ORIGINAL RESEARCH ARTICLE

Effects of remittances on life expectancy and under-five mortality in sub-Saharan Africa: Evidence using Generalized Method of Moments analysis

DOI: 10.29063/ajrh2023/v27i10.8

Shaojie Hao[1], Huanqi Yang[2], Ran Bi[1], Sakiru O. Akinbode[3] and Timothy A. Aderemi[4]*

Medical School, Harvard University, Boston, MA, 02138, USA[1]; Viterbi School of Engineering, University of Southern California, Los Angeles, CA, 90089, USA[2]; Department of Economics, Federal University of Agriculture P.M.B. 2240, Abeokuta, Nigeria[3]; Department of Economics, Accounting and Finance, Bells University of Technology, Ota, Nigeria and Research Fellow, University of Religions and Denominations (URD), Qom, Iran

***For Correspondence:** Email: *wwt11112@sina.com*

Abstract

The study examined the relationship between financial remittances and health outcomes in 45 sub-Saharan African countries (SSA) using data obtained from the World Development Indicator (WDI) over the period 1990 to 2021. Because of the issue of endogeneity, the System Generalized Method of Moments (SGMM) was adopted to analyze the impact of remittances on life expectancy and infant mortality respectively. The results showed that contrary to expectations, remittances did not significantly improve life expectancy and infant mortality rate in SSA. The life expectancy in the previous year, has a statically significant impact on life expectancy at birth for the current year. Also, the lagged value of infant mortality rate significantly increased under five mortality. Therefore, the study recommends that governments in SSA sub-region should evolve policies aimed at guiding recipients of remittances towards effective utilization with a view to improving social welfare and health outcomes. *(Afr J Reprod Health 2023; 27 [10]: 91-102).*

Keywords: SSA, death rate, infant mortality, healthcare provision

Résumé

L'étude a examiné la relation entre les envois de fonds et les résultats de santé dans 45 pays d'Afrique subsaharienne (ASS) à l'aide des données obtenues à partir de l'indicateur du développement mondial (WDI) sur la période 1990 à 2021. En raison de la question de l'endogénéité, la méthode généralisée du système of Moments (SGMM) a été adopté pour analyser l'impact des envois de fonds sur l'espérance de vie et la mortalité infantile respectivement. Les résultats ont montré que contrairement aux attentes, les envois de fonds n'ont pas amélioré de manière significative l'espérance de vie et le taux de mortalité infantile en ASS. L'espérance de vie de l'année précédente a un impact statiquement significatif sur l'espérance de vie à la naissance de l'année en cours. En outre, la valeur décalée du taux de mortalité infantile a considérablement augmenté chez les enfants de moins de cinq ans. Par conséquent, l'étude recommande que les gouvernements de la sous-région d'ASS élaborent des politiques visant à guider les destinataires des envois de fonds vers une utilisation efficace en vue d'améliorer le bien-être social et les résultats en matière de santé. *(Afr J Reprod Health 2023; 27 [10]: 91-102).*

Mots-clés: SSA, death rate, infant mortality, healthcare provision

Introduction

Economies undergoing development are usually faced with a number of challenges, which include standards of living, education, and health. In recent times, other forms of challenges are emerging. These include, but are not limited to insecurity, unemployment, and malnutrition. None of these challenges is of lesser or higher importance than the other in the pursuit of human capital development. Meanwhile, the extent of the experiences in the first three listed challenges form the basis for classifying nations into low, middle and high-income countries.

Available evidence indicates that many households in low-and middle-income countries (LIMCs) have difficulties paying for healthcare servces[1]. In these countries, households frequently face the joint difficulties of destitution and a

deficiently subsidized public medical services framework. Due to an ill-funded public healthcare system, the populace has to rely on the private healthcare system and out-of-pocket health expenditure has resulted in more people being pushed below the poverty line due to increasing catastrophic health expenditure, which involves households foregoing their long-term economic well-being such as sales of properties in order to access healthcare. According to Woldemicheal, Gurara and Shimeles[2], the non-availability of comprehensive health insurance schemes in most LIMCs and the high rate of poverty put people with low-income in vulnerable conditions when they are sick. This has been the basis for the search for another source of income to cater for health expenditures. Amega[3] asserted that people use money sent home (remittances) by family members and friends who live abroad to pay for healthcare.

Remittance receipts represents a transfer, most of the times coming from high income countries. Such exchanges are profoundly proficient as it needs zero financial regulations, carries exceptionally minimal exchange expenses, and commonly go to families with the most need. Although monetary transfers may be an inadequate placeholder of the roles which the migrant would have performed if available, but families which receive transfer benefit from remittances in one way or the other[4] .

There will be no remittances without migration which is a necessary condition for remittances. Migration refers to the temporary or permanent relocation of individuals from one geographical location to another. Migration around in sub-Saharan Africa (SSA) is categorized into intra-regional (that is, within SSA countries) and international migrations (that is, outside SSA countries). Although intra-regional migration maintains dominance, intra-regional remittances are low when compared with international remittances. This is because African migrants in European nations, United States of America, and Canada earn more than migrants in other African countries[5]. Around 60 percent of total inflows of remittances to SSA in 2019 originated from high income economies, with France, Italy, the United Kingdom, and the United States, as the largest contributors with the remaining coming from other countries outside SSA and some from countries within Africa[6].

