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# Effect of Health Development Assistance on Health Outcome Indicators in Sub-Saharan African Countries

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***Abstract:***
*This study investigates the effect of health development assistance (HDA) on health outcome indicators employing child mortality rates (CMR) as a proxy using the panel-constructed data set of twenty (20) Sub-Saharan African countries for the period 1990-2021. Panel co-integration estimation technique and System GMM econometric methods were employed to assess the relationship between CMR and HDA. The finding from the study indicates that health development assistance (HDA) has an improved effect on health outcome indicators (CMR) employed as a proxy. Health development assistance has a statistically significant and negative effect on child mortality rates. A one percent increase in health development assistance decreases the child mortality rates by eight (8) or one (1) per 1,000 live births in the region in each estimation technique employed in this study. This study concludes that health development assistance has an improved impact on the health outcome indicator (CMR) employed as a proxy in Sub-Saharan African countries. The study recommends, among others, that Sub-Saharan African countries should find ways of progressing domestic factors that (like GDPPC, improved exchange rate, and better domestic private health spending) will continue to impact health outcome indicators favourably in the region to bring an end to the era of repeated dependency on external resources for mitigating health-related challenges in the region; and also suggests that the reasons for the ineffectiveness of HDA in the short run in the region should be investigated and the findings made public.*

***Keywords:*** *Health development assistance, health outcome indicator, child mortality rates*

## 1. Introduction

The first asset of a nation, from the spectrum of things, regardless of its huge abundant resource endowments, is its health (Davidson, Kitzinger, & Hunt, 2006). According to World Health Organization (WHO, 1946), with an iota of truth, health is irrefutably viewed at a tremendous rate by many as an unalienable citizen's right, the attainment of which is a responsibility for the advanced, developing and emerging economies. It is also regarded unequivocally by Olarinde & Bello (2014) as one of the most essential and imperative components that ascertains the standard of human capital, an ingredient for economic growth and development which is the foundation of any activity that a man takes part in. Olarinde and Bello (2014) corroborate Atun & Fitzpatrick (2005), which state that empirical evidence revealed that a nation's health significantly boosts its economic development and vice-versa. If an Arabian proverb is succinctly and carefully considered by someone in the actual sense, that is, "he who has health has hope and he who has hope has everything" (Nwaobi, 2005) and it is x-rayed with the popular African maxim 'Health is wealth,' it becomes unambiguous and indispensable that the importance of health cannot be overrated. Due to its important nature, Alsan, Bloom and Canning (2006) opined that the quest for better health should not await or be tagged to a bettered economy; rather, a course of action to ameliorate health will contribute to economic growth.

Developing countries are reported to make up approximately 84% of the global population and recorded 92% of the burden of disease but with only 29% of Gross Domestic Product and 16% of health spending as of 2009. Global Health Data Exchange (GHDE) (2017) points out that as of 2015, more than 87 percent of global disease burden was in low and middle-income countries, but only 35 percent of global spending on health occurred in these countries. Towards this paucity of resource setting, there is a need to augment or help the developing countries out of this qualm through the timely and adequate provisions of health development assistance. Also, the Executive Secretary of the UN Economic Commission for Africa, Vera Songwe, states that ‘‘edging-out shortage of funds is a big qualm to delivering the goal of Universal Health Coverage (UHC) in the continent'' and that the continent wrestles with a health financing deficit of $66bn a year and that bridging the gap requires that African countries must look beyond government budgets to finance their health systems (Siona, 2019).

It has long been recognized that gains in child survival show imperative improvements in overall population health and socioeconomic development. Child mortality rates refer to the probability of dying between one and exactly five years of age expressed per 1000 live births in a given geographical area during a given year. While many countries globally have recorded significant reductions in under-five mortality over the past thirty years, it is saddening that many of the countries in Sub-Saharan African Countries (SSACs) have not attained the Millennium Development Goal (MDG) 4 target of reducing under-five mortality by two-thirds between 1990 and 2015 (You *et al*., 2015). Wang *et al.* (2016) also state that many of the SSA countries recorded under-five mortality rates of 75+ deaths per 1000 live births in 2015. These rates totally deviated from the Sustainable Development Goal (SDG) 3.2, which targets to reduce under-five mortality to < 25 deaths per 1000 live births by 2030. World Bank (2021) also reports that as of 2019, under-five deaths for males in SSA was 81 per 1000 live births, while that of females was 70 per 1000 live births. This shows that as of 2019, under-five deaths on average for both sexes were still 75 per 1000 live births. SDG 3.2 seems unrealizable in SSACs unless its current rate of reduction is triple within the remaining seven years ahead to make the target (goal) feasible.

Considering this disparity between SDG goal 3.2 and under-five deaths recorded by both sexes as of 2019 in developing countries, mobilizing more resources to improve health in developing countries has become imperative.

Health Development Assistance (HDA) is defined by Keeley and Brian (2012) as a health investment. In other words, donors give away money and other resources in the hope of bigger returns - both for themselves and for developing countries – in the years to come. Health Development Assistance differs from Development Assistance for Health in the sense that it factors in chiefly funding for health sector tasks and population programs, yet generally factors out tasks outside the health sector that may influence health positively, for instance, water and sanitation programs.

Health outcome is a change in the health status of an individual, group or population which is ascribable or attributable to an organized or designed intervention or sequences of interventions, not minding of whether such an intervention was aimed to change health status (Asiedu *et al.*, 2015). Health outcome indicators are states of health or events that follow care and that may be influenced by health care. Here are the five Ds of health outcome indicators:

- Death (mortality),
- Disease (morbidity),
- Discomfort,
- Disability and
- Dissatisfaction (Mainz, 2003)

In the last two decades, research on health aid has increased rapidly due to these attributable reasons.

- First, a surge in private funding for global health is encouraged by the growth in HIV/AIDS epidemic in SSACs (Afridi & Ventelou, 2013).
- Second, there has been an exodus from conservative modes of HDA to the appearance of diverse new actors (Szlezak *et a*l., 2010) handling the compounded problem of health status in SSACs.
- To conclude, the 'global health' evolution has become a principal motivating force for aid with a loud voice to give precedence to health (Afridi & Ventelou, 2013).

