



Categorisation of African Countries: Cluster Analysis of Maternal Mortality based on Health Expenditure Trends (2000-2023)- A Machine Learning Approach to SDG 3.1 Prioritisation

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ABSTRACT

The purpose of the study was to utilize maternal mortality ratios and health expenditure (HE) to categorise African countries into four distinct clusters to inform targeted policy interventions. The study used unsupervised machine learning approaches (K-Means clustering and Hierarchical clustering) with Ward's linkage relying on data for Maternal Mortality Ratio (MMR) trajectories and HE patterns from 2000 - 2023 to identify the clusters: (1) High MMR, Low Efficiency countries; (2) Moderate MMR, Improving countries; (3) Low MMR, High Spending systems; and (4) High MMR. The findings of the Cluster analysis showed that fragile states, which make up one cluster, for example, countries such as South Sudan, have extreme mortality levels. In countries like Rwanda, the cluster indicated an effective low-cost intervention. The cluster that contained countries such as Algeria was characterised by sustained healthcare investments. In the group of countries making up the fourth cluster, governance inefficiency was the dominant challenge for countries like Lesotho. In addition, 38% of the variation in MMR was explained by HE ($p < 0.0001$). The contribution to the study in research knowledge rests on the categorization of African countries in terms of MMR and HE.

Keywords: Health Expenditure, Africa, Maternal Mortality Ratio (MMR), Sustainable Development Goal (SDG), Clustering.

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INTRODUCTION

Reducing maternal mortality has been a long-standing health deliverable that has been listed as a target in the previous Millennium Development Goals (MDGs) as well as the current Sustainable Development Goals (SDGs). Maternal Mortality (MM) is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management.¹ It remains a critical global health challenge. This is especially common in low-and middle-income countries. Maternal Mortality Ratio (MMR) which is the number of maternal deaths per 100,000 live births, is regarded as the most sensitive indicator of healthcare system performance.² Africa alone accounts for about two-thirds (66%) of all global maternal deaths

¹ World Health Organization, *Maternal Mortality: Levels and Trends 2000 to 2017* (World Health Organization, 2019).

² World Health Organization, *Trends in Maternal Mortality 2000-2020* (World Health Organization, 2025).

despite a decrease in the number of maternal deaths since 2000. This paper seeks to inform targeted policy interventions for SDG 3.1 which seeks to reduce the global MMR to below 70 per 100,000 live births by 2030.³ The objective of the study is to utilize maternal mortality ratios and health expenditure to categorise African countries into four distinct clusters using MMR and HE trends for 2000 to 2023. The study fulfils a gap in that it uses unsupervised machine learning analysis to examine the relationship between MMR and HE and categorise countries. The study is based on unsupervised machine learning analysis and cluster analysis. This paper provides an overview of maternal mortality and health expenditure, followed by a discussion of the methodology and then presents the findings of the study.

LITERATURE REVIEW

An Overview of Maternal Mortality

The Maternal Mortality Ratio is the number of maternal deaths per 100,000 live births. Africa alone accounts for about two-thirds (66%) of global maternal deaths despite the increased HE in the region.⁴ MMR is also considered a key indicator of disparities in healthcare access and quality in sub-Saharan Africa (SSA), where preventable causes are predominant.⁵ In addition, the efforts at reducing MM across Africa have been uneven, despite the growing spending.

Importance of Health Expenditure

Health Expenditure forms an integral part of the government's spending package in terms of its budgetary requirements. This expenditure matters as the health status of the population is an important indicator in a country, determining the socio-economic obligations of the leadership. HE also determines the kind of health system that a country ends up with. This was why the 2001 Abuja Declaration compelled African countries to commit to allocating at least 15% of their annual budgets to health care, even though this commitment has not been fully achieved by all African countries.

HE also has a major impact on productivity. Healthy individuals are more productive, work longer, and earn higher incomes, which in turn leads to economic growth and a buoyant economy. Researchers also point out that a healthier and more productive workforce aids the creation and usage of new technologies, thereby pushing up economic growth.⁶ The WHO likewise notes that in developed and developing countries, HE enhances economic development.⁷ Improvements in health investments add to the general well-being of the population.⁸ HE is also the backbone of the health system in a country, ensuring optimal, efficient and sound health outcomes.⁹

The link between HE and health outcomes is clearly established in the literature. Many studies have looked at the relationship between HE and economic growth, as well as other health-related variables such as life expectancy, infant and child mortality, and MM. Another study examined the relationship between HE and health outcomes in countries within the European Union, and found that government HE can enhance life expectancy and infant mortality.¹⁰ The study looked at the link between HE and education in three health dimensions, such as infant mortality, child mortality and life expectancy. The study found that the interplay between HE by government and education was twofold, as both infant and MM

³ World Health Organization, *Trends in Maternal Mortality 2000-2020*.

⁴ World Health Organization, *Trends in Maternal Mortality 2000-2020*.

