Undernourishment on Longevity in West Africa: A Group Outcome

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https://doi.org/10.61090/aksujacog.2023.027

Abstract
The length of time a person lives from the date of birth is an essential dimension of a country's level of development. Several factors have been identified as responsible for longevity. This study investigated the effect of undernourishment prevalence and other factors on longevity in West Africa from 2000-2018. Using panel data, the random coefficient model was employed to examine the effect of a novel variable, such as the prevalence of undernourishment and others (government expenditure on health, population density, unemployment and out-of-pocket expenditure) on longevity. Except for a few, the findings revealed that longevity is a decreasing function of the prevalence of undernourishment in West Africa. In contrast, it was revealed that longevity is an increasing function of population density in all West African countries. The effect of government spending and unemployment on health contradicts theory in some countries, while they were in tandem with theory in other countries. Therefore, the study recommended, among others, the introduction of dynamic agricultural policies to increase income and ensure food security in West Africa.

Keywords: Prevalence of undernourishment, longevity, impingement.

Introduction
An important indicator of the efficacy of a nation's health system is how long and healthy a person lives after birth. Beyene & Kotosz (2021) argued that healthy people can positively contribute to the economic growth and development of a country (directly and indirectly) by providing labour to different sectors. By implication, a healthy populace will undoubtedly contribute to growth and a general standard of living. Despite government spending and interest shown by international health agencies on health issues in developing countries, West African countries still experience debilitating health issues that undermine longevity. For instance, the

domestic expenditure on health in Cape Verde in 2018 was 59.47 % of its current expenditure on health while health expenditure was 43.51% in Mauritania. In Senegal government domestic expenditure in 2018 amounted to 33.69 % of its current health expenditure and 41. 58 % in Guinea Bissau (World Health Organization, 2011).

The United Nations Population Division (2022) reports that countries such as Mali, Cote d'Ivoire, Guinea Bissau, Nigeria, and Sierra Leone had life expectancies ranging from 53.75 to 58.45 in 2018, representing the countries with the lowest longevity in the globe. In the view of Balani (2016), longevity is multidimensional, suggesting that factors affecting life expectancy vary from one continent or region to the other with environmental and economic factors mostly considered. Hence, some studies consider longevity to be relatively low in Africa because of high environmental pollution and poor policies, while low environmental pollution and well-developed environmental policies and other health care provisions account for long life in developed countries. In contrast, others believe that Africa's natural food intake, weather conditions, and low level of industrialization account for its relatively high life expectancy.

In line with the foregoing, the average life expectancy in the West African region from 2000 to 2018 was highest in Mauritania and Cape Verde (73.09 and 70.92 years) respectively (United Nations Population Division, 2019). However, average life expectancy was lowest in Sierra Leone and Nigeria (47.8 and 50.24 years) years, respectively. Although there has been a slight increase in life expectancy across the region, the majority of the nations still have a situation that warrants serious concern, especially when compared to North African countries like Tunisia, Morocco, and Libya, where absolute longevity is as high as 76, 76, and 72 years, respectively (United Nations Population Division, 2019).

Malnutrition is a risk factor for death. Hence a population aspiring for a healthy and long life may require an improved nutritional status. A report from Torero (2021) of the Food and Agricultural Organization, United Nations, shows that 720 to 811 million people faced hunger in 2020. This figure showed an increase of 118 million people who faced starvation in 2019. On average, the prevalence of undernourishment was highest in Liberia and Sierra Leone, where 38.43% and 30.51% of the population were undernourished and lowest in Mauritania and Ghana, with 5.6% and 7.9 % of the population undernourished (Food and Agricultural Organization, 2022). However, according to the Global Hunger Index (2022), West African nations were most plagued by malnutrition and hunger in 2020. Specifically, Liberia had 33.3%, Sierra Leone had 31.1%, Nigeria had 28.3%, Mali had 28.3%, Burkina Faso had 24.5%, and Togo had 23.7%. The Norwegian Refugee Council (2022) reports that West Africa faces its worst food crisis in ten years, with over 27 million people suffering from hunger. This situation requires a concerted effort of government check, otherwise, many West African countries may find it challenging to meet sustainable development goals 2 and 3 in 2030 (end hunger and ensure that everyone, everywhere, has enough quality food to live a healthy life). Figure 1 demonstrates the average longevity and undernourishment in countries of West Africa. The trend shows that longevity is highest in Mauritania and Cape Verde, while undernourishment is highest in Liberia and Sierra Leone.

