# UNDERSTANDING THE INFLUENCE OF SOCIOECONOMIC ENVIRONMENT ON PAEDIATRIC ANTI-RETROVIRAL TREATMENT COVERAGE – TOWARDS CLOSING TREATMENT GAPS IN SUB-SAHARAN AFRICA

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## SUMMARY

Objective: Many sub-Saharan African countries have massively scaled-up their antiretroviral treatment (ART) programmes, but many national programmes still show large gaps in paediatric ART coverage making it challenging to reduce AIDS-related deaths among HIV-infected children. We sought to identify enablers of paediatric ART coverage in Africa by examining the relationship between paediatric ART coverage and socio- economic parameters measured at the population level so as to accelerate reaching the 90-90-90 targets. Methods: Ecological analyses of paediatric ART coverage and socioeconomic indicators were performed. The data were obtained from the United Nations agencies and Forum for a new World Governance reports for the 21 Global Plan priority countries in Africa with highest burden of mother- to-child HIV transmission. Spearman's correlation and median regression were utilized to explore possible enablers of paediatric ART coverage. Results: Factors associated with paediatric ART coverage included adult literacy ($r = 0.6$, $p= 0.004$), effective governance ($r = 0.6$, $p= 0.003$), virology testing by 2 months of age ($r = 0.9$, $p= 0.001$), density of healthcare workers per 10,000 population ($r = 0.6$, $p= 0.007$), and government expenditure on health ($r = 0.5$, $p= 0.046$). The paediatric ART coverage had a significant inverse relationship with the national mother-to-child transmission (MTCT) rate ($r = -0.9$, $p< 0.001$) and gender inequality index ($r = -0.6$, $p= 0.006$). Paediatric ART coverage had no relationship with poverty and HIV stigma indices.
Conclusions: Low paediatric ART coverage continues to hamper progress towards eliminating AIDS-related deaths in HIV-infected children.
Achieving this requires full commitment to a broad range of socioeconomic development goals.

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## INTRODUCTION

It is remarkable that with innovative approaches and huge political commitment, the global epidemiological pattern of HIV is changing as the world struggles to achieve the goals of ending the AIDS epidemic by stopping HIV transmission and AIDS-related deaths by 2030 (1). However, it is evident that children living with HIV continue to experience persist- ent treatment gaps despite the scientific proof from published studies that have established the efficacy of early antiretroviral therapy (ART) initiation among children in clinical settings (2–4). Although the risk of HIV death among under-5 children is declining, paediatric HIV still contributes significantly to preventable child morbidity and mortality in the continent due to lack of diagnostic and treatment services for HIV-infected children (5, 6). In the face of serious political, economic and

social challenges, paediatric AIDS which is an important factor in overall child survival continues to threaten future productivity and development in Africa. Sub-Saharan Africa bears 90% of global burden of paediatric HIV infection but only 22% of HIV positive children under 15 years received ART in 2013 (5). The causes of poor ART coverage among children are multiple, ranging from health system to programmatic level factors. These include fewer facilities providing early infant diagnosis (EID), paediatric antiretroviral (ARV) shortages especially fixed-dose combination, inadequate integration and linkages to health facilities and community structures, limited number of health care workers providing paediatric ART services, low retention in care, and stigma and discrimination (7, 8). Poor implementation of provider initiated testing and counselling (PITC) and weak decentralization of paediatric ART services also play a part (5–7). The programmatic consequences of these obstacles are massive, e.g. the inability of the system to identify HIV infected children and linking them into care. Although, several strategies have been developed and implemented to mitigate these bottlenecks and subsequent AIDS-related death in developed countries, paediatric HIV is also a concern because African migrants and ethnic minorities have higher HIV prevalence than the general population and are more likely to experience delayed HIV diagnosis and treatment. Oftentimes, they have specific legal impediments, cultural, linguistic barriers, and perceived stigma from their communities hence making it difficult in accessing HIV testing and care.

