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Research Article

The state of costing research for HIV interventions in sub-Saharan Africa

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The past decade has seen a growing emphasis on the production of high-quality costing data to improve the efficiency and cost-effectiveness of global health interventions. The need for such data is especially important for decision making and priority setting across HIV services from prevention and testing to treatment and care. To help address this critical need, the Global Health Cost Consortium was created in 2016, in part to conduct a systematic search and screening of the costing literature for HIV and TB interventions in low- and middle-income countries (LMIC). The purpose of this portion of the remit was to compile, standardise, and make publicly available published cost data (peer-reviewed and gray) for public use. We limit our analysis to a review of the quantity and characteristics of published cost data from HIV interventions in sub-Saharan Africa. First, we document the production of cost data over 25 years, including density over time, geography, publication venue, authorship and type of intervention. Second, we explore key methods and reporting for characteristics including urbanicity, platform type, ownership and scale. Although the volume of HIV costing data has increased substantially on the continent, cost reporting is lacking across several dimensions. We find a dearth of cost estimates from HIV interventions in west Africa, as well as inconsistent reporting of key dimensions of cost including platform type, ownership and urbanicity. Further, we find clear evidence of a need for renewed focus on the consistent reporting of scale by authors of costing and cost-effectiveness analyses.

Keywords: costing, HIV/AIDS, LMIC, cost-effectiveness, systematic review

Introduction

Over the past decade, there has been a steady reduction in new HIV cases and AIDS-related mortality worldwide. New HIV infections declined from 3.4 million in 1996 to 1.8 million in 2017 and the annual number of AIDS-related deaths has decreased from its peak of 1.9 million in 2004 to a record low of 940 000 worldwide (UNAIDS, 2018). These reductions are largely driven by progress in sub-Saharan Africa, particularly eastern and southern Africa – home to 53% of people living with HIV – where there was a 42% decline of AIDS-related mortality and a 30% decline in the number of new HIV infections since 2010 (UNAIDS, 2018). Despite these promising advances, progress towards achieving 2020 milestones has slowed and current rates of progress will not be enough to achieve the target of 500 000 new infections by the end of the decade (UNAIDS, 2018).

In an age of shrinking donor funding and shortages of human resources for health, the need for high quality costing data to inform HIV interventions is clear (Kates, Wexler, Lief, & UNAIDS, 2017). Increased efficiency and cost-effectiveness of interventions from prevention and testing to treatment and care is critical (Siapka et al., 2014). Nowhere is this more apparent than in sub-Saharan Africa, where a dozen countries have the highest disease prevalence in the world and received 56% of global financial aid for the disease in 2010 (Resch, Ryckman, & Hecht, 2015). In order to achieve needed efficiencies, define priorities and properly allocate resources to those priorities, programme planners and decision makers must have cost data that is both current and contains a high level of detail and quality. To this end, the Global Health Cost Consortium (GHCC) was commissioned in 2016. As part of its mission to improve the availability, quality, timeliness

and policy relevance of costing research (Vassall et al., 2017; DeCormier Plosky et al., 2019), the GHCC conducted a systematic search and screening of published and grey literature reporting primary, non-modelled cost data for HIV and TB interventions in LMIC.

There have been various similar efforts to develop databases of published unit cost data across a variety of diseases including HIV/AIDS and TB (Avenir Health, 2013; Visscher et al., 2017). Additionally, several previous studies have attempted to characterise the state and quality of published costing literature for HIV treatment and care (Beck, Miners, & Tolley, 2001; Beck, Harling, Gerbase, & DeLay, 2010), community-based services (Beck et al., 2013), as well as particular types of HIV interventions (Galarraga et al., 2011) as well as those in specific LMIC settings (Meyer-Rath et al., 2019). Our efforts at GHCC contribute to this literature by providing an updated summary and characterisation of the state of research examining the costs of HIV interventions across all intervention categories using published (and grey) primary, non-modelled cost data. To the best of our knowledge, this paper represents the first attempt to characterise the state of the literature for costing and cost-effectiveness studies of HIV interventions in sub-Saharan Africa across all prevention and treatment activities using only non-modelled costs.

In this paper, we concentrate our review of the literature on 978 unit cost observations from 159 peer-reviewed and grey literature costing and cost-effectiveness studies of HIV interventions in sub-Saharan Africa. We start by giving a brief background of the search and screening process for literature conducted by the GHCC and discuss a few key points in the comparability and interpretation of cost data observations we have collected. Next, we characterise these data across three main dimensions: geography, publication information, and type of study to provide a clearer picture of the state of this costing literature. We follow this with a discussion of the timeliness, availability and potential reach of cost data. Finally, we examine several characteristics of data within studies that are important to precision and the rigor of reporting standards. We conclude by summarising key findings, offering interpretation based on the data, and advancing recommendations to improve both the scope and reporting standards of costing data for future data collection efforts. These recommendations aim to improve decision making regarding HIV financing, budgeting and programming.

Methods

After extensive consultation with multiple global partner organisations regarding their use of intervention typologies, the GHCC identified 54 HIV interventions under five categories: Prevention; Case Detection, Testing, and Diagnosis; Treatment and Care; Enablers and Support; and Health Systems. We then conducted a systematic search and screening of peer-reviewed articles and grey literature reports. The systematic search covered articles published from January 2006 to October 2017 across six databases (PubMed, Embase, Web of Science, Cochrane Library, NHS Economic Evaluations Database and Literatura Latinoamericana en Ciencias de la Salud (LILACS)) and included a combination of economic (e.g. “cost”, “care cost”)

and disease specific search terms (e.g. “HIV”, “human immunodeficiency virus”). There were no restrictions on treatment type or intervention. Searching also included grey literature resources (e.g. Google) and snowball sampling. After initial screening, three team members performed data extraction and two senior investigators reviewed key data points for quality assurance. All authors were contacted and asked to review the data extracted from their studies and flag inaccuracies. Details of the systematic search, screening, data extraction, data standardisation, data management and quality assurance process undertaken by the GHCC is available elsewhere (DeCormier Plosky et al., 2019). Figure 1 shows that the final tally of HIV studies included 1 344 cost observations from 217 articles across 43 different countries. Of these, 978 cost observations were from 159 studies in 25 sub-Saharan African nations. Data were standardised across a number of dimensions including cost category, intervention category and time frame. A specific list of these categories is available in DeCormier Plosky et al. (2019).