⁵ Nicholas J Kassebaum et al., "Global, Regional, and National Levels and Causes of Maternal Mortality during 1990–2013: A Systematic Analysis for the Global Burden of Disease Study 2013," *The Lancet* 384, no. 9947 (September 2014): 980–1004, [https://doi.org/10.1016/S0140-6736\(14\)60696-6](https://doi.org/10.1016/S0140-6736(14)60696-6).

⁶ David Bloom, Michael Kuhn, and Klaus Pretzner, *Health and Economic Growth: Discussion Paper Series* (IZA Institute of Labour Economics: Deutsche Post Foundation, 2018).

⁷ World Health Organization, "Macroeconomics and Health: Investing in Health for Economic Development," 2001.

⁸ Mario J. Azevedo, Akim T. Lukwa, and Olufunke A. Alaba, "Health and Economic Development," in *African Economic Development* (Emerald Publishing Limited, 2019), 257–85, <https://doi.org/10.1108/978-1-78743-783-820192014>.

⁹ Cleopatra Oluseye Ibukun, "The Role of Governance in the Health Expenditure–Health Outcomes Nexus: Insights from West Africa," *International Journal of Social Economics* 48, no. 4 (March 16, 2021): 557–70, <https://doi.org/10.1108/IJSE-06-2020-0404>.

¹⁰ Mihaela Onofrei et al., "Government Health Expenditure and Public Health Outcomes: A Comparative Study among EU Developing Countries," *International Journal of Environmental Research and Public Health* 18, no. 20 (October 13, 2021): 10725, <https://doi.org/10.3390/ijerph182010725>.

decreased whilst life expectancy increased. The study looked at 25 selected countries in SSA for the period 2000 to 2020 and used health expenditure per capita to denote HE.¹¹

Although a number of studies have looked at the relationship between HE and health outcomes, few studies have examined the relationship between HE and MM. Furthermore, findings from these studies are mixed. One study examined the relationship between HE and health outcomes for 161 developed and developing countries with different income levels for the period 1995 to 2014.¹² The study found that the relationship between HE and health outcomes is stronger for low-income countries compared to high-income countries. In the study, HE was found not to have any significant effect on MM.

An interesting study looked at the effect of government health spending and external debt on MM for 15 Southern African Development countries from 2000 to 2022 and found that HE and external debt reduce MM.¹³ Also, the link between HE and four health outcomes, namely, infant mortality, under five mortality, maternal mortality ratio and life expectancy for three income groupings (low, middle, and high) for 64 countries was also investigated.¹⁴ The study showed that government HE had a significant influence on health outcomes across all income levels, but there was a strong positive relationship between HE and MMR in low-income countries. A study of 22 regions in Madagascar over the period 2010 to 2017 looked at the link between HE and maternal and child mortality.¹⁵

Nonetheless, there is a dearth of research regarding the categorisation of countries by MMR expenditure trajectories. This study is aimed at leveraging Machine Learning (ML) taxonomy for Sustainable Development Goal (SDG) 3.1 targeting, which seeks to reduce the global MMR to below 70 per 100,000 live births by 2030.¹⁶ It is intended that no country is left behind in the quest towards reducing MM by categorising African countries based on MM trends compared to HE from 2000 to 2023. Using cluster analysis, the resulting classification of 52 countries in Africa will provide a data-driven prioritisation framework for policymakers. This is expected to enhance the effective allocation of resources and the acceleration of the progress toward SDG 3.1. A further decline in the MM seeks to reduce the global MMR far below 197 per 100,000 live births, which is advocated, and this will require an annual rate of reduction of 15%, a figure that is attainable.¹⁷

METHODOLOGY

The design of this study employed unsupervised machine learning techniques, including K-Means Clustering and Hierarchical Clustering, to categorise African countries into unique groups based on MMR trajectories and HE patterns. The period under focus is the years 2000 to 2023. The dataset for this study, sourced from the World Health Organization focused on maternal health and healthcare expenditure trends across 52 African countries.¹⁸ This data provided a structured, longitudinal dataset spanning three decades. Entries represent observations for countries and years across multiple countries.

The variables in the dataset include Country Name, Year, and MMR (a continuous numerical variable) reflecting the number of maternal deaths per 100,000 live births. The other variables are Health Expenditure expressed as a percentage of a country's Gross Domestic Product (GDP) and the Health Expenditure Per capita, representing the per capita health expenditure, which reflects the financial investment in healthcare on an individual basis. In addition, there are two derived variables designed to capture medium-term trends. These are the MMR Change representing the five-year rolling change in

¹¹ Yetunde Oluranti Adegoke, Gavin George, and Josue Mbonigaba, "Sustainable Thresholds, Health Outcomes, Health Expenditures and Education Nexus in Selected African Countries: Quadratic and Moderation Modelling," *Globalization and Health* 18, no. 1 (October 12, 2022): 84, <https://doi.org/10.1186/s12992-022-00876-8>.

