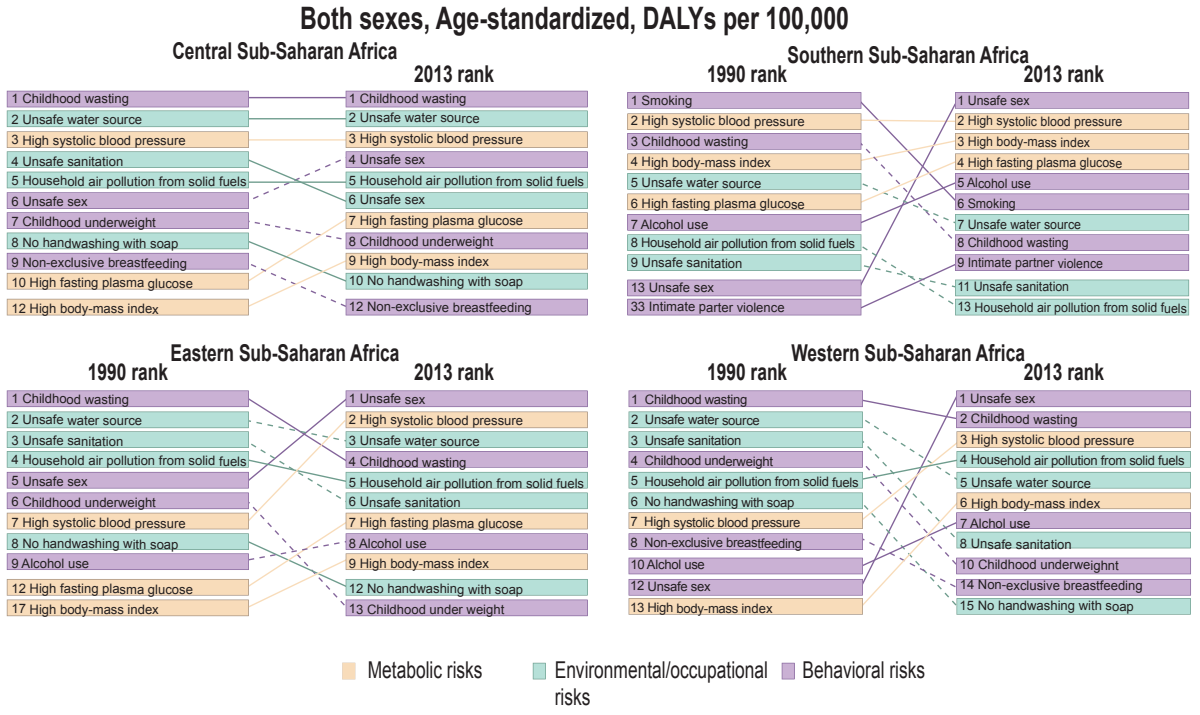

Figure 6: *Sub-regional trends of priority risk factors according to age standardized DALY rates, 1990 and 2013*

Figure 6, shows the role of priority risk factors as drivers of health loss across the four sub-regions between 1990 and 2013. Childhood wasting which was the leading determinant of health loss across the region in 1990 (expect in the southern sub-region, where smoking dominated), declined in importance, yielding to unsafe sex as the leading driver of health loss across the region (except in the central sub-region where the former maintained primacy) in 2013. A similar trend was observed for childhood underweight as a risk factor for overall health loss over the 23-year period. At the same time, unsafe water source declined in importance across the region, except in the central sub-region, where it remained a dominant determinant of health loss.

By the year 2013, high systolic blood pressure had risen in importance to rank 2nd or 3rd as a contributor to overall health loss across the four sub-regions of sub-Saharan Africa. Similarly,

high body mass index and high fasting plasma glucose displayed an increasing trend across the region to rank highly as contributors of health loss across the four sub-regions. In addition, the detrimental effects of harmful alcohol use were also evident in the eastern, southern and western sub-regions, where they ranked top ten as determinants of overall health loss in 2013. Household air pollution from solid fuels remained a significant contributor to overall health loss across the region, except in the southern sub-region where it dropped off from the top ten rank. At the same time, intimate partner violence, increased dramatically to rank as a top ten contributor of health loss in the southern sub-region, which was a unique characteristic. Figure 7, shows the risk factor ranking, as contributors to overall health loss, for the regional average, and makes comparison with its four sub-regions.

Both sexes, Age-standardized, 2013, DALYs per 100,000

	Sub-Sah Africa	C Sub-Sah Africa	E Sub-Sah Africa	S Sub-Sah Africa	W Sub-Sah Africa
Unsafe sex	1	4	1	1	1
Childhood wasting	2	1	4	8	2
High blood pressure	3	3	2	2	3
Unsafe water	4	2	3	7	5
Household air pollution	5	5	5	13	4
Unsafe sanitation	6	6	6	11	8
High body-mass index	7	9	9	3	6
Alcohol use	8	11	8	5	7
High fasting plasma glucose	9	7	7	4	9
Childhood underweight	10	8	13	25	10
Smoking	11	14	10	6	17
Handwashing	12	10	11	16	15
Low fruit	13	13	12	12	16
Low glomerular filtration	14	17	14	10	13
Partial breastfeeding	15	12	15	14	14
Iron deficiency	16	15	18	20	12
Ambient particulate matter	17	16	20	21	11
Intimate partner violence	18	22	16	9	26
High sodium	19	23	19	19	19
Low vegetables	20	18	21	18	22
Childhood stunting	21	19	22	27	21
Low physical activity	22	20	25	15	20
Lead	23	26	17	26	27
Low whole grains	24	21	23	22	23
Drug use	25	30	24	17	18

Figure 7: *Priority risk factors according to age standardized DALY rates, 2013*

DISCUSSION

Competent health systems are expected to comprehensively respond to the prevailing population health needs [13,14]. However, they can only achieve this feat, if and when they pay attention to the prevailing trends of important causes and determinants of health loss across the population. By tracking population health trends over time, decision makers would be able to appreciate areas of progress, stagnation and regression in order to take appropriate and timely action [4,5, 15]. In addition, important lessons could be learned by looking across borders and comparing

the performance of health systems faced with similar challenges. Our study lays the foundation for this important comparative assessment work across health systems in the sub-Saharan Africa.

Overall, the results presented in this study show that the sub-Saharan Africa region, has made significant progress in reducing the burden of disease during the last 23 years, despite that the levels of attainment have not been uniform across sub-regions and countries alike. This is particularly true when considering under-5 mortality trends that had a rapid deceleration across the region, particularly in the central, eastern and western sub-regions, while the southern stagnated until the 2005, only to follow the regional tandem.

Progress in tackling under-5 mortality could be explained by a number of factors, which not only include the rapid scale up of priority child health interventions, such as immunizations, malaria control measures and management of other childhood illnesses across many countries, but also efforts to address important, risk factors such as, childhood wasting, underweight and household pollution among others [3,4]. For instance, Mugeni C. et al. [16] established that child mortality decreased after the implementation of integrated community management of childhood illness at the national level in Rwanda. Further, Akachi Y and Atun R. [17] concluded that along with other key child health interventions, increased coverage with malaria prevention interventions significantly contributed to improved child survival in sub-Saharan Africa. Similar observations were made by Ng M. et al. [18] in a study conducted in Zambia.

Meanwhile, the stagnation witnessed in the southern sub-region, until the year 2005, coincides with the trends observed for the HIV/AIDS epidemic which greatly ravaged this sub-region in comparison to the rest of sub-Saharan Africa [3,10]. There has been overwhelming evidence from many settings that point to the detrimental effects of HIV/AIDS on child survival. Therefore, the subsequent progress in reducing under-5 mortality in the southern sub-region could largely be explained by the introduction and scale up of interventions to prevent and treat HIV/AIDS [19,20]. For instance, Schwartz SR. et al. [21] in a study conducted in Malawi, revealed that rapid maternal initiation with antiretroviral treatment can significantly improve HIV-related infant outcomes. In addition, Edmonds A. et al. [22] in a study conducted using data from the Democratic Republic of Congo established that antiretroviral treatment reduced the hazard of mortality in HIV-infected children by 75%.

However, despite the progress witnessed over the 23-year period, our study reveals that the sub-Saharan Africa still experiences significant health loss as a result of under-5 mortality. Therefore, health system stewards who are keen to improve population health cannot afford to relax, but further reinforce policy attention on this important area of population health. In addition, to improving access to priority health interventions, further progress could be attained by addressing important risk factors such as malnutrition, improving sanitation among others [3,4,10, 19].

When considering all age groups together, the progress has been slower in comparison to the accelerated progress witnessed in under-5 mortality. Across all sub-regions, faster declines in ASMR were observed from 2005 onwards, which could be attributed to the introduction and scale up of health interventions to address the HIV/AIDS epidemic. Progress is particularly pronounced in the eastern and southern sub-regions that were heavily affected by HIV/AIDS [23]. According to Williams B. et al. [24] significant progress has been made in controlling HIV and its effects in the southern African sub-region, particularly in terms of mortality and tuberculosis notification.

The slow progress in reducing overall health loss in the region, could also be explained by the increasing burden attributable to NCDs in the backdrop of the unfinished agenda of communicable diseases [3]. While countries have made progress in tackling important communicable diseases such as HIV/AIDS, malaria and tuberculosis, the same cannot be said for priority NCDs such as diabetes and cardiovascular diseases [3,19]. For example, Beran D. and Yudkin J. [25], confirmed that insulin was not available on an uninterrupted basis in many low- and middle income countries in Africa. Further, Justin-Temu et al. [26] concluded that a significant proportion of patients were unable to afford anti-diabetic drugs available in both public and private outlets in Tanzania.

This is particularly worrying, considering that important risk factors for NCDs such as high body mass index, high plasma fasting glucose and high systolic blood pressure are on the rise in many parts of the region. Similarly, lifestyle choices such as harmful alcohol use are gaining prominence as drivers of health loss in many parts of the region. Therefore, preventing these important risk factors that could often progress to costly chronic diseases offers a cost effective way of making further progress in the region. Otherwise, health systems across sub-Saharan Africa risk the erosion or even worsening of the recent population health gains that have been painstakingly achieved.

Our study is not without limitations. We have only focused on high level trends without fully drilling down to understand the drivers of the observed changes in population health trends. We have also not fully accounted for other important determinants of health that are beyond the health system in our attempt to explain the observed changes. However, our study is foundational, and provides a basis for further work, to understand the finer performance trends of health systems across the region. By focusing on mortality, DALYs and risk factors, we have touched on priority considerations for many health system stewards in the region and this will progress the debate on how to further advance public health.

CONCLUSION

We recognize that health systems in sub-Saharan Africa are in transition and are faced with multiple competing priorities [1,3]. The recent population health gains remain precarious, unless the region's health systems are adaptable and innovative in the face of the changing landscape. In order to make further progress and sustain the health gains that have been so painstakingly achieved, health systems stewards in sub-Saharan Africa must have the situational awareness and appreciate the challenges they are faced with and opportunities within their reach. Such opportunities include the existence of a substantial amount of systematic review evidence on many effective interventions for preventing, diagnosing and treating of key causes of health loss as well as for organizing, governing and financing health systems and implementing changes in low and middle-income country settings.

Table 2 presents high level recommendations, based on our understanding of the core functions of a well-functioning health system, that decision makers in sub-Saharan Africa seeking to make further progress, should consider. Courageous and committed leadership can change health system performance for the better. Leadership or governance interventions for health systems include processes that affect the way in which powers are exercised, particularly with regard to authority, accountability, openness, participation, and coherence. Effective interventions include (but are not limited to) community mobilization, patient involvement

in decision making, and contracting out services to private providers [27]. Policymakers also need to make the right choices regarding financial arrangements for national health systems; including how funds are collected, insurance schemes, how services are purchased, and the use of targeted financial incentives [28]. In addition, decision makers should raise adequate funds for health in ways that ensure people can use needed services and are protected from financial hardships associated with having to pay for health services [5].

How services are delivered in countries can have impacts on the effectiveness, efficiency and equity of national health systems in sub-Saharan Africa. Strategies for improving delivery of healthcare services have been the focus of numerous systematic reviews. Most of the systematic reviews have focused on who provides care, where care is provided, and coordination of care [29]. Even when a clear evidence-informed course of action has been agreed upon, its implementation can be problematic, especially if it requires complex changes in routines, better collaboration among disciplines, changes in patients' behavior, or changes in the organization of care [30]. Effective interventions at multiple levels of national health systems are therefore needed to implement improvements in healthcare services in sub-Saharan Africa. Implementation strategies that have been proven to be effective in improving health outcomes include strategies targeted at both providers and recipients of healthcare services. Overall, effective provider interventions include interactive educational meetings, supportive supervision, use of local opinion leaders, and audit and feedback. Effective strategies for healthcare recipients include patient education and engagement, awareness creation and reminders to improve adherence to treatment [31].

Therefore, in defining health systems arrangements that are effective and responsive to the population health challenges, it is vital that the policy makers in the region to embrace a holistic view. All components of the health system ranging from leadership, financing to service delivery and performance assessment must be harmonized to support the singular objective of improving population health through efficient and cost-effective measures.

Table 2: Recommendations for health systems

Functional Area	Challenges	Recommendations
Governance and leadership:	Health systems faced with multiple competing priorities	Bold and effective stewardship Improved coordination across the breadth and depth of health systems Better accountability to improve performance *(improving public health; promoting equity; efficiency and responsiveness)*
Health financing:	Huge burden of disease Limited financial resources to sustain the gains and make further progress	A clear strategy in collection and pooling of resources as well as strategic purchasing with the aim of improving health system performance Ensure financial access to essential health products and services; financial risk protection Embrace innovative ways of funding priority health services, such as progressive mobilization and allocation of domestic resources, adoption of cost effective allocation, informed priority setting and efficient delivery
Health service delivery:	An increasing burden of NCDs in the backdrop of an unfinished agenda of communicable diseases	Intensively pursue policies to make health services available and affordable for all at the point of delivery. Focus their efforts on strengthening primary health care and health systems to ensure increased accessibility and quality of health services Integrated health services, and elimination of health programing and serviced delivery silos that have often dominated the region's health systems. This would not only improve health outcomes, but also efficiency in service delivery. Adopt and emphasize cost effective preventative health services, particularly for emerging NCDsas a way of avoiding costly treatment and rehabilitative interventions
Medicines and health technologies:	Despite improvements in access to most of the priority medicines and health technologies for communicable diseases, the same is not true for NCDs e.g. diabetes	Taking appropriate measures to address high cost of medicines that limit access, including purposeful funding to support local manufacturing. Introduction and scale up of cost-effective, safe and quality assured health products targeting NCDs
Health data:	Many health systems in SSA cite lack of quality data for informed decision making as a keyconstraint	Improve accountability in data use and make it the central stage of their planning and monitoring framework. Strengthen health data collection and analytical capacity in order to provide a clear basis for objective performance assessment. Understanding performance at the national level is not enough, but health system stewards need to drill down to the subnational levels to unmask the different trends within national health systems that could be informative. With the increasing significance of NCDs, health information systems in SSA, should not only collect aggregated health data forms on an episodic nature which is characteristic of communicable diseases, be also be tailored to track NCDs at an individual level given that they often run a chronic course.
Health workforce:	Huge burden of burden of disease Epidemiological transition requiring a new skill set	Well-trained and motivated human resources Development and retention of effective human resources at all levels of the health system Re-orientation and training in order to effectively address the emerging challenges of NCDs particularly at the primary healthcare level

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CHAPTER 3

PERFORMANCE ASSESSMENT

CHAPTER 3.1

BENCHMARKING HEALTH SYSTEM PERFORMANCE ACROSS DISTRICTS IN ZAMBIA: A SYSTEMATIC ANALYSIS OF LEVELS AND TRENDS IN KEY MCH SERVICES

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ABSTRACT

Background

Achieving universal health coverage and reducing health inequalities are primary goals for an increasing number of health systems worldwide. Timely and accurate measurements of levels and trends in key health indicators at local levels are crucial to assess progress and identify drivers of success and areas that may be lagging behind.

Methods

We generated estimates of 17 key maternal and child health indicators for Zambia's 72 districts from 1990 to 2010 using surveys, censuses, and administrative data. We used a three-step statistical model involving spatial-temporal smoothing and Gaussian process regression. We generated estimates at the national level for each indicator by calculating the population-weighted mean of the district values and calculated composite coverage as the average of 10 priority interventions.

Results

National estimates masked substantial variation across districts in the levels and trends of all indicators. Overall, composite coverage increased from 46% in 1990 to 73% in 2010, and most of this gain was attributable to the scale-up of malaria control interventions, pentavalent immunization, and exclusive breastfeeding. The scale-up of these interventions was relatively equitable across districts. In contrast, progress in routine services, including polio immunization, antenatal care, and skilled birth attendance, stagnated or declined and exhibited large disparities across districts. The absolute difference in composite coverage between the highest-performing and lowest-performing districts declined from 37 to 26 percentage points between 1990 and 2010, although considerable variation in composite coverage across districts persisted.

Conclusions

Zambia has made marked progress in delivering maternal and child health interventions between 1990 and 2010; nevertheless, substantial variations across districts and interventions remained. Subnational benchmarking is important to identify these disparities, allowing policymakers to prioritize areas of greatest need. Analyses such as this one should be conducted regularly and feed directly into policy decisions in order to increase accountability at the local, regional, and national levels.

Keywords

Coverage, Indicators, Inequalities, Maternal and child health, Subnational benchmarking, Zambia

BACKGROUND

Achievement of universal health coverage (UHC) is a primary goal for an increasing number of health systems worldwide and has been proposed as a key objective for the post-2015 development agenda [1]. UHC aims to provide all people with the high quality health services they need without the risk of financial hardship from out-of- pocket expenses [2]. Included in UHC is the goal of reducing inequalities within countries, and this has led to an increased focus on within-country inequalities in low- and middle-income countries (LMICs) [3-6]. National gaps in UHC are closely related to inequalities in intervention coverage within countries [7,8]. While much progress has been made in reducing maternal and child mortality in the past two decades [9], many countries are lagging behind in the delivery of life-saving interventions and would benefit from intensified actions targeted to the worst-off and hardest-to-reach populations [10]. To inform these efforts, timely and accurate information is needed, and demand for the measurement of subnational coverage in maternal and child health (MCH) and for analysis of time trends in subnational inequality is increasing [11,12].

Information on subnational levels and trends in health in LMICs is limited but growing. To date, most studies and global monitoring systems have focused on within- country inequalities by wealth indices, education, gender, or urban residence [6-8,12-27]. While this literature has been immensely important in identifying strikingly large inequalities and informing policy in many countries, gathering information on variation by geographic sub- units has been under-prioritized. Subnational benchmarking has been instrumental in decision-making in high-income countries [28-32], but explicit comparisons of performance across subunits over time remain uncommon in much of the developing world. The Countdown to 2015 group has routinely tracked progress and equity in MCH intervention coverage for 75 countries since 2005, but reports incorporating health measures at subnational geographic levels only began in 2010 [33]. Several studies, most commonly in India, have quantified coverage and outcomes at the regional [33-42] and first administrative levels [43-61]; however, most examine only one indicator, do not evaluate trends over time, or are not explicitly targeted to policymakers interested in local benchmarking for their countries. Even fewer studies have explored the geographic distributions for indicators below the first administrative level [62-76], which is arguably of greater policy relevance [77]. Mexico was the first LMIC country to implement subnational benchmarking of effective coverage [48,78-80] and to then have these data feed into policy decisions, demonstrating how locally-relevant data can be used to inform health policymaking.

In recent years, Zambia has demonstrated multistakeholder commitment to UHC and equity in health service delivery [81-84]. The country's National Health Strategic Plan 2011-2015 [82] diverges from previous plans in its emphasis on UHC and overall health system strengthening rather than vertical programs. Zambia has successfully scaled up many priority MCH interventions in the past two decades [82]. However, previous studies have focused on national trends and have not explored within-country inequalities. Accurate, timely, subnational information on intervention coverage is needed to benchmark progress and to pinpoint areas in need of targeted policy intervention. In this study, we use all available data to produce the first systematic assessment of levels and trends in the coverage of 17 MCH interventions, with estimates of uncertainty, across Zambia's 72 districts from 1990 to 2010.

METHODS

Data and indicator selection

We conducted several in-country meetings with major stakeholders in MCH to identify all available data sources with information on MCH and socioeconomic factors, including 20 household surveys, 3 population censuses, and 4 administrative data sources covering Zambia's 72 districts (Additional file 1).

We identified 17 key indicators that are closely tied to child survival [85] and that could be estimated at the district level from the identified data sources: antenatal care (ANC, 1 and 4 visits); skilled birth attendance (SBA); immunization with Bacillus Calmette-Guérin (BCG); diphtheria-pertussis-tetanus (DPT); measles, polio, and pentavalent vaccines; exclusive breastfeeding (EBF); prevalence of underweight among children as a proxy for nutritional interventions [86]a; intermittent preventive therapy for malaria during pregnancy (IPTp, 1 and 2 doses); insecticide-treated net (ITN) ownership; ITN use by children under five; indoor residual spraying (IRS); the proportion of households that either owned at least one ITN or received IRS; and the proportion of children who either slept under an ITN the night before the survey or lived in a household that received IRS. Because several indicators were very similar, we report findings for 12 of these indicators in the main text and present results for the other five in Additional file 2. Other indicators of interest, including case management of childhood diarrhea and pneumonia, and artemisinin-based combination therapy for childhood malaria, could not be estimated due to sparse data at the district level. We did not include immunization coverage estimates constructed by pairing data on the number of doses administered with population figures, because, in contrast with survey-based estimates, such measures are often subject to significant numerator and denominator bias which are likely exacerbated at the district level [87]. Due to data availability, we restricted the analysis to the period from 1990 to 2010.

Our modeling strategy, described in more detail below, used the following covariates, identified based on previously established relationships [88-91] and strong correlations in our data: whether the household had electricity, sex of the head of household, household size, average years of education among women 15 to 44 years old, the use of improved wall materials in households, and the number of health facilities per capita in a district. The number of health facilities per capita was only available for the year 2006. Complete definitions of the indicators and covariates are provided in Table 1.

Data processing

We produced estimates of coverage from each survey- year for each source of data. Our unit of analysis was the district as defined in 2010 for a total of 72 districts. Data collected prior to 2000 referred to a different set of districts totaling 57. For districts that split during the transition from 57 to 72 districts we adjusted estimates from the original district by assuming that the average proportional relationships observed between original and inheriting districts in 2000–2010 applied to the time period 1990–2000 as well. Unlike the earlier Demographic and Health Surveys (DHS) and all three censuses, the 2001– 2002 and the 2007 DHS datasets did not contain district identifiers. For the 2007 DHS, the latitude and longitude of each cluster were available and we used these coordinates to identify which district each cluster belonged to. There was no information available in the 2001–2002 survey that allowed us to identify districts, so we used this survey only for province-level estimates.

Except for the Netmark surveys (Table 1), we calculated all indicator estimates according to the definitions in Table 1 using survey microdata, ensuring consistent definitions across sources and taking into account the multistage sampling design for each survey. Surveys provided information for children born up to 5 years before the survey. For ANC, SBA, IPTp immunizations, and EBF, we grouped responses for each child according to year of birth and estimated coverage corresponding to each group for as many years prior to the survey as there were births recorded. Since nationally coordinated programs for ITN distribution and IRS, IPTp, and pentavalent vaccine began in 1999, 2003, and 2005, respectively, we assumed 0.01% coverage for malaria interventions prior to 1997 and for pentavalent immunization prior to 2004. While there were isolated malaria control programs prior to 1997, for example, in Copperbelt province [92], there was no coordinated national effort for malaria control and the vast majority of the population was not covered by ITNs, IRS, or IPTp [93,94].

In addition to survey-based estimates, we calculated IRS coverage from National Malaria Control Centre (NMCC) administrative data by dividing the reported number of structures sprayed by the number of households in the given district-year according to the census. We interpolated the number of households for years between censuses assuming geometric growth.

DATA SYNTHESIS

Covariates

In many cases, multiple sources for the same year implied different levels for the same covariate. To address this issue and generate a complete time series that synthesized all available data, we used a two-step statistical model. The first step was a linear mixed-effects model which relates the outcome to year and location. The fixed effects of this model included the bases for a natural spline (a method of interpolation using piecewise polynomials) describing the time trend with one interior knot at 2000 while the random effects included a district level random intercept and random slope. The second step was a Gaussian process regression (GPR) that uses the results from the first stage as the mean function and draws from a multivariate normal distribution, based on the model's prior and uncertainty in the data, to generate a final estimate for each indicator-district-year. Provincial estimates of indicators were also produced using this method and used as covariates in the first step of the indicator model described below.

Indicators

A three-step statistical model was used to generate a complete set of indicator estimates, including uncertainty. The first step of the model was an ordinary least squares (OLS) regression of each indicator. Coverage was modeled in logit space to bound the result between 0 and 1. The following model was run separately for each coverage indicator:

$$\text{logit(Ind)}_{I,k,t} = \beta_0 + \beta_1 t + \beta 2\text{elec}_{i;t} + \beta 3\text{fhead}_{i;t} + \beta 4\text{hhsize}_{i;t} + \beta 5\text{edu}_{i;t} + \beta 6\text{wall}_{i;t} + \beta 7\text{HFPC}_{i} + \beta 8\text{Ind}_{k;t} + \varepsilon_{i;k;t}$$

where $logit(Ind)_{i,k,t}$ is the logit-transformed level of coverage for each indicator in district i, province k, and year t; $elec_{i,t}$ is the proportion of households that have electricity in district i and year t; $fhead_{i,t}$ is the proportion of households with a female head in district i and year t; $hhsize_{i,t}$ is the mean household size in district i and year t; $edu_{i,t}$ is the mean years of education for women

15 to 44 years old in district i and year t; $wall_{i,t}$ is the proportion of dwellings with improved wall type in district i and year t; $HFPC_i$ is the number of health facilities per capita in district i; $Ind_{k,t}$ is the coverage of the indicator at the province level for province k and year t; and $\varepsilon_{i,k,t}$ is the error, for district i, province k, and year t.

Table 1 Definitions of indicators and covariates

Indicator or covariate (abbreviation)	Definition	Sources of data
Indicator		
Antenatal care(ANC1,ANC4)	The proportion of women 15to49years old who gave birth in the given year and had one/four or more antenatal visits attended by skilled personnel (doctor, nurse, midwife, or clinical officer) at a health facility during the corresponding pregnancy	DHS :1992,1996–7,2001–2,2007 MIS :2006,2008,2010,2012
Skilled birth attendance	The proportion of women 15to49years old who gave birth in the given year and delivered with a skilled birth attendant(a doctor, nurse, midwife, or clinical officer)	DHS: 1992, 1996–7, 2001–2, 2007 MICS: 1999
Bacillus Calmette-Guérin immunisation	The proportion of children under5 years old who were vaccinated against tuberculosis in the given year	DHS:1992,1996–7,2001–2,2007 LCMS:1996,1998,2002–3,2004–5,2010 MICS:1999
Diphtheria-pertussis-tetanus immunization	The proportion of children 12 to 59 months old who received three doses of the diphtheria-pertussis-tetanus (DPT) vaccine in the given year	DHS: 1992, 1996–7, 2001–2, 2007LCMS: 1996, 1998, 2002–3, 2004–5, 2010 MICS: 1999
Measles immunization	The proportion of children 12 to 59 months old who received measles vaccination in the given year	DHS: 1992, 1996–7, 2001–2, 2007 LCMS: 1996, 1998, 2002–3, 2004–5, 2010 MICS: 1999
Polio immunization	The proportion of children 12to59months old who received three doses of the oral polio vaccine in the given year	DHS: 1992, 1996–7, 2001–2, 2007 LCMS: 1996, 1998, 2002–3, 2004–5, 2010 MICS: 1999
Pentavalent immunization	The proportion of children 12to59months old who received three the doses of the pentavalent vaccine, which includes protection against DPT, hepatitis B, and *Haemophilus influenza* type b	DHS:2007 LCMS:2010
Exclusive breastfeeding*	The proportion of children who were exclusively breastfed during their first 6months afterbirth	DHS: 1992 LCMS: 1996, 1998, 2003–3, 2004–5, 2010
Percentage of children not underweight	The proportion of children under-5years old determined as not being underweight, defined as weighing two or more standard deviations below the international anthropometric reference population median of weight for age	DHS: 1992, 1996–7, 2001–2, 2007 LCMS: 1996, 1998, 2002–3, 2004–5, 2006, 2010
Intermittent preventive therapy for malaria during pregnancy (IPTp1, IPTp2)	The proportion of women 15 to 49 years old who gave birth in the given year and who received at least one/two treatment doses of Fansidar (sulfadoxine/pyrimethamine) at antenatal care visits during the corresponding pregnancy	DHS:2007 MIS:2006,2008,2010,2012
Insecticide-treated net(ITN)ownership	Insecticide-treated net(ITN)ownership	DHS: 2007 HHCS: 2008 MIS: 2006, 2008, 2010, 2012 Netmark: 2000, 2004 SBS: 2005, 2009,MIS: 2006, 2008, 2010, 2012,NMCC: 2005-2010

Indicator or covariate (abbreviation)	Definition	Sources of data
ITN ownership or IRS	The proportion of households that either own an ITN, or were sprayed with an insecticide-based solution in the last 12 months, or both	DHS:2007 HHCS:2008 MIS:2006,2008,2010,2012 Netmark:2000,2004 SBS:2005,2009
ITN use or IRS	The proportion of children under5years who either slept under an ITN the previous night, or live in a household that was sprayed with an insecticide-based solution in the last 12 months, or both	DHS:2007 HHCS:2008 MICS:1999 MIS:2006,2008,2010,2012 Netmark:2000,2004 SBS:2005,2009
Covariates		
Household electricity	The proportion of households with electricity	Census: 1990, 2000, 2010 DHS: 1992, 1996–7, 2001–2, 2007 LCMS: 1996, 1998, 2002–3, 2004–5, 2006, 2010
Female headship of households	Female headship of households	Census: 1990, 2000, 2010 DHS: 1992, 1996–7, 2001–2, 2007 LCMS: 1996, 1998, 2002–3, 2004–5, 2006, 2010 MICS: 1999
Household size	The average number of members per household	Census: 1990, 2000, 2010 DHS: 1992, 1996–7, 2001–2, 2007 LCMS: 1996, 1998, 2002–3, 2004–5, 2006, 2010 MICS: 1999
Education of women-15to44years old	Education of women15to44years old	Census: 1990, 2000, 2010 DHS: 1992, 1996–7, 2001–2, 2007 LCMS: 1996, 1998, 2002–3, 2004–5, 2006, 2010 MICS: 1999
Improved dwelling wall type	The proportion of households with dwelling walls constructed of an improved material	Census:1990,2000,2010 DHS:1992,1996–7,2001–2,2007 LCMS:1996,1998,2002–3,2004–5, 2006,2010 MICS:1999
Health facilities per capita	The number of health facilities per 1,000 inhabitants	Census: 1990, 2000, 2010 JICA: 2006

Exclusive breastfeeding was selected rather than early initiation or continued breastfeed because it has the strongest relationship with child mortality.
DHS, Demographic and Health Survey
MIS, Malaria Indicator Survey
MICS, Multiple Indicator Cluster Survey
LCMS, Living Conditions Monitoring Survey
Netmark, Netmark Survey
HHCS, Household Health Coverage Survey
SBS, Sexual Behavior Survey
NMCC, National Malaria Control Center Administrative Data
Census, National Population Census
JICA, Japan International Cooperation Agency Health Facility Census

The second stage in the modeling process involved applying a spatial-temporal regression (ST) to the residuals derived from step 1. ST regression is a form of locally- weighted regression that allows residuals nearby in space and time to have more weight than those farther away. Spatial neighbors were defined as districts within the same province. Temporal neighbors were defined as adjacent data-years within the same district. The predicted residuals from the ST regression are added on to the linear predictions from the OLS regression to generate the mean function used in the final step.

The third and final step is a GPR model with the estimates from the linear and ST regression serving as the mean function. The covariance structure was defined by the Matern Covariance function. We used 1,000 draws from the posterior distribution to calculate estimates of the mean and uncertainty interval (UI). The three step modeling process applied here, including ST and GPR parameters, has been described in detail elsewhere [95] and has been extensively used in global health systematic analyses, most notably in generating many estimates for the Global Burden of Disease study [9,96-98].

We generated estimates at the national level for each indicator by population-weighting the district values. We also estimated an overall measure of composite coverage, based on 10 indicators that reflect the priorities of Zambia's health system and cover the full range of interventions we studied: the proportion of households with IRS, ITN ownership, or both; IPTp2; EBF; pentavalent, BCG, measles, and polio immunization coverage; ANC4; SBA; and the proportion of children not underweight. Composite coverage can be constructed using theory-based or arbitrary weighted averages, or latent variable techniques such as factor analysis [48]. For simplicity and ease of interpretation, we chose to apply equal weights to all interventions, and constructed composite coverage as the simple average of the 10 interventions. We also explored the relationship between socioeconomic status, measured as a composite of four socio-demographic variables[b], and composite coverage, and report the Pearson correlation between these measures across districts and years. In the results section, we present findings for the 12 indicators that are priorities in the Zambian health system. Results for the additional 5 indicators estimated in this analysis are presented in Additional files 2 and 3.

Ethical approval

Permission to implement this research project was obtained from the Ministry of Health of Zambia. Ethical approval for this study was obtained from the institutional review board of the University of Washington. The study was conducted in compliance with national regulatory and ethics guidelines.

RESULTS

Individual interventions

We found a wide variation in both the levels of coverage and average change between 1990 and 2010 across the 12 indicators shown in Figure 1.

