Review

Examining the Effects of the COVID-19 Epidemic Shocks on Life Expectancy in Selected African Countries: A Tripartite Analysis

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Abstract

Background: The Covid-19 pandemic has resulted in substantial loss of life and livelihood insecurity worldwide. It has shortened life spans, deteriorated living conditions, and impeded national economic development, particularly affecting supply chains of essential goods and services in Nigeria, Egypt, and Algeria.
Objective: This study investigates the impact of the Covid-19 pandemic on life expectancy in Nigeria, Egypt, and Algeria by exploring the effects of various pandemic-related indices.
Methods: The study employed a GARCH (1,1) model to analyze the effects of the Covid-19 pandemic on life expectancy. The data set consisted of daily Covid-19 indices, including the Covid Index (CIX), Medical Index (MIX), Vaccine Index (VIX), and Uncertainty Index (UIX), spanning from 31 December 2019 to 28 April 2021. Life expectancy (LEX) was measured using life expectancy as a percentage of the total population. Control variables included government health expenditure (GEXH) as a percentage of GDP and per capita income (PCI).
Results: The findings indicate that the Covid-19 pandemic had significant adverse effects on life expectancy in Nigeria, Egypt, and Algeria. The pandemic's negative impact on life expectancy was robust across all indices, underscoring the detrimental effects of the crisis on public health in these countries.
Conclusion: The Covid-19 pandemic has posed a serious threat to life expectancy in Nigeria, Egypt, and Algeria, highlighting the need for policies aimed at improving living standards and extending life expectancy. Governments should prioritize enhancing public health infrastructure and living conditions to mitigate future health crises' long-term impacts.
Keywords: Covid-19 pandemic, life expectancy, tripartite analysis, Africa.

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Introduction

Corona Virus is a global pandemic that has dealt mercilessly with people all over the world recently. Its emergence was first noted by the World Health Organization (WHO) in the city of Wuhan, China on December 31, 2019, since then it has spread to all countries of the world. Nigeria, Egypt and Algeria, like every other country, have suffered shocks from the COVID-19 pandemic. Therefore, the sole aim of this study is to investigate the impact of the COVID-19 pandemic on life expectancy. The consequences of COVID-19 on life expectancy are so cumbersome. The COVID-19 pandemic has led to a dramatic loss of life worldwide, posing unprecedented challenges to public health, food chain systems and national economies in various economies. This has led to a sharp decline in life expectancy due to an increase in the mortality rate of the elderly, increased mortality and difficult living conditions for people.[1,2] People's lives are at risk, health-wise, economically, socially and ecologically. As a result of the COVID-19 pandemic, more than 15 million people have lost their lives worldwide and tens of millions of people are at risk of falling into extreme poverty, while the number of undernourished people is currently estimated at nearly 690 million.[3]

Indeed, a recent document issued by the World Health Organization found that millions of businesses face an existential threat, and as a result, nearly half of the world's 3.3 billion workforces, especially the most vulnerable, have lost their livelihoods to the COVID-19 pandemic due to insufficient social protection, poor access to quality healthcare and low living standards.[4] Total economic lockdowns, job losses, high levels of layoffs by companies, food shortages and poor living conditions are the main threats to life expectancy in most countries of the world. Globally, more than 527 million cases of COVID-19 have been confirmed, while over 6.28 million people have died of COVID-19 worldwide,[5] reducing human life expectancy. Some African countries such as Nigeria, Egypt and Algeria have reduced life expectancy due to the scorching wave of the COVID-19 pandemic. But a wide-ranging World Health Organization (WHO) report assert that most people who contract COVID-19 have mild to moderate symptoms and recover without treatment, while some become seriously ill and require medical attention. Symptoms of the COVID-19 pandemic include severe coughing, sneezing, spitting, heavy breathing, and profuse discharge of small fluids from a person's mouth or nose that block a large part of the respiratory system.[6]

The macroeconomic environment thus worsened as a result of the complete economic blockade. Since food is one of the contributors to longevity, the government's efforts to deal with the spread of COVID-19 have created obstacles in people's lives. Because there is a complete economic lockdown, the entire food chain system has stopped and the supply and distribution of goods and services have been temporarily interrupted due to factors such as border closures and trade restrictions. People had limited buying and selling of products. People then relied more heavily on domestic goods and services, which were offered at a very high price. Lack of food and raw materials prevented farmers, less skilled workers and small businesses from producing at the required level. The pandemic has also decimated jobs and threatened the livelihoods of millions. As a result, people fell ill and died, food insecurity worsened and people's nutrient intake was at risk, especially in low-income countries, especially the most vulnerable populations characterized by predominantly small-scale farmers such as Nigeria, Egypt and Algeria, which hit hard.[4]

Given the above discussion, previous studies have shown that COVID-19 and its effects on life expectancy require attention.[2,7,8,9,10] However, considering the severity of the risks associated with COVID-19 epidemic and the paucity of empirical research, particularly in Nigeria, Egypt and Algeria, it is imperative to deepen the investigation and contribute to the body of knowledge on the issue, despite the fact that Africa has had lower COVID-19-related fatality rates than other continents. Nonetheless, it might be harmful to Africa as a whole to give in to the findings without conducting more study to deepen our understanding of COVID-19. Thus, the primary objective of this research was to investigate how the COVID-19 pandemic shocks affected life expectancy in a number of African nations. In particular, this research examines the following: a) the standardized and weighted impact of COVID-19 on life expectancy; b) the status of population health, the efficacy of healthcare policies, and the impact of various health interventions on life expectancy; c) the effect of COVID-19 vaccination campaigns on life expectancy in selected African countries; and d) the effect of the unpredictability and uncertainty associated with the COVID-19 pandemic on life expectancy. The results of this investigation might offer significant perspectives for enhancing pandemic readiness and reaction in Africa. As a result, this will strengthen long-term health strategy and resiliency, give a thorough knowledge of the pandemic's health repercussions, and guide socioeconomic and healthcare policy.

This study differs from earlier research in a number of ways. First, previous studies were particularly interested

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on COVID-19 indices such as the number of deaths attributed to COVID, number of hospital admissions due to COVID-19, average number of people to whom a single infected person will transmit the virus, and percentage of the population that has received COVID-19 vaccinations.[2,7,8,9,10] None of these studies concentrated on, a) how COVID-19 pandemic shocks affect life expectancy; b) the impact of composite measure of the COVID-19 pandemic indices on life expectancy; c) the extent medical index which provide valuable insights into the impact of health status of a population, the effectiveness of healthcare policies, and the health interventions on life expectancy; and d)how the vaccine index affects the population health, evaluating factors like vaccination rates, the efficiency of vaccine distribution, and public acceptance of vaccines. Lastly, we also took into consideration the impact that government spending and per capita income have on health-related issues and how they affect life expectancy in Africa. By guaranteeing better access to healthcare services, better living circumstances, and more economic stability, this will advance our understanding of the extent to which they impact a population's general well-being and lifespan. On the other hand, treating present health issues and becoming ready for pandemics in Nigeria, Egypt, Algeria, and all of Africa requires an awareness of the variances in the COVID-19 indicators in connection to life expectancy. The following sections of the paper will be organized as follows: Section 2 will discuss the review of related literature, Section 3 will discuss the methodology, and section 4 will discuss the empirical findings and discussion, while Section 5 will present the summary, recommendations and conclusion.