The interpretation of these cost observations across studies involves several elements. Generally, a unit *cost* represents the average cost of providing one unit of a particular service in a given HIV intervention. Many studies report unit costs for different intervention characteristics, different countries or even different interventions all together; thus, one study can be cross-listed in multiple ways. Furthermore, given heterogeneities in reporting, a unit cost may represent the average cost in one site, or across multiple sites. In some cases, such as health systems interventions, a unit cost may represent costs across an even larger geographic scale or population. Thus, analysis of actual cost values reported requires a deep review of each unit cost reported for studies within a given intervention category. We do not explore several important indicators that could help to better analyse the quality of cost data we have collected such as inputs that could lead to over- or under-estimation of unit costs (e.g. above service delivery costs, overhead, personnel inefficiency, downtime, volunteer time), measures of precision (e.g. sampling, period portrayed) or other dimensions of quality (e.g. intervention components, activity breakdowns). We exclude analysis of these variables in lieu of a more thorough future review. In this study, we focus only on the distribution of cost data and cost inputs across a number of different dimensions (e.g. geography, publication type, reporting). In addition, we examine the availability of other information reported by study authors that allows for proper interpretation, analysis, and in some cases, extrapolation of these cost data to other contexts.

Characterising extracted data

We begin by characterising the extracted HIV cost data by geographic scope, publication type, source, timing, and the kind of analysis performed by the study authors.

Distribution of data by country

Costing data obtained from our systematic search and screening, extraction and data standardisation process span 25 sub-Saharan African nations. As seen in [Figure 2](#),

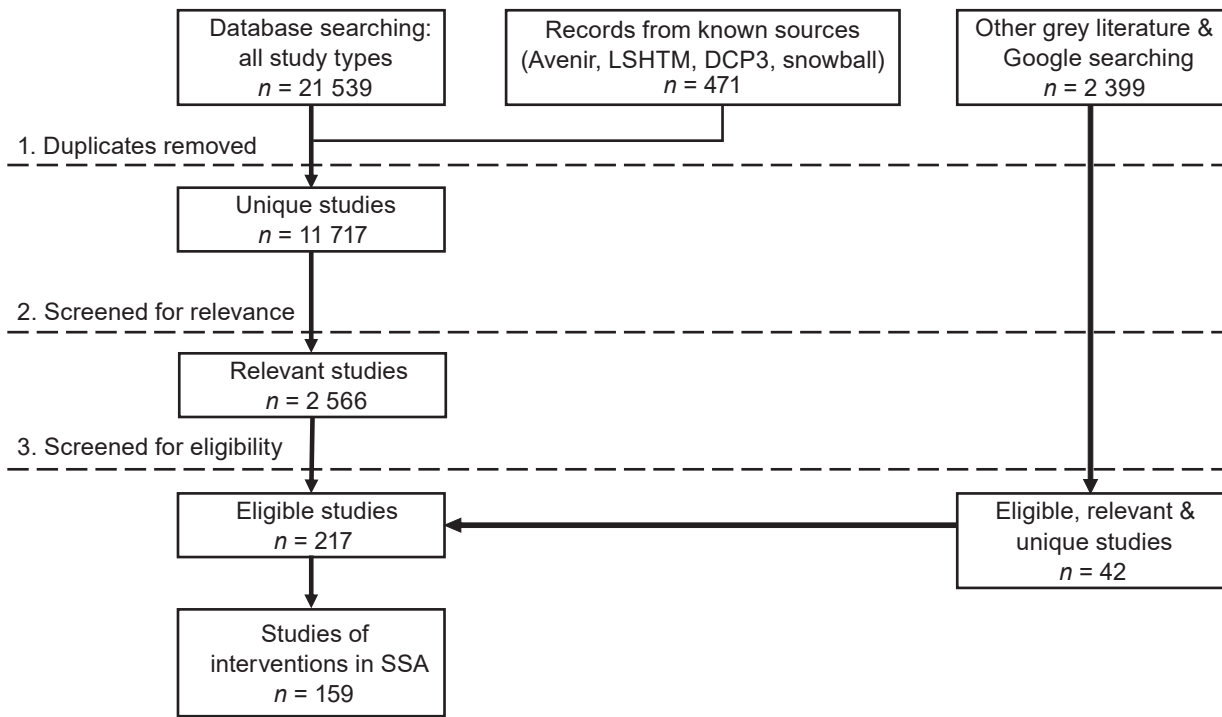


Figure 1: PRISMA diagram

the highest concentrations of both published studies and unit costs are from Southern and Eastern Africa. Just four countries in these regions (Kenya, South Africa, Uganda and Zambia) account for 63.5% and 58.4% of all published

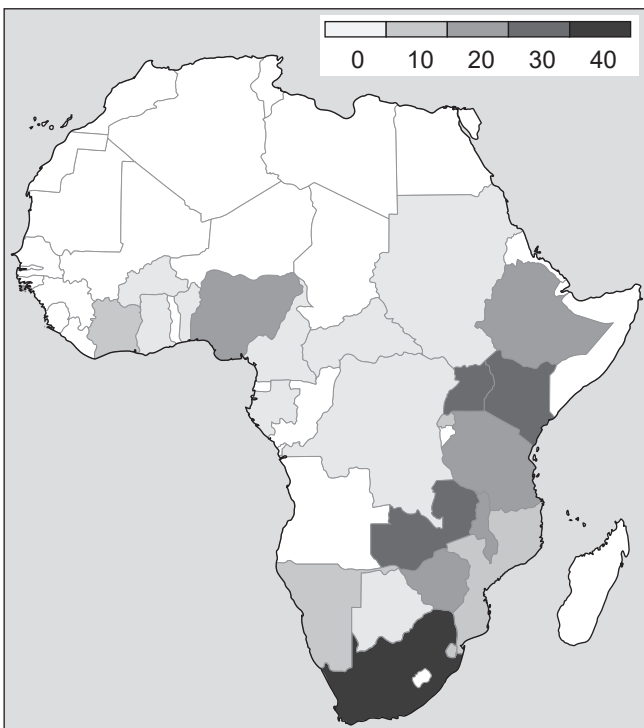


Figure 2: Heat map of studies per country

studies and unit costs, respectively. Nonetheless, we find a number of studies that report cost data from interventions in nearly two-dozen other countries across the continent.

In Table 1 we note that there have been fewer than five published studies across thirteen countries. Thus, although geographic variation is broad, the quantity of evidence within many of these countries is often sparse. We also note a scarcity of published costing in the region of West Africa, where data from HIV interventions is available from only 16 studies across just five countries (Benin, Burkina Faso, Ivory Coast, Ghana, and Nigeria). These 16 studies include just 64 unit cost observations. Other countries in the region lack costing data entirely. Note that the sum of the values in the studies row is greater than the 159 studies cited above because several studies report individual unit costs in more than one country. These are not to be confused with studies reporting average unit costs that combine estimates from across *multiple countries*, of which we identified five.