There is a tendency of remittance-receiving households to devote larger shares of their budget to health capital investment, rather than to other types of consumption of goods[7]. Despite the increasing volume of remittances to the SSA region, there have been only a couple of empirical research work on its impact on basic welfare indicators in the SSA sub-region. The present study therefore examined the effect of remittances on health outcomes in SSA with a focus on life expectancy and infant mortality. We believe the results will be useful for the design of policies and programs for the use of financial remittances for improving health outcomes in sub-Saharan African countries.

Literature review

There have been attempts aimed at understanding issues around effects of remittances to developing countries and regions around the world. For instances, López-córdova[8] assessed whether or not remittances across the border to Mexico stimulates development. Results showed that increases in remittances to families in the country is associated with better education and improved welfare. In the same vein, Airola[4] examined how much family life is affected by the receipts of remittance and the manner by which the more extensive local area is influenced utilizing data on Mexico from 1984 to 2000 analyzed with weighted least square. Families receiving remittances were found to spend a bit higher proportion of their receipt on durable products, medical care and housing.

Bebczuk and Battiston[9] examined the effect of remittances on the coverage of financial deficits arising during youth and retirement years and their influence on some household behaviors. The findings from the study revealed that remittances respond to the lack of pensions and especially to overall household financial deficits; encourage co-residence of the elderly with younger relatives and increase household expenditures on health, education among others.

De and Ratha[10] examined the effects of remittance income on children's welfare in terms of education and health in Sri Lanka from 1999 to 2000. It was discovered that remittances serve as a diversified source of income to the receiving households and helps children's human capital investment. Anderson and Kroeger[11] studied the

effects of remittances on investments in children using panel data from the Kyrgyz Republic. Remittances were found not to have improved investments in children's intellectual capital. Mahapatro, Bailey, James and Hutter[12] examined the effect of settlements both inside and abroad on the consumption examples of families in India, with an uncommon spotlight on Uttar Pradesh, Kerala, and Karnataka in India from 2007 to 2008 with propensity score matching technique. Families getting remittance were seen to save on food and spend more on instruction and medical-services.

Lim and Simmons[13] used fixed estimation to examine the effect of remittance inflows on social advancement markers in Antigua and Barbuda, the Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and Grenadines, Suriname, and Trinidad and Tobago from 1970 to 2019. Remittances were reported to have enhanced health indices by lowering newborn and child mortality and food insecurity, as well as increasing life expectancy, access to clean water, and sanitation. Howard, Stanley, Howard and Stanley[14] examined the impact of remittances on kids' body sizes and feeding habits of the families they live in utilizing board information of Honduras for chosen years using a panel data. In general, family consumption of schooling and medical care is found to be identified with remittances. Amega[3] used a 5-year interval panel data set on 46 Sub-Saharan African nations from 1975 to 2014. It was discovered that real remittances per capital improved education and health outcomes.

Ng[15] analyzed how the impact of the transitory movement of parents for work influences the wellbeing of children or young relatives left behind utilizing time series data of Indonesia from 2000 to 2007 estimated. It was realized that leaving a kid behind while parent migrate to other parts of the world for economic opportunities can have a net adverse consequence on the young people's well-being, particularly, in the case it was the mother who relocated.

Imran, Devadason and Cheok[16] examined the kind of formative effects of remittances for migrant sending families in areas of Punjab, Pakistan utilizing time series information of Punjab from 2014 to 2015. Most recipient families were observed to be in an ideal situation than families without this surge of pay. Lu, Yeung, Liu and Treiman[17] inspected the impact of movement on the wellbeing of left-behind children in China and the interceding channels utilizing cross-sectional data for China from 2012 to 2013. The outcome showed that the soundness of kids left behind in the countries by the two parents (however not by one parent) is more awful than that of youngsters living with two parent.

Bare, Bani, Ismail and Rosland[18] analyzed the effect of remittances on health outcomes for 39 selected SSA countries over the period 1996 to 2016. The study reported that remittances sustain health outcomes, while both financial development and institutional quality complement remittances and recommended the need for countries in the sub-region to improve their financial sectors and develop the quality of institutions to an adequate level in order to ease remittances which comes with its perceived benefits to the recipient countries.

Methods

Theoretical framework

The majority of people who migrate do so because of their hope for a better future which leads to the pursuit of greener pasture outside the country or region in which they are born. Most of them believe they can better their lives and those of their families which are left back at home. Financial assistance is expected from the migrant by the household left behind and this assistance is known as remittances and can be utilized by the household as a supplementary income thereby easing budget constraint of the household.

The study is built on the resource constraint model described by Amega[3]. Resource constraint refers to the input (in this case, household income) available to execute a task such as seeking better health outcome for household members. This approach is appropriate for the present study as it is not only robust in terms of variable inclusion but also allows for a clear view of the effect of remittance on households. This model (equation) begins with a health outcome function:

$$\text{Health} = \mathcal{F}(\text{m}, \text{z}) \qquad (1)$$

where m denotes medical treatment and the vector z denotes a multitude of factors influencing health outcomes in addition to medical care.

Households are supposed to maximize a utility function based on consumption of two items in common: X (market goods) and health (H). Each household strives to maximize utility by attaining the greatest indifference curve possible given financial restrictions. In the present scenario, the budget constraint is determined by remittances from overseas which together with other sources of income are utilized to pay for healthcare with the sole aim of achieving a targeted health outcome (H).

Model specification

The model is theoretically stated as the link from micro perspective to macro perspective between remittances and health outcomes. It is also being explained by other factors that influence health outcomes like public health expenditure, migrant flow, per capita income, physicians per 1000 people, unemployment rate and education level.

