Disaggregating health spending and life expectancy: The case of Nigeria

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Annotation: *Health financing is crucial for economic productivity and the life expectancy of a nation's labor force. However, Nigeria faces numerous economic factors that threaten its healthcare sector starting from a non-transparent fiscal autonomy leading to a rise in public health expenditure. This has been a significant threat to the Nigerian healthcare sector. From 2016 to 2021, the increase has been unhidden, possibly due to health insurgencies and governance issues. Despite this, fiscal allocation has decreased interest in government health financing, resulting in increased household health expenditures. This hinged the interest of the study to ascertain the disaggregated healthcare expenditures that caused life expectancy differentials in Nigeria between 1990 and 2021 finding a mixed integration at all levels, with life expectancy causing government health expenditure and government health expenditure causing out-of-pocket health expenditure. The study recommends continuous and increased government health spending to enhance life expectancy, boost productivity, and prepare Nigeria for sustainable development by 2030.*

1. Introduction

Health financing, amongst other drivers for economic productivity, plays a critical role through the efficiency of a nation's labor force and its impact on life expectancy. This implies that sufficient investment in healthcare guarantees a robust workforce that can propel sustained economic expansion. Thus, the need for health financing in developed and developing economies cannot be exaggerated. However, in Nigeria, the healthcare sector is faced with numerous economic factors, from inefficient allocation of resources to rising financial restrictions, and insufficient funds threaten the improvement of life expectancy and the attainment of value-added health outcomes (Amedari & Ejidike, 2021; Balogun, 2022; Akpor, Akingbade, & Olorunfemi, 2023). This could be responsible for the ranking of the Lancet health system, placing Nigeria at 142 out of 195 countries (Amedari & Ejidike, 2021).

Despite various efforts of the Nigerian government to improve healthcare delivery, the government's recurrent health expenditures revealed an unreliable pattern over four decades in light of tackling challenging healthcare issues. For example, there exists an increasing public health expenditure to address healthcare issues, leading to a rise in the recurrent healthcare expenditure from ₦50 million in 1990 to ₦4.74 billion in 1998, and

since then, it has consistently increased to ₦98.22 billion in 2008, which births a hinge in 2010 at ₦90.20 billion to a drastic rise to ₦231.80 billion but was reduced to ₦180 billion in 2013 (Central Bank of Nigeria, 2022).

Although, this revealed the reduction in the recurrent healthcare expenditure posed a heartfelt threat to the Nigerian healthcare sector. But from 2016 to 2021, the increase in the public health expenditure is known which could be a result of the outbreak of health insurgency in 2019 and 2020 and governance and fiscal allocation. Despite these increases in the annual recurrent health budget, the fiscal allocation has caused Nigerians to lose interest in government health financing, which hosts the increasing need for household health expenditures in Nigeria (Adebisi *et al.*, 2020). The reliance of most Nigerians on out-of-pocket medical expenses suggests a lack of public trust in the effectiveness of government-funded healthcare, which makes knowledge of the impact of disaggregated medical expenses on life expectancy necessary for the development of evidence-based policy.

It is then that this study investigates the causal influence of the disaggregated healthcare expenditures on life expectancy in Nigeria. To do this, the paper tests the hypothesis that disaggregated healthcare expenditures in Nigeria do not have a significant casual influence on life expectancy. The study adds empirical insights into the ways that various aspects of healthcare spending affect life expectancy in a developing economy like Nigeria by employing robust econometric techniques. The rest of the paper follows the literature review in Section 2; the methodology and empirical analysis of results in Section 3; and lastly, the conclusion and recommendations in Section 4. Above all, this study provides vital information and policy recommendations to the government, health practitioners, and policymakers on how healthcare expenditures can cause or bring about an improvement in the life expectancy of Nigerians.

2. Literature review

In Sub-Saharan Africa (SSA), life expectancy and health spending continue to be crucial topics in discussions of sustainable human development. The World Health Organization (2023) has often emphasized that the region's poor health results in comparison to global norms are a result of insufficient and poorly focused health spending. Although, according to SSA empirical research, there is a general agreement that health spending improves population health outcomes, empirical studies relating healthcare spending and life expectancy also point to methodological and contextual differences that call for a disaggregated, causality-oriented approach.

Although the health expenditures-growth nexus has been widely examined in Nigeria, major methodological and causation identifications remain rarely investigated. This shows that there exists a methodological vacuum in confirming the stance of previous studies on the causality direction in Nigeria. Jibril and Salisu (2024) found that public healthcare expenditure positively impacts life expectancy, while carbon dioxide emissions negatively affect it. The study recommended an expansion of health fiscal allocations, but their estimates are static and correlation-driven, highlighting the endogeneity problem in Nigerian health-spending studies.

Similarly, Usman (2024) found a negative relationship between out-of-pocket (OOP) expenditure and neonatal mortality, contradicting evidence that excessive private spending worsens health inequality. This suggests omitted-variable bias and potential simultaneity, as deteriorating health conditions can trigger higher private expenditure. Campbell, Oluwatosin, and Ojo (2022) applied

the Toda-Yamamoto approach to macroeconomic aggregates, revealing bidirectional causality between employment and growth but only a unidirectional link from public expenditure to employment. However, no Nigerian health expenditure study has replicated this rigor using disaggregated data on public and private health spending, leaving the causality between healthcare financing and life expectancy unresolved. Danladi (2021) investigated life expectancy using Dynamic Ordinary Least Squares and discovered that life expectancy is increased by both capital and ongoing expenditures. However, the study did not take government health allocations into account and disregarded any feedback effects. Despite using traditional Granger tests that are sensitive to integration and cointegration orders, Dodo and Isa (2020) found favorable correlations between health spending and health outcomes. In addition to addressing model misspecification, the Toda-Yamamoto approach may offer more trustworthy inference.

