



The Interplay of Economic, Environmental, and Political Factors on Life Expectancy in Somalia

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ABSTRACT

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Life expectancy in Somalia remains critically low due to the complex interplay of economic, environmental, and political factors. This study aims to examine the determinants of life expectancy in Somalia from 1985 to 2022. Using the Autoregressive Distributed Lag (ARDL) model and VECM Granger causality tests, the analysis incorporates GDP, income inequality, CO₂ emissions, institutional quality, and internal conflict as key explanatory variables. The ARDL bounds test confirms a long-run cointegration relationship among these factors. The results reveal that GDP has a positive and significant impact on life expectancy (coefficient = 0.0675, $p = 0.0163$), while income inequality (-27.582, $p = 0.0257$) and CO₂ emissions (-0.176, $p = 0.0324$) negatively affect life expectancy in the long run. Additionally, weak institutional quality (-2.187, $p = 0.000$) and internal conflict (-0.103, $p = 0.002$) significantly reduce life expectancy. The error correction term is negative and highly significant (-1.536, $p = 0.000$), indicating a strong adjustment toward equilibrium. The study concludes that fostering inclusive economic growth, improving governance, reducing inequality, and addressing environmental degradation are essential to improving life expectancy in Somalia.

1. INTRODUCTION

Life expectancy is a crucial indicator of a nation's overall health and development, reflecting the quality of healthcare, economic prosperity, and social stability [1]. In many countries, economic growth, environmental sustainability, and political stability play a decisive role in shaping public health outcomes. While higher GDP per capita is often linked to improved access to healthcare, nutrition, and sanitation [2], income inequality can limit these benefits by restricting essential services for lower-income groups [3]. The relationship between economic growth and life expectancy is well-documented; however, studies indicate that beyond a certain income threshold, unequal distribution of wealth negates the benefits of economic progress [4, 5]. Environmental factors such as CO₂ emissions and pollution have also been shown to negatively impact life expectancy, with air pollution contributing to an estimated 8.7 million premature deaths globally in 2018 [6]. Furthermore, political instability and weak institutional frameworks exacerbate health disparities by disrupting essential public health services and limiting access to healthcare [7, 8]. Somalia, a fragile state with a history of armed conflict, economic instability, and climate-related challenges, presents a unique case where these factors intersect in complex ways to shape health outcomes.

Existing research on the determinants of life expectancy has primarily focused on developed economies, where strong institutions and stable governance support long-term public

health improvements [9]. However, in conflict-affected and economically fragile states like Somalia, the relationship between economic growth, environmental degradation, and political instability remains underexplored. While previous studies have found that GDP growth tends to increase life expectancy [10], Evidence suggests that in highly unequal societies, the benefits of economic growth are disproportionately distributed, leading to widening health disparities [11]. Additionally, although environmental factors, such as CO₂ emissions and climate change, are widely recognized as determinants of global mortality rates [12], their specific impact on Somalia's public health system remains unclear due to limited environmental data. Moreover, internal conflict and weak institutions in Somalia have repeatedly disrupted healthcare services, exacerbated poverty, and contributed to persistently high mortality rates [13]. Despite these challenges, few empirical studies have examined how these factors collectively influence life expectancy in Somalia, leaving a significant research gap.

This study aims to analyze the long-term impact of economic, environmental, and political factors on life expectancy in Somalia from 1985 to 2022. Specifically, it investigates the roles of GDP growth, income inequality, CO₂ emissions, internal conflict, and institutional quality in shaping health outcomes. By integrating these factors, the research seeks to determine whether their effects on life expectancy are immediate or long-term, offering valuable insights into how economic, environmental, and political

challenges interact to influence health trends in Somalia. Ultimately, the study aims to answer the central question: How do economic growth, environmental sustainability, and political stability collectively influence life expectancy in Somalia?

Understanding the key drivers of life expectancy is essential for policymakers, particularly in fragile states where economic, environmental, and political challenges converge. This study provides a comprehensive empirical analysis of Somalia's public health determinants, offering insights that can inform targeted policy interventions aimed at reducing mortality rates and improving health outcomes. The findings have direct implications for policy reforms, including strategies for reducing income inequality, strengthening healthcare infrastructure, implementing environmental regulations, and improving governance. Moreover, this study contributes to the broader literature by analyzing the role of political instability in determining life expectancy, a critical but often overlooked factor in economic research.