Review of Related Literature

This section focuses on a literature review regarding the COVID-19 pandemic and life expectancy. Theoretically, conspiracy theories attempt to explain significant events and circumstances as malevolent acts of secret and powerful groups.[11,12] The psychological literature on this topic has grown rapidly over the past 15 years and suggests that people are drawn to conspiracy theories when important psychological needs are not being met. During a pandemic, people's psychological needs are likely to be particularly frustrating. Uncertainties are high and people are worried and scared about their future and the future of their loved ones. They are looking for information to answer important questions about the outlook for the coming months. In addition, the information landscape is complex, and people are often confronted with conflicting information. However, people are driven by fear, loss of control, and narcissistic feelings about the morality of their group,[17] which can lead to prejudice, hostility, and discrimination against alleged conspirators.

Various governments thus tend to protect their citizens to limit the spread of the pandemic. Figure 3 presents a typical response framework based on an understanding of the responses to date. Above is the task force (TF) coordinating the national plan against COVID-19 across the countries. The main mandate of the working groups is to develop strategies, implement them and mobilize stakeholders to ensure a multi-spectral response to the pandemic. Similar to Nigeria and other African countries, the TF is mainly ruled by government officials, although there has been an attempt to mobilize other stakeholders. For example, faith leaders have been substantially neglected even though Nigeria is a religious country.[13] Despite the original ban on religious gatherings, some faith leaders led congregational services. Faith leaders should be appropriately involved, instead of blunt state directives that have not produced the desired results. COVID-19 disrupts the world: a classic case of the unintended consequences of globalization. The flow of people helps the flow of infectious diseases. From a few imported cases, most nations now struggle with thousands of cases and deaths. In most African countries, existing health facilities and equipment are grossly inadequate to handle medical emergencies due to COVID-19.[2]

The COVID-19 Pandemic in Nigeria

Nigeria Centre for Disease Control (NCDC), training of rapid response teams in 36 states in Nigeria was completed in December 2019 and on January 28, NCDC announced that a coronavirus task force had been established to activate its incident response system to respond to any emergency. In addition, NCDC has worked with 22 states in Nigeria to activate their Emergency Operations Centers to manage and link with the National Outbreak Coordination Centres.[14] Although the government has strengthened airport surveillance since January 2020, Nigeria recorded its index case of COVID-19 on 27 February, which was imported from Italy. This raised concerns about the effectiveness of airport surveillance and, by extension, the country's general preparedness. The index case (Italy) visited some other states of the federation before testing positive for COVID-19. Preparedness before COVID-19 was grossly inadequate. The onset of COVID-19 has created severe panic in Nigeria, like every other country. As a result of globalization, the health risk of communicable diseases could become a pandemic. Trade and travel facilitate the movement of people who might otherwise be moving and therefore

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carrying a health risk. From one imported index case, many countries (including Nigeria) face huge health problems with many cases and deaths. Since the first index case in Nigeria, the number of cases has been increasing.

After the discovery of the index case, NCDC's multi-agency National Emergency Operations Center (EOC) was activated to oversee the national response to COVID-19. Subsequently, on March 9, 2020, the Presidential Task Force (PTF) to control the coronavirus was inaugurated. The PTF has announced that travellers from thirteen (13) countries with a high risk of COVID-19 have been restricted from entering the country. Port Health Services and NCDC have since been monitoring the self-isolation of returnees from affected countries. There were concerns from several quarters that the ban on high-risk countries would go into effect immediately. By the time the ban went into effect, the nation had seen more imported cases. Unfortunately, most of those who arrived in the country did not follow the 14-day isolation recommended by the NCDC.

The NCDC disclosed that all confirmed cases of COVID-19 in the country between February 27 and March 17 (the first 30 days) were imported by returning travellers. As of March 27, a month after the first case, ten states in Nigeria had 81 clinically confirmed cases. Three patients fully recovered, and one death was reported. The state of Lagos had the highest number of cases at this time (52; 64.2%). By April 5, the number of positive cases had increased exponentially to 232. The death toll rose to five and 33 people had recovered, while states with positive cases in Nigeria reached 14 as lockdown restrictions took their toll. Public health education and risk communication campaigns regarding COVID-19 have begun in earnest with the reported index case across African countries. Both conventional and social media, including WhatsApp, Twitter, and Facebook, aided in the spread of virus updates.[15] The government through its established agencies is providing regular updates on the outbreak with the support of major telecom operators in the country. The agencies regularly publish guidance on how to prevent the coronavirus (social distancing, safe hand washing, personal and respiratory hygiene, etc.) as well as a directory of helplines for each state.

COVID-19 in Algeria

In Algeria, the first case of COVID-19 was reported on February 25, 2020. The authorities responded quickly to the pandemic by introducing restrictive measures from the beginning of February 2020 (e.g., cancelling flights and imposing a quarantine for repatriated Algerians). The measures included closing schools, restaurants, and shops; cancellation of private and public events; closure transport services; putting half of the civil servants and private workers on compulsory leave with full compensation. Public demonstrations and religious activities were cancelled, affected areas were locked down and curfews were imposed in many cities, including the capital Algiers. A slow easing of detention restrictions began in early June 2020. Authorities continued to monitor and enforce lockdown measures as needed, including during the second wave of the pandemic in Algeria at the end of 2020. Borders partially reopened in June 2021. The number of daily new cases by the end of March 2021 fell sharply after the peak during the second wave, but they are increasing again. Algeria began a vaccination campaign in late January 2021 and has since received additional doses through COVAX facilities and other sources, totalling 2.7 million doses by the end of May 2021. Domestic production of the Sputnik V vaccine is expected to begin in September, according to an official government statement.

COVID-19 in Egypt

According to the WHO, the first case of COVID-19 was reported on February 14, 2020. The pandemic is likely to affect Egypt's economy primarily due to declining travel and tourism activity, reduced worker remittances, capital outflows, and a slowdown in domestic activities as people are asked to stay at home. Weaker global market demand will also reduce Egyptian exports as well as revenues from the Suez Canal. Authorities have taken several precautionary measures to improve testing as well as limit the community spread of the virus, including setting up testing centres, curfews, temporarily closing places of worship, halting all air travel and supporting government employees. Work from home in non-essential industries. The authorities have also suspended the export of all types of pulses for 3 months – which was extended for another 3 months in June 2020, and plan to start increasing strategic food stocks to meet domestic demand. Egypt has resumed exports of medical supplies after a temporary halt in March 2020. Around 77,000 Egyptians have been repatriated since the start of the pandemic. The central bank and the government are actively implementing measures to limit the economic consequences of the pandemic.

On April 30, 2020, the government began preparing plans for long-term "coexistence" with COVID-19. From the last week of April 2020, shopping centres and retail stores were allowed to open until 5:00 p.m. on weekends, while restaurant customers could order takeaway food directly from the store. From 4 May 2020,

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hotels could operate at 25% capacity until June 2020 and then at 50% capacity. Egypt's Ministry of Health has published a 3-step coronavirus management plan that includes the required procedures in preparation for a gradual return to normal life in the country. From 1 June 2020, the night curfew was one hour shorter - from 8:00 PM to 5:00 AM instead of 6:00 AM. From July 2020, there will be a gradual reopening of the economy - air travel will resume, restaurants and cafes will open at 25% capacity, shops will close at 21:00, restaurants and cafes will close at 22:00 and beaches will remain closed until further notice, public transportation will operate from 4:00 a.m. to midnight. All parks and specialized gardens around Cairo will open to the public from August 26, 2020, with a maximum capacity of 50 per cent. From September 21, funeral prayers and wedding ceremonies held in public places are allowed for a maximum limit of 300 people. Guidelines for risk mitigation measures, including social distancing and wearing masks, remain in place. International flights have resumed, and tourists are arriving in the country in small numbers.