Publication of costing data

Figure 3 shows the number of publications per year according to publication type (either grey literature or peer-reviewed journals). We find that publication rates were relatively low until the second half of the last decade, when evidence production increased substantially, in part due to an increase in grey literature resources. Note that in this figure we do not include production levels for either source in 2018 since our systematic search was completed only half-way through that year – thus any amount shown would likely underestimate the total volume of evidence produced in that year and might falsely suggest a downward trend.¹

Table 2 shows the production of evidence by source of

Table 1: Total studies and unit costs by country

Country	Studies	Unit costs
Benin	2	6
Botswana	1	6
Burkina Faso	1	10
Burundi	1	6
Cameroon	2	5
Central African Republic	1	12
Côte d'Ivoire	4	9
Democratic Republic of the Congo	1	1
Eswatini (formerly Swaziland)	6	33
Ethiopia	6	43
Gabon	1	1
Ghana	2	19
Kenya	20	97
Lesotho	3	5
Malawi	9	40
Mozambique	5	9
Namibia	5	26
Nigeria	7	20
Rwanda	4	17
South Africa	38	211
Sudan	1	2
Tanzania	9	81
Uganda	22	129
Zambia	21	134
Zimbabwe	12	35
Multiple countries*	5	21
Total	159	978

*Of the 5 studies reporting unit costs that average from across multiple countries, 3 studies (PEPFAR, 2012; 2013; 2014) report average unit costs from 11 sub-Saharan African countries (among others), including Botswana, Cote d'Ivoire, Ethiopia, Mozambique, Namibia, Nigeria, Rwanda, South Africa, Tanzania, Uganda and Zambia; 1 study (Lara et al., 2012) reports unit costs from Uganda and Zimbabwe; and 1 study (Menzies et al., 2013) reports unit costs averaged from 5 sub-Saharan African countries (among others), including Botswana, Ethiopia, Mozambique, Nigeria and Uganda

publication – either the name of the academic journal for peer-reviewed articles, or the institutional source for grey literature publications. We find that 122 (76.7%) studies are published in peer-reviewed journals. Among these, there are a few clear leaders – PLoS One, JAIDS and AIDS are responsible for a total of 57 publications, or 46.7% of all peer-reviewed literature. A total of 12 other journals have published multiple studies with costing data, and an additional 19 have published at least one article.

Table 3 explores the institutional sources for the grey costing literature. In total, 37 studies (or 23.3% of our overall sample) are considered grey literature. We find that among these, 18 studies, or 48.6% of all grey literature publications, list just three institutional affiliations (often in partnership with country ministries) – USAID, PEPFAR and the Futures Group. A further four studies cite the CDC as the primary institution in partnership with country ministries, and the remaining nine studies report other institutional sources or list their source as a conference proceeding.

Type of study

Next, we explore the study type and costing perspective of our available data. First, we examine whether the primary

Table 2: Peer-reviewed articles by publication source

Peer-reviewed journal citation	Count	Peer-reviewed articles (%)	All studies (%)
<i>PLoS One</i>	23	0.19	0.13
<i>Journal of Acquired Immune Deficiency Syndromes</i>	20	0.16	0.11
<i>AIDS</i>	14	0.11	0.08
<i>Tropical Medicine & International Health</i>	8	0.07	0.04
<i>Health Policy and Planning</i>	5	0.04	0.03
<i>Journal of the International AIDS Society</i>	5	0.04	0.03
<i>PLoS Medicine</i>	5	0.04	0.03
<i>South African Medical Journal</i>	4	0.03	0.02
<i>Cost Effectiveness and Resource Allocation</i>	4	0.03	0.02
<i>Sexually Transmitted Diseases</i>	4	0.03	0.02
<i>Bulletin of the World Health Organization</i>	3	0.02	0.02
<i>AIDS Care</i>	2	0.02	0.01
<i>BMC Health Services Research</i>	2	0.02	0.01
<i>BMC Public Health</i>	2	0.02	0.01
<i>Health Education Research</i>	2	0.02	0.01
<i>African Health Sciences</i>	1	0.01	0.01
<i>AIDS and Behavior</i>	1	0.01	0.01
<i>AIDS Patient Care and STDs</i>	1	0.01	0.01
<i>AIDS Research and Treatment</i>	1	0.01	0.01
<i>BMC Medicine</i>	1	0.01	0.01
<i>Drug Safety</i>	1	0.01	0.01
<i>Global Health Science and Practice</i>	1	0.01	0.01
<i>Global Health Action</i>	1	0.01	0.01
<i>Health Policy</i>	1	0.01	0.01
<i>Human Resources for Health</i>	1	0.01	0.01
<i>International Journal for Quality in Health Care</i>	1	0.01	0.01
<i>Lancet</i>	1	0.01	0.01
<i>Lancet Infectious Diseases</i>	1	0.01	0.01
<i>Nigerian Postgraduate Medical Journal</i>	1	0.01	0.01
<i>Prevention Science</i>	1	0.01	0.01
<i>Rural Remote Health</i>	1	0.01	0.01
<i>Sexually Transmitted Infections</i>	1	0.01	0.01
<i>Tropical Doctor</i>	1	0.01	0.01
<i>Urologic Nursing</i>	1	0.01	0.01
Total	122	–	0.67

objective of each study is purely costing or instead contains unit cost estimates by virtue of collecting primary cost data for use in a cost-effectiveness or cost-utility analysis. We find that the majority of our sample (76.7%) is indeed classified primarily as costing literature. For the 37 studies whose primary objective is cost-effectiveness or cost-utility analysis, almost all, 36, are peer-reviewed articles, while only one is a grey literature report. In terms of the total number of unit costs collected, 81.3% of the unit costs come from studies whose primary objective is costing, while 18.7% are extracted from cost-effectiveness or cost-utility analysis articles.

