

Unit costs of health services provided at hospitals and health centres in two provinces of Zambia

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Abstract: In Zambia, information on cost of services provided at health facilities are deficient. This study aims to contribute to fill this knowledge gap by estimating the unit costs of health services provided at different levels of health facilities. This costing exercise used cross-sectional data for the year 2016. Fourteen facilities were purposefully selected to represent different levels of health facilities and mix of characteristics. We used an accounting-based approach to calculate the unit costs of health services. Specifically, we employed the top-down approach to allocate total overhead costs incurred over to different services that were provided at the facility. Full costs of health facilities varied substantially between different levels, and even between facilities within the same level (particularly between health centres). The compositions of cost items within any facility were largely dominated by labour and material costs, each of which contributing approximately half the shares, whilst the proportion of capital costs remained small irrespective of the levels. Unit costs of outpatient services in the health centres ranged from ZMW 15 (USD 1.3) to ZMW 30 (USD 2.7) without medical consumables, while inpatient costs were between ZMW250 (USD 22.2) and ZMW 1,300 (USD 115.6) per admission and ZMW 140 (USD 12.4) to ZMW 500 (USD 44.4) per bed-day. Unit costs between services provided at the same facility exhibit fairly comparable pattern. The findings from this study provides useful information of unit costs for referencing in future studies. Further, the variations of unit costs among facilities with different characteristics provides policy relevant information for health administrators and policy makers.

Keywords: unit costs, health services, top-down, Zambia

Introduction

The Ministry of Health in Zambia (MOH) launched the National Health Care Package (NHCP) in 2016 which specified the basic and essential health care packages to be provided at different levels of health care. Zambia spends between 7 and 8% of its total national budget on health. In 2020, the total health expenditure amounted to USD 1,017 million which was about 5.6% of gross domestic product (GDP), and health allocation from the government's domestic revenue was USD 442 million, approximately 7% of general government expenditure and 2.4% of GDP (1). This falls short of the recommended government health expenditure (*i.e.*, at least 5% of GDP) (2), and remains unknown what extra resources are needed in providing services included in the NHCP since the package was not costed. Cost information of health services provide critical intelligence for health administrators for planning and

budgeting process. Without such information, planners are not able to make appropriate budgeting and allocate health resources to health facilities and services in an efficient way. In Zambia, health care costs have not been examined rigorously, up-to-date information on unit costs of health services are critically deficient.

Unit costs of health services are context-specific that is affected by multiple factors, and hence is not appropriate to assume the same cost information to be applicable from other countries. Therefore, it is critical to calculate the costs of health services in Zambia. Cost information can be used in various aspects of policy decisions: allocating resources to health facilities and services, calculating user fees where relevant, assessing relative efficiency of health care services in economic evaluation, and overall budgeting (3-6). In Zambia, information on unit costs could potentially be used for the costing of NHCP, National Health Strategic Plans (NHSP), National Health Insurance (NHI) services

and Medium Term Budget Frameworks (MTBF) particularly for services provided at the first level and below for which information is critically missing.

This study was conducted as part of an overarching technical assistance project undertaken by the MOH in collaboration with Japan International Cooperation Agency, which aimed to develop the managerial capacity of provincial and district health authorities in selected geographic areas: Lusaka and Chongwe Districts from Lusaka Province, and Choma and Kalomo districts of Southern Province (7). The aim of the study was twofold: first to estimate the unit costs of health services provided at different levels of health facilities in the target districts; and secondly, to compare the unit costs between facilities that have different characteristics. The study sample was purposefully selected to cover different levels and mix of characteristics including urban vs. rural, large vs. small, and high vs. low-volume caseload of specific services (birth, diagnostic services, etc.) at different levels. One health post, eight health centres, three first-level hospitals and two third-level hospitals were selected for the cost analysis. Table 1 lists the health facilities that were included. The study was cross-sectional using data from the year 2016. The currency rate adopted was 1 USD = 11.25 Zambian Kwacha (ZMW) in June 2016.

Materials and Methods

There are broadly two approaches that have been popularly used to estimate costs within healthcare: top-down and bottom-up (8). Top-down assigns and allocates total overhead costs incurred over a given time period to different services that are provided at a facility using a predefined set of rules (9,10). Bottom-up approach relies on detailed activity and input data at the service provider level to estimate unit costs (11). While an alternative bottom up method has been reported to produce more accurate estimates (12),

it is also considered more time demanding, specific to the setting and expensive to undertake (13,14). In the context of this study, we opted for the top-down approach. Under this approach, there were various steps involved in the assignment and allocation of costs into various cost centres including administrative services, ancillary services, patient services and non-patient services. Figure 1 provides the sequence of how costs were assigned and allocated to different cost centres.

The analytical process comprised three steps: defining cost centres; determining direct costs; and allocating direct costs to intermediate and final cost centres.