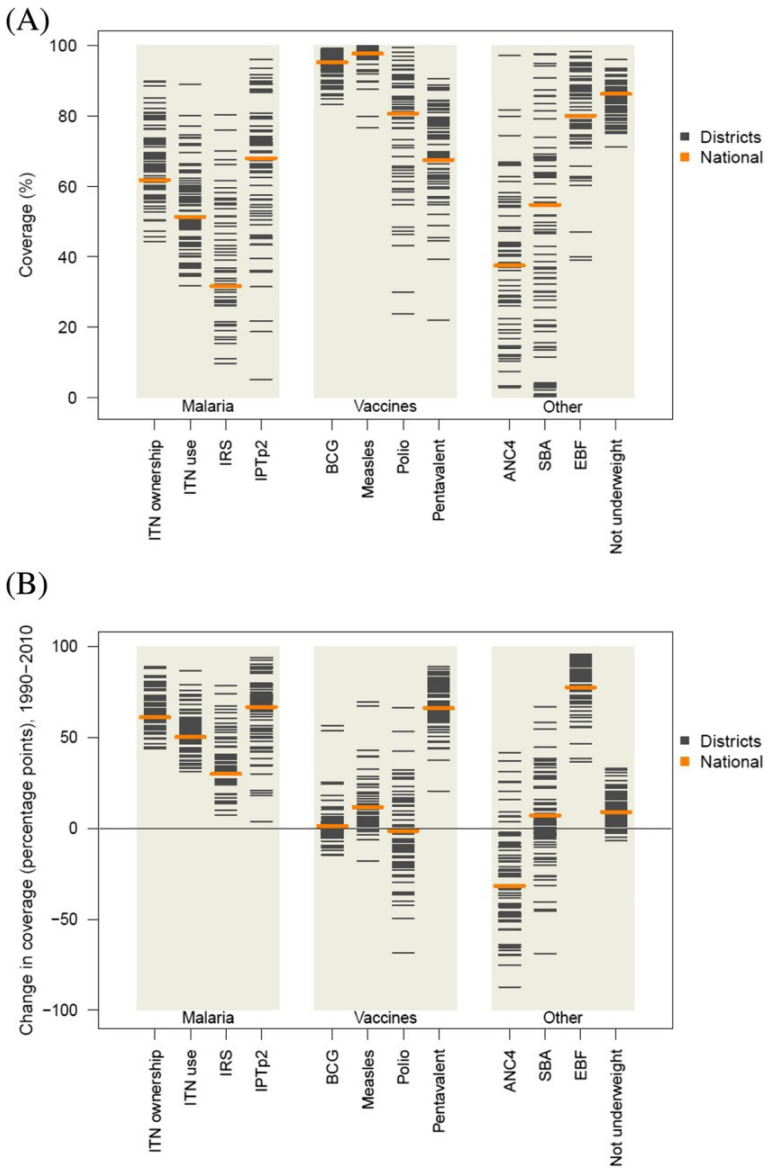

Figure 1 *Distribution of intervention coverage in 2010 (A) and absolute change in coverage from 1990 to 2010 among districts (B). IRS displayed only for targeted districts in 2010*

For malaria control interventions, the scale-up was remarkable across Zambia (Figure 2A). At the same time, in 2010 ITN ownership ranged from 44% (95% UI: 42–47%) to 90% (95% UI: 85–93%), while use of ITNs by children under the age of 5 years exhibited an even larger range (from 32% [95% UI: 25–40%] to 89% [95% UI: 81–94%]). IPTp2 levels rose rapidly in many districts, but leveled off or experienced declines in coverage in some districts after 2007, and as a result coverage levels ranged from 5% (95% UI: 2–11%) to 96% (95% UI: 92–98%) in 2010.

For immunizations, Zambia maintained high levels of BCG and measles immunization coverage across districts, but polio immunization coverage was highly variable across districts, with a range in 2010 from 24% (95% UI: 11–42%) in Mufumbwe to 99% (95% UI: 98–100%) in Chavuma, both in North-Western province. While at the national level coverage did not change significantly between 1990 and 2010, remaining around 81%, more than half of districts in Zambia had lower levels of polio immunization in 2010 compared to 1990 (Figure 1B). We

found similarly large disparities in pentavalent vaccine coverage across districts in 2010; as the vaccine was nationally launched in 2005, this finding likely reflects differential uptake of a new intervention throughout Zambia.

For the other MCH interventions included in this analysis, particularly notable progress was made for EBF (Figure 2B). On average across districts, EBF increased by 79 percentage points, with significant progress observed across all districts (Figure 1B). Districts in Southern province experienced the largest improvements, showing an average 85 percentage point increase in EBF between 1990 and 2010. Progress was also made on malnutrition: the proportion of children who are under-weight decreased during this time period and the range across districts is smaller than for any other indicator included in this analysis.

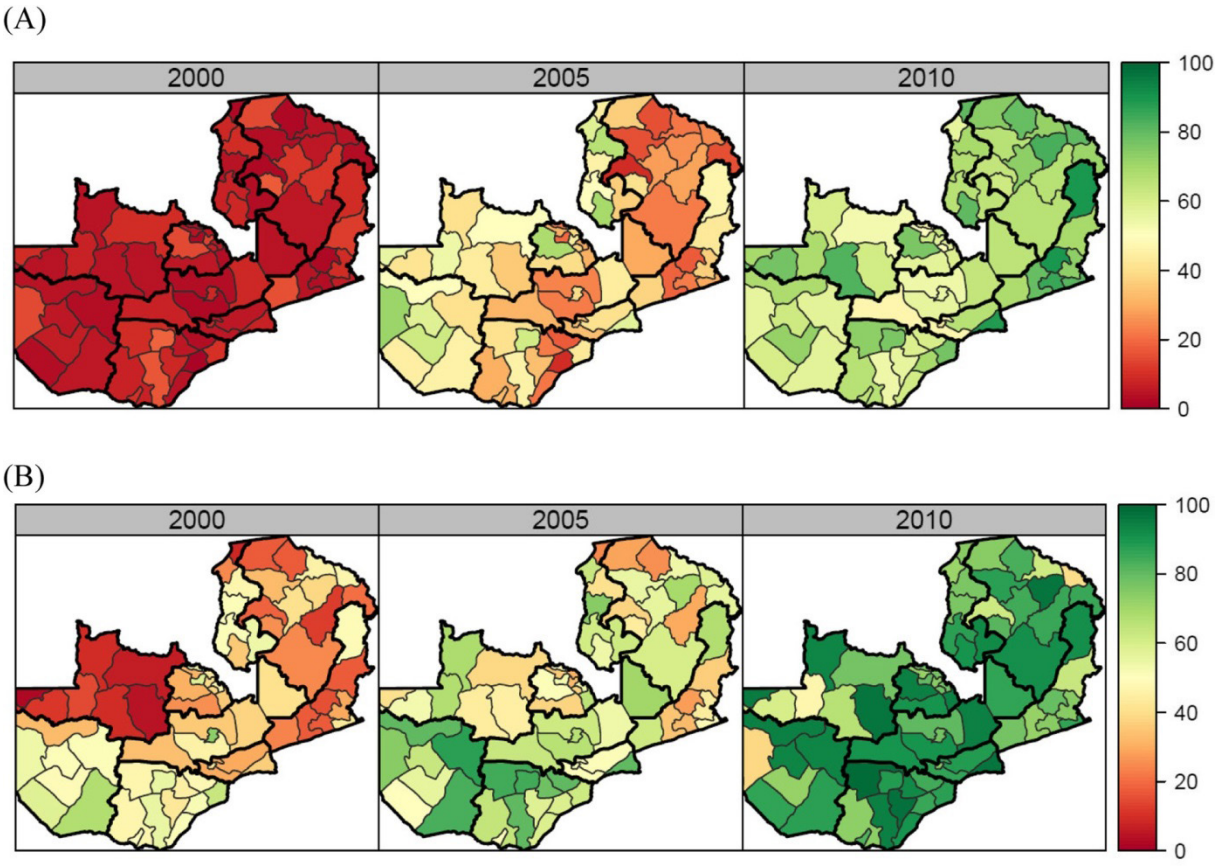

Figure 2 *Coverage of insecticide - treated net ownership(A) and exclusive breastfeeding(B) by district in 2000, 2005, and 2010.*

On the other hand, ANC4 and SBA displayed the largest differences in levels and trends. In 2010, the difference between the highest-performing and lowest-performing districts was 86 percentage points for ANC4 and 97 percentage points for SBA. At the same time, national ANC4 decreased by 31 percentage points between 1990 and 2010, and declining trends in many districts were also observed for SBA and polio immunization coverage, shown in more detail in Figure 3. During this 20-year period, 59 (of 72) districts in Zambia experienced declines in ANC4, 31 experienced declines in SBA, and 41 experienced declines in polio immunization. The number of districts with declining coverage is particularly worrisome for polio immunization since coverage dropped in several districts considered at high risk for polio importation from neighboring countries [99].

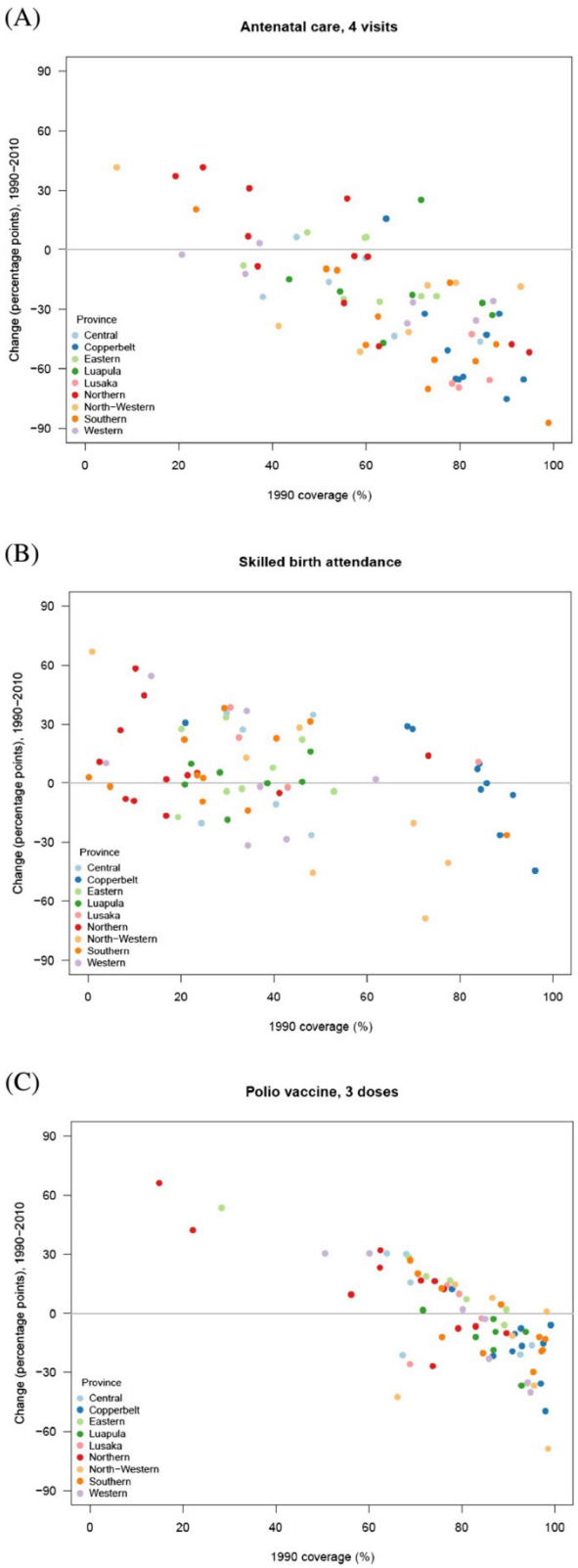

Figure 4 *National composite coverage by intervention composition, 1990 to 2010.*

Figure 3 also highlights that the highest-performing districts in 1990 tended to have the largest declines over the next two decades, while districts with lower baseline coverage achieved

the greatest gains. The correlation coefficients between coverage level in 1990 and change between 1990 and 2010 were −0.73 for ANC4, −0.37 for SBA, and −0.76 for polio immunization. Geographic patterns in indicator trends are also notable: districts in Copperbelt province (show in dark blue) had relatively high baseline levels and large declines, while districts in Northern province (dark red) largely had lower baseline levels in 1990 but experienced gains.

Composite coverage

Figure 4 shows the national trend in composite coverage by its component interventions. If coverage of all 10 interventions measured here was 100%, then composite coverage would be at 100%. While overall composite coverage increased from 46% in 1990 to 73% in 2010, with more substantial gains in the early 2000s, most of the expansion in composite coverage is due to the scale-up of malaria control, EBF, and pentavalent immunization. Polio immunization, ANC4, and SBA exhibited minimal progress and in some cases declined.

Figure 3 Absolute change in coverage between 1990 and 2010 compared with estimated coverage in 1990 for (A) antenatal care, 4 visits, (B) skilled birth attendance, and (C) polio immunization, by district. Each dot represents a district.

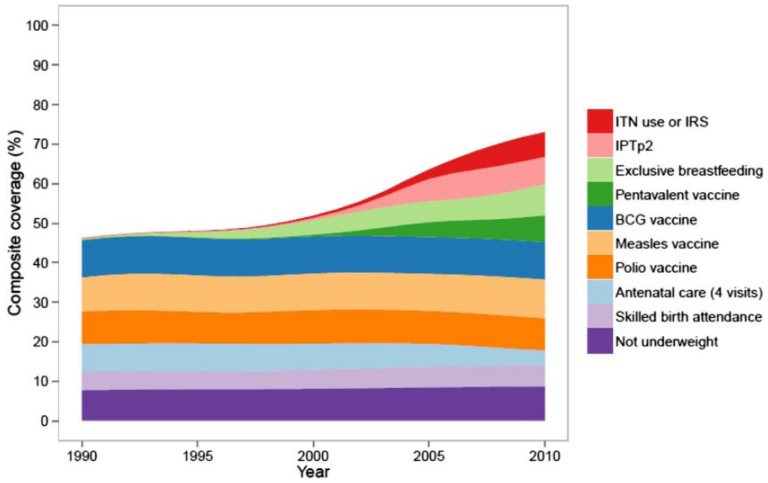

Figure4: *National composite coverage by intervention composition, 1990 to 2010*

This national trend also masked substantial heterogeneity across districts. While the absolute difference in composite coverage between the highest-performing and lowest- performing districts declined from 37 to 26 percentage points between 1990 and 2010, considerable variation in composite coverage persisted across districts in 2010 (Figure 5). Composite coverage ranged from 58% in Sinazongwe to 85% in Kalulushi; nevertheless, Figure 5 shows that the relative contributions of malaria control, immunizations, and other MCH interventions were actually quite similar across districts. Surprisingly, the bivariate correlation between composite coverage and socioeconomic status was only 0.43.

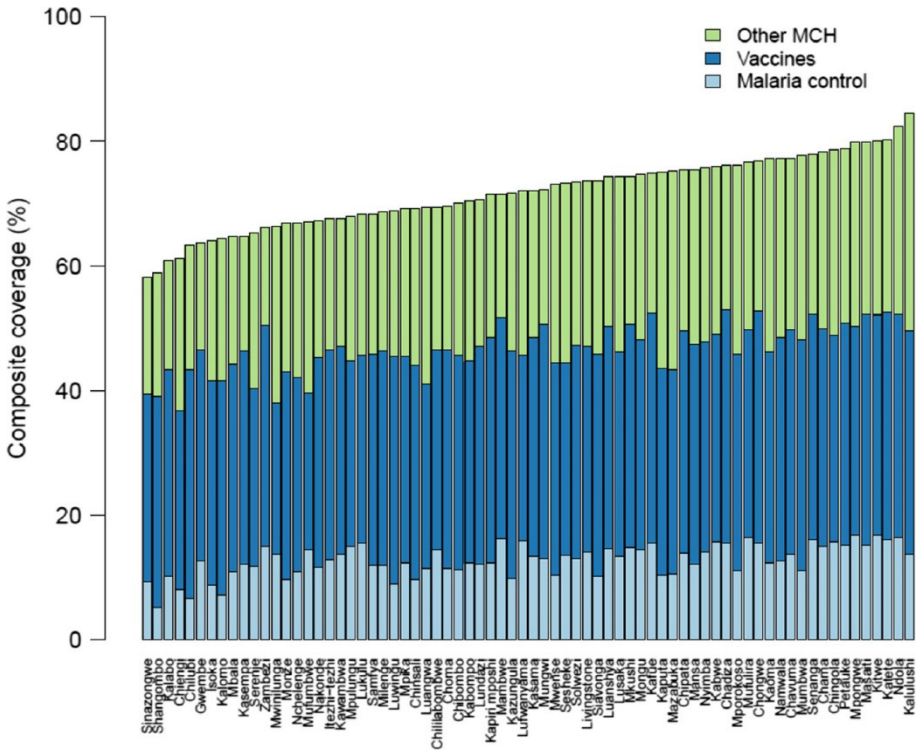

Figure 5: *Composite coverage by district and intervention cluster, 2010. Other MCH: ANC4,SBA, EBF and proportion of children not underweight. Vaccines:BCG, measles, polio, and pentavalent. Malaria control: ITN ownership or IRS and IPTp2*

DISCUSSION

The findings from this first-ever assessment of levels and trends in coverage of key MCH interventions across districts in Zambia show that substantial progress has been made in scaling up interventions such as malaria control and pentavalent immunization, as well as EBF. At the same time, stagnation and declines of intervention coverage occurred for routine services such as ANC4, SBA, and polio immunization. This district-level analysis revealed marked inequalities in coverage, particularly for maternal health interventions. Rates of progress for routine services varied substantially across districts, while rapidly scaled up interventions showed more uniform improvements across the country. Benchmarking performance of districts in delivering key interventions offers important insights and action points for policymakers, enabling them to identify underperforming districts and interventions with declining trends, as well as understand the largest disparities across districts.

This study revealed that very few districts in Zambia were high performers for all intervention types and, in general, performance was not highly correlated with average district socioeconomic status. While a few districts stand out as having uniformly low coverage and require immediate attention (Chiengi, Samfya, Sinazongwe, and Shang'ombo), several districts had mixed success. For example, coverage in Lusaka (the country's capital district, a region with lower malaria transmission intensity) in 2010 was above the national average for IRS, IPTp2, BCG, measles, and polio immunization coverage, and SBA, but it was well below the national average for ITN ownership and use, pentavalent immunization, ANC4, and EBF. In contrast to other countries where similar studies have been undertaken, geographic patterns in coverage did not reflect geographic variation in socioeconomic status. For example, in the United States

[100-102], Mexico [48], and China [50], patterns in health indicators largely mirror geographic variation in socioeconomic status and tend to be uniform across indicators; that is, wealthier regions within each country tend to have high life expectancy and high coverage of interventions such as in-facility delivery and hypertension treatment. In the case of Zambia, the fact that we did not see a strong association between socioeconomic status and coverage suggests that more complex factors are at work. Further investigation is needed to understand the drivers of the variation in performance across districts. In particular, more detailed case studies of districts with heterogeneous performance are needed to elucidate the reasons why certain interventions but not others are successful in these contexts. Zambia's experience highlights the importance of benchmarking to identify regions of high and low performance for a variety of key health indicators.

This work highlights two major patterns in health system performance across districts in Zambia: success in scaling up vertical programs and stagnation, or even weakening, of horizontal programs. At the national and district level, Zambia achieved greater successes in newer, rapidly scaled up interventions while gains in routine services delivery either stalled or declined, raising concerns that successes in vertical programs may have come at the expense of primary health care. Other key interventions such as HIV/ AIDS treatment, prevention of mother-to-child transmission of HIV, and case management of childhood malaria are not covered in the present study due to data limitations, but were also scaled up dramatically in this time period, and may have also contributed to our observed trends in routine service provision. Although there is some evidence that such a 'crowding-out effect' did not occur [103,104], the stark contrast between intervention coverage trends from horizontal and vertical programs warrants further examination. Concerns about vertical programs displacing horizontal ones are not unique to Zambia. A key challenge as LMIC health systems grow and the emphasis on UHC is heightened is to balance the roles of vertical and horizontal programs and ultimately leverage both to strengthen overall health system performance in each country. The Mexican health system reform is a notable example of success for implementing a more 'diagonal' approach, employing cost-effective interventions that link health facilities to community health needs, and benefiting from a balance between strong primary health care and vertical programs [105]. Zambia, along with many other countries, has begun to make the shift to diagonal programs that combine the strengths of disease-specific and comprehensive delivery systems [106].

This study underscores the importance of incorporating equity goals in target-setting. Zambia's scale-up of malaria control at the national level is impressive, but its emphasis on equity is lacking. The country's National Malaria Strategic Plan 2006–2010 set several malaria intervention coverage targets for the country to achieve by 2010 [83]. These targets were very ambitious, and despite marked progress since 2000, no district achieved all four targets in 2010. Zambia, as well as other countries, would greatly benefit from formulating health policy goals with explicit mention of targets for each district or region, as this would ensure that particular attention and resources are directed to the poorest performing regions. Zambia's National Health Strategic Plan 2011–2015 [82] emphasizes UHC, equity, and overall health system strengthening, but does not incorporate specific subnational targets. Achievement of the plan's targets (e.g., to reduce the national under-5 mortality rate from 119 deaths per 1,000 live births to 63 deaths per 1,000 live births by 2015) will require targeting interventions to the most disadvantaged populations. With the appropriate framing and implementation, this plan could be used as a platform to promote greater within-country equality. At the global level, it is well recognized

that the lack of clearly incorporating equity into the Millennium Development Goals (MDGs) was a major oversight, one that should not be repeated in the finalization of the forthcoming Sustainable Development Goals (SDGs) [107-109]. The experience of the MDGs warns that national target-setting not only fails to represent those most in need, but that such exercises can actually incentivize the opposite, to target the most accessible populations and to potentially propagate even greater inequalities [110-112].

Incorporating equity into global and national targets has significant implications for data collection systems. Data quality and availability limited the scope of this study, and a future global focus on subnational benchmarking will require substantial strengthening of existing and emerging data collection systems. In this analysis, the generation of district trends in coverage was challenging, and required triangulating information from many sources and applying sophisticated statistical techniques. Zambia is a comparatively data-rich country within sub-Saharan Africa, but most countries, both developed and developing, are not well-equipped for the routine collection and monitoring of data at the most relevant administrative levels. The demand from governments, international agencies, donors, civil society groups, and the public for high quality health information is growing rapidly and existing data collection systems are not keeping pace [113,114]. The MDGs motivated significant improvements in country-level monitoring of key health indicators, but the overarching evidence base and state of data collection systems, particularly in developing countries, remains weak. If the SDGs ultimately include subnational targets, a similar data revolution will be necessary. In order to report on subnational targets for a variety of indicators, data collection systems will need to become more integrated, cover a finer array of geographic regions and health topics, include measures of quality of interventions (such as biomarkers and health examinations), and encourage regular validation and use of the information collected for policymaking.

Limitations

The findings of this study need to be interpreted within the context of the limitations we encountered. First, the coverage of several key interventions could not be estimated in this analysis due to lack of data. Case management of childhood diarrhea, pneumonia, and malaria could not be estimated because caregivers reported too few cases per survey-district-year. Second, data on additional indicators from several administrative sources (i.e., the NMCC's ITN distribution database; National AIDS Council quarterly service reports; and Medical Stores Limited drug supply database) were excluded due to concerns about accuracy, completeness, and lack of appropriate denominator data. Third, our estimates of intervention coverage do not reflect the quality of the intervention received or any health gains associated with receiving the intervention. This a critical input for determining the effectiveness of health service provision and understanding whether the receipt or use of an intervention translates into improved health outcomes. Fourth, the findings from this study are largely based on self-reported information from household survey respondents, and thus are prone to biases related to self-reported data. Fifth, we encountered small sample sizes for some indicators from surveys that were not designed to be representative at the district level; for these indicators, coverage estimates were generally accompanied by larger levels of uncertainty. Finally, the analysis presented here did not seek to evaluate the causes of declines, improvements, or differences in coverage across districts and over time. Understanding the drivers of these trends in intervention coverage is critical, and it is likely that much could be learned by conducting a rigorous assessment of these changes.

CONCLUSIONS

Subnational benchmarking is important for assessing progress towards UHC, identifying drivers of success, and prioritizing areas of greatest need. This study shows that Zambia saw notable gains in the delivery of malaria control interventions, BCG and measles immunization, and EBF across districts, with small differences in the levels of coverage achieved. On the other hand, for SBA, ANC4, and polio and pentavalent immunization, the gap between the highest-performing and lowest-performing districts was very large. Geographic patterns in intervention coverage were not highly correlated with socioeconomic status, and further investigation is needed to understand what is driving such heterogeneity at the district level. Subnational analyses, such as the work presented here, should be conducted regularly so that the findings they generate can directly inform policy decisions and increase accountability at all levels of the health system and government.

Endnotes

[a]Stunting reflects chronic under-nutrition and wasting reflects acute under-nutrition. We selected underweight because it is representative of both chronic and acute under- nutrition and is the preferred World Health Organization measure of malnutrition [86].

[b]These variables include mean years of education among adults aged 18 and older, coverage of improved sanitation, coverage of improved cooking fuel, and household electricity availability.

Abbreviations

ANC: Antenatal care; BCG: Bacillus Calmette-Guérin; DHS: Demographic and health survey; DPT: Diphtheria-pertussis-tetanus; EBF: Exclusive breastfeeding; GPR: Gaussian process regression; IPTp: Intermittent preventive therapy for malaria during pregnancy; IRS: Indoor residual spraying; ITN: Insecticide-treated net; LMIC: Low- and middle-income countries; MDGs: Millennium Development Goals; MCH: Maternal and child health; NMCC: National Malaria Control Centre; OLS: Ordinary least squares; SBA: Skilled birth attendance; SDGs: Sustainable Development Goals; ST: Spatial-temporal; UHC: Universal Health Coverage; UI: Uncertainty interval.

Authors' contributions

KEC contributed to all parts of the analysis, produced the tables and figures, and wrote the first draft of the manuscript. LDL, TA, NF, MS, and MN identified data sources and contributed to the analyses of the microdata and methods development. PM and PH contributed to data acquisition, data verification, and interpretation of findings. FM and EG conceptualized the project and guided the data analysis and manuscript writing. All authors
read and approved the final manuscript. KEC and MS were at IHME when the research was undertaken. PM was at the University of Zambia when the research was undertaken.

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CHAPTER 3.2

IMPACT OF FUNDING MODALITIES ON MATERNAL AND CHILD HEALTH INTERVENTION COVERAGE IN ZAMBIA

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ABSTRACT

Objective

To determine the impact of different funding scenarios on the achievement of universal health coverage in Zambia.

Methods

We compiled a database of coverage trends for maternal and child health interventions for the period 2004–2009. Using the Arellano–Bond difference GMM model we estimated the effect of different funding channels on coverage for maternal and child health services over different time periods.

Findings

A 60% annual increase in funding channeled through the government system would lead to the achievement of overall intervention coverage of 85% for key maternal and child health interventions within a 6year period. A 60% annual increase in funding disbursed directly by donors would take over 9 years to achieve a similar effect.

Conclusion

Funding channels have an impact on health intervention coverage. Greater harmonization of funding from multiple sources into a single framework would help accelerate towards the attainment of universal health coverage.

INTRODUCTION

Recently the drive towards universal health coverage has gained momentum, with diverse stakeholders working in tandem to achieve the set targets [1–3]. Zambia like many countries in the sub-Saharan Africa has witnessed concerted efforts towards universal health coverage for key health interventions over the last decade [1,2]. Increased resources from different stakeholders including government and development partners have been committed towards scaling up key health interventions in the country [2]. Notably the focus has been on priority areas of maternal and child health including malaria which contributes significantly to the high disease burden in the country [1,3,5,6].

The Government of Zambia has equitable distribution of quality health care at the core of its ethos. The vision outlined by the government in the 1992 health policies and strategies, and successive national health strategic plans is to get health services as close to the family as possible [6]. With this objective in mind, there have been spirited efforts to promote access to health services particularly by removing barriers associated with cost [6–8]. Therefore, resource mobilization from multiple sources is an integral component of the overall vision of financing a health system aimed at achieving the health coverage targets by the year 2015 [2]. In a decentralized health system such as is in Zambia, there are often significant differences in resource allocation as well as models of channeling them, which may affect the overall results at the population level [4–6]. Funds for health service delivery in Zambia can be broadly categorized into government or donor sources. Government funds are normally directed towards public health entities while donors largely channel their funds through their own aid agencies, non-governmental organizations, or directly to the districts involved in health service delivery. Further, donor funds are often channeled in a project specific manner, usually defined by one disease area such as malaria or HIV/AIDS; while government funds are normally channeled in a system-wide fashion where all health system interventions are targeted. These two types of funding have been characterized vertical and horizontal, respectively [1,2,6].

A systematic comparison of different channels used to distribute resources for service delivery and levels of intervention coverage achieved offer a good measure for tracking the performance of sub-health systems in this context [3–5]. This comparison could be particularly important to sub- national health system stewards keen to benchmark and assess their performance across the country. Stewardship is often defined as those governance and administrative functions that are performed by health system leaders or governments to meet the set health policy objectives [3,4]. Therefore, lessons from better performing districts adjusted for resources could prove instructive to those that are lagging behind in terms of health service delivery. With pressing health needs and finite resources, it is imperative for decision makers to appreciate efficient ways of allocation and delivery of resources to ensure optimal gains [3].

In this paper, we make comparisons between donor and government funds disbursements and their effect on overall intervention coverage of key maternal and child health interventions in Zambia; taking into account different counterfactual funding scenarios. This is particularly relevant given the urgency to scale up interventions in the run up to the 2015 Millennium Development Goals.

METHODS

Data sources

Through a related project, Malaria Control Policy Assessment in Zambia, we have recently generated district and provincial level health intervention coverage trends in Zambia over the past two decades using multiple data sources available in country [9]. The interventions included were childhood immunizations (BCG, Polio, DPT3 and measles); the proportion of children who are not under- weight; antenatal care; intermittent preventive treatment for malaria in pregnancy; skilled birth attendance; and malaria prevention. We further aggregated all the interventions into a composite coverage metric at the district level as a measure of the overall health system output.

We then obtained a dataset of annual operational fund disbursements from government and donor sources to each of the 72 districts in Zambia over the period 2004–2009. This data is available through the Directorate of Health Policy and Planning of the Ministry of Health. Using population data from the Central Statistics Office of Zambia we calculated the population adjusted government and donor fund disbursements to each district and province in the country.

Statistical analysis

We extracted a dataset of composite coverage trends for the period 2004–2009, and linked it to the funds disbursement data at the district level. With this panel data we modeled coverage as a function of government and donor funds with district level fixed effects. We transformed coverage into logit space in order to constrain it between 0 and 1.

$$coverage_{it} = \beta_0 + coverage_{it\_1} + \beta_1 GRZ_{it} + \beta_2 Donor_{it} + \varepsilon_{it}$$

In the equation above:

- coverageit is the composite intervention coverage in district (i) at time (t).
- coverageit-1 is the lagged value of coverage.
- GRZit is the government funds disbursed to district (i) at time (t).
- Donorit is the donor funds distributed to district (i) at time (t).
- it is the randomly distributed error at district (i) at time (t).

We used the Arellano–Bond difference GMM, an econometric model suitable for analyzing panel datasets because it mitigates for the following potential problems that may arise with our data.

1. Coverage and funds disbursements are assumed to be endogenous, because causality may run in both directions—from funds to coverage and vice versa.
2. Another potential source bias is that the fixed effects such as district health structure and socioeconomics may be correlated with the explanatory variables. For instance, districts with low coverage may attract more funds or vice versa given the objectives of funding authorities
3. The presence of the lagged dependent variable $coverage_{it?1}$ also gives rise to autocorrelation.

The Arellano–Bond difference GMM model uses the lagged levels of endogenous variables as instruments which are not correlated to the error term. Similarly, the fixed effects at the

district level are dropped out in the first difference since they do not vary with time. The model is suitable for panel data with short time dimension (t = 5 years) and a large cross section dimension (72 districts).

RESULTS

Figure 1 shows that national composite intervention coverage in Zambia increased from 50% to over 60% within the period 2004–2009. There was increased coverage across the nine provinces in Zambia with most of them going beyond the 50% coverage mark by the year 2006. However, there is still a wide coverage gap across the different parts of the country, with the predominantly urban provinces (Copper- belt and Lusaka) consistently leading the pack while the rural provinces (such as North-Western and Central) showing lower coverage over the years.

Fund disbursements to the different provinces in the country show a mixed picture over time as shown in Figure 2. Government disbursements to the nine provinces show a steady increase between the year 2004 and 2009 while donor funds show an inconsistent picture over time. Population adjusted donor funds seem to decline from the year 2004 to 2006, and then shoot up in the years 2007 and 2008, only to decline in the year 2009 across all provinces.

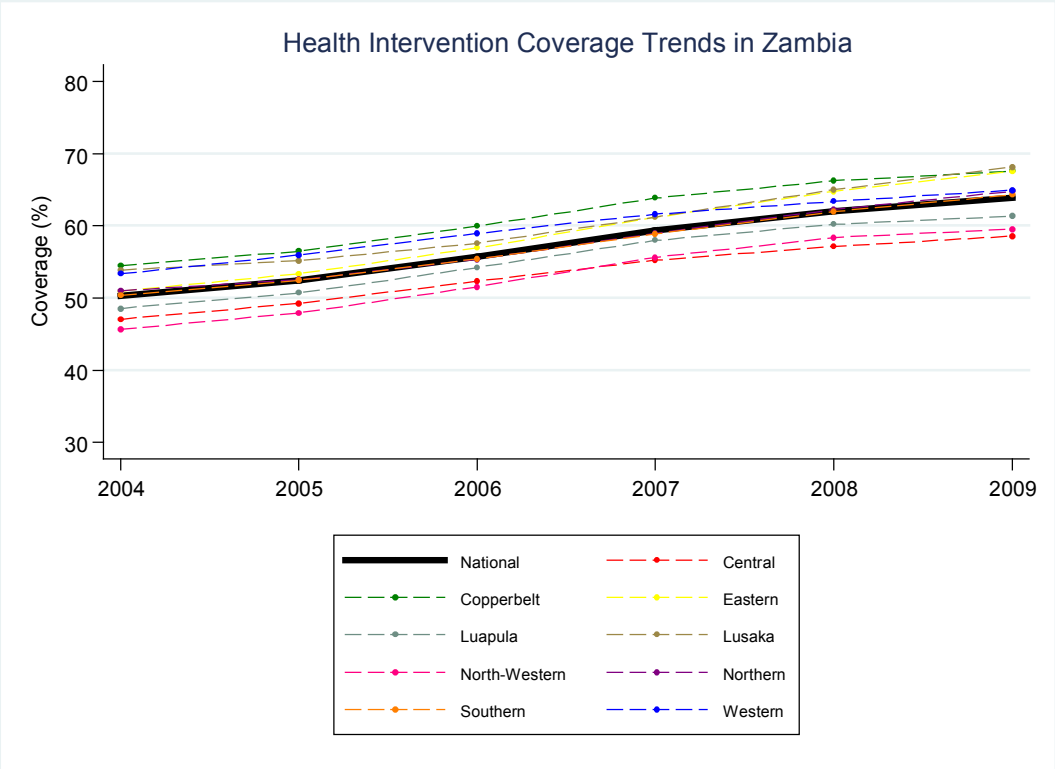

Figure 1: *Health intervention coverage trends in Zambia*

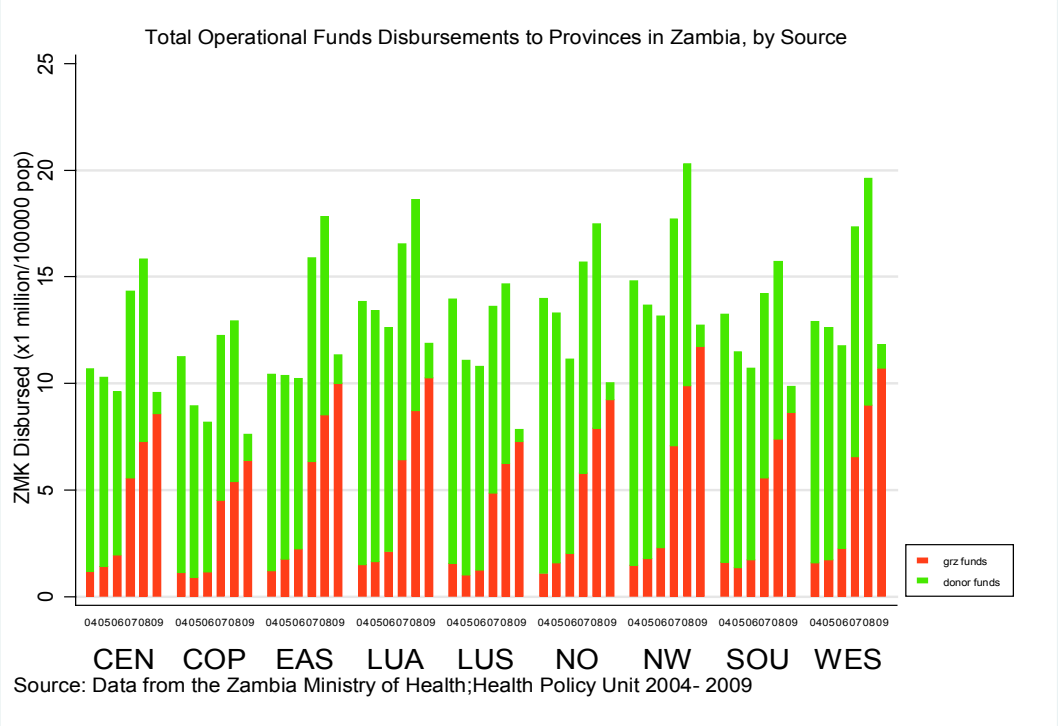

Figure 2: *Population adjusted funds of provinces in Zambia*

However, with the provincial health budgets remaining between ZMK 10 million and ZMK 15 million per 1000 population across most provinces, it seems that the government funds have been replacing donor funds wherever the later has shown a contraction.

