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Public Policy and Health Outcomes: Impact of Health Expenditure on Life Expectancy and Child Mortality

Kamu Politikası ve Sağlık Sonuçları: Sağlık Harcamalarının Yaşam Beklentisi ve Çocuk Ölümleri Üzerindeki Etkisi

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Abstract

Every government health strategy that has come before the present administration in Nigeria has had the same goal to reduce morbidity and death while raising life expectancy and preventing the spread of illness. It is challenging to draw the conclusion that the amount spent on healthcare services and facilities matches the results that are observed in the industry. Hence, the purpose of this research paper is to ascertain how government health spending affects life longevity and child mortality in Nigeria within the periods, 1984–2020. Using the autoregressive distributed lag estimator, the study found that public health spending negatively and significantly influenced life expectancy in the short run. However, the significant impact of public health spending on long-run life expectancy is positive. Meanwhile, it was discovered that government health expenses do not have a significant impact on infant mortality during the periods under study. The long-run positive links between public health spending and life expectancy indicate that healthy lifestyles and the broader social determinants of health are vital in improving life expectancy. This direct relationship emphasizes the importance of improving value for money in healthcare systems. It includes a greater emphasis on health promotion and other low-cost interventions, as well as a reduction in ineffective spending and waste. The government needs to invest more funds in healthcare infrastructure and services if it is to enhance the population's health outcomes. It is therefore envisaged that public spending should be comparable to that of industrialized nations. Also, steps should be taken to boost the government's revenue stream so that it may grow and spend more of its budgetary allotment on health-related facilities and services.

Keywords: ARDL, infant mortality, life expectancy, public health spending

Öz

Nijerya'daki mevcut yönetimden önce gelen her hükümet sağlık stratejisi, ortalama yaşam süresini yükseltirken ve hastalığın yayılmasını önlerken hastalık ve ölümleri azaltmak için aynı amaca sahipti. Sağlık hizmetleri ve tesislerine yapılan harcamaların, sektörde gözlemlenen sonuçlarla eşleştiği sonucuna varmak zordur. Bu nedenle, bu araştırma makalesinin amacı, Nijerya'da 1984-2020 dönemlerinde hükümet sağlık harcamalarının yaşam uzunluğu ve çocuk ölümleri üzerindeki etkisini belirlemektir. Otoregresif dağıtılmış gecikme tahmincisi kullanarak, çalışma kısa vadede kamu sağlık harcamalarının yaşam beklentisini olumsuz ve anlamlı bir şekilde etkilediğini bulmuştur. Bununla birlikte, kamu sağlık harcamalarının uzun vadeli yaşam beklentisi üzerindeki önemli etkisi olumludur. Bu arada, çalışma dönemleri boyunca hükümet sağlık harcamalarının bebek ölümleri üzerinde anlamlı bir etkisi olmadığı ortaya çıkmıştır. Kamu sağlık harcamaları ve yaşam beklentisi arasındaki uzun vadeli olumlu bağlantılar, sağlıklı yaşam tarzlarının ve sağlığın daha geniş sosyal belirleyicilerinin yaşam beklentisini iyileştirmede önemli olduğunu göstermektedir. Bu doğrudan ilişki, sağlık sistemlerinde paranın değerini artırmanın önemini vurgulamaktadır. Bu, sağlık teşvikine ve diğer düşük maliyetli müdahalelere daha fazla vurgu yapılmasını ve etkisiz harcamaların ve israfın

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azaltılmasını içerir. Hükümet, nüfusun sağlık sonuçlarını iyileştirmek için sağlık altyapısına ve hizmetlerine daha fazla kaynak yatırmalıdır. Bu nedenle, kamu harcamalarının sanayileşmiş ülkelerle karşılaştırılabilir olması öngörülmektedir. Ayrıca, hükümet gelir akışını artırmaya yönelik adımlar atılmalı ve bütçe tahsisatının daha büyük bir kısmını sağlıkla ilgili tesislere ve hizmetlere harcaması sağlanmalıdır.

Anahtar Kelimeler: ARDL, bebek ölümleri, yaşam beklentisi, kamu sağlık harcamaları

Introduction

Health outcomes contain modifications to the health of individual, or population, or a group of individuals (Chen et al., 2020). It simply means the prevention of preventable diseases or the complete healing of curable diseases, or the long-term care of incurable and unpreventable diseases. Health economist activists and the World Health Organization frequently advice the world leaders (both developed and underdeveloped) to designate health as one of the key priorities in national budgets due to the importance of good and quality health in economic growth and development agendas. Nurse (2000) noted that quality health is crucial for economic development and progress because, in general, unhealthy people are less or unproductive ceteris paribus. According to the National Health Information Management Group (1996), a specific intervention or set of interventions by the government, non-governmental organizations, cooperatives, individuals, and foreign assistance can fully or partially sustain good and high-quality health outcomes.

Health expenditure consists of the sum of capital investments in healthcare infrastructure and the ultimate consumption of healthcare products and services that are intended to improve health outcomes (World Health Organization, 2019). Regardless of the principal role or activity of the entity delivering or paying for the associated health services, health expenditures are categorized according to their main or major goal of improving health (Edeme et al., 2017). The authors went on to say that health expenditure is one of the key contributors to the availability of healthcare facilities, necessities, and services—which in turn contributes to positive and high-quality health outcomes.

In the twenty-first century, economists from all over the world have made great efforts to examine the role that government healthcare expenditure has played in the expansion of human capital development and health services. This is due to the significance of health care in the growth and development agenda as well as the role that health expenditure plays in its support system. Public health expenditures have been acknowledged as a significant component of fiscal outlays in most developed nations of the world, particularly considering the various research arguments from economic literature (World Health Organization, 2019). They are accountable for the global standard in the health sectors. It is interesting to note that this reasoning does not apply to sub-Saharan African nations, notably Nigeria, which have regularly budgeted for the health sector over the past 20 years despite continuing to rank last in terms of health facilities and services (Christiansen et al., 2019).