Step 1: Defining cost centres

This process was conducted by discussing with various stakeholders including officials from the District Health Offices (DHOs) such as the Planners, Human Resource Officers and Information Officers, and members from the hospitals (Administrators and Information Officers). Table 2 provides the list of identified cost centres.

Step 2: Determining direct costs

In this step, each cost item was assigned to a specific cost centre by certain rules to establish the "total direct cost" of each cost centre. Some of the cost items were straight forward in assigning to a cost centre, while others were more complicated. For instance, the cost of a drug that was used for anti-retroviral treatment (ART) were assigned to the cost centre "ART service". On the other hand, when assigning the cost of utility such as electricity and water, it was not immediately obvious how much of the total amount was used for which cost centre. For such items, a certain rule must be predefined how to assign the costs to each cost centre (e.g., proportionally based on the floor space of each cost centre). The following sections divide the cost items into three broad categories (i.e., labour cost, material

Table 1. Health facilities included in the study

Province	District	Health facility	Type of facility
National	Lusaka	UTH, Paediatrics Hospital	Third-level
	Lusaka	UTH, Women & Newborn Hospital	Third-level
Lusaka	Lusaka	Chilenje Hospital	First-level, urban
	Chongwe	Chongwe Hospital	First-level, peri-urban
	Lusaka	Mtendere Health Centre	Urban, large
	Chongwe	Chongwe Health Centre	Urban, medium-size
	Chongwe	Kanakantapa Health Centre	Zonal, medium-size
	Chongwe	Shiyala Health Post	Rural, small
Southern	Kalomo	Kalomo Hospital	First-level, rural
	Choma	Shampande Health Centre	Urban, medium-size, lab high-volume
	Choma	Mapanza Health Centre	Zonal, medium-size
	Choma	Popota Health Centre	Rural, small
	Kalomo	Chilala Health Centre	Zonal, medium-size
	Kalomo	Kanchele Health Centre	Rural, small, birth high-volume

UTH: University Teaching Hospital.

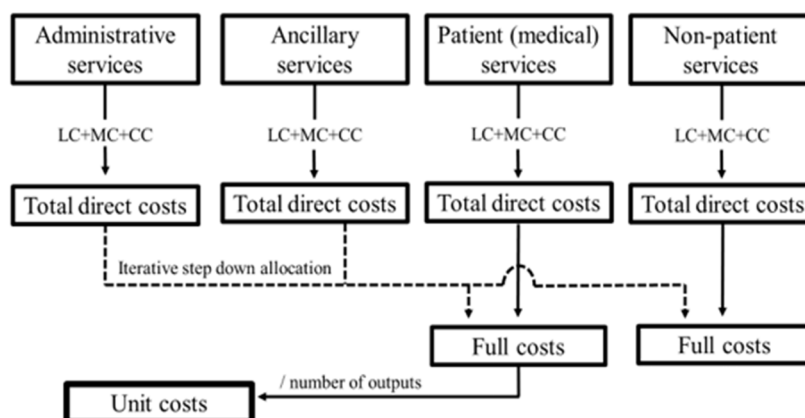


Figure 1. Conceptual framework of assignment and allocation of health facility costs.

Table 2. List of cost centres

Service	Health centre/health post	First level	Third level (paediatrics)	Third level (women & new born)
Admin	Administration General work	Administration	Administration	Administration
		Human resource	Human resource	Human resource
		HMIS	HMIS	HMIS
		Account	Account	Account
Ancillary	Pharmacy Laboratory Labour room Operating room	Procurement	Procurement	Procurement
		Pharmacy	Pharmacy	Pharmacy
		Laboratory	Laboratory	Laboratory
		Labour room	Radiology	Labour room
		Operating room		Operating room
Patient (outpatient)	OPD general ART ANC/PNC Under five Family planning Nutrition TB Surgery Dental Physiotherapy	OPD general	OPD paediatrics	ANC/PNC
		ART		PMTCT
		ANC/PNC		Neonatal
		Family planning		
		Nutrition		
		TB		
		Surgery		
		Dental		
		Physiotherapy		
		Patient (inpatient)	IPD general Obstetrics Paediatrics	IPD general (male)
IPD general (female)	PICU			Gynaecology
Obstetrics	Nutrition			Neonatal
Paediatrics	TB			NICU
Non-patient	Environ. health Outreach	Environ. health	Special (kidney)	
		Outreach		

ANC: antenatal care; ART: anti-retroviral therapy; HMIS: health management and information system; IPD: inpatient department; NICU: neonatal intensive care unit; OPD: outpatient department; PICU: paediatric intensive care unit; PMTCT: prevention of mother to child transmission; PNC: postnatal care; TB: tuberculosis.

cost and capital cost) and provide details of how each cost item was assigned.