We also find that each study's costing perspective varies little. The vast majority of unit cost observations (98.9%, or 967/987) are recorded from a provider perspective, though we report the perspective that we interpreted each study to take, not necessarily the perspective reported by

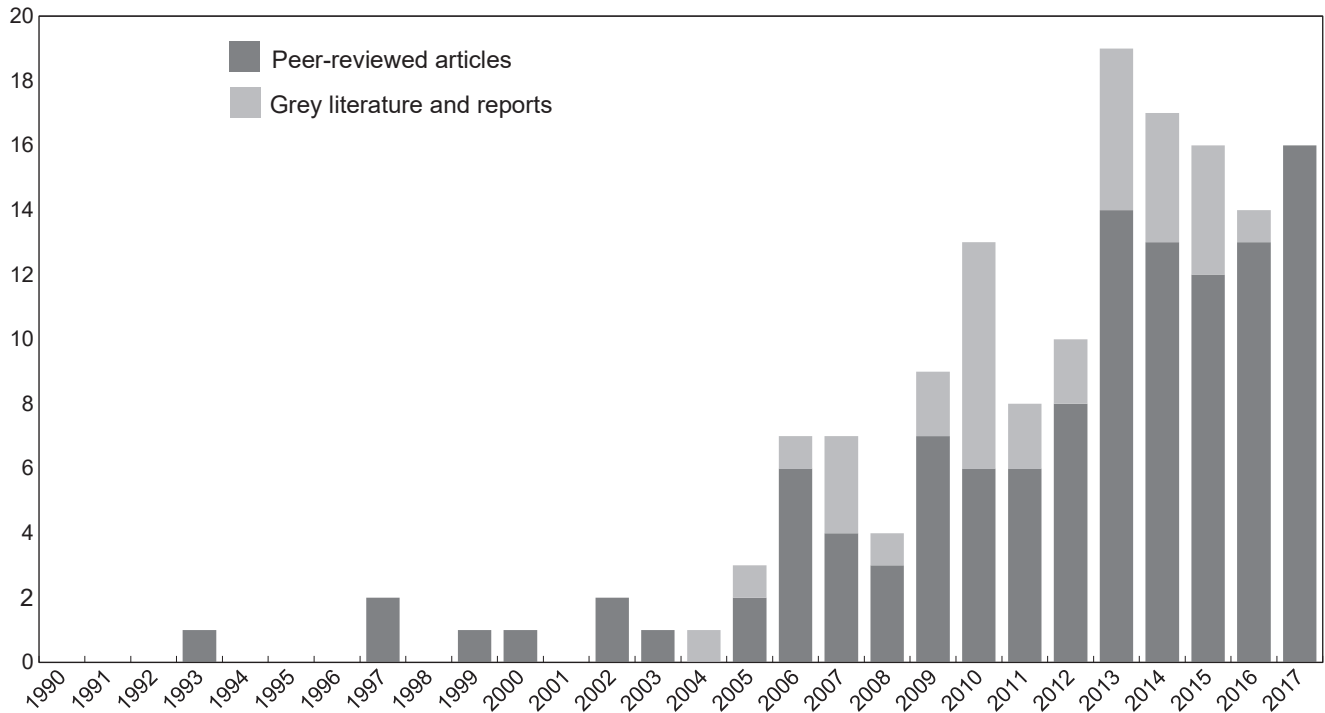


Figure 3: Publication over time

study authors. Often times, the interpretation of perspective was difficult to ascertain. Notably, only three studies among sub-Saharan African literature include patient costs in any form. Of the unit costs not reported from the provider perspective, eight are societal – including patient

costs in addition to provider costs – and an additional three are taken from a patient perspective. Further, these observations are from just three studies of interventions in HIV: Testing and Counseling in Malawi (Maheswaran et al., 2016), Linkage to Care in Zimbabwe (Miller, Halfors, Cho, Luseno, & Waehrer, 2013), and Key Populations also in Malawi (Maheswaran et al., 2018).

Table 3: Grey literature articles by publication source

Grey literature source	Count (n)	Grey lit. articles (%)	Overall (%)
USAID	7	0.19	0.04
PEPFAR	6	0.16	0.03
Futures Group	5	0.14	0.03
Health Policy Project	3	0.08	0.02
PANGEA	2	0.05	0.01
Abt Associates Inc.	1	0.03	0.01
CDC & Ethiopia Ministry of Health	1	0.03	0.01
CDC & Tanzania Ministry of Health	1	0.03	0.01
CDC & Kenya Ministry of Health	1	0.03	0.01
CDC & Mozambique Ministry of Health	1	0.03	0.01
Clinton Health Access Initiative	1	0.03	0.01
Conference Proceedings	1	0.03	0.01
Health Policy Initiative	1	0.03	0.01
Health and Development Africa	1	0.03	0.01
Makerere University School of Public Health	1	0.03	0.01
MEASURE Evaluation	1	0.03	0.01
Médecins Sans Frontières (MSF)	1	0.03	0.01
Medical Research Council, Pretoria	1	0.03	0.01
Zimbabwe Ministry of Health and Child Welfare	1	0.03	0.01
Total	37	–	0.20

Authorship

Finally, we examine whether the institutional affiliation of study authors matches the country in which intervention(s) took place. Several coding choices are worth mention: We recorded information separately for lead author and all authors; We record and report on the country/ies of lead author affiliation only; We did not include research groups mentioned in the author list in our counts; We code only the country/ies of the author’s institutional affiliation(s) reported in the study in question – since author affiliations are subject to change over time; If an author reports multiple institutional affiliations we record all affiliations in our statistics and consider all affiliations to count towards whether the author has an ‘in country’ or ‘out of country’ affiliation; If there is insufficient information within a study to code all author institutional affiliation(s), we exclude that study from analysis.

Out of 159 studies, 134 contained enough author information to code country of institutional affiliation for all authors. Among these studies, we coded affiliations for 1 013 authors in total (many of whom were listed across multiple studies) including 134 first authors and 879 additional authors. The average number of authors per study is 7.6 (median 7) with an interquartile range of 4 authors (25th percentile = 5; 75th percentile = 9). For the 134 first

author affiliations, 60 authors (or 44.8%) reported primary or secondary institutional affiliations in the country in which study data were collected while the remaining 74 (55.2%) reported affiliations in countries other than where the study took place. When we examine institutional affiliations for all 1 013 authors, we find that more than half (52.9%) report affiliations with institutions within the countries in which the study took place, while 51.9% report affiliations with institutions from other countries.

Next, we examine the country-locations of the affiliations reported by first authors. Among those 60 first authors reporting affiliations in the country in which the study took place, we find that the majority (70%) were from institutions based in either South Africa (26), Uganda (10), or Zambia (6). The remaining countries of institutional affiliation were Tanzania (3), Zimbabwe (3), Malawi (2), Mozambique (2), Rwanda (2), Ethiopia (1), Kenya (1), Lesotho (1), Namibia (1), Nigeria (1) and Sudan (1). Also, among these 60 authors, 28 reported additional institutional affiliations in countries including the United States (12), South Africa (7), the United Kingdom (5), Sweden (2), The Netherlands (1), Norway (1), and Tanzania (1).

Among the 74 first authors reporting affiliations in countries other than those in which the study took place, the majority (48 or 64.9%) were from institutions in the United States while 13 (17.6%) were from the United Kingdom. The remaining 13 were from either France (3), Mexico (2), South Africa (2), Australia (1), Belgium (1), Burkina Faso (1), Ireland (1), Italy (1), or The Netherlands (1). Further, among the 74 authors with affiliations outside of the country in question, 17 reported more than one affiliation in countries including the United States (14), the United Kingdom (2), and France (1).