On the contrary, there are conflicting results from time-series studies of life expectancy and health spending. Ojo (2020), using the ARDL framework, discovered no significant long-term relationship between life expectancy and health spending, which she attributed to inefficiency and underinvestment. Although they did not distinguish between public recurrent and household out-of-pocket, Ogunjimi and Adebayo (2019) discovered unidirectional causality between health expenditure and both GDP and infant and maternal mortality. Recent studies in Nigeria have shown mixed results on the causality of health spending and health status. While studies like Ibikunle (2019) suggest consistent public financing enhances productivity, others suggest that inefficiency and policy misalignment may be the cause. In Kaduna Metropolis, Ahmed (2018) revealed that patient costs, drug prices, and quality of care significantly influence household out-of-pocket health expenditure, while free healthcare and insurance significantly reduce it. This suggests that macro-level analyses overlook the role of private expenditure in shaping health-seeking behavior.

It is evident that Nigerian studies often deal with causation ambiguity, aggregation bias, and structural instability due to policy regime changes, budgetary shocks, and pandemics. By avoiding biased pre-tests, maintaining sample degrees of freedom, and testing for directional causality in level variances, the Toda-Yamamoto–Dolado–Lütkepohl (TYDL) methodology provides a methodological benefit. A significant empirical gap in Nigerian health economics is filled by applying this framework to disaggregated public recurrent and out-of-pocket expenditures. This allows for the identification of causal direction, the quantification of short-run dynamics, and the provision of evidence that is pertinent to policy regarding the relative effectiveness of household or fiscal spending in influencing life expectancy.

3. Methodology and data

3.1. Data source, description, and model estimation

The *ex post facto* research design was adopted by the study as a result of investigating the causal relationship between the disaggregated healthcare expenditures and life expectancy in Nigeria between the periods of 1990 and 2021. The study modifies the study of Ogunjimi and Adebayo (2019) as specified in (3).

$$PHO_t = f\ (RGHE_t, OOPHE_t) \quad (3)$$

Where PHO_t represents population health outcome, $RGHE_t$ is the government recurrent health expenditures, and while $OOPHE_t$ represents household current health expenditure. The dependent variable is the outcome of the population's health and it is

proxy with life expectancy at birth (total %). This is sourced from the 2024 World Development Indicators (WDI) database. Life expectancy at birth in this study is the average expectancy of one's life with the assumption that their mortality rate would remain constant over the course of their lives. It calculates how living conditions, health spending, and socioeconomic variables affect people's ability to survive and work. Life expectancy at birth is represented as $LEXP_t$. The series is expressed in its natural unit to measure the average gender for male and female.

The explanatory variables used to proxy health expenditures are the public and household health expenditures. The Federal Government recurrent health expenditure, which includes yearly spending on medical staff, hospital operations, and supplies, is a measure of public health expenditures in Nigeria that reflects the government's financial commitment to healthcare delivery and institutional performance. The public health expenditures were proxied by the Federal Government recurrent health expenditure (₦'Billion). The Federal Government recurrent health expenditure (₦ billion) was sourced from the 2023 Central Bank of Nigeria (CBN) Public Finance Annual Statistical Bulletins. The logarithmic scale of measurement was introduced for public health recurrent expenditure to reduce heteroskedasticity, stabilize variance, and ensure unit comparability.

On the other hand, the household health expenditures were proxied with out-of-pocket expenditure (% of current health expenditure. Current household out-of-pocket health expenditures are spending on health directly out-of-pocket by households. This is the amount of money that households and individuals pay out of pocket for medical products and services, such as hospital stays, prescription drugs, consultations, and preventative care that is not covered by insurance or government subsidies. This series was sourced from the 2024 WDI database and is measured in percentages. As such, the functional model is transformed into an econometric model as expressed in (4).

$$LEXP_t = \delta_0 + \gamma_1 InRGHE_t + \gamma_2 OOPHE_t + \varphi_t \quad (4)$$

Where $\gamma_0 - \gamma_2$ are vector parameters of the estimate, and φ_t is the white noise of the model. δ_0 represents the constant estimates. Thus, to determine the relationship between the disaggregated health expenditures and life expectancy, and if these disaggregated health expenditures cause life expectancy in Nigeria, the study prompts the conduct of some preliminary tests that determine the appropriate use of the econometric technique for the study. Expectedly, recurrent public health expenditures are expected to have a significant positive influence on life expectancy as a result of greater access to quality service delivery in the healthcare sector. Contrarily, the current household out-of-pocket health expenditures are expected to have a negative influence on life expectancy as a result of inadequate public provision, which daunts the consumption of the healthcare sector, especially among the lower-income strata. Thus, the *a priori* expectation is expressed in (5) as

$$\frac{\partial(InRGHE_t)}{\partial(LEXP_t)} > 0 \; ; \; \frac{\partial(OOPHE_t)}{\partial(LEXP_t)} < 0 \quad (5)$$

This preliminary test explains the behavior of the series from 1990 to 2021. The choice of these periods is a result of the unavailability of out-of-pocket health expenditure data from 2022 to 2024, which also connotes a limitation to the study at the time of conducting the study. The results were analyzed using version 12 of the Econometric View (EViews 12) statistical software.