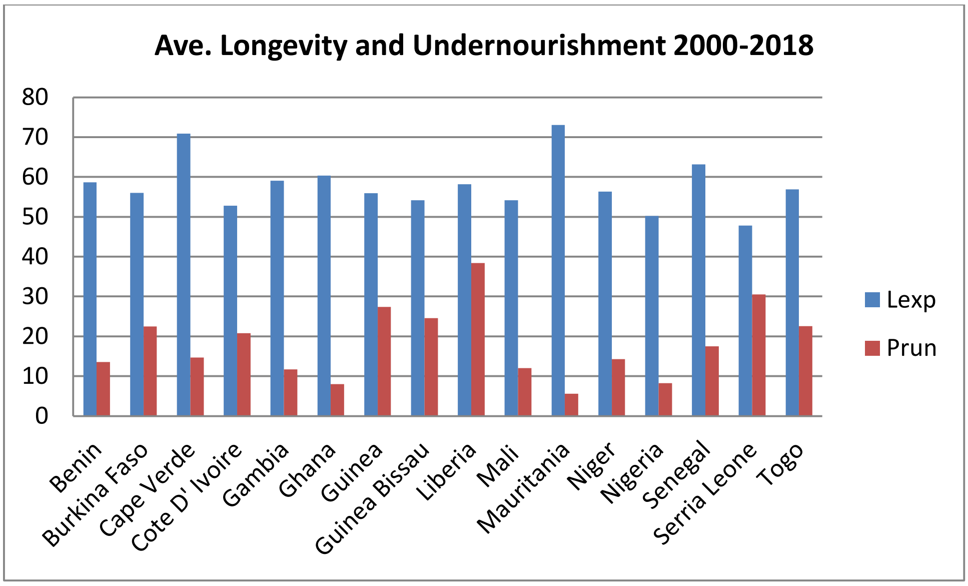

Figure 1. Average Longevity and Undernourishment in West Africa
Source: UNPD and FAO, 2019.

Recent health literature in Africa is awash with studies on longevity, such as Beyene & Kotosz (2021), Chewe & Hangoma (2020), Alim et al. (2019), Nkalu & Edeme (2019), Abubakari, Amponsah & Owoo (2019) and Urhie et al. (2020), among others. However, previous studies have concentrated mainly on the impact of carbon dioxide (CO_2) emissions and government expenditure on healthcare and life expectancy. This study is set to expand the literature on longevity, examining the effect of undernourishment on longevity in West African countries. It will address the question: does the prevalence of undernourishment affect longevity in West Africa?

This study deviates from previous ones and contributes to extant literature in many ways. First, using a panel dataset from 2000 to 2018 and a novel approach, it investigates the impingement of the prevalence of undernourishment on longevity in West Africa. Second, it provides a clear understanding of the connection between novel variables such as the prevalence of undernourishment and population density on longevity in the West African region, hence offering more comprehensive coverage and enhancing policy effectiveness in the region than the studies before it.

Theoretical Literature

Theoretical and empirical literature shows that several studies have been carried out on the determinants of longevity across the globe. The theory supporting this study is the Grossman's (1972) theory of demand for healthcare developed. It states that the concept of health is a robust capital good but devalues over time. Thus, investment in health is an activity where medical care is combined with other inputs to generate new health to partially offset the slow natural deterioration of health. Aligning with the framework of household production theory, the Grossman hypothesis opines that health is both a consumption and an investment good. This suggests that households are both consumers and producers of health. Grossman's model considers an individual's health as a long-lasting and endogenously determined capital good (Hren, 2012). Assumptions of the theory include: health capital cannot be traded; gross investment in health (*It)* must be non-negative; two inputs are considered here (medical care Mt and individual's time used on activities that can enhance one's health stock, for instance, sporting activities); rate of health depreciation to be constant within a given time interval. The Grossman model does make the present health behaviour depend on the past; it does preclude an individual from chosing to live forever. It does not predict that health declines with lower socio-economic status

The relevance of this theory stems from the fact that it arouses the conciousness of health consumers to detoriating nature of health. As a result, good health requires investment in the area of mdical care, time for spriting activities and other health inputs.

