Assessment of Impact of Improved Sanitation and Safe-Drinking Water on Child Health in West Africa

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Abstract

Despite a significant growth in all walks of life, the issue of child mortality still stands as a major concern in most of the developing economies especially in West Africa. The World Health Organization (WHO) has stressed the significance of improved sanitation and safe drinking water in reducing child mortality rate, however, countries in West African still lack in these services. Given this background, this paper investigated the impact of improved sanitation and safe drinking water on child health in West Africa using annual data from 2000 to 2020. Fixed Effect, Dynamic Ordinary Least Square (DOLS) and Panel Fully Modified Least (FMOLS) square estimation techniques along with Pedroni panel cointegration test were employed. Findings revealed that improved water and sanitation reduce the rate of under – five, infant and neonatal mortality. Also, rising health expenditure as well as increasing per capita income is important in improving child health while food deficiency raises the rate of child mortality in West Africa. Consequently, the study recommended that West African countries should provide enabling environment for improved sanitation and safe drinking water to its citizens. It is also suggested that prices of food be reduced for households' affordability. This will go a long way in improving child health status in West Africa and draw them closer to the attainment of the SDGs target on child health come 2030.

Keywords: Water, Sanitation, Infant Mortality, Maternal Mortality, Neonatal Mortality, Jel Classification

Introduction

One of the seventeen Sustainable Development Goals (SDGs) packaged by the United Nations (UN) to guide global development between 2015 and 2030 is to ensure availability and sustainable management of water and sanitation for all. The year 2030 which the UN targets for the attainment of the seventeen (17) SDGs is less than a decade ahead and most, if not all countries in the West African sub-region are still very far off the mark regarding their performances in relation to the SDGs. The UN's SDG water goal has both a direct and indirect impact on human health as it can be associated with such vital health issues as child mortality, maternal health, hunger, and several notable diseases (Ahmed, Wong, Chua, Hydrie, & Channa, 2022; Immurana, Iddrisu, Mohammed, & Mathew, 2022; Headey & Palloni, 2019).

Previously the Millennium Development Goals (MDG 7c) had targeted cutting by half the percentage of people worldwide that lacked sustainable access to safe drinking water and basic sanitation by the end of 2015. As noted by Fotio and Nguea 2022), access to clean and safe water coupled with adequate sanitation among other factors, can help to reduce preventable diseases – induced deaths, improve health, diminish poverty and enhance welfare. Water is life but the current reality is that it is being endangered globally due to pollution, climate change and diminishing resources.

As alarming as the health situation in Sub-Saharan Africa region is, West African countries presents a more worrisome scenario. The performance of the sub-region over the years has been terrible both in absolute and relative terms going by the key health indicators such as life expectancy, child mortality, maternal mortality, crude death rate, and so on. For instance, while the UN expects a minimum life expectancy of 71 years, the figure for West Africa was just 57.9 years in 2019 when the global average was 73.3 years. Again, while the expected under five mortality and Neonatal mortality were put at a maximum of 25 and 12 deaths per 1000 life-births respectively, the actual figures for most of the countries in West Africa are far above these benchmarks. In terms of their overall performance and progress made towards achieving all the SDGs, West African countries recorded an average score of 54.66% and just 60.82% on the SDG6 (water and sanitation) composite index (Sachs, Kroll, Lafortune, Fuller, & Woelm, 2021). The probability of achieving required levels of national coverage of basic water service, basic sanitation facilities and practice of open defecation by 2030 has become almost a mirage for most of the countries in the sub-region judging by their current pace of progress (Swe, Rahman, Rahman, Teng, Abe, Hashizume, & Shibuya, 2021; Kemajou, 2022). It is therefore not surprising that disease burden remains high in the region. Infant and maternal mortality rates in the region remain unacceptably high while their current annual rates of reduction for most of the countries fall far short of the projected rates of reduction to meet the SDG targets by 2030 (WHO and UNICEF, 2018).