3.2. Estimation technique

Unlike previous studies, this study employed

the Toda-Yamamoto-Dolado-Lütkepohl (TYDL) causality approach to evaluate the influence direction among variables without assuming cointegration between healthcare expenditures and life expectancy, avoiding bias and model misspecification risks. The TYDL method, unlike the Granger and Engle-Granger frameworks, avoids bias and model misspecification due to incorrect integration or cointegration orders. Regardless of whether the variables are integrated of order I(0), I(1), or I(2), the Toda and Yamamoto (1995) and Dolado and Lütkepohl (1996) approaches overcome the drawbacks of conventional methods by estimating a Vector Autoregressive (VAR) model in levels, permitting valid Wald (MWALD) tests for causality. Therefore, the TYDL framework successfully gets beyond the drawbacks of conventional causality techniques, which are susceptible to small-sample distortions and non-stationary data. Nevertheless, the choice of the appropriate econometric technique for the study is the 1995 Toda-Yamamoto (TY) and the 1996 Dolado-Lütkepohl (DL) causality test based on the second difference unit root result of life expectancy.

The TY-DL causality test is an econometric technique that enjoys several alternative advantages over the OLS, ARDL, VEC, and VAR techniques and offers two distinct advantages, which are the robustness to the order of integration and the valid modification of the Wald (MWALD) test with a chi-square distribution for restriction on the parameters of the VAR. Since the TY-DL causality test is an econometric technique that is modified from the VAR technique, then the logarithmic form of the recurrent public health expenditures is reported back in its natural form. With this, the earlier expressed econometric model in (4) is later expressed in (5) as

$$LEXP_t = \delta_0 + \gamma_1 RGHE_t + \gamma_2 OOPHE_t + \varphi_t \quad (6)$$

Where $LEXP_t$ signifies the natural form of the life expectancy at time t, $RGHE_t$ represents the natural form of government recurrent health expenditures at time t, while $OOPHE_t$ symbolises the household current out-of-pocket health expenditures at time t. Thus, to determine the relationship between the disaggregated Thus, another advantage of the TY-DL test as explained is that it is the best fit for the study because the study does not examine the effect or impact of the disaggregated health expenditures on life expectancy but rather aims at determining the relationship and if these disaggregated health expenditures cause life expectancy in Nigeria. The TY-DL approach conducted through the modified Chi-Square Wald approach is superior to other econometric tests, especially the ARDL Bounds test. It does not require a co-integrating test on the model because it assumes a normalized co-integration in the model. Amongst other econometric tests, the TY-DL test helps overcome the asymptotic problem of the critical values when the causality test is done in the presence of non-stationary and stationary series (Götz & Hecq, 2019); it likewise helps to minimize the risk associated with the possibility of wrongly identifying the order of integration, which makes the approach useful for any order of integration (Mohamed, Saafi & Farhat, 2014), and lastly, it guides the suitability of the standard VAR approach in their levels rather than its presumed first difference selection order (Fadol, 2020). Therefore, the generic null hypothesis of the TY-DL model is expressed in (7), (8), and (9).

$$LEXP_t = \delta_{10} + \sum_{i=1}^{k} \gamma_{11} LEXP_{t-i} + \sum_{j=k+1}^{k+d_{max}} \gamma_{12} LEXP_{t-j} + \sum_{i=1}^{k} \rho_{11} RGHE_{t-i} + \sum_{j=k+1}^{k+d_{max}} \rho_{12} RGHE_{t-j} + \sum_{i=1}^{k} \lambda_{11} OOPHE_{t-i} + \sum_{j=k+1}^{k+d_{max}} \lambda_{12} OOPHE_{t-j} + \eta_{1t} \quad (7)$$

$$RGHE_t = \delta_{20} + \sum_{i=1}^{k} \gamma_{21} RGHE_{t-i} + \sum_{j=k+1}^{k+d_{max}} \gamma_{22} RGHE_{t-j} + \sum_{i=1}^{k} \rho_{21} LEXP_{t-i} + \sum_{j=k+1}^{k+d_{max}} \rho_{22} LEXP_{t-j} + \sum_{i=1}^{k} \lambda_{21} \Delta OOPHE_{t-i} + \sum_{j=k+1}^{k+d_{max}} \lambda_{22} OOPHE_{t-j} + \eta_{2t} \quad (8)$$

$$OOPHE_t = \delta_{30} + \sum_{i=1}^{k} \gamma_{31} OOPHE_{t-i} + \sum_{j=k+1}^{k+d_{max}} \gamma_{32} OOPHE_{t-j} + \sum_{i=1}^{k} \rho_{31} RGHE_{t-i} + \sum_{j=k+1}^{k+d_{max}} \rho_{32} RGHE_{t-j} + \sum_{i=1}^{k} \lambda_{31} LEXP_{t-i} + \sum_{j=k+1}^{k+d_{max}} \lambda_{32} LEXP_{t-j} + \eta_{3t} \quad (9)$$

Where γ's, ρ's, and λ's are the parameters of the TY-DL causality estimates, and δ_0 is the constant parameter. As such, the determination of the maximum unit root order of integration (otherwise regarded as d_{max}), and VAR optimal lag length (k) can be determined from the unit root test while η_t is the pure white noise.

4. Results

This section presents the study's empirical data results and analysis. The pre-estimation technique includes stylized facts, descriptive statistics, the correlation matrix, and the unit root test. The study used the Phillip-Perron (PP), Kwiatkowski-Phillips-Schmidt-Shin (KPSS), and ADF unit root tests through the test equation at intercept and trend and intercept.