Literature Review

Empirical literature indicates that studies on longevity cut across specific countries, sub-Saharan Africa, Asia, and Europe. Anwar et al. (2021) investigated the relationship between health expenditures, forestation, and environmental quality using panel data from 87 countries for the period 1999–2018 and employing the difference and system Generalised Method of Moments method. The findings revealed a positive and significant relationship between CO2 emissions and per capita health expenditure among the countries. Okwan & Mcineka (2012) examined the relationship between health financing and health outcomes in 25 sub-Saharan Africa between 2000 and 2015. The study adopted the partial least square structural equation method and found a negative and statistically significant relationship between health financing and health outcomes. Again, the result indicated that health financing, directly and indirectly, affects health outcomes measured by the under-five mortality rate, maternal mortality rate, and life expectancy.

Nkalu & Edeme (2019) studied the extent to which environmental hazards affect life expectancy in Africa using Nigeria from 1960 to 2017. The study adopted a generalized autoregressive conditional heteroscedasticity estimator. The findings showed that environmental hazards in terms of carbon dioxide emissions significantly reduce life expectancy by one month and three weeks, while Gross Domestic Product (GDP) extends life expectancy by one year and six months, though statistically insignificant. Likewise, population growth extends life expectancy by five years and five months due to increased human resources, which enhances agricultural productivity in Africa. Thus, the study argues that income or GDP could hold if it is appropriately channelled to health programmes; otherwise, other covariates may be responsible for the result. Furthermore, the effect of population growth can also stand if agriculture is mechanized and the growing population is educated.

Abubakari et al. (2019) considered the effect of selected socioeconomic factors on life expectancy in Sub-Saharan Africa using data from 44 countries between 2000 and 2015 and applied the generalized method of moments estimation technique. Their findings showed that GDP per capita, health expenditure per capita, and education are positively and significantly responsible for changes in life expectancy. On the other hand, the Human Immunodeficiency Virus (HIV)/Acquired Immunodeficiency Syndrome (AIDS) prevalence rate and CO2 emissions negatively and significantly impacted life expectancy, and geographical location had a differing effect on life expectancy.

Beyene & Kotosz (2021) examined the impact of environmental quality on life expectancy in 24 African countries from 2000 to 2016, employing a panel autoregressive distributed lag dynamic fixed effect model. The results confirmed that in the long run, improvements in environmental quality significantly increased life expectancy in those countries; thus, an increase in the environmental performance index and ecosystem vitality increased the life expectancy of Africans in those nations by 0.137 and 0.1417 years, respectively.

Chewe & Hangoma (2020) estimated the effect of socioeconomic, environmental, health system, and lifestyle factors on life expectancy on infant mortality in 30 sub-Saharan African countries, from 1995 to 2014. The study employed a dynamic generalized method of moments estimator. The findings revealed that health expenditure, educational attainment, and healthcare access quality are associated with increased life expectancy and reductions in infant mortality. Higher HIV prevalence rates are related to declines in life expectancy, whereas urbanization, per capita income growth, and access to clean water are positively associated with life expectancy.

To investigate the causal linkage between environmental quality and healthcare expenditure in 15 Economic Community of West African States (ECOWAS) countries, from 1995 to 2014, Alim, et al. (2019) employed pooled Ordinary Least Squares (OLS), fixed effects, and system GMM. From the findings, carbon emissions exert a positive statistically significant impact on both public and national healthcare expenditures, while no relationship seems to exist between environmental pollution and private healthcare expenditures.

Hassan et al. (2017) examined the relationship between life expectancy and health expenditure, gross domestic product, education index, improved water coverage, and improved sanitation facilities in 108 selected developing countries between 2006 and 2010. They adopted the panel Vector Error Correction Model. The results yielded a positive relationship between the life expectancy rate and the explanatory variables. In addition, an unidirectional causality runs from health expenditure, education index, improved water, and improved sanitation to life expectancy at birth. Similarly, bidirectional causality exists between life expectancy and income.