The effect of donor and government funds on logit transformed coverage scale is shown in Table 1. For a unit (ZMK 1million/1000 population) increase in government funds, coverage increases by 1.2% in logit space. However, a similar increase in donor funds leads to a smaller increase in coverage of 0.4%. The effects of both government and donor funds are significant at the 95% CI. Invariably it is also clear that present coverage levels are highly influenced by past levels.

Table 1: Impact of Funds on Intervention Coverage

Variables	**logit.coverage**
Lagged .logit coverage	0.812***
	(0.0437)
Government funds	0.0120***
	(0.00230)
Donor funds	0.00408***
	(0.000474)
Constant	0.0646***
	(0.00947)
Observations	288
Number of districts	72

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

An extrapolation of these parameters into different counterfactual scenarios reveals that an annual increase 60% of funds channeled through government, would on average achieve the 85% coverage target, within a period of approximately 6 years as shown in Figure 3. However, it is further shown in the same figure that a 30% annual increase of funds channeled through government would increase overall coverage to 72% and would not achieve the desired coverage target within the 6 years' period.

Figure 4 shows that increasing the share of funds channeled directly by donor funds annually by either 30% or 60% will not achieve the universal health coverage targets of 85% within a 6-year period; only achieving 68% and 71% respectively. Further analysis compared government and donor funding both increasing at an annual rate of 60% over a 10-year period as shown in Figure 5. It is observed that on average, an annual increase of donor funds by 60% would only achieve overall coverage of 85% after a 9-year period, with progressively increasing uncertainty towards year 10. This further reveals a 4-year gap in the attainment of the universal health coverage goal between government and donor channeled funds.

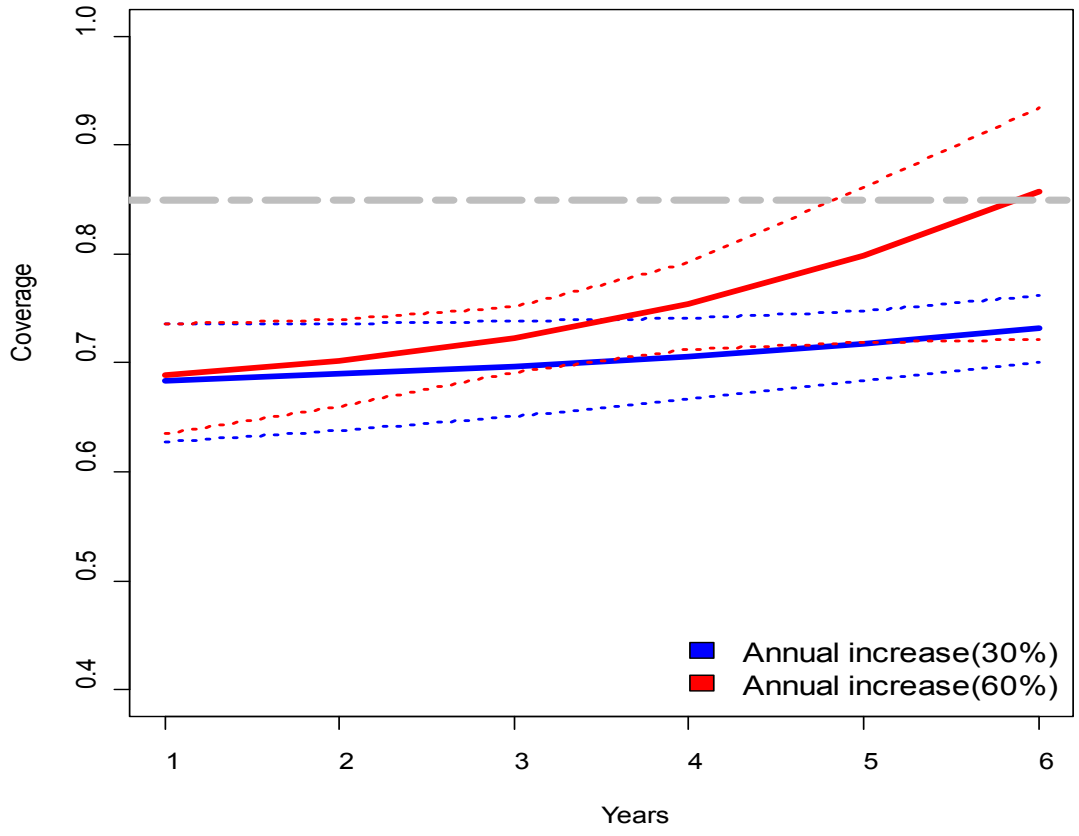

Figure 3: *Counterfactual Government Funding Scenarios*

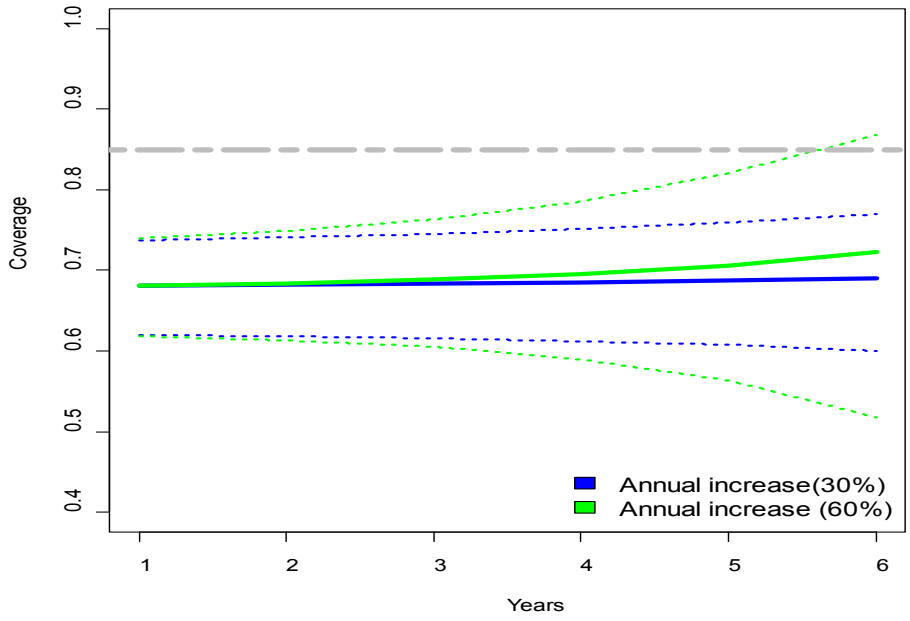

***Figure 4:Counterfactual** donor funding scenarios*

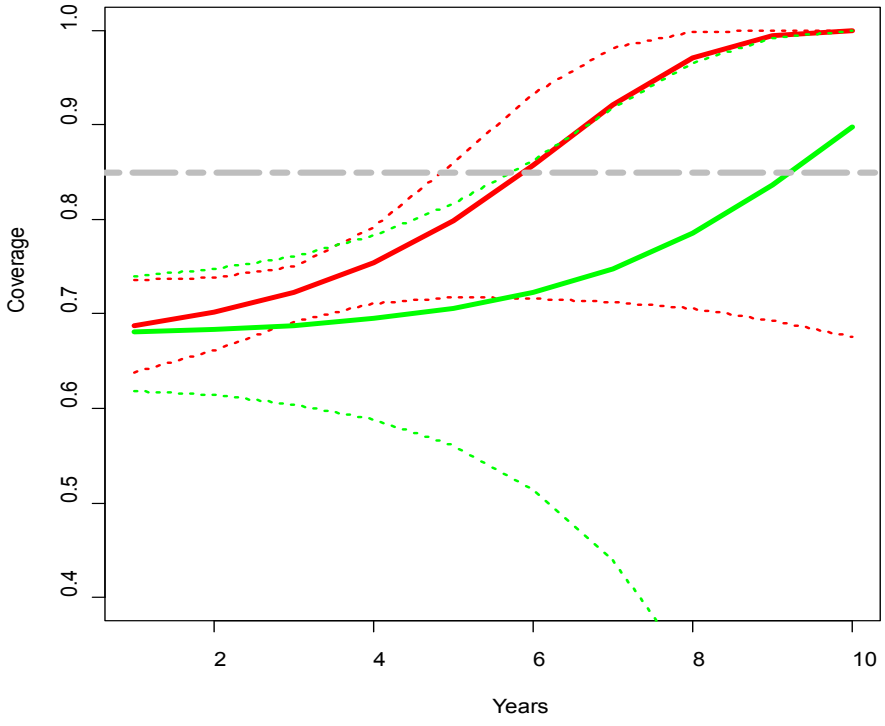

***Figure 5:** A comparison of donor and government funding channels.*

DISCUSSION

In the run up towards the 2015 Millennium Development Goals, health system stewards and funders need to be aware of their performance towards meeting the health needs of their populations. Intervention coverage offers a good metric for tracking progress and evaluation of the overall performance of health systems [3–5]. In this paper; we go a further step and consider both coverage and funds allocated through two different channels in Zambia. These findings, offer a simple framework through which policy makers can make objective decisions on effective strategies of channeling funds to the health system in order to achieve universal health coverage. More importantly, the questions raised in this paper would enrich the on-going debate on the most effective and efficient pathway towards universal health coverage.

Zambia continues to make progress in scaling up overall intervention coverage [10–13]. However, the rate of increase is not sufficient to achieve the desired target of universal health coverage for of the priority health interventions by 2015. An acceleration of the observed coverage trend would not only require a considerable commitment of operational resources, but appropriate channeling of funds in order to achieve the desired impact. Comparing government and donor funding channels, the former offers the most efficient pathway towards universal health coverage. In fact, there is evidence from Zambia that the uncoordinated and unpredictable funding that comes from some development partners could have deleterious effects on health system performance [13].

We are cognizant that the relationship between coverage and funding levels is not necessarily linear and maybe affected by multiple factors some of which we have attempted to control for in our model. However, this sets the scene for follow-up investigative questions into the fundamental differences in the construct of the two funding channels. Donor funds in Zambia tend to be focused on specific donor preferred projects on malaria, HIV/AIDS, and TB, while government funds tend to be more system-wide [14,15]. Furthermore, the donor funds tend to fluctuate more in comparison to the government funds disbursements. For example, studies have shown that the donors contributing to "basket-funding" in Zambia have been disbursing less and less money to the basket since 2006, while there is a three months' delay on average in disbursements by donors to the Ministry of Health Basket [16,17]. In this regard, a systematic approach to understanding the effect of these factors would be a significant step in resolving the bottlenecks that are curtailing faster achievement of universal health coverage.

From these findings, it would be reasonable to assume that efforts to harmonize funds from multiple sources into a single framework termed "basket-funding" would serve to accelerate scale up in overall coverage in the country. This is because basket-funding focuses more on the health system as a whole, instead of piecemeal or 'disease silo' programs. This approach also offers the advantage of predictability of funding, and use of joint systems for planning, implementation, and reporting which would facilitate effective planning and implementation scenarios [12,13].

In the interpretation of our findings, a number of analytical limitations should be borne in mind. The composite coverage metric that we have used as a measure of the health system output does not comprise of all the interventions offered through the health system, but a subset of those that are available through existing data sources. Further, we have used aggregate funds disbursements to districts, from the two sources, which could mask the fact that to some extent, there is a mixing of funds particularly in the case of basket funding or actual implementation at the local levels. However, we must stress that despite these limitations, this paper offers a good approximation for the efficiency of funding scenarios towards universal health coverage.

We observe that any country aiming to achieve universal health coverage of key health interventions would greatly benefit from innovative ways to allocate and channel the limited resources to achieve the maximal coverage gains. This is particularly vital given the different models of financing and health service delivery, which are often implemented in developing countries.

CONCLUSION

The funding modality does have an impact on the attainment of Universal Health Coverage. In Zambia Government funding has a greater impact on the attainment of universal health coverage in comparison to donor funding. This could be attributed to the unpredictable nature of donor financing in Zambia both in terms of volumes and timing of the disbursements. The limited focus and/or incomprehensive nature of donor funding makes it even harder for donor funds to have a large and system-wide impact on universal health coverage. We call for more efforts to harmonize funds from multiple sources into a single framework, which would help to accelerate the achievement of universal health coverage in Zambia.

Ethical approval

Permission to implement this research project was obtained from the Ministry of Health, Government Republic of Zambia. Ethical approval for this study was obtained from the ethics review boards of the University of Washington and the University of Zambia.

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CHAPTER 4

CHAPTER 4.1

TECHNICAL AND SCALE EFFICIENCY IN THE DELIVERY OF CHILD HEALTH SERVICES IN ZAMBIA: RESULTS FROM DATA ENVELOPMENT ANALYSIS

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ABSTRACT

Objective

Despite tremendous efforts in scaling-up key maternal and child health interventions in Zambia, progress has not been uniform across the country. This raises fundamental health system performance questions that require further investigation. Our study investigates technical and scale efficiency in the delivery of maternal and child health services in the country.

Setting

The study focused on all the 72 health districts of Zambia.

Methods

We compiled a district level database comprising of a health outcome (measured by probability of survival to age 5 years), a health output (measured by coverage of key health interventions) and a set of health system inputs namely, financial resources and human resources for health for the year 2010. We used data envelopment analysis to assess the performance of sub-national units across Zambia with respect to technical and scale efficiency, controlling for environmental factors that are beyond the control of health system decision makers.

Results

Nationally, average technical efficiency with respect to improving child survival was 61.5% (95%CI, 58.2-64.8), which suggests huge inefficiency in resource use in the country, but also the potential for expanding services without injecting additional resources to the system. Districts that were more urbanized and had a higher proportion of educated women were more technically efficient. Both use of improved cooking and donor funding had no significant effect on efficiency.

Conclusion

With the pressing need to accelerate progress in population health, decision makers must seek efficient ways of delivering services to attain universal health coverage. Understanding the factors that drive performance and seeking ways to enhance efficiency offer a practical pathway through which low-income countries could make progress on population health without necessarily seeking additional resources.

Key words

Technical Efficiency; Scale Efficiency; Data Envelopment Analysis; Health Systems Performance

Strengths and Limitations of Study

- The study measures technical and scale efficiency at the district level, lowest health system management unit in most developing countries
- Data envelopment analysis is used to determine sources of inefficiency in the health system
- The study covers only maternal and child health despite the fact that the health system also encompasses other broader programmatic areas

INTRODUCTION

Decentralization of health services has been pivotal in the efforts toward universal health coverage across the developing world [1–3]. There are many drivers of this trend, but improvements in service delivery remains an implicit motivation behind most decentralization efforts [2, 3]. This is mainly anchored around the ideals and principles of local ownership and accountability in service delivery as well as meeting key health system goals with respect to equity, efficiency and responsiveness [1-4].

As in most other countries, Zambia has embraced a decentralized health system model since 1992 as a pathway towards equitable access to health services for its population [3,4].This entailed devolution of key decision-making and implementation functions to the provincial and district level, where stewards were assigned specific roles aimed at meeting national health policy objectives. Consequently, health resources were directed toward districts which were given primary responsibility in the delivery of key health services to meet various local population health needs [3,5–7].

In this arrangement, the central government is largely focused on setting national priorities and allocating health resources to subnational units, based on projected health needs. In practice, this involves the Ministry of Health (MOH) providing budget ceilings to all district health offices (DHO), which would then make their own plans and budget for their activities in line with local projected health needs, bearing in mind the budget ceiling [3, 5]. Meanwhile, donor organizations, largely channel their funding through non-governmental and faith-based organizations involved in health service provision at the district level [4, 6, 8]. The Provincial Health Offices occupy an intermediate position between the national and district levels mainly taking an oversight role for districts nested within their respective jurisdictions [3,5,6]. The organization of the health system is aimed at ensuring equity in health service delivery, core health objective of the Government of Zambia [5–8].

Despite these efforts, in-depth investigation of the country's health system performance reveals wide subnational heterogeneity in goal attainment. Invariably, this underscores the need to understand the root cause of the differentials in performance across subsystems so that lessons drawn from high performing sub-units could be informative to those that are lagging behind [3,4,7–9]. A systematic and objective comparison of goal attainment and resource allocation across health sub-units in Zambia is timely. The results could provide a valuable benchmarking framework in the effort to push the country's health systems towards better performance [4,9,10].

In this paper we make a systematic comparison in performance across districts and provinces in Zambia; paying attention to the priority area of child survival, as a key health system outcome. Health intervention coverage for maternal and child health services is considered as the measure of health system output while human and financial resources allocated to districts, are considered as the health system inputs. Further, we seek to demonstrate how data envelopment analysis (DEA) [11] can be applied for efficiency benchmarking and comparative performance assessment for a decentralized health system.

CONCEPTUAL FRAMEWORK

The conceptual framework proposed here borrows its fundamentals from the World Health Organization (WHO) Health System Framework, which effectively connects health inputs, with health outputs, processes and outcomes. [2]. The framework identifies six discrete pillars that need to function in tandem to meet expected health goals [2,4,8–10]. The six pillars of a well-functioning health system include, good health service provision; adequate and progres-

sive health financing; well-functioning human resources; good governance and leadership; a well-functioning health information system; and access to and equitable distribution of essential medicines and health technologies [2].

In our analysis we have focused on human resources and health financing, as the key health systems inputs underlying the production function used in the estimation of efficiency scores. Meanwhile, health intervention coverage is the intermediate health system output through which changes in health outcomes (in this case mortality among children under 5 years of age) are realized. Health intervention coverage was constructed as a composite metric comprising of DPT3 and measles immunizations, skilled birth attendance, and malaria prevention. The approach employed in the construction of this metric and its merits are further discussed in the methods section.

We selected under 5 mortality rate (U5MR) in our assessment of district health system performance, since it is a key indicator used to monitor progress towards reduction in child mortality, which was a key objective of Millennium Development Goals (MDG). This indicator is further recognized as a good measure of overall population health, particularly in developing countries. Meanwhile, our health intervention coverage- as a measure of health system output- comprised of essential maternal and child health interventions critical for child survival in most developing countries in the tropics [4, 8]. However, given the fact that health outcomes depend on a variety of factors, some of which are under the control of the health sector and some that are not, we remain cognizant of the fact that there may not exist a direct relationship between improvement in health system inputs and achievement of better health system output and health outcomes [11]. Another point that equally deserves attention with regard to the study is the fact that efficiency estimates refer to the efficiency of an output (or an outcome) for a given level of input, and does not refer to the level of the output (or outcome) itself. In other words, it is still possible for a district or a country to be fully efficient and yet have lower output and/or outcome levels [12]. We have sought to explore this further in the assessment of district health system performance.

METHODS

In the definition of efficiency, a distinction should be made between technical, allocative, and scale efficiency measures [13-15]. In this study only technical and scale efficiencies were considered, mainly because input prices needed for the estimation of cost functions, were not available to us [12, 14]. For estimation of efficiency scores, we employed the Banker, Charnes, and Cooper (BCC) formulation of the DEA model. The choice of the BCC approach is partly guided by the fact that all our variables were ratio-based, and we endeavored to take economies of scale into account in the analysis. In addition, like all other DEA models, the BCC model also handles multiple inputs and outputs, which is particularly suited for complex fields such as health systems [13,15],where there is a multidimensional mix of input and output variables that have to be considered simultaneously [15-18]. Further, we applied the approach developed by Charnes, Cooper and Rhodes (CCR) to enable us to decompose overall efficiency score into scale and pure technical efficiency.

Given that each decision-making unit (DMU) may face locally unique conditions, the DEA approach assesses each unit separately, assigning some weighted combination of inputs and outputs that maximizes its efficiency score [13,15]. Algebraically, this is achieved by solving for each DMU (district) the following linear programming problem [15].

$$max_{\,u,v} \quad \left(\frac{\sum_{o=1}^{o} u_o \times y_{oo}}{\sum_{i=1}^{i} vi \times k_{i0}}\right)$$

$$subject\ to: \quad \frac{\sum_{o=1}^{o} u_o \times y_{on}}{\sum_{i=1}^{i} vi \times k_{in}} \leq 1 \quad n = 1, \ldots \ldots N$$

Where

y_{o0} = quantity of output "o" for DMU$_0$

u_o = weight attached to output o, $u_o > 0$, o = 1, ……., O

k_{i0} = quantity of input "i" for DMU$_0$

v_i = weight attached to input i, $v_o > 0$, i = 1, ……., I

The equation is solved for each DMU iteratively (for n=1, 2,…, N); therefore, the weights that maximize the efficiency of one DMU might differ from the weights that maximize the efficiency of one DMU might differ from the weights that maximize the efficiency of another DMU [17, 18]. Theoretically, these weights can assume any non-negative value, while the resulting technical efficiency scores vary only within a scale of 0 to 1, subject to the constraint that all other DMUs also have efficiencies between 0 and 1.

However, the ratio formulation expressed above leads to an infinite number of solutions, because if (u^*, v^*) is a solution, then (αu^*, αv^*) is another solution [15, 17, 19, 20]. To avoid this problem, one can impose an additional constraint by setting either the denominator or the numerator of the ratio to be equal to 1 (for example, v'xj= 1), which translates the problem to one of either maximising weighted output subjected to weighted input being equal to 1 or of minimising weighted input subjected to weighted output being equal to 1 [15, 21]. This would lead to the multiplier form of the equation as expressed as follows [15, 19, 20]:

$\max_{\mu,v} (\mu' y_j)$,
Subject to:
$v'x_j = 1$
$\mu' y_j - v' x_j \leq 0$, j = 1,2 …..J
$\mu, v \geq 0$

This maximization problem can also be expressed as an equivalent minimization problem [15, 19].

Technically, a DEA-based efficiency analysis can take either an input- or output-orientation. In an input-orientation, the primary objective is to minimize inputs, while in an output-orientation the goal is to attain the highest possible output with the given amounts of inputs. In our case, an output-oriented DEA model was deemed more appropriate on the premise that district health teams have essentially a fixed set of inputs to work with at any given time [3,5,6]. In other words, the district health system stewards would have more leverage in controlling outputs through innovative programming rather than raising additional resources.

As performance and institutional capacity are expected to vary across districts [4], a variable-returns-to-scale (VRS) approach was also considered more relevant to the study setting. This approach allows for economies and diseconomies of scale, rather than imposing the laws of direct proportionality in input-output relationships as espoused in the constant-returns to scale (CRS) [16-19]. A VRS model also offers the advantage of decomposing Overall Technical

Efficiency into Pure Technical Efficiency (PTE) and Scale Efficiency (SE), which is essential in locating the source(s) of differentials in performance across production units [16–18].

Analyses were done using R version 3.2.1, specifically the r-DEA package that has the capability to combine the inputs, outputs, and environmental variables into one stage of analysis. This package implements a double bootstrap estimation technique to obtain bias-corrected estimates of efficiency measures, adjusting for the unique set of environmental characteristics under which different DMUs are operating [11, 20]. To obtain robust estimates, we bootstrapped the model 1,000 times and generated uncertainty around the estimates [20, 21]. The same approach was used to generate robust DEA efficiency scores corresponding to health intervention coverage, applying the same input and environmental variables

Data Sources

We used data from the Malaria Control Policy Assessment project (MCPA) in Zambia, which compiled one of the most comprehensive district-level data on U5MR, health intervention coverage and socioeconomic indices for the country based on standardized population health surveys [4,8]. For both indicators, to capture the most recent period for the country, the data representing the year 2010 were used.

In our DEA model, U5MR was used to measure district health system outcomes. In order to measure the outcome, output and inputs in the same direction in such a way that "more is better" we converted the probability of dying under five years of age (which is conventionally known as under-5 mortality rate) into probability of survival to age 5. This was accomplished simply by subtracting the reported under five mortality rate per 1000 live births from a 1000 [11, 22]. Health intervention coverage was a composite metric comprising of the proportion of the population in need of a health intervention who actually receive it [4, 8].

The composite metric comprised of DPT3 and measles immunizations, skilled birth attendance, and malaria prevention. For malaria prevention, we included the indicator approximating malaria prevention efforts across districts, i.e. the combination of insecticide treated net (ITN) ownership or indoor residual spraying (IRS) coverage. The average of all the 5 health interventions for each district, was taken as the health intervention coverage [4]. This innovative way of data reduction through combining a range of health interventions has the advantage of reducing the number of variables that enter into the model. This in turn helps to maintain reasonable balance between the number of DMUs and input and output variables which is required to avoid scarcity of adjacent reference observations or "peers," which if not taken care of would lead to sections of the frontier being unreliably estimated and inappropriately positioned [15, 16,18].

For the inputs part, we obtained a dataset of annual operational funds from both government and donors to each of the 72 districts for the year 2010. These data are available through the Directorate of Health Policy and Planning (DHPP) of the Ministry of Health [8]. Using population data from the Central Statistics Office of Zambia, we calculated the total population-adjusted funds disbursed to each district. We further obtained data from the Ministry of Health on the human resource complement for the year 2010 covering the medical professionals (doctors and clinical officers) and nurses (including midwives) for each district and adjusted them for the district population.

In addition, we included the mean years of education among women aged 15-49 years, the proportion of districts funds originating from donors, household access to electricity and the proportion of household with improved cooking methods, as environmental variablesthat are external to district health units but nonetheless affect performance and efficiency levels of the health system. These variables were chosen based on their importance in addressing the key global health targets around maternal and child health in Africa [1–3]. Donor funding is a major feature in African health systems and has been a subject of major debate in the efforts toward health system strengthening. Similarly, the relationship between health and education,

particularly among women, has been variously documented [2–4,8]. Both datasets were obtained from the MCPA database.

Ethical approval

Permission to conduct the study was obtained from the Ministry of Health, Zambia. Since our study only used de-identified secondary data, we were granted exemption from the IRB, University of Zambia: IRB00001131 of IROG000074.

RESULTS

Descriptive statistics

Table 1 presents descriptive statistics for the variables used in the study. The range for both inputs and outputs is quite wide. For example, under-5 mortality rate across districts varies between 87.16 deaths per 1000 live births and 161.96 deaths per 1000 live births, while health intervention coverage varies from 44.20% to 93.42%. Similar patterns are apparent for health workforce and financing indicators, where the distribution of nursing personnel ranged from 5.16 nurses/1000 population to 33.03 nurses/1000 population, while total funds to districts ranged from 4.24 million ZMK/1000 population to 23.77 million ZMK/1000 population. This suggests that at the subnational level, the Zambian health system is quite heterogeneous.

Table 1: Summary statistics of the variables

	Variable	Units	Mean	Standard deviation	Min	Max
Outcomes	Under-5 mortality	*Deaths per 1000 live births*	115.61	(14.66)	(87.16)	(161.96)
	Under 5 Survival Rate	*per 1000 live births*	884.39	(14.73)	(838.04)	(912.84)
Outputs	Health intervention[1] coverage	*Percentage %*	67.09	(10.99)	(44.20)	(93.42)
Inputs	Total funds	*Millions of Zambian Kwacha per 1,000 population*	13.60	(3.55)	(4.24)	(23.77)
	Medical personnel	*Medical personnel[2] per 1,000 population*	6.96	(3.34)	(.92)	(18.23)
	Nursing personnel	*Nursing personnel[3] per 1,000 population*	12.72	(5.76)	(5.16)	(33.03)
Environmental	Proportion of donor funds	*Percentage%*	38.43	(5.21)	(31.39)	(57.21)
	Proportion of households with access to electricity	*Percentage%*	13.23	(17.06)	(0.19)	(61.29)
	Proportion of households with improved cooking	*Percentage %*	10.26	(14.55)	(0.33)	(53.77)
	Average years of education for women aged 15-44	Years	5.72	(1.60)	(2.93)	(9.51)

[1] Health intervention coverage is a composite metric comprising of 5 health interventions
[2] Medical personnel includes both medical doctors and clinical officers (medical assistants).
[3] Nursing personnel includes both registered nurses and midwives

Table 2, makes provincial comparisons for input, output and outcome variables, revealing further heterogeneity across the country. For instance, in the predominantly urbanized Copperbelt province, health intervention coverage was as high as 81.05% (95%CI: 75.31-86.78), in comparison to the North-Western province, which was predominantly rural, with a coverage of 61.64% (95%CI: 53.80-69.48). Still within provinces, there was significant heterogeneity, considering that all provincial estimates for health intervention coverage had wide confidence intervals of more than 10% points. This trend further underscores the differences in goal attainment across the districts in country. Similar differences were also observed with respect to under-5 survival rate where provincial estimates revealed a wide gap across provinces, with the Southern province topping the list with 898.14 survivors per 1000 live births (95%CI: 892.64-903.63) and Northern province lagging with 869.82 survivors/1000 live births (95%CI: 862.25-877.38).

Table 2: Summary of variables across provinces

Provinces	**Under-5 mortality**	**Under-5 survival**	**Health intervention coverage**	**Total funds**	**Medical personnel**	**Nursing personnel**
Units	*Deaths per 1000 live births*	*Per 1000 live births*	*Percentage%*	*Millions of Zambian Kwacha per 1,000 population*	*Medical Personnel per 1,000 population*	*Nursing Personnel per 1,000 population*
Central	109.46 (103.00, 115.91)	890.54 (884.09, 897.00)	63.92 (54.41, 73.42)	12.70 (11.97, 13.44)	7.75 (5.63, 9.87)	12.02 (6.53, 17.51)
Copperbelt	111.07 (106.40, 115.75)	888.93 (884.25, 893.6)	81.05 (75.31, 86.78)	10.27 (7.39, 13.16)	8.08 (6.36, 9.80)	16.83 (14.89, 18.77)
Eastern	126.35 (120.73, 131.97)	873.65 (868.03, 879.27)	69.96 (65.41, 74.50)	14.58 (12.71, 16.46)	6.64 (4.26, 9.02)	10.26 (8.26, 12.27)
Luapula	127.99 (115.62, 140.36)	872.01 (859.64, 884.38)	62.18 (57.94, 66.43)	15.26 (13.94, 16.57)	5.99 (4.44, 7.54)	10.11 (7.35, 12.88)
Lusaka	111.76 (101.84, 121.69)	888.24 (878.31, 898.16)	77.00 (71.96, 82.05)	11.26 (2.56, 19.96)	7.65 (4.36, 10.94)	15.59 (3.60, 27.58)
North-Western	106.64 (101.07, 112.22)	893.36 (887.78, 898.93)	61.64 (53.80, 69.48)	16.52 (14.59, 18.45)	6.89 (3.77, 10.00)	15.98 (10.65, 21.32)
Northern	130.18 (122.62, 137.75)	869.82 (862.25, 877.38)	62.52 (58.38, 66.67)	13.76 (12.57, 14.96)	3.66 (2.40, 4.93)	8.82 (6.72, 10.93)
Southern	101.86 (96.37, 107.36)	898.14 (892.64, 903.63)	65.08 (58.06, 72.10)	12.79 (11.49, 14.10)	9.27 (7.05, 11.50)	14.80 (11.66, 17.94)
Western	110.49 (99.99, 120.99)	889.51 (879.01, 900.01)	62.24 (54.07, 70.42)	15.73 (14.67, 16.79)	7.73 (5.70, 9.77)	11.40 (7.80, 15.01)

Note: 95% confidence intervals in parentheses, these were calculated under the normal distribution assumption

Overall efficiency, pure technical efficiency, and scale efficiency

Figure 1, shows the estimates of overall technical efficiency (OTE) scores obtained using an output-oriented bias-corrected DEA model across the 72 districts of Zambia considering under-5 survival rate as our outcome indicator. A value of 1 indicates that a district produces at the frontier; and the lower the value, the farther the district is from the efficient frontier. As with the input, output and outcome indicators shown in Table 1, the results shown in Figure 1 portray a deeply heterogeneous picture in terms of overall technical efficiency across subnational units. For example, both the worst and best performing districts, Luangwa, at 31.0% (95%CI: 29.5-33.0) and Kafue at 88 %(95%CI: 79.2-97.1) are both found in the predominantly urban province of Lusaka.

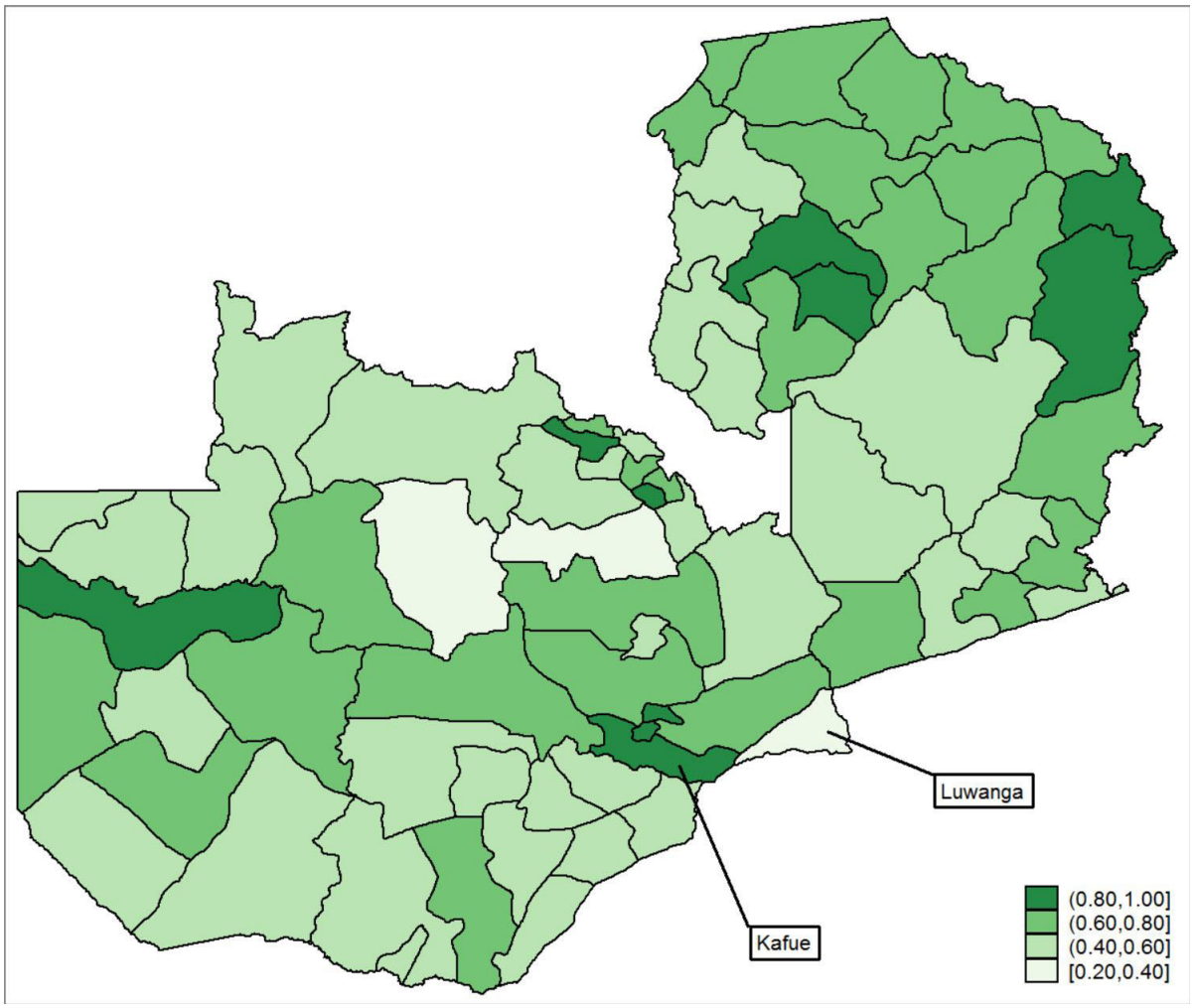

Figure 1: *Overall technical efficiency across Zambia*

Only 22 (31.0 %) districts in the country (predominantly from the Northern and Lusaka provinces) had efficiency scores above 70%. The next tier of top performers, with an overall technical efficiency score between 60% and 70%, showed a mixed picture but also with predominant representation from the Copperbelt province and other districts from the northern and eastern parts of the country, which suggests a phenomenon of spatial clustering in

performance in the country. The average efficiency score for the country as a whole was 61.5% (95%CI, 58.2-64.8), which suggests a significant potential for further improvement without the need for additional resources.