¹² Rezwanul Hasan Rana, Khorshed Alam, and Jeff Gow, "Health Expenditure, Child and Maternal Mortality Nexus: A Comparative Global Analysis," *BMC International Health and Human Rights* 18, no. 1 (December 16, 2018): 29, <https://doi.org/10.1186/s12914-018-0167-1>.

¹³ Gildas Dohba Dinga, Gisele Mah, and Teboho Mosikari, "Government Health Expenditure and Maternal Mortality: The Moderating Role of External Debt," *Healthcare* 12, no. 20 (October 12, 2024): 2030, <https://doi.org/10.3390/healthcare12202030>.

¹⁴ Justus Mwaura Wanjiku, "Public Health Expenditure and Health Outcomes: An Empirical Study Analysis" (UMEA University, 2023).

¹⁵ Marilyns Victoire Razakamanana, Voahirana Tantely Andrianatoandro, and Tiarinisaina Olivier Ramiandrisoa, "Do Public Health Expenditures Affect Maternal and Child Health in Madagascar?," *Health Economics Review* 13, no. 1 (October 18, 2023): 47, <https://doi.org/10.1186/s13561-023-00462-7>.

¹⁶ United Nations, *The Sustainable Development Goals Report 2020* (United Nations, 2020).

¹⁷ World Health Organization, *Trends in Maternal Mortality 2000-2020*.

¹⁸ World Health Organization, *Trends in Maternal Mortality 2000-2020*.

MMR, which enables the analysis of whether maternal health outcomes are improving or not. The other derived variable is the Health Expenditure Change, which measures the five-year rolling change in HE as a percentage of GDP, indicating the expenditure growth or otherwise within the timeframe. Data cleaning involved handling missing values, particularly in the earlier years. Data is preprocessed using the min-max scaling normalisation method for all numerical features, and linear interpolation for missing values (where applicable). Four different scenarios were established, namely:

- (1) High MMR, Low Efficiency
- (2) Moderate MMR, Improving
- (3) Low MMR, High Spending
- (4) High MMR, High Spending.

These scenarios were developed based on the assumption of efficient government expenditure, assuming that all other variables are not taken into account. The researchers focused solely on the link between HE and MMR to the exclusion of other influences.

In terms of feature engineering, a 5-year MMR change rate was applied, HE efficiency ratios were computed, and temporal trend features were created. The K-Means Clustering technique uses the objective function.

$$\text{Objective function:} \quad \arg \min_s \sum_{i=1}^k \sum_{x \in S_i} \|x - \mu_i\|^2 \quad (1)$$

Where:

k = number of clusters

S_i = set of points in cluster i

μ_i = mean points in S_i

For Hierarchical Clustering, the Agglomerative approach with Ward’s linkage given below was used.

$$\text{Ward's linkage:} \quad d(u,v) = \sqrt{\frac{|v|+|s|}{T} d(v,s)^2 + \frac{|v|+|t|}{T} d(v,t)^2 - \frac{|v|}{T} d(s,t)^2} \quad (2)$$

Where:

$T = |v| + |s| + |t|$

The Elbow method was used for selecting the optimal k and validation was achieved by the *Davies-Bouldin* index.

PRESENTATION OF RESULTS /FINDINGS

The temporal trends for ten selected countries in Africa with the highest variation in MMR between 2000 and 2023 revealed that countries, such as Sierra Leone and South Sudan, consistently show high MMR. Ethiopia and Rwanda were among the countries which demonstrated a significant decrease in MMR over the period. Lesotho and Malawi were examples of countries that exhibit high volatility in their MMR trends. This exploratory data analysis provided the basis for further analysis.

The summary statistics of the dataset, shown in Table 1, reveal extreme dispersion in the MMR distribution. The mean MMR of 590.8 hides the huge disparity between the minimum 17 and the maximum 8045. The 75th percentile (766) is far greater than the SDG 3.1 target of 70, while 25% of the countries (below 254) are closer to the target. The median of 495.5, indicates a right-skewness in the distribution. There is a weak correlation between average health expenditure and MMR. The median 5-year MMR change of -64 is indicative of general progress, irrespective of some crisis countries. The GDP change over 5 years is negligible, but volatility (std=1.6) indicates unstable health budgeting.