In 2010, the UNAIDS strategy was adopted to accelerate progress towards universal access to ART for people living with HIV (PLHIV) who are eligible for treatment by 2015 (9). However, the target could not be reached in 2015, as more than 60% of PLHIV did not have access to ART (10). To ensure treatment scale-up beyond 2015, a new 2020 target was set in 2013 to close the ART gaps (10). From the perspective of improving HIV treatment, care and support, a people-centred investment approach has been postulated by UNAIDS as a key component of HIV response, accelerating the target of helping 90% of all people living with HIV to know their HIV status, 90% of all people with diagnosed HIV infection to receive sustained ART, and 90% of people receiving ART to have viral suppression (90-90-90) by the year 2020 (11). The critical enablers and developmental synergies that were hypothesized as the core building blocks of national AIDS responses included work on social exclusion, marginalization, criminalization, stigma, social protection, education, legal reform, gender equality, poverty reduction, gender-based violence, health systems, community systems, and employment practices. Evaluating the social and health factors which influence paediatric ART coverage in Africa has been an issue of great interest to policymakers in ascertaining the most important barriers and bottlenecks to programme success as little is known about the influence of socioeconomic and health characteristics on the effectiveness of national paediatric ART programmes in some African countries. We analysed socioeconomic correlations of national HIV response in various regions of the continent to increase our understanding of the relationship between paediatric ART coverage and socioeconomic factors in sub-Saharan Africa in a broader context of social determinants of health so as to accelerate achieving the UNAIDS 90-90-90 targets of paediatric ART.
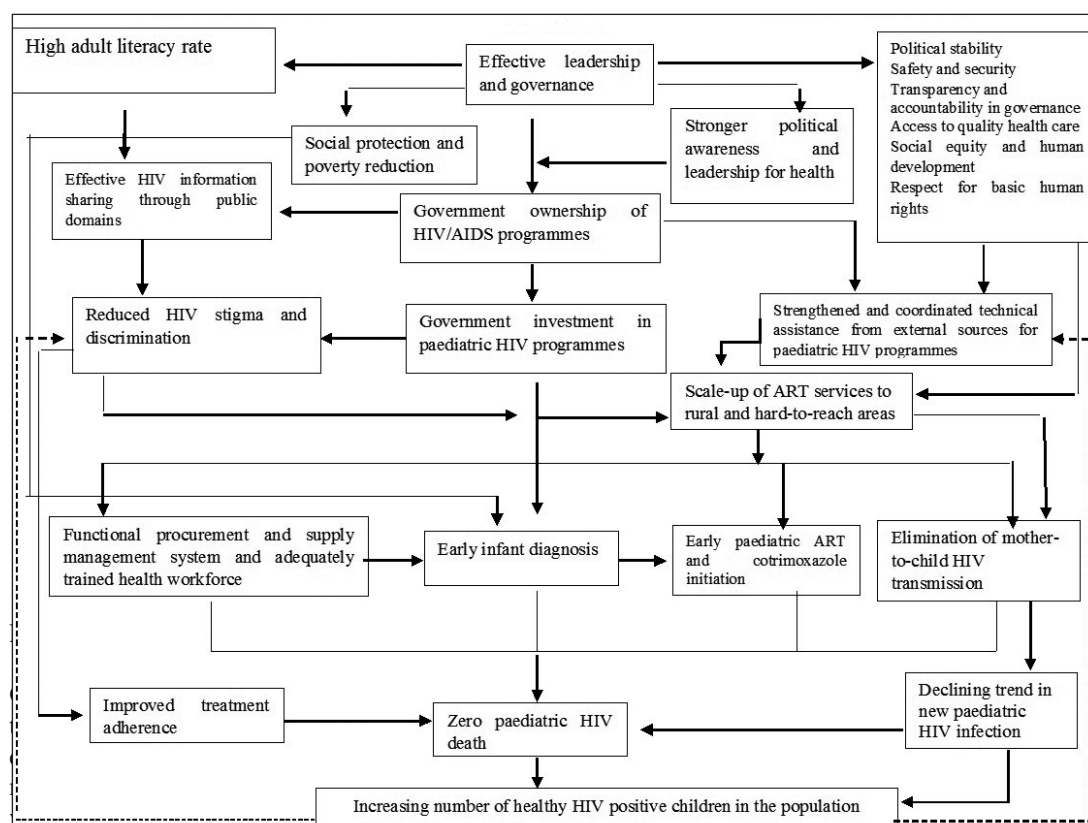
MATERIALS AND METHODS

Study Design and Data Sources
This is an ecological study, which correlated country-level data on paediatric ART coverage (outcome variable) that were obtained from 2014 UNAIDS progress report on global AIDS epidemic plan (9) with a range of critical enablers for strategic investment of HIV response. A framework was developed by conceptualizing social determinants of paediatric ART coverage from programmatic experiences of the authors, published literature (2–4, 8) and reviewing the proposed critical enablers and developmental synergies from UNAIDS (11) (Fig. 1). There are different plausible pathways through which good leadership and governance could lead to improvement of economic indices. At the individual level, gender and economic inequalities may lead to women's economic dependence on men, resulting in reduced autonomous decisions as regards to care of their children (Fig. 1). Furthermore, at the national level, dimensions of leadership and governance play a key role in determining access to quality health care by strengthening health sector through government ownership and investment in paediatric HIV programmes.

The 21 Global Plan priority countries in Africa with highest burden of mother-to-child transmission (MTCT) were selected as they have different health system profiles, committed to global elimination of mother-to-child transmission (EMTCT) plan by 2015, but also are at different levels of prevention of mother-to-child transmission (PMTCT) programming and socioeconomic status. The representative countries were grouped into four regions based on their socio-political characteristics: Western Africa (Cote d'Ivoire, Ghana and Nigeria), Central Africa (Angola, Cameroon, Chad, and Congo), Eastern Africa (Burundi, Ethiopia, Kenya, and Uganda), and Southern Africa (Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe).

The outcome and predictor variables, data sources and year of data reporting were described in Table 1. The outcome variable (paediatric ART coverage) was defined as the percentage of children (< 15 years) living with HIV receiving ART as derived from 2014 UNAIDS progress report on global AIDS epidemic plan. The other major data sources for predictor variables were 2014 World Health Statistics Report (12), 2011 Report of Forum for a new World Governance version 2.0 (13), 2011–2014 UNAIDS Reports of the PLHIV stigma index (14), World Bank (15), and 2014 UNDP Human Development Report (16). The predictor variables included leadership and governance (measured by governance index score), empowerment of women (measured by gender inequality index score), economic development (measured by adult literacy rate, Gini coefficient and unemployment rate), health system strengthening (measured by density of health workforce per 10,000 population, general government and external expenditure on health as percentage of total expenditure on health), service delivery (measured by MTCT rate, births attended by skilled health staff and infants born to women living with HIV receiving a virology test by 2 months of age – early infant diagnosis), and HIV stigma index (measured by PLHIV being denied health services including dental care due to their HIV status, exclusion from family activities and internal stigma causing shame).