Empirical Review

(7) analyzed changes in life expectancy in the United States and 16 other high-income countries from 2010-18 and 2020 by gender, race, and ethnicity. The data was sourced from the National Center for Health Statistics and Human Mortality Database. The analysis excluded 2019 due to death table data not being available for many similar countries, and the results were compared with peer nations. Life expectancy in 2020 was estimated using life table simulations and age-specific death rates, with medians and 95th percentiles, allowing for 10% random error. The results show that US experienced a larger decline in life expectancy than other high-income countries between 2018 and 2020, particularly among Hispanic and non-Hispanic black populations. This long-term health disadvantage, high mortality in 2020, and inequitable impacts on racial and ethnic minorities are likely due to long-term policy decisions and systemic racism.

(2) examined the impact of COVID-19 on life expectancy in 29 countries, including Europe, Chile, and the USA, from 2015 to 2020. The findings show that Life expectancy at birth decreased in 27 out of 29 countries from 2019 to 2020. Men in the US and Lithuania experienced the largest losses, with 2.2 and 1.7 years respectively. However, 11 countries experienced reductions of over a year for men and 8 for women. The decrease was primarily due to increased over-60 mortality and official deaths from COVID-19. The pandemic caused a significant increase in mortality, unprecedented since World War II or the collapse of the Soviet Union. Women from 15 countries and men from 10 countries had lower life expectancy at birth in 2020 than in 2015.

(8) analyzed the impact of COVID-19 on the United States population in 2020, focusing on excess deaths, life expectancy, and total years lost. The findings showed that there were 375,235 excess deaths, with 83% attributable to direct and 17% to indirect effects. Life expectancy decreased by 1.67 years, a return of 14 years in the historical increase. The total number of years of life lost in 2020 was 7,362,555 in the US, with considerable heterogeneity at the state level. In Maharashtra, India, the study examined the impact of COVID-19 infection on life expectancy, premature mortality, and disability-adjusted life years (DALYs). Deaths attributable to COVID-19 accounted for 5.3% of total deaths in the state and reduced life expectancy at birth by 0.8 years. If COVID-19-attributable deaths increased to 10% of total deaths, life expectancy at birth is likely to decrease by 1.4 years. The probability of death for those aged 20-64 increased from 0.15 to 0.16 due to COVID-19. In Maharashtra, 1.06 million additional life years lost and DALYs were estimated at 6 per thousand.

Method

Data

The dataset used for this study is selected from the new global measures of the COVID-19 pandemic as proposed by Narayan et al. (2021). The COVID-19 measures indices were compiled by the researchers using a series of words related to the COVID-19 pandemic that was established in 45 daily newspapers from 31 December 2019 to 28 April 2021. They used the ProQuest TDM Python algorithm for each word, which resulted in the generation of different types of data that includes (COVID, Medical, Vaccine, Travel, Uncertainty and Summary). However, our study selects the indices of COVID, Medicine, Vaccine and Uncertainty to measure the impact of the COVID-19 pandemic, measuring life expectancy (LEX) with life expectancy (% of total); and the Government Expenditure on Health (GEXH) control – a proxy for current government expenditure on health (% of GDP) and per capita income (PCI). The choice of variables was strictly based on the availability of data for the selected countries. The nature of our data will be monthly, spanning from December 2019 to April 2021.

Stationarity Test

Time series data were used in this study. A stationary time series dataset is one whose attributes do not change over time. More specifically, it is defined as a series in

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which statistical properties such as autocorrelation, mean, and median remain constant over time. Consequently, it is important to ensure that the time series is stationary before time series modelling. The authors chose the Augmented Dicky-Fuller (ADF) test to determine the level of stationarity of the variables and the ADF test is defined as:

$$y_t = c + \beta_t + \delta y_{t-1} + v\Delta Y_{t-1} + \varepsilon_t \text{-------------} (1)$$

Such that:
δ = the coefficient of the first lag of Y.
$y(t-1)$ = is the first lag of the time series
ΔY_{t-1} is the first difference between the series at the time $(t = 1)$

Test of normality

The normality test is used to determine whether a data set is well-modelled by a normal distribution or not. It is also used to calculate how likely the random variable underlying the data set is to be normally distributed. If the data set is not normally distributed, a non-parametric statistic is used. When normality is not achieved, it is reasonable to plot a histogram of the data to determine if the data set contains outliers. In this study, we will use the Jacque-Ber (JB) test statistic to test the normality of the series we will use for this research, which is defined as follows:

$$JarqueBera\ \frac{N}{6}(Skewness + \frac{Kurtosis}{4}) \text{-------------} (2)$$

Skewness measures the level of skewness of distribution, while kurtosis describes how strongly the distribution under consideration is compared to a normal distribution, which can also be called degrees of freedom.

Auto-Regressive Conditional Heteroscedasticity (ARCH)

To build a GARCH model with series, it is reasonable to consider serial correlation under heteroskedasticity. That is, we seek to measure the correlation between the volatility of the series as measured by the conditional variance in past innovations. Consequently, the Lagrange Multiplier (LM) test will be used to measure the ARCH effect with the null hypothesis of "no ARCH effect in the series".

$$f(x,\lambda) = f(x) = \lambda_g(x) \text{--------------------------} (3)$$

Where:
λ =Langrangan Multiplier, $g(s)$ = equality constraint, $f(x)$ = function and x = integer. Let ε_t be time series error term (X_t). If the real size of the ε_t is characterized by stochastic term U_t and the time-dependent standard deviation (σ_t), then.

$$\varepsilon_t = U_t\sigma_t \text{--------------------------} (4)$$

Where (μ_i) is the stochastic term of the white noise and the time-dependent variance be expressed as:

$$\sigma_t = \delta_0 + \delta_1\sum_{t-1}^{2} +.+ \delta_p\sum_{t-p}^{2}, \delta_0 > 0 \text{---------------} (5)$$

$$\delta_t = \delta_t + \sum_{i=1}^{p}\delta_i\sum\nolimits_{i-1}^{2}, \delta_t > 0, i > 0 \text{------------} (6)$$

Where p is the length of ARCH lag
Thus, considering the ARMA (pq), equation 7 will be written as follows:

$$X_t - \delta_i X_{t-1} -,- \delta_p X_{t-p} = \varepsilon_t - \beta_i\varepsilon_{t-1} -,- \beta_p\varepsilon_{t-p} \text{------------} (7)$$

Reparametrizing equation 7, we have:

$$X_t = X_{t-p} + \varepsilon_t \text{----------------------------} (8)$$

$$\delta_t = w + \delta_i\sum\nolimits_{t-p}^{2} + \beta_1\sigma_t +, + \beta_p\sigma_{t-q} \text{------------------} (9)$$

Thus, equation 4 can be rewritten for ARMA (p,q) as follows.

$$\delta_t = w + \sum_{t-1}^{p}\delta_i\sum\nolimits_{t-1}^{2} + \sum_{j=1}^{q}\delta_{t-j} \text{-----------------} (10)$$

Equation 10 represents the GARCH (p,q) model.