Looking specifically at Nigeria's 2017 authorized health budget, the health sector gets N380.46 billion (USD1.05 billion), representing about 13% of all non-debt recurrent expenditures (BudgIT, 2017). According to the breakdown, Ministry of Health receives the largest portion—79.7%—of all funds allocated to the health sector. The remaining 20.3% is split among the National Health Insurance Scheme, the procurement of medical equipment, medical consulting, State House Medical Center, the National Agency for the Control of AIDS, and among others (BudgIT, 2017). The approved health sector computation yielded a total allocation of N380.46 billion for 2017 (health-related expenditure, including the Federal Ministry of Health and its agencies), which represents a 7.54% increase in nominal terms above the N353.5 billion allocated in 2016. However, as stated in the 2017 budget, the nominal percentage of the total budget decreased from 5.7% to 5.1%. According to the Ministry of Health's (headquarters) allocation, the health sector received 81% of the entire allocation, with the remaining 19% being split among other agencies. According to Edeme and Olisakwe (2019), Nigeria's health sector receives a significant amount of healthcare development assistance despite the country's large health budget allocation. This suggests that healthcare inflows and assistance should have reached Nigeria through official development assistance, but the physical evidence points to the contrary (Seth et al., 2018). In reality, grants made up $3.2 billion of the $6 billion in official development aid that was given to the healthcare sector (Seth et al., 2018).

This study thereby investigates the effects of government health spending on health outcomes in Nigeria within the period of 1986 and 2020. It differs from previous research by considering two health outcome indices: life longevity and child mortality rates. Government spending is quite favorably correlated with both life expectancy and per capita income, which is crucial for nations to achieve the sufficient economic potential for continued development. This vicious cycle of low per capita income, dwindling life expectancy, high death rates, and generally dismal economic consequences poses a severe development challenge. An economy must improve to increase production, promote economic growth and development, and lessen poverty. Because it tends to raise life expectancy and lower death rates, the provision of proper health facilities and services is anticipated to have a favorable impact on the future of people, societies, and countries. Therefore, an increase in government spending, life expectancy, and mortality rates are seen as prerequisites for a nation's long-term socioeconomic advancement and key development indices.

Other sections are divided into four parts. The second section presents a brief literature review and the third section provides

the methodology. As for the fourth section, the study provides results and discussion. The last section concludes and proffers policies.

Brief Literature Review

This study hinges on Grossman's theoretical framework of health expenditure and outcomes. Grossman developed a model for good health in 1972, and health has been treated as a durable capital stock (Jager, 2017; Polasky et al., 2019). According to Grossman, healthy days are said to have been born out of health stock, whereas utility is said to have been gained both directly because it allows for the enjoyment of good health (via consumption commodity) and indirectly because it allows for time to be expended on other markets as well as non-market activities (via individual commodity) (Jager, 2017). As Grossman enforces two constraints, it is assumed that individuals maximize the utility they derive from consumption. First, such time constraints that establish time in a specified period have to be allotted to investment, consumption, or wage generation. An increase in sick days reduces the amount of time available for actions. Second, income constraints should represent the real cost of time spent on consumption or some levels of investment rather than wage generation, which is a maximization issue. There is an unwavering assumption that individuals are born with some level of health stock that deteriorates with age. The reduction could be offset by investment activities, but when the stock reaches the critical level, it dies. Grossman develops a pure model of consumption as well as a pure investment model on the assumption that the marginal cost is constant (Wasiu, 2020), based on the marginal benefit being increased with consumption and investment activities taken as additive.

The marginal benefit of consumption and that of investment are separated and then equated to the health shadow price as an additive function of interest rate and rate of health depreciation. As a result, the empirical evaluation of the investment model's three key predictions is possible. First, a higher depreciation rate with a positive correlation with wages would lead to a decrease in demand for health care. This is due to the fact that as the cost of producing healthy days rises, the marginal cost of investment tends to be higher than the marginal benefits of investment. Second, an increase in wages will have an indeterminate effect on the quantity of health demand. When wages rise, marginal productivity rises because more health days are available to earn higher wages, resulting in more incentives for health investment and higher health stock demand (Wasiu, 2020).

Following previous empirical studies, Onofrei et al. (2021) analyze the extent to which public health expenditure impacted health outcomes among EU developing nations. They discovered a long-run equilibrium association between government health spending and health outcomes. Also, high life expectancy and low infant mortality are guaranteed with growing health expenditure. Afterward, they examined the role of governance in the links between healthcare system performance and health outcomes of the sampled EU nations. Their result showed that the effectiveness of public health spending toward curtailing infant mortality and improving life longevity is conditioned on quality governance.

Rahman et al. (2018) investigate the relationship between health expenditure (private, public, and national) as a ratio of gross domestic product (GDP) and health outcomes of 15 selected SAARC[1] and ASEAN[2] countries from 1995 to 2014. The two regions were sampled due to their low rates of health expenses to GDP when compared to the Organisation for Economic Co-operation and Development (OECD) and the globe. They employed both panel fixed and random effect estimators. The findings revealed that the three components of health expenditure significantly reduced infant mortality rates. It was discovered that the impact of private spending on health outcomes is larger than that of public expenses. Thus, the study showed that the role of private health spending is imperative in lowering the crude death rate. In addition, high income per capita and access to quality sanitation facilities ameliorate human health in the regions.

Raghupathi and Raghupathi (2020) evaluate the effect of government health expenditure on economic performance of the United States. The authors used visual analytics to collect health and economic data from the Bureau of Labor Statistics and Bureau of Economic Analysis between 2003 and 2014. Findings revealed that health spending leads to improved healthcare services, which has the impetus to brace human capital and boost productivity, in that way causative to economic performance. In general, the findings found that public health spending has a direct impact on economic performance indicators such as income and labor production. Even as health spending is indirectly related to multi-factor productivity, it directly impacted income and labor efficiency. Summarily, high healthcare expenses contribute to economic performance.

While examining the link between public health expenditure and health outcomes (using maternal mortality), Nigeria et al. (2017) found a co-integration between public health spending and maternal mortality. Also, findings revealed that increasing government health spending amplifies human life longevity and lowers child mortality. Besides, the HIV prevalence rate and urban population significantly impacted health outcomes, whereas the impact of income per capita on human health outcomes is statistically insignificant. They conclude that government health spending is still an important component for ensuring quality health outcomes in the country.

Igbinedion and Olele (2018) look at the empirical association between government health spending and health outcomes

1 South Asian Association for Regional Cooperation.
2 Association of South East Asian Nations.

(captured by maternal mortality) in Nigeria from 1981 to 2014. Using the cointegration and error correction modeling procedure, the findings revealed that as both private and public health expenses increase, maternal mortality rates decrease, indicating that government health financing failed to crowd out private health spending. However, the poverty rate was discovered to play a key role in the rising rate of maternal mortality. To sum up, official development assistance focused on health had an adverse effect but was insignificant on Nigeria's maternal mortality rate.