High adult literacy rate

Effective leadership and governance

Political stability
Safety and security
Transparency and accountability in governance
Access to quality health care
Social equity and human development
Respect for basic human rights

Social protection and poverty reduction

Stronger political awareness and leadership for health

Effective HIV information sharing through public domains

Government ownership of HIV/AIDS programmes

Reduced HIV stigma and discrimination

Government investment in paediatric HIV programmes

Strengthened and coordinated technical assistance from external sources for paediatric HIV programmes

Scale-up of ART services to rural and hard-to-reach areas

Functional procurement and supply management system and adequately trained health workforce

Early infant diagnosis

Early paediatric ART and cotrimoxazole initiation

Elimination of mother-to-child HIV transmission

Improved treatment adherence

Zero paediatric HIV death

Declining trend in new paediatric HIV infection

Increasing number of healthy HIV positive children in the population

of law, and control of corruption. We utilized governance index data from the report of 2011 Forum for a New World Governance for this analysis (16). Country-specific data on income Gini coefficient were obtained from the World Bank website. It measures deviation of the distribu- tion of income among individuals or households within a country from a perfectly equal distribution. A value of 0 represents absolute equality and a value of 100 denotes absolute inequality. The gender inequality index is a composite measure reflecting gender disparity in three dimensions of reproductive health, empowerment and the labour market, where the lowest possible score is 0 (equality) and highest possible score is 1 (inequality).

Ethical Statement
Ethical approval was not required for this study as the data were obtained from secondary aggregate data sources in the public domain.

Statistical Analysis
The outcome and predictor data were extracted into Microsoft Excel and analysed with STATA v.12.0. A normal probability plot was used to visualize the pattern of each distribution. All the variables except governance index, gender inequality index, general government expenditure on health as percentage of total

overage.

d expenditure on health as th, and births attended by skewed. Hence, non- se the skewed variables. ive analysis of continuous variables and categorical variables were described by frequencies and percentages. Kruskal-Wallis test for equality-of-populations rank and one-way ANOVA were used to compare differences across the regions. We explored the pattern of relationships with scatter plots. For those cases where a linear relationship was observed, the strength of association between covariates was as- sessed by generating a Spearman's correlation matrix. Bivariate analyses using the outcome variable and each of the predictor variables were undertaken using median regression. We computed the least number of variables required with the lowest p-values for the multivariable analyses to give the best regression model. The β-coefficients were estimated based on the maximum likeli- hood method. A p-value of 0.05 was considered to be statistically significant.

RESULTS

Figure 2 describes the outcome variable (i.e. paediatric ART coverage) for each country. The median paediatric ART coverage was 16% (IQR: 11–31%) with the highest and lowest coverage observed in Botswana (84%) and Chad (5%). As seen in Table 2, there was significant difference in ART coverage for children (p = 0.004), being highest in Southern Africa (30%, IQR: 22–45%) and lowest in Central Africa (7%, IQR: 5.5–11%).

Table 1. Description of variables and data sources

| Variable | Description | Source (reference) | Year of data reporting |
|---|---|---|---|
| Outcome variable | | | |
| Paediatric ART coverage | Percentage of children living with HIV (< 15 years) receiving ART (children receiving ART as a percent of all HIV positive children) | 2014 UNAIDS Progress Report on Global AIDS Epidemic Plan | 2013 |
| Predictor variables | | | |
| Index of Governance | Percentage aggregated score for dimen- sions of good governance: voice and accountability, political stability and lack of violence, government effectiveness, regulatory quality, rule of law and control of corruption; ranging from 0 (ineffective governance) to 100 (perfect score of effective governance). | Report of Forum for a New World Governance version 2.0 | 2011 |
| Gender Inequality Index score | Measures of gender disparity in the 3 dimensions of reproductive health, empowerment and labour market: the lowest possible score is 0 (equality) and highest possible score is 1 (inequality). | United Nations Development Programme (UNDP) Human Development Progress Report 2014 | 2013 |
| Adult literacy rate | Percentage of population ages ≥ 15 who can read and write a short simple state- ment on their everyday life. | 2014 World Health Statistics Report | 2006–2012 |
| Poverty Index | Percentage of population living below $1.25 a day (extreme poverty) | World Bank Development Indicators 2013 | 2013 |
| Gini coefficient | Measured income inequality, where the lowest possible value is zero and the highest being one, when there is more concentration of wealth. | World Bank Development Indicators 2013 | 2013 |
| Unemployment rate | Percentage of total labour force that is without work but available for and cur- rently seeking employment | World Bank Development Indicators 2013 | 2011–2014 |
| HIV Stigma Index | Measured by the percentages of PLHIV who reported being denied health serv- ices due to their HIV status, experienced exclusion from family activities and felt internal stigma causing shame in the previous 12 months of data reporting. | UNAIDS PLHIV Stigma Index Report | 2011–2014 |
| Density of healthcare workers per 10,000 population | Number of doctors, nurses and midwives per 10,000 populations | 2014 World Health Statistics Report | 2006–2013 |
| General government expenditure on health as percentage of total expenditure on health | Ratio of government expenditure on health to total government expenditure (expressed as %) | 2014 World Health Statistics Report | 2011 |
| External resources for health as percentage of total expenditure on health | Ratio of external resources for health to total expenditure on health (expressed as %) | 2014 World Health Statistics Report | 2011 |