4.1. Pre-estimation techniques

4.1.1. Stylised facts

Figure II depicts that from the years observed by the study, the government's health expenditure is lower than the nation's life expectancy compared to the domestic out-of-pocket and domestic health expenditure. Also, the Figure showed that there is not much disparity in the out-of-pocket health expenditure in Nigeria. Likewise, Nigeria's government health expenditure is consistently lower than the nation's life expectancy, despite increased health budgets. Fiscal allocation issues have led to a significant reliance on household health expenditures, resulting in a minimal disparity between out-of-pocket and domestic private health expenditures. This trend indicates that individuals in Nigeria increasingly bear the cost of healthcare, contributing to an upward trend in life expectancy, albeit slowly. The growing healthcare expenditures reflect economic threats to the labor force, human capital, and employability skills in Nigeria, with more health-deprived individuals spending a significant portion of their income on healthcare.

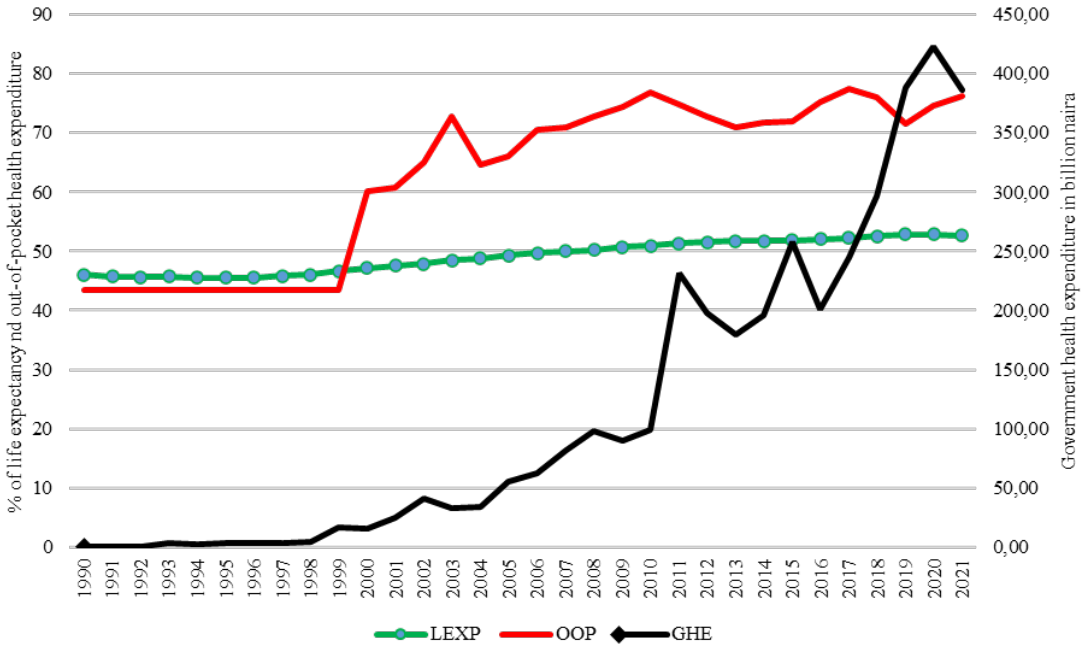

Figure II. Trend of the Disaggregated Healthcare Expenditures and Life Expectancy in Nigeria
Source: Authors' compilation.

4.1.2. Summary of descriptive statistic

Table 1 revealed the descriptive statistics, where the life expectancy at birth is benched on a threshold of 49 years and 3 months, which suggests that Nigerians have substantial health concerns since the country's average life expectancy is below 50 years. A considerable degree of variability in life expectancy throughout the observed time is shown by the 2.69 standard deviation. A distribution with a larger tail on the left side is implied by the somewhat negative skewness, which points to a few observations where life expectancy was noticeably shorter. A flatter distribution is indicated by the low kurtosis. The kurtosis of the life expectancy series is slightly above 3, which is leptokurtic, suggesting a distribution with a peak higher than that of a normal distribution, indicating a more pronounced central clustering with some outliers. The average out-of-pocket expenditure is ₦62.13 billion, with less variability compared to government expenditure; the distribution's negative skewness of -0.52 suggests a longer left tail movement, indicating that there were some years where out-of-pocket health spending was lower; the kurtosis at 1.50 suggests a flatter distribution, signifying that out-of-pocket health expenditures were relatively evenly spread around the mean, with few extreme values. Nigeria's life expectancy is low, indicating challenging health conditions and a potential impact on economic productivity. The data shows a significant reliance on out-of-pocket expenditures, with government spending insufficient to meet population needs. Households bear a significant healthcare burden, exacerbated by fiscal challenges. Based on the trends, policy recommendations include consistent and increased government spending on health, reducing financial burdens on households, and stabilizing government health expenditure to improve health outcomes and economic productivity.

Table 1. Descriptive Statistics

Variables	$LEXP_t$	$RGHE_t$	$OOPHE_t$
Obs.	32 years	32 years	32 years
Kurtosis	1.444934	2.829134	1.549441
Min.	45.48700	0.150161	43.42000
Max.	52.91000	423.3593	77.38787
Std. Dev.	2.722792	129.6736	13.74003
Skewness	-0.089687	1.007831	-0.562923
Mean	49.14534	114.9338	62.12682

Source: Authors' computation.