Labour costs included salary of staff members at health facilities, allowances (housing, transport, hardship, etc.) and also daily subsistence allowance (DSA). Salaries were standardised for cadres, so we obtained information about the position of each staff member from the health facilities and matched with the salary specified in the standard salary scale of the MOH. Information on allowances were obtained from the Human Resource section of the DHOs or hospitals.

Information on DSA was a major challenge as such information was not recorded in official document or data base. We obtained this information through interviews with individual staff members and In-Charges from the health facilities.

Staff members at health facilities were typically involved in multiple tasks that cut across different cost centres. It was therefore not straight forward to assign individual labour costs to different cost centres. To work out the proportion of contributions of individuals to each cost centre, we interviewed the In-Charges from

each facility or department to provide an estimate of the proportion of time each staff member spent for each service (cost centre). This was not an easy undertaking as such an exercise is prone to a major recall bias. In many cases, estimating the proportion of time spent for each cost centre proved difficult. If the estimates did not seem plausible, we interviewed the individual staff members to verify the estimates provided by the In-Charges. Further, in some cases, adjustments were made by pooling and splitting the total time spent proportions within each of the four-broad cost centre classification (*i.e.*, administrative, ancillary, outpatient, inpatient and non-patient services) based on common units such as number of visits, tests, bed-days, *etc.* This adjustment implicitly assumed that the time spent on each unit of output within the broader cost centre classification was the same regardless of the services provided. This issue was a challenge particularly for smaller facilities (as the staff members were more likely to be engaged in multiple services) than larger ones (where staff members were more specialised and assigned to a specific service centre).

Material costs comprised drug, vaccine, medical and non-medical supplies (< ZMW 1,000 (USD 88.9)), utility, fuel, maintenance of building and equipment. Data for each item came from different sources that are summarised in Supplemental Table S1 (<https://www.ghmopen.com/site/supplementaldata.html?ID=87>).

Amongst the material cost items, utility, fuel, general supplies and general maintenance costs were all assigned to "administration" that became subjects for further allocation to other cost centres in the subsequent steps. Drugs, vaccines and medical supplies were directly assigned to the relevant cost centres where those items were actually used (ancillary, outpatient, inpatient and non-patient services). While the issuance of those items was generally recorded in the stock control cards, information where those items were actually used was almost totally missing. Therefore, the assignment of those items had to rely on certain assumptions. A physician (YY) from the research team was tasked to develop a matrix that specified which drug and supply items were likely to have been used in which cost centres. Based on the matrix, the total quantity of each drug and item was proportionally assigned to each identified cost centre based on the number of outputs (test, visit, and bed-day). On the other hand, the cost centres were self-evident for some drugs and supplies such as those for ART, TB treatment or malaria diagnosis.

One major challenge related to the quantification of drug consumption was that many stock control cards did not specify the number of tablets, capsules or blisters per container/package. The actual and calculated quantities varied by a factor of 10 or 100 if the correct units were not used. We minimised such errors by asking the pharmacists, referring to the Medical Stores

Limited (MSL) catalogue and comparing with the actual number of patients. Prices of drugs were mostly available from the MSL catalogue. In case the price of a drug was not listed in the catalogue, we referred to the International Medical Products Price Guide to obtain the reference price, with preference put on price from South Africa.

Capital costs comprise building, medical and non-medical equipment (\geq ZMW 1,000 (USD 88.9)) amounts above this threshold are considered capital cost) and transport facilities. As capital assets are purchased at one point of time but used over several years, allocation of costs required some computations. We calculated the cost of capital assets for 2016 by means of annuitisation using the following formula (15):

$$K = \frac{E(1 - (1 + r)^{-i})}{r}$$

where K is the cost of a capital asset, E is the equivalent annual cost of the asset (we have solved for this), r is the interest rate and i is the number of useful years of that asset. We assumed 3% for r and obtained information of i from the "Estimated useful lives of depreciable hospital assets" (16).

Obtaining price information of capital assets at the time of acquisition proved problematic. Therefore, we decided to use the replacement costs of the assets during the study year (2016). We used the market price of equipment collected in 2017, which was inflation-adjusted for year 2016. Construction costs of building was not available, so we obtained the standard construction cost of a standard health centre to calculate the average cost per square meter from the Department of Physical Plant and Medical Equipment, MOH (calculated as ZMW 350 (USD 31.1) per m^2 in 2017, which was adjusted for inflation). Land cost was not included in the cost estimation as it was very difficult to obtain information of price and difficult to determine the land area of health facilities.

Cost of transport facilities were assigned to "administration". Equipment costs were assigned directly to the cost centre where each equipment was used. Information of the presence and quantity of equipment was obtained from inventory list where applicable, but most information was collected by the enumerators through direct observation and physical counting. Building cost was proportionally assigned to each cost centre based on floor spaces occupied by each cost centre. Floor space of each cost centre was physically measured by the enumerators.