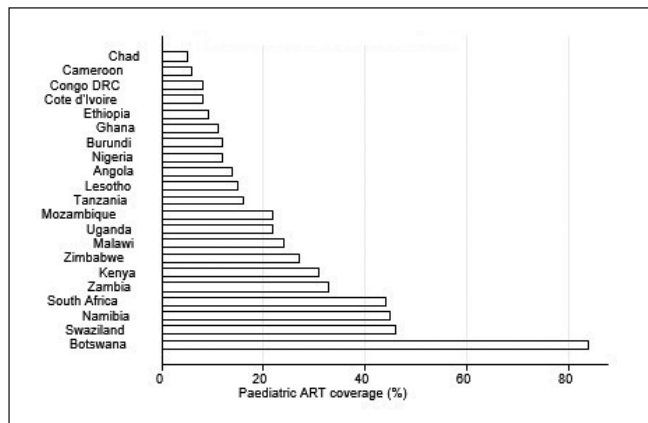| | | | |
|---|---|---|---|
| Mother to child HIV transmission rate | Probability of perinatal or vertical trans- mission of HIV infection which occurs when HIV positive woman spread the infection to her baby during pregnancy, labour and delivery or breastfeeding. | 2014 UNAIDS Progress Report on Global AIDS Epidemic Plan | 2013 |
| Infants born to women living with HIV receiving virology test by 2 months of age | Percentage of HIV-exposed infants receiving a virological HIV test within 2 months of birth | 2014 UNAIDS Progress Report on Global AIDS Epidemic Plan | 2013 |
| Births attended by skilled health staff | Percentage of deliveries conducted by trained health personnel | 2014 UNAIDS Progress Report on Global AIDS Epidemic Plan | 2013 |

Fig. 2. Paediatric ART coverage.

### Leadership and Governance

The mean governance index was 54% (SD = 6.8%), with little difference across the regions (Table 2). The scatter plot (Fig. 3a) indicates a clear linear relationship between paediatric ART coverage and governance index (r = 0.6, p = 0.003).

### Empowerment of Women

The mean gender inequality index score was high (0.6, SD = 0.1). The gender inequality score was lower among countries with a higher paediatric ART coverage (r = −0.6, p = 0.006).
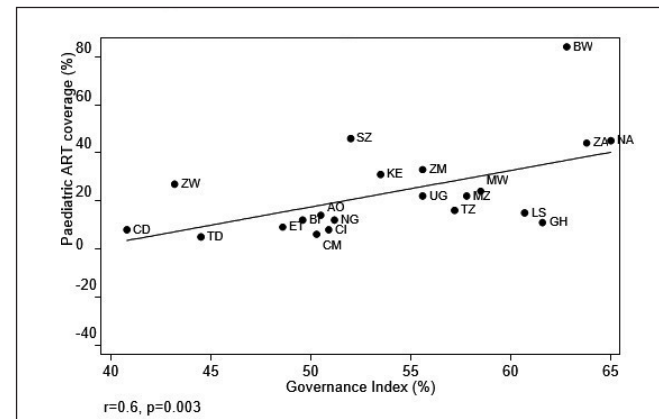


Fig. 3a Paediatric ART coverage and governance index.
Angola – AO, Botswana – BW, Burundi – BI, Cameroon – CM, Chad – TD, Congo – DRC-CD, Cote d'Ivoire – CI, Ethiopia – ET, Ghana – GH, Kenya – KE, Lesotho – LS, Malawi – MW, Mozambique – MZ, Namibia – NA, Nigeria – NG, South Africa – ZA, Swaziland – SZ, Tanzania – TZ, Uganda – UG, Zambia – ZM, Zimbabwe – ZW

Table 2. Descriptive analysis of continuous variables by regions

| Regions | Western Africa | Central Africa | Eastern Africa | Southern Africa | p-value |
|---|---|---|---|---|---|
| Outcome variable | | | | | |
| Paediatric ART coverage, median % (IQR) | 11 (8–12) | 7 (5.5–11) | 17 (10.5–26.5) | 30 (22–45) | 0.004 |
| Predictor variables | | | | | |
| Governance Index, mean % (SD) | 54.6 (6.1) | 46.5 (4.7) | 51.8 (3.3) | 57.7 (6.4) | 0.03* |
| Gender Inequality Index, mean score (SD) | 0.6(0.1) | 0.7(0.04) | 0.5(0.02) | 0.6(0.1) | 0.0314* |
| Adult literacy rate, median % (IQR) | 57 (51–71) | 65.5 (48–70.5) | 72.5 (55.5–80) | 76 (61–85) | 0.20 |
| Population living below $1.25 a day, median % (IQR) | 35(28.6–62) | 40 (32.1–65.6) | 40.6 (37.3–62.4) | 43.5(23.5–60.7) | 0.9365 |
| Gini coefficient, median % (IQR) | 42.8(41.5–48.8) | 41.3(39.4–43.6) | 33.6(33.3–47.7) | 52(44.8–60.3) | 0.0851 |
| Unemployment rate, median % (IQR) | 4.6 (4–7.5) | 6.9(5.4–7.5) | 6.3(4.8–8.1) | 15.1(7.6–22.5) | 0.1138 |
| Denied health services, median % (IQR) | 20 | 5 | 9(4.5–15) | 5.9 (4.5–8) | 0.3048 |
| Experienced exclusion from family activities, median (IQR) | 34.3 | 12.9 | 25.6(9.6–30) | 11.7(10.3–13.6) | 0.3476 |
| Felt internal stigma causing shame, median (IQR) | 62.5 | 35.2 | 45.6(43.8–51.2) | 25.9(16.7–34.8) | 0.1222 |
| Density of healthcare workers per 10,000 population, median (IQR) | 10.3(6.2–20.2) | 5.2 (2.3–18.3) | 6.3 (2.8–9.8) | 13.5 (4.5–31.5) | 0.59 |
| General government expenditure on health as percentage of total expenditure on health, mean % (SD) | 38.1 (16.1) | 44.4 (15.1) | 44.4 (16.2) | 59.4 (13.6) | 0.12* |
| External resources for health as percentage of total expenditure on health, mean % (SD) | 9.8 (4.2) | 16.8 (17.4) | 41.5 (10.4) | 29.7 (23) | 0.14* |
| Mother to Child HIV Transmission rate, median % (IQR) | 23(21–26) | 27(25–30.5) | 20.5(14.5–25) | 12.5(10–15) | 0.0035 |