Figure 2 shows that there was a strong association between overall technical efficiency scores for under-5 survival (outcome) and the overall technical efficiency scores for health intervention coverage (output). This means that efficient attainment of health intervention coverage is strongly predictive of how efficiently districts in Zambia perform in meeting their child survival objectives. However, in as much as this is prevailing in most districts, there are some that deviate from this trend raising further questions into the role of environmental factors that are beyond the health system.

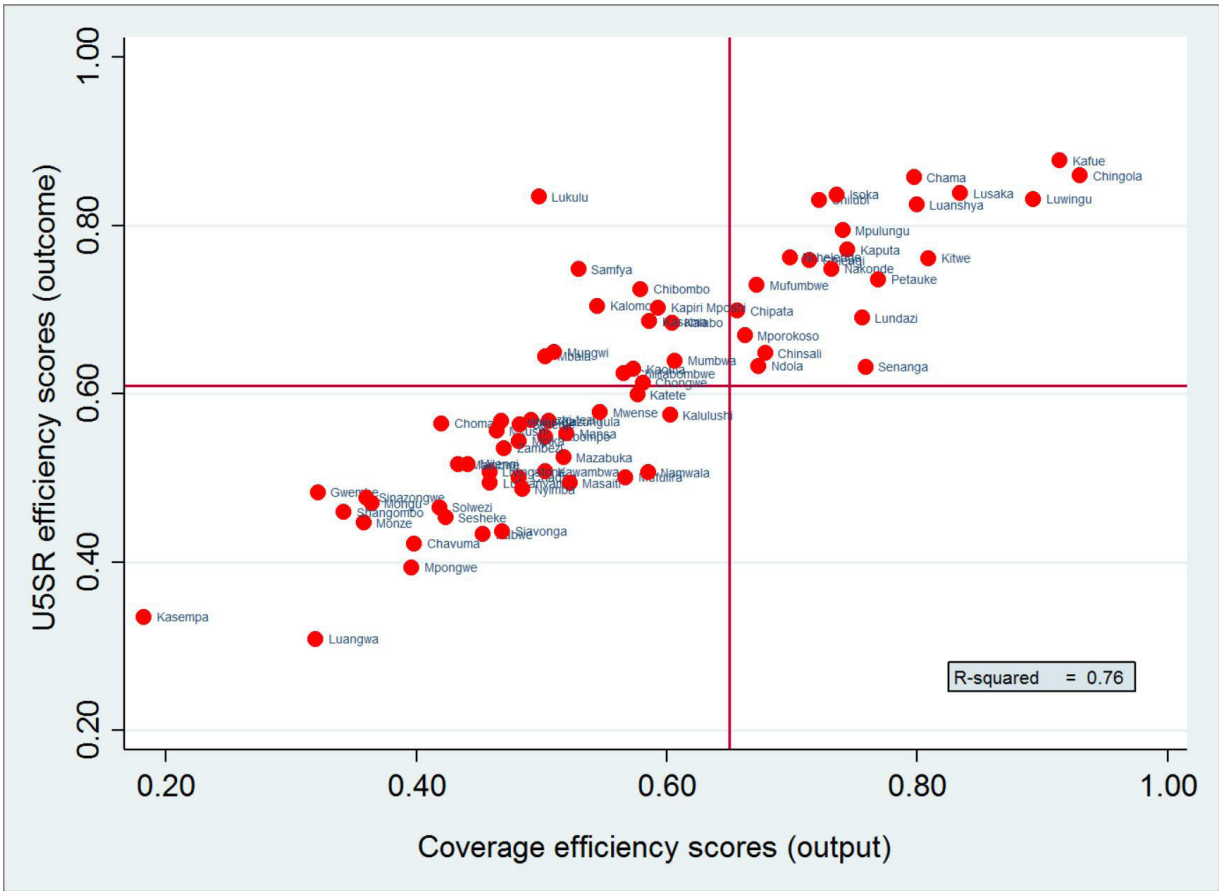

Figure 2: *A comparison between efficiency scores of health intervention coverage and under-5 survival*

The OTE, can be further decomposed into pure technical efficiency (PTE) which is a measure of managerial performance in the production process and scale efficiency (SE) which is the ability to choose the optimum size of resources in production. Figure 3 shows PTE, SE, and OTE scores for the nine provinces of Zambia. OTE appears to be higher in the Northern, Lusaka and Eastern provinces. Still Northern and Lusaka provinces are also in the lead in terms of PTE, while the Southern and North-Western provinces are at the bottom tier. Meanwhile, SE appears to be generally high across the country with the Lusaka province leading at 100%.

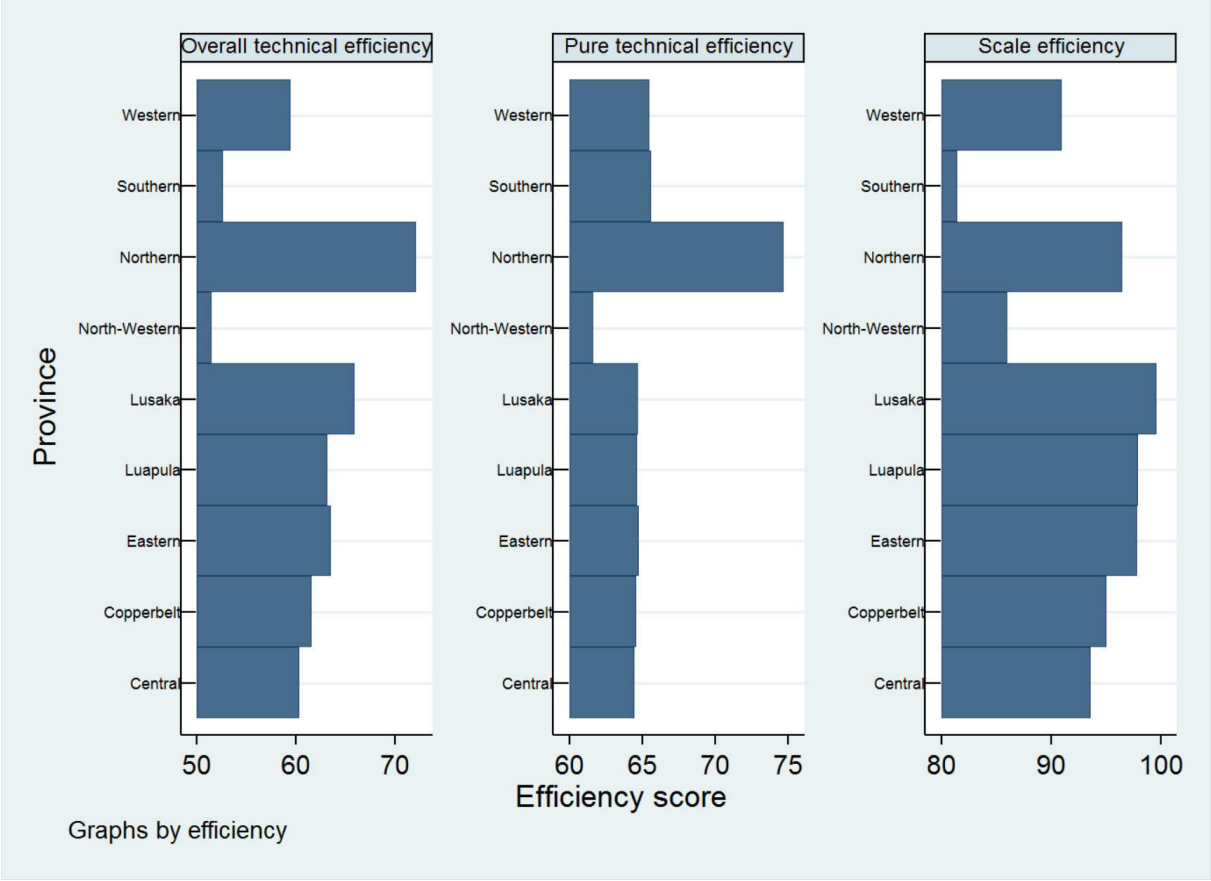

Figure 3: *Provincial efficiency scores*

The efficiency measures discussed above only look into the use of resources or scale of operation and do not directly address outcomes. For instance, it is possible for districts or provinces to have lower service coverage but perform better in the management of resources available to them and vice versa. Figure 4 shows a comparison of PTE and health intervention coverage across the 72 districts of Zambia, with the quadrants defined at the means of each estimate. The PTE scores presented in the figure provide opportunity for policymakers and local decision-makers to examine the effect of managerial competence without the diluting effects of scale of operation on performance.

In Figure 4, 37 of the 72 districts fall into the high managerial performance category, of which 18 have managed to combine high managerial efficiency with high health intervention coverage. However, in the remaining 19 districts in this category, health intervention coverage is still low despite high efficiency. On the other hand, there are 17 districts, where both managerial performance and coverage remain low. The average pure technical efficiency score was 66.3% (95%CI: 62.9-69.7), while actual scores ranged between 31.3% (95% CI: 31.0-32.9) and 89.5% (95%CI: 83.7-96.8).

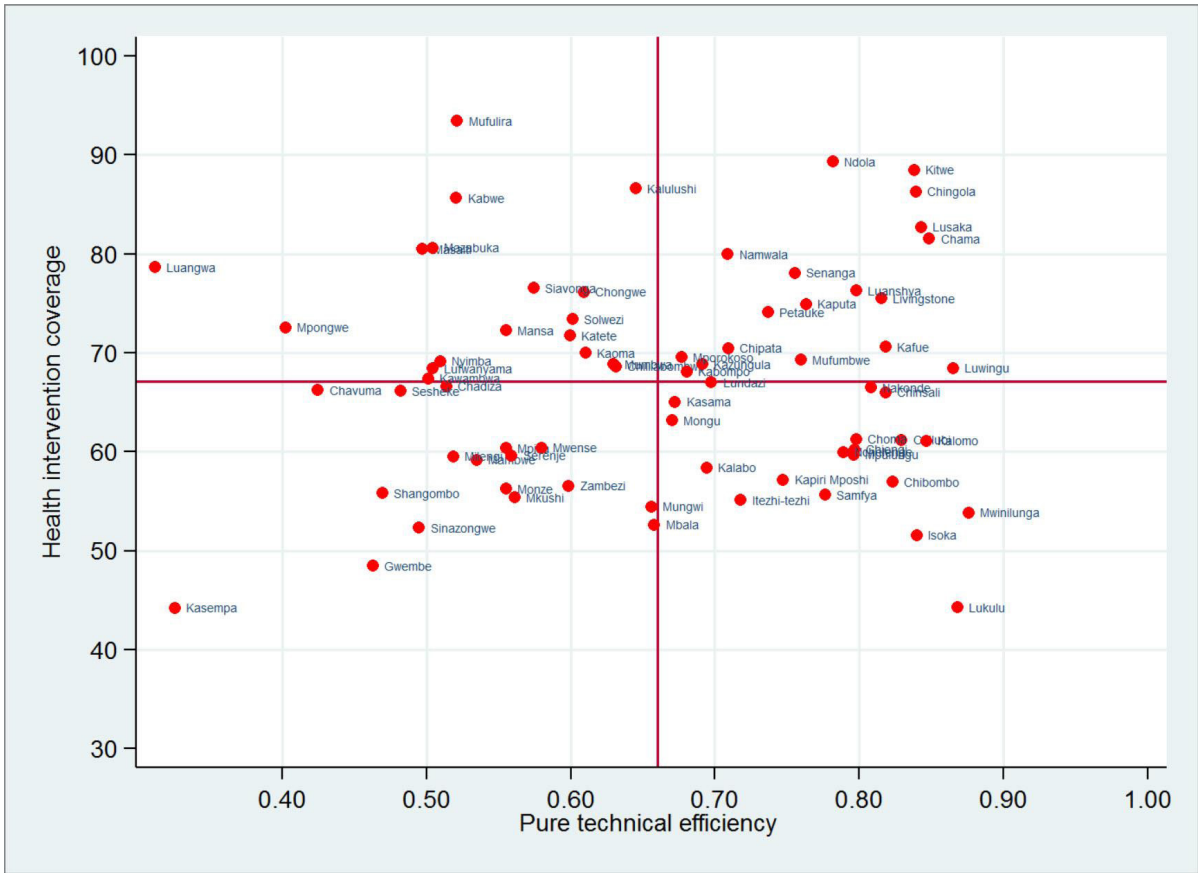

Figure 4: *A comparison of pure technical efficiency and health intervention coverage*

Further, figure 5 shows a comparison between under-5 survival across districts and PTE. It is clear that high performance in terms of PTE in a given district does not necessarily translate to better health outcomes. This is observed in districts such as Chiengi and Chilubi which score highly in terms of PTE but trail their peers in under- five survival.

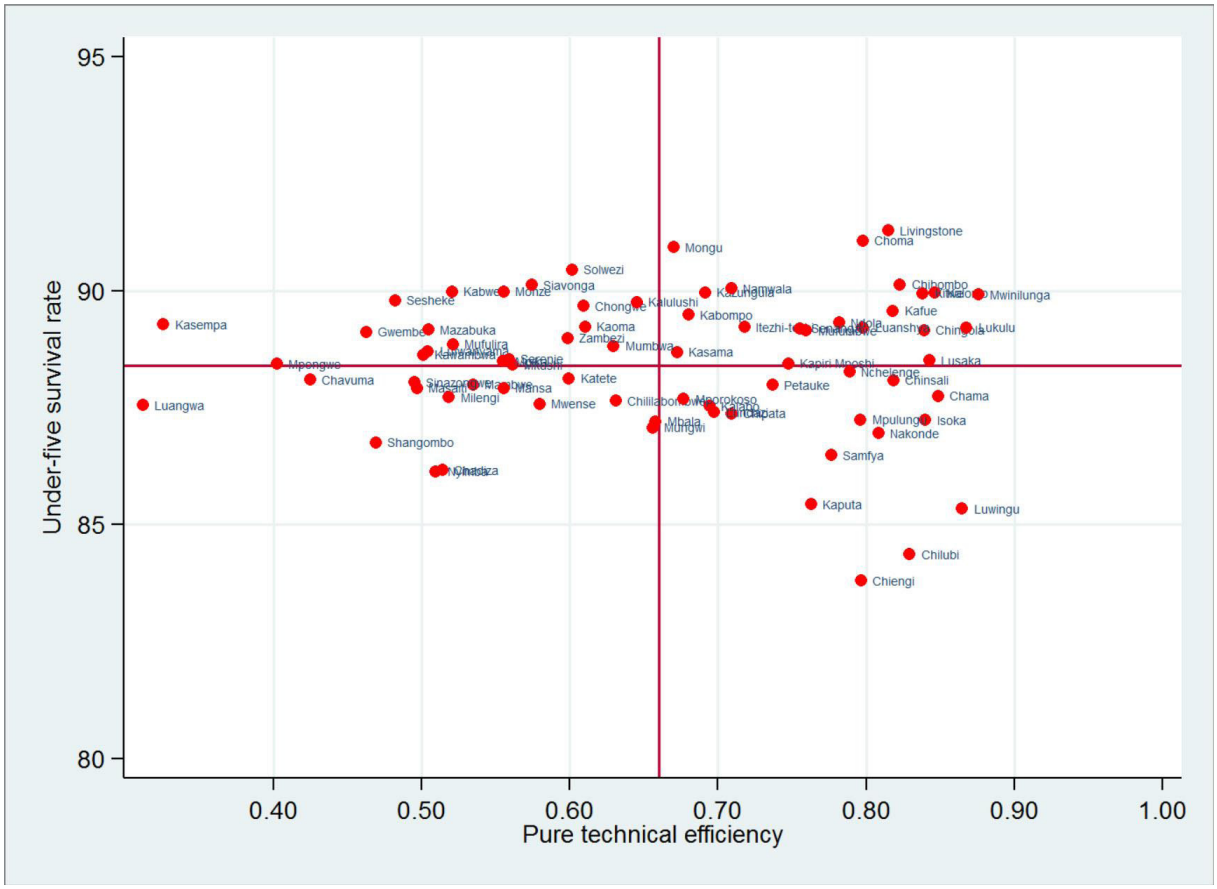

Figure 5: *A comparison of pure technical efficiency and under-5 survival rates*

Effects of environmental factors on overall technical efficiency

Table 3, presents results from regression analysis to estimate the effect of environmental factors on the OTE for under five survival at the district level. The results were obtained using the bias-corrected two-stage estimation process for the four environmental variables we chose for our analysis. The results suggest that the channeling of donor funding in Zambia seems to have an insignificant effect on technical efficiency. Meanwhile, female education had a significant positive effect, confirming the interdependencies between health and education noted in previous studies.

Table 3: The effects of the environmental variables

	Coefficients
Constant	0.85*
Female education	0.18**
Household access to electricity	-0.03
Proportion of funding from donor sources	-0.09
Household access to improved cooking	0.02

*p< 0.05, **p< 0.01

DISCUSSION

With the push toward universal coverage across the developing world and uncertainties about future global investment on health, the question of efficiency in health service delivery has become increasingly important. This paper attempted to evaluate the extent of pure technical, scale, and overall technical efficiencies in Zambia using cross-sectional data from 72 districts. In addition, an attempt has been made to investigate the role of environmental factors specifically donor funds and maternal education on the efficiency of maternal and child health in the country.This is particularly relevant given the finite nature of available health resources in the face of rising health needs [1,2,4,8].

DEA is an attention-directing managerial technique [15-19, 23]. By evaluating the relative efficiency of sub-national units, it locates trouble spots in the service delivery system and potential for further improvement. This is based on the understanding that in a decentralized health system, subnational units have a far-reaching impact on the overall performance of the health system [4,7,9]. Through this framework, policymakers can objectively benchmark the performance of the district health system with the aim of fostering peer learning and accountability.

DEA has been extensively used to assess the performance of health systems across different settings. For instance, Ortega, Sanjuan and Casquero [11] used DEA to analyse the impact of income inequality and government effectiveness on the efficiency of health inputs to improve child survival in developing countries. Kirigia, Sambo and Lambo [24] applied DEA to measure technical and scale efficiency across 55 public hospitals in South Africa. Kirigia, Emrouznejad and Sambo [25] also used the DEA methodology to measure relative efficiency of 54 hospitals in Kenya. In Ghana, Alhassan et al. [14], applied DEA to estimate technical efficiency of private and public health facilities accredited by the National Health Insurance Authority. In addition, Masiye F. [26] has used DEA to measure technical and scale efficiency of hospitals in Zambia.

Building on existing evidence on application of DEA in Zambia, findings from the present study reveal significant heterogeneity in performance across the country.It is clear that overall technical efficiency in the production of health outcomes is strongly correlated with the efficiency in the production of health outputs, considering the same inputs. However, as pointed out earlier efficiency estimates refer to the efficiency of an output (or an outcome) for a given level of input, and does not refer to the level of the output (or outcome) itself. In other words, it is still possible for a district or a country to be fully efficient and yet have lower output and/or outcome levels [11, 12].

Low performance in districts and provinces was largely due to both poor input utilization (i.e., pure technical inefficiency) rather than the failure to operate at the most productive scale size (i.e., scale inefficiency). The average PTE score for the country has been observed to be 66.3%, which implies that 33.7% percentage points of the about 38.5% overall technical inefficiency in the country was due to district health managers who are not following appropriate management practices and are selecting incorrect input combinations. The remaining shortfall in overall inefficiency appears to be due to inappropriate scale of operations. This is consistent with the findings of Masiye F. [26], which established that a significant proportion of hospitals in Zambia were technically inefficient.

Specifically, urban districts seemed to be more scale-efficient in comparison to their rural counterparts, probably as a result of having a densely populated environment where the marginal cost of increasing population coverage is significantly lower than in rural areas. Similarly, urban residents tend to have better access to health services, both in physical and financial terms, than their rural counterparts, resulting in higher utilization of the available services. In contrast, due to access challenges in rural areas, there is often low utilization of the available health services.

We showed that 37 of the 72 districts fall into the high managerial performance category, of which 18 have managed to combine high managerial efficiency with high health intervention coverage. In the remaining 19 of the 37 districts in this category, health intervention coverage is still low, but this had nothing to do with the efficiency with which managers combined the inputs at their disposal, suggesting that for this group of districts the only way to improve coverage could be to put additional resources into the system. On the other hand, in the remaining 17 districts, where both PTE and coverage of services remained low, improvements in health intervention coverage should first and foremost focus on improving managerial underperformance (i.e., managerial inefficiency) in organizing the inputs at their disposal, followed by introducing new resources, especially in areas where coverage rates are extremely low. A similar interpretation applies when considering health outcomes whereby in those districts such as Chiengi and Chilubi where efficiency level is already high but outcome levels are still low, further progress in child survival can only come by way of putting new resources in these areas.

We further demonstrated that the relationship between health system inputs, outputs and outcomes is complex [11]. In as much as there is a strong association between the efficiency measures in the production of health outputs and health outcomes, there is some deviations that need further investigation. Health systems are mostly responsible for organizing the available resources to maximize health outputs with the hope that these would translate into better health outcomes. However, environmental factors within which the district health system is operating also play a significant role in determining outcomes.

Therefore, in health programming it is equally important not to ignore the social determinants of health, particularly the educational status of women, which is shown to have a positive impact on the efficiency of the health care system. Educated women are likely to be aware of and demand appropriate health services when they need them. In fact, the variables that have been included in the composite metric, comprise of skilled birth attendance, childhood immunizations and malaria prevention, all that are considered crucial for maternal and child health in most of Africa [4].Therefore, it would only be natural that educated women would have the awareness to seek and utilize these important health services when they are available, in comparison to their less educated counterparts. The cumulative effect at the district level would also translate to higher utilization and therefore efficient service provision in districts where women are more educated. This would ultimately translate to better survival in areas where care-givers are better educated.

In as much as donor funding has been a dominant feature of the African health systems landscape in recent years and has contributed significantly to the scale-up of priority health interventions, many have raised questions in terms of its effectiveness [2,27–29]. From this analysis we cast doubt as to whether the donor funds are being channeled and utilized optimally at the district level. The reasons that donor funding had no significant effect on efficiency could be explained by various factors. First, districts with limited institutional capacity might lack the implementation capacity to use the available funds to deliver the required health services effectively. This would lead to inefficiency within the health system, whereby districts will have large amounts of money without the ability to deliver required services. Second, donor funds are often earmarked for specific programs such as malaria, HIV/AIDS, and tuberculosis [3]. In such vertical programming, the donor-funded programs might reduce other health programs' implementation capacity, leading to sub-optimal performance in other key program areas such as skilled birth attendance and other preventive services that are relevant for maternal and child health care.

Our analysis is not, however, without limitations. First, we have only focused on a limited number of health system outputs (i.e., maternal and child health indicators), despite the fact that a health system produces many more outputs covering different programmatic areas. Similarly, due to data availability constraints, we have also considered a limited set of health inputs and non-discretionary variables as explanatory of the differences in efficiency across districts. Moreover, in our comparison of relative efficiency across districts, we did not fully account for important structural and organizational factors such as leadership and governance that play a key role as determinants of performance [10,27–29].These limitations call for an in-depth assessment that will seek to further explain the observed differences in performance across districts in Zambia.

The DEA approach implemented in the present study is also not without limitations, with the major drawback being the sensitivity of derived estimates to methods and the presence of outliers in the data. Although these issues cannot be circumvented altogether, we have examined the sensitivity of derived estimates using both internal and external consistency checks on the data. Specifically, we fitted 72 separate DEA models, each of which had one less observation obtained by removing one district from our analysis, and then compared the root-mean-square error (RMSE) and pairwise correlations of efficiency score across these models. We have also re-estimated technical efficiency scores using a parametric approach following the stochastic frontier model and compared the outcome with our original DEA-based model. These results (not shown here) confirmed that our efficiency estimates are unlikely to have been biased by outliers, as the RMSE for the different models is less than 2% in most cases, while the pairwise correlation coefficients estimated using alternative models showed a strong significant correlation.

CONCLUSION

The WHO underscores efficiency in health service delivery as a key attribute of a performance-oriented health system [2,10,26,27]. Therefore, with many health systems facing resource constraints, decision-makers must strive to understand the factors that drive health system performance and seek ways to improve efficiency. Paying attention to factors such as stewardship, resource allocation and management is particularly useful if meaningful progress towards universal health coverage is to be realized in low- and middle income countries.

DATA SHARING

The main data-sets supporting the conclusions of this article are available upon request and with written permission from the Ministry of Health of the Government Republic of Zambia.

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CHAPTER 4.2

HEALTH SYSTEM PRODUCTIVITY CHANGE IN ZAMBIA: A FOCUS ON THE CHILD HEALTH SERVICES

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ABSTRACT

Zambia has witnessed progress in child health in recent years. In this study, we explore productivity change, particularly the contribution of technological progress and efficiency gains associated with improvements in child health outcomes. Productivity is measured using the Malmquist productivity index, and a regression technique is further applied to assess the effect of socioeconomic factors on productivity, technological change and efficiency gains. District- level panel data are used in the analysis. Overall productivity increased by 5.0%, largely due to technological progress. Gains from efficiency improvements have been minimal. Within-country comparisons reveal wide heterogeneity and favor more urbanized and densely populated districts. Improved cooking methods, improved sanitation and better education affect productivity positively, whereas larger household size has an adverse effect. Addressing district- level factors to ensure the efficient delivery and optimal application of existing health technologies offers a practical pathway for further improving the country's population health goals.

INTRODUCTION

Efficiency and productivity improvement have become central in the global health debates as governments around the world strive to do more with limited resources. [1, 2]The pressure to perform is greater in low- and middle-income countries with rising health needs in the backdrop of resource constraints. [2, 3]This paper contributes to the understanding of health system performance and factors influencing productivity growth by focusing on Zambia, a country that has registered improvements in child health in recent years. [4, 5]

Back in 1992, Zambia adopted health system decentralization as a policy aimed at delivering cost-effective healthcare services as close to the family as possible. By 2004, the health system had been devolved to 72 districts responsible for service delivery throughout the country. As part of the primary healthcare agenda, preventive health services such as immunization and integrated management of childhood illnesses were also reinforced. Prior to this period, most government services concentrated on curative care and were offered through centrally managed public hospitals, with limited attention paid to preventive and community health interventions.[6-9]

Newer health interventions including vaccines, artemisinin-based combination therapies (ACTs), antiretroviral treatments(ARVs), insecticide-treated nets (ITNs) and indoor residual spraying (IRS) for malaria control, were systematically introduced and combined with health promotion activities.[4, 7] Often the new interventions were piloted in select urban districts before expansion to the rest of the country. Non-governmental organizations also played a crucial role in scaling-up interventions, primarily through donor support.[6-8] Figure 1 shows that, taken jointly, these initiatives contributed to significant declines in under-5 mortality.

Considering all these developments, important questions arise pertaining to the productivity of the Zambian health system. For instance, did the additional investments translate to improvements in child health? Was progress realized through adoption of new technologies or through embracing better ways of combining existing resources, or both? Were there differences in performance across the country? And if so, did socio-economic factors play a role as determinants? These are some of the key questions we address in this paper.

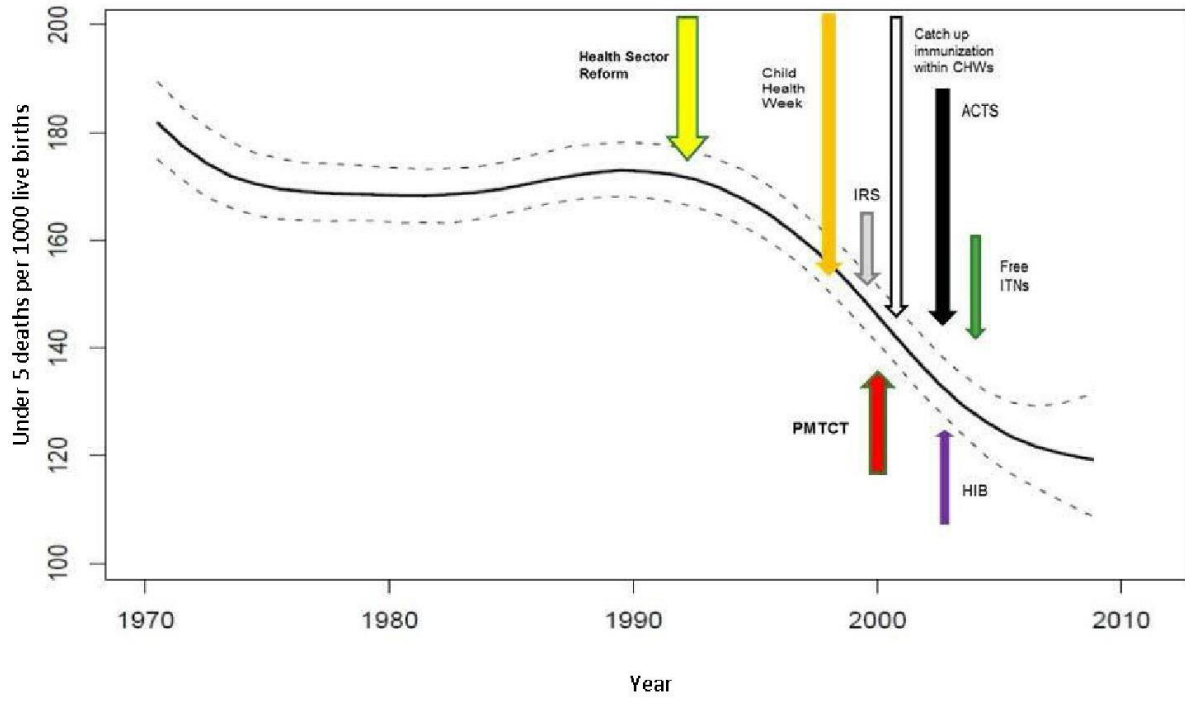

Figure 1: Progress in Zambia child health landscape

In our context, productivity, is simply an efficiency measure that compares the level of health outputs produced from a unit of health inputs used in the health system.[10-13] This analysis allows to distinguish better performers from lagers, and help evaluate the role of technological progress and efficiency on health system performance. In addition, a detailed subnational comparison facilitates benchmarking and peer learning across the system.[4] As the first study in sub-Saharan Africa to examine productivity of child health interventions and outcomes, the approach and conclusions presented here are expected to have wider policy implications for the region.

METHODS

We assessed Zambia's health system productivity change in terms of reduction of under- 5 mortality, a universally accepted good measure of health system performance.[1, 2] We compared progress in child survival between 2004 and 2009 against a set of priority health interventions and key inputs for the same period. This followed two distinct, but related steps. First, we measured health system productivity using Malmquist Productive Index (MPI).[10] This step assessed if there was an improvement or worsening of productivity during the study period. Secondly, a regression technique was applied to examine the effects of socioeconomic factors on productivity. These steps are described below:

i) Productivity measurement

The MPI approach involves constructing an aggregate (country-wide) efficiency frontier based on data for all health districts, and then estimating the distance of individual districts from the country frontier. Accounting for time, the index represents ratios of distance functions from the efficiency frontier for each district. Changes in total productivity may result when the district catches up with the country's frontier due to efficiency gains or adoption of new technologies causing a shift in the production frontier for the country.[10–13] Considering two time periods, (t) and (t+1), the MPI can be algebraically expressed as follows:

$$MPI = EC \times TC = \left[\frac{d^t(y^{t+1}, x^{t+1})}{d^t(y^t, x^t)} \times \frac{d^{t+1}\ (y^{t+1}, x^{t+1})}{d^{t+1}(y^t, x^t)} \right]^{0.5} \quad \text{..... (1)}$$

4.2

An MPI of above one, signifies productivity growth (i.e. improvement in the rate of return per unit of health input) while values of less than one indicate a decline in productive use of resources in the system.[10, 11]

The resultant total factor productivity change (TFPCH) can also be decomposed further to assess if the observed change was due to technical efficiency change (EFFCH) or technology change (TECHCH) or both. Further, by modelling the frontier using both constant-return-to-scale (CRS) and variable-returns-to-scale (VRS), EFFCH can be decomposed into pure technical efficiency change (PTEC) and changes in scale efficiency (CSE).[10-12]

$$MPI = \left[\frac{d^{t+1}(y^{t+1}, x^{t+1})}{d^t(y^t, x^t)} \right] \times \left[\frac{d^t(y^{t+1}, x^{t+1})}{d^{t+1}(y^{t+1}, x^{t+1})} \times \frac{d^t(y^t, x^t)}{d^{t+1}(y^t, x^t)} \right]^{0.5} \quad \text{..... (2)}$$

EFFCH *TECHCH*

Whereby in the model:

MPI = the productivity of the most recent period relative to the past period	*x* = system inputs
EFFCH = efficiency change	*d* = distance functions
TECHCH= technology change	*t* = past time period
y = system outputs	*t+1* = recent time period

The advantages of MPI include being suitable for small sample sizes and not requiring information on prices of inputs or outputs, which are not generally available for publicly funded health services.MPI is also flexible as no assumption is required about the functional form of the model.[11, 12]We applied, a user-written command prepared for the STATA platform, malmq, to analyze productivity change.[10]

ii) Accounting for socioeconomic factors

Health system performance is influenced by the broader socio-economic environment.[13] Hence, after obtaining measures of productivity, we sought to determine the effect of contextual factors as determinants of productivity. This was accomplished by applying an ordinary least squares regression, whereby the productivity indices were taken as dependent variables, and educational attainment for women aged 15-44 years, household size, nutritional status of children under 5, quality of housing, cooking methods and access to improved sanitation were taken as the independent variables. The selection of contextual variables was guided by previous studies and data availability. [2, 4] Evidence suggests that education raises awareness among care-givers, which translates to improvements in child health.[13, 14] Similarly, the link between child health and nutrition and environmental factors—such as sanitation and indoor air pollution from the use of solid fuels—is well documented. [9, 15]

DATA SOURCES

We primarily relied on data from the Malaria Control Policy Assessment project (MCPA), in Zambia.[4] From this database, we obtained information on under-5 mortality and population coverage for key health interventions (i.e., skilled birth attendance (SBA), childhood vaccinations, and malaria prevention) for the period 2004-2009 for all 72 districts in Zambia.[4, 5] Overall district attainment for the intervention-related variables was measured using a composite coverage index, which was derived as an average of the key health interventions described above. This is similar to the approach used for constructing the Human Development Index and has also been used in different settings where health intervention coverage is measured. [4, 16]

Data on annual financial flows, covering both government and donor sources, were obtained from the Ministry of Health, Zambia (MOH-Z). This information combined with data on intervention coverage constituted the inputs to the system, while child survival, measured as the reciprocal of the under-5 mortality rate estimated for each district at a given time, was taken as the main output in our analysis. The transformation of under-5 mortality was necessary to ensure that the output and the inputs were measured in the same direction.