Today, one of the major factors responsible for these woeful health outcomes is lack of access to safe water supply and adequate sanitation facilities in the sub-region. This is despite huge expenditure incurred by the governments of these countries over the years purportedly to enhance access to safe water and improved sanitation facilities. The current situation in West Africa is such that they are far off the mark already and the rate of progress falls far short of that which is required for them to attain the goal by 2030 (Anderson, Gupta, Birken, Sakas, & Freeman, 2022; Fotio, & Nguea, 2022). The question, therefore, is why despite the huge amount claimed by the government of West African countries on infrastructural facilities and health sector, millions of people still lack access to improved sanitation and safe drinking water and rate of child mortality have not really fall below the target set by SDGs come 2030? Therefore, the objective of this paper is to investigate the impact of access to sanitation and safe drinking water on child health in West Africa.

The paper contributed to knowledge in the following ground. First, the use of all measure for child health as against previous studies that concentrated on only one measure of child health (Lu, Badara & Paramoto, 2020). Further, in terms of methodological contribution, the study is the first to address the issues of the impact of improved sanitation facilities and water supply on child health in West Africa using the panel fixed effects, panel dynamic ordinary least square (DOLS) and panel fully modified ordinary least square (FMOLS) that can accommodate the issue of cross-sectional dependence in the estimation.

Apart from the introduction, the rest of the paper is structured into six sections. Section 2 presents the literature review. Section 3 presents the data and empirical methodologies that are used in the paper. Section 4 presents the results and discussion of findings while section 5 concludes the study and provides policy implications.

Literature Review

Conceptual Issues

Access to Water source and Improved Sanitation facilities

Access to improved water source refers to the percentage of the population using an improved and safe drinking water source. These include piped household water connection inside the apartment, and other improved drinking water sources such as public taps or standpipes, tube wells or boreholes, protected dug wells, protected springs, and rainwater collection. Good sanitation has also been seen as relevant to good health. Access to improved sanitation facilities refers to the percentage of the population using improved sanitation facilities. These facilities include flush/pour flush (to piped sewer system, septic tank, and pit latrine), ventilated improved pit latrine, pit latrine with slab and composting toilet.

Infant mortality is the death of an infant before his or her first birthday. The infant mortality rate is the number of infant deaths for every 1,000 live births. The under-five mortality rate refers to the probability of dying before age 5 years per 1,000 newborns. Neonatal mortality refers to the number of deaths during the first 28 completed days of life per 1000 live births in a given year or another period.

This research was based on the Dependency Theory, which was created in the late 1960s in the aftermath of World War II by scholars looking for the core cause of Latin America's lack of progress. Poor states are impoverished and rich nations are benefited by the way poor states are integrated into the "global system," according to dependency theory. The theory arose as a reaction to modernization theory, an earlier development theory that retained that all societies progress through similar phases of development, that the task of assisting the poorer nations out of poverty is to accelerate them along this supposed common path of development, using various means such as investments, transfer of technology, and dragging them closer into the world market through integration.

Empirical Review

Using 84 developing countries in the world, Lu, Bnadara and Paramato (2020) investigated the impact of sanitation, safe drinking water and health expenditure on infant mortality using annual data from 1995 to 2013. Dynamic ordinary least square as well as the panel fully modified ordinary least square estimation techniques were employed in analysing the collected data. They concluded that improved water, sanitation facilities and health expenditure will substantially reduce infant mortality rate while food deficiency raises the level of infant mortality. The study however concentrated on only infant mortality neglecting other aspect of child health such as under five mortality and neonatal mortality which would have provide a robust result as regard child mortality.

Ummalla, Samal, Zakari, & Lingamurthy (2022) investigated the effect of sanitation and safe drinking water on child mortality and life expectancy using a global sample of 100 countries. Panel econometric techniques were used to achieve the study objectives using annual data from 1990 to 2015. Their findings establish that sanitation and safe drinking water facilities have a significant negative on child mortality and positive impact on life expectancy, respectively. They concluded that the effect is more from safe drinking water facilities than the sanitation across both models. The robustness check results confirm that access to sanitation and water facilities in rural and urban areas also plays a vital role in reducing child mortality and improving quality of life by increasing life expectancy.