The econometric specification for the model depicted in equation (2)

$$\mathrm{HT_{it}} = \alpha_0 + \alpha_1 \mathrm{RM_{it}} + \alpha_2 \mathrm{PHE_{it}} + \alpha_3 \mathrm{MIG_{it}} + \alpha_4 \mathrm{PCI_{it}} + \alpha_6 \mathrm{PHYS_{it}} + \alpha_7 \mathrm{UN_{it}} + \alpha_8 \mathrm{EDUC_{it}} + \beta_i + \beta_t + \mu_{it} \quad (2)$$

Where: HT_{it} is the health outcome of country i, at time t (proxy by life expectancy at birth and infant mortality rate).

RM_{it} is the remittance received by country i in time t.
PHE_{it} is the public health expenditure of country i at time t.
MIG_{it} is the migration flow of country i at time t.
PCI_{it} is the per capita income of country i at time t.
$PHYS_{it}$ is physician density i.e., the number of medical doctors available per one thousand individuals in country i at time t.
UN_{it} is the unemployment level in country i at time t.
$EDUC_{it}$ is the education level in country i at time t.
β_i is country fixed but time-invariant variables that influence remittance and health outcome
β_t is a time fixed effects that have resulted in shocks in some SSA countries for the period.
$\alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6, \alpha_7, \text{and } \alpha_8$ are coefficients.

A priori expectations: All the coefficients are expected to be positive in the life expectancy model except unemployment while reverse is expected in the infant mortality rate model
The general model is specified in equation 3):

$$\mathrm{HT_{it}} = \mathrm{f}(\mathrm{RM_{it}}, \mathrm{PHE_{it}}, \mathrm{MIG_{it}}, \mathrm{PCI_{it}}, \mathrm{PHYS_{it}}, \mathrm{UN_{it}}, \mathrm{EDUC_{it}}) \quad (3)$$

The dependent variable specific models estimated are:

Model I:

$$\mathrm{LE_{it}} = \mathcal{F}(\mathrm{REM_{it}}, \mathrm{PHE_{it}}, \mathrm{MIG_{it}}, \mathrm{PCI_{it}}, \mathrm{PHYS_{it}}, \mathrm{UNEMP_{it}}, \mathrm{EDUC_{it}}) \quad (4)$$

Where, $\mathrm{LE_{It}}$ is the life expectancy at birth in country i at time t

Model II:

$$\mathrm{IMR_{it}} = \mathcal{F}(\mathrm{RM_{it}}, \mathrm{PHE_{it}}, \mathrm{MIG_{it}}, \mathrm{PCI_{it}}, \mathrm{PHYS_{it}}, \mathrm{UN_{it}}, \mathrm{EDUC_{it}}) \quad (5)$$

Where, IMR_{It} is the infant mortality rate.

Rationale for variable inclusion

Variables included in the model are health outcome, remittances, migration flow, per capita income, public health expenditure, physicians per 1000 individuals, unemployment rate, and education level.
Life expectancy, under-five mortality and remittances are included as they are the basis for the model. Migration flow was included as migration is a necessary though not sufficient condition for remittance. It may also represent skilled health professionals moving in and out of the country. This was included in past studies[3,14,19].

Per capita income was included because empirical studies have shown that household income level has a positive relationship with its health seeking behavioral pattern. That is, the higher a household income level the higher the likelihood of seeking medical care. This was included in some past studies on effects of foreign in-flow on health outcomes[20]. Public health Expenditure determines the quality of public health services available which in turn determines the

level of health outcome, thus it was included in the model. This is in line with the model of Akinbode and Oseni[21]. Physician per 1000 individuals shows the ease of access to medical doctors by individuals, the higher the ratio the easier the access. This was included in a number of past studies

The unemployment rate is included as unemployment connotes low earning status thereby having the tendency to reduce access to healthcare and health outcome.

Education level is included as migrants with a higher level of education can compete better in high-income countries and as a result, earn higher and are more likely to remit more. This was included in past studies such as Akinbode and Oseni[21] Amega[2].

Variables measurement and data sources

Table 1 presents the summary of measurement and sources of data used for the study.

Estimation procedures

These are preliminary analyses performed on the data, they included:

***Descriptive statistics*:** These were used to describe the main characteristics of data in a study, and they provide succinct summaries of the sample. The statistics provide comprehensive information regarding the characteristics, distribution, and behavior of the variables under consideration by presenting statistics such as the mean, median, kurtosis, skewness, standard deviation, maximum and minimum value among others.

***Correlation analysis**:* This is a bivariate analysis that uses the correlation coefficient to examine the degree of association and direction between two variables. This served as guide against including two or more regressors which are highly correlated and can constitute a major problem to the estimated model.

Estimation technique

The preferred method of estimation for the study is the Generalized Method of Moments (GMM) which is an analytical technique that combines economic data with information on population moment conditions to estimate unknown parameters. The two types of GMM are the differenced GMM and the system GMM. Specifically, the system GMM was employed for the present study as it has been demonstrated in application to be capable of compensating for endogeneity problem, unreported country heterogeneity, measurement errors, and omitted variable bias, all of which frequently impair growth and by extension development and welfare estimation. In addition, the system GMM technique was adopted because it has been established that bi-causal relationship exists between remittance and health outcomes, resulting in an endogeneity problem will be taken care of; the time period covered was lower than the cross-section (i.e. T < N) and finally some regressors were not strictly exogenous. To avoid instrument proliferation, the instrument was collapsed in the estimation and appropriate lag limit were set.