Information on nutritional status of children, educational attainment for women, household size, quality of housing, access to improved cooking and sanitation were also obtained from the MCPA. These factors were considered relevant in our context and used to account for the effects of contextual factors on health system performance.[6, 9]

PERMISSION TO CONDUCT STUDY

Permission to implement this research was obtained from MOH-Z and University of Zambia.

RESULTS

Table 1 summarizes the main variables used in the study for the 9 provinces of Zambia. The large standard deviations observed with regard to under-5 mortality, malaria prevention, and health expenditure indicate large regional differences over the six years. In contrast, measles and DPT3 vaccination coverage oscillated within a narrow band and were consistently high over the same period. Access to SBA appears to be comparable across provinces, although coverage was consistently lower than for childhood vaccinations.

Table 1: Descriptive statistics of the main study variables

	Variable name	Description	Mean	Standard deviation
Output variable	Under-5 mortality	Deaths of children under 5 years per 1,000 live births	122•01	7•63
Input variables	Funds	Zambian Kwacha in millions per 1,000 population	12•96	2•62
	Skilled birth attendance	Proportion (%) of women aged 15-49 who delivered attended by skilled health personnel	43•68	0•58
	Measles vaccination	Proportion (%) of children under the age of 5 years that have received a measles vaccine	95•20	1•83
	DPT3 vaccination	Proportion (%) of children under the age of 5 years that have received all three recommended vaccine doses against diphtheria, pertussis, and tetanus	85•18	2•84
	Malaria prevention	Proportion (%) of households that reported owning at least one insecticide-treated net or having had indoor residual spraying	52•75	17•50
Contextual variables	Education attainment	Average number of years of formal education for women aged 15-44 years	5•69	0•27
	Household size	Average number of people living in the household	5•27	0•03
	Improved cooking	Proportion (%) of households using clean fuels and improved cooking stoves	10•56	0•27
	Improved housing	Proportion (%) of households living in a house with a permanent external wall	37•78	1•53
	Improved sanitation	Proportion (%) of households with an improved toilet (flush to sewer or septic tank) or latrine (ventilated improved pit or slab) that is not shared with other households	12.34	0.82
	Nutritional status	Proportion (%) of children under the age of 5 years who were not underweight	85.26	1•06

Temporal trends, shown in Figure 2, reveals a consistent decline in under-5 mortality, from 132.2 deaths per 1,000 live births in the year 2004 to 111.9 deaths per 1,000 live births in the year 2009. In contrast, funds disbursed to districts fluctuated over time. However, aggregating funds from the first two years (2004-2005) and contrasting that with the average of the last two years (2008-2009) reveals an 11.1% increase in financial inputs into the system.

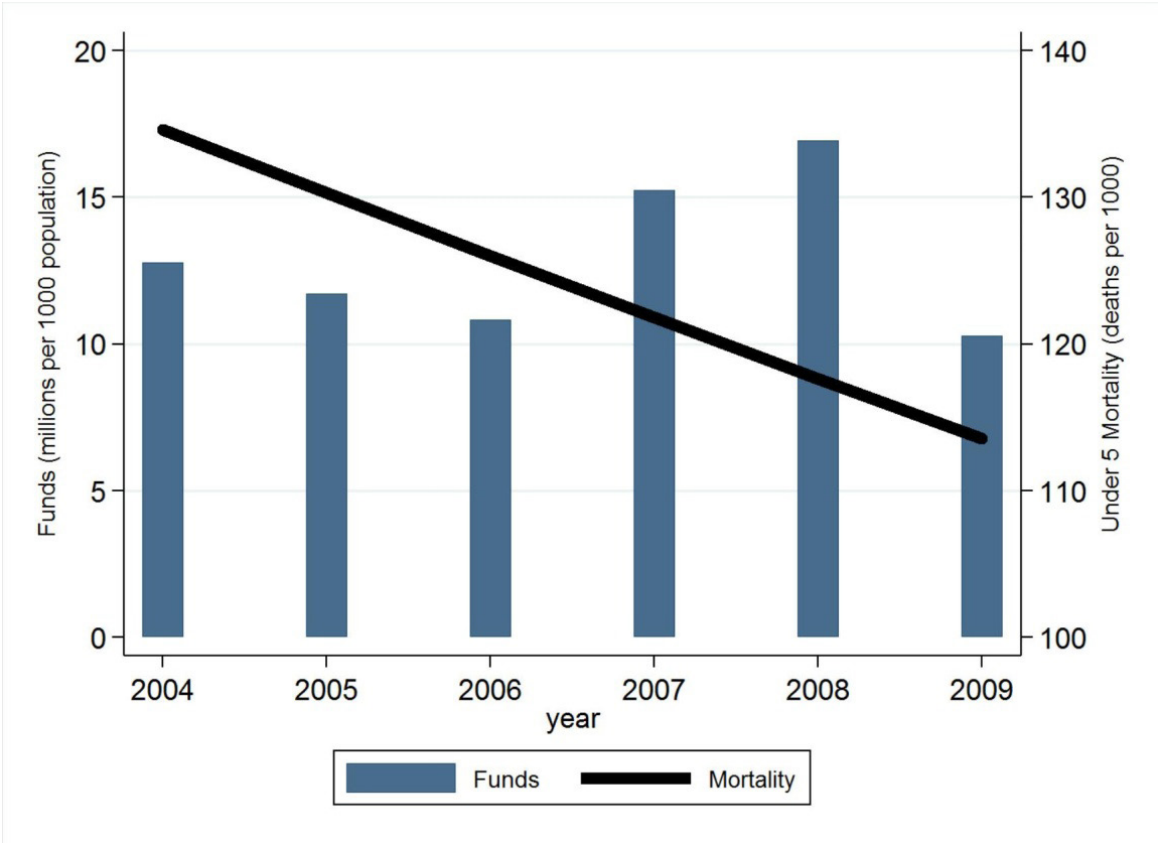

Figure 2: *A comparison between funds for health and under-5 mortality*

Figure 3 presents national and provincial trends in intervention coverage using the composite index described earlier. This shows improvement in coverage along with wide provincial variations that remained over the years. Overall, predominately urban provinces (such as Lusaka and Copperbelt) had higher coverage compared with the rest of the country.

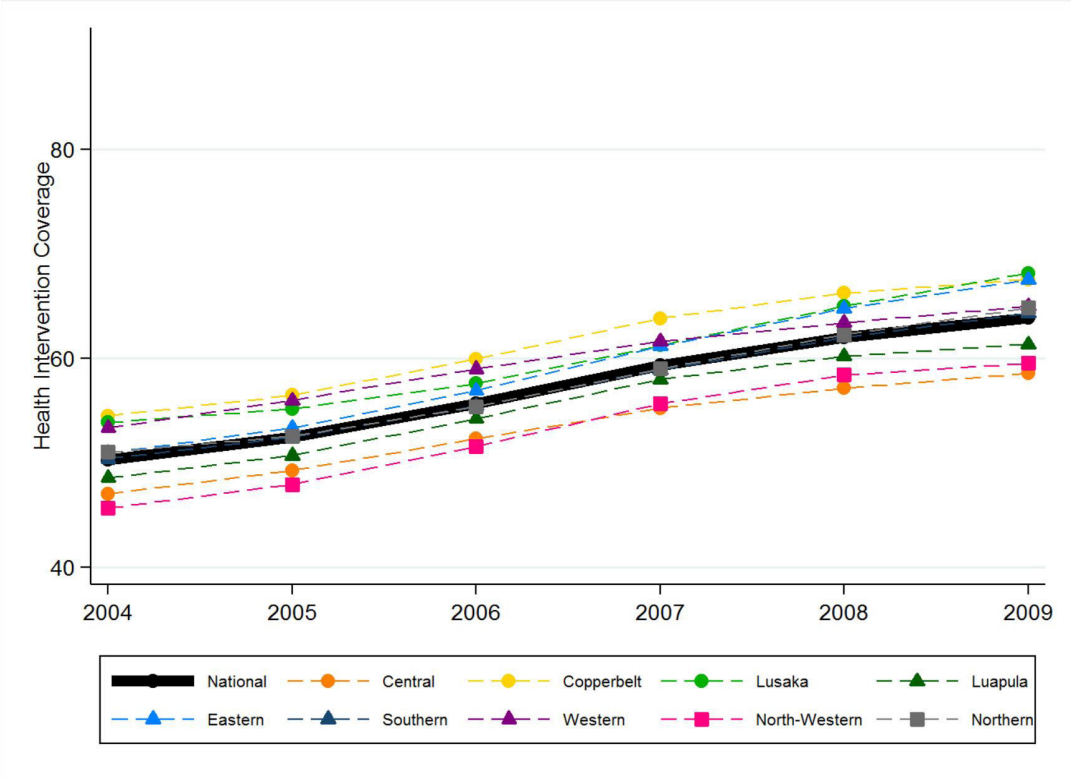

Figure 3: *Progress in health intervention coverage in Zambia*

The results on productivity change, presented in Table 2, mirror a similar picture as that of the trends in intervention coverage, with more urbanized locations showing a higher productivity improvement than their rural peers. The fastest mean productivity growth, at approximately 33.0%, was registered in Lusaka Province followed by Copperbelt, at 16.5%. However, there was considerable heterogeneity within provinces, as evidenced by the wide confidence intervals.

Notably, the productivity growth observed in some provinces, such as Luapula (11.1%) and Western (8.1%), were primarily driven by efficiency gains without contribution from technological progress. Meanwhile, in the relatively urban provinces, Lusaka and Copperbelt, technological change contributed most of the productivity gains, at 25.0% and 17.2%, respectively. Nationally, productivity increased by a factor of 5.0%, a change largely driven by technological progress. Gains due to efficiency improvement were rather minimal.

Table 2: Provincial performance

Province	Total factor productivity change	Efficiency change	Technology change
Lusaka	1·33 (0·56, 2·11)	1·05 (0·90, 1·21)	1·25 (0·70, 1·8)
Copperbelt	1·16 (1·00, 1·33)	0·99 (0·95, 1·04)	1·17 (1·03, 1·31)
Luapula	1·07 (0·99, 1·14)	1·11 (1·05, 1·18)	0·96 (0·93, 0·98)
Western	1·07 (0·98, 1·15)	1·08 (1·02, 1·14)	0·99 (0·94, 1·03)

Province	Total factor productivity change	Efficiency change	Technology change
Southern	1·02 (0·90, 1·14)	0·99 (0·92, 1·06)	1·03 (0·97, 1·08)
Central	0·99 (0·95, 1·02)	0·99 (0·93, 1·04)	1·00 (0·95, 1·06)
North-Western	0·99 (0·94, 1·03)	1·00 (0·94, 1·05)	0·99 (0·96, 1·01)
Northern	0·93 (0·88, 0·98)	0·97 (0·93, 1·01)	0·96 (0·94, 0·98)
Eastern	0·90 (0·83, 0·97)	0·88 (0·76, 1·00)	1·04 (0·96, 1·13)
National	1·050 (0·89, 1·21)	1·01 (0·93, 1·08)	1·04 (0·93, 1·15)

95% CI in parentheses

Further analysis of productivity growth at the district level, shown in Figure 4, demonstrated that despite wide heterogeneity, smaller and densely populated urban districts were more productive than their larger and sparsely populated rural peers. Lusaka District, the country's capital, was able to improve its productivity by more than 100.0% over the six-year period, whereas in the rural district of Katete, productivity had actually decelerated by approximately 23.0%. This means that in the latter case, the same level of output is now being produced with more inputs as compared to previous years or that the introduction of new technologies didn't necessarily lead to improved outcome. The same figure shows a spatial pattern in the distribution of productivity change in the country, where districts with similar performance are seen to cluster around each other.

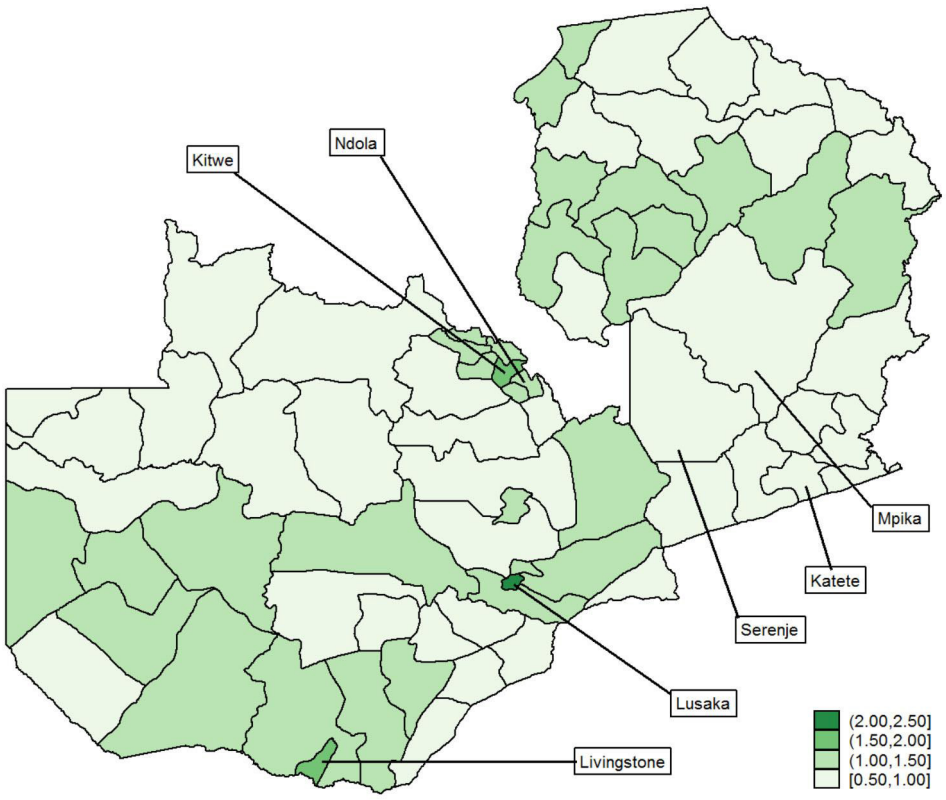

Figure 4: *Productivity growth at the district level*

Figure 5 shows further disaggregation of the components of productivity change into EFFCH and TECHCH; and of the former to PTEC and CSE. In general, EFFCHwas relatively higher in districts located in the southwestern and northwestern parts of the country, while TECHCH was relatively higher in the central parts of the country and in the predominantly urban districts from the Copperbelt and Lusaka provinces. The contribution of CSE was rather mixed and mainly apparent only in the smaller and more densely populated areas. The larger more sparsely populated districts on the other hand lost ground in PTEC over the same period.

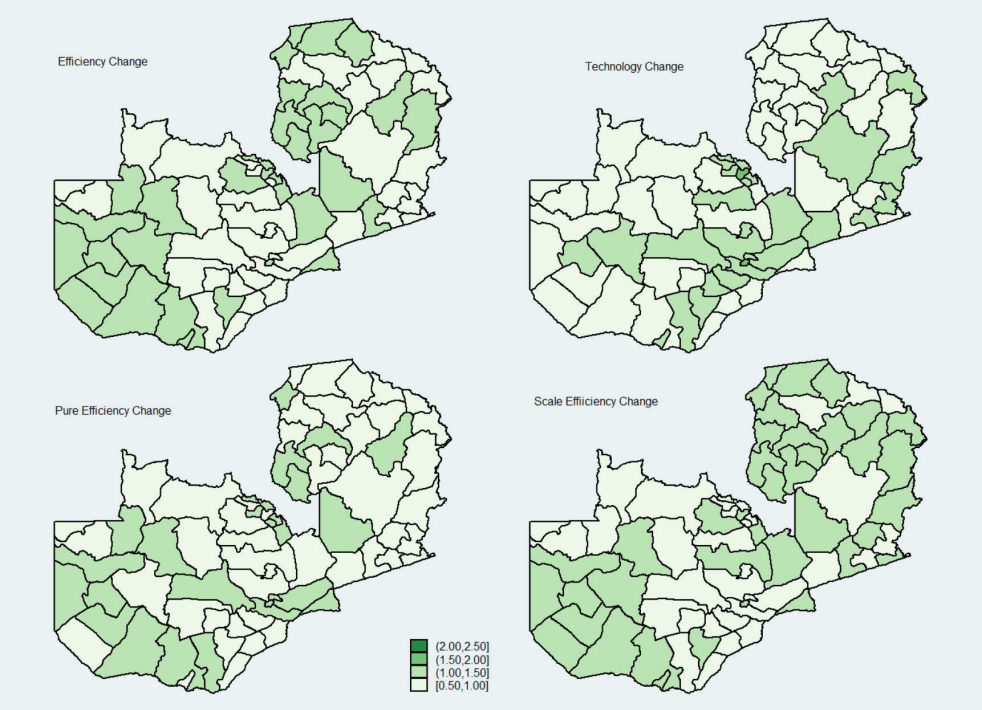

Figure 5: *Decomposition of productivity growth into various components*

Table 3 explores the effect of socioeconomic factors on productivity. The coefficients suggest that a year's increase in educational attainment among women aged 15-44 was associated with a 6.5% improvement in TFPCH, whereas a decrease in the average household size by one person was associated with a 13.4% increase in TFPCH. In addition, improved sanitation and cooking methods had a significant positive effect on TFPCH. As expected, improving children's nutritional status had a positive effect on the productivity of the health system, although the relationship was not statistically significant.

We extended the same analysis to the two components of productivity change, TECHCH and EFFCH. Education still retained a positive effect on both. Hence, a year's increase in education attainment improved EFFCH by 5.1%. Better access to improved sanitation and cooking methods also had a positive impact on TECHCH. In contrast, household size had a negative effect on both TECHCH and EFFCH.

Table 3: Determinants of productivity change

	TFPCH	TECHCH	EFFCH
Education	0.0649**	0.00864	0.0513**
	(3.01)	(0.59)	(3.08)
Household size	-0.134**	-0.0163	-0.112**
	(-3.04)	(-0.55)	(-3.29)
Improved nutrition	0.240	0.297	0.0259
	(0.35)	(0.63)	(0.05)
Improved housing	0.000698	0.00127	-0.000540
	(0.67)	(1.79)	(-0.67)
Improved cooking	0.0123**	0.0106***	-0.000671
	(3.40)	(4.29)	(-0.24)
Improved sanitation	0.00945***	0.00465*	0.00273
	(3.55)	(2.57)	(1.33)
Constant	1.305***	0.945***	1.354***
	(5.75)	(6.14)	(7.72)

t statistics in parentheses

*p< 0.05, **p< 0.01, ***p< 0.001

DISCUSSION

On average, Zambia's health system witnessed a 5% productivity growth over the six-year period. In other words, the country saved about 5 % more children in 2009 in comparison to the year 2004, using the same level of health system inputs. However, the gains in productivity were primarily linked to TECHC[10, 12], which may have resulted from the adoption of new technologies such as novel vaccines, ARVs and ITNs in the country. [4]

The pathways between the interventions we have considered and child survival have been widely documented. For example, Nankabirwa et al.[17] established thatBCG vaccination was associated with an increased likelihood of child survival in Uganda. Andre et al.[18] gives further compelling evidence on the benefits of vaccination, extending beyond disease prevention and increased survival, to include economic returns to countries. Focusing on malaria, Chanda et al.[19] demonstrated that malaria control measures at the community level reduced the incidence of severe malaria, which is a major cause of mortality of children in Zambia. In addition, a study by Steketee and Campbell concluded thatachieving high coverage for malaria control interventions significantly reduced child mortality in endemic countries.[20]

SBA, has been demonstrated as vital in the detection and effective management of complications that might arise during child birth, leading to both maternal and neonatal deaths.[21] Preterm birth conditions, intrapartum complications and infections that contribute to neonatal mortality could easily be tackled by skilled personnel. [21, 22] Yakoob et al.[23] through a systematic literature review revealed that SBA led to a reduction in still births. Considering that neonatal mortality accounts for approximately 40% of under-5 mortality, measures aimed at tackling the former would invariably contribute to improvements in under-5 survival.[24] Lastly financial resources that have been considered as a key health system input are essential in the provision of all the health services that we have considered in this study.[1, 2]

Overall, the minor role played by EFFCH is particularly indicative of the weak managerial capacity to optimally combine outputs with the inputs available in the health system.[25] For example,

the rapid increase in funding for health, might have outpaced the essential build-up of managerial and technical capacity to effectively implement programs.[4,6-9] Additionally, in the process of rapid decentralization, health administrative units could have been created without the required human resources and effective stewardship. The effects thereof, include low absorption capacity, limited coordination and weak accountability systems, further curtailing effective implementation.[6,26] This could have been characteristic of the many low-performing districts in Zambia, calling for a comprehensive effort to address such inadequacies if significant progress is to be realized.[6–9] The same result also alludes to the huge opportunity for improving under-5 survival without any additional inputs to the system through embracing more efficient practices.[11, 12, 25]

The fact that productivity gains were largely concentrated in the predominantly urban districts should also attract the attention of policy makers for at least two reasons. First, the inequalities in health system performance may help perpetuate existing health outcome inequalities in the country. Second, by knowing the best performers in terms of productivity gain, policy makers can draw instructive lessons on adoption of existing health technologies and efficient delivery to benefit the rest of the country.

The relatively faster productivity growth in urban areas was not unexpected, considering that urban locations were likely to be better equipped and have more experienced personnel.[6-9] This in turn could create an enabling environment for adopting new technologies and/or for combining existing inputs with greater efficiency than their rural peers. Furthermore, as discussed earlier, in Zambia the introduction of new health technologies started mostly as pilot projects in urban locations before rollout to the rest of the country.[7, 8] This in itself could have helped urban districts to gain useful implementation experience and capacity for expansion and may have paved the way for the new health interventions to diffuse faster and reach the intended population.In contrast, most rural areas not only have limited access to proven health interventions such as SBA and vaccines, but also remain ill equipped in terms of essential health infrastructure.[4,7,8] For example, absence of a functional cold chain system could compromise the quality of vaccines and other health interventions administered to children, rendering them ineffective.[2, 4]

The uneven distribution of key socio-economic drivers of health outcomes also tends to favor urban areas which experienced higher productivity growth. For example, households in urban areas are more likely to have better educated caregivers, tend to enjoy better nutrition or have better access to clean water and sanitation.[4, 9, 14] Educated caregivers with the necessary knowledge and awareness, are likely to seek priority health services for their children, and vice versa. [2, 14] In addition, with better education and its associated income effect, also comes better access to social amenities, which allowed urban areas to improve child health much faster and complement the efforts from the health sector.[14] Therefore, the country should not only focus on scaling up access to priority health interventions but also seek to address more broader structural and socio-economic determinants that affect the demand and utilization of health services.[2, 14, 27] Failure to embrace such a holistic approach would mean that large sections of the country would continue lagging behind in key health indicators despite colossal investments.

Finally, we recognize the limitations associated with this study. First, our analysis does not include all important health system inputs. For example, infrastructure and human resources for health which are critical components for the functioning of any health system.[2] The impact of these other additional factors on health systems productivity need further investigation as more data becomes available. Second, due to lack of data on prices, the analysis presented also refers only to technical efficiency ignoring allocative efficiency, which may be important in some contexts.[12]

In addition, the MPI approach used in our analysis is based on Farrell radial efficiency distance metrics which means that any gain or loss which is not captured by the radial efficiency measures will not be captured by our results.[25] This has led to some criticism of the Malmquist approach, but to date there has been no widely accepted solution to this problem. [12]

Focusing only on child health as a measure of health system performance is also a limitation, particularly when many countries are experiencing a growing burden of non-communicable diseases that normally affect adult populations.[28] However, under-5 mortality is a key health indicator underscored in the Millennium Development Goals (MDGs) and is universally accepted as a good measure of health system performance.[29] In addition, we have considered population coverage for priority health interventions (including preventative vaccines such as DPT3) that are also crucial indicators of health system performance in many low- and middle- income countries.[4] In doing so we have constructed a composite coverage index derived as an average of the four health interventions, i.e., SBA, malaria prevention, DPT3 and measles vaccinations. [4,5, 16] It should be noted that while such an approach is widely used in the literature and carry several advantages (as reported earlier) they also have associated disadvantages, especially as related to the issue of equal weights assigned to each variable and the difficulty of pinpointing the exact coverage variable contributing to under or over performance.[16] However, as results of our own analysis undertaken separately for each variable and the literature review reported above showed each of these variables are having the expected effect and the composite measure is also consistent with them.

CONCLUSION

This study is particularly instructive to health system stewards in low and middle-income countries that are striving to improve health outcomes in the backdrop of limited resources. It underscores the need for health system stewards to understand the various factors that drive health system performance, paying particular attention to subnational disparities in order to tailor effective solutions for the population. The analysis indicates that opportunities to expand output may have been missed due to the prevailing inefficiencies in health service delivery. Hence, decision makers must not only advocate for more resources but also embrace novel resource-saving techniques to avoid unnecessary wastage of the limited resources available. This would require strengthening the managerial and implementation capacity of health systems so that they are able to effectively utilize the resources available to address prevailing needs.[2, 13]

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CHAPTER 5

THE EVOLVING BURDEN OF DIABETES: HOW ARE COUNTRIES IN THE SUB-SAHARAN AFRICAN REGION RESPONDING?

Currently in press: BMC Medicine

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ABSTRACT

Background

Overall, countries in the sub-Saharan Africa region have registered progress in tackling priority communicable diseases, maternal and child health conditions. However, with the increasing burden of non-communicable diseases, many are casting doubt into the sustainability of the recent gains.

Methods

We used publicly available data, from the Global Burden of Disease Study 2013 and Health Action International prices database, and made high level comparisons of the burden of diabetes with availability and affordability of essential anti-diabetic drugs in sub-Sahara Africa.

Results

Between 1990 and 2013, age-standardized mortality rates attributable to diabetes increased by 25.2% across the region; with substantial heterogeneity between and within sub-regions. Despite comparatively high mortality rates, the southern sub-region, peaked in 2005, and has since registered a decline of -2.8% per year, while the other regions experienced an increase. The fastest increase in age-standardized years lived with disability rate was registered in parts of western sub-region, with Cote d' Ivoire leading other countries in the region by registering an increase of 4.8% per year. Meanwhile, Rwanda made progress in tackling diabetes, reducing age-standardized disability-adjusted life years rate, by -1.6% per year, while Zambia, registered a 2.2 % increase per year. High body mass index as a risk factor also registered an increase in most countries in the region. However, despite increasing diabetes burden, many countries still experience low access to priority antidiabetic medicines.

Discussion

The burden of diabetes is on the rise in many parts of the sub-Saharan Africa region. Effective health systems are expected to ensure both physical and financial access to essential medicines and other health technologies in order to improve health; lack of access to basic antidiabetic medications in many countries casts doubt into the effectiveness of health systems in the region. Therefore, health system stewards need to apply the available policy tools judiciously in order to increase access to essential medicines.

Key words

Burden of Diseases; Sub- Sahara Africa; Diabetes; Access to Medicines

BACKGROUND:

Health systems across the world are faced with many competing health needs and priorities. Contending with resource constraints, particularly in many low- and middle- income countries, decision makers are hard pressed on how best to respond to the prevailing population health needs. Therefore, a clear understanding of the magnitude and levels of health loss attributable to different causes as well as the cost and effectiveness of the different options and interventions available, provides an objective basis for resource allocation [1-3].

Diabetes has been on the rise as a leading contributor to mortality and morbidity in many parts of the world. This is particularly true in a significant number of low- and middle- income countries, where the response to non-communicable diseases (NCDs), in terms of prevention and treatment has not been adequately prioritized [4,5]. This worrying trend, is despite the fact there are many cost effective interventions for prevention, diagnosis and treatment of NCDs, such as diabetes that can be readily applied to scale, by health systems in low- and middle-income countries [5].

The World Health Organization (WHO) in its health system framework, identifies access to essential medicines and other health technologies as a primary component of a well-functioning health system. In order to improve health, the population must have equitable access to quality assured, safe and efficacious medical products, vaccines and other health technologies that correspond to the various priority health needs. Population access means that the essential health products, should not only be physically available, but also affordable to those who need them [6].

Many countries in Africa have made progress in tackling some of the priority communicable diseases such as malaria, HIV/AIDS and tuberculosis [7], largely through the scale up of proven health interventions such as medicines and vaccines [8]. However, despite these signs of progress, there are still many gaps in responding to the rising burden of NCDs such as diabetes [5, 9]. For example, Beran D. and Yudkin J. [10], reporting the in-depth assessments conducted by the International Insulin Foundation (IIF) confirmed that insulin was not available on an uninterrupted basis in many low- and middle-income country health systems. An in-depth assessment that included two countries from Africa, Mali and Zambia, also revealed that diabetes care was largely unaffordable as a result of various factors critical for insulin delivery [11]. Justin-Temu et al. [12] in a study conducted in Tanzania, also concluded that a significant proportion of patients were unable to afford anti-diabetic drugs available in both public and private outlets. Invariably, limited availability and unaffordability of anti-diabetic drugs, coupled with other constraints in accessing health services, often leads to sub-optimal health outcomes as established by Mwavua et al. [13], in a study conducted in two Kenyan hospitals.

This paper seeks to contribute to the ongoing debate, by focusing on countries in the sub-Saharan Africa region, in an attempt to assess the performance of respective health systems in tackling diabetes. We use publicly available data to compare the burden of diabetes with availability and affordability of essential anti-diabetic drugs, in order to identify policy relevant gaps that health systems decision makers must seek to address, in order to make progress. This is motivated by the fact that diabetes has been identified as a priority population health need in many countries [5, 7] and access to essential medicines is an undisputable performance metric for health systems around the world [6,8].

METHODS

In this study, we have mainly relied on data from the Global Burden of Disease Study (GBD) and the Health Action International (HAI), to assess the health system response to the burden of disease attributable to diabetes and its risk factors in the sub-Saharan Africa region. Here, we have embraced the premise that essential medicines are those that have the capacity to respond to the prevailing burden of diseases [8]. Therefore, with the emerging burden of diabetes in the region, both physical and financial access to antidiabetic medications becomes an important performance metric for health systems within the region.

The GBD is the largest and most comprehensive effort to date that measures epidemiological levels and trends worldwide. The methodology has been adequately described elsewhere [14]. Briefly, it espouses a comprehensive and consistent analytical framework that collects and collates disparate data sources, and applies consistent statistical estimation which includes uncertainty analysis to determine the magnitude of population health loss and risk factors across geographies, sex and age groups [14,15]. Specifically, on propagation of sampling and non- sampling error as well as model uncertainty, all the reported estimates are obtained by repeating all the steps in the calculations 1000 times. From these draws, the 95% Uncertainty Intervals (UI), are represented by the values in the 2.5 percentile and 97.5 percentile [15].

The hierarchical nature embraced in this analytical framework also ensures that causes of health loss are grouped into mutually exclusive and collectively exhaustive categories at every level of aggregation. For instance, diabetes mellitus which is found on level 3, is derived from a broad group comprising of diabetes, urogenital, blood and endocrine diseases in level 2, which is further derived from the level 1 classification of non-communicable diseases [14].

In our paper, we have used data from GBD 2013 that provides trends of health loss due to various causes, from 1990 to 2013 [16]. Within the GBD framework, metrics for health loss include mortality rates, years of life lost due to premature death (YLLs), years of life lived with disability (YLDs) and disability adjusted life years (DALYs). YLLs are obtained as a product of the observed deaths at a given age group and the reference life expectancy at the age of death. YLDs, on the other hand are obtained by multiplying the prevalence of a sequela (which is a clinically defined health consequence of a specific cause) and its disability weight, which is obtained from large population surveys. Finally, DALYs are obtained as a summary measure of health loss by summing YLDs and YLLs [14,15]. Information on trends of important risk factors for diabetes is also obtained from the GBD data. For the sake of comparability, we report our results in rates (counts per 100,000 population).

Meanwhile, the HAI price database comprises of periodic in-depth national and subnational surveys covering different aspects of access to priority medicines in different countries, employing a standard methodology which ensures comparability across countries [17, 18]. Briefly, the methodology utilizes quantitative approaches to measure availability, price and affordability of essential medicines in the public, private and non-governmental health sectors. Data on medicine availability and prices paid by patients for medicines on the day of the survey is collected by trained research assistants. Availability of a specific medicine is calculated as the proportion of medicine outlets where the medicine was found in comparison to the total medicine outlets sampled in the study [17].

The median, minimum and maximum unit prices (in United States Dollar terms) of respective health products are also collected and recorded during the survey of medicines outlets. In the case of antidiabetic medicines, affordability is then calculated based on the number of days required to

pay for a standard treatment regimen for diabetes. Here, the duration of the standard treatment is defined as a month's refill for a diabetic patient requiring Metformin 500mg or Glibenclamide 5mg. More specifically, ability to pay is calculated based on the daily income of the lowest-paid unskilled government employee in the different countries, taking a standard treatment regimen based on the lowest priced generic medicines. Treatments requiring more than a day's wages to purchase are considered unaffordable [17].

RESULTS

Mortality

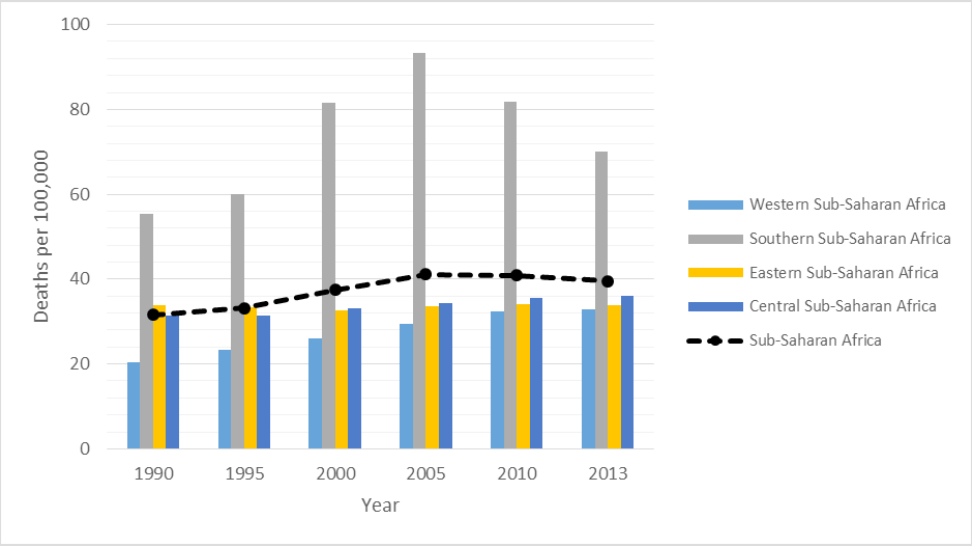

Figure 2: *Age standardized mortality rate attributed to diabetes in sub-Saharan Africa from 1990 to 2013*

Overall, the contribution of diabetes to mortality in the sub-Saharan Africa region registered an increase between the year 1990 and 2013. Figure 1, shows that on aggregate, age-standardized mortality in the region increased by 25.2%, over the 23-year period. Despite the general increasing trajectory, sub-regional trends varied widely, revealing deep heterogeneity within the region. For instance, the southern sub-region, consistently experienced higher mortality rates in comparison to the other sub-regions, while the western sub-region experienced lower mortality than the other sub-regions, but was rapidly catching by registering a 60.3% increase over the 23-year period. Meanwhile, the age-standardized mortality in the southern sub-region seemed to have peaked in the year 2005, at 93.29 deaths per 100,000 (95% UI: 85.79- 101.41), and has since steadily declined to 70.15 deaths per 100,000 (95% UI: 60.92- 79.49) in the year 2013, representing annual decline of -2.8%. However, this still remained above the regional average which stood at 39.52 deaths per 100,000 (95% UI: 36.89- 42.41) in 2013.