4.1.3. Correlation matrix

Table 2 demonstrates a substantial positive correlation between life expectancy, out-of-pocket health expenditures, and government recurrent health expenditures, suggesting a strong relationship between health expenditures and population health outcomes in Nigeria. The substantial relationship between life expectancy and government recurrent health expenditures exhibits longer life expectancy from birth as a result of increased investments in government health spending levels. The government's investment in medical staff, preventive programs, and health infrastructure is positively and significantly correlated with better health outcomes. According to the Grossman Health Capital Hypothesis (1972), higher health spending improves people's health stock, which raises productivity and lifespan. This finding is consistent with the World Bank (2022).

Similarly, household out-of-pocket health expenditures and life expectancy revealed a positive and significant relationship. This implies that improvements in life expectancy are linked to household increases in private health spending. This association might not, however, always indicate causation in a way that improves life expectancy. However, the higher the household out-of-pocket health costs are, the more they are sometimes a result of households in poor nations like Nigeria having less access to reasonably priced public health facilities, forcing them to pay for medical care out of pocket. Therefore, increased out-of-pocket spending raises equity problems and may increase financial vulnerability among low-income groups, even though it may momentarily improve individual health outcomes for those who can afford it. This approves the stance that an over-reliance on household out-of-pocket health can worsen poverty and health disparities (Rahman *et al.*, 2022). This result is in line with Owumi and Eboh (2022) and Aregbesola and Khan (2024).

Despite the strong correlation between health expenditures patterns and life expectancy in Nigeria, with significant coefficients ranging from 0.91 to 0.93 as revealed in the correlation matrix. The results support the idea that public and private health investments are critical for population health, but their efficiency depends on an improved healthcare system, and access equity. However, the high magnitude between the variables suggests potential multicollinearity concerns. Thus, to ascertain these multicollinearity concern between life expectancy, out-of-pocket health expenditures, and government recurrent health expenditures, there is need to conduct the Variance Inflation Factors (VIF).

Table 2. Correlation matrix

Variables	$LEXP_t$	$LRGHE_t$	$OOPHE_t$
$LEXP_t$	1.0000 [----] (----)		
$LRGHE_t$	0.932014 [14.08536] (0.0000)	1.0000 [----] (----)	
$OOPHE_t$	0.930961 [13.96556] (0.0000)	0.913924 [12.33299] (0.0000)	1.0000 [----] (----)

Brackets [] implies the t-statistic value, and parenthesis () signifies probability value.
Source: Authors' computation.

Table 2 revealed that despite the effort of the study to transform the series to logarithmic form to avoid skewness and heteroskedasticity, the relationship between life expectancy, out-of-pocket health expenditures, and government recurrent health expenditures still exists, and the issue of multicollinearity among them persists. The problem of multicollinearity occurs when two or more independent variables have a high degree of correlation (Tsagris & Pandis, 2021). This can have an impact on the accuracy of predicted coefficients and erode statistical inference. Thus, the multicollinearity rule of thumb is that there truly exists the problem of multicollinearity where the values of the centered variance inflation factors (VIF) exceed 10, and reject if the values are less than 10. Table 3 presents the VIF results, indicating that there does not exist the problem of multicollinearity between life expectancy, out-of-pocket health expenditures, and government recurrent health expenditures since the values of the centered variance inflation factors are less than 10 indicating no severe multicollinearity.

Table 3. Variance Inflation Factors (VIF) multicolinearity results

Variable	Coefficient variance	Uncentered VIF	Centered VIF
$LEXP_t$	0.160949	21.94349	6.070089
$LRGHE_t$	0.000767	136.0008	6.070089
$OOPHE_t$	1.474063	63.79396	NA

Source: Authors' computation.

4.1.5. The unit root test

Therefore, to test the stationarity properties of the time series, the Phillip-Perron (PP), the Kwiatkowski-Phillips-Schmidt-Shin (KPSS), and the Augmented Dickey-Fuller (ADF) unit root tests were employed. The choice of these unit root tests is a result of mirroring the negative direction of the series in their respective stationary form. Initially, the KPSS and ADF unit root tests were employed since the KPSS mirrors the acceptance of the ADF null hypothesis. This selection is done because of the fragility of the ADF unit root test in the face of structural breaks through its chosen sample period. This decision establishes the superiority of the KPSS over the ADF. As such, the PP was employed not only to determine the consistency in the stationarity form of the series but also because it captures the same significance as that of the KPSS. Therefore, based on the unit root test, it is necessary to perform the optimal lag

length for the ADF unit root test to establish the appropriate optimal lag length criteria, and this is done through the VAR approach as shown in Table 4. This test is sufficient to avoid the problem of serial autocorrelation and heteroskedasticity in the series in selecting the appropriate choice of econometric technique.

As such, the interpretation of the results in Table 4 is explained through the rule of thumb, which states that the lag length is selected at the corresponding lowest criterion from the Akaike Info Criteria (AIC), Schwarz Criteria (SC), and the Hannan-Quain (HQ) criterion, respectively, showing that the maximum lag length to select while conducting the ADF unit root test is lag 2 through the AIC.

Table 4. VAR Optimal Lag Length Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-161.1720	NA	16.58761	11.32220	11.46365	11.36650
1	-64.76516	166.2186	0.040189	5.294149	5.859927*	5.471344
2	-52.23832	19.00625*	0.032272*	5.050918*	6.041029	5.361009*

Source: Authors' computation.