Post estimation analyses

***Serial correlation test**:* The proper serial correlation test statistics for panel linear GMM regressions are the Arellano-Bond Serial Correlation tests, AR(1) and AR(2). The null hypothesis is that serial correlation does not exist in the model. Roodman[23] posited that the null hypothesis of the non-existence of serial correlation of the first order i.e., AR(1) is expected to be rejected while the null hypothesis of the non-existence of second order serial correlation i.e., AR(2) is expected to be accepted. This means that lower p-value for AR(1), and a higher p-value for AR(2) are desirable.

***Test of overall validity of instruments**:* Due to the problem of endogeneity, there was the need for the inclusion of instruments to correct for this problem, the instruments were tested for validity and also to ensure they were strictly exogenous. This is an important assumption for the validity of the GMM model. The Sargan and the Hansen tests are the appropriate tests to assess the exogeneity of the instrumental variables as such condition is necessary for the validity of the estimated system GMM model. The implication of this is that higher p-values are desirable.

Robustness check: The robustness check is conducted following Roodman[23]. The test is conducted by estimating the Pooled OLS and

Table 1: Summary of variable measurement and data source

Variables	Definition	Measurement
RM	Remittance per capita	US Dollars
PHE	Public health expenditure	US Dollars
MIG	Migration flows	Units of migrant
PCI	Per capita income	US Dollars
PHYS	Physician per 1000 individuals	No of physician per 1000 individuals
UN	Unemployment rate	Percentage of population unemployed
EDUC	Education Level	Percentage of age grade with a primary school certificate
LEB	Life Expectancy at birth	Years
IMR	Infant Mortality Rate	Death recorded among children below a year old in every one thousand live-birth.

The datasets of all the variables employed were sourced from World Development Indicators (WDI) by the World Bank in 2022[22]

Within Group (fixed effect) versions of the estimated GMM models. For the system GMM result to be accepted as robust, the coefficient value of the lagged dependent variable must fall between its pooled OLS coefficient value (upper bound) and its fixed effect coefficient value (lower bound).

Results

Results in Table 2 presents the summary of the descriptive statistics of the study variables. The average life expectancy in SSA during the period of the study was 55.6 years while infant mortality rate was 70.9 per 1000 live-births. The average IMR in SSA for the period was 70.9 per 1000 live-births. The average PCI value is $3677.7 as reported in the present study. The physician density value has average value of 0.21. All the variables in the study skewed to the right while only education skewed to the left. On the other hand, the kurtosis values show that all the series were leptokurtic except unemployment rate, which was mesokurtic since its value was close to 3. The Jarque-Bera statistics are insignificant for all the variables, this implies that they were all normally distributed.

Correlation analyses: The correlation analysis was carried out to be sure that the independent variables do not have a perfect or near perfect correlation with one another. Table 3 shows the result of the correlation analysis and it can be inferred from the table that none of the included variables has very high correlation coefficient to portend the risk of multicollinearity in the model estimated. This implies that the major explanatory variables, life expectancy and infant mortality rate are free from the problem of multicollinearity.

Effect of remittance on life expectancy

Table 4 presents the estimated outcomes of the two-step system GMM. The estimated results revealed that one period lag of life expectancy (LE_{t-1}) had significant and positive effect on present year life expectancy in conformity with the *a priori* expectation at one percent level of significance. The effect of remittance on life expectancy was negative but not statistically significant. The result further shows that physician density (PHYS), per capita income (PCI) and unemployment (UN) all had significant effect while education did not significantly affect life expectancy (LEB). Physician per 1000 individuals and per capita income had significant positive effect on life expectancy.

Post estimation

Serial correlation test

In order to assess the validity of the system GMM model estimated there is the need to test for the presence of the first order and second order serial correlation i.e., AR(1) and AR(2) respectively. The null hypothesis is that there is no serial autocorrelation. The AR(1) and AR(2) result showed a probability value of 0.036 and 0.157, respectively. The AR (1) test rejects the null hypothesis at 5% level of significance implying the

Table 2: Descriptive statistics

	Mean	Max.	Min	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Prob.
LE	55.624	62.809	51.695	3.793	0.661	1.908	3.556	0.169
IMR	70.879	94.226	46.374	16.204	-0.01	1.547	2.55	0.279
MIG	152749	379827.3	3.846	161637.1	0.098	1.052	4.629	0.099
PCI	3667.747	5516.205	2082.195	1205.081	0.139	1.476	2.898	0.235
PHE	299.799	692.205	76.454	251.83	0.623	1.472	4.698	0.095
PHYS	0.210	0.406	0.067	0.082	0.269	2.551	0.594	0.743
RM	43900000	1090000000	70318000	367000000	0.360	1.445	3.547	0.17
UN	10.629	15.650	3.458	2.773	-0.330	3.092	0.536	0.765
EDUC	59.729	76.159	41.389	10.674	-0.213	1.641	2.452	0.293

Source: Authors' computation

Note: REM the remittance, PHE public health expenditure, MIG is migration flow PCI is per capita income PHYS is physician density, UN is unemployment, EDUC is education