Despite the increasing volumes of support from Health Development Assistance targeted at ameliorating health care delivery and overall health systems achievement in SSACs, a rising argument has been generated whether the build-up of health development aid has bolstered the current health systems of SSACs and also whether it is bringing about the expected or little health outcomes (Ejughemre, 2013). This statement partly signifies that despite immense inflows of HDA to SSACs, little achievement has only been recorded in terms of health outcomes and that this little achievement occurs in common diseases and other health-related challenges recently coming to the limelight in SSACs. More infant and child deaths, maternal deaths, neo-natal deaths, morbidity, and economic losses are occurring because of these health challenges in the region.

Confined scholarly works have emerged in the domain of the effectiveness of Health Development Assistance (HDA) and health outcome indicators and there is no consensus among the researchers. On one side are those that believe that HDA is not effective, in the middle are those that believe that HDA has negligible effect on health outcomes and at the extreme are those that hold a belief that much has been achieved in SSACs as a result of HDA channeled to the region by the developed countries. A paucity of research and failure of consensus among the researchers in this area of study request that additional research be cautiously carried-out to inquire into the nature of the relationship that exists between HDA and health outcome indicators (Child Mortality Rates) in SSACs.

**2. Theoretical Framework and Empirical Review of Literature**

According to the Big-Push theory by Rosenstein Rodan (1943), the sluggishness or inactivity of the developing countries' economies could get better off only through massive or great capital investments from overseas (foreign aid). He kicks against any strategy of economic development that rests basically upon the philosophy of economic 'gradualism' because it is bound to be frustrated and fail. He states that a 'big push' (foreign aid) is needed to undo the initial sluggishness of the stagnant economy and that it is only after this that a smooth journey of the economy towards higher levels of productivity and income can be guaranteed.

As developing countries happen to depend on health development assistance from developed countries, the appraisal of its effect or impact on health outcome indicators becomes important. Though there are a few pieces of empirical literature that investigated this impact, to arrive at a more emphatic outcome associated with this impact in the region, it is of utmost importance that the region is scrutinized separately. In the meantime, no concord establishes in the literature regarding the effectiveness of HDA on the health outcome indicators of SSACs.

A study by Wilson (2011) investigates health aid and mortality in 96 high-mortality countries between 1975-2008 in a paper titled "Chasing Success: Health Sector Aid and Mortality" using regression analysis. The finding revealed that aid interventions appeared to be associated with small improvements in the MDG indicators. The conclusion reaches that health aid is trailing past success instead of recording more successes in recent times.

Taylor, Hayman, Crawford, Jeffery and Smith (2013) apply systemic review to investigate "The impact of official development aid on maternal and reproductive health outcomes." The study uses electronic databases that identified 30 studies reporting aid-funded interventions designed to improve maternal and reproductive health outcomes. The finding also reveals that aid interventions appeared to be associated with small improvements in the MDG indicators.

Also, Brempong (2015), in his paper titled "Do African Countries Get Health from Health Aid?" investigates the effects of health aid on health outcomes between 1990-2012. Using panel data and a dynamic panel data (DPD) estimator, the study finds that health aid has a positive and significant effect on health outcomes in African countries. However, the study does not investigate which type of health aid is responsible for improving health outcomes.

Negeri and Halemariam (2016) explore the effect of health development assistance on health status in Sub-Saharan Africa, using the panel data analytic method and infant mortality as a proxy for health outcomes in 43 Sub-Saharan African countries from 1990–2010. The result shows that health development aid significantly reduces the infant mortality rate in the region. The study recommends that other health focus areas should be looked into through channeling health aid to reduce their incidences.

Head, Goss, Gelister, Alegana, Brown, Clarke, Fitchett, Atun, Scott, Newell, Padmadas, and Tatem (2017) apply search strategy and selection criteria methods and data analysis were done through intervention and product development (including pharmaco vigilance), public health research or cross-disciplinary research to describe the trends of investments in malaria-related research in Sub-Saharan Africa and compare an investment with national disease burden, to identify areas of funding strength and potentially neglected populations in their titled paper "Global funding trends for malaria research in Sub-Saharan Africa: a systematic analysis." Findings show significant decreases in disease burden of research awards solely focused on malaria.

Kebre (2018) investigates ''Can aid improve people's health in Sub-Saharan African countries?'' using panel data for a sample of 43 SSACs over the period of 1990 to 2014. The health outcome indicators used were infant mortality rate, crude mortality rate and HIV/AIDS prevalence rate. The results show that aid significantly reduced crude mortality, infant mortality, and HIV/AIDS prevalence rates. There is a non-direct effect and this suggests that health aid is more potent in reducing mortality and HIV prevalence in comparatively poverty-stricken or necessitous countries and in those with remarkably bottommost health expenditure.

Pickbourn and Ndikumana (2018), in their paper titled "Does health aid reduce infant and child mortality from diarrhea in Sub-Saharan Africa?" place their searchlight on the impact of foreign aid to the health sector on diarrhea mortality in children under five in 47 sub –Saharan African countries from 2000-2013. The study applies panel data on the sectoral allocation of official development assistance in conjunction with country-level secondary data on health outcomes. The result indicates that expanded health aid is associated with lower diarrhea mortality in children under five.

Banchani and Swiss (2019) examine the impact of foreign aid on maternal mortality in 130 low- and middle-income countries between 1996 – 2015 using a two-way fixed effects panel regression model with both year- and country-fixed effects. The study finds that the effects of total foreign aid on maternal mortality are finite or limited. However, that aid assigned to the reproductive health sector and exactly at maternal health is related to significant cuts in maternal mortality.

Doucouliagos, Hennessy and Mallick (2019) estimate the impact of health aid and governance on infant mortality in 96 recipient countries using the long difference estimator and instrumental variable estimation technique analysis. The finding reveals that good governance (measured either as government effectiveness or control of corruption) is an important determinant of the effectiveness of health aid in reducing infant mortality. Also, a four (4) percent reduction in infant mortality is achieved from the health aid disbursed to the recipient nations that have improved institutional quality.

Kavanagh and Chen (2019) investigate "Governance and health aid from the global fund: Effects beyond Fighting Disease" using a unique dataset from 112 low- and middle-income countries from 2003 to 2017 on Global Fund financing and multiple measures of health development and governance. The study uses a regression model of analysis. The finding shows there is an associated benefit for overall adult mortality, human development and reduction in the burden of diseases in these countries.