Years of life lived with disability

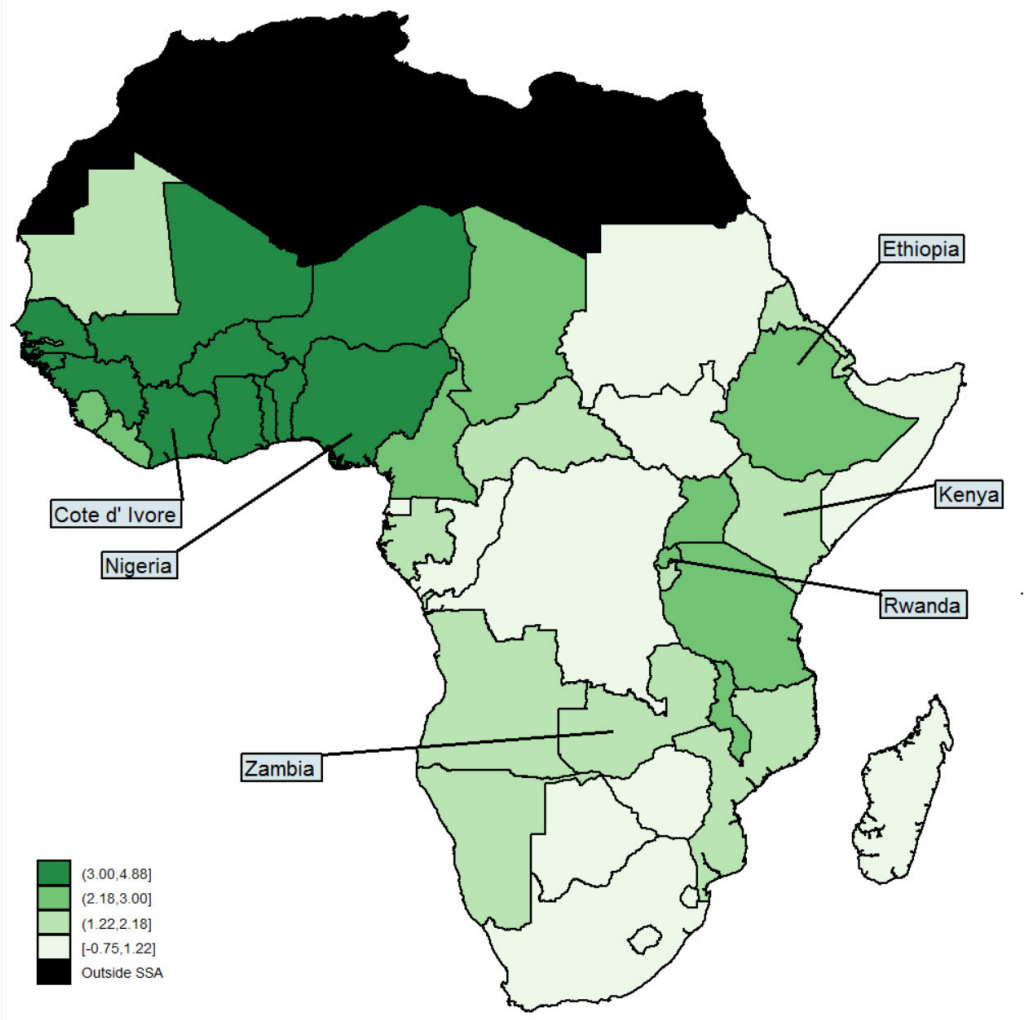

Figure 3: *Annual percentage change of age-standardized YLD rates between 1990 and 2013*

Figure 2, drills down to the country level, revealing that health loss as measured using age-standardized YLD rates increased in nearly all countries in the region, except in the Congo which registered a marginal decline of -0.75% per annum. The highest increase was registered in the West African countries, Cote d' Ivoire, Ghana, Togo, Benin and Mali, which registered an annual increase of 4.9%, 4.8%, 4.1%, 4.1% and 4.0% respectively. In addition, Nigeria and Ethiopia, which are large population countries in the region also registered a significant increase of above 3.0% per annum over the 23-year period. Countries in the southern African sub-region also continued to register an increase in the YLDs attributed to diabetes, despite the fact that mortality in the region seems to be on the decline.

However, different countries started from different baselines in the year 1990. For instance, Benin, Ethiopia and Nigeria started from low baselines of 68.03 YLDs per 100,000 (95% UI: 42.13- 100.10); 88.63 YLDs per 100,000 (95% UI: 57.70- 127.76) and 86.26 YLDs per 100, 000 (95% UI: 56.52- 121.90) respectively. Meanwhile, countries from the southern sub-region such as South Africa, Swaziland and Lesotho started from relatively higher baselines of 341.64 YLDs per 100, 000 (95% UI: 226.03- 477.74); 294.71 YLDs per 100,000 (95% UI: 192.99- 423.97) and 269.47 YLDs per 100,000 (95% UI: 178.75- 377.18) respectively.

Disability-adjusted life years

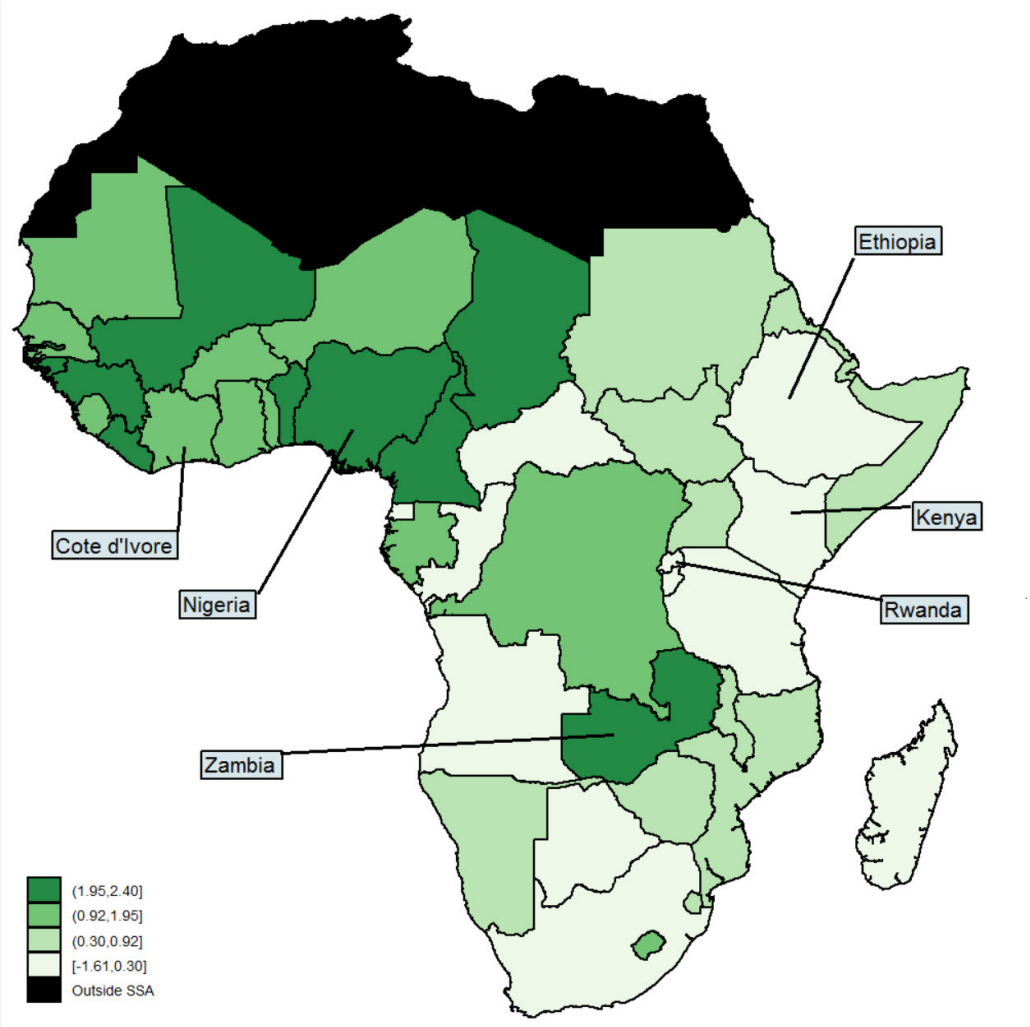

Figure 4: *Annual percentage change of age-standardized DALY rates between 1990 and 2013*

Considering overall health loss as measured using age-standardized DALY rates, countries in the sub-Saharan Africa region, showed deep differences as shown in Figure 3. For instance, Nigeria, Zambia and Mali, registered a rapid worsening in overall health loss, averaging 2.3%, 2.2% and 2.2% per annum, respectively over the 23-year period. Meanwhile, Rwanda, Botswana and Ethiopia, made progress in tackling diabetes and registered a decline in age-standardized DALY rates by -1.6%, -1.4%, and -1.1%, per annum, respectively since the year 1990.

However, it must be emphasized that these countries also started from different baselines in 1990, in terms of overall health loss attributable to diabetes. In fact, Nigeria, had the lowest rate in the whole region, at 386.2 DALYs per 100,000 (95%UI: 313.8- 501.1), while Zambia had a rate of 553.4 DALYs per 100,000 (95% UI: 469.5- 653.9). Meanwhile, Rwanda, Botswana and Ethiopia started from a relatively higher baseline of 987.2 DALYs per 100,000 (95% UI: 848.3- 1135.4), 1063.4 DALYs per 100,000 (95% UI: 805.9- 1357.6) and 997.4 DALYs per 100,000 (95% UI: 867.7- 1130.9), respectively.

Still, to illustrate deeper heterogeneity across countries; within the eastern sub-region, Kenya and Uganda, registered an increase in age-standardized DALY rates by 0.16% and 0.57% per annum, respectively, while neighboring countries, Burundi and Tanzania, registered a decline of -0.59% and -0.13% per annum, respectively.

Risk factors

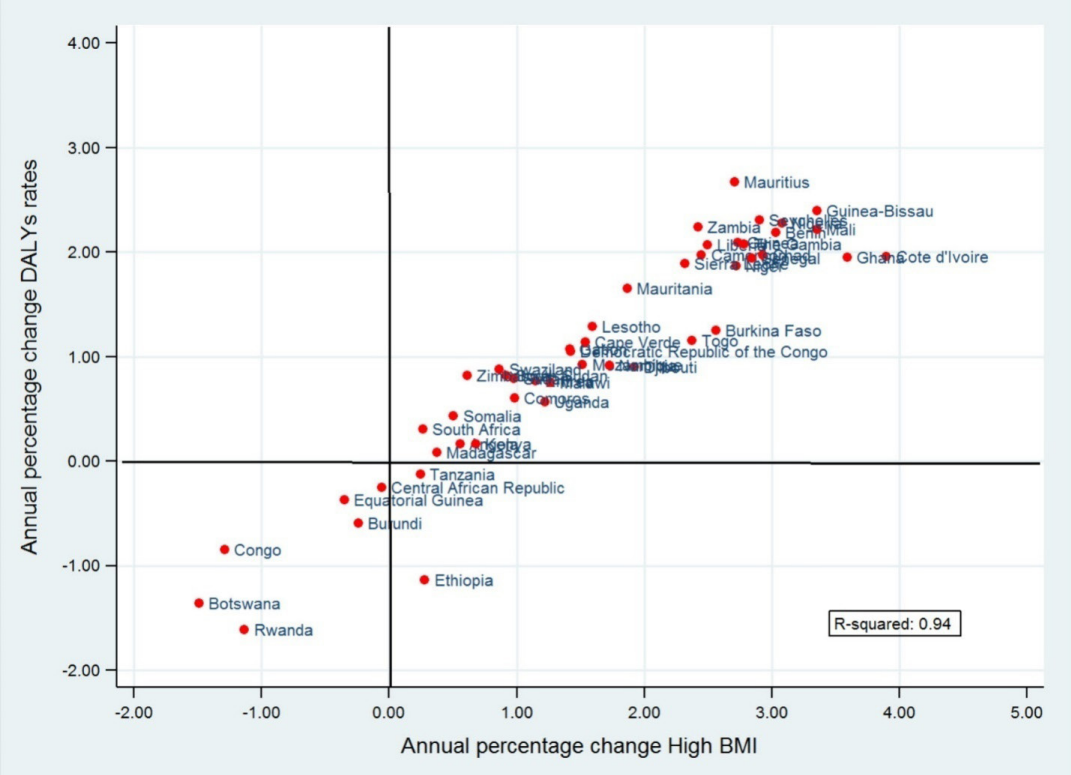

Figure 4: *High body mass index as a priority risk factor for diabetes*

Figure 4, shows that most countries in the sub-Saharan Africa region registered an increase in the contribution of high body mass index as a risk factor driving the diabetes epidemic in the region. There is a strong correlation to indicate that countries that registered a surge in diabetes such as Cote d' Ivoire, Ghana and Mauritius also registered a rapid acceleration of high body mass index as a driver of health loss due to diabetes. The opposite was true for countries that showed progress such as Rwanda, Botswana and Congo.

Table 2: Availability and affordability of Metformin 500mg (Lowest Priced Generic-LPG)

Country Name	Period: 2000-2004		Period: 2005-2009		Period: 2010-2015	
	Public sector availability	Private sector availability	Public sector availability	Private sector availability	Public sector availability	Private sector availability
Burkina Faso	-	-	-	-	-	-
Burundi	-	-	-	-	0%; (2013)	14.8%; 3 (2013)
Cameroon	-	-	5%; - (2005)	0%; (2005)	-	-
Chad	0%; (2004)	0%; (2004)	-	-	-	-
Congo	-	-	0%; (2007)	4.2%; 2.2 (2007)	-	-
Democratic Republic of Congo	-	-	2.8%; - (2007)	7.7%; 14.6 (2007)	-	-
Ethiopia	11.8%; (2004)	80%; (2004)	-	-	-	-
Ghana	32.1%; (2004)	92.9%; (2004)				
Kenya	62.3%; 0.7 (2004)	65.5%; 3.2 (2004)				
Mali	-	-	-	-	-	-
Nigeria	28.6%; 2.8 (2004)	36.4%; - (2004)	-	-	-	-
South Africa (Gauteng Province)	-	66.7%; - (2004)	-	-	-	-
Tanzania	15.6%; 1.1 (2004)	45.8%; 5.4 (2004)	-	-	29.7%; 1.6 (2012)	44.4%; 1.6 (2012)
Uganda	25%; free (2004)	85%; - (2004)	25%; free (2008)	59%; - (2008)	56%; free (2010) 71.1%; free (2013) 65.1%; free (2014) 67.5%; free (2015)	73%; - (2010) 53.6%; 3.5 (2013) 70.4%; 2.2 (2014) 63.6%; 1.4 (2015)

Table 1, shows the availability and affordability of metformin in various countries in the region where data were publicly available. It is clear that there is a dearth of data across many countries in the region, with many having piecemeal information. Further in countries where data is available, it is clear that despite the drug being offered free in majority of public facility outlets, availability was still low. However, there were signs of progress, in countries such as Uganda, where availability improved from 25% in 2004 to 71% in 2013, within public sector outlets. Generally, availability was better in private facility outlets in comparison to the public sector facilities, in many countries where data were available. However, affordability was low in many of these private sector outlets despite having better availability in comparison to the public sector.

Table 3: Availability and affordability of Glibenclamide 5mg (Lowest Priced Generic-LPG)

Country Name	**Period: 2000-2004**		**Period: 2005-2009**		**Period: 2010-2015**	
	Public sector availability	Private sector availability	Public sector availability	Private sector availability	Public sector availability	Private sector availability
Burkina Faso	-	-	50%; (2009)	20.6%; 0.6 (2009)	-; 0.6 (2010)	-; 5.3 (2010)
Burundi	-	-	-	-	0%; (2013)	55.6%; 1.1 (2013)
Cameroon	5.1%; 0.5 (2002)	0%; (2002)	45%; 0.4 (2005)	35%; 5.9 (2005)	-	-
Chad	16.7%; 0.7 (2004)	0%; (2004)	-	-	-	-
Congo			0%; (2007)	20.8%; 1.8 (2007)		
Democratic Republic of Congo	-	-	36.1%; 2 (2007)	61.5%; 2 (2007)	-	-
Ethiopia	79.4%; 0.8 (2004)	100%; 0.9 (2004)	76.5%; 0.8 (2005)	96%; 0.9 (2005)	64.7%; 0.4 (2013)	80%; 0.6 (2013)
Ghana	39.3%; 1.3 (2004)	92.9; 1.3 (2004)	-	-	-	-
Kenya	75.5%; 0.4 (2004)	70.7%; 1.4 (2004)	-	-	-	-
Mali	4.8%; - (2004)	45%; 3.2 (2004)	-	-	-	-
Nigeria	45.2%; 3.3 (2004)	75%; 3.3 (2004)	-	-	-	-
South Africa (Gauteng Province)	-	90%; 0.5 (2004)	-	-	-	-
Tanzania	12.5%; 0.4 (2004)	37.5%; - (2004)	-	-	32.4%; 1.1 (2012)	50%;1.1 (2012)
Uganda	25%; Free (2004)	85%; 1.2 (2004)	46%; free (2008)	59%; 1.5 (2008)	59%; free (2010) 56.3%; free (2013) 69.8%; free (2014) 52.5%; free (2015)	60%; 1.2 (2010) 50%; 1.2 (2013) 63%; 1 (2014) 68.2%; 1 (2015)

*Originator Medicines

Table 2, presents similar results forglibenclamide, a commonly used antidiabetic medication, which still shows a dearth of data across many countries. However, from the sparse data points that were available, it was clear that, in the period between 2000 and 2004, Kenya registered high availability at 70.7%, in the public sector outlets in comparison to the other countries where data were publicly available. Mali had the lowest availability in the public sector, although its private sector performed relatively better in at 45% availability. Most countries where data were available, followed a similar trend pointing to higher availability in the private sector outlets; Nigeria at 75% and Ghana at 92.9%.

However, affordability was questionable through the private sector outlets as evidenced in Nigeria in 2004 and Burkina Faso in 2010, where the lowest paid government worker would need an average of 3.3 days and 5.3 days of work respectively, to pay for the standard treatment refill. But still on a positive trend is revealed in the region, where Uganda is progressively improving availability and affordability in both public and private sector outlets.

DISCUSSION

The contribution of diabetes to population health loss continues to increase across many countries in the sub-Sahara Africa region. With the risk factors associated with diabetes, such as high body mass index, also on the increase, there is concern that, unless concerted action is taken to stymie the tide, many of the population health gains so painstakingly achieved by health systems across the region, might be lost [7,19].

Over the past three decades, many countries in the sub- Sahara Africa region have made steady progress in tacking communicable diseases, maternal and child health conditions, by scaling up priority health interventions [7, 20]. The focus has mainly been on effective childhood vaccines, malaria prevention and treatment, antiretroviral treatment, among others [21, 22]. There is demonstrable evidence from many sources that mortality and morbidity due to these conditions has been on the decline [7].

However, the same cannot be said about priority non-communicable disease conditions such as diabetes, which are registering increasing mortality and morbidity across the region [5,10]. Considering that effective health systems are expected to ensure both physical and financial access to essential medicines and other health technologies in order to improve health; lack of access to basic antidiabetic medications in many countries casts doubt into the effectiveness of health systems in the region [9,11,12].

Our study aims to contribute to the on-going debates on the imperative for health systems in low- and middle- income countries to address the emerging epidemic of non-communicable diseases by scaling up access to priority medicines and other cost- effective interventions. By combining trends of burden of diabetes and its risk factors with access to medicines measures, we provide a basis for national health systems to benchmark and assess their performance as well as layout clear priorities towards meeting the set policy objectives.

The increasing burden of diabetes that has been registered across the different sub-region, is strongly correlated to the fact that many countries in the region have also registered an increase in high body mass index, which is an important risk factor. Therefore, health systems can effectively intervene, by putting preventative measures in place to curb this trend, such as encouraging physical activity and reducing high caloric intake. In addition, advocacy through informational and educational products would go a long way to raise awareness and discourage negative cultural

and lifestyle practices that increase the populations' chances of developing diabetes. However, for those who already have diabetes, in as much as such preventive interventions could be vital in improving the quality of life and reducing progression, access to antidiabetic medicines is still a prerequisite to prevent mortality and morbidity.

In fact, the high or rising mortality and morbidity trends observed across different parts of the region, could be explained by a combination of factors, characterized by increasing risk factor trends in the backdrop of limited access to antidiabetic medicines in many countries. Low availability of antidiabetic medicines, which was a feature observed in some public health systems would mean that patients who use these facilities would be sub-optimally managed, leading to chronic complications and eventually death. Similarly, when the medicines are not affordable as seen in some private sector outlets, despite high availability, inequalities within the health system would be exacerbated, leading to disastrous population health outcomes.

Therefore, health systems stewards would be best served to explore various measures to increase access to basic antidiabetic medicines at the population level. However, in as much as the overall policy objective would be to increase access to essential medicines; considering the interconnectedness of the various health system components, any successful measures would need to have an integrated approach, touching on critical areas such as health stewardship, financing, service delivery and health information.

For any meaningful progress to be realized in the efforts to improve access to medicines, it is imperative to have clear policy guidance, underscoring the same as a priority for the health system [6,8]. Invariably, this would take bold leadership and establishment of supportive governance and regulatory structures to midwife the entire process. In addition, health system stewards would need to find ways of financing such an ambitious endeavor; particularly in the context of low- and middle-income countries where resources are limited.

In order to effectively mobilize resources to meet the various health objectives, health systems must develop the means to collect adequate resources from various sources and pool those resources into a collective, where they could be used for the purchase of the desired health goods and services. In order to realize the desired policy objectives of universal health coverage, purchasing should not be a passive exercise, but rather, a strategic undertaking that seeks to promote efficiency, cost effectiveness and equity within the health system [6].

In terms of service delivery, various forms of partnership between the public, private and civil society stakeholders have been demonstrably successful in addressing some of the critical population health challenges in the region such as malaria and HIV/AIDS [23]. These competencies in forging successful partnerships could be harnessed, to promote the access to medicines agenda in various countries. However, partnership cannot only be confined to service delivery but also encompass other aspects such as financing and governance.

In fact, there is evidence from various countries showing that various aspects of the access to medicines value chain have been greatly enhanced through such collaborative partnerships [24-26]. For instance, leveraging private sector competencies in the logistics and supply chain management could be beneficial in addressing the challenge of low availability that often plagues many public sector outlets. Meanwhile, competition with the non-profit sector outlets, could serve as a catalyst to drive down prices in the private sector and increase affordability.

Overall, policy makers have various instruments at the disposal that they can strategically apply to increase access to medicines.Cost effective selection, efficient delivery, regulation, and promoting competition through strategic purchasing, could all be instrumental in

increasing access to antidiabetic medicines. However, the effectiveness of such instruments is only dependent of how best the policy makers understand the context in which they are operating. Therefore, careful collection and interrogation of health data, becomes an indispensable consideration for any health system steward seeking to improve access to medicines. It is therefore worrisome that, many countries in the region, do not routinely collect information on access to medicines, leaving much guesswork in important decision making processes.

The data gaps mean that progress, stagnation and regression of important performance measures in access to medicines are being missed, and health system stewards cannot intervene effectively. Meanwhile, scarce resources could have been wasted, and opportunities squandered, all because well-meaning health system stewards did not have access to the information they needed to make appropriate decisions. For progress to be realized, this chronic deficiency of health data for decision making in priority areas such as access to diabetes medicines must not be tolerated.

In interpreting the findings of our study, we are cognizant of the limitation of only relying on publicly available data sources to inform on country health system performance. Particularly, in the case of access to medicines, publicly available data might not represent the most up to date estimates in various countries reported. However, we have made efforts to contact the custodians of the Health Action International database for validation. To date, this is the most comprehensive, publicly available database that collects information on availability and affordability of medicines at the country level.

CONCLUSION

Majority of health systems in the sub-Saharan Africa region are faced with an emerging epidemic of non-communicable diseases such as diabetes, in the backdrop of the unfinished agenda of communicable diseases [7]. This makes access to priority medicines a top consideration for any health system keen to improve population health outcomes in the region. The results of this study will contribute to the on-going debate towards Universal Health Coverage in many low and middle income countries. It will also attempt to highlight areas where health system stewards could look into making quick gains in addressing the rising burden of diabetes in the region.

List of abbreviations

DALY, disability adjusted life years; GBD, Global burden of disease; HAI, Health action international; NCD; Non-communicable diseases; UI, Uncertainty Intervals; WHO, World Health Organization; YLD, years of live with disability; YLL, years of life lost

Ethical approval and consent to participate

Ethical approval for this study was obtained from the Utrecht University

Availability of data and materials

All data on burden of diabetes in the present study are publicly available and could be downloaded from:

All data on access to medicines are publicly available and could be downloaded from:

Competing interests

All authors declare no competing interests

Funding

This research used data that is publicly available and received no funding

AUTHORS CONTRIBUTION

TA, conceptualized the project, undertook data analysis and wrote the first draft of the manuscript; DK, collected and analyzed data on access to medicines, and critically reviewed the manuscript. TF, AH, CW and HL, critically reviewed the manuscript, and provided comments that were incorporated in the final manuscript

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CHAPTER 6

THE IMPERATIVE FOR SYSTEMS THINKING TO PROMOTE ACCESS TO MEDICINES, EFFICIENT DELIVERY, AND COST-EFFECTIVENESS WHEN IMPLEMENTING HEALTH FINANCING REFORMS: A QUALITATIVE STUDY

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ABSTRACT

Background

Health systems across Africa are faced with a multitude of competing priorities amidst pressing resource constraints. Expansion of health insurance coverage offers promise in the quest for sustainable healthcare financing for many of the health systems in the region. However, the broader policy implications of expanding health insurance coverage have not been fully investigated and contextualized to many African health systems.

Methods

We interviewed 37 key informants drawn from public, private and civil society organizations involved in health service delivery in Botswana. The objective was to determine the potential health system impacts that would result from expanding the health insurance scheme covering public sector employees. Study participants were selected through purposeful sampling, stakeholder mapping, and snowballing. We thematically synthesized their views, focusing on the key health system areas of access to medicines, efficiency and cost-effectiveness, as intermediate milestones towards universal health coverage.

Results

Participants suggested that expansion of health insurance would be characterized by increased utilization of health services particularly among those with health insurance cover. The health system, particularly within the private sector, would be expected to see higher demand for medicines and other health technologies. However, majority of the respondents cautioned that, realizing the full benefits of improved population health, equitable distribution and financial risk protection, would be wholly dependent on having sound policies, regulations and functional accountability systems in place. It was recommended that, health system stewards should embrace efficient and cost-effective delivery, in order to make progress towards universal health coverage.

Conclusion

Despite the prospects of increasing financial resources available for health service delivery, expansion of health insurance also comes with many challenges. Decision-makers keen to achieve universal health coverage, must view health financing reform through the holistic lens of the health system and its interactions with the population, in order to anticipate its potential benefits and risks. Failure to embrace this comprehensive approach, would potentially lead to counterproductive results.

Key words

Health Financing; Efficiency; Access to Medicines; Health Insurance; Health Systems

INTRODUCTION

Recently, many African countries have reported steady progress in tackling the major health challenges that ravaged the region [1-3]. A significant amount of resources from various sources have been invested to implement comprehensive health programs aimed at addressing HIV/AIDS; malaria and tuberculosis, among other priority health conditions in the region [4,5]. Key maternal and child health interventions have also been rapidly scaled up and these measures have been suggested to have contributed significantly to the recent improvements in child survival [1–4].

With many countries striving to consolidate their recent health gains, the question on how to tackle the increasing health needs in the face of emerging non-communicable diseases is becoming increasingly important [2,3]. This has compelled a vibrant debate on sustainability, mainly centered on the aspiration of universal health coverage (UHC) and the means to finance such an endeavor in low- and middle- income countries, where resources are scarce. UHC is about all people having access to healthcare services they need without suffering financial hardship [4, 6]. According to the World Health Organization (WHO), the health services should be of high quality and include, prevention, promotion, treatment and rehabilitation [6].

However, majority of African health systems are resource constrained and heavily reliant on donor funds to finance different aspects of health service delivery. This financing situation is largely untenable in the long-term, given the recent plateauing of financial resource inflows to recipient countries and the unpredictable nature of donor funding [2,3,5]. In response, there have been concerted efforts in many countries seeking ways to align their health financing strategies with the ambitious policy aspirations of UHC. Key to this goal, is to unlock the potential of domestic resources as a means towards sustainable health financing [4–6]. Domestic resources are perceived to be more predictable, unlike donor funds that often shift with the changing whims of funders, with little regard to national priorities. In addition, it is often opined that domestic resources are likely to strengthen the sense of ownership and therefore accountability in health programming at different levels of implementation [1,4,6]. To effectively mobilize domestic resources for health, countries should have functional structures to collect and pool resources in order to strategically purchase appropriate health goods and services [4-6].

Ultimately, the overarching policy objective of any national health financing strategy is to raise sufficient funds in ways that ensure the population in need can access quality health services without undue financial pressure [4–6]. Kutzin [7] further elaborates that the concept of UHC is not only achieved through financial risk protection, but closely linked to effective coverage, such that the beneficiaries who receive the health services should experience health gains as a result. Therefore, to be congruent with the UHC aspirations, health financing reforms should not only be viewed through the narrow lens of providing financial risk protection alone, but also seek to expand effective coverage and improve population health outcomes [4, 6, 7]. Obviously, to achieve these objectives, health financing reforms should also be aligned with the desirable attributes of efficiency, equity, transparency and accountability [4, 7].

These facts clarify that any health financing reform needs to be investigated holistically, paying specific attention to the complex interactions with different components of the broader health system, and how that affects progress towards UHC. Often, health financing reforms have both intended and unintended consequences, which health system stewards need to anticipate and address accordingly. Failure to consider and appreciate this holistic view could lead to disastrous consequences that have far reaching implications on population health [4, 7].

Agyepong and Adjei [8] in a case study describing the policy development and implementation of Ghana's National Health Insurance Scheme (NHIS), point out to the complex interactions and power plays among different actors in the politics of health systems reform. In this case, it was clear that the available technical evidence was not necessarily used to inform important decisions, but rather the persuasions of the strong and dominant political actors. Therefore, the resultant health insurance scheme that was adopted still faces many challenges. For example, Addae-Korankye [9] explains that, within NHIS there are still economic and financial barriers and membership is skewed against the poor and marginalized groups. Fusheini [10] further identifies governance, operational, administrative and financial challenges as factors leading to service delivery challenges within the Ghana NHIS. Similar challenges have been reported by Chuma and Okungu [11] in assessing Kenya's efforts to introduce a national health insurance scheme.

Further, Tangcharoensathien et al. [12] recognize that pre-payments to health insurance schemes in some cases does not guarantee financial risk protection. This is particularly true in small health insurance pools where there is inadequate cross subsidization among the membership. However, despite these challenges, a number of countries such as Thailand, Rwanda and the Philippines have made steady progress towards UHC, by expanding health insurance coverage [4, 13]. In addition, Knaul et al. [14] provides a compelling case for expansion of health insurance coverage as a remedy for catastrophic health spending and impoverishment of households in Mexico.

This paper is based on the perspectives of health system stakeholders in Botswana, a middle income country in Africa, which sought to expand the public sector employees' health insurance scheme as a step towards UHC. In our analysis, we specifically focused on access to medicines, efficiency and cost-effectiveness of health service delivery as intermediate milestones towards UHC. This was motivated by the fact that, medicines and other health technologies have been shown to be a major driver of health expenditure in many low- and middle- income countries, and that significant resources could be saved through cost-effective selection and efficient management of the same [4]. We have further mainstreamed important aspects of the health system performance such as quality, equity, transparency and accountability in our analysis.

METHODS

This was a qualitative study that sought to determine the potential health systems impacts that would result from the proposed expansion of the public sector employees' health insurance scheme as a pathway towards UHC in Botswana. It was part of a larger study that sought to understand the demand and uptake of health insurance among the public sector employees in the country.

Setting

In Botswana, the health system follows a decentralized structure with varying levels of autonomy at the district level. The national Ministry of Health (MOH) is the central planning and policy formulation unit, with the overall responsibility of coordinating and supervising district level implementers to achieve the national health policy objectives [15, 16].

The district health system is comprised of many actors, drawn from the public, private and civil society, all working together to deliver health services. The district is the core implementation unit providing health services based on the principles of the primary health care (PHC) [15, 16]. Within the district, there are different levels of health facilities that form the service delivery chain. These range from clinics and health posts, to primary and district hospitals. The latter form the

first referral point within the district health system, offering a range of basic specialist support to the clinics and health posts (that mainly provide preventive health services) [16,17]. There are also private providers at the district level, some of which have entered into collaborative arrangements with the public sector to provide health services. At the pinnacle of the referral system, are two national referral hospitals and two large private hospitals that offer a range of specialist health care. Figure 1, is a schematic presentation of the MOH organizational service delivery structure [15].

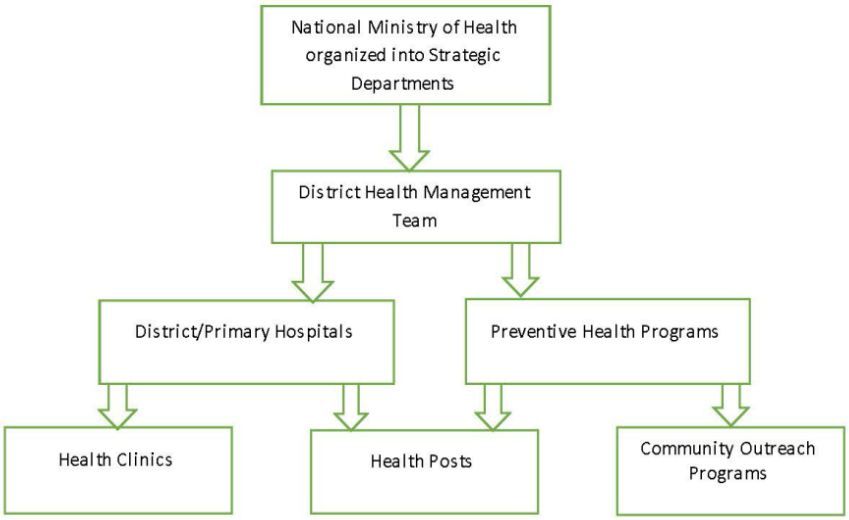

Figure 1 *MOH organizational service delivery structure*

Private sector providers are mainly concentrated in urban areas, where they cater for the population with the capacity to pay, while those in the rural areas are chiefly served by public sector providers [18]. Within the public sector, particularly in the peripheral areas, some of the key challenges that are often cited include, lack of adequate infrastructure, limited access to essential medicines and other health technologies, among others. Within the public sector, access to essential medicines is guaranteed by the government whereas in the private sector, clients pay for medicines through medical insurance or out-of-pocket [15, 18]. However, for a number of chronic medications, the government has entered into partnership with the private outlets (starting with major urban centers) to dispense medicines to patients from the public sector.