Table 3: Results of Pearson's correlation analysis

	LE	IM	MIG	PCI	PHE	PHYS	REMIT	UN
LEB	1							
IM	-0.69	1						
MIG	-0.54	0.63	1					
PCI	0.51	-0.28	-0.6	1				
PHE	-0.61	0.67	0.57	-0.27	1			
PHYS	0.74	-0.7	-0.42	0.71	-0.37	1		
RM	0.56	-0.45	-0.57	0.38	-0.66	0.67	1	
UN	-0.34	0.21	0.11	-0.23	0.32	-0.53	-0.37	1

Source: Authors' Computation

Note: REM the remittance, PHE public health expenditure, MIG is migration flow PCI is per capita income PHYS is physician density, UN is the unemployment , EDUC is education

presence of first order autocorrelation in the idiosyncratic error term. This is expected given the manner the differenced error term upon which the test was conducted is usually generated. The AR (2) test on the other hand accepts the null hypothesis, which is in line with theoretical expectation. Both the AR (1) and AR (2) test results validate the estimates of the system GMM result presented in Table 4.

Test for validity of the instrumental variable

The Sargan and the Hansen tests are both specification tests of over-identifying restriction which test for the overall validity of the instrumental variables used in the estimated system GMM model. The test in necessary for the integrity of the results. The null hypothesis was that all instruments as a group were exogenous or more specifically, that all instruments are valid. Both tests returned p-values which were higher than 5 percent. Specifically, the p-value of the Sargan test was 19.2% while that of Hansen was 24.1% both accepting the null hypothesis of the validity of the instrumental variables employed for the study.

OLS and fixed effect estimates (Robustness check)

Table 4 presents the result of the Pooled estimate and the fixed effect estimate respectively for model I, the lagged dependent variable (life expectancy) is significant in both the pooled ols and the fixed effect estimate. Roodman[23] posited that for a system GMM result to be considered robust, the lagged dependent variable coefficient in the system GMM estimate should fall between the values of the Pooled OLS and the fixed effect values. In the case of the life expectancy model, the condition was met and the result is therefore accepted as robust since 0.991566 (Pooled Ols estimate) > 0.9819494 (system GMM estimate) > .9641107 (Fixed effect estimate).

Table 4: Results of the Life Expectancy (Model 1)

	Main Results			**Robustness Check Results**					
	Two-Step System GMM			**Pooled OLS model**			**Fixed Effect Model**		
	Coeff.	S.E.	t-value	Coeff.	S. E.	t-value	Coeff.	S. Error	t-value
L1.LEB	0.9819***	0.0473	20.74	0.9916***	0.1351	7.34	0.9641***	0.0880	10.9
RM	-0.0005	0.0020	0.25	0.0006***	0.0002	3.05	0.0018**	0.0007	2.56
PHE	0.0206	0.0173	1.19	0.7216	0.4779	1.51	0.0379	0.0306	1.24
MIG	0.2028	0.2091	0.97	0.3104	0.2608	1.19	0.8274	1.0804	0.77
PHYS	0.1067**	0.0518	2.06	0.0022	0.0017	1.30	0.0082**	0.0033	2.45
PCI	0.0642*	0.0338	1.90	0.0009	0.0008	1.20	0.0115*	0.0019	6.20
UN	-0.0008**	0.0004	1.99	-0.0002***	0.0001	2.92	-0.0021	0.0010	-2.01
EDUC	-0.0014	0.0010	-1.40	0.0019	0.0022	-0.87	0.0373	0.0178	2.10
AR(1) p-value	0.036	-	-	-	-	-	-	-	-
AR(2) p-value	0.157	-	-	-	-	-	-	-	-
Hansen test p-value	0.241	-	-	-	-	-	-	-	-
Sargan test p-value	0.192	-	-	-	-	-	-	-	-
R-Squared	-	-	-	0.9912	-	-	-	-	-
Adj. R^2	-	-	-	0.9703	-	-	-	-	-
No. of instruments	27	-	-	-	-	-	-	-	-

S.E = Standard Error; *, ** and *** implies significant at 10%, 5% and 1% respectively
Note: REM the remittance, PHE public health expenditure, MIG is migration flow PCI is per capita income PHYS is physician density, UN is the unemployment , EDUC is education
Source: Authors' Computation

Effect of remittance on infant mortality rate (MODEL II)

The estimated two-step system GMM result is presented in Table 5. The results revealed that one period lagged infant mortality rate (IMR) has significant and positive effect on present year IMR at one percent level of significance. The result further shows that remittances has a negative but insignificant effect on infant mortality. Public health expenditure (PHE) came up with significant negative coefficient implying that increase in government spending on health reduced death of children under the age of one year in the region significantly during the period. Furthermore, Physician density came up with negative and significant coefficient in line with *a priori* expectation. In the same vein, per capita income (PCI) significantly reduced infant mortality in SSA in line with a priori expectation.

Post estimation

Serial correlation test

The null hypotheses of both test conducted here state that no autocorrelation exists. AR(1) and AR(2) yielded probability values of 0.049 and 0.438, respectively. The AR(1) test, which examines the existence of serial correlation of the first order in difference error term, rejects the null hypothesis at a 5% level of significance, implying the presence of autocorrelation which was expected, but the AR(2) test accepts the null hypothesis. Both tests validated the system GMM result estimated.

Test for validity of the instrumental variable

The result of the Sargan and Hansen test are reported in Table 5. The Sargan test accepted the null hypotheses as each of them returned p-values greater than acceptable threshold for rejection of the hypotheses thereby affirming the validity of the instruments adopted for the estimation of the system GMM models.