Kiross, Chojenta, Barker and Loxton (2020), in their paper titled "The Effects of Health Expenditure on Infant Mortality in Sub-Saharan Africa: Evidence from Panel Data Analysis," using secondary data from 2000 to 2015 covering 46 countries in Sub-Saharan Africa, carefully consider the effect of both public and external spending on infant mortality. Evidence from the finding shows that both sources of healthcare spending show a significant inverse relationship with infant and neo-natal mortality.

Nwude, Ugwoke, Uruakpa, Ugwuegbe and Nwonye (2020) employ a dynamic two-step system (GMM) estimator (Panel data) to compare the effects of official development assistance and income per capita on health outcomes in 81 developing countries between 1999-2017. The study finds that official health development assistance fails to improve health outcomes in developing countries, while income per capita significantly boosts health outcomes in developing countries.

Toseef, Jensen and Tarraf (2019) assess how effective foreign aid is at improving health outcomes in recipient countries. The study uses five health outcomes: infant mortality, life expectancy, the annual death rate, and immunizations against measles and diphtheria and also employs a two-step-system Generalized Method of Moments technique panel data

set covering 90 developing countries between 2001-2015. The study finds that life expectancy in developing countries improves, but the effect is very tiny. The study suggests the reexamination and classification of the current forms if it considers unyielding or unproductive.

Zounkifirou (2020) applies Dynamic Panel Data (DPD) and difference estimation techniques using longitudinal data to investigate the effects of health aid on health outcomes between 2000 and 2017. It considered health aid effects on maternal mortality, HIV prevalence, Tuberculosis prevalence, life expectancy and under-5 mortality. The study found that it has miniature effects but a statistically significant positive impact on health outcomes in SSACs.

Jemiluyi, Bank and Alao-Owunna, (2021) apply a fully modified ordinary least square (FMOLS) estimator to investigate the effects of aid targeted at children's health on the various child health outcomes using annual time series data from 1970 to 2018. It found reducing impacts on the mortality indicators and a positive correlation with child immunization coverage. It recommended that efficient management of health aid inflow should be prioritized at all levels for improvement in Nigeria.

Muhammad and Ahmad (2021) employ ARDL technique to examine the relationship between health aid and health outcomes in Nigeria using the annual time series data from 1996-2019. The study found that health aid improved under-5 mortality rates in Nigeria both in the long and short run. The study recommended that donor agencies should direct health aid to certain health-targeted areas.

The existing studies across the globe that addressed health development assistance or health aid and health outcome indicators rarely paid attention to or included some economic variables like inflation rate, exchange rate, foreign direct investment and others.

This present study defeats these drawbacks by using some domestic and external economic variables that have hardly been used to investigate the effectiveness of health aid on health outcome indicators.

*2.1. Model Specification*

Based on the discussed framework of Rosenstein Rodan (1943) and the implicit mathematical forms of Negeri and Halemariam (2016), the explicit functional model of this study is stated below:

$$\ln HOI_{(i,t)} = \alpha_0 + \alpha_1 lnHDA_{(i,t)} + \alpha_2 lnGDPPC_{(i,t)} + \alpha_3 DPHE_{(i,t)} + \alpha_4 DGHE_{(i,t)} + \alpha_5 INF_{(i,t)} + \alpha_6 lnEXR_{(i,t)} + \alpha_7 lnFDI_{(i,t)} + \alpha_8 IMMS_{(i,t)} + \alpha_9 PCRF_{(i,t)} + \alpha_{10} GOEF)_{(i,t)} + \varepsilon_1(i,t) + +\mu_1(i) + \mu_2(t) \quad (1)$$

Equation (1) is the long-run determinants of log of health outcome indicator (l*n*HOI).

The equ (1) above is further split into three (3) models.

2.1.1. Model I

$$CMR1_{(i,t)} = U5MR1_{(i,t)} = \alpha_0 + \alpha_1 lnHDA_{(i,t)} + \alpha_2 lnGDPPC_{(i,t)} + \alpha_3 DPHE_{(i,t)} + \alpha_4 DGHE_{(i,t)} + \alpha_5 INF_{(i,t)} + \alpha_6 lnEXR_{(i,t)} + \alpha_7 lnFDI_{(i,t)} + \alpha_8 IMMS_{i,t)} + \alpha_{10} PCRF_{(i,t)} + \alpha_{11} GOEF)_{(i,t)} + \varepsilon_1(i,t) + \mu_1(i) + \mu_2(t) \quad (2)$$

The above model (termed Model I) assumes the stability of elasticities of health status with respect to the identified explanatory variables without controlling for the previously existing level of health outcome.

2.1.2. Model II

$$CMR2_{(i,t)} = U5MR2_{(i,t)} = \eta_0 + \eta_1 CMR2_{(i,t-1)} + \eta_2 lnHDA_{(i,t)} + \eta_3 lnGDPPC_{(i,t)} + \eta_4 DPHE_{(i,t)} + \eta_5 DGHE_{(i,t)} + \eta_6 INF_{(i,t)} + \eta_7 lnEXR_{(i,t)} + \eta_8 lnFDI_{(i,t)} + \eta_9 IMMS_{i,t)} + \eta_{10} PCRF_{(i,t)} + \eta_{11} GOEF)_{(i,t)} + \varepsilon_2(i,t) + \mu_3(i) + \mu_4(t) \quad (3)$$

The second model (termed Model II) assumes the stability of the elasticities of health status by taking the lagged effects of the outcome variable and the explanatory variables into account to give an unbiased estimation of the coefficient. The inclusion of lagged health status level in the equation is equivalent to incorporating all past lagged effects of the explanatory variables.

2.1.3. Model III

$$CMR3_{(i,t)} = U5MR3_{(i,t)} = \gamma_0 + \gamma_1 CMR3_{(i,t-1)} + \gamma_2 lnHDA_{(i,t)} + \gamma_3 lnGDPPC_{(i,t)} + \gamma_4 DPHE_{(i,t)} + \gamma_5 DGHE_{(i,t)} + \gamma_6 INF_{(i,t)} + \gamma_7 lnEXR_{(i,t)} + \gamma_8 lnFDI_{(i,t)} + \gamma_9 IMMS_{i,t)} + \gamma_{10} PCRF_{(i,t)} + \gamma_{11} GOEF)_{(i,t)} + \varepsilon_3(i,t) + \mu_5(i) + \mu_6(t) \quad (4)$$

The third model (termed Model III) assumes stability of the product of the elasticities and health status instead of stability of the elasticities. It further assumes stability of the marginal effect of the previous level of health status on the present level of health status.