Table 5 summarizes the unit root tests for both the intercept and the trend and intercept test equations. The result revealed that at the intercept test equation, life expectancy and out-of-pocket health expenditure are stationary at the first difference using the PP, KPSS, and ADF unit root tests, while when using the PP and KPSS unit root tests, the recurrent government health expenditure was stationary at the first difference but stationary at the level when using the ADF unit root test. Consequently, when using the trend and intercept test equation, it was revealed that life expectancy was stationary under the PP and ADF unit root test at the second difference, while when using the KPSS unit root test, it was stationary at level. For other series of the study, the recurrent health expenditure and out-of-pocket health expenditure were stationary at the first difference using the PP, KPSS, and ADF unit root tests, respectively.

Summarily, it then means that under the intercept and trend and intercept test equation of the PP, KPSS, and ADF unit root tests, the series are integrated of mixed order. Although the trend and intercept test equation for life expectancy, which showed an integration of the second difference, normally accounts for the total removal of the series in the model with special reference to the importance of the series in the model, the series cannot be deleted; the results in Table 2 also best explain the extent to which health expenditures truly relate and significantly improve life expectancy in Nigeria.

Table 5. Summary of the unit root test results

Test equation: Intercept									
Variables	$I_t \sim (0)$			$I_t \sim (1)$			$I_t \sim (2)$		
	PP	**KPSS**	**ADF**	**PP**	**KPSS**	**ADF**	**PP**	**KPSS**	**ADF**
$LEXP_t$	0.1928 (-2.9639)	0.6172 (0.4630)	-1.6264 (-2.9677)	-2.9592 (-2.9639)‡	0.1787 (0.4630)‡	-2.999 (-2.9639)	-	-	-
$LRGHE_t$	-2.1530 (-2.9604)‡	0.7198 (0.4630)	-4.9420 (-2.9677)‡	-11.2407 (-2.9639)‡	0.3317 (0.4630)‡	-	-	-	-
$LOOPHE_t$	-1.0981 (-2.9604)	0.6460 (0.4630)	-1.1154 (-2.9604)	-5.8255 (-2.9639)‡	0.1142 (0.4630)‡	-5.8140 (2.9639)‡	-	-	-
Test equation: Trend and intercept									

Variables	$I_t \sim (0)$			$I_t \sim (1)$			$I_t \sim (2)$		
	PP	KPSS	ADF	PP	KPSS	ADF	PP	KPSS	ADF
$LEXP_t$	-2.4223 (-3.5628)	0.1020 (0.1460)‡	-1.2116 (-3.5742)	-2.5130 (-3.5683)	-	-2.6720 (-3.5683)	-10.5415 (-3.5742)‡	-	-7.6617 (-3.5742)‡
$LRGHE_t$	-2.9608 (-3.5628)	0.1946 (0.1460)	-3.5028 (-3.5742)	-36.7233 (-3.5683)‡	0.4261 (0.1460)	-9.9022 (-3.5683)‡	-	-	-
$LOOPHE_t$	-1.7938 (-3.5628)	0.1447 (0.1460)	-1.6550 (-3.5628)	-5.7883 (-3.5683)‡	0.0887 (0.1460)‡	-5.7710 (-3.5683)‡	-	-	-

$I_t \sim (0)$, $I_t \sim (1)$, and $I_t \sim (2)$ imply stationary of the series at level, first difference, and second difference respectively while ‡ indicates significance at 5% level critical values.

Source: Authors' computation.

The Toda–Yamamoto–Dolado–Lütkepohl (TYDL) causality test results are shown in Table 6 according to the variables' mixed integration order. Their MWALD statistics $(\chi^2 = 3.94;\ p = 0.1395)$, and $(\chi^2 = 1.26;\ p = 0.5324)$, respectively has no causal association between life expectancy and either household out-of-pocket health expenditure or government recurrent health expenditures. This implies that differences in public and private health spending do not always result in quantifiable increases in Nigerians' lifespans. In terms of the economy, this suggests the existence of allocative inefficiencies and weak expenditure–outcome links, whereby higher health spending would not significantly raise life expectancy because of leaks, inadequate infrastructure, or unequal access to services.

There is a unidirectional causal relationship between life expectancy and government recurrent health expenditures, as evidenced by the rejection of the null hypothesis that there is no causation from life expectancy when government recurrent health expenditures is included as the dependent variable $(\chi^2 = 18.22, p < 0.0001)$. This finding is in line with the health demand–expenditure feedback loop proposed by Grossman's Health Capital Theory, which holds that increases in population longevity put financial pressure on the government to boost recurring health budgets. Conversely, household out-of-pocket health expenditures has no casual influence on government recurrent health expenditures, signifying that household health financing decisions are independent of government spending patterns.

Additionally, it is discovered that government recurrent health expenditures has casual influence on household out-of-pocket health expenditures $(\chi^2 = 6.74, p = 0.0343)$ when household out-of-pocket health expenditures is the dependent variable, whereas life expectancy has no casual influence does not $(\chi^2 = 0.08, p = 0.9594)$. This illustrates the crowding-out effect, in which higher household out-of-pocket expenses are correlated with rising government recurring spending rather than easing private health costs. This is probably caused by inefficiencies in public healthcare delivery and the persistent dominance of private supply.

Above all, the causality structure shows a feedback loop that starts with life expectancy and ends with public spending and private health expenditures, but not the other way around. The difficulty of translating financial investments in health into observable health results is highlighted by this relationship. In terms of policy, converting Nigeria's health spending into actual increases in life expectancy requires bolstering expenditure efficiency, health system accountability, and equitable resource allocation.