Wasiu (2020) introduces governance to the association among healthcare financing and human health outcomes in Nigeria using time series data spanning from 1985 to 2018. For the short-run estimates, an error correction model (ECM) was used, while an autoregressive distributed lagged (ARDL) model was employed to investigate the long-run relationships among the variables understudy. The findings revealed that government health expenses have a significant positive impact on human life longevity in Nigeria. The results also showed that increasing public health spending results in a declining infant mortality.

Chireshe and Ocran (2020) examine the impact of health spending (private, public, and national) on human health outcomes (measured by under-5 mortality and life expectancy) in 45 sub-Saharan Africa (SSA) countries between 1995 and 2018. For the analysis, it employs panel fixed effects and panel generalized method of moments (GMM) estimators. The results showed that both national health financing per capita and public health expenses as a ratio of GDP significantly curtail under-5 mortality rates. Likewise, only national health expenses per capita significantly improve human life longevity. However, Akinlo and Sulola (2019) and Adewumi et al. (2018) found a positive and significant link between government health financing and infant mortality in SSA and Nigeria, respectively. They concluded that health expenditure failed to translate into the reduction in infant mortality.

There is evidence of divergent conclusions on the actual effect of public health financing on human health outcomes in developed and developing economies based on reviews of existing literature. As a result, their findings are best described as inconclusive. It is also worth noting that their findings and conclusions differ depending on the models and data used to achieve them. The majority of studies, however, confirm the existence of a nexus, albeit a negative one. Furthermore, while the a priori expectations are consistent with the majority of the reviewed literature, the results may differ due to scope and methodology differences. Regardless of these findings and given the current economic situation of dwindling government revenues brought on by the COVID-19 pandemic, the government seeks to improve rapid human health outcomes by ensuring access to quality healthcare facilities and services.

Materials and Methods

Data Sources and Description

This research paper utilizes an annual time series data for the periods of 37 years, 1984–2020. The secondary data of public health financing to GDP were published by the Central Bank of Nigeria statistical bulletin, vol. 32, 2021, while, life expectancy, child mortality, financial sector development, gross fixed capital formation, trade openness, and inflation data were sourced from the World Development Indicators (WDI), 2021. Table 1 presents the source and measurement of the variables.

Model Specification

Following Grossman's theoretical framework of health spending and outcomes, the study adapts and modifies the model of previous studies such as Edeme et al. (2017), Adewumi et al. (2018), Boachie et al. (2018), Raeesi et al. (2018), Rahman et al. (2018), Obisike et al. (2021), and so on to examine the impact of government health expenses as a ratio of GDP on human health outcomes (measured by life longevity and infant mortality) in Nigeria. The model specifies health outcomes (*hout*) as

Table 1.
Definition and Source of Data and Variable Measurements

Signs	Description	Measurement	Data Source
hout	Health outcomes are the treatment results that affect health status as measured by the length or quality of a person's life and child mortality in a country for a specific period of time.	Number of years and mortality per 1000 births	WDI (2021)
phexp	Public health expenditure measures the total amount of government spending on healthcare services and facilities in a country.	% of GDP	CBN Bulletin (2021)
fsd	Financial sector development measures the total amount of domestic credit to private sector by banks to gross domestic product.	Domestic credit to private sector by banks as % of GDP	WDI (2021)
topen	Trade openness captures the total trade as a percentage of gross domestic product in a country.	Total trade as a % of GDP	WDI (2021)
inf	Inflation is measured by annual rate of consumer price index of a country.	Annual growth	WDI (2021)
gfcf	Gross fixed capital formation includes the total domestic investment of private and public sectors to the size of GDP in a country	% of GDP	WDI (2021)

Source: Author's compilation (2022).
Note: CBN = Central Bank of Nigeria; WDI = World Development Indicators.

a function of public health spending to GDP (*phexp*), financial sector development (*fsd*), gross fixed capital formation (*gfcf*), trade openness (*topen*), and inflation (*inf*). Consequently, the model is stated functionally as:

$$hout_t = f(ph\exp_t, gfcf_t, fsd_t, topen_t, \inf_t) \quad (1)$$

In mathematical form, it becomes:

$$hout_t = \theta_0 + \theta_1 ph\exp_t + \theta_2 gfcf_t + \theta_3 fsd_t + \theta_4 topen_t + \theta_5 \inf_t + e_t \quad (2)$$

where *hout* is a vector of health outcomes denoted by life expectancy and infant mortality; *phexp* represents public health finances to GDP; *gfcf* is gross fixed capital formation to GDP; *fsd* measures financial sector growth measured by domestic credit to private sector by banks to GDP; *topen* represents trade openness measured by total trade to GDP; *inf* denotes inflation; θ_0, θ_{1-5} are parameters; *t* is time; *e* is stochastic term.

Estimation Strategy

The descriptive statistics are estimated to detail the distributional characteristics of the chosen variables during the study period. It displays mean, Kurtosis, skewness, standard deviation, and Jarque-Bera statistics. Afterward, the unit root tests, which are carried out by the Augmented Dickey-Fuller (ADF) Test (Dickey & Fuller, 1979) and Philips-Perron Test (PP) (Phillips & Perron, 1988), were used to decide if the variables are stationary or non-stationary. After that, the ARDL estimator by Pesaran et al. (1999, 2001) was employed to estimate the link between public health expenses and health outcomes.

The ARDL estimator was chosen because it performed well in a small sample size. Pesaran et al. (1999, 2001) claim that the estimator was "developed on the basis of the F-statistic or Wald test in a generalized Dickey-Fuller type of regression typically used to test the significance of lagged levels of those variables that are taken into account in a conditional unrestricted equilibrium error correction model." The estimating method also aids in the analysis of the short- and long-term dynamic relationships among variables. Based on the conventional F- and t-statistics, it examines the significance of the lagged values of the variables in a first difference regression. Whether the underlying regressors are I(0), I(1), or mutually integrated does not affect how the approach works.