OLS and fixed effect estimation (Robustness check)

Table 5 also contain the result of the pooled OLS estimate and the fixed effect estimates. The result

Table 5: Results of the infant mortality rate (Model II)

	Main Results			**Robustness Check Results**					
	Two-Step System GMM			**Pooled OLS model**			**Fixed Effect Model**		
	Coeff.	S.E.	t-value	Coeff.	S. E.	t-value	Coeff.	S. Error	t-value
L1.IMR	0.9431***	0.2037	4.63	0.9679***	0.0784	12.34	0.9031***	0.0515	17.53
RM	-0.0031	0.0044	0.71	-0.0084	0.0400	-0.21	-0.0076	0.0049	-1.54
PHE	-0.0919**	0.0401	-2.29	-0.1325*	0.0683	-1.94	-0.2105	0.1413	-1.49
MIG	0.02823	0.0297	0.95	0.0918	0.3166	0.29	0.7231	0.6399	1.13
PHYS	-0.1645***	0.0482	-3.41	-0.0001	0.0000	8.79	0.0115***	0.0038	3.05
PCI	-0.0211*	0.1000	2.11	-0.0246***	0.0078	-3.16	-0.0016***	0.0003	6.09
UN	0.0902	0.1961	0.46	0.0687	0.0142	4.83	0.0892***	0.0147	6.05
EDUC	-0.0010	0.0011	-0.92	0.0322	0.2301	0.14	0.0075	0.0056	-1.35
AR(1) p-value	0.049	-	-	-	-	-	-	-	-
AR(2) p-value	0.438	-	-	-	-	-	-	-	-
Hansen test p-value	0.146	-	-	-	-	-	-	-	-
Sargan test p-value	0.204	-	-	-	-	-	-	-	-
R-Squared	-	-	-	0.9987	-	-	-	-	-
Adj. R^2	-	-	-	0.9682	-	-	-	-	-
Instruments	22	-	-	-	-	-	-	-	-

S.E = Standard Error; *, ** and *** implies significant at 10%, 5% and 1% respectively
Source: Authors' Computation

shows that the system GMM estimated could be taken as robust as the coefficient of the lagged dependent variable lies between its value in the pooled OLS and the fixed effect model i.e., 0.9679 (Pooled OLS estimate) > 0.9431 (system GMM estimate) > 0.9031 (Fixed effect estimate).

Discussion

In line with the research question and objective of this study, the findings are discussed as follows; the average life expectancy in SSA during the period of the study was 55.6 years while infant mortality rate was 70.9 per 1000 live-births. The average life expectancy reported in the present study is lower than the average of 72.4 years and 72.2 years for East Asia and the Pacific (EAP) and Latin America and the Caribbean (LAC) respectively during the same period. The average PCI value of $3677.7 reported in the present study is far below the $6,407.44 in Middle East and North Africa (MENA) and the world average of $8,855.44 for the period. This low-income level may justify the need by households in the sub-region to spend part of remittances received to procure basic welfare needs such as healthcare.

The physician density value of 0.21 reported in the present study is far below the WHO recommendation of 1: 1000 people and it is far below the figure of 3.28 per 1000 people in the European Union and 1.76 in the LAC during the same period. Meanwhile, Kumar and Pal[24] reported 44 percent of the WHO member countries have not been able to achieve the recommended ratio. Furthermore, lag of life expectancy had significant and positive effect on present year life expectancy. This implies that a one percent improvement in the value of life expectancy in the previous year led to more than 0.98% increase in the value of life expectancy in the present year.

Improved life expectancy in the previous year connote some improvement in health and healthcare facilities and this is expected to yield more positive health outcome in the present year as people are likely to take advantage of their good health to work and earn more, and demand for better healthcare which improves longevity. The effect of remittance on life expectancy was negative but notstatistically significant. This is not particularly surprising as remittance has many uses e.g., acquisition of properties, funds for feeding or school expenses etc. Therefore, its use in ensuring

better healthcare may not be significant at an instance. This finding is in line with those of Pan and Dong[25] and Terrelonge[26] but was contrary to those of Amega[3] Kan[27] Kan[28] and López-Córdova[8]In the same vein, physician density (PHYS), per capita income (PCI) and unemployment (UNEMP) all had significant effect while education did not significantly affect life expectancy (LEB). PHYS and PCI had significant positive effect on LEB and this implies that increases in these variables increased life expectancy significantly. Specifically, a percentage point increase in PHY increased LEB by 0.1067 percentage point and similar increase in PCI increased LEB by 0.0642 percentage point. A key finding here is that availability of physicians improves life expectancy relatively more than income given the difference in the value of their marginal increase. Furthermore, a percentage point increase in UNEMP reduced LEB by 0.0008 percentage point. This aligned with the *a priori* expectation as well as the fact that an increase in unemployment rate could be due to job loss, which will reduce welfare among which is health outcome of the individual as well as those who depend on such persons significantly.

In addition, one period lagged infant mortality rate (IMR) has significant and positive effect on present year IMR, this implies that a one percent increase in the value of infant mortality rate in the previous year caused to 0.94% increase in the value of infant mortality rate in the present year. This reflects some level of persistence. The result further shows that remittances has a negative but insignificant effect on infant mortality. This is in accordance with the findings of Ponce, Olivié and Onofa[29] but contrary to the findings of Airola[4]; Howard *et al*.[14]; Lim and Simmons[13].