Table 6. TY-DL Causality Test Results

Excluded	MWALD Results	Df	Prob.	TY-DL Causality Decision
Dependent variable: $LEXP_t$				
$RGHE_t$	3.938521	2	0.1396	Accept
$OOPHE_t$	1.260618	2	0.5324	Accept
All	4.335500	4	0.3625	
Dependent variable: $RGHE_t$				
$LEXP_t$	18.22487	2	0.0001	Reject
$OOPHE_t$	2.681938	2	0.2616	Accept
All	18.31442	4	0.0011	
Dependent variable: $OOPHE_t$				
$LEXP_t$	0.082901	2	0.9594	Accept
$RGHE_t$	6.743335	2	0.0343	Reject
All	20.40965	4	0.0004	

Source: Authors' computation.

Having established the causality of the series through the TY-DL causality test, Figure II explains the reaction of an endogenous variable to one of the economic shocks that could affect the non-causality between the series, and it also describes the evolution of the series of interest, that is, life expectancy along a specified time series after a shock in a given economic movement. However, the impulse response function trend is employed as an empirical tool for causal analysis and policy effectiveness based on the results of the TY-DL test. As such, to trace the present and future values of the endogenous series through the recurrent government health expenditures and household out-of-pocket health expenditures through one standard deviation shock to one of the innovations. This is explained through the impulse response function (IRF).

Therefore, to clearly explain the concept of pass-through in the non-causality TY-DL test as shown in Table 7, and also to assess the significant tendencies of the TY-DL test, the impulse response is conducted. Thus, the impulse response trend showed that a change of one standard deviation in the error terms of the TY-DL model will have an impact on the recurrent government health expenditures and household out-of-pocket health expenditures, showing that the black line within the red dotted lines in the trend in Figure II traces out the economic shocks for several periods in the future of the Nigerian economy. The IRF indicates that government health expenditure shocks positively impact life expectancy in Nigeria, indicating the effectiveness of public health investment. Private spending, while contributing to life expectancy, may not have the same impact as systemic government investment in healthcare infrastructure. Thus, based on the results, the government's recurrent and household out-of-pocket health expenditures have positive economic shocks to life expectancy in Nigeria between 1990 and 2021.

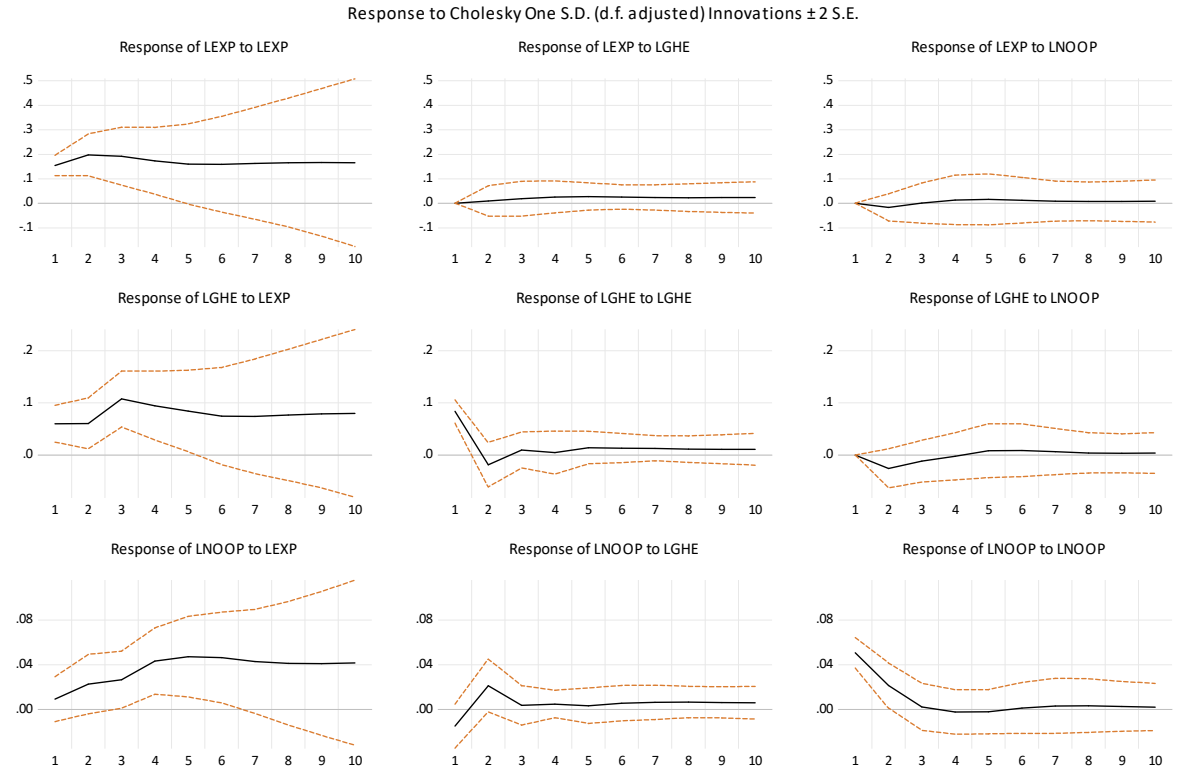

Figure III. Impulse Response Trend to Economic Shocks in Nigeria
Source: Authors' compilation from EViews 12.

4.2.1. Post-Diagnostic Test Results

Table 7 presents the results of the post (residual) diagnostic tests, with results showing that all tests had a probability value greater than 5%, indicating that the null hypothesis of Lütkepohl's Cholesky normality test, no serial correlation, and heteroskedasticity was not rejected and that the model was correctly specified, which then suggests that the TY-DL model is normally distributed and does not have any econometric error of homoscedastic variances or serial correlations.