Results

Descriptive and volatility Results

Table 1 contains descriptive statistics for selected countries - Nigeria, Algeria, and Egypt. It shows the basic characteristics of the variables, hence, we present each country's data and analyse it for clarity. However, one could count on the fact that descriptive statistics measure the basic characteristics of each of the variables in the model, which makes it easier for researchers to make decisions in econometric research. In Nigeria, we find that the total variation in Nigeria has shifted from -6.754391 to 5.906086, while the mean, median, standard deviation, skewness, and kurtosis are closely related, indicating that the error terms of each of the model variables are normally distributed, therefore the variables are very suitable for analysing the relationship that is being tested. In addition, the probability values of the Jarque-Bera statistic for all variables are less than 0.05, which confirmed that the series is normally distributed. Similarly, for Algeria and Egypt, the series mean deviations range from -3.912023 to 4.782102 and -1.389294 to 4.586191, respectively. The results also show that the mean, median, standard deviation, skewness, and kurtosis values are not far apart.

Furthermore, we also observed that for countries, the minimum and maximum values for all variables were not

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far apart, but the minimums are negatively skewed for all variables during the COVID-19 era. This means that the COVID-19 pandemic is hurting life expectancy in Nigeria, Egypt and Algeria respectively. Additionally, the mean, median, standard deviation, and kurtosis values are not too far apart. The probability values of the Jarque-Bera statistic are less than 0.05 for all the specified countries, indicating that the series are normally distributed. Hence, the variables are found to be a good fit for the model in the study.

Table 1: Descriptive statistics

	LEX	CIX	MIX	VIX	UIX	GEXH	PCI
NIGERIA							
Mean	4.413	0.878	3.319	3.319	3.633	-0.584	2.987
Median	4.489	0.980	3.193	3.194	3.792	-0.493	3.069
Maximum	5.906	4.015	4.782	4.710	4.373	4.226	4.250
Minimum	2.430	-3.939	1.879	1.893	0.309	-6.754	0.751
Std. Dev.	0.469	1.122	0.627	0.677	0.598	1.314	0.748
Skewness	-0.739	-1.014	0.629	0.606	-3.982	-0.449	-0.729
Kurtosis	4.553	5.426	2.993	2.914	19.93	7.140	3.777
Jarque-Bera	65.72	107.9	22.89	20.66	5058.4	202.7	39.52
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	343	259	347	347	347	271	347
ALGERIA							
Mean	0.919	3.529	3.320	2.431	2.403	2.826	2.661
Median	1.053	3.563	3.184	2.388	2.323	3.442	2.866
Maximum	4.466	4.529	4.728	4.185	4.170	4.456	4.216
Minimum	-2.307	2.402	1.889	-0.734	-2.120	-3.912	-1.833
Std. Dev.	0.986	0.543	0.722	0.965	1.017	1.366	1.271
Skewness	-0.371	-0.195	0.692	-0.136	-0.636	-1.074	-1.281
Kurtosis	4.031	2.476	2.961	2.675	4.615	4.166	4.587
Jarque-Bera	17.03	6.163	22.60	2.596	61.07	85.85	130.6
Probability	0.000	0.046	0.000	0.273	0.000	0.000	0.000
Observations	253	347	347	347	347	345	345
EGYPT							
Mean	3.353	2.919	2.985	2.464	2.534	2.987	2.107
Median	3.767	2.905	3.035	2.670	2.738	3.067	1.917
Maximum	4.586	4.491	4.264	4.131	4.115	4.250	4.347
Minimum	1.102	1.167	0.621	-1.389	-0.288	0.751	-1.386
Std. Dev.	0.946	0.759	0.767	0.821	0.717	0.748	1.176
Skewness	-0.667	-0.105	-0.738	-1.299	-0.956	-0.730	-0.274
Kurtosis	2.270	2.148	3.778	5.185	4.018	3.777	2.635
Jarque-Bera	33.41	11.14	40.28	166.6	67.81	39.52	6.271
Probability	0.000	0.004	0.000	0.000	0.000	0.000	0.014
Observations	347	347	347	347	347	347	347

Source: Authors' Concept. LEX represent life expectancy, CIX; COVID-19 index, MIX; medical index, VIX; Vaccine Index, UIX; Covid-19 uncertainty index, GEXH; Government Expenditure on Health, and PCI; per capita income

Figure 1 below shows the charts of the volatility of the COVID-19 indices and life expectancy in Nigeria, Egypt, and Algeria. The Life Expectancy (LEX) plot has been quite volatile about the COVID-19 pandemic in the many months since the outbreak was discovered but is becoming more volatile towards the end of the COVID-19 era. Moreover, the COVID-19 index (CIX) was found to be very volatile at the beginning of the pandemic era in all the countries examined. Its volatility decreased slightly until April 28, 2021. This was due to the initiation of government intervention programs in Nigeria, Egypt, and Algeria as a way to curb the spread of the contagious COVID-19 pandemic within the countries. Similarly, the trend of the medical index (MIX) shows that the activities of the medical team have been volatile over the period. However, since the onset of COVID-19 in the countries under study, medical experts received shocks because it was their first experience of the virus in these countries as well as globally, and therefore their action was based on trying different ways to cure each confirmed case of COVID-19 pandemic.

In addition, government efforts to reduce the spread of the COVID-19 pandemic which include total economic

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lockdown, social distancing, and use of hand sanitisers, and face masks among others, measured the governments of Nigeria, Algeria and Egypt took to tackle the pandemic. The government also used some fiscal and monetary to launch reappraisal attacks on the impacts the pandemic had on their citizens. The economic stimulation policies were aimed at supporting the feeding of the households, supporting the small and medium enterprises the in production of goods and services, and farmers – who are the most vulnerable to produce domestic goods to satisfy the increased insatiable wants of most households' consumption. This improves household consumption, and personal income and stimulates economic growth (see., 1 2, 16, 17, 15, 7) among others.