Timeliness, reach and availability of data

Next, we review the timeliness of study publication as a way to explore how quickly cost data may be reaching its intended audiences. We then explore one measure of the possible reach of this data – journal impact factor. Finally, we examine the proportion of observations that include any input costs.

Publication characteristics

One important indicator of the potential utility of cost data is how quickly it reaches its intended audience. One signal of the timeliness of data is the time taken between data collection and publication of those data. When available, we extracted the end-line year of data collection.² End-line data collection date was reported in 76.1% of studies (121 total; 99 peer-reviewed and 22 grey literature). In Figure 4, we examine the difference between year of end-line data collection and the year of publication. We also distinguish between grey literature studies and peer-reviewed publications – which often require more time for revision and resubmission. We find that only seven studies were published within a year of end-line data collection (four grey literature; three peer-reviewed). The majority of all studies take between one and five years to publish in their entirety, with a mean of 2.8 years (SD = 1.57), and a median of 3.0 years until publication. We conduct a *t*-test of years to publication comparing article publication type and find that grey literature studies (1.4 years; SE = 0.22) are published an average of 1.7 years faster ($p < 0.001$) than their peer-reviewed counterparts (3.0 years; SE = 0.14).

A complementary indicator of the reach of study data could be the journal impact factor to which authors manuscripts are accepted. A journal's impact factor is an approximation of the mean citation rate per citable item for a journal and reflects the potential impact of its content on other academic scholarship. Of the 122 peer-reviewed publications, 118 journals have impact factor information available from the Web of Science. The average impact factor of these journal articles is 4.3 (SD = 5.41), with a median impact factor of 2.8. Two publications in our sample were featured in very high-ranking journals (The Lancet and Lancet Infectious Diseases). After removing these titles, the average impact factor is 3.7 (SD = 2.19; median 2.8).

Availability of data

Next, we examine the availability of study data as it relates to the number of studies, unit cost observations, and input cost data by different broad categories of HIV interventions. Input costs are a key to understanding and making use of unit

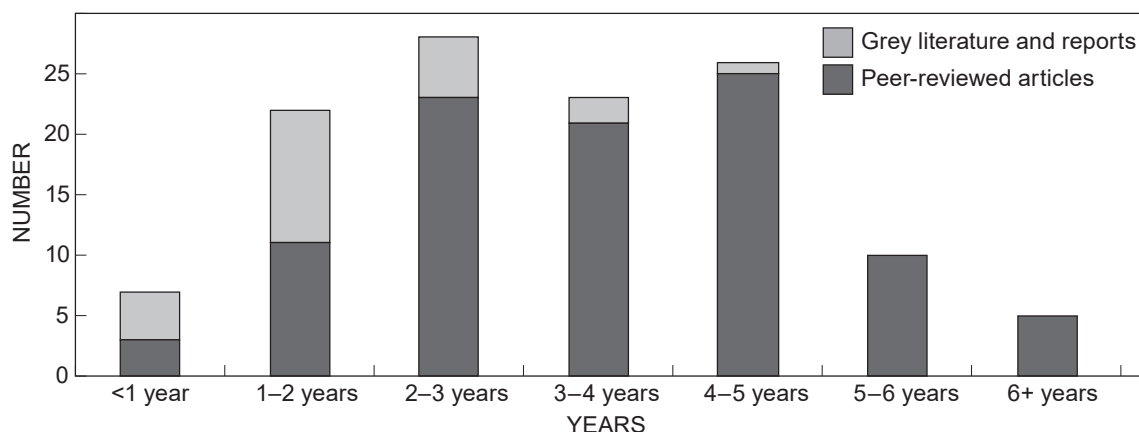


Figure 4: Time to publication

costs reported for a given intervention. As shown in Table 4, studies are distributed somewhat evenly across broad intervention categories addressing prevention (60 studies reporting 320 unit costs), testing (21 studies reporting 182 unit costs), and treatment and care (72 studies reporting 439 unit costs). There are half as many observations in testing as in prevention. However, there is a relative lack of published studies and unit cost evidence among studies examining enabling interventions as well as programmes at the health system level (e.g. supply chain, surveillance, lab monitoring).

Regarding the reporting of disaggregated costs, among those studies in the former categories, we highlight the number of unit costs that are accompanied by *any* input cost reporting. For prevention interventions broadly, nearly

half (49.7%) of all unit cost reports include input costs (i.e. include key information about the components of that unit cost such as personnel, capital and recurring goods expenses). Interventions addressing treatment and care have a similar proportion of costs that include input cost details (45.6%), while interventions costing testing activities contain the least detail on average (39.0%).

In Table 5 we examine the number of studies by intervention, as well as the percentage of input costs reported given the unit costs available in each category. These categories were predetermined by the GHCC for classification purposes before our review began. The background and rationale of these categories is discussed in greater detail elsewhere (see DeCormier Plosky et al.

Table 4: Studies, unit costs and input cost reporting by intervention type

Intervention category	Studies	Unit costs	Unit costs with any inputs reported	Unit costs including inputs (%)
Enablers	1	4	4	100.0
Health system	5	33	33	100.0
Prevention	60	320	159	49.7
Testing	21	182	71	39.0
Treatment and care	72	439	200	45.6
Total	159	978	467	47.8

Table 5: Studies, unit costs and input cost reporting by intervention category

Intervention category	(1) Studies per intervention	(2) Number of unit costs	(3) No. including input costs	(4) Including input costs (%)
Adult ART	49	234	140	59.8
HIV testing and counselling	25	182	71	39.0
Voluntary medical male circumcision	31	100	60	60.0
Prevention of mother-to-child transmission	11	86	39	45.3
Key populations	8	53	14	26.4
Paediatric ART	12	50	8	16.0
HIV/TB care delivery	4	39	12	30.8
Information, education and communication	8	37	21	56.8
Retention and adherence	2	29	0	0.0
STI management	4	29	16	55.2
Supply chain management	3	29	29	100.0
Socioeconomic support for plhiv	4	26	2	7.7
Pre-ART care	9	16	12	75.0
Inpatient care	3	13	2	15.4
OI prophylaxis	2	11	5	45.5
Linkage to care	2	6	6	100.0
Blood safety	2	5	3	60.0
CD4 monitoring	1	5	5	100.0
Pre-exposure prophylaxis	1	5	1	20.0
Viral load monitoring	1	5	5	100.0
Post-violence care	1	4	4	100.0
Condom social marketing	1	2	2	100.0
Drug resistance surveillance	1	2	0	0.0
OI diagnosis and treatment	1	2	2	100.0
Patient tracking	1	2	2	100.0
Post-exposure prophylaxis	1	2	2	100.0
Female condom provision	1	1	1	100.0
Male condom provision	1	1	1	100.0
Provider training	1	1	1	100.0
Workplace service package	1	1	1	100.0
Total	159*	978	467	47.8

*Studies per intervention does not sum to the total studies examined as many studies cost activities in multiple intervention categories

2019 in this volume). Columns (3) and (4) of Table 5 show the number and proportion, respectively, of unit costs reported that include accompanying data on input costs of any amount. If input costs are not available for a unit cost we have recorded, this means that only one cost was provided by the original authors (the mean, or median, unit cost), without input costs or a description of inputs sufficient to calculate input costs from the percentages of the total represented by those inputs.