Financial resources for health are mainly drawn from government, donors and private sector (including household) sources [15, 18]. For government as a source, a portion of tax revenues is allocated for health service provision in accordance with the national health policy guidelines. Government contributes the bulk of resources, with the private sector playing an increasingly important role in contributing approximately 25% of the total health expenditure. Donor funding on the other hand is mainly focused on specific health program areas such as HIV/AIDS and tuberculosis [18, 19].

Both the government and the private sector also play a significant role in pooling financial resources for health. Through its general taxes, the government raises revenues which it earmarks a proportion to finance health service delivery. At the same time, government as an employer has a medical scheme for its employees, which covers approximately 55% of the public sector employees which translates to approximately 70,000 principal beneficiaries. The scheme is voluntary with the government contributing 50% of the premium amount that employees have to pay to become members [18]. In addition to the public sector employee's health insurance scheme, there are more than 10 private medical insurance companies of various sizes which in total also cover approximately 70,000 beneficiaries. Therefore, in total there are approximately 140,000 principal beneficiaries with health insurance coverage for a population of about 2.2 million people [18, 20].

With this arrangement, Botswana has made great strides in critical areas such as HIV/AIDS and maternal and child health. For example, the country has recorded universal coverage with key interventions such as antiretroviral treatment (ART) and prevention of mother to child transmission (PMTCT) of HIV. Priority services such antenatal healthcare, skilled birth attendance and childhood vaccination have also consistently recorded high coverage across the country over time [15, 21].

However, as Kutzin points out, UHC should be viewed as a direction rather than a destination [7]. This is particularly true for Botswana when considering the other priority areas such as non-communicable diseases that have not been comprehensively addressed, despite concerted efforts [2, 5, 21].

Sampling

The study period was from June to September 2015. The study participants were selected through purposeful sampling, stakeholder mapping, and snowballing. First, we undertook a desk review mapping out the different stakeholders involved in health service delivery in Botswana. These comprised of the public and private sectors; non-governmental and civil society organizations (NGO), including the faith based actors; and bilateral and multilateral development organizations, among others. A representative list of 31 organizations was drawn to ensure that views of all key stakeholders were represented in our study.

Of the 31 organizations, 8 were identified as public sector; 11 were from the private sector; 6 were classified as NGOs; and 6 fell into the bilateral and multilateral development organizations. The public sector consisted of employers; health service providers such as hospitals and clinics; and academic and research institutions. Meanwhile, the private sector had an array of providers (mainly private hospitals and private practitioners), health financiers, as well as small-to-large employers.

From the 31 organizations, 1-2 key informants were identified based on their organizational functions and knowledge of health financing and service delivery in the country. In total, we had a purposively selected sample of 42 participants, of which 5 were not able to participate due to work commitments. Thirty-seven key informants, ranging from policy-makers to frontline health workers, were interviewed using a semi-structured interview guide touching on all aspects of the health system. Table 1, shows the category of different participants.

Table 1. Categories of Participants

Category of participants	Number of Participants
Policy makers	5
Public health providers	7
Private health providers	6
NGO representatives	5
Researchers	4
Health insurance providers	5
Multilateral organizations	3
Bilateral organizations	2
Total	37

Data collection and analysis

For each key informant interview (KII), arrangements were made to secure a 45-minute appointment and a suitable venue to conduct the interview. This ensured that participants were not unduly distracted during the interview. Before the KII started, researchers introduced themselves, explaining the objectives of the study and securing verbal informed consent to proceed with the interview. Participants were made aware that they could cease participating in the interview at any stage without prejudice.

The interview proceeded with the participant introducing himself or herself and giving an overview of his/her work experience as it relates to the objectives of the study. Leading questions, prepared by the authors, ensured that the participants responded to the key topical issues of interest. The specific focus was on access to medicines, efficiency, and cost-effectiveness of health service delivery. Table 2, shows the summary of some of the open ended questions that participants were asked during the interview. The interviews were conducted in English and transcribed verbatim. Subsequently, the data gathered was manually organized into thematic areas of the health system by two researchers.

Table 2: Summary of the Interview Questions

1. If the government made it compulsory for public sector employees to join the public employees medical scheme; in your opinion, what would be the potential impacts on the following areas of the health system:
   - b. Level of financial resources to purchase essential health goods and services for different population groups?
   - c. Access to and utilization of essential medicines and other health technologies by different population groups*?
   - d. Quality of health goods and services available within both the private and public sectors?
   - e. Efficiency in resource utilization within the health system to produce the desired health outputs?
   - f. How cost-effectively the health system selects interventions to meet the population health needs?
2. Overall, what are the potential merits and demerits of this proposed policy reform in the effort towards universal health coverage?
3. What can health system stewards do to mitigate the potential negative impacts of the proposed reform?

*Further clarification was provided to include comparisons between the urban –rural populations; those using private-public sector facilities; those employed and unemployed.

Analytical Framework

Our analysis was anchored on the framework described by WHO, where the health system is viewed as comprising six discrete pillars [22–24,25]. This definition was essential in promoting a common understanding among the stakeholders. As shown in Figure 2, the framework is underpinned by the core functions of the health system, namely; service delivery; health workforce; health information; medical products, vaccines and technologies; financing; and leadership and governance. The framework espouses a logical pathway from inputs into a health system to produce the desired impacts in the form of population health gain [23,25].

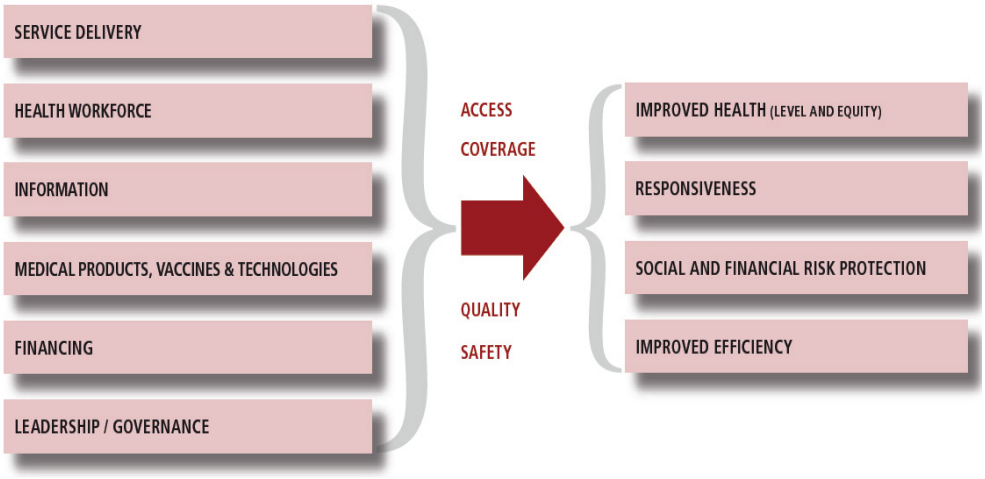

Figure 2: *Health System Framework*

Effective health systems are expected to increase population access to quality medicines and other health interventions in order to improve health [26]. Apart from improving health, the health system is also expected to enhance the responsiveness to the legitimate non-health expectations of those seeking health, and ensure fairness in financial contribution [22, 23, 25]. Responsiveness captures the aspect of the individual's interactions with the health system, with the considerations of dignity, respect and freedom of choice for those seeking healthcare. Financial and risk protection, on the other hand, covers the fact that contributions to the health system should be based on household ability to pay, and therefore that poor households should not be impoverished in their quest for quality health care. Finally, service provision should be done efficiently and cost effectively while adhering to the principle of equity [23,24,25].

RESULTS

Participants noted that considering the interlinkages across the health system, expansion of the health insurance scheme for public sector employees would reverberate across the entire health system. Many respondents identified that this would be characterized by increased access and utilization of health services among those covered. In addition, participants identified that financial resources to spend on health service delivery as a result of increased employee contributions as well as the government subsidy, would increase substantially offering more options to improve population health in general. However, respondents cautioned that failure to have a holistic view and appreciate this reform within the broader health system context and its interaction with the

general population would risk compromising the gains and be potentially counterproductive in the pursuit of UHC in Botswana. We summarize the emergent policy implications focusing on access to medicines, efficiency, and cost-effectiveness of service delivery.

Access to Medicines

Participants postulated that as more financial resources became available, the demand for and utilization of medicines and other health technologies would increase among those with health insurance coverage. This was because, the public sector employees and their beneficiaries who would normally seek healthcare through public health facilities, would have the option to access the private sector health facilities where such health technologies are readily available. In addition, having health insurance often comes with an entitlement where beneficiaries are more prone to demanding specific health goods and services from their providers. Majority of the respondents agreed that, given the profit incentive, providers in the private sector are more likely comply with such specific demands unlike their public sector counterparts, where such incentives do not exist and access to specialized health technologies are largely available through a complex referral system.

Respondents further suggested these market dynamics would attract more private sector participation in the medicine access value chain, even to some small towns and rural areas where civil servants have been deployed, with the view of making a profit. Many of those interviewed felt that this presented opportunities for both increased collaboration and a level of healthy competition among health providers as well as challenges and risks that have to be anticipated and managed.

In terms of potential benefits, some participants suggested that the proposed policy reform could catalyze meaningful collaborations between the public and private sectors that could lead to increased access to medicines and other essential health technologies to a wider population, particularly in the rural areas. It was proposed such partnerships could take various forms such as contracting or outsourcing various services linked to medicine and health technology access, with the aim of increasing effective coverage at the population level. Specifically, some of the respondents felt that the private sector could be incentivized to set up medicine outlets or diagnostic facilities in the new markets where the public sector has limited reach. In addition to serving the civil servants with health insurance coverage in these new markets, these could also be contracted out to serve public sector clients without health insurance at preferential rates. Majority of the participants were in agreement that these measures could greatly contribute to reducing urban-rural inequalities. In fact, it was revealed by a respondent from the public sector that this model was already being implemented on a pilot basis in an attempt to increase access to chronic medications in some locations. Many of those interviewed felt that the significance of such partnerships would increase as health systems reorient themselves to address the emerging epidemic of non-communicable diseases.

"Already we are piloting various ways to work with private sector, starting with big cities. We plan to increase access to medicines for diabetes and hypertension … and we have started seeing benefits that include decongestion (at the public health facilities) and improved supplies. This approach will become even more important as more people get health insurance throughout the country." (Public sector participant)

However, it was noted with caution by some respondents, that unless there are deliberate policy measures and accountabilities to guide the proposed health financing reform to ensure that it is congruent with UHC objectives, the larger part of the population would still face challenges

in accessing medicines and other health technologies. In fact, a participant from the private sector hospital cautioned that health inequalities would be exacerbated if there were no measures in place to enable the larger part of the population without health insurance to access essential medicines and other health technologies through private outlets in areas where the public sector has limited reach.

It was further emphasized by some respondents that the risk of having a two tier health system where the public sector is left to serve the unemployed section of the population that does not have health insurance and the private sector predominantly serves the insured group would go against the ideals of UHC. Respondents further indicated that the perceived or real quality implications of such a two tier health system phenomenon would be counterproductive in the overall UHC pursuit.

Despite the potential challenges, majority of the participants concurred that there were many benefits that could be harnessed from the proposed policy reform if handled carefully. Obviously, this was predicated upon effective partnership between the public and private sectors operating within a sound regulatory framework. Specifically, a respondent from a multilateral organization noted that there could opportunities to improve logistic management systems by leveraging the private sector competencies, with areas such as procurement, warehousing and distribution of essential medicines in focus. In addition, by shifting a significant proportion of patients (those with insurance cover) to receive services from the private sector, the pressure on the public sector procurement and distribution channels could be relieved, translating to fewer delays and stock-outs at service delivery points. Invariably, this would translate into improvements in the quality and coverage of essential medicines within the population.

"*The public sector alone cannot cope with the demands of health service delivery. They simply do not have the capacity considering the increasing demand.*" (Multilateral organization participant)

In addition, respondents suggested that competition between the public and private sector providers, could act as a catalyst for the health system to focus on efficient and cost-effective delivery. This could lead to reductions in the cost of medicines and overall improvement in the quality of health products available in the market. However, participants further cautioned that this would only be possible with appropriate incentives and accountabilities encouraging health system decision-makers at all levels to reduce wastage, ensure quality and value for money. If such measures were not in place, such competition between the public and private sectors might be counterproductive. Therefore, majority of the respondents observed that it is profoundly important to have policies and regulations that proactively support access to medicines within the pluralistic framework of UHC.

Those interviewed also identified that expansion of health insurance coverage should be coupled with strategic purchasing which prioritizes value-based patient outcomes instead of quantity of interventions and services in order to make a meaningful impact on population health. Participants suggested that measures such as capitation at the primary health care level or some form of case based payment system could reduce the incentive for over-servicing among health providers that are normally reimbursed on a fee-for-service basis. Furthermore, it was emphasized by a respondent from the health insurance industry that large medical pools have the ability to effectively negotiate better prices for medicines and actively encourage the use of cheaper and effective generic medicines where appropriate, and this would have a net-positive impact on improving access to medicines at the population level.

Efficiency and Cost-Effectiveness

Majority of participants observed that the proposed policy reform would lead to the creation of a larger health insurance pool that conferred advantages of economies of scale, with better financial risk protection for its membership. However, given its narrow focus on public sector employees, many felt that it would have an insignificant impact on the population level, unless there were sound policies and regulations that seek to promote equity and accountability within the health system. Equally important are the mechanisms to implement and enforce those regulations such that they coherent with the desirable health system objectives of UHC.

In terms of specific benefits, many of those interviewed recognized that expansion of the public sector medical scheme could effectively translate to lower administrative costs, better bargaining and strategic purchasing options from providers, and effective risk sharing, all factors that enhance efficiency and cost-effectiveness within the health system. A participant from the health insurance industry further explained that by pooling risks and resources the large, unpredictable individual financial risks could become more predictable and distributed among all members of the pool.

Therefore, majority of the respondents felt that despite its potential drawbacks, the proposed measure provided the health system with a practical and more efficient option of pooling resources in comparison to the current highly fragmented insurance market. Respondents further clarified that insurance market fragmentation is inefficient and difficult to sustain within any health system and often runs counter to the UHC direction. Inadequate risk pooling, high administrative costs, adverse risk selection and low reserves to effectively deal with financial shocks from large claims are some of the challenges that participants identified as characteristic of highly fragmented health insurance markets. Therefore, participants suggested that through deliberate legislation or market dynamics or a combination of both, efforts towards consolidation in the health insurance market could enhance efficiency. However, there was caution that regulators ought to guard against monopolistic tendencies that could emerge if only one player were allowed to dominate a certain key market.

It was a prevailing view among participants that having health insurance comes with an entitlement whereby individuals and households are likely to be aware and demand for health services. Therefore, many respondents cautioned that it was necessary to carefully balance access to and utilization of health services with appropriate accountability and cost-curbing measures such as copayments to discourage the potential moral hazard that could lead to misuse. In addition, majority of participants suggested that reimbursement options should be carefully planned to reduce the temptation towards over-servicing by health providers and should prioritize value-based patient outcomes instead. This approach could lead to improvements in effective coverage with essential health services without unnecessary and wasteful cost escalations.

During the interviews, a participant from the insurance industry pointed out that a large health insurance pool could also have a set of tools, such as strategic purchasing of health services that could be easily applied to ensure that their beneficiaries receive effective health interventions at the lowest possible cost. For example, using cheaper and effective generic medicines instead of branded ones with similar outcomes. In addition, some participants suggested that, through appropriate incentives such as premium rebates, large insurance schemes could play a crucial role in promoting cost-effective public health interventions such as smoking cessation and adoption of other healthy lifestyles in order to avoid expensive medical treatments. On the contrary, small insurance schemes do not often have adequate fiscal space to offer such incentives to their members that could encourage positive behavior.

"(Health) insurance companies can play an active role in health promotion by getting their clients to take up healthier lifestyles like going to the gym. Actually some pay for such membership which is good for the health of their clients." (Private sector participant)

Furthermore, majority of the participants felt that larger health insurance pools could have the capacity to effectively play a gate-keeping role by ensuring that patients move up the referral chain based on need and not demand; such that only those needing advanced specialist care have access to such services. A participant from the insurance industry explained that this could be achieved by contracting providers and standardizing practice across board, in terms of utilization of expensive diagnostic technologies, prescription practices and procedures with the aim of ensuring quality, efficient and cost-effective delivery. In addition, the larger the pool, the more leverage there is to negotiate better prices for different health services, medicines and other health products. Invariably, this would translate to more efficient and cost-effective health service delivery in contrast to smaller pools or individual purchasers that would not necessarily have such leverage.

However, a number participants still expressed concern that the proposed health financing reform will have a negligible impact in terms of the country's UHC aspirations, largely because of its narrow focus on the public sector employees. Majority indicated that overall, UHC would only become a reality when the larger part of the population that is unemployed could also have equal access with their employed counterparts. Table 3, summarizes some of the key merits and demerits identified by the participants.

Table 3: Advantages and disadvantages of the proposed health financing reform

Advantages	Disadvantages
Potential to increase financial resources available for purchasing of health goods and services	Narrow focus on public sector employees that is likely to worsen the existing inequalities when considering the whole population
Larger health insurance pool with better risk sharing and cross subsidization among those covered	Real risk of establishing a two tier health system that would be counterproductive to the UHC ideals (particularly in terms of quality of services)
Larger pool with lower administration fees; better opportunities for strategic purchasing to enhance efficiency, cost-effectiveness and ensuring value based outcomes	Without adequate regulation and accountability, the proposed policy reform could potentially lead to cost escalation in health service delivery due to factors such as over servicing by health providers and monopolistic tendencies
Provides opportunities to address urban-rural inequalities through innovative public private partnership in service delivery as well as improvements in health system responsiveness	
Provides a platform for health system stewards to expand health insurance across the population through deliberate policy decisions	

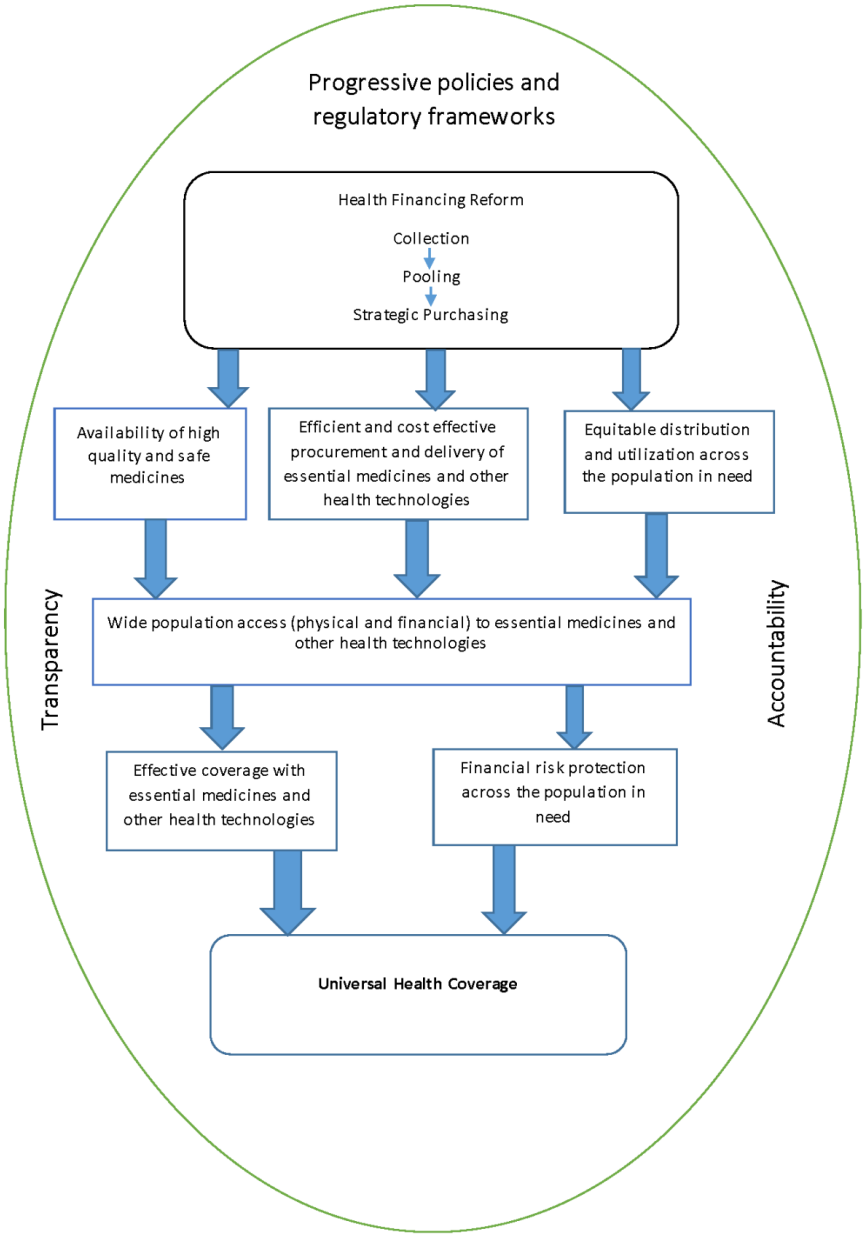

Figure 3: *Pathway towards universal health coverage*

DISCUSSION

Any health system aspiring towards UHC must strive to have adequate financial resources to pay for health service delivery [4,6,24]. For many decision-makers, expansion of health insurance coverage, particularly among those in formal employment, has become an attractive first step [4, 8, 29, 30]. However, taking a broader health system view, it is increasingly clear that the process of expanding health insurance coverage can be fraught with many challenges and unintended consequences that can derail progress towards UHC [8,27–30].

Kutzin [7] cautions that health financing reforms alone do not necessarily translate to UHC, in as much as they are a necessary ingredient to achieve the goal. He further opines that countries

cannot simply spend their way to UHC, but equity, efficiency, cost-effectiveness, transparency and accountability within the health system must be prioritized in order to make progress towards UHC. Figure 3, is a schematic illustration [4, 7, 25], showing the pathway (with intermediate steps) from health financing reform to universal health coverage.

In fact, as previously mentioned some reforms implemented in the name of expanding coverage have led to exacerbation and entrenchment of inequalities in some settings [7, 8-11]. However, Tangcharoensathien et al. [12] and Lagomarsino et al. [13] in their analysis of various attempts to expand health insurance coverage in low- and middle- income countries, established that despite the many challenges, progress has been realized in many settings. Their analysis further underscores the fact that there is no single prescriptive pathway towards UHC, but each country must adapt to its own circumstances.

Our study contributes substantially to this debate by taking a Botswana health system view to distill relevant information that could be useful to decision-makers implementing health financing reform in low- and middle- income countries. In our analysis, we have paid specific attention to the key health system topics of access to medicines, efficiency and cost-effectiveness, given their significance and relevance in solving the hurdles that many health systems in low- and middle-income countries face along their path to UHC [4, 31].

Cognizant of the potential limitation of basing our findings on observations of a small sample of participants, we made efforts to have a diverse group drawn from different stakeholders of the health system such that the discussion was rich and informative. In addition, qualitative studies offer the benefit of a deeper investigation into important policy matters and perceptions that could be concealed through simple aggregation methods.

Invariably, expanding the public sector employees' health insurance offers an easy and practical way to increase the financial resources available to pay for essential medicines and other health services [4,27]. However, health financing does not act alone to achieve all the attributes necessary for UHC, such as improvements in effective coverage and financial risk protection for the whole population. Deliberate policy and implementation actions that mainstream equitable distribution and utilization of medicines, technology and other essential services across the health system are vital to ensure that health financing reforms translate to overall population health gains [7, 31, 32]. Therefore, expanding health insurance coverage within a small section of the population (such as public sector employees), could potentially increase or entrench existing inequalities.

On the other hand, health insurance coverage comes with an entitlement where beneficiaries are proactive in demanding health goods and services [8, 23,27,29,30]. Therefore, as the proportion of those insured increases, other key components of the health system particularly medicines and health technologies should be prepared to cope with the increased demand. Removing the financial barriers that largely constraint utilization among those in peripheral areas, might not necessarily lead to increased utilization since the services in demand might not be physically in place. However, this provides a good opportunity for private sector and other actors including NGOs to contribute substantively in enhancing service provision in the country, by investing in those new markets where services are in demand [8, 26].

In fact, with proper regulation, public private partnerships in service provision, could offer a practical way through which decision makers could improve the performance of their respective health systems in improving access and bridging the existing inequalities between urban and rural areas. Invariably, when financial access barriers have been minimized through the expansion of health insurance coverage, physical access to medicines, technology and other essential services

is a challenge that could be effectively addressed by such collaborative partnerships. Furthermore, considering that with health insurance, money practically follows the patient, responsiveness of the health system is likely to improve with the increased competition among providers.

The narrow focus on public sector employees alone in the proposed policy reform, poses significant challenges that health systems stewards need to recognize and mitigate accordingly. There is a real risk of exacerbating the existing inequalities between those employed and the unemployed section of the population, unless there are deliberate steps to innovatively extend coverage to the rest of the population. For instance, the employed group would be able to access and utilize services from both the public and private sectors while those who are unemployed would be constrained to the public sector. The risk of creating a two tier health system, where there is an oversupply of expensive and hi-tech services in the private health sector serving the rich and powerful class and the public health sector serving the unemployed would be counterproductive in progress towards UHC [4, 7, 12, 13].

Furthermore, given that the government subsidy for the public sector employees who join the insurance scheme comes from general tax revenues; many would argue that this would be tantamount to taxing the poor (who are the majority) and subsidizing the rich. Therefore, unless there are deliberate efforts to extend coverage to include those who are unemployed, marginalized and indigents, the proposed policy reform might be regressive to the overall UHC aspirations.

Despite, these potential challenges, a larger health insurance pool would have many advantages, such as the capacity to spread risks across a large membership base, to incur lower administrative costs, and bargain for lower tariffs from health providers. In addition, large pools have the leverage to incentivize health providers to focus on value based outcomes instead of quantity of services as well as promote the use of cheaper and effective medicines and technologies rather than expensive ones [4,27,31]. All these, if properly harnessed, could be vital to enhancing efficiency and cost-effectiveness in health service delivery.

Therefore, the role for effective regulation and enforcement cannot be overstated in any health financing reform. There should be measures in place aimed at strengthening governance and accountability structures within both public and private sectors to ensure that all stakeholders adhere to the ideals of quality, efficiency and cost effectiveness. A focus on equity in health and finance is essential to ensure that there is population risk sharing and cross subsidization. Failure to recognize and address such market dynamics could derail progress towards UHC [4,27,28,30].

CONCLUSION

Overall, the features that characterize the pathway towards UHC are not necessarily linear, but require an adaptive outlook that balances various health systems' objectives and demands in order to maximize population health at the lowest possible cost [4,6,25]. Therefore, it is vital that the policy objectives of any proposed health financing reform be clearly defined and with a pragmatic intent on how various developments fit to the overall UHC goal. It is only through this approach that decision-makers would be able to optimize the gains and mitigate risks accordingly. Failure to do this could result in negative unintended consequences that would put the overall reform in jeopardy [22,27–31]. Health system stewards must judiciously apply the tools of regulation and accountability to ensure that they steer the health system toward achieving its intended objectives of maximizing population health in an efficient and cost-effective manner [23,24].

Abbreviations

MOH: Ministry of Health; NGO: Non-governmental organization; PHC: Primary Healthcare; PPP: Public Private Partnership; UHC: Universal Health Coverage; WHO: World Health Organization

Ethics approval and consent to participate

Ethical approval to conduct the study was provided by the Department of Research at the Ministry of Health, Botswana. The data collection process ensured that all participants fully understood the objectives of the study and consented verbally to provide the required information.

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CHAPTER 7

PROGRESS IN THE SELECTION OF COST-EFFECTIVENESS INTERVENTIONS FOR PREVENTION OF MOTHER TO CHILD TRANSMISSION (PMTCT) IN BOTSWANA

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ABSTRACT:

Botswana has made impressive progress in tackling the HIV/AIDS epidemic. Prevention of mother to child transmission is one of those measures that have been considered important in these efforts. Recently, treatment regimens based on highly active antiretroviral treatment have been introduced and rapidly scaled up. Using country program data we highlight some of the successes towards elimination of mother to child transmission of HIV. Our assessment indicates that treatment regimens based on high active antiretroviral treatment are highly cost effective to the tune of USD 3668.75 per HIV infection averted. Overall, the country has made progress towards elimination of mother to child transmission of HIV. However, further research would be needed to account for a broader set of population health benefits derived from these interventions, in order to make a strong investment case for HIV prevention efforts.

KEY WORDS:

Prevention of mother to child transmission; cost effectiveness; HIV

BACKGROUND:

Botswana is one of those countries that has been both a pioneer and trendsetter in the global resolve to address the HIV/AIDS epidemic from the outset [1, 2]. In fact, it was one of the first countries in the region to initiate antiretroviral treatment programs and other effective measures to curb the devastating effects of the disease [3]. Recently, elimination of mother to child transmission (EMTCT) of HIV has been elevated to national health priority status, with government and stakeholders putting extra efforts to usher the possibility of an HIV free generation in the country [4].

One of those measures that have received strong policy attention in the country, is the introduction and scale up of effective regimens based on Highly Active Antiretroviral Treatment (HAART), to prevent vertical transmission of HIV from mothers to their babies [1, 2, 4]. Overall, these interventions coupled with other supportive measures such as increasing access to antenatal healthcare services and skilled birth attendance, have demonstrated encouraging signs [4]. We aimed to make a basic assessment of the cost effectiveness of these interventions in order to inform policy making in the country and the broader region.

Setting and approach:

We have used program data from Botswana spanning a period of 5 years (2007-2012) to highlight some of these success stories in the pursuit of EMTCT. Briefly, infants of HIV+ mothers were tested by the age of 8 weeks, using a virological test, HIV DNA Polymerase Chain Reaction (PCR) to determine their status, with follow up tests at 6 months and 12 months. Serological assays that are normally appropriate for adult HIV testing, are not reliable in confirming HIV status in infants since maternal antibodies could persist up to around 18 months [4].

During this transitional period different PMTCT regimens were offered. Those who had CD4+ counts at or below 350 cells/microliter, were eligible for lifelong antiretroviral treatment, while those who did not meet this criterion were put on different PMTCT regimens. One regimen, termed option A, comprised of giving the HIV+ mother antepartum zidovudine (AZT) from 14 weeks of pregnancy, single dose Nevirapine (NVP) at the onset of labor, and then followed with AZT and lamivudine (3TC) until one week after delivery. The infant was also put on daily NVP, as preventive measure until breastfeeding stopped. The other PMTCT regimen, which was offered at this period was termed option B. It comprised of, giving the HIV+ mother the standard three drugs (Tenofovir, Lamivudine and Efivarenz) used for HAART, from week 14 of pregnancy, and this was continued until cessation of breastfeeding. Meanwhile, the infant was also put on NVP, as a preventative measure for 4 to 6 weeks. The other approach, was option B+, whereby the HIV+ mother was put on standard HAART regardless of CD4 levels and continued treatment for life, with the infant receiving NVP for 4-6 weeks [1, 4].

Comparison across PMTCT regimens

The cost per patient pair associated with different regimens varied widely, mainly as a result of the different drugs used. In summary, for option A, the annual cost for drugs was estimated at USD 76.20, while for the HAART based options, the annual cost for drugs was estimated at USD 193.60. Meanwhile, the average cost for infant HIV DNA PCR was USD 32.50, and this was assumed to be available to every HIV exposed infant, and therefore did not vary with regimens [5].

Figure 1, shows the proportion of HIV+ mothers of infants aged 8 weeks and below, who were on different regimens for prevention of mother to child transmission (PMTCT). Over the 5-year period, the proportion of mothers on HAART based regimens increased steadily from 20.2%, in 2007 to 62.8% in 2012, while those on option A regimen declined, to 33.0%.

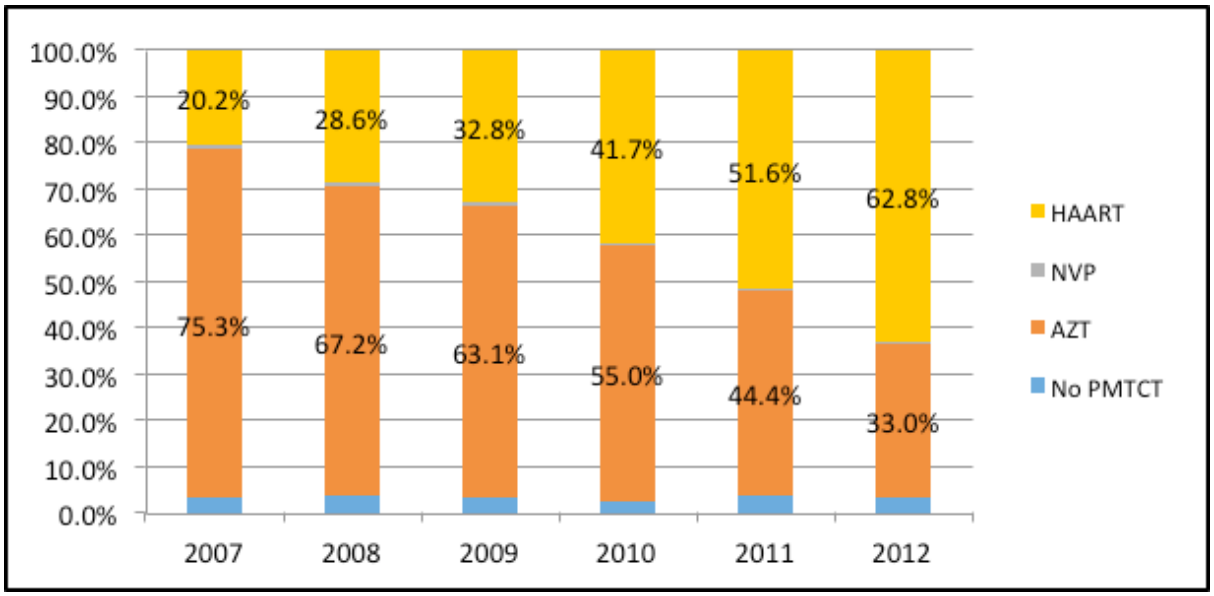

Figure 1: *Proportion of HIV+ mothers on different PMTCT regiments*

Figure 2, shows the temporal trends of HIV transmission rates to infants of mothers who did not receive PMTCT, or where on the different PMTCT regimens available. It is clear that there were wide differences in terms of HIV transmission rates across the different groups.