Table 1: Summary Statistics for MMR in SSA 2000 - 2023

MEASURE	Mean	Std	Min	25%	50%	75%	Max
Maternal Mortality Ratio	590.8	583.3	17	254	495.5	766	8045
Health Expenditure Ratio	5.0	2.2	1.1	3.6	4.5	5.9	21.96
Health Expenditure Per Capita	105.8	139.5	4.2	26.3	50.3	105.1	708.7
MMR Change (5 years)	-85.5	307.9	-6315	-128	-64	-9	4483

Health Expenditure Change (5 years)	0.2	1.6	-10.6	-0.5	0.2	0.9	11.9
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Cluster Analysis

The elbow method plot and the cluster validation metrics, as shown in Figure 1, provide insights into how the optimal number of clusters (k) was determined and used for the analysis of the MM data. The Within-Cluster Sum of Squares (WCSS) values decreased with the number of clusters, suggesting improved cohesion within each cluster. A visible decline in the rate of increase is seen in the plot, and this is where the 'elbow' is formed. The optimal number of clusters is between 2 and 3, and the value of the Silhouette Score of the cluster validation metrics further confirms this. This suggests the existence of well-separated clusters, which the low Davies-Bouldin scores confirm.

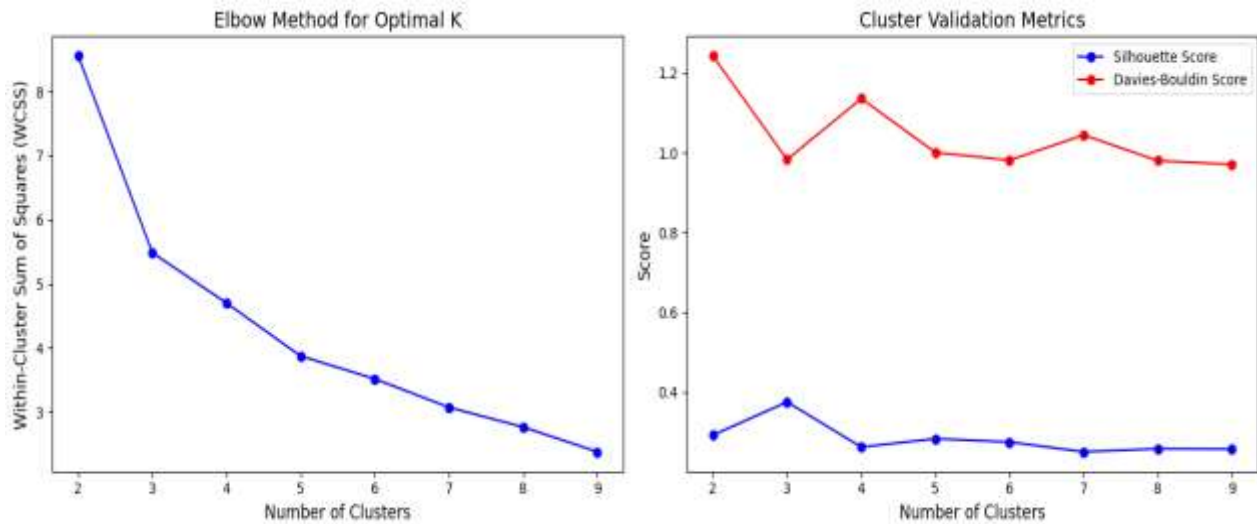


Figure 1: The Elbow Method plot optimal k and the Cluster Validation Metrics plot

In Figure 2, the **K-Mean Clustering** plot provides a good categorisation of African countries based on MM trends and HE patterns for the period in view, in line with SDG-3.1. Using Principal Component Analysis (PCA), the countries are projected onto two principal components, highlighting four distinct clusters. The first cluster in purple, **Cluster 0**, represents low MM with sustained healthcare investments. Some of the countries here, like Algeria, Morocco, and Kenya, have relatively better healthcare systems. The second cluster, **Cluster 1** (blue), consists of countries having moderate MMR with gradual improvements, which are likely driven by increased efficiency in spending. Nigeria, Madagascar and Tanzania are examples of countries in the second cluster. The third cluster, **Cluster 2** in green, demonstrates countries with low MMR and high HE. South Africa, Botswana, and Mauritius are examples of countries in this cluster, and they seem to be well-funded with sustained investments. The last cluster, **Cluster 3** in yellow, comprising countries like South Sudan, Somalia, and the Central African Republic, reflects countries with high MMR despite significant expenditure. This is indicative of challenges with governance, poor infrastructure, and fragile health systems. These findings stress the need for cluster-specific policy interventions.

The Hierarchical Clustering Dendrogram in Figure 3, highlights how closely linked the African countries are based on MMR and HE patterns. The dendrogram complements the K-Means clustering analysis, thereby reinforcing the existence of four broad clusters of African countries. These results provide a layered understanding of intra-cluster relationships. This shows the basis for tailored cluster-specific interventions across the continent to ensure timely acceleration of the SDG 3.1 progress. Hence, the key areas of focus should include investment in infrastructure, more efficient spending and well-defined government reforms.