Step 3: Allocating direct costs to intermediate and final cost centres

Once all cost items were assigned to one of the cost centres, the next step was to allocate the overhead costs to the intermediate and final cost centres. A stepdown

method with iteration was employed for this process (15). The iterative stepdown approach allocates each overhead cost item (*i.e.*, administrative and ancillary services) to all relevant cost centres that benefit from those services based on a pre-defined set of criteria. The criteria for the allocation of each overhead cost item are provided in Supplemental Table S2 (<https://www.ghmopen.com/site/supplementaldata.html?ID=87>).

Step 4: Full cost determination and unit cost calculation

After the allocation of overhead costs, full costs were determined for each cost centre of ancillary services, patient services and non-patient services in the following forms: *i*) with and without variable costs (*i.e.*, drugs, vaccines and medical supplies), *ii*) with and without allocation of costs of ancillary services (for patient and non-patient services).

Unit costs were calculated for all patient services (and for selected ancillary services) by dividing the full costs by the corresponding volume of outputs. The unit

of outputs for each service were: *i*) number of visits (for outpatient services), *ii*) number of admissions and bed-days (for inpatient services), *iii*) number of tests, imaging and examination (for laboratory, radiology and ultrasound)

Results

Descriptive statistics of health facilities

Table 3 provides general information of each health facility showing the level of health care, the number of staff attached to the facility and the volume of health services provided in terms of outpatient visits, admissions and laboratory tests conducted.

Full cost and cost breakdown

Figure 2 provides the full costs of health facilities. Full costs of health facilities varied substantially between different levels, first level hospitals incurred higher

Table 3. General information of health facilities

Level of facility	Name of facility	Number of staff	Total number of outpatient visits	Total number of inpatient admissions	Total number of lab tests
Third	UTH (women & newborn)	489	23,041	41,396	39,509
	UTH (paediatrics)	439	30,925	25,079	25,642
First	Chilenje Hospital	167	249,648	6,289	80,902
	Chongwe Hospital	121	23,796	6,042	11,796
	Kalomo Hospital	59	87,975	4,595	15,690
Primary	Mtendere HC	122	222,625	2,501	28,599
	Chongwe HC	29	91,087	307	17,961
	Kanakantapa HC	20	26,465	413	3,774
	Shampande HC	53	52,799	664	40,510
	Mapanza HC	14	29,780	635	4,140
	Chilala HC	9	26,358	641	3,776
	Popota HC	8	12,257	110	1,384
	Kanchele HC	4	34,433	718	5,625
	Shiyala HP	3	6,062	29	3,080

UTH: University Teaching Hospital; HC: health centre; HP: health post.

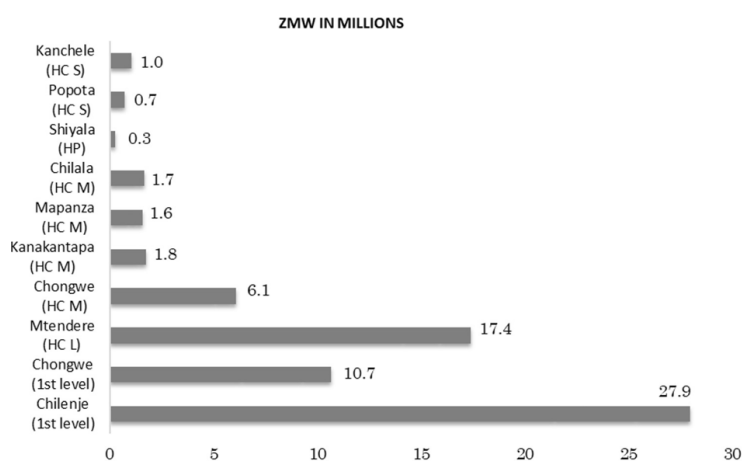


Figure 2. Total costs by facility.

costs and rural health centres the lowest.

A large portion of facility costs at all levels comprised labour and material costs, each of which contributing half the shares, whilst the proportion of capital costs remained small (Supplemental Figure S1, (<https://www.ghmopen.com/site/supplementaldata.html?ID=87>)).

However, there were some notable differences between the share of labour and material costs in some facilities. Figure 3 provides the share of each cost item.

A larger portion of costs at Chongwe Hospital and Popota HC comprised labour costs (65%-75%), while material costs dominated in Chongwe HC and Kanchele HC (around 67%). The share of capital costs was generally small at around 10%, yet with variations between 3% and 17%.