The remainder of the paper is structured as follows: Section 2 reviews relevant literature on the relationships between economic growth, environmental sustainability, political stability, and life expectancy. Section 3 outlines the methodology, detailing the data sources and econometric models used for analysis. Section 4 presents the results and discussion, while Section 5 provides conclusions and policy implications based on the study's findings.

2. LITERATURE REVIEW

2.1 Economic factors (GDP and income inequality) and life expectancy

Empirical studies show a positive relationship between GDP and life expectancy, especially in low-income countries, where economic growth improves access to healthcare, nutrition, and sanitation [4]. However, this effect diminishes in high-income countries, where income inequality becomes a major determinant of health outcomes [3]. Countries like Japan achieve high life expectancy through strong healthcare systems despite lower GDP per capita, while the U.S. suffers from lower life expectancy due to high inequality [14, 15].

In developing regions, GDP growth enhances life expectancy but often benefits the wealthy more, with inequality limiting broader health gains [16, 17]. Sub-Saharan Africa faces compounded challenges from low GDP, inequality, and poor health infrastructure, resulting in persistently low life expectancy [18, 19]. Somalia represents an extreme case where conflict, poverty, and weak governance undermine the impact of economic growth on health, despite some positive effects [10, 20]. Overall, income distribution and institutional quality critically shape the GDP–life expectancy link.

2.2 Environmental factor (CO₂ emissions) and life expectancy

Empirical evidence shows that CO₂ emissions significantly harm human health by contributing to air pollution, climate-related disasters, and food insecurity [21]. The Environmental Kuznets Curve (EKC) suggests that environmental degradation initially rises with economic growth but declines as countries adopt cleaner technologies [22]. However,

developed nations remain major CO₂ emitters, where emissions still pose health risks despite technological advances and strong environmental policies [12, 23, 24].

In developing countries, economic growth often comes with higher CO₂ emissions, worsening air quality, and reduced life expectancy [25, 26]. Studies in China, India, and ASEAN countries reveal that emissions are linked to rising respiratory and cardiovascular diseases [27, 28]. Additionally, climate change-driven food insecurity and disease outbreaks further threaten health outcomes, especially in rural areas [29, 30].

Sub-Saharan Africa, while contributing minimally to global emissions, suffers disproportionately from their impacts. Climate-induced droughts, food insecurity, air pollution from biomass use, and the spread of infectious diseases like malaria significantly lower life expectancy in the region [31–34]. Overall, the findings underscore that CO₂ emissions adversely affect life expectancy worldwide, with developing and vulnerable regions facing the greatest risks.

2.3 Political factors (internal conflict and institutional quality) and life expectancy

Empirical studies consistently show that internal conflict and institutional quality are critical determinants of life expectancy. Internal conflicts disrupt healthcare systems, displace populations, and divert resources from public health, leading to increased mortality and lower life expectancy [7, 8]. Evidence from OECD and emerging economies indicates that conflict significantly reduces life expectancy, with women often disproportionately affected [35, 36].

Strong institutions mitigate these effects by ensuring equitable resource distribution and effective service delivery [37]. Countries with high institutional quality, like New Zealand and Costa Rica, maintain higher life expectancy even amid economic or health crises [38, 39]. Conversely, weak institutions, as seen in Venezuela, Syria, and Nigeria, exacerbate health challenges, contributing to declining life expectancy [40–42].

Sub-Saharan Africa faces compounded challenges of weak institutions and frequent conflicts, which severely undermine health outcomes, particularly among women and children [43, 44]. In Somalia, improving institutional quality has shown positive effects on environmental conditions and indirectly on health outcomes [45]. Overall, the evidence highlights that stable governance and strong institutions are essential for improving and sustaining life expectancy in both developed and developing regions.

3. METHODOLOGY

3.1 Data and sources

This study examines the factors influencing life expectancy in Somalia from 1985 to 2022, a period marked by significant historical, political, and socio-economic changes that have shaped public health. The late 1980s saw the onset of political unrest, culminating in the 1991 civil war and the subsequent collapse of the state, which severely disrupted healthcare services. Recurrent famine crises (1992, 2011, 2017, and 2022), disease outbreaks, and widespread malnutrition further exacerbated mortality rates. However, from the early 2000s onward, the expansion of private healthcare, increased NGO interventions, and gradual political stabilization contributed to

improved healthcare access. Additionally, economic, political, and environmental factors have played a crucial role in shaping life expectancy trends. This period is well-documented by global organizations such as the WHO, World Bank, and UN, ensuring reliable data for analysis. Prior to 1985, no comprehensive life expectancy data existed for Somalia, making this the logical starting point for the study.