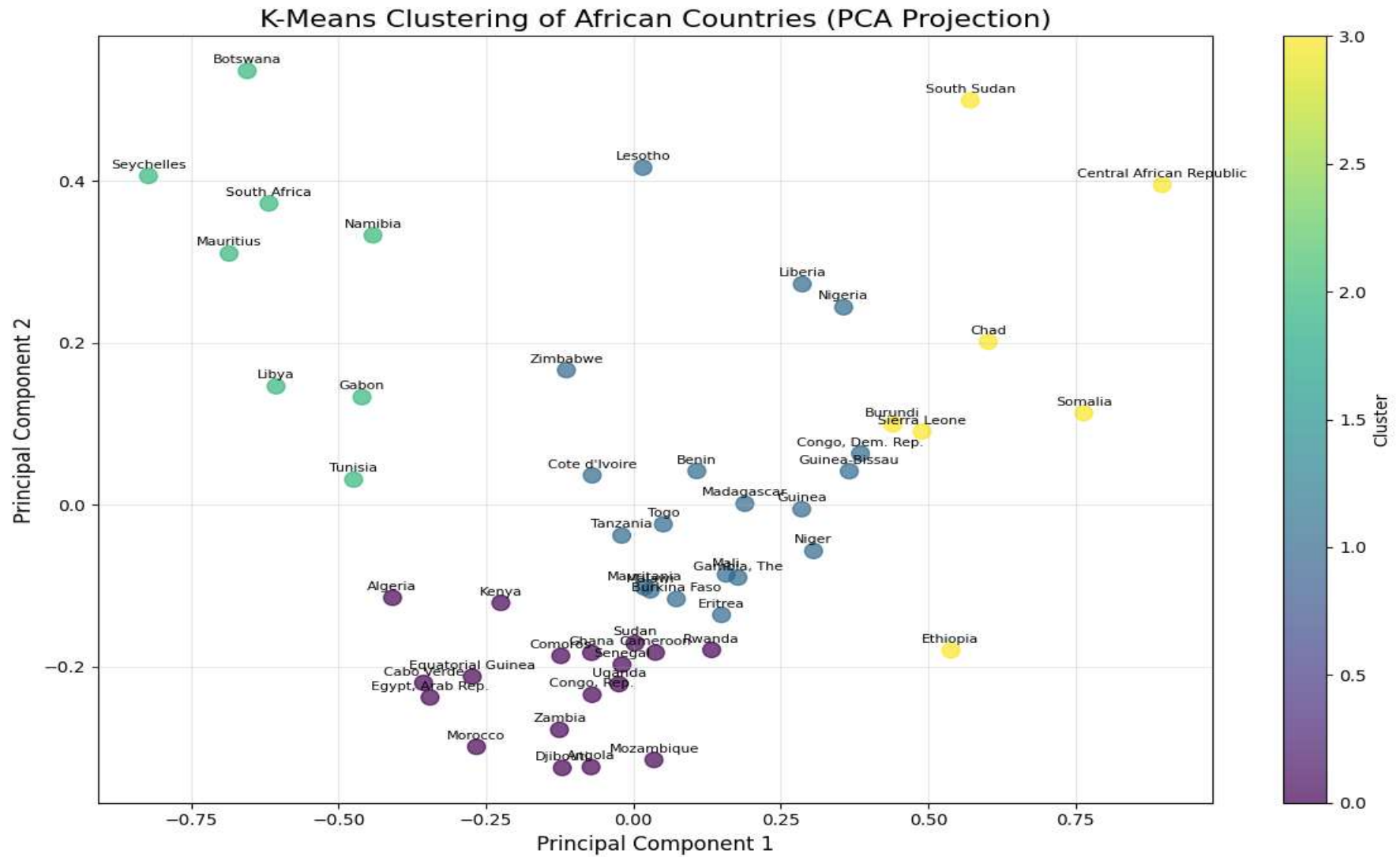


Figure 2: K-Means Clustering of African Countries (PCA Projection)