Table 7. Post (residual) diagnostic test results

Test	Statistic value	Df	Prob.
Lütkepohl's Cholesky of covariance normality test	JB = 3.057222	6	0.8016
VAR Residual Serial Correlation LM tests	Rao F-stat. = 0.819123	(9,31.8)	0.6030
VAR Residual Heteroscedasticity tests (Levels and Squares)	Chi-Sq. = 93.45710	108	0.8394

Source: Authors' compilation using EViews 12.

4.3. Discussion of findings

As revealed by the results of the Toda-Yamamoto-Dolado-Lütkepohl, healthcare expenditures had no causal influence on life expectancy in Nigeria between 1990 and 2021. Grossman's Health Capital Model contends that increased healthcare spending improves human capital and prolongs productive life, which runs counter to this. Financial resources are not efficiently converted into high-quality health services in Nigeria's health funding system, as indicated by the absence of

causality. Nigeria's health financing is primarily focused on recurrent expenditures, leading to limited improvements in health infrastructure, preventive care, and disease control. Out-of-pocket expenditure, often concentrated on curative services, is primarily accessible to wealthier households, limiting aggregate improvements in life expectancy. This weak expenditure-outcome link aligns with the findings of Nwani and Kelikume (2019), suggesting that increased spending alone doesn't guarantee better population health without effective governance and expenditure efficiency.

Funding increases have not consistently resulted in longer lifespans between 1990 and 2021, as evidenced by the lack of a causal relationship between household out-of-pocket health expenditures and life expectancy and government recurrent health expenditures. Studies demonstrating limited returns from aggregate spending, allocative inefficiency, gaps in service delivery, and distributional hurdles that impede the conversion of fiscal inputs into health outcomes are consistent with Nigeria's poor transmission of health spending. This is in line with earlier research conducted in Nigeria that discovered conditional or limited returns from aggregate spending. These findings point to distributional barriers, service delivery gaps, and allocative inefficiencies that prevent fiscal inputs from translating into health outcomes (Ojo *et al.*, 2020; Nwani & Kelikume, 2019).

Moreover, the study also revealed that life expectancy has a causal influence on recurrent government health expenditure, indicating a reverse fiscal-health feedback mechanism. As longevity increases, healthcare demand rises, necessitating larger budgetary allocations. This aligns with Ogunjimi and Adebayo (2019) in Nigeria, emphasizing the cyclical nature of health financing pressures in developing economies. The causality pattern in health financing highlights the endogeneity of policy responses, as health status improvements drive them rather than result from them.

Likewise, the study reveals that government recurrent expenditure has a causal influence on out-of-pocket spending, suggesting that public spending may crowd out or crowd in private health expenditure. In Nigeria, this effect is positive, with increased public spending accompanied by higher household outlays due to inefficiencies, cost-sharing mechanisms, and limited access to government-funded health facilities. This suggests that while government expenditure expands service supply, it may not adequately reduce households' financial vulnerability, weakening health financing's equity objective. The study by Dodo and Isa (2020) and Ahmed (2018) suggests that rising public spending doesn't reduce private payment burdens but instead coexists with household expenditures due to limited access to subsidized healthcare, weakening the equity objective of health financing.

In view of a broader macroeconomic perspective, Nigeria's health financing framework lacks transformative efficiency to convert fiscal and private expenditures into measurable gains in human capital and productivity. Although strong associations exist between health spending and life expectancy, causality results show co-movement rather than causal influence. This suggests Nigeria's health financing is reactive, driven by immediate needs rather than strategic investment in health capital accumulation. Therefore, this study revealed a weak fiscal-health transmission mechanism in Nigeria, with higher longevity boosting government health expenditure but not significantly improving life expectancy. This suggests systemic inefficiencies in expenditure allocation, leakages in public finance management, and limited investment in

preventive health infrastructure. To improve population health, Nigeria needs to increase budgetary commitment, restructure expenditure, enhance fiscal accountability, and expand healthcare access.

5. Conclusion and policy recommendations

Evidence from the TY-DL causality technique from the study revealed that recurrent government and household health expenditures cause a decrease in the average life expectancy of Nigerians annually. This then showed that the efforts of the Nigerian government on health are stifled by Nigeria's fiscal misallocation dilemma. Also, the study equally submits through the evidence of the TY-DL technique accepted the null hypothesis that household health expenditure does not cause an increase in the government's recurrent health expenditure. Lastly, the results imply that every unit increase in government recurrent health expenditures causes an increase in the household out-of-pocket health expenditure, while an increase in the average life expectancy of Nigerians does not significantly increase household health expenditure annually. Likewise, the study revealed that government health expenditure shocks positively impact life expectancy in Nigeria, indicating the effectiveness of public health investment. Household health spending, which contributes to life expectancy, may not have the same impact as systemic government investment in healthcare infrastructure.

In addition, using the TY-DL causality test, this study strikes out the flaws of previous studies varying from their typical static context. However, the relationship between healthcare spending and life expectancy may not be stable over time, particularly in the face of economic shocks. Thus, there is a critical need for research that applies the TY-DL causality test in a floating causality context, thereby capturing potential shifts in causality across different economic periods. Furthermore, investigating the resilience and responsiveness of various categories of healthcare expenditure to economic shocks remains underexplored. Finally, comparative analysis using other econometric methods alongside the TY-DL causality test is necessary to validate the findings' robustness and ensure methodological rigor. Based on the results, the study concludes by recommending continuous and increased government health spending to enhance life expectancy, boost productivity, and prepare Nigeria for sustainable development by 2030 through judicious management and healthcare investment policies.

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