The choice of this topic is driven by the need to understand the multi-dimensional factors influencing life expectancy in Somalia, a country that has faced decades of economic struggles, political instability, and environmental challenges. Existing research often focuses on isolated determinants, but this study integrates economic (GDP, income inequality), political (internal conflict, institutional quality), and environmental (CO₂ emissions) factors to provide a holistic analysis.

GDP is chosen as a variable impacting life expectancy in Somalia because higher GDP is often associated with better healthcare infrastructure, improved nutrition, and access to essential public services, all of which contribute to longer life expectancy [46]. Studies [47-50] highlight how economic development enhances public health outcomes by increasing government investment in healthcare.

Income inequality is chosen as a variable impacting life expectancy in Somalia because high income inequality limits access to healthcare, education, and proper nutrition, disproportionately affecting lower-income populations and increasing mortality rates. Wilkinson and Pickett [3] argued that greater income inequality leads to worse health outcomes and shorter life expectancy due to heightened social stress and reduced investment in public health. Additionally, previous studies have analyzed income inequality [51-53] as a key factor influencing life expectancy in both developed and developing countries, highlighting its significant role in public health disparities.

CO₂ emissions are chosen as a variable impacting life expectancy in Somalia because environmental degradation and climate change significantly affect public health, particularly in fragile states with weak healthcare systems. Rising CO₂ levels contribute to air pollution, extreme weather events, and food insecurity, all of which increase mortality rates. Lelieveld et al. [6] highlighted that prolonged exposure to air pollution from CO₂ emissions is strongly linked to respiratory diseases, cardiovascular conditions, and premature deaths, especially among vulnerable populations. Furthermore, previous studies explored the impact of CO₂ emissions on life expectancy, reinforcing the connection between environmental factors and public health outcomes [54-56].

In the Somali context, the selection of CO₂ as the sole environmental indicator is driven by data limitations, as alternative environmental health indicators (e.g., particulate matter, air quality indices) are not consistently available for the full study period. CO₂ emissions are widely accepted in the literature as a proxy for broader environmental degradation, reflecting underlying industrial activity, deforestation, and fuel consumption. In fragile countries like Somalia, CO₂ emissions also correlate with indirect health risks through climate-induced challenges such as drought, water scarcity, and food insecurity, all of which are known to influence life expectancy.

Internal conflict is chosen as a variable impacting life expectancy in Somalia because prolonged violence and instability disrupt essential public services, destroy healthcare

infrastructure, and displace populations, leading to higher mortality rates. Ghobarah et al. [57] found that civil conflicts significantly increase disease burdens and reduce life expectancy due to weakened healthcare systems and lack of access to medical care. Similarly, Li and Wen [58] highlighted that conflict diverts government resources away from health and social welfare, worsening overall public health. Somalia's ongoing instability since the 1991 civil war has led to widespread displacement, famine, and inadequate medical services [59], making internal conflict a critical factor in understanding fluctuations in life expectancy.

Institutional quality is chosen as a variable impacting life expectancy in Somalia because strong institutions are essential for effective healthcare systems, public service delivery, and overall governance, which directly influence health outcomes [60]. Weak institutions often lead to corruption, mismanagement of healthcare resources, and inadequate policy implementation, worsening mortality rates [61]. Additionally, previous studies examined the impact of institutional quality on life expectancy [62, 63], highlighting its critical role in shaping public health outcomes.

The study's dependent variable, life expectancy (LE), was examined along with independent variables like the area's gross domestic product (GDP), Income inequality (INQ), Carbon dioxide emissions (CO₂), Internal conflict (IC), and Institutional quality (IQ). The life expectancy (LE) and CO₂ Emissions (CO₂) data were obtained from SESERIC, the Gross Domestic Product (GDP) data were obtained from World Development Indicators (WB), Income inequality (INQ) data were obtained from the World Inequality Database (WID), which provides the most consistent long-term data for Somalia from 1985 to 2022. Other databases, such as the World Bank or the UN, do not offer continuous inequality data for Somalia over this period. WID constructs inequality estimates based on national accounts and regional modeling when household survey data are missing, which is common for fragile states like Somalia. Internal conflict (IC) data were obtained from ICRG published by PRS, while the Institutional quality (IQ) data were obtained from Freedom House. All data relevant to different variables were acquired annually. Table 1 provides a thorough explanation of the variables used in the research, as well as their sources and data descriptions.