The interventions with the highest numbers of studies reporting unit cost data (in order of the quantity of that data) are Adult ART, HIV Testing and Counseling (HTC), Voluntary Medical Male Circumcision (VMMC), and Prevention of Mother-to-Child Transmission (PMTCT). Among these, both Adult ART and VMMC report input cost data for about 60% of all cost data, while less than half of unit cost reports for HTC and PMTCT include accompanying input cost data. The remaining categories are heterogeneous in terms of author reporting on input costs – some categories, like Pediatric ART are low (16%), while others, like Supply Chain Management (100%), have much greater reporting of cost inputs. However, most interventions offer a paucity of costing data compared to the first four, so examination of trends is limited.

Reporting standards and key characteristics

Finally, we examine a few key elements of costing publications that might indicate greater precision and completeness in reporting standards. These include the number of sites reported per unit cost, as well as three key characteristics for valid interpretation, analysis and potential extrapolation of unit costs to other settings. We review each of these in turn.

Reporting standards

First, we examine the number of sites per unit cost report. In many cases a site represents one facility or platform like a hospital, clinic or a particular type of field-based location in which intervention services were provided.

Table 6: Number of sites per unit cost observation

Number of sites	Unit costs	Per cent of total
Not reported	120	12.27
1	468	47.85
2	36	3.68
3	35	3.58
4	29	2.97
5	46	4.70
6	17	1.74
7	26	2.66
8	12	1.23
9	17	1.74
10	15	1.53
11–20 sites	41	4.19
21–30 sites	50	5.11
31–40 sites	4	0.41
41–50 sites	12	1.23
50–100 sites	48	4.91
100+ sites	2	0.20

As seen in Table 6, we find that the majority (87.7%) of reported unit costs include a description of the number of sites represented by the unit cost, or at least enough information for our extractors to interpret a site count for a given cost. In only around 12.3% of the unit costs reported is there insufficient information to determine the number of sites represented by a unit cost. Nearly half of all unit costs extracted (47.9%) are from a single site, and 55.1% are from 3 sites or fewer. Meanwhile, about a third of all costs are averages from four or more sites, with two extreme high values of 158 and 400 sites per unit cost.

Through analyses conducted in several other ongoing publications, the GHCC has identified three key variables related to quality reporting standards which are critically important predictors of unit cost. Among these are: *urbanicity* – whether a site is located in a rural, urban, or peri-urban locale; *ownership* – whether a given site is public, private, non-profit or an international NGO; *platform type* – including several broad categories like health care facilities (e.g. hospitals, clinics, and imbedded clinics), outreach (e.g. mobile clinics, temporary sites, and at-risk settings), community based sites (e.g. school, community centers, and workplace), population-wide, laboratory setting, or other. Complicating matters, we observe that because multiple sites are often represented by a unit cost, each of these three variables could be a mixture of multiple categories within a characteristic. For example, some unit costs may contain cross delineations between categories like both private and public platforms, or both urban and rural sites.

In Table 7 we report on the frequency of unit costs reporting for each of these three characteristics (urbanicity, ownership, and platform type). We indicate whether there is sufficient information for a unit cost to be categorised into any of the established categories within each of the key characteristics, whether a cost representing multiple sites is a mix of different categories, or whether insufficient information is reported to characterise that cost at all.³ We find that reporting on urbanicity is sufficient to categorise observations into discrete rural, urban, or peri-urban sites in 65% of cases, and in an additional 26% unit costs represent multiple locales that span categories of urbanicity. Overall, 9% of unit costs we collected could not be categorised at all in terms of urbanicity. In terms of ownership, a higher overall percentage of unit cost reports (76.8%) can be categorised, and an additional 16.3% span multiple categories, while 7% have no information. For platform type, the distributions were similar, while the total number not reporting information on the nature of the platform

Table 7: Reporting on key characteristics

	Categorised	Mixed	Not reported
Urbanicity			
Number	636	254	88
Per cent	65.0%	26.0%	9.0%
Ownership			
Number	751	159	68
Per cent	76.8%	16.3%	7.0%
Platform type			
Number	705	220	53
Per cent	72.1%	22.5%	5.4%

was the smallest of the three characteristics (5.4%). It is worth noting that for analysis to utilise all three of these characteristics, the most useful observations have clear reporting in terms of all three variables. We examine this potential for maximum usefulness, and find that out of 978 unit costs reported, 557 (or only 57%) have sufficient detail in all three categories to characterise a unit cost across all three characteristics.

Scale

Finally, we examine the availability of information on the scale (or output quantity) provided by study authors for each unit cost observation. Scale is an important characteristic of cost reporting because it provides key information about the number of units of output produced (e.g. patients served over time) for a reported cost. We find that for the 978 unit costs reported for interventions in sub-Saharan Africa, scale information was not available for more than half of cost reports (55.6%). Table 8 explores the number of unit costs reporting scale by intervention. Some interventions contain better scale reporting than others, though most of these contain very few articles and thus very few unit costs in total. Those interventions containing the largest number of studies and unit costs (Adult ART, HTC, VMMC, PMTCT) each have a low overall percentage of costs that include scale (35.0%, 25.8%, 57.0% and 17.4%, respectively).

Discussion

After reviewing the available published cost data on HIV interventions from sub-Saharan Africa we find a number of interesting trends. In terms of geographic distribution of evidence, we find that a great deal of cost data are available in some of the most populous nations on the continent, as well as those with the highest HIV burden. This information is key for providing the most relevant information to decision makers with influence over the largest vulnerable populations. However, the relative scarcity of cost data on interventions from a large number of other countries creates challenges, and places greater pressure on the accuracy and reporting quality of studies from some of the more densely populated and researched locations. Of greater concern is the relative lack of cost reporting from countries in western Africa. With a lack of cost data in many countries, there is greater concern about projecting costs to those settings using available data.

Publication rates have increased over the last 10 to 15 years. Much of this increase can be attributed to the production of grey literature, though peer-reviewed journals are still the medium of choice for study authors. Since just a few journals are responsible for a large share of this published evidence, we argue that a greater emphasis could be placed on the publication of cost data by the editors of other high-ranking public health and economics journals.