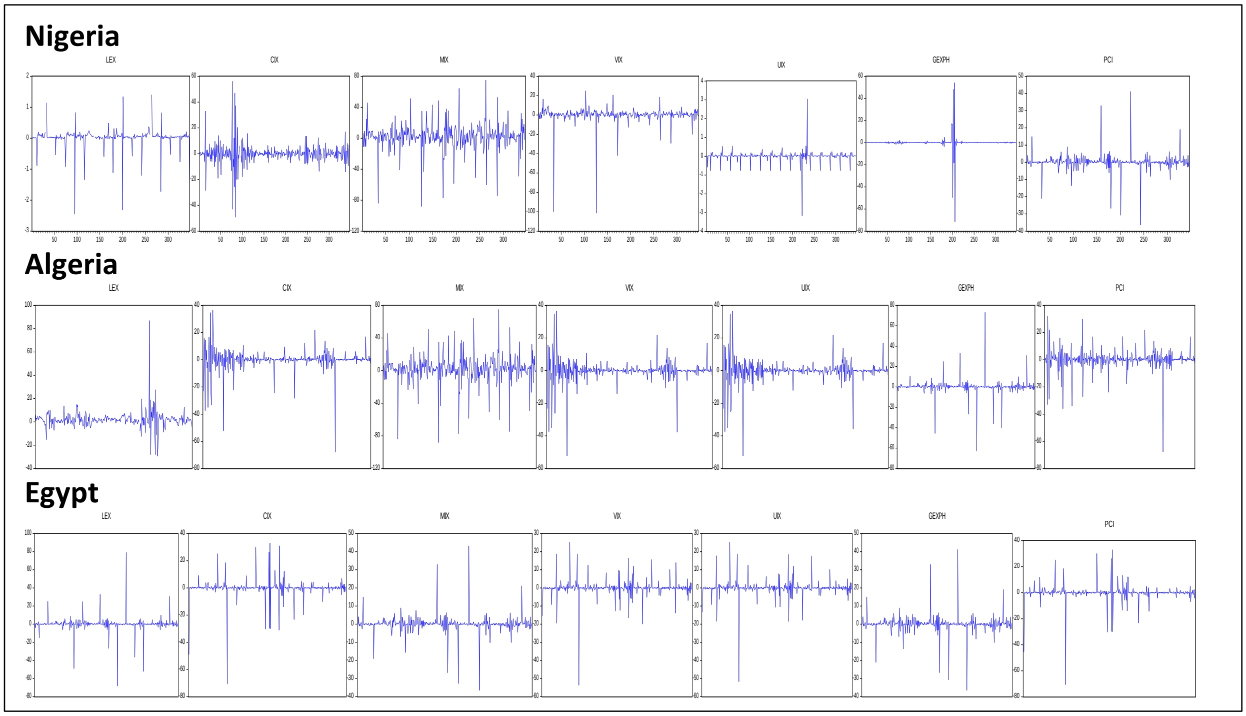

Figure 1: Volatility Plots

Figure 1 displays the volatility plots of the COVID-19 indices and life expectancy across Nigeria, Egypt, and Algeria. The life expectancy (LEX) data have experienced considerable volatility since the outbreak of COVID-19, with increasing fluctuations towards the latter stages of the pandemic. Similarly, the COVID Index (CIX) demonstrated significant volatility early in the pandemic, which diminished slightly over time, particularly by April 28, 2021. This reduction is attributed to government interventions aimed at curbing the virus's spread in the three countries.

The volatility of the Medical Index (MIX) was similarly pronounced due to the initial shock and uncertainty faced by medical professionals in responding to a new and highly contagious virus. However, as the pandemic progressed, medical responses became more standardized, contributing to a gradual stabilization of volatility. In response to the pandemic, the governments of Nigeria, Algeria, and Egypt implemented various public health and economic measures, including total lockdowns, social distancing, the use of hand sanitizers, and mandatory face masks. These efforts were aimed at reducing the spread of COVID-19 while also cushioning the economic impact on households and businesses. Fiscal and monetary policies targeted the sustenance of households and the support of small and medium enterprises (SMEs) to maintain the production of essential goods and services. Such policies contributed to improving household consumption, raising personal incomes, and stimulating economic recovery in the affected countries (1, 2, 16, 17, 15, 7).

Table 2 displays the outcomes of the stationarity and normality tests conducted across Nigeria, Algeria, and Egypt. The Augmented Dickey-Fuller (ADF) test indicates that most variables are stationary at their level, except for a few cases: VIX and PCI in Nigeria, MIX,

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VIX, and GEXH in Algeria, and LEX, CIX, MIX, and GEXH in Egypt, which only achieve stationarity after first differencing. The Jarque-Bera statistics reveal that all variables in all countries deviate from normal distribution, as evidenced by high values and significant probabilities ($p<0.05$). This non-normality must be addressed during model estimation. However, the findings show that the null hypothesis "unit root is present in the series" should be rejected as the probability values for all variables are statistically significant i.e. less than 0.05. Accordingly, the findings from the normality test results show that the variables are normally distributed as the Jarque Bera normality test result shows that the p-value of all the COVID-19 indices used is statistically significant at the 1% level. Importance. In the same vein, life expectancy, government spending on health, and per capita income are also statistically significant at the 1% significance level. This means that we fail to accept the null hypothesis and conclude that the distribution of the COVID-19 pandemic on life expectancy is normally distributed. Thus, this align sonance with previous empirical studies which include (1, 4, 6, 2 8, 9, 7, 10, 11, 12) among others.

Table 2: Test of stationery and normality

NIGERIA Variable	ADF-Statistic	Probability	Integration Order	Jarque-Bera Statistic	Probability
LEX	-6.176***	0.0000	I(0)	1288.963	0.0000
CIX	-5.662***	0.0000	I(0)	12791.28	0.0000
MIX	-3.223**	0.0195	I(0)	282.1377	0.0000
VIX	-18.92***	0.0000	I(1)	288.3698	0.0000
UIX	-6.541***	0.0000	I(0)	171.2374	0.0000
GEXH	-6.591***	0.0000	I(0)	85413.32	0.0000
PCI	19.92***	0.0000	I(1)	56.36582	0.0000
ALGERIA Variable	ADF-Statistic	Probability	Integration Order	Jarque-Bera Statistic	Probability
LEX	-11.97***	0.0000	I(0)	54032.07	0.0000
CIX	-3.361**	0.0131	I(0)	41.59275	0.0000
MIX	-3.923***	0.0089	I(1)	296.8523	0.0000
VIX	-3.532***	0.0077	I(1)	115.1255	0.0000
UIX	-3.572***	0.0068	I(0)	118.2065	0.0000
GEXH	-19.39***	0.0000	I(1)	27.01390	0.0000
PCI	-2.967**	0.0391	I(0)	37.59410	0.0000
EGYPT Variable	ADF-Statistic	Probability	Integration Order	Jarque-Bera Statistic	Probability
LEX	-19.28***	0.0000	I(1)	20.68806	0.0000
CIX	-25.13***	0.0000	I(1)	89.94427	0.0000
MIX	-19.88***	0.0000	I(1)	79.42344	0.0000
VIX	-4.104***	0.0011	I(0)	467.7831	0.0000
UIX	-4.058***	0.0013	I(0)	433.4763	0.0000
GEXH	-19.92***	0.0000	I(1)	82.33517	0.0000
PCI	-3.096**	0.0278	I(0)	183.9194	0.0000

Source: Computed by the Author, *** represents a 1% level of significance, ** represents a 5% level of significance, and * represents a 10% level of significance.

Table 3 presents the results of the Autoregressive Conditional Heteroskedasticity (ARCH) effects, which examined heteroscedasticity. The null hypothesis of no heteroscedasticity is rejected for all variables, indicating significant heteroscedasticity in Nigeria, Algeria, and Egypt. This supports the use of the GARCH model, which accommodates volatility clustering—a crucial factor in analysing the impact of the COVID-19 pandemic on life expectancy. Thus, this is a basic test which will satisfy the preconditions for the estimation of the GARCH model. This test has a null hypothesis which states that "p-value<0.05" and an alternative hypothesis "p-value>0.05" as well as the decision rule "reject the null if the probability value is greater than

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0.05". Thus, the rejection of the null hypothesis implies that there is the existence of heteroscedasticity between the variables across the countries. The results indicate substantial volatility in life expectancy and related indices across the three countries due to the pandemic. Nigeria experienced the highest volatility, likely due to the severe effects of economic lockdowns on consumption, employment, and household income.[1] Algeria exhibited lower volatility, possibly due to the government's prompt actions, including early public space closures and restrictions on civil servants' activities.[18] In contrast, Egypt faced notable volatility caused by halted tourism and significant capital outflows, which strained the economy and affected life expectancy.[19]

Table 3: Results of ARCH effects

Variables	NIGERIA		ALGERIA		EGYPT	
	ARCH Test	Probability	ARCH Test	Probability	ARCH Test	Probability
LEX	204.4252	0.0000	116.6495	0.0000	101.4420	0.0000
CIX	2096.841	0.0000	122.9573	0.0000	2271.409	0.0000
MIX	1968.816	0.0000	120.8049	0.0000	47.97169	0.0000
VIX	1845.804	0.0000	122.8126	0.0000	2762.535	0.0000
UIX	1990.163	0.0000	122.9080	0.0000	2653.258	0.0000
GEXH	1980.085	0.0000	120.5971	0.0000	70.27410	0.0000
PCI	2025.475	0.0000	123.1392	0.0000	2584.522	0.0000

Source: Calculated by the author.