Balkhi et al. (2012) assessed the impact of health expenditures on improving healthcare systems and health in the Middle East and North Africa (MENA) from 1995 to 2015. The study employed the Pearson correlation coefficient to measure the relationship between life expectancy and health expenditure. The results showed a negative relationship between healthcare expenditure and life expectancy.

In country-specific studies, Owumi & Eboh (2021) assessed the contributions of healthcare expenditures to life expectancy at birth in Nigeria for a period spanning 2000 to 2017. The use of robust least squares regression revealed that domestic general government health expenditures, out-of-pocket payments, and external health expenditures significantly positively affected life expectancy in Nigeria. In addition, Osabohien et al. (2021) studied Nigeria's carbon emissions and life expectancy from 1980 to 2017 using an autoregressive distributed lag. The result revealed that carbon emissions are significant but inversely affect life expectancy.

A cursory overview of the recent empirical literature on drivers of life expectancy reveals that studies gravitate heavily towards environmental ($CO2$ emission) and government expenditure on health, with less emphasis on other socioeconomic factors, such as undernourishment. There are also conflicting findings among authors on the effect of health financing and environmental factors on life expectancy. While many findings confirmed the negative influence of environmental factors on health, a few reported otherwise. Similarly, a few studies confirmed an inverse relationship between health financing and life expectancy. These differences may be associated with data collection processes, analysis techniques, and the time dimension.

Methodology

Data Type and Data Sources

This study collected panel data from well-known and trustworthy international institutions for 15 West African countries. Data availability and consistency determined the choice of data and variables used for this study. The sources and description of data are presented in Table 1.

Table 1: Description and sources of data

Variable	Description	Sources
Life expectancy-LEXP	Indicates the number of years a newborn will live after birth	United Nations Population Division. World Population Prospects: 2019 Revision. https://www.indexmundi.com/facts/indicators/SP.DYN.LE00.IN
Population Density -PODE	Population density is midyear population divided by land area in square kilometers.	World Bank population estimates. https://www.indexmundi.com/facts/indicators/EN.POP.DNST
Prevalence of undernourishment- PRUN	Shows the percentage of the population whose food intake is insufficient to meet the dietary energy requirement	Food and Agriculture Organization http://www.fao.org/publications/en/
Out-of-pocket expenditure-OPEX	Out-of-pocket payments are percentage spending on health directly out-of-pocket by households.	World Health Organization Global Health Expenditure database http://apps.who.int/nha/database
Domestic Government Expenditure on Health- GEXH	Share of current health expenditures funded from domestic public sources for health	World Health Organization Global Health Expenditure database (http://apps.who.int/nha/database)
Unemployment-UNEM	Unemployment refers to a percentage share of the labor force without work.	International Labour Organization, ILOSTAT database. https://www.indexmundi.com/facts/indicators/SL.UEM.TOTL.NE.ZS
Sampled countries		
Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo.		

Source: Authors' construction*s*

EstimaionTechniqes

To provide insight into the effect of undernourishment prevalence and longevity in West Africa, this study employed Swamy's random coefficients model as elaborated in Poi (2003); Hsiao & Persaran (2004); and Moussa et al. (2011). Although "all panels share common slope parameters, the random-coefficient models (RCM) are more general in allowing each panel to have its vector of slopes randomly drawn from a distribution common to all panels" (Poi, 2003 p.2). The RCM provides for group and country-specific outcomes and allows for different coefficients among the cross-sectional units. It also has the advantage of accommodating large datasets for panel studies. Laszlo & Patrick (2008) assert that the RCM can easily be adapted for dependence across the error terms. Adopting Swamy as cited in Poi (2003), the general form of the random coefficient model is as stated in equation 1.

$yi = X_i \beta_i + \varepsilon$...1

Where, i = denote cross sections, y_i is a $Ti \times 1$ vector of observations for the ith cross-section, X_i is a $T_i \times k$ matrix of non-stochastic covariates, and $\beta\, i$ is a k×1 vector of parameters specific to cross-section i. The error term vector ε_i is distributed with mean zero and variance $\sigma\, ii$ I.