Table 8: Scale reporting by intervention

Intervention	Studies	Unit costs (n)	Reporting scale (n)	Reporting scale (%)
Adult ART	49	234	82	35.0
HIV testing and counselling	25	182	47	25.8
Voluntary medical male circumcision	31	100	57	57.0
Prevention of mother-to-child transmission	11	86	15	17.4
Service packages for key populations	8	53	6	11.3
Paediatric ART	12	50	40	80.0
HIV/TB care delivery	4	39	39	100
Information, education and communication	8	37	19	51.4
Retention and adherence	2	29	28	96.6
Supply chain management	3	29	27	93.1
STI management	4	29	17	58.6
Socio-economic support for PLHIV	4	26	2	7.7
Pre-ART care	9	16	12	75.0
Inpatient care	3	13	13	100
OI prophylaxis	2	11	0	0
Linkage to care	2	6	6	100
Blood safety	2	5	5	100
Pre-exposure prophylaxis	1	5	5	100
CD4 monitoring	1	5	0	0
Viral load monitoring	1	5	0	0
Post-violence care	1	4	4	100
Condom social marketing	1	2	2	100
OI diagnosis and treatment	1	2	2	100
Patient tracking	1	2	2	100
Post-exposure prophylaxis	1	2	2	100
Drug resistance surveillance	1	2	0	0
Provider training	1	1	1	100
Workplace service packages	1	1	1	100
Female condom provision	1	1	0	0
Male condom provision	1	1	0	0
Total	159	978	434	44.4

Further, the publication of evidence that is open-source makes for greater circulation and accessibility of this evidence by decision makers who may lack extensive and expensive library access through educational institutions. We also note that an increase in high quality grey literature evidence could be further promoted by global health institutions. Finally, given the quantity of evidence that comes from studies of cost-effectiveness and cost-utility, we argue that engagement with authors of these studies in addition to those producing purely 'costing' research is essential.

Authorship trends seem to suggest that most first authors of costing and cost-effectiveness studies reporting cost data are still located in countries other than those under study (most often in the US and Western Europe). Nonetheless, more than half of study authors report affiliations within the countries under study, and a large share of all authors are affiliated with institutions within sub-Saharan Africa. It is also unclear whether there is a strong relationship between author institutional affiliation and the consumption of evidence by key decision makers within that country, however our findings suggest that the majority of those producing cost evidence maintain affiliations within the countries from which that evidence was collected.

In terms of publication statistics, the time between end-line data collection and publication may be an indicator of the overall timeliness of unit costs entering the public realm but does not necessarily reflect the extent to which authors make their data publicly available to decision makers through other mechanisms before a final journal article goes to print. Further, an increase in the production of grey literature may be a response to the relatively slow production of peer-reviewed data, or it may simply reflect a growing interest in the commissioning of such research by institutions with less interest in scholarly publication. Further, it is unclear whether the impact factor of journals in which cost data are reported is an accurate reflection of the potential quality or reach of that evidence (especially if publications remain behind pay walls).

There is a relative lack of data in two of five broad intervention categories, namely enablers and health systems interventions. More costing of these activities seems warranted. However, data do seem to be available in mostly equal parts between prevention, testing and treatment. We find a relative lack of data for testing but speculate that this may be because many programmes that would be coded as prevention now involve testing – in other words, testing seems to be examined less often in isolation for HIV interventions. However, scarcity of data could still be problematic for representation of different kinds of narrow intervention categories. Most available cost data is concentrated in studies of interventions in just a few intervention (ART, VMMC, HTC, PMTCT), while a large share of intervention categories (e.g. CD4 monitoring, pre-exposure prophylaxis, viral load monitoring, patient tracking, etc.) contain very little cost data. Furthermore, in this report, we only include the number of observations of published studies and unit cost reports from 30 interventions for which we have data available. In Table 5 we do not show the resounding lack of evidence across 22 other pre-defined intervention types that were included in our systematic search criteria (see DeCormier Plosky et al., 2019 for a

complete list). In other words, there are 22 other intervention categories for which there are no cost data available.

In terms of the availability of input costs, it is troubling that less than half (47.8%) of unit costs reported across our sample include input cost reporting by authors. The number of sites per unit cost report is another area of interest in terms of data quality. Estimates that average from across a large number of sites could be considered to provide a better reflection of the average unit cost of a particular intervention or activity. However, unit cost reporting that only includes these aggregates threatens to mask important variation in unit cost reporting that might reveal important trends in terms of key reporting variables such as urbanicity platform type, and ownership.

Encouragingly, the number of sites represented by each unit cost is reported or can be inferred in a majority of cases (87.7%). We caution, however, that it is possible that the number of sites may not be applicable for all studies – not all interventions are implemented in static facilities (for example, those utilising tv, radio and social media). In terms of promoting confidence in unit costs that *do* report a number of sites, about a third of all costs (overall) include more than three, but the majority still provides estimates from three or fewer sites. However, having more sites doesn't necessarily lead to an increase in the quality of available data. Indeed, the low number of sites per unit cost report may be due in part to our extraction procedures, which favored more granularity in the extraction of cost reports for the sake of analysis and extrapolation. Thus, some unit cost estimates that possibly included more site observations may have been excluded in favor of those with fewer, to avoid double-counting. However, this extraction prioritisation happened in a minority of instances.

We are encouraged that a majority of studies include sufficient information to determine urbanicity, platform type and ownership of unit cost observations – however, we caution that reporting on these characteristics was extremely inconsistent. In many articles in which we had success providing appropriate coding, this was only after searching for information on specific facilities through separate channels (i.e. by contacting original authors or looking online). In future, authors should be sure to provide as much detail as possible regarding these characteristics in their reporting. Furthermore, we find that only about half of unit cost observations contain sufficient information for all three categories to be useful for analysis. In the other half of cases unit costs are mixed in one or more of these categories (report average costs across different platform types, levels of urbanicity, or types of ownership). Therefore, we also encourage authors to consider providing averages of unit cost estimates with these three variables in mind to maximise the usability of their cost data for analysis by others – especially in the absence of underlying data being published with the article.

Finally, we find that the relative lack of information on scale is disturbing. Indeed, there should be a drastic increase in the proportion of costing studies reporting information about the output quantity in their cost measurements. Without this key information, the quality and generalisability of cost reporting suffers tremendously.