| | | | | | |
|---|---|---|---|---|---|
| Infants born to women living with HIV receiv- ing virology test by 2 months of age, median % (IQR) | 15(4–30) | 13.5(7–20.5) | 28.5(19–39) | 52.5(35–58) | 0.0158 |
| Births attended by skilled health staff, mean % (SD) | 55(15.4) | 53.5(24.4) | 46(16.8) | 68.1(16.2) | 0.2224* |

*One-way ANOVA was used while other associations were tested with Kruskal-Wallis equality-of-populations rank test.
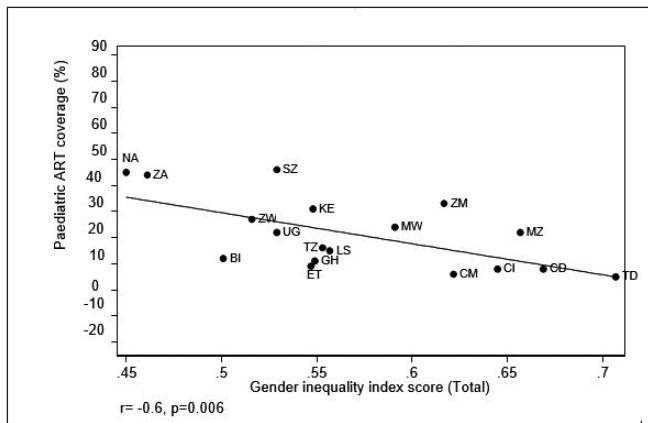
Fig. 3b Paediatric ART coverage and gender inequality index score.

Angola – AO, Botswana – BW, Burundi – BI, Cameroon – CM, Chad – TD, Congo – DRC-CD, Cote d'Ivoire – CI, Ethiopia – ET, Ghana – GH, Kenya – KE, Lesotho – LS, Malawi – MW, Mozambique – MZ, Namibia – NA, Nigeria – NG, South Africa – ZA, Swaziland – SZ, Tanzania – TZ, Uganda – UG, Zambia – ZM, Zimbabwe – ZW
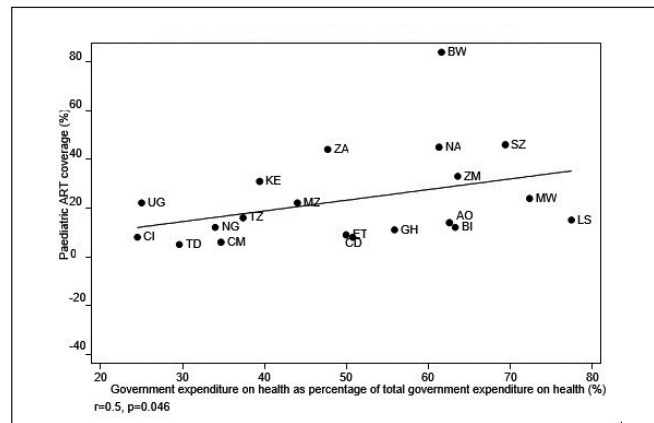


Fig. 3e Paediatric ART coverage and government expenditure on health.

Angola – AO, Botswana – BW, Burundi – BI, Cameroon – CM, Chad – TD, Congo – DRC-CD, Cote d'Ivoire – CI, Ethiopia – ET, Ghana – GH, Kenya – KE, Lesotho – LS, Malawi – MW, Mozambique – MZ, Namibia – NA, Nigeria – NG, South Africa – ZA, Swaziland – SZ, Tanzania – TZ, Uganda – UG, Zambia – ZM, Zimbabwe – ZW
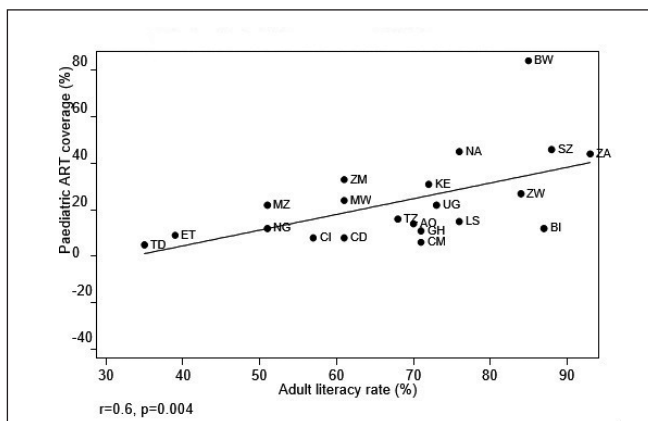


Fig. 3c Paediatric ART coverage and adult literacy rate.