Public health expenditure (PHE) came up with significant negative coefficient implying that increase in government spending on health reduced death of children under the age of one year in the region significantly during the period. Physician density came up with negative and significant coefficient. A percentage point increase in physician density reduced IMR by 0.1645 percentage point. The result aligns with that of Russo, Scott, Sivey and Dias[30] which reported that primary care physician supply contributed to the decline of infant mortality in Brazil and that increase of one primary care physician per 10,000 population was associated with 7.08 fewer infant deaths per 10,000 live births. Also, per capita income (PCI) significantly reduced infant mortality in SSA. The results also align with that O'Hare, Makuta, Chiwaula and Bar-Zeev[31], Obasaju *et al*.[32], Xu *et al*.[33], Zhang *et al*.[34], Nasir *et al*.[35] Lawal *et al*[36].

This underscores the importance of income level of the people in demanding for health and may partly explain while high income countries have low infant mortality rate compared with low income countries. Therefore, it is important to stress that in addition to remittances, public health expenditure, physician density and per capita income were main determinants of life expectancy and under five mortality in SSA. As such, the results underscore the potential role of the remittances in improving health outcomes, particularly in reducing infant mortality. Policymakers in SSA should consider fostering an environment that encourages inflows of remittances into the sub region. In the same vein, recruitment of more trained medical doctors alongside policies capable of ensuring growth and development are to be pursued by the policymakers in this sub region in order to raise income to acceptable level, as this has been shown to improve health outcomes – life expectancy and under five mortality in SSA.

The strengths of this study lie in its rigorous quantitative analysis in providing a clear answer to the research question. Robustness checks were carried out in this study to validate and strengthen its empirical findings. This study also utilized a system GMM to analysis data of 45 sub-Saharan African countries, which makes this study to be unique. This study is limited and serves as a future direction for other researchers. The study focused on only SSA. Studies therefore could be carried out on the entire African continent in one hand, sub regional studies could also be carried out to cater for peculiar nature of each of the African sub regions.

Conclusions

This study therefore concludes that remittances did not have any significant positive effect on life expectancy but physician density and per capita income significantly increased life expectancy in SSA while remittances had a negative but insignificant effect on infant mortality. Public health expenditure, physician density and per capita

income significantly reduced infant mortality rate in SSA.

Author's contribution

Shaojie Hao conceived and designed the study; Huanqi Yang collected and analysed the data;
Ran Bi reviewed empirical studies; Sakiru O. Akinbode designed the methodology; Timothy A. Aderemi wrote the introduction and edited the paper. All the authors wrote the paper.

References

1. Wagner AK, Graves AJ, Reiss SK, LeCates R, Zhang F and Ross-Degnan D. Access to careand medicines, burden of health care expenditures, and risk protection: Results from the World Health Survey. *Health policy 100*, 2011: 151–158.
2. Woldemichael A, Gurara D Z and Shimeles A. Community-Based Health Insurance and Out-of- Pocket Healthcare Spending in Africa: Evidence from Rwanda. *Institute for the Study of Labor.* 2–37, IZA Discussion Paper No. 9922, 2016.
3. Amega K. Remittances, education and health in Sub-Saharan Africa. *Cogent Economics & Finance* 2018: *6*(00): 1–27. https://doi.org/10.1080/23322039.2018.1516488
4. Airola J. The use of remittance income in Mexico. *International MigrationReview* 2007: *41*(4): 850-859.
5. Uberti SD., De Lombaerde P, Nita S and Legovini E. Analyzing intra-regional migration in Sub-Saharan Africa. *Regions & Cohesion* 2015: 5(2): 77-113.
6. Allen C. Remittances in Sub-Saharan Africa: An update. *Africa Department*,*International Monetary Fund*. Retrieved on May 20:2021, 2023 from https://www.imf.org/ /media/Files/Publications/covid19-special-notes/en-special-series-on-covid-19 remittances-in-sub-saharan-africa-an-update.ashx
7. Berloffa G and Giunti S. Remittances and healthcare expenditure: Human capitalinvestment or responses to shocks? Evidence from Peru. *Review of Development Economics* 2019: 23(4): 1540-1561.
8. López- Córdova JEL. Globalization, migration and development: the role ofMexican migrant remittances *(Working Paper ITD= Documento de Trabajo ITD; n.20)* (Vol. 20), 2006, BID-INTAL.
9. Bebczuk R and Battistón D. Remittances and Life Cycle Deficits in Latin America.CEDLAS, *Working Papers* 0094, CEDLAS, Universidad Nacional de La Plata 2010.
10. De PK and Ratha D. Impact of remittances on household income, asset and human capital: Evidence from Sri Lanka. *Migration and Development* 2012: *1*(1): 163-179.
11. Anderson K H and Kroeger A. Remittances and Children's Capabilities: New Evidence from Kyrgystan, 2005-2008. Discussion Papers of DIW Berlin 1170, DIWBerlin, *German Institute for Economic Research*, 2011.
12. Mahapatro S, Bailey A, James KS and Hutter I. Remittances and household expenditure patterns in India and selected states. *Migration and Development* 2017: *6*(1): 83-101.
13. Lim S amd Simmons WO. What Have Remittances Done to Development ? Evidence from the Caribbean Community and Common Market. *The Review of Black Political Economy*, 2016: 343–361. https://doi.org/10.1007/s12114-016-9240-y.
14. Howard LL, Stanley DL, Howard LL and Stanley DL. Remittances channels and the physical growth of Honduran children. *International Review of Applied Economics* 2017: *2171*(March):1–22. https://doi.org/10.1080/02692171.2016.1257582.
15. Ng J. Labor Migration in Indonesia and the Health of Children Left Behind. *IZA Journal of Development and Migration* 2019*:* 10(2), doi.org/10.2478/izajodm-2019-0006.
16. Imran K, Devadason ES and Cheok CK. Developmental Impacts of Remittances on Migrant-Sending Households: Micro-Level Evidence from Punjab, Pakistan. *Journal of South Asian Development* 2019: 14(3): 338-366.
17. Lu Y, Yeung WJ, Liu J and Treiman DJ. Health of left-behind children in China: Evidence from mediation analysis. *Chinese Journal of Sociology* 2019: *5*(4): 431-452.
18. Bare UA, Bani Y, Ismail NW and Rosland AR. Remittances and health outcomes in Sub-Saharan African countries: Understanding the role of financial development and institutional quality. *Economic Annals* 2021: *66*(129): 119-144.
19. Zhou D, Bassey RA, Yan M and Aderemi TA. Do health expenditures affect under-five mortality and life expectancy in ECOWAS sub-Region? African Journal of Reproductive Health 2023: 27(8):105-113.
20. Oseni IO, Odusanya IA and Akinbode SO. Effectiveness of foreign aid for health in reducing HIV prevalence in Sub-Saharan Africa. *South-Eastern Europe Journal of Economics* 2022: *20*(2): 141-158.
21. Akinbode SO and Oseni IO. Effect of health aid on life expectancy in Sub-Saharan Africa. *Journal for the Advancement of Developing Economies* 2022*:* 11(1): 1-17.
22. World Bank. World Development Indicators, 2022. Retrieved fromhttps://databank.wprldbank.org/source/world-development-indicators.
23. Roodman D. A Note on the theme of too many instruments, *Oxford Bulletin of Economics and Statistics* 2009: *71*(1):135-158.
24. Kumar R and Pal R. Indian achieves WHO recommended doctor-population ratio: A call for paradigm shift in public health discourse. *Journal of Family Medicine and Primary Care* (2018): *7*(5): 841-844.
25. Pan Z and Dong W. Can money substitute adult children ' s absence ? Measuring remittances ' compensation effect on the health of rural migrants ' left-behind