Unit cost of health services

The unit costs of health centres and health posts are provided in Tables 4 and 5 for Lusaka and Southern

Provinces, respectively. The unit cost of nutritional services at Mtendere HC in Lusaka Province was ZMW 828 (USD 73.6) per patient visit, which was considerably higher than those of other HCs in the same province. The unit cost of surgeries at Mtendere was also higher compared to Chongwe and Kanakantapa HC. Although there were no comparators among HCs, the unit cost of physiotherapy at Mtendere HC seemed substantially high, which was ZMW 1,455 (USD 129.3) per patient visit (this was also substantially higher than the first-level hospitals provided in Table 6 below). Regarding the inpatient care, the unit cost of delivery at Kanakantapa HC was twice as high as that of Mtendere HC and was one and a half times as high as that of Shiyala HP. The unit costs between three HCs and Shiyala HP were more or less similar.

With respect to the HCs in the Southern Province, the unit costs were relatively comparable to those in the Lusaka Province, except for Kanchele HC. Most unit costs, except for ART and surgery, at Kanchele HC were the lowest of all HCs and HPs examined in this

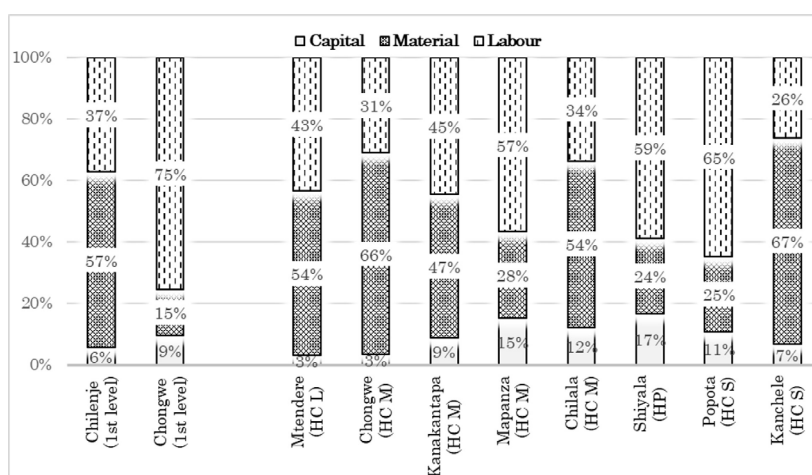


Figure 3. Facility Cost structure based on major line items.

Table 4. Unit costs of services at health centres/posts in Lusaka Province (ZMW)

Service	Unit	Mtendere HC	Chongwe HC	Kanakantapa HC	Shiyala HP
Laboratory	Test	13* (17)**	16 (18)	19 (23)	3 (8)
OPD general	Visit	24 (45)	25 (37)	27 (45)	33 (41)
ART	Visit	19 (105)	17 (103)	18 (125)	59 (78)
ANC/PNC	Visit	55 (58)	26 (28)	22 (24)	30 (36)
Under five	Visit	26 (34)	17 (33)	15 (24)	26 (33)
FP	Visit	24 (36)	17 (25)	15 (25)	26 (33)
Nutrition	Visit	828 (828)	17 (18)	15 (16)	26 (26)
TB	Visit	34 (151)	34 (149)	72 (188)	19 (135)
Surgery	Visit	355 (384)	107 (160)	257 (270)	-
Dental	Visit	89 (92)	-	-	-
Physiotherapy	Visit	1,455 (1,455)	-	-	-
IPD general	Admission/ bed-day	-	440 (490)/409 (455)	449 (471)/263 (276)	-
Obstetrics	Admission/ bed-day	372 (392)	-	780 (791)	468 (523)
Paediatrics	Admission/ bed-day	-	356 (397)/340 (380)	406 (419)/200 (206)	-

OPD: outpatient department; ART: anti-retroviral therapy; ANC: antenatal care; PNC: post-natal care; FP: family planning; TB: tuberculosis; IPD: inpatient department; HC: health centre; HP: health post. *Unit costs without variable costs (*i.e.*, drugs and medical supplies). **Unit costs with variable costs in parentheses. The currency rate was 1 USD = 11.25 Zambian Kwacha

study. For instance, laboratory services at Kanchele HC costed only ZMW 3 (USD 0.27) per test, which was just about 10% of that at Mapanza HC. The unit cost of general OPD was ZMW 15 (USD 1.33) per visit, which was a-third of those in other HCs such as Mtendere, Kanakantapa, or Popota.

The unit costs of first-level hospitals are provided in Table 6. By comparing the results with Tables 6 and 7, the unit costs of outpatient services at HCs and first-level hospitals were comparable, whereas costs of inpatient services were generally higher at first-level hospitals.

A comparison between Chilenje Hospital and Chongwe Hospital revealed that the unit costs at Chilenje Hospital were generally lower than those at Chongwe Hospital. For instance, the general OPD and family planning (FP) in Chongwe hospital costed more than three times of those at Chilenje Hospital. Unit costs at Kalomo Hospital lay somewhere in-between Chilenje

and Chongwe Hospitals including laboratory services, OPD general, ART, dental care. On the other hand, some services were considerably more costly at Kalomo Hospital such as TB and surgery while others were less particularly inpatient services.