Angola – AO, Botswana – BW, Burundi – BI, Cameroon – CM, Chad – TD, Congo – DRC-CD, Cote d'Ivoire – CI, Ethiopia – ET, Ghana – GH, Kenya – KE, Lesotho – LS, Malawi – MW, Mozambique – MZ, Namibia – NA, Nigeria – NG, South Africa – ZA, Swaziland – SZ, Tanzania – TZ, Uganda – UG, Zambia – ZM, Zimbabwe – ZW
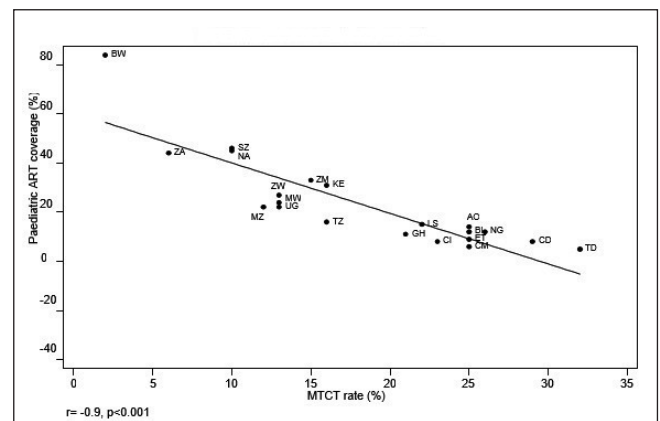


Fig. 3f Paediatric ART coverage and MTCT rate.

Angola – AO, Botswana – BW, Burundi – BI, Cameroon – CM, Chad – TD, Congo – DRC-CD, Cote d'Ivoire – CI, Ethiopia – ET, Ghana – GH, Kenya – KE, Lesotho – LS, Malawi – MW, Mozambique – MZ, Namibia – NA, Nigeria – NG, South Africa – ZA, Swaziland – SZ, Tanzania – TZ, Uganda – UG, Zambia – ZM, Zimbabwe – ZW
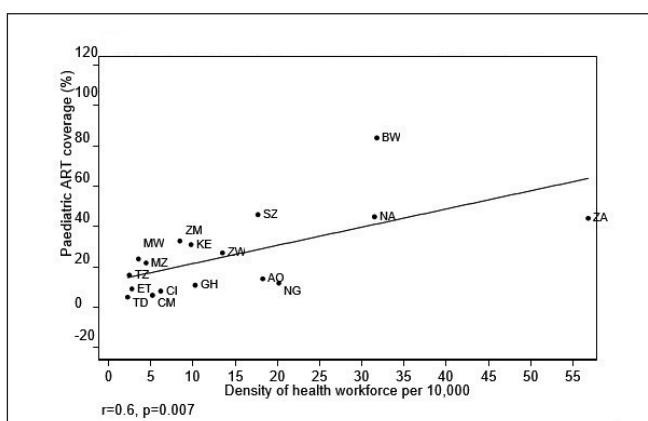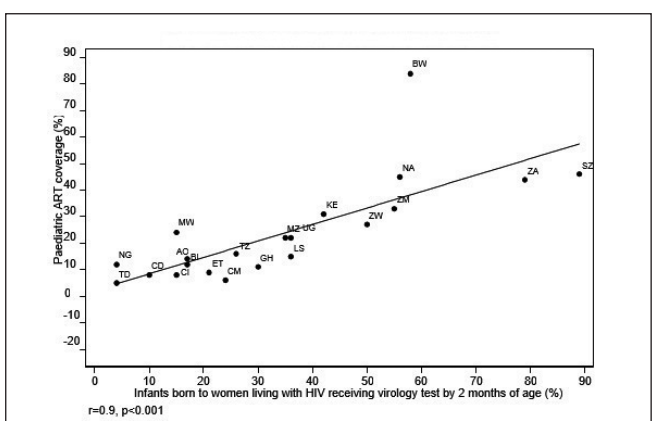


Fig. 3d Paediatric ART coverage and density of health work-



force.

Angola – AO, Botswana – BW, Burundi – BI, Cameroon – CM, Chad – TD, Congo – DRC-CD, Cote d'Ivoire – CI, Ethiopia – ET, Ghana – GH, Kenya – KE, Lesotho – LS, Malawi – MW, Mozambique – MZ, Namibia – NA, Nigeria – NG, South Africa – ZA, Swaziland – SZ, Tanzania – TZ, Uganda – UG, Zambia – ZM, Zimbabwe – ZW

Fig. 3g Paediatric ART coverage and infant diagnosis at 2 months.