Random coefficient modelling expresses equation 1 as two linear equations. One with y as a dependent variable and another with a random slope β_i as a dependent variable as follows:

$\beta_i = \beta + v_i$...2

where, β is a random slope predicted by other covariates while the error terms $\varepsilon_{i.}$ and v_i. are allowed to vary.

Combining equations 1 and 2, we have that;

$yi = x_i(\beta + v_i) + \varepsilon i$...3

$= x_i \beta + \mu_i$

where, $\mu_i \equiv x_i v_i + \varepsilon_i$

Model Specification

This study has its theoretical underpinning in the Grossman health model. The model views a person's health as a long-term capital good that is determined endogenously and progresses through time. The model in its general framework is presented as follows:

$H_t = I_t - \delta_t H_t$...4

Where, H_t is the health capital at the beginning of an interval, I_t is the gross investment in health during interval t, and δ_t is the rate of health depreciation assumed to be constant within a given time interval t, dependent only on an individual's age and exogenously determined. Including medical care and time in the model, equation 4 becomes:

$H_t = I_t(M_t, t_i) - \delta_t H_t$...5

Where: M_t is medical care, and t_i is one's own time on the sport.

Adapting the Grossman health model in equation 5 as the theoretical backbone of this study as well as using the RCM and introducing other relevant health variables, we hypothesize that:

$LEXP = f(PRUN, OPEX, PODE, UNEM, GEXH)$...6

LEXP is life expectancy or longevity; PRUN is the prevalence of undernourishment; OPEX is out-of-pocket expenditure by individual households; PODE is Population Density; UNEM is unemployment; and GEXH is government expenditure on health.

The operational model of this study econometrically transformed from Equation 6 is presented as

$LNLEXP_{it} = \Psi_0 + \Psi_1 PRUN_{it} + \Psi_2 LNPODE_{it} + \Psi_3 OPEX_{it} + \Psi_4 UNEM_{it} + \Psi_5 GEXH_{it} + \mu_{it.}$....................7

Where Ln is the natural log of the variables. Ψ 1-5 are the coefficients of the model. OPEX, UNEM GEXH are in percetages as such are not logged.

Empirical Results

Except for unemployment, the summary of statistics in Table 2 reveals that the data set is not dispersed from their means, indicating that the variables are adequate for model estimation. It also reveals a normal distribution and no extreme value. The correlation matrix reveals a negative and significant correlation between the prevalence of undernourishment, out-of-pocket expenditure and longevity.

Table 2: Descriptive statistics and correlation matrix

Statistic	Descriptive Statistics					
	LNLEXP	**LNPODE**	**PRUN**	**GEXH**	**OPEX**	**UNEM**
Mean	4.053	4.273	17.552	28.157	49.428	7.377
Std. Dev	0.120	0.946	9.269	15.243	15.245	6.650
Maximum	4.311	6.435	40.700	73.010	83.140	27.530
Minimum	3.675	2.192	4.700	3.770	20.250	0.260
Skewness	0.133	-0.034	0.738	0.942	-0.075	1.477
Kurtosis	3.228	3.459	2.958	3.541	2.201	4.235
Correlation matrix						
LNLEXP	1.000					
LNPODE	0.451***	1.000				
PRUN	-0.428***	-0.295	1.000			
GEXH	0.600***	0.289	-0.339	1.000		
OPEX	-0.526***	-0.1857	0.172	-0.612	1.000	
UNEM	0.632***	0.432	-0.438	0.670	-0.384	1.000

*** refers to significant at a <.001% level
Source: Computed by the authors using EViews 10

Table 3: Cross-sectional dependency and heterogeneity tests

Variable	Breusch-Pagan-LM	Pro.Val	Pesaran scaled LM	Pro. Val	Bias-corrected scaled LM	Pro. Val	Pesaran CD	Pro. val
Cross Dependency Result								
LNLEXP	2219^{+}	<.001	135.49^{+}	<.001	135.05^{+}	<.001	47.10^{+}	<.001
LNPODE	2243.65^{+}	<.001	137.081^{+}	<.001	136.64^{+}	<.001	47.36^{+}	<.001
PRUN	1007.45^{+}	<.001	57.28^{+}	<.001	56.84^{+}	<.001	22.74^{+}	<.001
GEXH	346.47^{+}	<.001	14.62^{+}	<.001	14.17^{+}	<.001	1.83^{+}	<.001
OPEX	421.00^{+}	<.001	19.43^{+}	<.001	18.99^{+}	<.001	7.43^{+}	<.001
UNEM	649.73^{+}	<.001	34.19^{+}	<.001	33.75^{+}	<.001	1.69^{+}	<.001
Slope Heterogeneity Result								
	Delta	Pro. Val						
	12.21	<.001						
Adj. Val	15.37	<.001						