Following the unrestricted ECM, the ARDL bound estimator states the underlying model (equation 2) as:

$$\begin{aligned}\Delta hout_t = {} & C_0 + \sum_{i=1}^{p} \varphi_i \Delta hout_{t-i} + \sum_{i=1}^{p} \phi_i \Delta ph\exp_{t-i} + \sum_{i=1}^{p} \vartheta_i \Delta gfcf_{t-i} \\ & + \sum_{i=1}^{p} \varpi_i \Delta topen_{t-i} + \sum_{i=1}^{p} \omega_i \Delta \inf_{t-i} + \pi_1 hout_{t-1} + \pi_2 ph\exp_{t-1} \\ & + \pi_3 gfcf_{t-1} + \pi_4 fsd_{t-1} + \pi_5 topen_{t-1} + \pi_6 \inf_{t-1} + \upsilon_t\end{aligned} \quad (3)$$

The variables did not change from what they were earlier shows. Δ, the change operator sign represents the first difference operator; C_0 is drift; π_{1-6} denote long-run coefficients associated with the long-run relationships; $\varphi_i, \phi_i, \vartheta_i, \varpi_i, \omega_i$ represent the short-run dynamic estimates of the basic bound testing estimator in model (3); and υ is the white noise error. With the calculated F-statistics, the test of rejection of the null hypothesis (no cointegration) against the alternative hypotheses (cointegration) is used to determine the existence of cointegration. Based on the aforementioned equations, the null and alternative hypotheses are as follows:

$H_0 : \pi_1 = 0, \pi_2 = 0, \pi_3 = 0, \pi_4 = 0, \pi_5 = 0, \pi_6 = 0$ [i.e., there is no cointegration], and

$H_0 : \pi_1 \neq 0, \pi_2 \neq 0, \pi_3 \neq 0, \pi_4 \neq 0, \pi_5 \neq 0, \pi_6 \neq 0$ [i.e., there is cointegration]

The tabulated upper and lower bounds from Narayan (2004) are compared to the calculated *F*-test values. When the calculated *F*-values are higher than tabular ones at the upper bound, the "no cointegration" hypothesis is rejected, thereby, cointegration is accepted. However, we do not reject the null hypothesis of "no cointegration" if the *F*-values fall below the lower bound. Meanwhile, the results become uncertain if the *F*-values fall within the two crucial boundaries. The ECM for the short run is stated as:

$$\begin{aligned}\Delta hout_t = {} & C_0 + \sum_{i=1}^{p} \varphi_i \Delta hout_{t-i} + \sum_{i=1}^{p} \phi_i \Delta ph\exp_{t-i} + \sum_{i=1}^{p} \vartheta_i \Delta gfcf_{t-i} \\ & + \sum_{i=1}^{p} \varpi_i \Delta topen_{t-i} + \sum_{i=1}^{p} \omega_i \Delta \inf_{t-i} + \lambda ECT(-1) + v_t\end{aligned} \quad (4)$$

$(-)\lambda$ shows that the short-run disequilibrium brought on by shocks to all the pertinent variables would eventually return to long-run equilibrium. How soon the dynamic model's equilibrium is regained through adjustment is shown by the error correction term (ECT). The ECT coefficient, which assesses the speed of re-establishment of equilibrium, ought to be statistically significant and have a negative sign. Error correction strategies are used to restore equilibrium between the short-run and long-run behaviors of the outcome variable.

Result and Discussion

Summary Statistics

Table 2 provides a summary of the preliminary study that details the average, standard deviation, skewness, and peakness of the series used to examine the connection between public health spending and health outcomes in Nigeria. According to the table, the average life expectancy and infant mortality rates were 48.66 years and 102.35 per 1000 live births, respectively. The table showed that their maximum values were 55.02 years and 124.8 live births, while their minimum values were 45.84 years and 72.2/1000 live births. This suggests that Nigeria's health outcomes are low. The average rate of government health spending to GDP was 0.19%, with highest and minimum

Table 2.
Descriptive Statistics

	lexp	*imor*	*phexp*	*topen*	*inf*	*gfcf*	*fsd*
Mean	48.65673	102.3459	0.187947	33.85964	19.14149	31.80169	9.447661
Median	46.83500	103.8000	0.207540	34.45783	12.55496	28.37090	8.218357
Maximum	55.01800	124.8000	0.363817	53.27796	72.83550	58.95629	19.60353
Minimum	45.84300	72.20000	0.016573	9.135846	5.388008	14.16873	4.948032
Std. Dev.	3.205812	19.32322	0.092465	11.45837	17.43859	13.75767	3.537013
Skewness	0.721678	-0.134112	-0.112876	-0.531914	1.772200	0.285025	1.085589
Kurtosis	1.966401	1.381807	2.086022	2.779206	4.839039	1.815202	3.882405
Jarque-Bera	4.858720	4.147844	1.366410	1.819906	24.58162	2.665081	8.467840
Probability	0.088093	0.125692	0.504996	0.402543	0.000005	0.263806	0.014495
Observations	37	37	37	37	37	37	37

Source: Author's computation (2022).

values of 0.36% and 0.02%, respectively. Additionally, the average figures for total trade, domestic bank lending to the private sector, and gross fixed capital formation are 31.8%, 9.45%, and 33.86%, respectively, in terms of GDP. Additionally, their maximum rates are 58.96%, 19.6%, and 53.28%, respectively, while their minimum rates are 14.17%, 4.95%, and 9.14%. The average rate of inflation is 19.14% with the highest and minimum values of 72.84% and 5.39%, respectively.

Furthermore, a normal distribution always exists at 0 for the skewness, which quantifies the asymmetry of the distribution of the series around its mean. A distribution is said to have a long right tail if the skewness is positive and a long left tail if the skewness is negative. The findings of Table 2 revealed that all the variables are positively skewed, with the exception of infant mortality, public health spending, and trade openness (which are negatively skewed), suggesting that the right tails of the distributions are long. Kurtosis gauges the series' distribution's peaking or flattening as well. The distribution is peaked or leptokurtic in relation to the normal if the kurtosis is greater than 3, and flat or platykurtic in relation to the normal if it is less than 3. According to the table's outcome, only the values for inflation rate and financial sector development are greater than 3, which suggests that they have peaked or are leptokurtic. The values of the other variables are below 3, indicating flatness or platykurtic behavior. According to their Jarque-Bera statistics, this suggests that the variables are not normally distributed.