Where CMR represents health outcome indicator as measured by Child Mortality Rates, $CMR_{(t-1)}$ represents health outcome indicator as measured by Child Mortality Rates lagged by one period for country, log of health development assistance (*ln*HDA), log of Gross Domestic Product Per Capita (*ln*GDPPC), Domestic Government Health Expenditure (DGHE), Domestic Private Health Expenditure (DPHE), inflation Rate (INF), log of Exchange Rate (*ln*EXR), log of Foreign Direct Investment (*ln*FDI), Immunization status (IMMS), Primary Completion Rate of Female (PCRF), Government Effectiveness (GOEF), ($\alpha_1 \ldots \alpha_{14}$) parameters or slopes of model I to be estimated, ($\eta_1 \ldots \eta_{15}$) parameters or slopes of model II to be estimated, ($\gamma_1 \ldots \gamma_{15}$) parameters or slopes of model III to be estimated, $\alpha_0$, $\eta_0$ and $\gamma_0$ = constant terms of CMR equations, in country $i$ at time $t$ for $i$ =1,2, …, 20 (number of countries), $t$=1,2,3,4 (number of time units), $\varepsilon(i,t)$ is an error term, $\mu_1(i)$ and $\mu_2(t)$ are country- and time-specific effects, respectively.

Lagged health outcome indicator is to be used as a regressor, given that the previous period's health outcome indicator is likely to affect the health outcome indicator in the current period. Equations (1), (2) and (3) are stated in autoregressive distributed lag forms.

Similarly, the variables that already appeared in their rate forms (CMR and INF) were not logged, and others that appeared in percentages and others with smaller values were used directly while the logarithmic forms of HDA, GDPPC, FDI and EXR variables were utilized and the nominal form of institutional quality (GOEF) was integrated into the estimated models in line with Iyoboyi and Pedro (2014).

Equ. (3) and equ. (4) are the same because $CMR2_{(i,t)}$ = $U5MR2_{(i,t)}$ and $CMR2_{(i,t-1)}$ and $CMR3_{(i,t)}$ = $U5MR3_{(i,t)}$ and $CMR3_{(i,t-1)}$ are already in rate forms hence cannot be logged.

*2.2. Estimated Techniques*

The panel co-integration estimation technique and Generalized Method of Moments (GMM) were adopted in this study. Panel co-integration splits into three stages. The first stage deals with the testing of stationarity, i.e., panel unit root test; the second stage deals with error correction-based panel co-integration and the last stage deals with both the long-run and short-run equations. GMM was employed due to some shortcomings (like serial correlation and endogeneity) that manifest in panel ARDL.

*2.3. Data and Measurement of Variables*

Negeri and Halemariam (2016) pointed out in their study that health status has no collectively approved unit of measure. Rather, commonly used as the aggregate focus area of empirical research, mortality rates and life expectancy at birth are examined proxies for health status. To investigate the effect of HDA on health outcome indicators in this study, CMR was chosen as an indicator for health outcomes. The simple reason for choosing CMR is based on the fact that it is one of the most widely used measures in the literature and a suitable health outcome indicator for estimating the aftermath of various interventions program designed to ameliorate child life span (United Nations Report, 2005). Clearly, an attempt to evaluate the effect of HDA requires the control of other effects that crop up from economic variables, medical variables and social variables. For this purpose, together with the principal variable of interest – HDA – per capita income, domestic private health expenditure, domestic government health expenditure, inflation rate, exchange rate, foreign direct investment, immunization status, primary school completion rate of female and government effectiveness were treated to be the major economic, medical and social variables. The data of these mentioned variables were sourced from World Development Indicators, Financing Global Health Database, Global Health Expenditure database, UNICEF Global database and Worldwide Governance Indicators.

- *Child mortality rates or under-five mortality rates*, which were extracted from UNICEF Global database, refer to the probability of a child dying between one and exactly five years of age expressed per 1000 live births in a given geographical area during a given year. Its unit of measure is child deaths per 1000 live births.
- *Health Development Assistance* - It is a financial and in-kind donation made by channels of development assistance –that is, by institutions or major development agencies whose primary purpose is providing development assistance to improve health in developing countries. It is measured in 2019 constant US Dollars. Its data were sourced from Financing Global Health Database.
- *Gross Domestic Product Per Capita* - It is a metric that breaks down a country's economic output and services per person and is calculated by dividing the GDP of a country by its population. It is measured in 2019 constant US Dollar. Its data were sourced from World Development Indicators. This variable is carefully regarded to be associated with health outcome indicators because an increased level of income will throw its weight to the consumption of quality goods and services, improved nutrition, quality housing and also serves as a financial boosting ability to seek for and settle for better medical services and cares for children.
- *Domestic Private Health Expenditure* - It is the share of current health expenditure funded from domestic private sources. Domestic private sources include funds from households, corporations and non-profit organizations. It is measured as a percentage of GDP. It is included to examine its effect on child health in SSACs. Its data were extracted from World Development Indicators.
- *Domestic Government Health Expenditure.* It is the portion of general government health expenditure from domestic or home sources. It is measured as the percentage of GDP. It is included to examine the effect of domestic government health expenditure on child health in SSACs. Its data were extracted from Global Health Expenditure database.
- *Inflation rate* which takes to be the rate at which prices rise or increase over time, thereby resulting in a fall in the purchasing value of a unit of money in the country. It is measured by the consumer price (annual percentage) index and sourced from World Development Indicators. It is included because it determines the amount of quality and quantity consumption of food, the amount of quantity and quality drugs and medical care services through their various prices a child can have access to through his or her mother.
- *Exchange rate.* It is the rate determined by national authorities or in the legally sanctioned exchange market. It is calculated as an annual average based on monthly averages (local currency units relative to the U.S. dollar). It is measured based on exchanging one US dollar for a local currency. It is included because it determines the prices of the imported food products and drugs that will be sold in a country. Its data were extracted from World Development Indicators also.
- *Foreign Direct Investment.* It is the sum of equity capital, reinvestment of earnings, and other capital. Direct investment is a category of cross-border investment associated with a resident in one economy having control. It is measured in 2019 constant US dollar and its data were similarly sourced from World Development Indicators. It is included because it is expected to expand the employment base, create jobs and increase the country's GDP.