Abdelhady, Alfeus, & Hamatui, (2022) examined the influence of water and sanitation on child health in Namibia: using demographic and health surveys. Data from the Namibian demographic and health surveys (NDHS) covering the period 2006 and 2013 was used. They applied logistic regression model in determining the relationship between improved sanitary facilities and water sources and under – five mortality rate in Namibia. Their findings revealed that improved access to sanitation facilities in Namibia is associated with a lower reduces under five mortality rates, according to the 2013 survey. Also, there exists no significant association between improved access to safe water and child death. They also confirmed that mothers who are HIV-positive are more likely to experience under-five death.

Headey & Palloni, (2019) investigated the impact of water and sanitation on child health using data for 59 countries in the world from 1990 to 2015. Difference -in-difference regressions estimation techniques that allows the examination of the existence of whether longer-term changes in water and sanitation at the Sub-national level predict improvements in child morbidity, mortality, and nutrition was used. Their findings revealed that improved water access and sanitation prevents diseases and predict large reductions in diarrhea prevalence and child mortality but are not associated with changes in stunting or wasting.

Methodology

Data

The study sample includes all the sixteen countries in West Africa. These are Benin, Burkina Faso, Cape Verde, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra

Leone and Togo. West African countries are selected since they are geographically contiguous being in the same part of the continent of Africa and displaying similar socio-economic characteristics. They also belong to the same regional group – the Economic Community of West African States (ECOWAS). The variable of interest includes under – five mortality rate, infant mortality rate, maternal mortality rate, percentage of people having access to clean water and improved sanitation, GDP per capita, government health expenditure and prevalence of undernourished people. The sample period is from 2000 to 2020. Data were sourced from the World Development Indicators (http://data.worldbank.org).

Empirical Model

This study aims to investigate the impact of improved sanitation and water facilities on child health measured by under – five mortality, infant mortality rate and neonatal mortality rate using a panel data set of the 16 West African countries. To achieve the study objectives, the study followed the model by Lu, Bandara, and Paramati, (2020) with a slight modification. The functional form of our model is expressed as

$$CH = f(ASA, ASW, GHE, PKY, DFD, zi) \qquad (1)$$

Where: CH = Child health measured by under -five mortality, infant mortality, and neonatal mortality rate. ISA represents people with sanitation facilities as a percentage of the total population, ASW stands for people having access to improved water source. GHE represents government health expenditure, PKY represents GDP per capita in current US dollars, and DFD stands for population of undernourished people as measure for depth of the food deficit in kilocalories for each person per day Although, the paper seek to investigate the impacts of improved sanitation and safe water source on child health, government health expenditure, GDP per capita and depth of food deficit are added as control variables as supported by (Lu, Bandara, and Paramati, 2020, Lee , Lee, Lim, & Park, 2016) as major determinants of child health.
Equation 1 is respecified in econometric form as

$$CH_{it} = \beta_0 + \beta_1 ASA_{it} + \beta_2 ASW_{it} + \beta_3 PKY_{it} + \beta_4 GHE_{it} + \beta_5 DFD_{it} + Zi_t + \varepsilon_t \qquad (2)$$

In equation 2, β_0 is the constant, $\beta_1, \beta_2, \beta_3, \beta_4$ *and* β_5 are coefficient of the independent variables, countries and time periods are indicated by the subscript i (i = 1,……,N) and (t = 2000,…….,2020), respectively, and zi denotes individual fixed country effects. Equation 2 is specified in its logarithm form as

$$logCH_{it} = \beta_0 + \beta_1 logASA_{it} + \beta_2 logASW_{it} + \beta_3 logPKY_{it} + \beta_4 logGHE_{it} + \beta_5 logDFD_{it} + Zi_t + \varepsilon_t \qquad (3)$$

On apriori, we expect $\beta_1 < 0, \beta_2 < 0,\ \beta_3 < 0,\ \beta_4 < 0\ and\ \beta_5 > 0$