Correlation Analysis

Table 3 presents the correlation matrix of the variables understudied. Following the table, public health spending is positively associated with life expectancy but negatively related to infant mortality rate. Furthermore, the correlation matrix revealed that life expectancy is inversely related to inflation and gross fixed capital formation but directly correlated with trade openness and domestic bank lending to the private sector. Additionally, the results showed that infant mortality rate is positively correlated to gross fixed capital formation and inflation but indirectly related to domestic bank lending to the

Table 3.
Correlation Matrix

	imor	*phexp*	*iq*	*topen*	*Inf*	*gfcf*	*fsd*
lexp	-0.947	0.507	0.009	0.025	-0.367	-0.602	0.689
imor	1	-0.648	-0.107	-0.219	0.456	0.721	-0.672
phexp		1	0.178	0.433	-0.226	-0.672	0.457
iq			1	0.720	-0.005	-0.245	0.088
topen				1	-0.079	-0.377	0.151
inf					1	0.341	-0.333
gfcf						1	-0.675

Source: Author's computation (2022).

Table 4.
ADF and PP Test Results [Trend and Intercept]

Variables	Augmented Dickey Fuller Test		Phillip-Perron Test		Remarks
	Stat at Level	Stat at First Diff.	Stat at Level	Stat at First Diff.	
lexp	-2.513(6) [-3.568]	-8.281***(1)[-4.244]	-1.707(4)[-3.540]	-5.019***(4)[-4.234]	I(1)
imor	-2.534(3) [-3.553]	-5.265***(2)[-4.263]	-2.556(5)[-3.540]	-5.060(1)[-4.244]	I(1)
phexp	-4.878***(0) [-4.235]	–	-4.870***(1)[-4.235]	–	I(0)
iq	-3.169(2) [-3.545]	-5.139***(0)[-3.544]	-2.346(6)[-3.540]	-5.116***(7)[-3.544]	I(1)
gfcf	-1.497(0) [-3.540]	-7.828***(0)[-3.544]	-1.486(3)[-3.540]	-7.685***(1)[-3.544]	I(1)
fsd	-3.874**(1) [-3.544]	–	-2.523(0)[-3.540]	-6.873***(3)[-3.544]	I(1)
topen	-2.809(0) [-3.540]	-7.422***(0)[-3.544]	-2.686(2)[-3.540]	-11.034***(10)[-3.544]	I(1)
inf	-4.235**(1) [-3.544]	–	-4.256***(1)[-3.540]	–	I(0)

Source: Author's computation (2022).
Note: ***, **, and *signify significance levels at 1%, 5%, and 10%, respectively. ADF = Augmented Dickey-Fuller Test; PP = Philips-Perron Test.

private sector and trade openness. The domestic bank lending to the private sector and trade openness is positively correlated with public health spending, while the inflation rate and gross fixed capital formation are negatively correlated with health spending. Table 3 also provides the correlation coefficients for other controlling variables. The low correlation coefficients show no evidence of a multicollinearity issue. The signs and magnitudes of the variables are subject to confirmation using appropriate estimators as the correlation coefficients are just preliminary analyses.

Unit Root Test

Table 4 shows the stationarity level of the variables using the ADF and PP techniques. When applying the ADF and PP estimators, the apriori expectation is that a variable is stationary when the test statistics are higher than the critical values at 5%. From the test result, public health expenditure, financial sector development, and inflation rate were found not to accept the null hypothesis "they have unit root test" at the 5% level. This suggests that the series (i.e., public health expenditure, financial sector development, and inflation rate) are stationary at levels. As a result, these three series are integrated at order 0. Life expectancy, infant mortality rate, public debt, gross fixed capital formation, and trade openness, however, are not stationary at levels but they are integrated of order 1, that is, I(1). Accordingly, they were discovered not to accept the alternate hypothesis "stationary" at levels, but after multiple rounds depending on the quantity of lag lengths and differencing, they were discovered to accept the alternate hypothesis at first difference. It therefore suggests that these series' first-difference were stationary at first difference.

Cointegration Test Result

The ARDL-bound cointegration approach was employed to examine the long-run relationships between public health financing and health outcomes. Table 5 provides the *F*-statistics estimate for examining the possibility of a long-term relationship between public health expenses and health outcomes in Nigeria.

In Table 5, the normalized estimated *F*-statistics (19.905 and 5.3662) of the equations exceed both the lower and upper critical bounds at a 5% level of significance. This suggests that at a 5% significance level, the null hypothesis that there is no long-term association is rejected. In accordance with the estimation above, public health expenditure, gross fixed capital creation, financial sector development, trade openness, inflation rate, and health outcomes all have equilibrium conditions that maintain them together throughout time. As a result, there is a long-term connection between public health expenses and health outcomes in Nigeria.

Table 5.
Existence of a Long-Run Between Public Health Expenditure and Health Outcomes

Test Statistics	Value	*K*
F-statistics (*lexp*| *phexp*, *gfcf*, *fsd*, *topen*, *inf*) (3, 3, 3, 1, 3, 3)	19.905	5
F-statistics (*imor*| *phexp*, *gfcf*, *fsd*, *topen*, *inf*) (4, 0, 2, 0, 2, 1)	5.3662	5
Critical Value Bounds		
Significance	**I(0) Bound**	**I(1) Bound**
10%	2.08	3.00
5%	2.39	3.38
2.5%	2.70	3.73
1%	3.06	4.15

Source: Author's computation (2022).