- *Immunization Status* - It measures the percentage of children of twelve to twenty-three months (12-23 months) who received DPT vaccinations before reaching 12 months or at pre-survey time. It is measured in percentage and its data were also sourced from World Development Indicators. Its inclusion is based on the fact that the more children between the age one-five are vaccinated or immunized, the lesser the number of children's deaths expected to be recorded.
- *Primary school completion rate of females* - The primary school completion rate of females or a gross intake ratio to the last grade of primary education is the number of new entrants (enrollments minus repeaters) in the last grade. It is measured as the percentage of relevant age group and its data were sourced also from World Development Indicators. It is included because more education for women affords them an opportunity for greater awareness and consciousness about how to improve their family, community and country health outcome level.
- *Government effectiveness* - It is a concept that focuses on the quality of public services, the quality of the civil service and the degree of its independence from political/pressure, the quality of policy formulation and implementation, and the reliability of the government's loyalty to such policies. Its estimate of governance ranges from approximately -2.5 (weak) to 2.5 (strong) performances. Its data were sourced from Worldwide Governance Indicators of the World Bank.

*2.4. Scope of the Study*

The study covers the period between 1990 and 2021 and uses cross-sectional and yearly time series data consequently for 20 SSACs. These chosen countries represent the four major regions of SSACs from low-income countries (LICs), lower-middle-income countries (LMICs), upper-middle-income countries (UMICs) and high-income countries (HIC) of the region (Central African Republic, Chad, Equatorial Guinea, Gabon, DR Congo, Ethiopia, Kenya, Madagascar, Mauritius, Tanzania, Angola, Botswana, Lesotho, South Africa, Zambia, Benin Republic, Cote d'Ivoire, Ghana, Nigeria and Senegal).

## 3. Results and Discussion

*3.1. Descriptive Results*

As specified or illustrated by table 1, during the evaluated period 1990-2021, it was estimated that the average child mortality rate (CMR) per 1000 live births was 106 in the Sub-Saharan African countries. In accordance with the data set, CMR reached its zenith in Central African Region (CAR) 169 in 1990, 129 in East African Region (EAR) in 1990, 122.97 in South African Region (SAR) in 1998 and 161 in West African Region (WAR) in 1990. However, in 2019, good performances (lowest CMR) were noticed in CAR (87), EAR (42), SAR (60) and WAR (76). The average per capita values of HDA and GDPPC in the region were $201.51 and $2232.54, respectively, both in constant 2019 USD. The mean of DPHE is 1.97% of the GDP of the region, while the average of DGHE is 1.4% of the GDP of the region. The average inflation rate in the region stood at 8.6%, while the mean of local currency to a dollar in the region stood at 375. The average foreign direct investment in the region stood at 762 million US dollars. The immunization status of children aged between 12-23 months averaged 68.2% in the region, while the primary completion rate of females in the region averaged 57.6%. Finally, the table points out that during the investigated period, the mean index of GOEF in the region was less than zero in the region. This suggests that the overall government effectiveness towards reducing children's deaths in the region was relatively low.

| Variables | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| CMR | 640 | 105.526 | 49.824 | 14.493 | 222.280 |
| HDA | 640 | 201.518 | 320.325 | 0.000 | 1972.380 |
| GDPPC | 640 | 2232.542 | 3214.666 | 102.598 | 22942.580 |
| DPHE | 640 | 1.971 | 0.899 | 0.034 | 4.948 |
| DGHE | 640 | 1.427 | 1.171 | 0.000 | 5.800 |
| INF | 640 | 8.638 | 4.920 | 0.000 | 23.773 |
| EXR | 640 | 375.057 | 534.771 | 0.000 | 3618.322 |
| FDI | 640 | 762.146 | 1411.110 | -27.676 | 10028.210 |
| IMMS | 640 | 68.242 | 21.847 | 10.000 | 99.000 |
| PCRF | 640 | 57.624 | 25.444 | 4.787 | 114.694 |
| GOEF | 640 | -0.559 | 0.887 | -2.400 | 2.300 |

*Table 1: Health-Related Indicators across SSACs (1990-2021)*
*Descriptive Statistics of Variables*

3.1.1. Abbreviations

- CMR= Child mortality rates (deaths per 1000 live births),
- Health Development Assistance (million USD),
- GDPPC= Gross Domestic Product Per Capita (USD),

- DGHE = Domestic Government Health Expenditure (% of GDP),
- DPHE = Domestic Private Health Expenditure (% of GDP),
- INF = Inflation Rate (%),
- EXR = Exchange Rate (Local currency unit),
- FDI = Foreign Direct Investment (million USD),
- IMMS =Immunization status (%),
- PCRF = Primary Completion Rate of Female (%),
- GE = Government Effectiveness (ranges between -2.5 to 2.5).

*3.2. Estimation Results and Discussion*

From table 2 below, all the incorporated variables (CMR, HDA, GDPPC, DPHE, DGHE, INF, EXR, FDI, IMMS, PCRF and GOEF) were permitted to pass through stationarity test using Levin-Lin-Chu (LLC), Im-Pesaran-Shin (IPS) and Fisher test (FT) to devoid the finding from spurious results that may allow conflicting results. It is worth noting that the results from these tests carried out were included to allow accuracy regarding the unit root test conclusion. Table 2 clearly shows the results of the panel unit root tests undertaken in the finding, which is premised on the pooled observations of the Sub-Saharan African countries selected in this study. The table obviously manifests that child mortality rate, domestic private health expenditure, domestic government expenditure, inflation rate, exchange rate, and primary completion rate of females are stationary at level, i.e., they are integrated of order zero, i.e., I(0). On a contrary note, the result reveals that HDA, GDPPC, foreign direct investment and government effectiveness were not stationary at the level but became stationary after the first difference, meaning that these variables are integrated of order one I(1). Fundamentally, the panel unit root result reveals that variables utilized in this research are a mixture of an order of integration, i.e., I(0) and I(1).