Results and Discussion

Descriptive Statistics

Table 1 presents summary statistics on a panel data set of the 16 West African countries for the period of 2000 - 2020. The results show that the average under – five mortality rate, infant mortality rate and neonatal mortality rate are 106.32, 66.63, and 34.02 per 1,000 live births in West Africa. During this period, the higher recorded under – five mortality rate, infant mortality rate, and neonatal mortality rate are 224.90, 138.00 and 55.30 per 1,000 live births and the lowest are 14.20. 12.70, and 8,50 per 1,000 live births. On average, 21.65% and 56.87% of the population across West Africa countries have access to improved water and sanitation facilities Further, the average per capita health expenditure is only 5.08billion U.S. dollars, while the average per capita GDP is 1018.25 dollars. Finally, the per capita consumption of kilocalories per person per day is only 17.23. These statistics indicate that West African countries have a higher under – five, infant and neonatal mortality rate and lower rate of improved access to water and sanitation facilities.

Table 1: Descriptive statistics

	IFM	U5M	NNM	ASA	AWS	PKY	GHE	DFD
Mean	66.63	106.32	34.02	21.65	56.87	1018.25	5.08	17.23
Median	65.50	104.20	34.55	16.95	59.21	741.33	4.46	15.10
Maximum	138.10	224.90	55.30	56.77	85.79	3740.37	20.41	40.70
Minimum	12.70	14.20	8.50	3.55	7.90	138.69	2.27	2.24
Std. Dev.	23.39	41.95	8.26	13.43	17.29	760.70	2.46	9.14

Correlation

Table 2 report the correlation matrix among the variables. As displayed from the results, infant mortality rate, under five-mortality rate and neonatal mortality have significant negative correlations with access to improved water and sanitation facilities in West Africa. Similarly, higher health expenditure and per capita income reduces the level of child mortality. However, the lower consumption of food displayed positive relationship with child mortality. Consequently, it is important to provide basic needs such as safe drinking water and sanitation facilities to all households. To further reduce infant mortality rate, it is important to improve healthcare facilities and availability of nutritional food for both mother and children. By improving each of these factors, we can significantly reduce the level of under – five, infant and neonatal mortality rate in West Africa. All the relationship are statistically significant at the 1% level.

Table 2: Correlation Matrix

	IFM	U5M	NNM	AWS	ASA	PKY	GHE	DFD
IFM	1.000							
U5M	0.979***	1.000						
NNM	0.923***	0.921***	1.000					
AWS	-0.452***	-0.479***	-0.568***	1.000				
ASA	-0.055***	-0.079***	-0.216***	0.619***	1.000			
PKY	-0.625***	-0.669***	-0.569***	-0.333***	0.231***	1.000		
GHE	-0.195***	-0.143***	-0.102***	-0.039***	-0.188***	-0.355***	1.000	
DFD	0.354***	0.300***	0.238***	-0.158***	-0.402***	-0.505***	0.508***	1.000

*Note: (1) All the variables are in their logarithm form (2) *** denotes statistical significance at 1% level.*

Cross – Sectional Dependence Test

As a first step of the empirical analysis, we investigate whether cross – sectional dependence exists among the variables used in the West African countries. This is important as failure to determine the existence of cross – sectional dependence when indeed it exists may lead to methodological bias (Pedroni, 1999). To avoid this, Pesaran's (2004) cross-sectional dependence (CD) test was employed on all the variables to confirm the existence of cross – sectional dependence or not

Table 3 presents results on cross-sectional dependence test conducted on all the variables used in the model. Result indicates that the null hypothesis of no cross-sectional dependence is strongly rejected in all the four tests for all the variables. Further, results indicate that the null hypothesis is rejected at the 1% significance level. Therefore, we establish that all our considered variables in West Africa have a cross-sectional dependence

Table 3 Pesaran Cross Sectional Dependence Test

	IFM	U5M	NNM	ASA	ASW	PKY	GHE	DFD
Pesaran CD	48.423	48.443	49.419	38.323	27.525	44.571	8.682	25.900
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Note: values in parenthesis are the rho values