Conclusion

Our review of the existing costing literature in sub-Saharan Africa reveals a number of important trends and suggests several paths forward in producing more timely, detailed cost data to improve HIV budgeting and decision making. Our recommendation is a renewed emphasis among study authors on the importance of transparency and improved reporting of both cost estimates and supporting contextual information. We recommend that future costing and cost-effectiveness studies closely follow the GHCC reference case and adhere to the reporting checklist for best practices (Vassall et al., 2017). In particular, we point to the need for the production of more unit cost data of HIV interventions in west Africa. Further, we encourage more detailed reporting of input costs and greater specificity across dimensions of cost reporting including the number of sites per estimate, the level of urbanicity of the locale, ownership classification (public, private, etc.) and the platform type (hospital, clinic, etc.) of each reported observation. Finally, this review provides clear evidence of the urgent need for a renewed focus on the accurate reporting of scale by authors of cost and cost-effectiveness studies, which we find to be severely lacking across the literature.

Notes

- 1 In total, we collected 20 unit cost observations from seven studies published in 2018.
- 2 For completeness of reporting in our Unit Cost Study Repository, we record the year of publication minus one when end-line date is unavailable. In this analysis we exclude those observations for clarity.
- 3 In the discussion section we elaborate on some of the difficulties encountered with author reporting when trying to code studies within these categories.

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References

- Avenir Health. (2013). Unit cost repository [online]. Glastonbury, USA: Avenir Health. <http://policytools.avenirhealth.org/UC/>
- Beck, E. J., Fasawe, O., Ongpin, P., Ghys, P., Avilla, C., & DeLay, P. (2013). Costs and cost-effectiveness of HIV community services: Quantity and quality of studies published 1986–2011. *Expert Review of Pharmacoeconomics & Outcomes Research*, 13(3), 293–311. <https://doi.org/10.1586/erp.13.28>
- Beck, E. J., Harling, G., Gerbase, S., & DeLay, P. (2010). The cost of treatment and care for people living with HIV infection: Implications of published studies, 1999–2008. *Current Opinion in HIV and AIDS*, 5(3), 215–224. <https://doi.org/10.1097/COH.0b013e32833860e9>
- Beck, E. J., Miners, A. H., & Tolley, K. (2001). The cost of HIV treatment and care. A global review. *PharmacoEconomics*, 19(1), 13–39. <https://doi.org/10.2165/00019053-200119010-00002>
- DeCormier Plosky, W., & Bollinger, L. A. (2012, July) A quality review process for HIV prevention costing studies in developing countries. Presentation at the IAEN 7th AIDS and Economics pre-conference, Washington DC. http://www.iaen.org/library/Presentation_2_Willyanne_Plosky.pdf
- DeCormier Plosky, W., Bollinger, L. A., Alexander, L., Cameron, D. B., Carroll, L. N., Gomez, G. B., ... Kahn, J. G. (2019). Developing the Global Health Cost Consortium unit cost study repository for HIV and TB: methodology and lessons learned. *African Journal of AIDS Research*, 18. <https://doi.org/10.2989/16085906.2019.1680398>
- Galarraga, O., Wirtz, V. J., Figueroa-Lara, A., Santa-Ana-Tellez, Y., Coulibaly, I., Viisainen, K., Medina-Lara, A., & Korenromp, E.L. (2011). Unit costs for delivery of antiretroviral treatment and prevention of mother-to-child transmission of HIV – a systematic review for low- and middle-income countries. *Pharmacoeconomics*, 29(7), 579–599. <https://doi.org/10.2165/11586120-000000000-00000>
- Kates, J., Wexler, A., Lief, E., & UNAIDS. (2017). Donor government funding for HIV in low- and middle-income countries in 2017. Washington, DC: Henry J Kaiser Family Foundation. Retrieved from <http://files.kff.org/attachment/Report-Donor-Government-Funding-for-HIV-in-Low-and-Middle-Income-Countries-in-2017>
- Maheswaran, H., Petrou, S., MacPherson, P., Choko, A. T., Kumwenda, F., Lalloo, D. G., ... Corbett, E. L. (2016). Cost and quality of life analysis of HIV self-testing and facility-based HIV testing and counseling in Blantyre, Malawi. *BMC Medicine*, 14, 34. <https://doi.org/10.1186/s12916-016-0577-7>
- Maheswaran, H., Clarke, A., MacPherson, P., Kumwenda, F., Lalloo, D. G., Corbett, E. L., & Petrou, S. (2018). Cost-effectiveness of community-based human immunodeficiency virus self-testing in Blandyre, Malawi. *Clinical Infectious Diseases*, 66(8), 1211–1221. <https://doi.org/10.1093/cid/cix983>
- Meyer-Rath, G., van Rensburg, C., Chiu, C., Leuner, R., Jamieson, L., & Cohen, S. (2019). The per-patient costs of HIV services in South Africa: Systematic review and application in the South African HIV Investment Case. *PLoS One*, 14(2), e0210497. <https://doi.org/10.1371/journal.pone.0210497>
- Miller, T., Hallfors, D., Cho, H., Luseno, W., & Waehrer, G. (2013). Cost-effectiveness of school support for orphan girls to prevent HIV infection in Zimbabwe. *Prevention Science*, 14(5), 503–512. <https://doi.org/10.1007/s11121-012-0315-0>
- Resch, S., Ryckman, T., & Hecht, R. (2015). Funding AIDS programmes in the era of shared responsibility: An analysis of domestic spending in 12 low-income and middle-income countries. *The Lancet. Global Health*, 3(1), e52–e61. [https://doi.org/10.1016/S2214-109X\(14\)70342-0](https://doi.org/10.1016/S2214-109X(14)70342-0)

- Siapka, M., Remme, M., Obure, C. D., Maier, C. B., Dehne, K. L., & Vassall, A. (2014). Is there scope for cost savings and efficiency gains in HIV services? A systematic review of the evidence from low-and middle-income countries. *Bulletin of the World Health Organization*, *92*, 499–511. <https://doi.org/10.2471/BLT.13.127639>
- UNAIDS. (2018). *UNAIDS data 2018*. Geneva: UNAIDS. <https://www.unaids.org/en/resources/documents/2018/unaids-data-2018>
- Vassall, A., Sweeney, S., Kahn, J.G., Gomez, G., Bollinger, L., Marseille, E., Herzel, B., DeCormier Plosky, W., Cunnam, L., Sinanovic, E., Bautista-Arredondo, S., GHCC technical advisory group, GHCC stakeholder group, Harris, K., & Levin, C. (2017). *Reference case for estimating the costs of global health services and interventions* [working paper]. Global Health Cost Consortium. Retrieved from https://ghcosting.org/pages/standards/reference_case
- Visscher, S., Naessens, J., Yawn, B., Reinalda, M., Anderson, S., & Borah, B. (2017). Developing a standardized health care cost warehouse. *BMC Health Services Research*, *17*, 396. <https://doi.org/10.1186/s12913-017-2327-8>