| Variables | Level | | | First Difference | | | Remark |
|---|---|---|---|---|---|---|---|
| | LLC | IPS | FISHER | LLC | IPS | FISHER | |
| CMR | -6.42588* | -3.92829* | 94.8496* | --- | --- | --- | I(0) |
| HDA | -3.40953* | -1.28548 | 49.8369 | -29.7005* | -31.9191* | 579.259* | I(1) |
| GDPPC | -1.58365 | 2.48156 | 21.9235 | -17.4829* | -16.3378* | 297.747* | I(1) |
| DPHE | -3.95503* | -3.33607* | 69.3006* | --- | --- | --- | I(0) |
| DGHE | -3.07711* | -3.11350* | 71.0858* | --- | --- | --- | I(0) |
| INF | -6.43150* | -9.14803* | 186.743* | --- | --- | --- | I(0) |
| EXR | -7.37885* | -4.98317* | 93.5621* | --- | --- | --- | I(0) |
| FDI | -1.72546 | -1.13444 | 10.085 | -14.6343* | -25.4874* | 444.836* | I(1) |
| IMMS | -5.13787* | -4.64075* | 88.6313* | --- | --- | --- | I(0) |
| PCRF | -2.78613* | -3.42979* | 86.7168* | --- | --- | --- | I(0) |
| GOEF | -0.09938 | -12.8669 | 28.108 | -21.7937* | -28.1583* | 456.178* | I(1) |

*Table 2: Panel Unit Root Test Result*
*NOTE: These variables HDA, GDPPC, EXR and FDI Are in Natural Logarithm While Others Are Not*
*(*) Connote Rejection of Unit Root Hypothesis at (5%) Level of Significance Level*
*Source: Author's Computation (2022)*

*3.3. The Panel Co-Integration Tests*

Due to the fact that some variables were not stationary at the level but became stationary at the first difference, it is imperative to carry out a panel co-integration test to determine the presence or absence of panel co-integration. To do this, Kao and Fisher tests of co-integration are carefully undertaken to make known the convergence between the long-run equilibrium and short-run dynamics of the studied data. Table 3 shows the condensed panel co-integration tests of Kao and Fisher undertaken for CMR in this work. Results show validation for rejecting the null hypothesis of 'no co-integration' between Child Mortality Rates and its corresponding determining variables. In particular, results stood at -5.416045 ($p < 0.05$) for Kao ADF stat, while Fisher's result stood at 594 ($p< 0.05$) and 2097 ($p < 0.05$) for trace and max eigen stats, respectively. Thus, there is robust evidence supporting the existence of co-integration between child mortality rates and its determinants pointed out in this work. To this end, an examination into the long-run equilibrium relationship between CMR and its determinants in this work is methodologically valid, employing panel Autoregressive Distributed Lag estimation that can find the duo of the long-run and short-run relationship between Health Development Assistance and Child Mortality Rates.

| Model | Test | Stats. | Stat. Value | Prob. |
|---|---|---|---|---|
| CMR | Kao test | (ADF-stat) | -5.416045* | 0.0000 |
| | Fisher test | (trace stat) | 594.0* | 0.0000 |
| | | (Max-eigen stat) | 2079.* | 0.0000 |

*Table 3: CMR Related Series*
*Panel Co-Integration Tests Result for CMR*
*Note: * Connote Significance at 5% Level of Significance; (Fisher Test Reports Test Concerning The Rejection of 'At Most' 1 And 2 Co-Integrating Equation for CMR, Thus Suggesting The Existence of at least 1 and 2 Co-Integration Equation for CMR*
*Source: Author's Computation (2022)*

The estimation results from the three approaches, which turned into two results (CMR could not be logged since it is in rate form, so equation 3 and equation 4 are the same), are presented in table 4 as follows.

| LONG-RUN ESTIMATES | | | | | |
|---|---|---|---|---|---|
| PMG ESTIMATION | | | MG ESTIMATION | | |
| **Variable** | **Coefficient** | **Probability** | **Variable** | **Coefficient** | **Probability** |
| lnHDA | -8.063407 | 0.000*** | lnHDA | 2,884 | 0.646 |
| lnGDPPC | -15.14745 | 0.000*** | lnGDPPC | 36.788 | 0.356 |
| DPHE | -32.7574 | 0.000*** | DPHE | -12.092 | 0.637 |
| DGHE | .5070705 | 0.802 | DGHE | 6.293 | 0.463 |
| INF | 1.253518 | 0.145 | INF | 7.003 | 0.201 |
| lnEXR | -18.51273 | 0.000*** | lnEXR | -47.174 | 0.067 |
| lnFDI | -1.546747 | 0.000*** | lnFDI | 0.507 | 0.932 |
| IMMS | .2996162 | 0.002*** | IMMS | 0.102 | 0.814 |
| PCRF | .131731 | 0.071 | PCRF | 0.090 | 0.893 |
| GOEF | 7.43299 | 0.000*** | GOEF | 2.193 | 0.732 |
| **SHORT-RUN ESTIMATES** | | | | | |
| Variable | Coefficient | Probability | Variable | Coefficient | Probability |
| ECT | -0.052 | 0.000 | ECT | -0.197 | 0.000 |
| C | 14.416 | 0.000 | C | 43.235 | 0.184 |
| D(lnHDA) | .0919209 | 0.618 | D(lnHDA) | 0.486 | 0.099 |
| D(lnGDPPC) | -2.389838 | 0.012 | D(lnGDPPC) | -3.490 | 0.043 |
| D(DPHE) | .9849436 | 0.163 | D(DPHE) | -0.017 | 0.988 |
| D(DGHE) | -.1916288 | 0.808 | D(DGHE) | -0.311 | 0.625 |
| D(INF) | .0835298 | 0.321 | D(INF) | 0.044 | 0.826 |
| D(lnEXR) | -1.55348 | 0.377 | D(lnEXR) | -4.751 | 0.014 |
| D(lnFDI) | .0025905 | 0.959 | D(lnFDI) | -0.008 | 0.962 |
| D(IMMS) | .029334 | 0.707 | D(IMMS) | 0.017 | 0.587 |
| D(PCRF) | -.0544222 | 0.018 | D(PCRF) | 0.031 | 0.388 |
| D(GOEF) | .086571 | 0.583 | D(GOEF) | 0.112 | 0.796 |
| Hausman 1978 Test: 6.27 (p= 0.7919 > 0.05) | | | | | |

*Table 4: Panel ARDL Estimation Result*
*DepVar: D (CMR)*
*NOTE: These Variables HDA, GDPPC, FDI and EXR Are in Natural Log Forms*
*Note: PMG= Pooled Mean Group Estimation, and MG=Mean Group Estimation*
**** P < 0.01; ** P < 0.05; * P < 0.1*
*Source: Author's Computation (2022)*

The Hausman test presented at the bottom of table 4 shows the comparison between the pooled mean group estimation result with that of the mean group estimation result under the null hypothesis that the difference in coefficient is not systematic. The chi-square statistics report in table 4 stood at 6.27 with a probability figure of 0.7919, which manifests that there is not enough proof to reject the null hypothesis that the difference in coefficient of the mean group and pooled mean group estimation is not systematic. Thus, in this study, validation of the pooled mean group is affirmed and used. Hence, the panel ARDL estimation's interpretation rests on the pooled mean group, as shown in table 4.