Cross – Sectional Dependence Unit Root Test

Having confirmed the presence of cross – sectional dependence among the variables, we proceed to carry out the unit root test to test for the stationarity property of all the variables. Empirical studies have shown that the conventional first-generation panel unit root tests are inappropriate to use when variables exhibit cross – sectional dependence. Therefore, we apply the recently developed CIPS unit root test by Im, Pesaran and Shin that can handle panel data series that exhibit cross-sectional dependence. Table 4 presents the outcome of the CIPS unit root test carried out. As reported, the results on level series show that the null hypothesis of unit root cannot be rejected for all variables at the 5% significance level. However, at first order difference, the null of non-stationary can be rejected at the 1% significance level for all the variables. The CIPS unit root test results suggest that not all the variables are non-stationary at levels but that all are stationary at their first difference order.

Table 4: Cross -Sectional dependence unit root test

Variable	CIPS at Level	CIPS at first difference
IFM	1.029	-1.297*
	(0.849)	(0.097)
U5M	-0.231	-4.866***
	(0.407)	(0.000)
ASA	-18.147***	
	(0.000)	
ASW	-51.653***	
	(0.000)	
PKY	-2.329***	
	(0.009)	
GHE	-0.706	-7.550***
	(0.340)	(0.000)
DFD	2.793	-4.475***
	(0.997)	(0.000)

*Note: *** and ** denotes statistically significant at 1% and 5% level*

Cointegration test results

The above unit root test results indicate that not all the variables are integrated at level I(0). However, after their first difference I(1) all the variables are stationary. This shows that cointegration test can be conducted to determine whether any long-run relationship exists between the dependent variable (IFM, U5M and NNM) and the independent variables (AWS, ASA, PKY, GHE, and DFD). To address this issue, we employed the panel cointegration tests methodology proposed by Pedroni's (1999, 2004) to determine the existence of long-run equilibrium relationship among the selected variables in the model. Tables 5, 6, and 7 reported the empirical results out of the seven statistics, there were three (within-dimension) which rejected the null hypothesis of no cointegration at 1% significant level, and two (between-dimension) which rejected the null hypothesis at the 1% significant level for infant mortality. Similarly, for under-five mortality rate, there were three (within-dimension) and two (between-dimension) which rejected the null hypothesis of no cointegration at the 1% significant level. For neonatal mortality rate, report from Table 8 displayed three (within-dimension) and two (between-dimension) which rejected the null hypothesis of no cointegration at the 1% significant level. Based on the outcomes of the results, we conclude that a significant long-run equilibrium relationship exists among the selected variables. Consequently, the results suggest that the variables share a common stochastic trend in the long run

Table 5: Pedronic Residual Cointegration Test for Infant Mortality Rate

Alternative Hypothesis Common AR Coefficients (within Dimension)				
	Statistics	$\rho - value$	**weighted Statistics**	$\rho - value$
Panel V-Statistics	5.643***	0.000	4.999***	0.000
Panel rho-Statistics	3.634	0.999	3.442	0.999
Panel PP- Statistics	0.029	0.512	-5.767***	0.001
Panel ADF- Statistics	-1.819**	0.034	-0.317	0.376
Alternative Hypothesis Individual AR Coefficients (between Dimension)				
Group rho-Statistics	4.449	1.000		
Group PP-Statistics	-4.048**	0.010		
Group ADF-Statistics	-5.295**	0.020		

*Note: *** and ** denotes statistical significance at 1% and 5% respectively*

Table 6 Pedronic Residual Cointegration Test for Neo Natal Mortality Rate

Alternative Hypothesis Common AR Coefficients (within Dimension)				
	Statistics	$\rho - value$	**weighted Statistics**	$\rho - value$
Panel V-Statistics	3.997***	0.000	4.560***	0.000
Panel rho-Statistics	3.993	1.000	3.428**	0.019
Panel PP- Statistics	4.110***	0.005	-0.065	0.474
Panel ADF- Statistics	-3.479**	0.042	1.039	0.851
Alternative Hypothesis Individual AR Coefficients (between Dimension)				
Group rho-Statistics	4.435	1.000		
Group PP-Statistics	-2.042**	0.021		
Group ADF-Statistics	0.544	0.707		