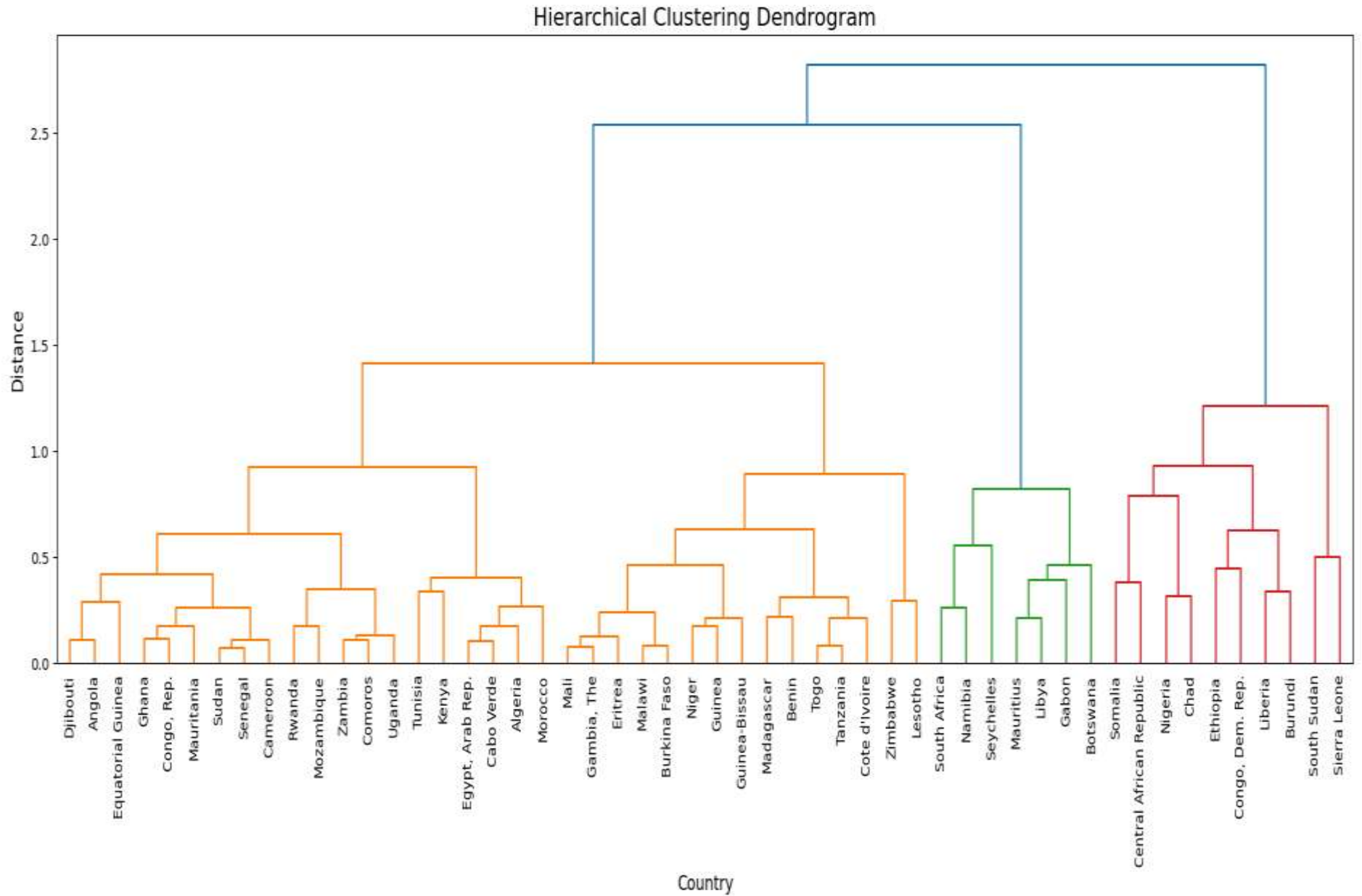


Figure 3: Hierarchical Clustering of countries in Africa

Table 2 represents a detailed summary of the characteristics of the four clusters identified through cluster analysis of MM and HE trends in Africa. Cluster 0 (high MMR, low efficiency) consists of 18 countries. These countries exhibit moderate MM (MMR mean = 0.154) despite low HE (15.8% of GDP) and low per capita spending (0.113). The lowest health expenditure efficiency (0.044) is seen in this group. Cluster 1 (high MMR, low efficiency) consists of 19 countries having a high average MMR (0.336) with promising signs of improvement. The health spending (%GDP = 19%) and per capita expenditure (0.052) are relatively low. This group records better efficiency (0.130) and a high MMR change rate (0.304), which seems to suggest effective, low-cost intervention at improving maternal health outcomes.

Cluster 2 (low MMR, high spending) has 8 countries, which are well-performing health systems. These countries have the lowest MMR (0.073) and the highest per capita health expenditure (0.522). Despite the high investment, the health expenditure efficiency is very low (0.002). The last cluster, Cluster 3, has the lowest number of countries (7), highlighting the paradox of poor outcomes despite huge investments. This is indicative of an obvious case of systemic issues, because these countries have the highest MMR (0.540) and the highest health expenditure (%GDP=27.7%), yet per capita expenditure (0.031) is only moderate (0.031). In general, the results show that spending alone is insufficient without ensuring improvement in the efficiency of the system and in governance.

Table 2: Summary of the characteristics for each of the four identified clusters

Cluster	Cluster Name	MMR mean(sd)	Health Exp%GDP mean(sd)	Health Exp PC mean(sd)	MMR Change mean(sd)	Health Efficiency mean(sd)	Country Count
0	High MMR, Low Efficiency	0.154 (0.078)	0.158 (0.060)	0.113 (0.075)	0.291 (0.007)	0.044 (0.034)	18
1	Moderate MMR, Improving	0.336 (0.105)	0.190 (0.081)	0.052 (0.031)	0.304 (0.009)	0.130 (0.062)	19
2	Low MMR, High Spending	0.073 (0.062)	0.222 (0.099)	0.522 (0.170)	0.320 (0.013)	0.002 (0.002)	8
3	High MMR, High Spending	0.540	0.277	0.031 (0.017)	0.293 (0.012)	0.303 (0.097)	7

The map in Figure 4 below shows the location of the countries in the four clusters, which serves as a quick guide for the recommended policy insights. The clustering provided in this paper differs from the previous regional groupings utilized by the African Union (AU's 5-region model) and offers new insight into regional groupings.