Figure 2 offers a visual representation of the ARCH effects in Nigeria, Algeria, and Egypt, highlighting the volatility in life expectancy and related indices during the COVID-19 pandemic. Haven confirmed the existence of ARCH effects in the variables of the model for all the countries under study, we went further to plot the ARCH residual graphs to further check if we will estimate the GARCH model or not. The ARCH graphs further test the pictorial existence volatility between the COVID-19 pandemic and life expectancy. The graphs assessed the average life expectancy of the population during the COVID-19 pandemic. The ARCH effects model is used to measure model stability. However, the basic rule for the GARCH model is that heteroscedasticity must exist in all the variables before specifying the GARCH model. We plot the ARCH graphs for each of the variables for each of the countries to assess the nature of volatility which exists between the COVID-19 pandemic and life expectancy; thus, the graphs are presented below in figure 2. Thus, in Nigeria, there exist a high sign of heteroscedasticity and volatility in the variables. The graphs suggest that the COVID-19 pandemic caused so much volatility in the life expectancies of people. Volatility in the COVID-19 index, medical index, vaccine index and COVID-19 uncertainty index show that the sudden outbreak of the pandemic which spread throughout the nuke and crannies of cities, villages, and households, in Nigeria, damaged household consumption patterns, household consumption expenditure, and personal income. Thus, following the effects of the total economic lockdown, people lost their jobs, small-scale companies folded, and few available foods and resources could no longer be enough to carter for the welfare of all the people in Nigeria.[1]

In addition, the subsequent analysis with the GARCH (1,1) model reveals the pandemic's significant effects on life expectancy in these countries, with varying responses based on the extent of government intervention and economic resilience. In Nigeria, the GARCH results show that the COVID-19 Index (CIX) and Medical Index (MIX) reduce life expectancy significantly, by 62% and 13.8%, respectively, indicating adverse effects from governmental medical efforts and fluctuating economic conditions. Conversely, the Vaccine Index (VIX) positively affects life expectancy by 3%, reflecting the benefits of vaccination efforts. The COVID-19 Uncertainty Index (UIX) also negatively impacts life expectancy by 2%. Government health expenditure (GEXPH) contributes positively, increasing life expectancy by 12%, while personal income (PCI) negatively affects it by 11%. In Algeria, all COVID-19-related indices—CIX, MIX, VIX, and UIX—negatively impact life expectancy, with the COVID Index and COVID-19 Uncertainty Index causing the most significant reductions of 49% and 89%, respectively. However, government health expenditure and personal income have substantial positive effects, accounting for 98% and 57% of life expectancy variation, respectively. In Egypt, the CIX, UIX, and government health expenditure decrease life expectancy by 4%, 1%, and 12%, respectively, while the Medical Index and personal income positively impact life expectancy, contributing 13% and 7% to its variance. The Vaccine Index also has a positive effect of 9%, highlighting the importance of

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vaccination in mitigating the pandemic's adverse effects on public health.

Moreso, the economic hardships also spread across all countries of the world, of which Nigeria, Algeria and Egypt are no exception. A closer look at figure 2 shows that there is less volatility in life expectancy, COVID Index, medical index, vaccine index, COVID-19 uncertainty index, government expenditure on health and personal income when compared with Nigeria. This could be a result of a swift government intervention response towards mitigation of the COVID-19 pandemic. This could also be a result of many COVID-19 treatments of confirmed patients and government COVID-19 response policies. The government attacked the spread of the COVID-19 pandemic swiftly by cancelling flights and imposing a quarantine for repatriated Algerians.[19] followed by the closing of schools, restaurants, and shops; cancellation of private and public events; closure of transport services; putting half of the civil servants and private workers on compulsory leave with full compensation among others, which results in drastic reductions in the spread of the COVID-19 pandemic in Algeria. Lastly, in the stance of Egypt, we observed from figure 2 that there is the existence of great volatility in life expectancy, COVID index, medical index, vaccine index, COVID-19 uncertainty index, government expenditure on health and personal income. This shows that the COVID-19 pandemic had an enormous impact on the life expectancy of the Egyptians.

Like most emerging markets, the COVID-19 pandemic has been an enormous shock for the Egyptian economy. The fallout was immediately felt through a sudden stop in tourism—which, at the onset of the crisis, accounted for around 12 per cent of GDP, 10 per cent of employment, and 4 per cent of GDP in foreign currency earnings.[19] Precautionary measures to contain the spread of the virus, including partial lockdowns and restrictions on capacity in public spaces, resulted in a temporary decline in domestic activity, while the government's budget was stretched as the economic slowdown reduced tax revenues. Egypt also experienced significant capital outflows of more than $15 billion from March-April 2020 as investors pulled out of emerging markets in a flight to safety.[20]