*Note: *** and ** denotes statistical significance at 1% and 5% respectively*

Table 7 Pedronic Residual Cointegration Test for Under five Mortality Rate

Alternative Hypothesis Common AR Coefficients (within Dimension)				
	Statistics	$\rho - value$	**weighted Statistics**	$\rho - value$
Panel V-Statistics	6.952***	0.000	6.067	0.000
Panel rho-Statistics	3.402	0.998	3.444	0.999
Panel PP- Statistics	-1.495**	0.037	-0.677	0.249
Panel ADF- Statistics	-1.842**	0.033	-0.899	0.184
Alternative Hypothesis Individual AR Coefficients (between Dimension)				
Group rho-Statistics	4.792	1.000		
Group PP-Statistics	-2.923**	0.022		
Group ADF-Statistics	-1.009	0.159		

*Note: *** and ** denotes statistical significance at 1% and 5% respectively*

Empirical Results

Table 8 displayed the empirical results on the impact of improved sanitation and safe drinking water on child health. As explained earlier child mortality are measured by under – five mortality rate, infant mortality rate and neonatal mortality rate. To begin our empirical estimation of long-run parameters, the fixed effect methodology was first applied. This methodology is preferred over random effect model as supported by the Hausman specification test. After this, we then estimate the long-run elasticities by making use of DOLS and FMOLS methods as these two techniques uses parametric and nonparametric approaches to counter the issues of endogeneity, serial correlation, and heterogeneity in the model. The empirical results of fixed effect, DOLS and FMOLS methods are displayed in Table 8 These three approaches produce very similar results for each of the variables in terms of sign, statistical significance, and magnitude.

From the result, access to improved water and sanitation facilities significantly reduces under - five mortality rate in West Africa. Specifically, a 1% increase in access to improved water will reduce under-five mortality rate between (-0.088% and -0.085%) while improved sanitation reduces under – five mortality rates between (-0.384% and -0.630%) respectively. The result was significant in DOLS model for improved water and significant for both models in the case of access to sanitation. The findings are in line with (Ali, Abbas, & Shah, 2022; Ummalla, Samal, Zakari, & Lingamurthy, 2022; Omotayo, et al, 2021).

In the case of infant mortality and access to improved sanitation facilities and safe drinking water, the elasticities on the long – run infant mortality rate demonstrate that effort of West African countries increasing access to improved sanitation facilities and safe drinking water will significantly reduce the rate of infant mortality in the region. Specifically, a 1% increase in access to water will reduce infant mortality rate between -0.142% to -0.477%, while percentage increase in improved sanitation in West Africa reduces infant mortality rate between -0.331% to – 0.407% respectively. Based on the result, among the indicators, the magnitude of access to improved sanitation facilities is higher than the access to safe drinking water. Our findings supported the results by (Lu, Bandara & Paramate, 2020; Alsan, & Goldin, 2019; Beach, 2022: El-Shal, Mohieldin, & Moustafa, 2022).

As regard to neonatal mortality, findings also revealed that in all the models, improved access to safe drinking water and sanitation reduces the level of neonatal mortality in West Africa. As reported, a rise in access to improved sanitation facilities and safe drinking water will reduce neonatal mortality between – 0.131% to – 0.280% and – 0.130% and -0.179% respectively. The result however was only significant with respect to access to improved sanitation. The findings supported that of (Patel, Gupta, Chauhan, & Bansod, 2019; Cameron, Chase, & Suarez, 2021)

Further, results from the control variables added in the model show that a 1% increase in government health expenditure will reduce infant mortality rate, under five mortality rate and neonatal mortality rate in West Africa between (0.021% - 0.138%, 0.030% - 0.091%, and 0.023% - 0.052%) respectively and a significant factor that can determine the rate of child mortality in West Africa. The findings are in line with (Joseph & Aina, 2022. Owusu, Sarkodie, & Pedersen, 2021).