The estimation results in table 4 above provide the duo of the short-run and long-run coefficients and the probability estimates of the association between child mortality rates and health development assistance in Sub-Saharan African countries.

Considering the long-run Pooled Mean Group estimation results, the estimator gives -8.063407 as the coefficient of log-HDA, which is strongly significant p = 0.000, indicating that HDA has a strong inverse impact on CMR. The estimate implies that during the investigated period, in SSACs, a unit percent increase in HDA saves the lives of eight children per 1000 live births, holding other variables constant in the region (It means that HDA is an effective tool that can be utilized to ameliorate health outcome indicator in SSACs because it has a strong effect in enhancing the health status of the

region's population). In the same vein, the log-GDPPC estimate is -15.147, which is also significant at p = 0.000, implying that increasing per capita income growth adds to the enhancement of health outcomes in SSACs. In clear terms, during the studied period, 1990-2021, the average CMR was 106; if, in successive periods, the region tries to increase the growth rate by 1% (holding other explanatory variables unchanged), CMR will decline to 91. Similarly, the estimator gives -32.7574 as a coefficient estimate of DPHE, which again is statistically significant. It implies that a unit percent increase in DPHE saves the lives of 33 children per 1000 live births, confirming the strong effect that increasing domestic private health expenditure has in ameliorating health outcomes in SSACs. The table also provides strong empirical evidence in support of the view that the log-exchange rate (domestic currencies appreciations, statistically significant) has an exceptional role in SSACs health outcome. The estimation result implies that 1 percent increase in exchange rate (domestic currencies appreciation) pruned child deaths and saved the lives of 19 children per 1000 live births. In the same vein, log-foreign direct investment (statistically significant), which is capable of generating employment opportunities and increasing income in the region, has a strong impact on CMR. A unit percent increase in FDI saves the lives of two children per 1000 live births in the region. Contrarily, a unit percent increase in DGHE (statistically insignificant) increases child death by .5070705, one child death per 1000 live births. A unit percent increase in inflation (statistically insignificant) raises child death by 1.253518, a child death per 1000 live births also. A unit percent increase in IMMS (statistically significant but not economically significant) increases child death by .2996162, approximately one child death per 1000 live births too (this shows the ineffective nature of immunization in the region and this may be attributed to some human factors in the region), a unit percent increase in PCRF (statistically significant but economically insignificant) increases child death by .131731, approximately one child death per 1000 live births (this goes against the strong empirical evidence to affirm the opinion that primary education completion of female has a useful and invaluable role in promoting health status in Sub-Saharan African countries). Meanwhile, the estimate of government effectiveness (though statistically significant) (institutional quality) is positive and statistically significant. This result amplifies that government effectiveness plays an unexciting role in reducing children's deaths in the region.

Also, PMG short-run result shows a positive insignificant relationship between child mortality rates and health development assistance, given a coefficient of .0919209 (p=0.618 > 0.05). Results further reveal that GDPPC, domestic government health expenditure, exchange rate and primary completion rate of females have negative relationships with child mortality rates, while domestic private health expenditure, inflation rate, FDI, immunization status (IMMS) and GOEF have positive relationships with child mortality rates.

The likely endogeneity problem (some explanatory variables correlating with the error term) and serial correlation necessitated the employment of other estimation techniques, i.e., using system GMM (Immurana, Boachie & Iddrisu, 2021).

The estimation results of system GMM are presented below.

| Variable | Coefficient | Corrected Standard Error | Z-Stat | Probability |
|---|---|---|---|---|
| C | 27.880 | 1.568794 | 17.770 | 0.000*** |
| CMR(-1) | 0.905 | .0037222 | 243.090 | 0.000*** |
| lnHDA | -.634192 | .0527405 | -12.02 | 0.000*** |
| lnGDPPC | -1.880836 | .1672696 | -11.24 | 0.000*** |
| DPHE | -2.413386 | .1741576 | -13.86 | 0.000*** |
| DGHE | -.3999377 | .1317392 | -3.04 | 0.002*** |
| INF | -.0228202 | .0405363 | -0.56 | 0.573 |
| lnEXR | -.7481987 | .0696201 | -10.75 | 0.000*** |
| lnFDI | -.0516237 | .0221269 | -2.33 | 0.020 |
| IMMS | -.0008463 | .0079031 | -0.11 | 0.915 |
| PCRF | .0083139 | .0053002 | 1.57 | 0.117 |
| GOEF | .1731623 | .0920208 | 1.88 | 0.060* |

*Table 5: System GMM One-Step Estimation*
*Dep Var: D (CMR)*
*NOTE: HDA, GDPPC, FDI and EXR are in natural log forms*
*Prob > chi2= 0.000, No of Instruments=450*
**** p < 0.01; ** p < 0.05; * p < 0.1*
*Source: Author's Computation (2022)*

The estimation result of the system GMM one-step presented in table 5 reveals the dynamic effect of lagged CMR on Child Mortality Rates (CMR) in the Sub-Saharan African countries selected for this study. Going by the above-estimated results, lagged child mortality rates are statistically significant, 0.905, p=0.000 (suggesting that in the estimation process of log-HDA, controlling for previous levels of CMR is important). An estimator gives -.634192 as the coefficient estimate of log-HDA, which is statistically significant p=0.000, indicating that HDA has a strong negative impact on CMR. A unit percent increase in HDA saves a life of a child per 1000 live births, holding other variables constant (this supports the belief of some scholars that HDA is an effective tool that could be used to improve health status in SSACs). Similarly, the log-GDPPC coefficient estimate is -1.880836 and statistically significant, p=0.000. A unit percent increase in GDPPC saves two children's lives per 1000 live births, indicating that raising per capita income results in a drop in child mortality rates in SSACs. Also, DPHE's estimator gives -2.413386 and is significant also at p=0.000, implying that a unit percent increase

in DPHE saves the lives of two children), a unit percent hike in DGHE (statistically significant) lowers child mortality rates by -.3999377 and a unit percent negative inflation declines child mortality rates by -.0228202, a unit percent increase in EXR (appreciation in the local currency) (statistically significant) gives coefficient -.7481987 (a child saves per 1000 live births). Similarly, a unit percent increase in foreign direct investment and immunization (statistically insignificant) lowers child mortality rates by -.0516237 and -.0008463. On a contrary note, a unit percent increase in the primary completion rate of females (statistically insignificant) increases child mortality rates by .0083139 (this signals an increase in CMR) (this contradicts evidence that female elementary education completion rate has a strong impact on health outcome level in the region) and finally Government Effectiveness with a coefficient estimate of .1731623 signals that government institutions in the region are not effective and this resulted into an increased CMR in the region.