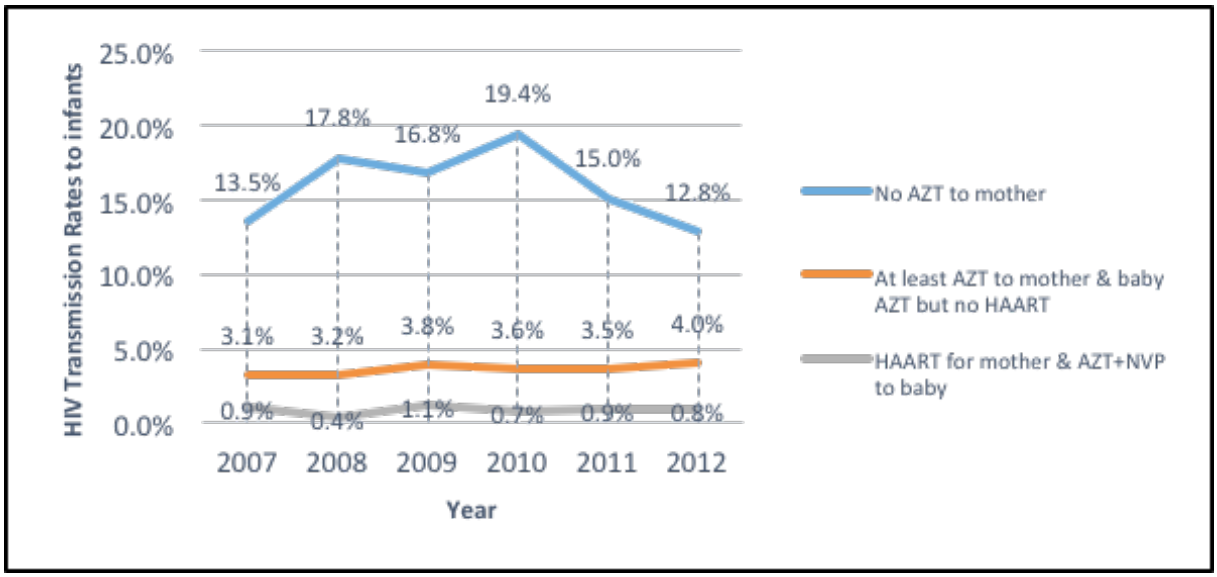

Figure 2: *HIV transmission rates by PMTCT regimen*

An extension of this comparison is shown in a simple decision tree on figure 3, where option A costs and outcomes (in terms of infants infected with HIV) are compared with costs and outcomes of option B or HAART based regimens. This takes into account the estimated costs and

transmission rates for the year 2012. A hypothetical cohort of 1000 HIV infected pregnant women is considered in each arm of the decision tree.

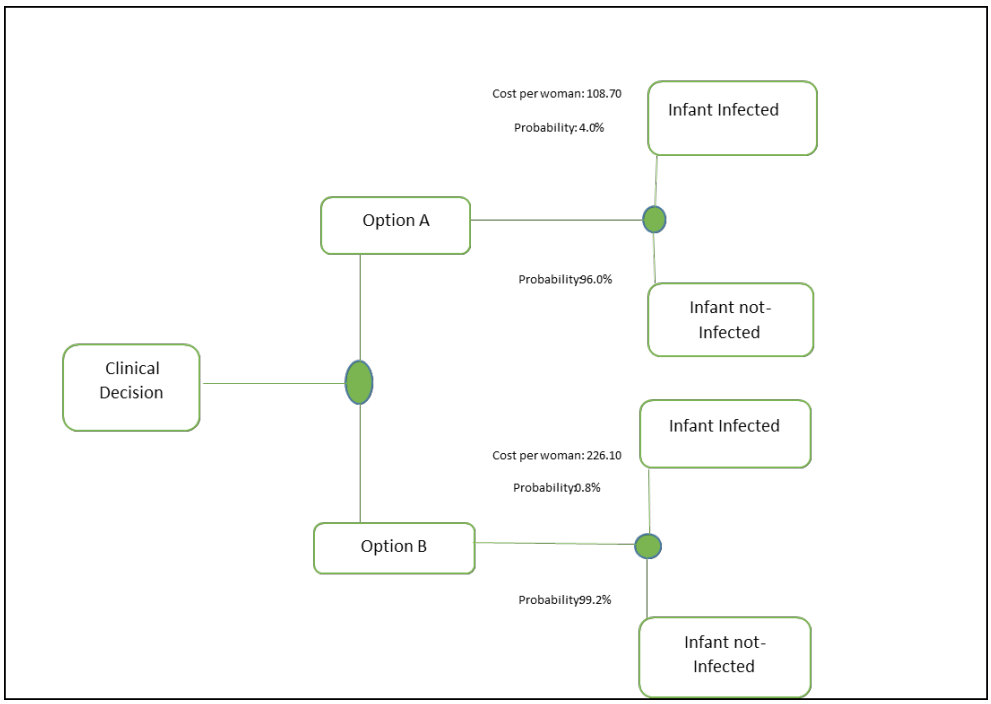

Figure 3: *Decision Tree comparing PMTCT regimens*

Considering the total annual costs and consequences in treating 1000 women, option A would cost USD 108700, and prevent 960 infants from getting infected, while option B, would cost, USD 226100, and prevent 992 infants from getting infected. Roughly this would translate to incremental cost effectiveness ration of USD 3668.75 per HIV infection averted. With Botswana's Gross Domestic Product (GDP) per Capita estimated at USD 7,315 in 2013, the HAART based regimens would be highly cost-effective, based on our basic analysis. Our analysis only considered the benefits linked the infant and can therefore be considered conservative.

Overall, there has been progress in preventing vertical transmission of HIV from mothers to their babies. With the need for additional resources to further scale up effective interventions, more research would be needed in this area, in order to fully account for the long-term benefits to both infants and mothers. This would allow health systems to draw lessons and advocacy messages to make the investment case for further scale up of HIV prevention efforts. Many countries the sub-Sahara Africa region have made steady progress in tackling the disease, but more needs to be done – despite the tight and in some cases, rapidly shrinking fiscal space for health and social services [6].

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CHAPTER 8

GENERAL DISCUSSION AND CONCLUSION

CONCLUSIONS AND PERSPECTIVES

The production process for improving population health, entails the organization of people, institutions, and resources to deliver high quality health interventions that meet the health needs of the target population [1,2]. To be effective and sustainable, this production process must also adhere to the principles of equity, efficiency, responsiveness and fairness in financial contribution [3]. This interconnected framework, forms the basis for health system performance assessment upon which progress is measured [4,5]. Failures in one part of the health system would eventually become apparent in other areas putting the entire enterprise in jeopardy. Therefore, health system stewards need to appreciate these linkages and embrace a holistic view when interpreting various trends.

Rather than focus narrowly on specific aspects of the health system, we have embraced this holistic and system-wide approach, throughout this thesis, where we have employed both quantitative and qualitative research methods. In doing so, we have sought to demonstrate the interconnectedness of the different components of the health system and the reason why health systems stewards, should have a fuller understanding of performance in order to make informed decisions and take appropriate action.

While still firmly rooted on the understanding that health systems are made up of specific components such as medicines and health technologies; health services delivery; human resources and health financing, in this thesis we have further sought to assess how various interactions across different components determine intermediate outputs and final outcomes. Here, we have relied on the concept of population health intervention coverage to assess the intermediate performance of health systems [5].

Intervention coverage is defined as the proportion of the population in need of a health intervention who actually receive it. Three components go into the estimation of intervention coverage: need, utilization, and quality. Proper measurement of intervention coverage must begin with a clear determination of the population that needs a given intervention. The population that needs an intervention is not necessarily those that demand the intervention but the ones that would gain health benefits from receiving or using the intervention. The second component of intervention coverage measurement revolves around determining the subpopulation that actually receives or uses the intervention in question. A third component seeks to explore the quality aspects of the intervention received and, hence, effectiveness and health gains to individuals or the population [6].

In our thesis, health intervention coverage has been extended to assess, important considerations of the health system such as access, inequalities, efficiency and productivity. By drilling down to the subnational levels, we have been able to unmask, inequalities in health goal attainment that exist within the country. Further, we have combined the same measure with various health system inputs, such as human resources and finances as well as outcomes, such as under-5 mortality, and then employed frontier analysis techniques (data envelopment analysis and Malmquist productivity analysis) to determine health system efficiency and productivity respectively. In the later we have actually been able to determine the important role of health technologies in improving the health system productivity.

Furthermore, in terms of assessing health outcomes, we have not only focused on mortality which is an important measure of health system performance, but we have also relied on a composite measure, disability adjusted life years (DALYs), which combines both mortality with morbidity into a useful population health metric [7,8]. This approach, allows for useful comparisons across disease areas that are useful in priority setting as well as performance assessment.

Our thesis began with an overview of the burden of disease in the sub-Saharan Africa region as a basis for defining the population health needs that health systems in the region must seek to address. Overall, it is clear that, the region's epidemiological landscape continues to be dominated by communicable diseases such as malaria, HIV/AIDS and tuberculosis, but with the rising scepter of non-communicable diseases. In particular, maternal, neonatal and childhood conditions are still significant contributors to health loss in the region, despite tremendous progress in tackling them over the last three decades. Non-communicable diseases and their risk factors are also on the rise needing further policy attention and retooling of health systems to respond effectively.

Paying attention to the drivers of health loss in sub-Saharan Africa, in chapter 3.1, we focus on Zambia a low-income country in the region that has made significant progress in tackling under-5 mortality. Here we assessed the performance of the health system in responding to the maternal and child health needs across the 72 districts in the country. Our analyses generated the most comprehensive district-level population coverage trends for 17 maternal and child health interventions spanning the period 1990 to 2010. This provided the basis of subnational benchmarking of performance, revealing gaps and inequalities that health system stewards must address in order to make progress.

Still, in Zambia, by combining the subnational intervention coverage estimates derived from the previous analysis, with data on financial disbursement to districts, we sought to determine the impact of different funding scenarios on progress in health intervention coverage in chapter 3.2. We established that increasing the level of funds channeled through the government system could lead to faster progress in attainment of population coverage goals than disbursing the same through donor channels. This analysis further implied that, fragmentation in funding, which is characteristic of donor support to many countries, is at best inefficient, underscoring the need for greater harmonization of funding from multiple sources into a single framework.

In chapter 4.1, we extended the analysis to focus on efficiency of health service delivery and improvement of child survival across the 72 districts in Zambia in the year 2010. In this analysis which accounted for financial and human resources as health system inputs, it was established that the Zambian health system had huge inefficiency gaps in resource use, which presents an opportunity to improve population health without necessarily injecting additional resources. This analysis further revealed significant heterogeneity at the subnational level which could be instructive to decision-makers. The fact that urban districts were generally more efficient than their rural counterparts underscored the need to strengthen various components of the health system capacity prior to investing resources. Furthermore, the important role played by socio-economic factors such as maternal education as determinants of population health trends was also clarified in this analysis. This understanding provides a basis upon which health system stewards could build meaningful cross- sectoral collaborations and channel resources more effectively in the efforts to improve population health.

Cognizant of the progress that Zambia has made in improving child survival [9,10], in chapter 4.2 we further sought to investigate the health system productivity change in reducing under-5 mortality between 2004 and 2009 across the 72 districts, accounting for health intervention coverage and financial resources. This was a period of formidable transition where the health system focused on child health outcomes and services with the aim of achieving the set global health goals [11,12]. Overall, a similar trend of subnational performance emerged, whereby urban districts outperformed their rural counterparts, pointing to fundamental differences in

the technical and organizational capacity at the subnational level. It emerged that adoption of health technologies was responsible for most of the gains made by the country in tackling under 5 mortality rather than improvements in managerial and organizational capacity in resource utilization. This further underscores the fact that more progress could be achieved with the available resources.

Recognizing the fact that non-communicable diseases are on the rise in many low- and middle- income countries, in chapter 5, we shift from the maternal and child health landscape and focus on diabetes mellitus. Our analysis focuses on four countries, and seeks to understand how their health systems are responding to the emerging population needs of those suffering from diabetes mellitus in terms of provision of the essential medicines. From our analysis, health loss due to diabetes is on the rise but there are gaps in terms of access and affordability to essential medicines such as insulin and oral hypoglycemic drugs. With the risk factors associated with diabetes also on the rise, health system stewards need to come up with innovative ways of preventing the disease as well as improving physical and financial access to the essential medicines for those in need.

The role of health financing is fundamentally important in any health service delivery effort. Therefore, in chapter 6, we present the views of different health systems stakeholders in Botswana, a middle-income country that has made tremendous progress in meeting population health needs, but still aspires to do more by instituting health financing reforms. We assess the impact of the proposed health financing reform, focusing on access to medicines, efficiency and cost-effectiveness in health service delivery as a pathway towards universal health coverage. It emerges that a narrow focus on health financing reform without fully appreciating its interactions with different components of the health system might lead to counterproductive results. Equalities might be exacerbated, inefficiencies worsened and health outcomes jeopardized. Therefore, it is incumbent upon health system stewards to espouse a holistic view when instituting health financing reforms.

In chapter 7, we have presented a brief report that considers how Botswana is making progress in selecting cost effective interventions to prevent mother to child transmission (PMTCT) of HIV from infected mothers to their babies. We demonstrate that, by embracing the option B+, whereby HIV infected mothers are put on Highly Active Antiretroviral Treatment (HAART), regardless of the level of CD4+ count or pregnancy status, Botswana has made steady progress towards elimination of mother to child transmission of HIV.

Overall, our assessment of health systems in the sub-Sahara Africa region, points to progress, particularly in terms of tackling communicable diseases, while much more needs to be done to address the emerging non-communicable diseases. However, despite signs of progress, attainment has not been uniform, when drilling down to the subnational levels or when comparing countries within regions. It was also clear that countries could make much more progress, by applying the available resources efficiently particularly in this landscape, when the global health community is facing a stagnant or in some cases contracting fiscal space.

We conclude our thesis by underscoring the importance of health system performance assessment as a policy directing tool, that health system decision-makers cannot do without. It has further demonstrated how to combine different data sources that are readily available to researchers and health systems stewards in low- and middle-income to answer some of the critical questions linked health system performance. It is only through such a comprehensive view that health system decision-makers could be able to fully appreciate the impact of their efforts.

PERSPECTIVES

The challenges facing health system decision-makers in many low- and middle-income countries are increasingly complex; yet there many opportunities to make progress. Therefore, understanding the complexity of health systems is essential in deciphering the important interactions that could influence performance in one way or another.

In many health systems in low- and middle-income countries, efforts to monitor performance are often confined to examining trends and levels of single aspects of the health system in isolation e.g. number of services delivered or number of health personnel trained or providing certain services. This simplistic approach, in as much as it is important in providing health system stewards with quick information for decision-making, it does not tell the full story and could lead to erroneous conclusions.

We propose a health system performance assessment framework that integrates different pieces of available data in order to answer some of the pressing policy questions. By combining different datasets and examining them jointly, health system stewards would be better placed to appreciate, the root causes of the challenges they are faced with and address them effectively. In addition, this approach makes it possible to fully explain performance trends, anticipate risks and institute appropriate mitigation strategies.

In the efforts to demonstrate the proposed integrative approach in our thesis, we encountered a number of limitations. First, in chapter 3.1, we unable to calculate effective population coverage for the health interventions we presented since the data sources we used did not collect information on the quality of intervention. In other words, it was impossible to determine from the data sources if those who received the health interventions derived health benefits as a result. Secondly, the data sources only focused on the maternal and child health landscape, and we were unable to estimate population coverage trends for those interventions that are useful in the control of non-communicable diseases. Thirdly, in chapter 4.1, where we sought to assess health system efficiency, we lacked data on prices of inputs and therefore could not calculate allocative efficiency which could be instructive in health systems in low- and middle income countries. Lastly but not least, our efforts in chapter 5, to assess the performance of health systems in providing access to essential medicines for diabetes was constrained by the limited availability of recent data in many countries.

In view of these challenges, we recommend that health systems should strive to fill the prevailing data gaps by innovatively collecting relevant pieces of data that could be informative. For instance, much could be achieved by expanding the existing population based surveys in order to collect additional information on quality of health interventions as well as cover some core interventions targeting non-communicable diseases. In addition, the quality of routine health information systems could be strengthened and deliberate efforts made to collect important pieces of information such as prices and costs of health inputs that could be informative in health system performance assessment.

Finally, we further recommend that different stakeholders within the health system should actively share the various data sources in their custody so that integration becomes a reality. This approach could be mutually beneficial to all stakeholders and place many in a firmer evidential base to make informed decisions. Failure to embrace this collaborative approach, will condemn many health systems in low- and middle income countries to piecemeal analyses, whose utility in comprehensive health system performance assessment remains questionable.

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CHAPTER 9

SUMMARY/SAMENVATTING

SUMMARY

Health systems in the sub-Saharan Africa region have long contended with a huge burden of disease, amidst pressing resource constraints. More recently, this has been characterized by an emerging epidemic of non-communicable diseases and injuries in the backdrop of an unfinished agenda of communicable diseases, which have long plagued the region. In addition, many countries in the region have weak health systems that are unable to effectively respond to some of the challenges they face. Yet, there have been calls for governments in the region to do more with tight and—in some cases—stagnant or shrinking fiscal space for social and health services.

However, despite the constraints, the last three decades have seen the region make progress in tackling some of the most critical health challenges. Notably, many countries have registered improvements in child survival, which could be attributable to the rapid expansion of priority health interventions such as childhood immunizations, nutritional supplementation, malaria prevention and treatment, among others. Mortality due to HIV/AIDS has also declined as a result of the steady scale up of antiretroviral treatment in many affected countries. In fact, efforts to prevent vertical transmission of HIV, from mothers to their babies, have also been tremendously successful in many settings, beckoning the possibility of an HIV-free generation.

Despite the progress, much remains to be done. For instance, under-5 mortality rates in many countries still remains unacceptably high. Paradoxically, this is largely driven by preventable diseases that could easily be tackled using highly cost effective interventions, such as childhood immunization, better sanitation and effective management of common childhood illnesses using simple health technologies. On the other hand, non-communicable diseases such as diabetes are also increasingly becoming dominant as contributors of health loss in many countries. Associated risk factors such as high caloric intake, obesity and low physical activity have also been shown to be on the increase in many countries, raising the scepter of a double burden of disease in the region. Therefore, in this landscape where demands on health systems are only going to increase, careful and objective priority setting becomes an overwhelming imperative for those that aspire to perform effectively in responding to the population health needs.

In this thesis, we have revisited the key considerations for health system performance assessment, contextualized to the on-going public health debates in the sub-Saharan Africa region. Overall, we have underpinned our analysis on the generally accepted premise that effective health systems are supposed to improve health, in ways that are responsive and financially fair, and make the best and most efficient use of the available resources. In the process of improving population health, it is recommended that health systems should also ensure equity. Furthermore, as an intermediate step towards improving health, those in need, should have access to (both physically and financially) the essential medicines, health technologies and services that they require.

Therefore, measuring the proportion of the population in need that is covered with these essential medicines and other health interventions, becomes one of the most important performance metrics for any health system. However, as previously pointed out, there are many competing demands for the available resources and health systems have to carefully prioritize how to allocate the scarce resources. In chapter 2 of this thesis, we emphasized the importance for decision makers to first understand the magnitude of the burden of disease attributable to different causes and their risk factors as a basis for objective priority setting and resource allocation within the health system. This is particularly relevant when considering that amidst the multiple health challenges and resource constraints that are facing the region, there are many cost effective interventions that could led to huge improvements in population health if they were sufficiently scaled up. At

the same time, we have further pointed out that by tracking trends and levels of disease burden, health system stewards would be empowered to make useful comparative assessments that would facilitate effective decision making and appropriate actions.

In chapter 3.1, we have further developed the concept of population coverage, focusing on child health in Zambia, at both national and subnational levels. Here, we recognize that in order for health systems to improve health, access to priority medicines, vaccines and other health technologies is fundamentally important. We have further pointed out that tracking and benchmarking progress at the subnational levels is a crucial policy directing tool for decision makers that are keen to improve health as well as address the existing inequalities. This section also reveals the existing limitations in the available data, not only in terms of the limited scope of health interventions covered, but also the lack of understanding on how effective the health interventions are in benefiting or improving the health of those that receive them. In the transitional epidemiological climate in sub-Saharan Africa, performance assessment should not only be limited to communicable, maternal and neonatal diseases, but also encompass non-communicable diseases and injuries that are gaining prominent in many parts of the region.

Considering that proper utilization of financial resources available for health service provision requires careful planning, in chapter 3.2, we have explored the potential impact of different funding scenarios on progress in health intervention coverage in Zambia. Overall, we make the case for financing health care systems in a holistic fashion rather than as vertical programs, which is mostly characteristic of donor funded health programs. By analyzing two separate funding channels – government and donors – we found that funneling money through the former is far more effective. We further, postulated that failure to harmonize funding channels not only leads to duplication of effort, but leaves health system stewards unable to effectively plan and implement hindering progress in service delivery.

Understanding that efficiency and productivity is a key consideration in health system performance, in chapter 4.1, we have considered technical and scale efficiency of 72 districts in Zambia in the year 2010; while in chapter 4.2 we have assessed total factor productivity change for the same districts between 2004 and 2009. This was a period of formidable transition in Zambia and the region as a whole, characterized by increased levels of funding as well as introduction and scale up of access to priority medicines, vaccines and other health technologies focusing on the child health landscape. Overall, our analyses revealed that despite the progress in child survival, there were still high levels of inefficiency within the health system, meaning that more could be achieved with the available resources. Specifically, our productivity growth assessment, indicated that most of the productivity gains, were as a result of technological progress rather than efficient combinations of resources to produce the desired health outcomes.

Given the increasing significance of non-communicable diseases in sub-Sahara Africa, in chapter 5, we have assessed the burden of disease attributable to diabetes and its risk factors between 1990 and 2013 and compared that, with access and affordability of priority antidiabetic medicines. Here, we have established that many country health systems are lagging behind in responding to the emerging challenge of diabetes. This situation if not addressed comprehensively risks eroding the gains that have been achieved by so many countries in the region in addressing communicable diseases.

Still, recognizing the challenges health systems are faced with in raising sufficient resources to address the many population challenges, in chapter 6, we focus on Botswana a country that has made progress towards universal health coverage largely by investing its domestic resources. We

have broadly assessed the potential impacts of a proposed health financing reform that is aimed at mobilizing additional domestic resources for health, against the overall goal of universal health coverage. Here it becomes clear that, unless progressive policies and regulations are carefully instituted and enforced, well-meaning reforms might become counterproductive to the universal health coverage aspirations. Furthermore, it is worth paying attention and tracking the intermediate objectives of universal health coverage such as access to medicines, population coverage, efficiency and cost effectiveness, such that timely corrective action could be instituted whenever necessary.

Finally, in chapter 7, we demonstrate the importance of cost effective selection focusing on measures to prevent mother to child transmission of HIV, in Botswana. Here we have established that putting HIV+ mothers on Highly Active Antiretroviral Treatment (HAART) is more effective in preventing transmission of HIV to their babies in comparison to the other regimens. This gives further impetus for health systems in low- and middle income countries to strive to expand access to priority health interventions in the face of the many population health challenges.

We conclude this thesis by underscoring the centrality of health system performance assessment in the efforts to improve population health in the sub-Saharan Africa region. Further, we recommend that effective measurement strategies should not focus narrowly on single aspects of the health system, but should seek to integrate data across various components in order to foster a fuller understanding of performance. In addition, we demonstrate that useful performance assessment should not only wait to measure the final outcomes such as mortality, but should also focus on attainment of intermediate goals such as access and coverage with priority health interventions. It is only through such an integrated approach to performance assessment that health system stewards will be empowered to make informed decisions and take appropriate action to improve health.

SAMENVATTING

Gezondheidsstelsels in de sub-Sahara regio in Afrika worstelen als sinds lange tijd met een enorme ziektelast, terwijl ze beperkte middelen tot hun beschikking hebben om zorg te verbeteren. Recentelijk wordt de ziektelast gekenmerkt door een opkomende epidemie van niet-overdraagbare ziekten en verwondingen terwijl overdraagbare ziekten nog niet voldoelde bestreden zijn. Daarnaast hebben veel landen in de regio zwakke gezondheidzorgsystemen die niet in staat zijn om effectief te reageren op een aantal van de uitdagingen waarmee zij worden geconfronteerd zijn. Toch zijn er oproepen tot regeringen in de regio om meer te doen met strakke en in sommige gevallen-stagnerende of krimpende fiscale ruimte voor sociale en gezondheidsdiensten.

Echter, ondanks de beperkingen, hebben in de laatste drie decennia landen in deze regio vooruitgang weten te boeken door de aanpak van een aantal van de meest kritische gezondheidszorguitdagingen. Met name hebben veel landen verbeteringen in de overlevingskansen van kinderen bewerkstelligd, die worden toegeschreven aan de snelle uitrol van interventies, zoals de pediatrische vaccinaties, voedingssupplementen, malaria preventie en behandeling. Sterfte ten gevolge van HIV / AIDS is gedaald als gevolg van de gestage opschaling van de antiretrovirale behandeling in veel getroffen landen. Pogingen om verticale transmissie van HIV, van moeder op kind te voorkomen zijn ook enorm succesvol in veel instellingen en wenken de mogelijkheid van een HIV-vrij generatie.

Ondanks de vooruitgang moet er nog veel worden gedaan. Bijvoorbeeld, het sterftecijfer van kinderen onder vijf jaar is in veel landen nog steeds onaanvaardbaar hoog. Paradoxaal genoeg,

wordt dit grotendeels gedreven door vermijdbare ziekten die gemakkelijk kunnen worden aangepakt met behulp van zeer kosteneffectieve interventies, zoals de pediatrische vaccins, betere sanitaire voorzieningen en effectief beheer van gemeenschappelijke kinderziekten met behulp van eenvoudige gezondheid technologieën. Aan de andere kant, zijn niet-overdraagbare ziekten zoals diabetes ook steeds meer dominant als veroorzakers van ziektelast in vele landen. Geassocieerde risicofactoren zoals hoge calorie-inname, obesitas en weinig lichaamsbeweging hebben ook aangetoond invloed te hebben op de stijging in veel landen in de regio. Daarom is in dit landschap waar de eisen die aan de gezondheidszorgsystemen alleen zal toenemen, zorgvuldige en objectieve prioriteitenstelling wordt een overweldigende noodzaak voor degenen die streven naar effectief beantwoorden van gezondheidsbehoeften van de bevolking.

In dit proefschrift hebben we de belangrijkste overwegingen voor het gezondheidssysteem prestatiebeoordeling, gecontextualiseerd aan de hand van lopende volksgezondheiddebatten in de regio sub-Sahara Afrika. Over het algemeen hebben we onze analyse onderbouwd aan de algemeen aanvaarde veronderstelling dat effectieve gezondheidssystemen worden verondersteld de gezondheid te verbeteren, en dat deze systemen het meest efficiënt gebruik maken van de beschikbare middelen. In het proces van verbetering van de gezondheid van de bevolking, is het raadzaam dat de gezondheidsstelsels ook voor equity moeten zorgen. Bovendien, als een tussenstap op weg naar verbetering van de gezondheid van mensen in nood, moet er toegang zijn (zowel fysiek als financieel) tot de essentiële medicijnen, medische technologieën en diensten die zij nodig hebben.

Derhalveishetpercentagevandebevolkinginnooddiemetdezeessentiëlegezondheidsinterventies geholpen wordt, een van de belangrijkste prestatiegegevens voor gezondheidszorg. Echter, zoals eerder opgemerkt, zijn er vele concurrerende eisen voor de beschikbare middelen en de gezondheidszorg hebben om deze zorgvuldig te prioriteren en te besluiten hoe de schaarse middelen toe te wijzen. In hoofdstuk 2 van dit proefschrift, benadrukten we het belang voor beleidsmakers om de omvang van de ziektelast eerst te begrijpen en toe te schrijven aan verschillende oorzaken en de risicofactoren te nemen als basis voor objectieve prioriteiten en de toewijzing van middelen binnen de gezondheidszorg. Dit is met name van belang bij het overwegen, dat te midden van de vele uitdagingen voor de gezondheid en de beperkte middelen die worden geconfronteerd met de regio, er veel kosten zijn aan effectieve interventies die kunnen hebben geleid tot grote verbeteringen in de gezondheid van de bevolking als zij voldoende werden opgeschaald. Tegelijkertijd hebben we er verder op gewezen dat door het volgen van trends en niveaus van de ziektelast, gezondheidszorg-stewards moeten worden gemachtigd om nuttige afwegingen te maken die effectieve besluitvorming en passende maatregelen zou vergemakkelijken.

In hoofdstuk 3.1, hebben we verder het concept van het aandeel van de bevolking ontwikkeld, gericht op de gezondheid van kinderen in Zambia, zowel op nationaal als subnationaal niveau. Hier laten wij zien dat het voor de gezondheid van systemen om de gezondheid te verbeteren, de toegang tot prioriteit geneesmiddelen, vaccins en andere medische technologieën van fundamenteel belang is. We hebben verder op gewezen dat het bijhouden en benchmarking de voortgang op het subnationale niveau is een cruciaal beleidstool voor beleidsmakers Deze sectie gaat ook in op de bestaande beperkingen van de beschikbare gegevens, niet alleen in termen van de beperkte reikwijdte van gezondheidsinterventies, maar ook het gebrek aan kennis over hoe effectief de gezondheidszorg interventies in aanmerking komen of verbetering van de gezondheid van degenen die ze ontvangenIn Sub-sahara Afrika moet beoordeling van de zorgprestaties niet alleen worden beperkt tot overdraagbare, maternale en neonatale ziekten,

maar omvatten deze ook niet-overdraagbare ziekten en verwondingen die prominent worden steeds in vele delen van de regio.

Gezien het feit dat een goede benutting van de beschikbare financiële middelen voor de gezondheid dienstverlening een zorgvuldige planning vereist, hebben we in hoofdstuk 3.2 de mogelijke gevolgen van de verschillende scenario's op de financiering over de vooruitgang in de dekking van gezondheidszorginterventies in Zambia onderzocht. Voor de financiering van de gezondheidszorgsystemen is het belangrijk om op een holistische manier te evalueren in plaats van te kijken naar losse verticale programma's, zoals kenmerkend voor door donoren gefinancierde gezondheidsprogramma's. Door het analyseren van twee afzonderlijke financieringskanalen - de overheid en donoren - vonden we dat de inzet van geld door middel van de overheid is veel effectiever is. Als financieringskanalen niet geharmoniseerd worden, wordt de vooruitgang in de dienstverlening belemmerd en zijn gezondheidszorg-stewards niet in staat om effectief zorg te plannen en uit te voeren.

Het in kaart brengen van efficiëntie en productiviteit is een belangrijke indicatie van de gezondheidszorg prestaties van het systeem; in hoofdstuk 4.1, hebben we technische en schaal efficiëntie van de 72 districten in Zambia in het jaar 2010 onderzocht en in hoofdstuk 4.2 onderzochten we de totale productiviteitsfactor verandering in dezelfde regio's tussen 2004 en 2009. Dit was een periode van enorme transitie in Zambia en de regio als geheel, gekenmerkt door verhoogde niveaus van financiering, alsmede introductie en opschaling van de toegang tot essentiele geneesmiddelen, vaccins en andere medische technologieën gericht op de gezondheid van het kind. Over het algemeen, is uit onze analyses gebleken dat, ondanks de vooruitgang in de overlevingskansen van kinderen, er nog steeds een hoge mate van inefficiëntie binnen de gezondheidszorg bestaat, wat betekent dat er meer kan worden bereikt met de beschikbare middelen. In het bijzonder uit de evaluatie van productiviteit blijkt dat het grootste deel van de productiviteitswinsten een gevolg van de technologische vooruitgang waren, in plaats van efficiënte combinaties van middelen om de gewenste gezondheidsuitkomsten te genereren.

Gezien het toenemende belang van niet-overdraagbare ziekten in sub-Sahara Afrika, in hoofdstuk 5 hebben we de ziektelast toe te schrijven aan diabetes en de risicofactoren tussen 1990 en 2013 beoordeeld en vergeleken dat met de toegankelijkheid en betaalbaarheid van de prioritaire antidiabetica. Hier hebben we vastgesteld dat veel gezondheidsproblemen systemen van de landen achterblijven bij het beantwoorden van de opkomende uitdaging van diabetes. Als deze situatie niet aan effectief wordt geadresseerd bestaat het risico dat de gezondheidswinsten geërodeerd worden die door zoveel landen zijn bereikt in de regio bij de aanpak van overdraagbare ziekten.

Toch is het herkennen van de uitdagingen waarmee zorgstelsels worden geconfronteerd in het verhogen van voldoende middelen om de vele bevolking uitdagingen aan te pakken. In hoofdstuk 6, richten we ons op Botswana, een land waarin de vooruitgang in de richting van de universele dekking van gezondheidzorg grotendeels is gemaakt door te investeren in het eigen systeem. We hebben in grote lijnen de mogelijke gevolgen onderzocht van een voorgenomen hervorming van de financiering van de zorg die gericht is op het mobiliseren van aanvullende binnenlandse om de algemene doelstelling van de universele dekking van de gezondheidszorg te halen. Hier wordt duidelijk dat, tenzij progressief beleid en regelgeving zorgvuldig worden ingesteld en afgedwongen, goedbedoelde hervormingen contraproductief kunnen zijn voor de universele dekking van de gezondheidszorg. Verder is het de moeite waard aandacht te vestigen op het bijhouden van de tussentijdse doelstellingen van de universele dekking van de gezondheidszorg, zoals de toegang tot geneesmiddelen, zodat tijdig corrigerende maatregelen kunnen worden ingesteld.

Tot slot in hoofdstuk 7, tonen we het belang van kosteneffectieve selectie richten op maatregelen om de moeder op kind overdracht van HIV te voorkomen, in Botswana. Hier hebben wij vastgesteld dat de invoering HIV + moeders zeer actieve antiretrovirale behandeling (HAART) effectiever is bij het voorkomen van overdracht van HIV op hun baby's in vergelijking met de andere behandelingen. Dit geeft een extra impuls voor de gezondheidszorg in lage- en middeninkomenslanden te streven naar toegang tot prioriteit gezondheidsinterventies uit te breiden in het gezicht van de vele bevolking gezondheid uitdagingen.

We sluiten dit proefschrift door de centrale plaats van prestatiebeoordeling van gezondheidssysteem te benadrukken in de inspanningen om de volksgezondheid te verbeteren in de sub-Sahara Afrika. Verder adviseren wij effectieve meetstrategieën die niet focussen op slechts enkele aspecten van de gezondheidszorg, maar met als doel om gegevens over alle verschillende componenten te integreren en zo een beter begrip van de prestaties te bevorderen. Daarnaast hebben we laten zien dat voor een nuttige prestatiebeoordeling we niet alleen maar moeten wachten op de definitieve resultaten zoals sterfte, maar ook de focus moeten leggen op de verwezenlijking van de intermediaire doelstellingen, zoals toegang tot en de dekking voor essentiële gezondheid interventies te meten. Het is alleen door een geïntegreerde benadering van dergelijke prestatiebeoordeling dat gezondheidsstelsel stewards zullen worden gemachtigd om de juiste beslissingen te nemen en passende maatregelen te nemen om de gezondheid te verbeteren.

CHAPTER 10

ADDENDUM

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The stethoscope image on the cover is via the Rosmarie Voegtli flickr photostream, August 2010.

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