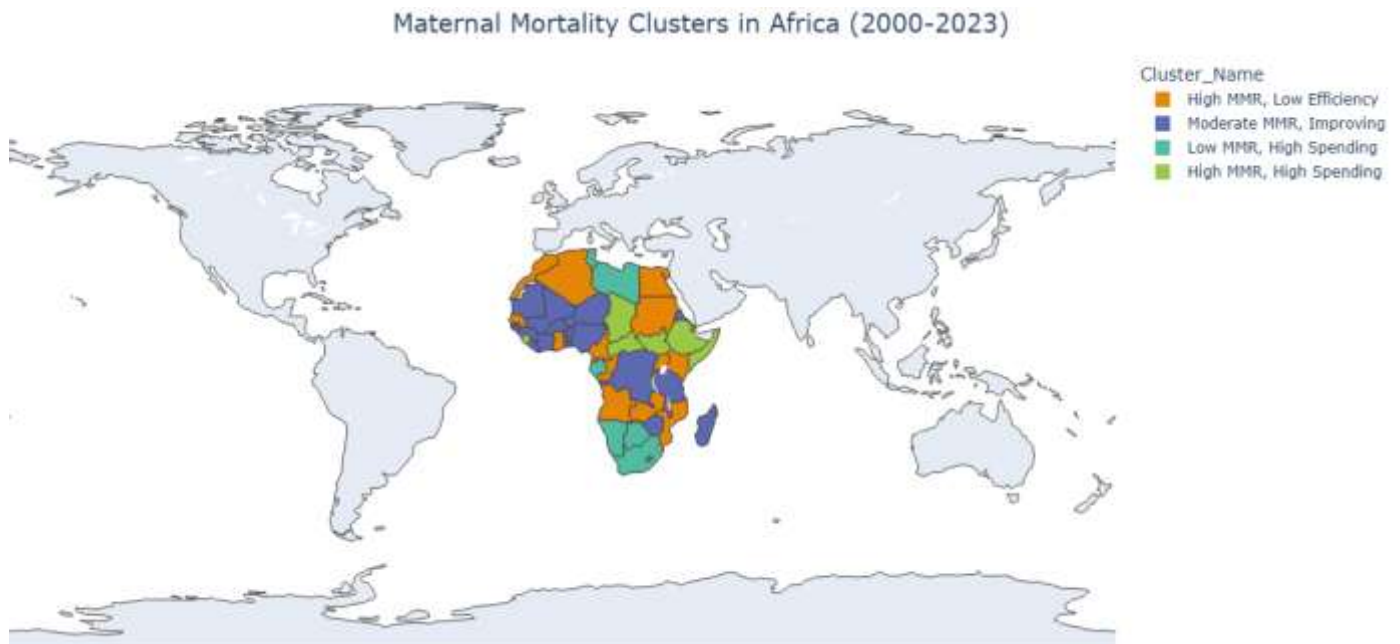


Figure 4: Maternal Mortality Clusters in Africa (2000-2023)

DISCUSSION

Maternal Mortality (MM) has remained a major challenge in the developing world, including Africa. This situation is exacerbated by the unevenness in Health Expenditure (HE) across the continent. Despite the strides made in addressing maternal health care and maternal morbidity, maternal mortality shows no signs of abating. In 2023, approximately 260,000 women died during and after pregnancy and childbirth. The period 2000 to 2023 saw a drastic fall in the MMR of around 40% globally. Sub-Saharan Africa and southern Asia were home to about 87% (225,000) of the global level in 2023. In Sub-Saharan Africa, roughly 70% occurred here, or 182,000 maternal deaths, while southern Asia was responsible for 17% of maternal deaths or 43,000 maternal deaths.¹⁹ Sub-Saharan Africa underwent a decrease in MMR of 40% between 2000 and 2023, even though it still had a high MMR in 2023.²⁰

Maternal deaths are more dominant among women residing in rural areas and poorer communities or low-resource locations. Although least developed countries have only 13% of the global population, close to 43.9% of all maternal deaths took place in these countries in 2023.²¹ Also, adolescents are more susceptible to complications and death. Women in low-income countries also face a higher risk of maternal death. A woman's lifetime risk of maternal death refers to the likelihood that a 15-year old girl will ultimately die from a maternal cause. In 2023 whilst the lifetime risk was 1 in 7933 for high income countries, it was as steep as 1 in 66 for low-income countries.²² The provision of medical care by skilled health personnel before pregnancy, during the pregnancy phase and the period following childbirth, plays a key role in saving the lives of both women and newborns.²³

Health expenditure is crucial in delivering sound health outcomes. Health expenditure has varied widely in the African continent over the period 2012-2020. For the 47 countries that comprise the WHO African region, only 8 achieved the limit of spending a minimum of US\$249 per capita on health for the 2012-2020 period. In 2020, only 5 countries were able to meet this requirement. Overall, health expenditure varied from US\$16.4 to US\$236.6, indicating the discrepancies across countries.²⁴

¹⁹ World Health Organization, *Trends in Maternal Mortality 2000-2020*.