In addition, the long-run elasticities suggest that an increase in GDP per capita reduces under -five mortality rate, infant mortality rate and neonatal mortality rate in West African region. Specifically, 1% rise in GDP per capita reduces mortality rate between 0.018% - 0,185%, 0.009% - 0.172%, and 0.005% - 0.084%) for under – five mortality, infant mortality, and neonatal mortality respectively. The result was significant. On the other hand, an increase in depth of food deficiency arising from high rate of undernourished people raises the growth of under – five mortality, infant mortality rate and neonatal mortality rate in West Africa. The result conforms with theoretical apriori expectation. This implies that a lack of nutritional food consumption has significant adverse impact on child health in West Africa.

Table 8: Empirical Results

	Dep Var: U5M			Dep Var: IFM			Dep Var: NNM		
	Fixed Effect	FMOLS	DOLS	Fixed Effect	FMOLS	DOLS	Fixed Effect	FMOLS	DMOLS
ASA	-0.409	-0.384	-0.630	-0.353	-0.331	-0.407	-0.289	-0.280	-0.181
	(0.000)	(0.000)	-0.008	(0.000)	(0.000)	-0.026	(0.000)	(0.000)	(0.087)
ASW	-0.014	-0.085	-0.888	-0.084	-0.142	-0.477	-0.082	-0.131	-0.179
	(0.877)	(0.568)	-0.058	-0.246	-0.213	-0.187	(0.123)	(0.126)	(0.397)
PKY	-0.168	-0.185	-0.018	-0.155	-0.172	-0.009	-0.078	-0.084	0.005
	(0.000)	(0.008)	-0.614	(0.000)	(0.000)	-0.741	(0.001)	(0.007)	(0.753)
GHE	-0.028	-0.021	-0.138	-0.035	-0.030	-0.091	-0.026	-0.023	0.052
	(0.465)	(0.718)	-0.003	-0.224	-0.499	-0.002	(0.233)	(0.501)	(0.002)
DFD	0.206	0.210	0.043	0.126	0.123	0.02	0.126	0.129	0.021
	(0.000)	(0.003)	-0.436	(0.000)	-0.005	-0.635	(0.000)	(0.001)	(0.404)
R^2	0.86	0.92	0.94	0.94	0.95	0.95	0.94	0.94	0.96

Note: values in parentheses are the rho value

Conclusion and Policy Implication

The study investigated the impact of improved sanitation and safe drinking water on child health in West Africa for the period 2000 to 2020. Government health expenditure, per capita income and proportion of undernourished people proxied by depth of food deficiency was also captured as determinants of child health. The balanced panel data set was constructed using the 16 West African countries in Sub- Saharan Africa. The Fixed effect, FMOLS and DOLS estimation techniques that account for cross-sectional dependence, endogeneity, and heterogeneity was used in the analysis. The long-run equilibrium relationship was examined using the cointegration methodology by Pedroni (1999, 2004). The study concluded as follows: first, existence of long-run equilibrium relationship exists among under – five mortality, infant mortality rate, neonatal mortality rate, improved sanitation facilities, safe drinking water, government health expenditure, per capita income, and depth of the food deficiency in West Africa. Secondly, long-run elasticities suggest that an increase in improved sanitation facilities, safe drinking water, higher health expenditure and GDP per capita reduces under – five mortality, infant mortality rate and neonatal mortality while depth of food deficiency hampered child health in West Africa. Consequently, we concluded that the significant child mortality rate in West Africa can only be reduced by improving access to safe drinking water and sanitation facilities. Hence, the study recommended as follows:

i. Both policy makers and government officials of West African countries should consider the immediate policy actions, which can improve access to safe drinking water and sanitation for her populace.
ii. More expenditure should be channeled towards the health sector to boost healthcare facilities for all households both in rural and urban areas.
iii. West African countries should consider policy action that will raise the per capita income of households so as to enable them improves their standard of living.
iv. Further, there is need for West African countries to also initiate policies which provide nutritional food during maternity for poorer households.

As evidenced by the findings of this study, the effective implementation of these policies would significantly reduce under-five mortality rate, infant mortality rate, and neonatal mortality rate across the West African countries.

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