*3.4. Robustness Test*

| Order | Z-statistics | Probability |
|---|---|---|
| 1 | -2.47 | 0.014 |
| 2 | -0.94 | 0.349 |

*Table 6: Arellano Bond Test Result*
*Source: Author's Computation, (2022)*

Table 6 above reveals the Arellano Bond autocorrelation test result, which indicates that there is evidence to reject the hypothesis of zero autocorrelation between successive values of the error term for the case of first-order serial autocorrelation. However, regarding the case of second-order serial autocorrelation, there is a lack of evidence to reject the null hypothesis of zero serial correlation between successive values of the error term. Thus, it is crystal clear that the model is freed of second-order serial autocorrelation, establishing the fitness of the model.

| | Chi-Stat | Probability |
|---|---|---|
| Sargan test | 164.49 | 0.000 |
| Hansen test | 14.40 | 0.1289 |

*Table 7: Sargan and Hansen Test Result*
*Source: Author's Computation, (2022)*

The Sargan and Hansen test results in table 7 above show enough evidence that the instruments employed in the estimation are valid. Considering the Sargan test, the reported statistic evidencing 164.49 ($p < 0.05$) suggests rejection of the Sargan null hypothesis that the employed instruments are not robust. Moreover, regarding Hansen test, reported statistics of 14.40 ($p > 0.05$) suggests the acceptance of the Hansen null hypothesis that the employed instruments' validity is robust. Thus, the results of the two tests indicate that there is enough proof to finalize that the instruments employed in the estimation are valid and that the estimated model is strong enough to examine the dynamic association that exists between HDA and CMR in SSACs.

The CMR-estimating equation (3) in this study proposes the existence of lagged impacts yet rests the presumption of stability of CMR elasticity with respect to the explanatory variables and rather proposes the stability of the product of the elasticities and CMR. In this sense, it evaluates rising elasticities in arbitrary terms as child mortality rates drop with the passage of time.

**4. Summary and Conclusion**

This study, employing Child Mortality Rates (CMR) as a proxy for health outcome indicators, investigated the effect of Health Development Assistance on health outcome indicators which is based on a panel data set built on twenty (20) SSACs from 1990-2021. Three estimating equations stated in this study rested on alternative assumptions, but the second and the third equations were the same because CMR was in rate form and hence could not be logged. The first child mortality rates estimating equation proposes that the present level of child mortality rates is mainly determined by the current level of explanatory variables. The lagged effects of all explanatory variables and the lagged effect of child mortality rates were absent in the first estimating equation. This estimating equation is characterized by the absence of lagged effects of explanatory and dependent variables oversimplified because the actual situation comprises the inclusion of lagged effects. Additionally, the stability of elasticity of child mortality rates with respect to explanatory variables is also assumed by the equation. The assumption for this estimating equation has no well-constructed explanation method that guarantees the stability assumption.

The second estimating equation that could not be logged became the same as the third estimating equation and these two equations assume the presence of lagged effects but relax or drop the assumption of stability of child mortality rates with regard to explanatory variables in the models and rather propose the stability of the product of the elasticities and child mortality rates. Health Development Assistance, GDPPC, DPHE, DGHE, INF, EXR, FDI, IMMS, PCRF and GOEF were employed as the explanatory variables in the econometrics analysis of this work.

The estimated result obtained from the third child mortality rates (CMR) equation (which is the same as the second CMR equation) indicates that GOEF (Government effectiveness) has a positive and statistically insignificant coefficient, indicating that non-strengthening of this variable by the governments of SSACs has not made it a potent tool that could be employed in the reduction of child mortality rates in the region.

The results indicate that one percent rise in GDPPC will lead to saving the lives of two (2) children per 1000 live births. It implies that for the sampled countries to witness the reductions of child mortality by two (2) in the region, it requires raising per capita income continuously by one percent (1%). Similarly, raising DPHE, DGHE, FDI and IMMS by one percent also have negative effects on child mortality rates in the region. It implies that by raising domestic private and domestic government health expenditures, the inflows of foreign direct investments and immunization levels in the region will go a long way in reducing the children's deaths in the region. Similarly, exchange rate appreciation will also reduce CMR in the region. However, a one percent increase in the primary completion rate of females increases child mortality rates in the region.

Finally, regarding the main variable of interest, Health Development Assistance, its estimator gives negative and statistically significant co-efficient estimates and it implies that a one percent increase in Health Development Assistance would lead to an additional one (1) child life saved per 1000 live births in the region. This shows that HDA received in the region has an improved impact in ameliorating the health outcome of the people of SSACs. This finding is in agreement with the findings of these researchers: Marty, Dolan, Leu and Runfola (2017), Byaro and Deusdedit (2018), Kotsadam, Ostby, Rustad, Tollefsen and Urdal (2018). However, this finding contradicts the findings in: Patenaude (2021), Nwude, Ugwoke, Uruakpa, Ugwuegbe, and Nwonye (2020) and Toseef, Jensen and Tarraf (2019). Based on the effectiveness of Health Development Assistance on child mortality rates in this study, it is recommended that governments of SSACs should increase the investment of health development assistance received in the area of child mortality rates, block leakages of HDA received in any form it appears and that the government of each country should investigate reasons for its ineffectiveness or less effectiveness in the short run and that each country's findings should not be swept under the ground. Finally, regardless of the effectiveness of HDA received on child mortality rates in this study, it is also recommended that SSACs should seek ways of advancing domestic factors (GDPPC, DGHE and others) in each country that will continue to impact health outcome indicators favorably in the region to end the era of endless dependency on HDA in the region.

**5. Conflict of Interest**

The authors of this article declare no conflict of interest.

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