²⁰ World Health Organization, *Trends in Maternal Mortality 2000-2020*.

²¹ World Health Organization, *Trends in Maternal Mortality 2000-2020*.

²² African Health Organization, "Maternal Mortality Fact Sheet," accessed June 20, 2025, <https://www.aho.org/fact-sheets/maternal-mortality-fact-sheet/>.

²³ World Health Organization, *Trends in Maternal Mortality 2000-2020*.

²⁴ World Health Organization, *Africa Region Health Expenditure Atlas 2023* (World Health Organization, 2025).

In 2001 a pledge to allocate at least 15% of their annual budget to better health offerings was endorsed by members of the African Union given the poor state of health in many low-income countries. There was also a call to donor countries to contribute 0.7% of their Gross National Product (GNP) as official Development Assistance (ODA).²⁵ Two decades later, data showed that only 3 countries, namely, Rwanda, Botswana and Cabo Verde were able to fulfill targets of the Abuja Declaration. On the other hand, the contributions of 30 African Union member states amounted to less than 10% and some countries only allocated between 5-7% of their budget to health.²⁶

Globally, Universal Health Coverage (UHC) is a commitment to making sure that everyone, including the marginalized and vulnerable enjoys access to quality health care and is not burdened financially when doing so. It is a means to reducing extreme poverty and boosting productivity and health investments. From 2015, the coverage of health services has been on the decline and the financial burden brought on by out-of-pocket health spending has been catastrophic. Close to 50% of the global population are deprived of basic health services. UHC impels governments to investment in their health systems and ensure that equity is the guides health service coverage.²⁷

The study found that 38% of the variation in MMR was explained by HE ($p < 0.0001$). The first cluster, Cluster 0, represents low MM with sustained healthcare investments. Some of the countries, including Algeria, Morocco, and Kenya, have relatively better healthcare systems. For the second cluster, 1 consists of countries that have moderate MMR with gradual improvements, which are likely driven by increased efficiency in spending. Nigeria, Madagascar and Tanzania are examples of countries in the second cluster. The third cluster, Cluster 2, demonstrates countries with low MMR and high HE. South Africa, Botswana, and Mauritius are examples of countries in this cluster, and they seem to be well-funded with sustained investments. The last cluster, Cluster 3, comprising countries like South Sudan, Somalia, and the Central African Republic, reflects countries with high MMR despite significant expenditure. This is indicative of challenges with governance, poor infrastructure, and fragile health systems. These findings stress the need for cluster-specific policy interventions.

RECOMMENDATIONS

This study establishes that expenditure efficiency varies across the entire continent. Three leverage points emerged, including the fact that the fragile states require security stabilisation before health investment. The middle performers need to scale up proven community-based models, and the high-spending underperforming countries should implement more effective reforms in governance. In general, conflict-affected states (e.g, South Sudan) will require targeted humanitarian aid. The Moderate MMR, improving countries seem to have succeeded in policies that encourage community health workers' engagement. The Lesotho paradox will require more detailed investigation, which has an MMR of 491, despite a 9.1% health GDP expenditure, the MMR level rising from 413 in 2000. A systemic leakage is a plausible explanation for this, because of the country's corruption index score of 28, which is quite elevated (WHO, 2023). On the other hand, Rwanda had a MMR of 885 in 2000 and 3.6% health GDP expenditure, which saw a decline in the MMR to 234 in 2022, accompanied by health GDP expenditure of 7.9%.

CONCLUSION

The objective of the study is to utilize maternal mortality ratios and health expenditure to categorise African countries into four distinct clusters to inform targeted policy interventions. The findings underscore the need for efficient HE allocation and governance reforms to reduce MM disparities, and basic infrastructure should be prioritised in fragile states for SDG 3.1 actualisation. Our strategy of categorizing MMR and HE contributes to the understanding of maternal mortality as it introduces the element of efficiency into the health expenditure analysis. This will enable governments to track both MMR and HE to ensure that said targets are met, especially targets relating to the SDGs.

²⁵ World Health Organization, *The Abuja Declaration: Ten Years On* (World Health Organization, 2019).

²⁶ Bwalya Jack, "SADC and the Abuja Declaration: Honouring the Pledge," Policy Brief 230, February 2021.

²⁷ The World Bank Group, *Universal Health Coverage*, 2025.

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