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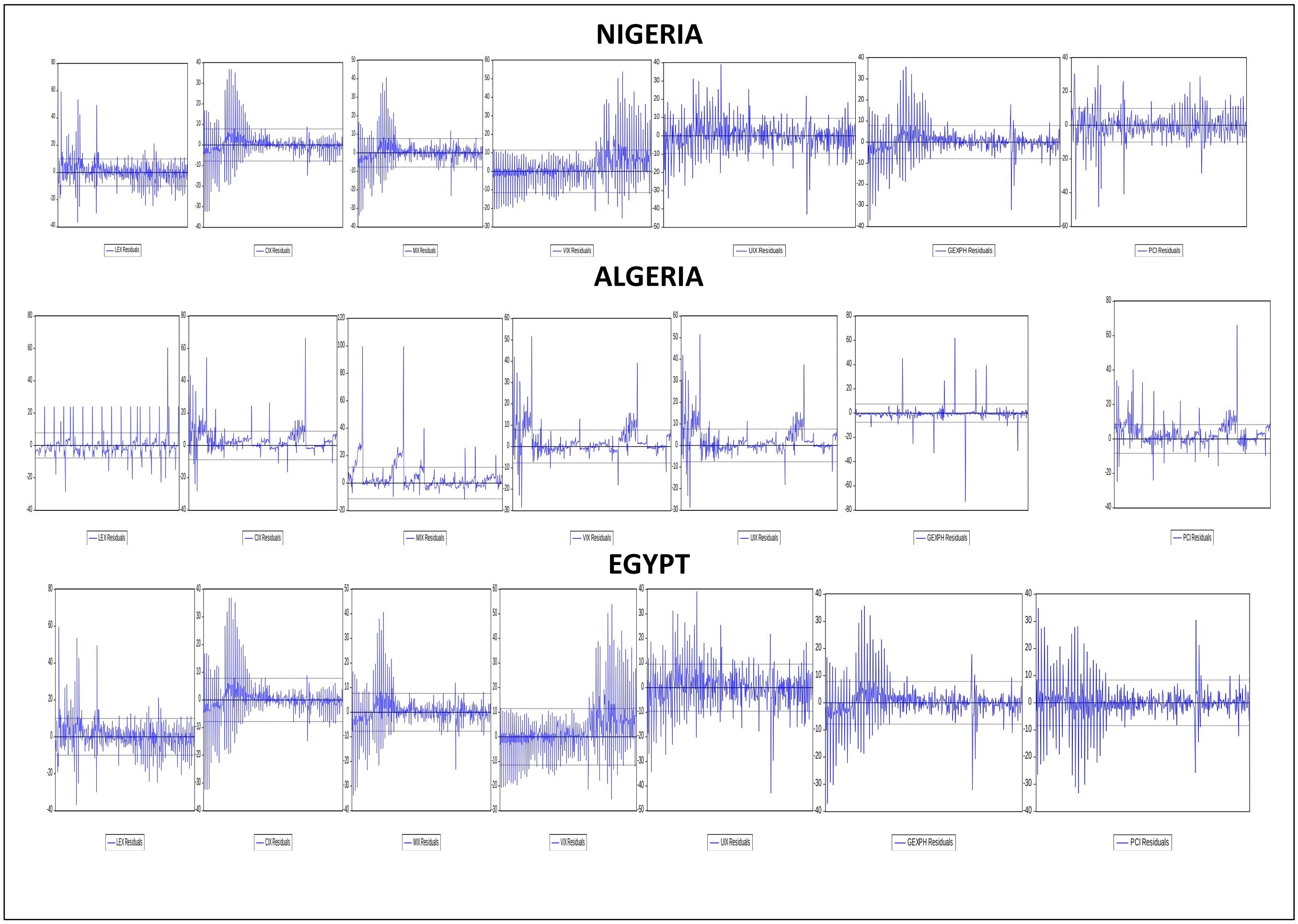

Figure 2: Summary of ARCH Effects Graphs

However, despite the economic hurt to the Egyptian economy, Egypt was one of the few emerging market countries that experienced a positive growth rate in 2020. As a result of the government's swift and prudent policy response, coupled with IMF support, the Egyptian economy showed resilience in the face of the pandemic. We deepened our investigation by using the Generalized Autoregressive Conditional Heteroscedasticity (GARCH (p, q)) model for analysis of the impact of the COVID-19 pandemic on life expectancy in Nigeria, Algeria and Egypt. Thus, before regressing our GARCH model, we ensured the existence of ARCH effects for all variables in the model for Nigeria, Algeria and also Egypt (see table 3 and figure 2 above). To effectively measure the impact of the COVID-19 pandemic on life expectancy in the aforesaid countries, we employed the following indicators – COVID Index (CIX), the Medical Index (MIX), the Vaccine Index (VIX) and the COVID-19 Uncertainty Index (UIX) to effectively measure the shocks of COVID-19. In addition, we equally used life expectancy (% of total) to measure life expectancy and control for government expenditure on health (GEXPH) and personal income (PCI). We find that the sum of and is slightly close to one (0.924572, 0.983670, and 0.981472) for the models in Nigeria, Algeria, and Egypt, indicating that the stability conditions of the conditional variance specification are satisfied by the models, which means that the unconditional variance of the error terms of the models is stationary.

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Table 4: GARCH (1, 1) Dep. Var.: LEX

Variable	NIGERIA Dep. Var.: LEX	ALGERIA Dep. Var.: LEX	EGYPT Dep. Var.: LEX
LEX (-1)	0.436***	0.601***	0.010***
	[0.002]	[0.027]	[0.0003]
CIX	-0.622***	-0.499**	-0.0485***
	[0.003]	[0.165]	[0.00009]
MIX	-13.835***	-0.167	13.38***
	[0.041]	[0.157]	[0.008]
VIX	0.0319***	-0.214**	0.0010
	[0.004]	[0.027]	[0.0005]
UIX	-0.029***	-0.894***	-0.002***
	[0.004]	[0.061]	[0.0005]
GEXPH	12.87***	0.579**	-12.39***
	[0.042]	[0.178]	[0.007]
PCI	-0.113***	0.988***	0.0008***
	[0.025]	[0.056]	[0.0001]
Residual	Resid(-1)^2= b_1 = 0.117	Resid(-1)^2= b_1 = 0.273	Resid(-1)^2= b_1 = 0.062
	GARCH(-1)= θ_1 = 0.807	GARCH(-1)= θ_1 = 0.711	GARCH(-1)= θ_1 = 0.919

Where ***, **, and * represents the 1%, 5% and 10% level of significance. [.], represents the standard error, {.} represents the T-statistic, and (.) represents the probability values.

For Nigeria, the COVID index (CIX) depicted a significant negative impact on life expectancy, implying that the COVID-19 shocks have total volatility of 9% on the life expectancy of Nigerians. Similarly, the health index also has a negative and significant impact on life expectancy in Nigeria. It further suggests that the medical indices that measure all medical efforts made by the Nigerian government to limit the shocks of COVID-19 and the fluctuation of the exchange rate in the life expectancy of Nigerians by 13%. In contrast, the vaccine index has a positive impact on the life expectancy of Nigerians. This means a 3% volatility in the life expectancy of Nigerians during the COVID-19 era. Findings from the COVID-19 Uncertainty Index – which includes economic, socio-psychological and health uncertainties due to the portrayed negative impact of COVID-19 on life expectancy in Nigeria at 2%. Finally, the control variables – government expenditure on health (GEXPH) and personal income (PCI) have positive and negative impacts on life expectancy in Nigeria. This means that they account for about 12% and 11% of the variation in life expectancy during the COVID-19 era in Nigeria.

Moreover, in Algeria, the measures related to the COVID-19 shocks – CIX, MIX, VIX and UIX have negative effects on life expectancy in Algeria. This means that the COVID Index, the Medical Index, the Vaccination Index, and the COVID-19 Uncertainty Index caused Algerian life expectancy to fluctuate by 49%, 16%, 21%, and 89%, respectively, during the COVID-19 era. We also observed that government expenditure on health (GEXPH) and personal income (PCI) account for about 98% and 57% of the variation in the life expectancy of Algerians, respectively. In the context of Egypt, the COVID Index, the COVID-19 Uncertainty Index and government spending on health hurt life expectancy. This means that they cause about 4%, 1% and 12% volatility in life expectancy in Egypt during the COVID-19 era. Conversely, the health index, vaccine index, and personal income have a positive impact on Egyptian life expectancy, accounting for a total of 13%, 9%, and 7% of the variation in life expectancy in Egypt during the COVID-19 era.