$^{+}$ denotes rejection of the null hypothesis of no cross-sectional dependency
Source: Computed by the authors using EViews 10

The outcome of the cross sectional dependency in Tabe 3 shows that all the criteria confirmed significant cross-sectional dependencies among the variables, hence we reject the null hypothesis of no cross-sectional dependency. Further, the heterogenous result confirms differences among the intercepts of the cross sections. Next, is the unit root outcome using Pesaran (2007) CIPS and CADF as shown in Table 4.

Table 4: Pesaran CADF and CIPS Panel Unit root tests

Variable	**Pesaran CADF (Levels)**					**Pesaran CADF (First Diff)**				
	t-bar	Cv10	Cv5	Cv1	P-Val	t-bar	Cv10	Cv5	Cv1	P-Val
LEXP	-3.70***	-2.10	-2.21	-2.40	<.001	-	-	-	-	-
PRUN	-3.90***	-2.10	-2.21	-2.40	<.001	-	-	-	-	-
PODE	-3.47***	-2.10	-2.21	-2.40	<.001	-	-	-	-	-
OPEX	-1.70	-2.10	-2.21	-2.40	0.55	-2.75***	-2.10	-2.21	-2.40	<.001
GEXH	-1.82	-2.10	-2.21	-2.40	0.37	-2.88***	-2.10	-2.21	-2.40	<.001
UNEM	-1.55	-2.10	-2.21	-2.40	0.76	-2.15*	-2.10	-2.21	-2.40	0.05
	CIPS (Levels)					**CIPS (First Diff)**				
LEXP	-2.26**	-2.1	-2.2	-2.4						
PRUN	-1.91	-2.1	-2.2	-2.4		-2.1	-2.1	-2.2	-2.4	
PODE	-2.29**	-2.1	-2.2	-2.4		-	-	-	-	
OPEX	-2.20	-2.1*	-2.2	-2.4		-4.30***	-2.1	-2.2	-2.4	
GEXH	-2.13	-2.1*	-2.2	-2.4		-4.56***	-2.1	-2.2	-2.4	
UNEM	-1.82	-2.1	-2.2	-2.4		-3.23	-2.1	-2.2	-2.4	

***, **, * refers to significant at <.001, <.05 and <.1% levels, respectively.
Source: Computed by the authors using Stata 16

Using the CADF criterion, results show that life expectancy, the prevalence of undernourishment and population density are stationary at levels, while life expectancy and population density are stationary at levels using the CIPS criterion. All other variables are stationary at the first difference using both criteria. The stationarity of the variables voids a possible spurious regression but confirms the outcome's reliability for prediction and policy briefs.

Table 5: Pedroni Cointegration Test Results

Parameter	**Statistics**	**Prob. Val**
Modified- Phillips Perron t	3.308	<.001***
Phillips- Perron t	0.086	0.466
Augmented Dickey-Fuller t	0.525	0.300

*** implies significant at <.001% .
Source: Computed by the authors using Stata 16

The Cointegration test result is presented in Table 5. From the results, the null hypothesis of no cointegration is rejected, thus, a long-run relationship exists between longevity and the variables of interest studied. Finally, we employed the Westerlund (2007) and Banerjee & Carrion (2017) cointegration test for further validation, as shown in Table 6.

Table 6: Westerlund and Banerjee and Carrion-I-Silvestre panel cointegration tests

	Westerlund[25] Z-value (Only target variables)				Banerjee and Carrion-I-Silvestre All variables in the model
Z- Value	Gt	Ga	Pt	Pa	Levels Statistic
Bootstrap	-2.104**	6.274	3.099	5.078	-3.384***
P-Value	<.001***	0.470	0.040**	0.380	

***, **, refers to significant at <.001 and <.05% levels, respectively.
Source: Computed by the authors using Stata 16

Since Westerlund (2007) suffers from insufficient observations, especially when the number of independent variables increases, this study adopted the Westerlund only for target variables. However, it employed Banerjee & Carrion-i-Silvestre (2017) for all variables in the model. The Westerlund result shows that two out of four results are significant at the 5% level, hence, it can be inferred that a long-run relationship exists between the variables. Moreover, Banerjee and Carrion-i-Silvestre's results confirm the long-run relationship among all variables in the model.