Table 6.
Estimated ARDL Results of Life Expectancy

Dependent Variable: Life Expectancy (lexp)				
Selected Model: ARDL(3, 3, 3, 1, 3, 3)				
Sample: 1984 to 2020			Included observations: 33	
		Short-Run Estimates		
Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
dlog(*lexp*(-1))	1.404216	0.039234	35.79057	.0000
dlog(*lexp*(-2))	-0.539756	0.032152	-16.78764	.0000
d(*phexp*)	0.000895	0.000179	5.008858	.0003
d(*phexp*(-1))	-0.002662	0.000359	-7.414871	.0000
d(*phexp*(-2))	-0.000957	0.000250	-3.822442	.0024
d(*gfcf*)	8.70E-06	4.37E-06	1.991722	.0697
d(*gfcf*(-1))	5.13E-05	6.51E-06	7.886535	.0000
d(*gfcf*(-2))	2.56E-05	4.50E-06	5.688226	.0001
d(*fsd*)	-6.99E-06	7.23E-06	-0.966787	.3527
d(*topen*)	4.71E-06	1.67E-06	2.815388	.0156
d(*topen*(-1))	8.60E-06	1.68E-06	5.121625	.0003
d(*topen*(-2))	2.63E-06	1.68E-06	1.563772	.1438
d(*inf*)	2.78E-07	1.20E-06	0.231748	.8206
d(*inf*(-1))	8.97E-06	1.41E-06	6.343545	.0000
d(*inf*(-2))	2.41E-06	1.10E-06	2.197018	.0484
ECT(-1)	-0.115671	0.008001	-14.45698	.0000
Long-Run Estimates				
phexp	0.453274	0.082441	5.498151	.0001
gfcf	-0.004721	0.000505	-9.340795	.0000
fsd	-0.002517	0.000948	-2.655094	.0210
topen	-0.000399	0.000372	-1.072513	.3046
inf	-0.001149	0.000286	-4.017106	.0017
c	4.074181	0.029725	137.0615	.0000
R^2	0.8723	***F*-stat**	94.236 (0.0000)	
Adj. R^2	0.7231	**D-Watson**	1.9145	
		Diagnostic test results		
Serial correlation	1.5995 [0.2496]	**Normality test**	2.3212 [0.3133]	
Functional form	1.3753 [0.1964]	**Heteroskedasticity test**	0.9501 [0.5579]	

Source: Author's computation (2022).

Short-Run and Long-Run Estimates

Effects of Public Health Spending on Life Expectancy

Table 6 presents the short-run and long-run estimates of the links between public health financing and life longevity in Nigeria. The estimated short-run results show the error correction mechanism as it gauges the rate or intensity of adjustment of the outcome variables to changes in the explanatory variables. The model's lag length was positioned at 3 to make sure there is an adequate degree of freedom based on automatic

selection of the Akaike Information Criterion, and the ARDL estimator automatically selects the lag duration on all variables. The parameter of the ECT is negative and significant statistically at 5% level. The ECT value at −0.1157 suggests that the empirical model adjusts its short-run disequilibrium at 11.57% speed of adjustment to go back to its long-run equilibrium.

At the conventional level, the short-run coefficients of the change in life expectancy at lags 1 and 2 are significant and positive, respectively. While its first and second lags are statistically significant and negative, the short-run parameter estimates of current public health expenditure were determined to be positive and statistically significant at 5%. It follows that public health spending at lags 1 and 2 had a short-term negative influence on life expectancy. This shows that public health spending does not guarantee an improvement in the anticipated mean years of an individual's life after birth. The current, first, and second lags of gross fixed capital creation have a positive and significant impact on human life expectancy. Life expectancy was adversely and insignificantly impacted by the rise of domestic bank lending to the private sector in the short run. With the exception of its second lag, which is statistically insignificant at 5%, all the parameters relating to trade openness are positive and statistically significant. It was also discovered that, except for the current level, which was not significant at 5%, inflation at the current level, first and second lags significantly impacted life expectancy.

According to the long-term projections in Table 6, public health spending increases life expectancy in Nigeria. The indicator's

Figure 1.
Cumulative Sum (CUSUM).

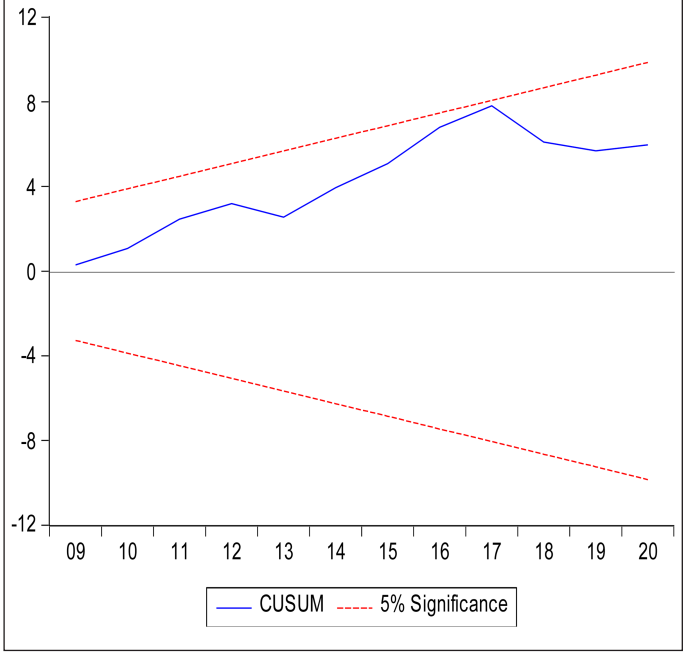
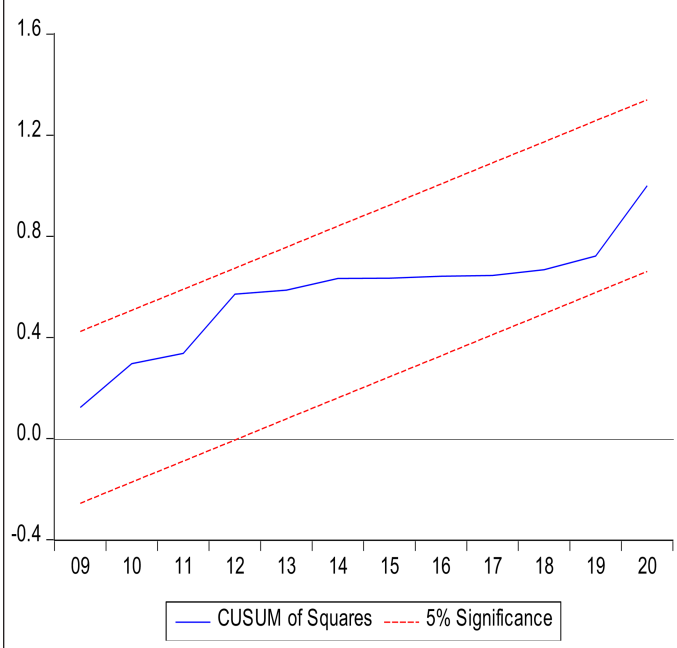


Figure 2.
Cumulative Sum of Square (CUSUMQ).



parameter was in line with theoretic assumptions, and the result is statistically significant at 5%. It implies that if well managed, public health spending has the potential to increase life expectancy. According to a scale of magnitude, a 10% increase in government health spending will result in a 4.53% increase in life expectancy. Low inflation has also been demonstrated to have a favorable and considerable impact on life expectancy. Thus, a 100% decline in the inflation rate results in a 0.12% change in life expectancy. However, for the research years, trade openness, financial sector growth, and gross fixed capital formation have indirect effects on life expectancy in Nigeria. The only factors that significantly impacted life expectancy were investments and domestic bank loans to the private sector. As a result, life expectancy decreases by 0.47%, 0.25%, and 0.04% with every 100% rise in gross fixed capital formation, domestic bank lending to the private sector, and trade openness, respectively.