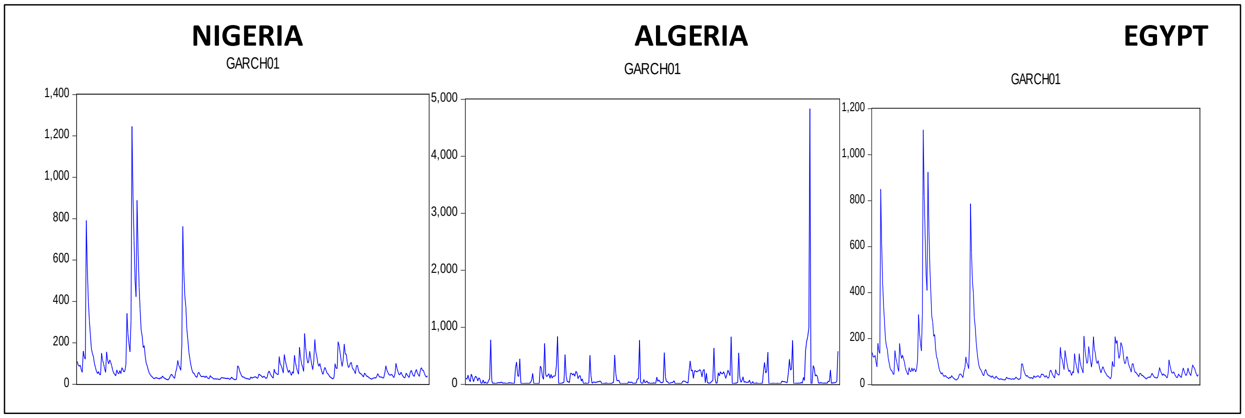

Figure 3: GARCH graphs

We further plotted the GARCH graphs, which is a residual graph for each of the country's GARCH models to further investigate the nature of volatility in the series. Findings however show that the COVID-19 pandemic has great volatility on the life expectancies of Nigerians, Algerians, and Egyptians. These findings however tallied with previous empirical studies by scholars such as (1 2, 4, 6, 8, 9, 7, 10, 11, 12, 17, 13, 16 and 15) among others.

Discussion

The study explores the impact of Covid-19 on life expectancy in African countries like Nigeria, Algeria, and Egypt using the GARCH approach. It found that volatility in life expectancy was highest during lockdowns, health interventions, and economic disturbances. Nigeria exhibited the highest volatility, a pattern seen in many developing nations where economic vulnerabilities intensified the pandemic's effects. Nigeria experienced a 62% reduction in life expectancy due to the COVID-19 Index (CIX) and an additional 13.8% decline due to the Medical Index (MIX). This is consistent with studies, which show the strain on healthcare systems during the pandemic, especially in countries with pre-existing medical infrastructure challenges (7) The slight 3% increase in life expectancy due to the Vaccine Index (VIX) in Nigeria highlights the importance of vaccination campaigns. Algeria, on the other hand, experienced less volatility but still faced significant challenges, with the CIX and COVID-19 Uncertainty Index causing life expectancy reductions of 49% and 89%, respectively. However, Algeria saw a positive response from government interventions, with government health expenditure (GEXPH) and personal income (PCI) positively influencing life expectancy. This aligns with studies from Tunisia and Egypt (10), where effective government spending on healthcare and social safety nets played a critical role in mitigating the pandemic's adverse effects.

Egypt experienced a mixed response to the COVID-19 pandemic, with CIX and UIX contributing to reduced life expectancy. However, government expenditure and personal income positively influenced life expectancy, offsetting some negative impacts. Egypt's volatility in medical and vaccine indices reflected the delicate balance between public health initiatives and economic challenges. Vaccine campaigns helped mitigate some health risks, but their overall impact remained limited due to broader economic instability. The GARCH (1,1) model confirmed significant volatility across all three countries, with Nigeria experiencing the highest levels. This is consistent with studies indicating that developing economies, particularly those with less diversified economic structures and weaker healthcare systems, faced the brunt of the pandemic's effects (5). Government interventions were critical in addressing immediate health concerns but were not sufficient to prevent the economic fallout from significantly impacting life expectancy.

Strengths and Limitations of the study

A key strength of this study is the use of daily data, which provides valuable, high-frequency insights into how the COVID-19 pandemic has influenced life expectancy in Nigeria, Egypt, and Algeria. The research adopts a detailed methodology, incorporating indices such as the COVID Index (CIX), Medical Index (MIX), Vaccine Index (VIX), and COVID-19 Uncertainty Index (UIX) to capture the pandemic's various dimensions effectively. Additionally, the GARCH (1,1) model was employed to examine volatility in life expectancy,

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offering deeper analytical insights. Nevertheless, the study has certain limitations. Its focus on Nigeria, Egypt, and Algeria constrains the generalizability of the findings to other emerging markets. Moreover, although the research spans the period from December 2019 to April 2021, the ongoing pandemic suggests that its long-term effects on life expectancy may not yet be fully captured. The study also lacks comprehensive data on rural areas, which represent a significant share of the population, potentially resulting in an incomplete assessment of the pandemic's overall impact on life expectancy.

Implications of the findings

The findings present significant insights for policymakers in Nigeria, Egypt, and Algeria. They underline the essential role of governmental efforts, such as health policies and vaccination drives, in reducing the negative impact of the COVID-19 pandemic on life expectancy. However, the study also points to the need for more targeted measures, particularly in rural areas where healthcare services and income levels remain insufficient. Strengthening healthcare systems and improving economic conditions through increased government health spending and fostering per capita income growth are shown to have a potential positive effect on life expectancy.

To improve life expectancy, the governments of Nigeria, Egypt, and Algeria should introduce targeted policies. While medical and vaccination initiatives were implemented during the COVID-19 pandemic, they did not reach rural regions, where more than 70% of the population resides. Effective public education about COVID-19 symptoms is crucial for controlling the spread of the virus. Furthermore, enhancing living conditions and increasing per capita income are vital. This can be accomplished by offering financial assistance to small and medium-sized businesses that have been hit hard by the pandemic, thereby creating job opportunities and lessening the pandemic's impact on people's lives.

Conclusion

This study investigated the impact of the COVID-19 pandemic on life expectancy in Nigeria, Egypt and Algeria using daily data from 31 December 2019 to 28 April 2021. We selected indices of COVID-19 that include the COVID Index (CIX), the medical index (MIX), the vaccine index (VIX) and the COVID-19 uncertainty index (UIX) as proposed by Narayan et al. (2021) to measure the impact of the COVID-19 pandemic. Similarly, we also measured life expectancy (LEX) using life expectancy (% of total) and controlled for government expenditure on health (GEXPH) and per capita income (PCI). A preliminary analysis was performed on the data in other to understand the nature of the data used. The data set was tested for normality and stationarity and all assumptions were met before modelling. In addition, we discovered GARCH effects before estimating the GARCH model. Thus, the result of the GARCH (1,1) model shows that the COVID-19 pandemic has high volatility on life expectancy in Nigeria, Egypt and Algeria. The results of the COVID-19 index (CIX) showed a negative significant effect on life expectancy. This is related to the fact that the COVID-19 uncertainty index (UIX) has a negative, insignificant effect on life expectancy. Other measures such as the medical index (MIX), vaccine index (VIX), government expenditure on health (GEXPH) and per capita income (PCI) have positive and significant effects on life expectancy in Nigeria, Egypt and Algeria. Finally, the summation of α and β – the residual squared coefficients and the GARCH lag value is (0.962837), which is not up to one and this shows that the stability conditions of the conditional variance specification are satisfied by the model.

Declarations

Authors' Contribution: The authors contributed equally to the conceptualization and development of the research. All authors have reviewed and approved the final manuscript.

Conflict of interest: The authors declare that there are no conflicts of interest regarding the publication of this article.

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