Angola – AO, Botswana – BW, Burundi – BI, Cameroon – CM, Chad – TD, Congo – DRC-CD, Cote d'Ivoire – CI, Ethiopia – ET, Ghana – GH, Kenya – KE, Lesotho – LS, Malawi – MW, Mozambique – MZ, Namibia – NA, Nigeria – NG, South Africa – ZA, Swaziland – SZ, Tanzania – TZ, Uganda – UG, Zambia – ZM, Zimbabwe – ZW

## Economic Development

The lowest adult literacy rate was observed for Western Africa at 57%, while Southern Africa had the highest rate at 76%. The adult literacy rate ranged from 35% (Chad) to 93% (South Africa). There is evidence to suggest that countries with higher literacy rate had greater paediatric ART coverage (r = 0.6, p = 0.004). Ap- proximately 43% (IQR: 32–61%) of African population live below $1.25 per day (extreme poverty). However, no relationship was observed between paediatric ART coverage and poverty index (r = −0.1, p = 0.610).

The Gini coefficient and unemployment rate were 44.2% (IQR: 39.8–51.5%) and 7.5% (IQR: 5.4–13.3%), respectively. The graphical distribution of the relationship between ART cover- age in children in relation to Gini coefficient and unemployment suggests, counterintuitively, that ART coverage increases as income inequality (r = 0.7, p = 0.001) and unemployment (r = 0.6, p = 0.004) increase.

## HIV Stigma Index

Looking at HIV stigma and discrimination, 6.2% (IQR: 4.6–8.9%) of people living with HIV reported being denied health services including dental care because of their HIV status, 12.9% (IQR: 10.5–26.5%) experienced exclusion from family activities and one-quarter felt internal stigma causing shame. However, no relationship was observed between paediatric ART coverage and HIV stigma index in the parameters that were studied.

## Health System Strengthening

The density of health workforce (physician, nurses and midwives) was generally low, 9.8 (IQR: 4.5–18.3) per 10,000 population. This was highest in South Africa (56.8) and lowest in Chad (2.3). Countries with a high paediatric ART coverage had a significantly higher density of health workforce per 10,000 population (r = 0.6, p = 0.007). Except for Mozambique, Tanzania and Uganda, general government expenditure on health as percentage of total expenditure on health was higher across the regions compared to external resources for health as percentage of total expenditure on health (50.2%, SD = 16.1%; and 26.5%, SD = 20.2%), respectively. Correlation coefficients indicated that increasing government expenditure on health was associated with a higher rate of paediatric ART coverage (r = 0.5, p = 0.046). However, external expenditure on health appeared not to be related to paediatric ART coverage (r = 0.02, p = 0.93).

## Service Delivery

The overall MTCT rate was 16% (IQR: 13–25%) and the proportion of infants born to women living with HIV receiving virology test by 2 months of age was 30% (IQR: 17–50%). The paediatric ART coverage correlated significantly with MTCT rate (r = −0.9, p < 0.001) and HIV-exposed infants receiving virology test by 2 months of age (r = 0.9, p < 0.001). Over half (58.8%, SD = 18.9%) of births were attended by skilled health staff. Indeed, the percentage of deliveries by skilled birth attendants was somewhat related to ART coverage in children but the relationship was not statistically significant (r = 0.4, p = 0.088).

## Multivariate Analysis

In multivariate analysis, MTCT rate, governance index, un- employment rate, and percentage of infants born to women living with HIV receiving virology test by 2 months of age were included in the model. Only MTCT rate was significantly associated with paediatric ART coverage in the multivariate model (β = −1.27; 95% CI: −2.3, −0.24; p = 0.002).

## DISCUSSION

Countries with higher paediatric ART coverage tended to have higher governance index, higher adult literacy rate, bigger health workforce, higher government expenditure on health, more uptake of EID, higher unemployment rate, and income inequality. Gen- der inequality and MTCT rate had an inverse relationship with paediatric ART coverage in the 21 African countries. Multivariate analysis indicated that the most significant factor was MTCT. Health inequality has been widely reported as a major barrier of health service utilization globally and there is growing evidence that socio-economically disadvantaged populations include HIV exposed and infected children. Prior literature recognizes that inappropriate awareness of EMTCT and paediatric HIV services might be responsible for low detection and treatment coverage rates (5–7). So far, there is paucity of research in this area of paediatric HIV to provide a strong evidence base for its possible socioeconomic correlates hence making it difficult to formulate strategies for closing the existing treatment gaps. This study con- tributes to the limited literature in paediatric HIV care in the light of increasing understanding of the relationship between paediatric ART coverage and critical socioeconomic factors in sub-Saharan Africa. Also, this study reinforces that ensuring that no child is born with HIV through EMTCT strategies will allow for scaling- up of linkages to paediatric HIV treatment in sub-Saharan Africa. Contrary to what was previously known, paediatric ART cover- age is not associated with stigma. The lack of association might have resulted from an amplified HIV stigma-related awareness campaigns in the recent years leading to a more positive health seeking behaviour and friendly attitudes within communities towards PLHIV (17). Also, our results did not reflect poverty rate as a correlate but research elsewhere was inconclusive as relative poverty predicts health better than absolute poverty (18). Our study shows that there is a link between good governance and successful implementation of HIV treatment services for children. Strong political leadership and commitment to HIV pro- grammes are critical enablers necessary to accomplish the national paediatric ART targets and eradication of paediatric HIV (7). The governance index may be important because of its implications on programme ownership and sustainability, policy environment, human rights promotion, and health equity. In countries with low paediatric ART coverage, there is emerging evidence of gaps in coordination of the national response owing to the differing perspectives and practice resulting in a lack of ownership and clarity of process in implementing the HIV programmes. The relationship between general government expenditure on health as percentage of total expenditure on health and paediatric ART coverage had borderline statistical significance. Furthermore, inadequate domestic funding for health was observed which might be responsible for non-prioritization of paediatric HIV treatment

services. However, there has been documented evidence that financial barriers have been impediment to HIV programmes (9, 19). Therefore, emphasis should be placed on making paediatric HIV a national priority and governments should consider having clearly defined budgets for paediatric ART.