The unit costs of third-level hospitals are provided in Table 7. Regardless of nature of services, the unit costs at the UTH were higher than those of the HCs or first-level hospitals, with a few exceptions. For instance, the unit costs of ANC/PNC services at the UTH Women and Newborn Hospital were more than six times higher than that of HCs or first-level hospitals. The inpatient TB care at the UTH Paediatrics costed the highest of all unit costs per admission estimated in this study, which was ZMW 5,789 (USD 514.6) per admission. The paediatric intensive care unit (PICU) costed the highest per bed-day, which was ZMW 1,162 (USD 103.3).

Table 5. Unit costs of services at health centres in Southern Province (ZMW)

Service	Unit	Mapanza HC	Chilala HC	Shampande HC	Popota HC	Kanchele HC
Laboratory	Test	28* (31)**	18 (21)	9 (-)	3 (7)	2 (3)
OPD general	Visit	24 (33)	19 (33)	14 (24)	34 (46)	6 (15)
ART	Visit	16 (-)***	17 (99)	27 (32)	-	8 (120)
ANC/PNC	Visit	47 (51)	29 (32)	24 (26)	31 (33)	10 (13)
Under five	Visit	18 (23)	12 (23)	13 (22)	29 (43)	6 (16)
FP	Visit	18 (30)	11 (41)	13 (22)	29 (45)	6 (7)
Nutrition	Visit	18 (18)	12 (13)	13 (14)	29 (29)	6 (6)
TB	Visit	16 (131)	18 (134)	13 (168)	26 (141)	7 (123)
Surgery	Visit	98 (116)	67 (148)	149 (171)	87 (237)	67 (202)
Dental	Visit	-	-	-	-	-
Physiotherapy	Visit	-	-	-	-	-
IPD general	Admission/ bed-day	451 (526)/243 (283)	498 (579)/79 (91)	-	-	317 (338)/119 (127)
Obstetrics	Admission/ bed-day	516 (533)	744 (767)	905 (927)	659 (668)	143 (155)
Paediatrics	Admission/ bed-day	451 (528)/223 (262)	276 (284)/223 (229)	-	-	209 (224)/72 (77)

OPD: outpatient department; ART: anti-retroviral therapy; ANC: antenatal care; PNC: post-natal care; FP: family planning; TB: tuberculosis; IPD: inpatient department; HC: health centre. *Unit costs without variable costs. **Unit costs with variable costs in parentheses. ***Information on ART drug consumption was not available. The currency rate was 1 USD = 11.25 Zambian Kwacha.

Table 6. Unit costs of services at first-level hospitals (ZMW)

Service	Unit	Chilenje Hospital	Chongwe Hospital	Kalomo Hospital
Laboratory	Test	12* (-)**	34 (-)	27 (-)
Radiology	Imaging	-	118 (135)	153 (156)
OPD general	Visit	28 (49)	141 (184)	75 (114)
ART	Visit	23 (155)	127 (205)	15 (81)
ANC/PNC	Visit	53 (57)	-	17 (18)
FP	Visit	42 (43)	92 (161)	17 (33)
Nutrition	Visit	72 (72)	-	11 (76)
TB	Visit	96 (225)	83 (199)	51 (121)
Surgery	Visit	413 (615)	627 (666)	1160 (1459)
Dental	Visit	93 (177)	137 (143)	68 (69)
Physiotherapy	Visit	219 (219)	111 (111)	260 (260)
IPD general (male)	Admission/ bed-day	995 (1,147)/187 (216)	1,329 (1,415)/487 (519)	383 (795)/138 (287)
IPD general (female)	Admission/ bed-day	893 (1,045)/152 (177)	1,134 (1,208)/484 (516)	386 (494)/243 (311)
Obstetrics	Admission/bed-day	351 (433)	660 (685)	267 (392)/178 (261)
Paediatrics	Admission/bed-day	938 (957)/289 (294)	1,127 (1,165)/516 (534)	791 (1142)/301 (435)

OPD: outpatient department; ART: anti-retroviral therapy; ANC: antenatal care; PNC: post-natal care; FP: family planning; TB: tuberculosis; IPD: inpatient department. *Unit costs without variable costs (*i.e.*, drugs, vaccines and medical supplies). **Unit costs with variable costs in parentheses. The currency rate was 1 USD = 11.25 Zambian Kwacha.