The adjusted R^2 (coefficient of determination) is high (72.31%), meaning that the explanatory variables in the model accounted for about 72.31% of all variations in life expectancy. It only said that variations in public health spending and other influencing factors accounted for 72.31% of the range in changes in life expectancy. The model is properly described and statistically significant as shown by the *F*-statistic (94.236), which is significant statistically at 5% level. Serial autocorrelation is not present in the model, as evidenced by the Durbin-Watson value of 1.9145. The table also displays the outcomes of four diagnostic tests. The serial correlation, normality, and heteroskedasticity tests were all passed by the estimated ARDL model. It indicates that the error terms are not serially associated

Table 7.
Estimated ARDL Results of Infant Mortality

Dependent Variable: Infant Mortality (*imor*)				
Selected Model: ARDL(4, 0, 2, 0, 2, 1)				
Sample: 1984 to 2020			Included observations: 33	
		Short-Run Estimates		
Variable	Coefficient	Std. Error	t-Statistic	Prob.
dlog(*imor*(-1))	1.303341	0.127381	10.23186	.0000
dlog(*imor*(-2))	0.182747	0.246181	0.742327	.4675
dlog(*imor*(-3))	-0.569399	0.133863	-4.253593	.0005
d(*phexp*)	0.001269	0.003100	0.409500	.6870
d(*gfcf*)	1.23E-05	5.03E-05	0.245498	.8088
d(*gfcf*(-1))	-0.000297	6.33E-05	-.686196	.0002
d(*fsd*)	0.000105	8.78E-05	1.195618	.2474
d(*topen*)	-1.05E-05	1.92E-05	-0.547207	.5910
d(*topen*(-1))	-6.44E-05	1.88E-05	-3.423351	.0030
d(*inf*)	-3.66E-05	1.22E-05	-3.005434	.0076
ECT(-1)	-0.165251	0.023351	-7.077043	.0000
		Long-Run Estimates		
phexp	0.076814	0.198853	0.386285	.7038
gfcf	0.018977	0.002658	7.138591	.0000
fsd	0.006354	0.006017	1.056122	.3049
topen	0.003826	0.002131	1.795767	.0893
inf	-0.000430	0.001047	-0.410744	.6861
c	3.722162	0.188210	19.77663	.0000
***R*²**	0.7944	***F*-stat**	87.650 (0.0000)	
Adj. *R*²	0.6725	**D-Watson**	2.0708	
		Diagnostic test results		
Serial correlation	1.5995 [0.2496]	**Normality test**	2.3212 [0.3133]	
Functional form	1.3753 [0.1964]	**Heteroskedasticity test**	0.9501 [0.5579]	

Source: Author's computation (2022).
Note: ARDL = autoregressive distributed lagged.

and have the same variances as their normal distribution. Additionally, the ARDL model passed the Ramsey Regression Equation Specification Error Test (RESET) test, showing that the estimated model is evenly specified. As well, the cumulative sum and cumulative sum of squares, respectively, as publicized in Figures 1 and 2 are steady.

Effect of Public Health Expenses on Infant Mortality

This sub-section presents the estimated short- and long-run relationship between public health spending and infant mortality in Nigeria. The estimated results are provided in Table 7. The short-run estimation findings show how the error correction process, which measures the speed or intensity of adjustment, works. It gauges how quickly the result variable changes in response to changes in the explanatory variables. Based on the automatic selection of the Akaike Information Criterion, the model's lag length was set to 3, and the ARDL test automatically selected the lag duration for each variable. At the conventional level, it is discovered that the ECT's coefficient is negative and significant statistically. Following the ECT value (—0.1653), it means that the model adjusts its short-run disequilibrium at 16.53% speed of adjustment to reach the long-run equilibrium.

At the conventional level, the short-run coefficients of the change in infant mortality at lags 1 and 2 are positive but negative at lag three. While its first and third lags are statistically significant, the overall short-run parameter estimates of previous infant mortality contribute to the current infant mortality in Nigeria. More so, the current public health financing was determined to be positive and statistically significant at 5%. It implies that government health spending had a short-term positive influence on infant mortality. The current and first lag of gross fixed capital formation had a direct and indirect significant impact on infant mortality, respectively. Further, infant mortality was directly and insignificantly impacted by an increase in financial sector development in the short run. With the exception of the first lag that was statistically insignificant at 5%, the parameters of trade openness are negative and significantly related to infant mortality. Also, the table indicated that the current level of inflation rate significantly and negatively impacted infant mortality.

In accordance with the long-term estimated reported in Table 7, public health spending increases infant mortality in Nigeria. The series was not consistent with the theoretic expectation, and the result is statistically insignificant at 5%. It implies that public health spending does not have the potential to curtail infant mortality for the periods under study. As to the magnitude scale, a 10% increase in government health spending results in a 0.77% increase in infant mortality. In addition, for the research years, gross fixed capital formation, financial sector development, and trade openness have direct effects on infant mortality in Nigeria. The only factors that significantly impacted infant mortality were investment at 5% level and trade openness at 10% level. As a result, infant mortality increases by 0.19%, 0.064%, and 0.038% with every 10% rise in gross fixed capital formation, financial sector development, and trade openness, respectively. Low inflation has also been shown to have a direct impact on infant mortality. Thus, a 100% rise in inflation rate results in a 0.04% change in infant mortality.

Given that the coefficient of determination was high at 67.25%, this indicates that the model's explanatory variables accounted for roughly 67.25% variations in infant mortality. The overall test using the Fishers statistic (87.65), which is significant statistically at 5%, demonstrates that the estimated model is correctly specified. The Durbin-Watson value of 2.0708 shows that the model does not contain serial autocorrelation. The findings of the diagnostic tests are also shown in Table 7. The estimated ARDL model passed the normality, serial correlation, and heteroskedasticity tests. It shows that the error terms do not exhibit serial association and exhibit normal distribution-like variances. The ARDL model passed the Ramsey Regression Equation Specification Error Test (RESET), demonstrating the model is evenly specified. As demonstrated in Figures 3 and 4, the cumulative sum and cumulative sum of squares, respectively, are stable.