elderlyparents. *Journal of Rural Studies* 2020: *79*(6): 216–225.https://doi.org/10.1016/j.jrurstud.2020.08.022.

26. Terrelonge SC. For health, strength, and daily food: the dual impact of remittances and public health expenditure on household health spending and child health outcomes. *The Journal of Development Studies* 2014: *50*(10): 1397-1410, DOI: 10.1080/00220388.2014.940911.
27. Kan S. Improving health in Tajikistan: remittances trump other income (No. 206).*Discussion Papers,* 2016.
28. Kan S. Is an ounce of remittance worth a pound of health? The case of Tajikistan. *International Migration Review* 2021: *55*(2): 347-381.
29. Ponce J, Olivié I and Onofa M. The role of international remittances in health outcomes in Ecuador: Prevention and response to shocks. *International Migration Review* 2011: *45*(3): 727-745.
30. Russo LX, Scott A, Sivey P and Dias J. Primary care physicians and infant mortality: Evidence from Brazil. *PLoS One* 2019: 14(5):e0217614. doi: 10.1371/journal.pone.0217614. PMID: 31150468; PMCID: PMC6544253.
31. O'Hare B, Makuta I, Chiwaula L and Bar-Zeev N. Income and child mortality in developing countries: a systematic review and meta-analysis. *Journal of the Royal Society of Medicine* 2013: *106*(10): 408-414. doi: 10.1177/0141076813489680. Epub 2013 Jul 3. PMID: 23824332; PMCID: PMC3791093.
32. Obasaju B, Adama I, Ishola OP, Oloyede F, Osabohien R, Aregbesola A and Onabote A. Effects of immunisation on child mortality in West Africa. In *2023 International Conference on Science, Engineering and Business for Sustainable Development Goals (SEB-SDG)* (Vol. 1, pp. 1-5), 2023. IEEE. https://doi.org/10.1109/SEB-SDG57117.2023.10124485
33. Xu Y, Peng MYP, Ahuru, RR, Anser MK, Osabohien R and Aziz A. Individual and community-level factors associated with non-institutional delivery of women of childbearing-age in Nigeria. *Humanities and Social Sciences Communications* 2022: *9*(1): 1-7. https://doi.org/10.1057/s41599-022-01168-7
34. Zhang X, Anser MK, Ahuru RR, Zhang Z, Peng MYP, Osabohien R and Mirza M. Do predictors of health facility delivery among reproductive-age women differ by health insurance enrollment? A multi-level analysis of Nigeria's data. *Frontiers in Public Health*: 2022: *10*, 797272. https://doi.org/10.3389/fpubh.2022.797272
35. Nasir MH, Anser MK, Ahuru RR, Osabohien R, Ebiaku KC, and Abbas, S. A comparative study of the effect of health insurance on women's use of health facility delivery: Evidence from demographic health survey in Benin Republic. *African Journal of Reproductive Health* 2022: *26*(6): 104-115. https://doi.org/10.29063/ajrh2022/v26i6.12
36. Lawal NA, Adegun EA, Aderemi TA and Dauda ROS. Migrant remittances, growth and poverty reduction: ARDL-Bounds Test and Granger Causality approach. *Izvestiya Journal of Verna University of Economics* 2022: 66(1-2): 74-90.