As cointegration is confirmed, the long-run results using a random coefficient regression model for a group in Table 7 can be estimated.

Table 7 Estimates Group Outcome of the Random coefficient Regression model

LEXP	Coefficient	Std. Err	z	Pro. Val
PRUN	-0.0022	0.0011	-1.89	0.058*
PODE	0.3078	0.0389	7.90	<.001***
GEXH	-0.0001	0.0002	-0.31	0.756
OPEX	-0.0002	0.0002	-1.14	0.253
UNEM	-0.0004	0.0034	-0.12	0.908
CONS.	2.7456	0.2545	10.79	<.001
Parameter constancy	Chi2(90) = 1.5e+05 Prob Chi2= <.001			

***, * refers to significant at <.001 and <.1% levels, respectively.
Source: Computed by the authors using Stata 16.

The group outcome in Table 7 shows that the model meets the parameter constancy assumption, hence, inferences and policy briefs drawn from this study will not be misleading.

The result of this study shows an inverse and significant relationship between the prevalence of undernourishment and life expectancy at a 10% level of significance. This suggests a relatively high population whose food intake is insufficient to meet dietary energy requirements, hence, a decrease in life expectancy in West Africa. This outcome was expected because insufficient dietary energy requirement or lack of it has the potential to reduce life span. The inverse and significant relationship may be linked to insufficient food production in the region resulting from an un-mechanized farming system and the region's low income.

The increase in persons per square meter (population density) significantly explains the systemic change in longevity. Also, this result is supported by the work of Beyene & Kotosz (2021) in some selected African countries. This outcome is associated with some institutions and projects with expansion and development that enhance life, such as medical, and recreational facilities and schools.

Government expenditure on health, out-of-pocket spending, and unemployment had inverse relationships with longevity and are all insignificant in explaining their variations. This outcome negates our expectations as it implies that increased government expenditure on health did not translate to increased life expectancy. This result conflicts with the study of Beyene &

Kotosz (2021) and Chewe & Hangoma (2020) on life expectancy in some selected African countries. This present study attributes the inverse relationship between government expenditure on health and life expectancy in West Africa, as revealed in the group outcome, weak health programmes, inconsistent health policies and implementation of health policies by governments, and corruption. Again, the inverse relationship between individual household expenditure on health and life expectancy may be due to low income, insufficient and lack of quality health facilities in the region, mostly in rural areas.

Conclusion

Over time, the number of years one lives after birth in Africa has attracted the interest of several groups-scholars, analysts, international organizations, and policymakers alike. Although there have been several studies on life expectancy in Africa, few have been directed to some selected countries in West Africa. Besides, no one has considered the prevalence of undernourishment as a determining factor of longevity in the entire region. In addition, empirical postulations provide conflicting views using limited robust analytical techniques. Therefore, this study employed the RCM to study the impingement of the prevalence of undernourishment and population density on life expectancy in all 15 countries of West Africa. Our findings suggest that the prevalence of undernourishment is a significant driver of decreased longevity in countries of West Africa, while population density drives increased longevity.

Recommendations

Following the findings of this study, it is suggested that agricultural policies designed to ensure food security will be appropriate to enhance life expectancy in the West African region. Furthermore, given that longevity in West Africa was increased by the density of people per square Kilometer of land, deliberate growth and development of rural areas with health-improving amenities like medical and recreational facilities, educational facilities, and welcoming immigration policies should be a major government policy.

Although this study endeavoured to fill the existing gap in the literature on life expectancy by providing insight into the influence of the prevalence of undernourishment and population density on life expectancy, it did not cover all spectrums of life expectancy. Moreover, given the concept's multidimensional nature, studies considering international agencies' intervention in West African countries will boost the literature on life expectancy.

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