Table 7. Unit costs of services at third-level hospitals (ZMW)

Service	Unit	UTH Women & Newborn	UTH Paediatrics
Laboratory	Test	19*	19
Radiology	Imaging	-	88
Ultrasound	Examination	21	-
OPD paediatrics	Visit	-	239
ANC/PNC	Visit	313	-
PMTCT	Visit	617	-
Neonatal	Visit	671	-
IPD paediatrics	Admission/bed-day	-	1,360/405
PICU	Admission/bed-day	-	3,760/1,162
Nutrition	Admission/bed-day	-	1,482/99
TB	Admission/bed-day	-	5,789/367
Special (paediatrics)	Admission/bed-day	-	1,281/361
Obstetrics	Admission/bed-day	808/237	-
Gynaecology	Admission/bed-day	775/226	-
Neonatal	Admission/bed-day	833/231	-
NICU	Admission/bed-day	2,031/722	-

UTH: University Teaching Hospital; OPD: outpatient department; ANC: antenatal care; PNC: post-natal care; PMTCT: prevention of mother to child transmission; IPD: inpatient department; PICU: paediatric intensive care unit; TB: tuberculosis; NICU: neonatal intensive care unit. *Unit costs without variable costs (*i.e.*, drugs, vaccines and medical supplies). The currency rate was 1 USD = 11.25 Zambian Kwacha.

Discussion

Overall, the relative levels of unit costs between services provided at the same facility exhibited reasonably comparable pattern, albeit with some notable exceptions. For instance, unit costs without drugs and consumables for ANC/PNC, family planning, nutrition and TB were fairly similar within the same facility (an example of a notable exception includes nutrition in Mtendere HC), and the unit costs of OPD general tended to be higher. Among outpatient services, unit cost of surgery was consistently on the higher end followed by TB and ART if drugs were included. Inpatient services costed more than outpatient services as expected. This is consistent with other studies that have generally reported that inpatient departments consumed more resources than outpatient services (4,17).

It is plausible to conclude from these findings that resource allocation pattern within a facility was generally comparable to other facilities. For some notable exceptions, such as nutrition and physiotherapy in Mtendere HC, resources may have been disproportionately assigned to those services. For such irregular unit cost patterns within the same facility, it is recommended to review the balance between the resources allocated to those services and the actual number of patients utilising those services in comparison to other services. In some cases, discontinuing the provision of an expensive service may be considered by merging the service provision with another facility at the same or higher levels.

On the other hand, findings from the comparison of unit costs between facilities were mixed. Some services exhibited similar unit costs within the same levels, whilst others differed substantially. For instance, unit costs without drugs and consumables for ART at health

centres mostly fell in the range between ZMW 16 (USD 1.42) and 19 (USD 1.69). On the other hand, unit costs of outpatient surgery without drugs and consumables at health centres varied between ZMW 46 (USD 4.09) and ZMW 355 (USD 284). The reasons behind the substantial heterogeneity of unit costs between the same level of facilities can be multi-faceted, including difference in the number and compositions of staff members, size of facilities, number of patients, quality of care, amongst others (3,18,19).

Among the health centres, unit costs of services at Kanchele HC in Kalomo District were mostly lower than any other health centres. Kanchele is known as the hub for delivery in the Southern part of Kalomo District that managed 559 delivery cases in 2016 with just three professional staff members (midwife, nurse and environmental health technologist). The number of deliveries was considerably larger than others given the capacity of the facility. The relative quantity of outputs given the available input resources could be the main driver of the lower unit costs. In other words, efficiency is likely the key driver of the varied levels of unit costs between facilities at the same level. However, the term "efficiency" used here solely reflects the relationship between outputs and inputs that do not reflect quality and performance. In less densely populated rural areas, the establishment of a stand-alone facility can be warranted if access to health care will be significantly compromised in absence of that, even if the catchment population may be small. Such facilities may likely have higher unit costs of services, as the denominator of unit costs (*i.e.*, number of patient visits) will be smaller for the capacity. Similarly, the higher unit costs of Chongwe Hospital may be explained by the smaller number of patients given the district's proximity to Lusaka that may be more convenient to access for a sizable portion of the district's population. Nonetheless,

it is recommended to review the resource allocated if a particular service or facility has substantially higher unit costs than others, including number of staff and skill mix, capital assets and others. However, the reallocation of resources should be performed with caution so that the equitable access to health services would not be significantly compromised.

It is generally expected that the unit costs of services become higher as the level of facility moves up the hierarchy. This is not surprising given that facilities at higher levels deal with more severe and complex cases and require more intensive resources such as specialists. Comparing the overall unit costs between health centres, first-level hospitals and UTH, it is obvious that the overall levels of unit costs become higher as the levels become higher. The pattern is particularly prominent for inpatient services as the patients' severity levels can become substantially greater at higher levels requiring more complex, resource-intensive and specialised services. There is a similar pattern for outpatient services, though to a lesser extent than inpatients.

From the estimates, it is evident that unit costs at UTH are many-folds more expensive than those at lower levels. Although this may be caused by a combination of multiple factors, the higher costs should not be driven by the extensive resources directed towards treating less severe cases that can be managed at lower levels. Here, UTH has been arguably quoted as accepting all referral cases from Lusaka area that could have been managed by first-level hospitals. In this regard, the upgrade of five health centres in Lusaka to first-level hospitals was a significant step forward to improve the efficiency of service delivery. However, it is critical to have guidelines to foster appropriate decision-making for referrals to make the most out of this opportunity.