Figure 3.
Cumulative Sum (CUSUM).

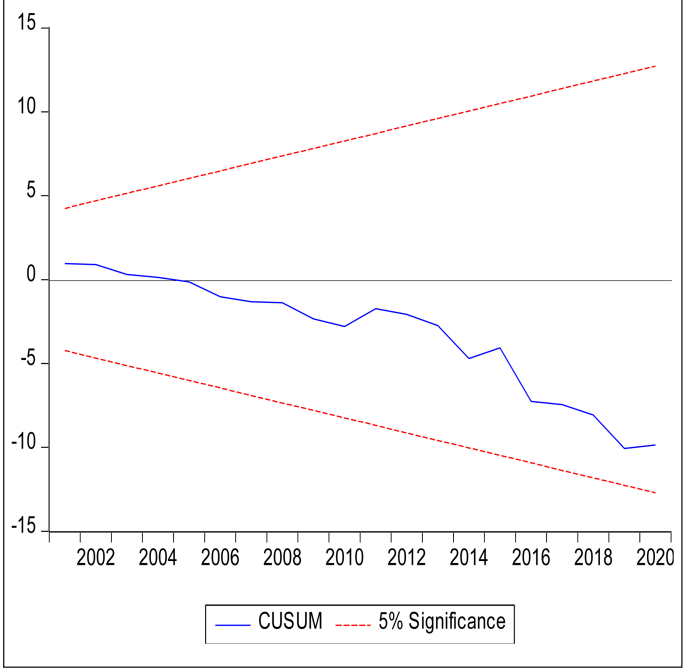
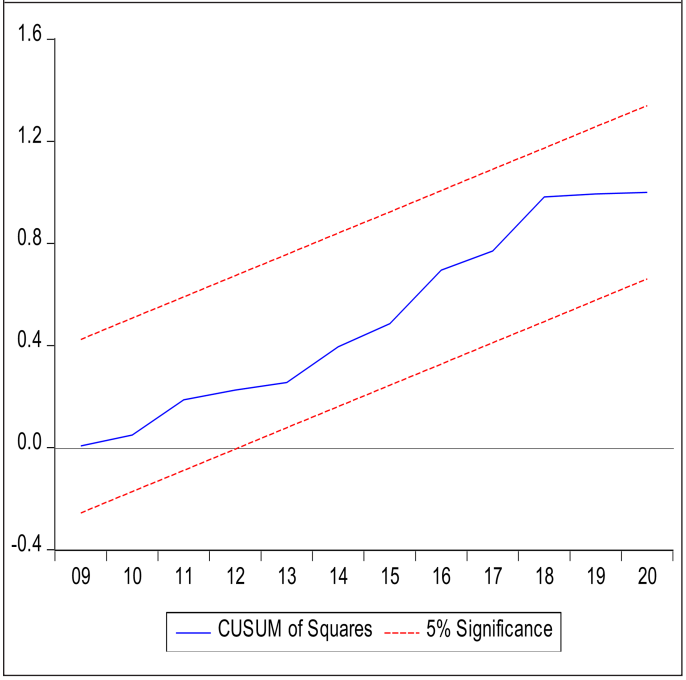


Figure 4.
Cumulative Sum of Square (CUSUMQ).



Discussion oF findings

Following the research outcomes, government health expenditure negatively influenced life expectancy in the short run but the impact was positive in the long run. In the short run, public health spending does not have the stimulus to improve life expectancy in the short run. However, in the long run,

government spending on healthcare facilities and services has the chance of improving the average number of years an individual lives after birth. Thus, it shows that increasing government health spending increases life expectancy. It aligns with the research outcomes of previous studies like Ahmad and Hasan (2016), Edeme et al. (2017), Chireshe and Ocran (2020), Wasiu (2020), Onofrei et al. (2021), and so on that government health spending improves life expectancy. Thus, long-run public health capital spending is key ingredient toward improving life expectancy. The long-run positive links between public health financing and life expectancy in the country mean that healthy lifestyles and the broader social determinants of health are vital in improving life expectancy. This direct relationship, however, emphasizes the importance of improving value for money in healthcare systems. It includes a greater emphasis on health promotion and other low-cost interventions, as well as a reduction in ineffective spending and waste. Meanwhile, it was discovered that government health finances do not have a significant effect on infant mortality during the periods under study. This is related to the study of Akinlo and Sulola (2019) conducted for a small number of countries in SSA where healthcare spending failed to translate into the reduction of infant mortality. It is similar to a Nigerian study by Adewumi, Acca, and Afolayan (2018) that found a direct and significant link between public health spending and infant mortality. It negates the results of previous studies (Ahmad & Hasan, 2016; Chireshe and Ocran, 2020; Rahman et al., 2018, 2021; Wasiu, 2020) that public health financing significantly lowers infant mortality rates.

Conclusion

This research study examines the impact of public health spending on health outcomes in Nigeria over the period 1984-2020 using the ARDL bound testing approach. We found that government health spending negatively and significantly influenced life expectancy in short run. However, the significant impact of public health finances on long-run life expectancy is positive. Meanwhile, it was discovered that government health expenses do not have a significant effect on infant mortality during the periods under study. The research outcomes show that public health expenditure does not have the stimulus to improve life longevity in the short run. As to the long-run results, government spending on healthcare facilities and services has the chance of improving the average number of years an individual lives after birth. It implies that increasing government health spending enhances life expectancy. Thus, public health capital spending is key ingredient toward improving life expectancy in the long run. This further indicates that healthy lifestyles and the broader social determinants of health are vital in improving life expectancy. This direct relationship, however, emphasizes the importance of improving value for money in healthcare systems. It includes a greater emphasis on health promotion and other low-cost interventions, as well as a reduction in ineffective spending and waste. On the policy front, it is imperative that the government spend more money on healthcare facilities and services in order to improve the population's health outcomes. As a result, it is anticipated that public spending will be equivalent to that of industrialized nations. Also, steps should be taken to boost the government's revenue stream so that it may grow and spend more of its budgetary allotment on health-related products and services.

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