Our analysis indicated that staff per 10,000 population varies from one country to the other. There were estimated 9.8 doctors, nurses and midwives per 10,000 population, but sub-Saharan Africa falls short of the minimum threshold of 23 per 10,000 population recommended by the WHO as necessary to deliver essential maternal and child health interventions. Large disparities in the distribution of health workforce across the regions compound the matter further, with Central and Eastern Africa being particularly under-resourced (5.2 and 6.3, respectively). For example, some countries notably Chad, Ethiopia and Tanzania have less than three healthcare staff per 10,000 population, whereas South Africa, Botswana and Namibia have 56.8, 31.8 and 31.5, respectively. These estimates did not take into account the type of services provided by the doctors, nurses and midwives. Urgent action is needed to address the causes of health worker shortages and in implementing clinical mentoring and task-shifting to best utilize human resources for health care by reallocating tasks within healthcare team.

We demonstrated that the proportion of children tested at 2 months was low (30%). This is similar to findings from developing countries like Jamaica and Cambodia where much older children were enrolled into the programme (20, 21). In countries with high MTCT rate such as Chad, Congo DRC, Nigeria, Angola, and Burundi, it was observed that the proportion of infants tested for HIV by 2 months was low. This suggests that the large population of HIV exposed children might have overstrained their healthcare system making it difficult to test the children early. Moreover, we found a strong correlation between paediatric ART coverage and infants born to women living with HIV receiving virology test by 2 months of age. The gap between the number of EID and paediatric ART sites has been documented to have contributed to weak linkage of HIV infected children to treatment services (9). Identified HIV positive children are not being initiated early on ART because of shortages of HIV commodities and long turnaround time for dried blood spot result using PCR (9). From previous observational studies, the mean age at first DNAPCR for EID and ART initiation were 10 weeks and 5 years, respectively (22, 23). This might be attributed to health inequalities in different regions as paediatric ART programmes lag behind adult programmes (5). This observation is of key importance in generating demand for paediatric HIV services through provider initiated testing and counselling (PITC) and integration into the Maternal and Child Health services as some of the caregivers might not have adequate information on the availability of paediatric HIV services.

In spite of current global efforts in elimination of mother-to-child HIV transmission, it was observed that MTCT rate and gender inequality score were high (16% and 0.6, respectively), with unmet need of paediatric HIV services remaining inadequate in Africa. Among the countries, MTCT rate and gender inequality index score were consistently higher among countries with lower paediatric ART coverage. Importantly, Central Africa was observed to have the highest gender inequality index score (0.7) which might have been partly responsible for the highest MTCT rate observed there (27%) and an associated low ART coverage

for children (7%). Likewise, this finding is consistent with the UNAIDS report that countries where gender inequality was not neglected showed improvement in uptake of ART services (11). This study has identified education as an important association with paediatric ART coverage. Our findings indicated that adult literacy was positivity correlated with paediatric ART coverage. However, a major obstacle was the low level of education among adults especially in Western Africa (43%) and Central Africa (34%). This result corroborates the findings by Okomo et al. who identified that the caregivers were predominantly illiterate grand-parents with poor health-seeking behaviours (24). Also, Mondal and Shitan in their study have identified that being able to understand medical treatment is crucial for treatment adherence (25). Therefore, illiteracy can pose a long term barrier to accessing treatment and optimizing adherence especially in PLHIV. Our findings underscore the importance of promoting health literacy through the use of simplified information, education and communication (IEC) materials during community advocacy and awareness outreaches. Comparable to other studies outside Africa, migrant populations which represent a significant proportion of reported HIV cases in high-income countries is attributed to epidemiological patterns in countries of origin such as high prevalence settings of sub-Saharan Africa. The identified barriers to migrants and ethnic minorities accessing HIV testing and care in France, Spain, United Kingdom, Canada, and the United States included stigmatization and discrimination by their community, implication on legal status, high levels of unemployment, poverty, low social status, and inequalities (26–31). Several studies have highlighted the need to remove socioeconomic barriers that deter African migrants from being tested for HIV and linked to HIV care (26–27).

A distinctive finding for which further research is needed is the result that suggested that paediatric ART coverage is greater in countries with higher unemployment rates and greater income inequality, whereas the opposite would be expected. This finding might have been due to residual confounding. This finding might also have been due to the ecological fallacy.

Ecological studies at population level are important when considering social risks that cannot be deduced from individual level data and can be used to develop policy and plan healthcare programmes by government. However, our findings require cautious interpretation because associations at both country and regional levels might not reflect associations at the individual level. As with all correlation studies, significant limitations exist with respect to causal inferences and are inherent in this study.

CONCLUSION

Low paediatric ART coverage in sub-Saharan Africa have continued to hamper satisfactory progress towards eliminating AIDS-related deaths among HIV-infected children. This study has provided evidence of inter-relationships between paediatric ART coverage and the socioeconomic environment. Ensuring the survival of HIV-infected children requires broader development planning processes and greater commitment from social, economic and political leadership.

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