On the other hand, facilities at the lowest level may not necessarily have the lowest unit costs in providing the services. Shiyala HP was at the lowest level among the facilities included in this analysis. If we compare the unit cost estimates, they were generally more costly than health centres. This may be a case where economies of scale had a role to play. The relatively higher unit costs may be improved by gaining economies of scale through merger with other facilities. However, as mentioned earlier, such rearrangements should be carefully weighed against the potential compromise in efficiency and equitable access to health services (20).

Although this study was conducted to examine health facilities at different levels and characteristics using most detailed data that were available at the time of study, it is not without limitations. Here we describe the main challenges that we faced in estimating each of the three cost items: labour, material and capital costs. Whilst labour costs comprised nearly half the total

cost of health facilities, service-specific costs of labour were estimated by the time spent by staff members on each service at the facilities. It proved difficult for each staff member to recall the time spent for each service accurately, particularly for smaller and lower level facilities where individuals were more involved in multiple tasks than more specialised facilities at larger and higher levels. Therefore, we obtained the information of time spent in broader groupings such as ancillary services, outpatient services and inpatient services, and apportioned the staff time in each group to specific services by the relative size of outputs within the same service groups. This assumed that the time required to provide a unit output in each group (*e.g.*, one outpatient visit) was the same for all services in the group, and the relative difference in unit costs between those services were driven by the different resource use related to materials and capital assets.

Similar to labour costs, material costs comprised close to another half of the full costs of health facilities. The majority of material costs were drugs that were largely procured centrally and distributed to the health facilities nation-wide. While we obtained the quantity of drug consumptions from the stock records and prices from the price catalogue prepared centrally, some of the drugs were purchased at the district levels as emergency procurement. Those drugs were procured from the private vendors which may or may not have been procured at the same price levels. Further, some drugs that were consumed in health facilities were not on the price list of the government, for which we obtained information from the international price database. These limitations may have had over or under estimated the overall drug costs, but given the very small portion of drugs where we needed to refer to international sources and that the emergency drug procurement was capped at 4% of the district budget that is already small, the impact on the unit costs was deemed negligible.

Reliable information on the price of capital assets was deficient, particularly for buildings. For equipment, we obtained various quotations that were obtained by the MOH for different purposes and assumed replacement costs in the base year. For buildings, we obtained a standard construction cost for a standard health facility provided by the MOH, and calculated the cost per square meters that were applied for the size of buildings. If a building had multiple floors, the area of each floor was added up to obtain the total square meters of the building. Although assuming the size of building as the only determining factor of the costs can be an over-simplification, the proportion of building in the full facility costs was small compared to other cost items (*i.e.*, labour, material and equipment) that is unlikely to have substantially distorted the estimation of the unit costs.

Despite the limitations, this study is likely the most accurate unit cost estimates of services provided

at health facilities in Zambia to date. We compared the unit cost estimates with those estimated by econometrical means by the WHO-CHOICE study (21). Supplemental Table S3 (<https://www.ghmopen.com/site/supplementaldata.html?ID=87>) provides a rough comparison of unit costs at different levels of health facilities. Estimates for health centres are rather comparable between the two, although the estimates from WHO-CHOICE appear to be on the lower end. However, the estimated unit costs by this study for hospitals are significantly higher than those of WHO-CHOICE, particularly for IPD and tertiary hospitals (i.e., USD 21.92-112.71 vs. USD 6.06, respectively). Given the significant resources that are used at higher level hospitals, the WHO-CHOICE estimates may be underestimating the true costs. While the reasons for the differences remain to be studied, this potentially points to the need to update the country-specific estimates with primary data obtained from the facilities. Further, although this study provides the cost estimates in 2016 value for Zambia that may seem somewhat dated, they still remain the best estimates with adequate inflation adjustments to date. Given the general lack of literature on unit costs of health services in Africa, especially in recent years, it can provide some indications of unit costs in peer countries with similar health systems and income levels. Particularly in conducting economic evaluations of various health services in Zambia, the estimated unit costs can serve as a superior alternative source to WHO-CHOICE 2021 update, which provided estimates in 2010 value requiring a more rigorous adjustment for inflation.

Conclusion

This study provides the unit costs of health services that are provided in two provinces of Zambia. Apart from the use of unit cost information in future studies, the variations of unit costs among facilities with different characteristics provided policy relevant information to be considered by health administrators and policy makers. Nonetheless, although this study discussed potential issues that may explain the differences in the level of unit costs, those issues need to be confirmed by additional specialised analyses that investigate each specific issue more intensively (e.g., efficiency, economies of scale).

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