3.2 Econometric model specification

The Autoregressive Distributed Lag (ARDL) model, developed by Pesaran et al. [64], was employed to examine the short-run and long-run effects of the independent variables on life expectancy in Somalia. The ARDL model is particularly suitable when variables are integrated at I(0) or I(1), which is the case in this study, making it an appropriate choice for analyzing the relationship between the selected factors and life expectancy. It effectively addresses spurious regression issues by incorporating lag dynamics, which are essential for accurate modeling in non-stationary time series analysis [65]. The model is suited for comparing short-run and long-run elasticities for small samples based on OLS assumptions to examine the existence of cointegration between the components of interest [66].

The relationship between Economic, Political, and Environmental Factors on Life Expectancy was examined using the following functional model:

$$LE = f(GDP, INQ, CO_2, IC, IQ) \quad (1)$$

Table 1. Variable description and data source

Symbol	Variable	Measurement	Source
LE	Life Expectancy	Life Expectancy at Birth, Both Sexes	SESRIC
GDP	Gross Domestic Product	Gross Domestic Product (constant 2015 US\$)	World Development indicators (WB)
INQ	Income inequality	Gini coefficient of Post-tax national income, The coefficient is an index ranging from 0 to 1, with 0 meaning no inequality and 1 meaning perfect inequality	World Inequality Database (WID)
CO ₂	Carbon dioxide emissions	Total CO ₂ emissions (millions of metric tons)	SESRIC
IC	Internal conflict	It is assessment rating contains three components: (a) civil war/ coup threat, (b) terrorism/political violence, (c) civil disorder	ICRG published by PRS
IQ	Institutional quality	Composite index of political and civil rights	Freedom House

Sources: Computed by authors (2025)

To explore the long-term link between LE, GDP, INQ, CO₂, IC, and IQ, we employ the following equation derived from Eq. (1):

$$LE_t = \beta_0 + \beta_1 GDP_t + \beta_2 INQ_t + \beta_3 CO2_t + \beta_4 IC_t + \beta_5 IQ_t + \varepsilon_t \quad (2)$$

To get the direct Elasticities of coefficients and make the estimation process smooth, we use the logarithm of the variables, which helps in selecting appropriate time series models derived from Eq. (2):

$$LLE_t = \beta_0 + \beta_1 LGDP_t + \beta_2 LINQ_t + \beta_3 LCO2_t + \beta_4 LIC_t + \beta_5 LIQ_t + \varepsilon_t + \varepsilon_t \quad (3)$$

where, $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$, and β_5 are the slope coefficients, ε is the error term, t is the time period, and L is the logarithm function.

Eq. (3) may be reformulated as an ARDL expression as follows:

$$\begin{aligned} \Delta LLE_t = & \beta_0 + \sum_{j=0}^q \beta_1 \Delta LLE_{t-j} + \\ & \sum_{i=0}^p \beta_2 \Delta LGDP_{t-i} + \sum_{i=0}^p \beta_3 \Delta LINQ_{t-i} + \\ & \sum_{i=0}^p \beta_4 \Delta LCO2_{t-i} + \sum_{i=0}^p \beta_5 \Delta LIC_{t-i} + \\ & \sum_{i=0}^p \beta_6 \Delta LIQ_{t-i} + \alpha_1 LLE_{t-1} + \alpha_2 LGDP_{t-1} + \\ & \alpha_3 LINQ_{t-1} + \alpha_4 LCO2_{t-1} + \alpha_5 LIC_{t-1} + \\ & \alpha_6 LIQ_{t-1} + \varepsilon_t \end{aligned} \quad (4)$$

The symbol Δ represents the first difference operator, which is used to transform the variables into their short-run changes. LLE_t denotes life expectancy (measured by the natural logarithm of Life expectancy) at time t . The terms $LGDP$, $LINQ$, LCO_2 , LIC , and LIQ represent the lagged values of Gross Domestic Product, Income Inequality, Carbon dioxide emissions, internal conflict, and institutional quality, respectively. β_0 is the constant term in the model. The coefficients $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$, and β_6 capture the short-run effects of the independent variables on economic growth, while $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$, and α_6 represent the long-run coefficients, indicating the equilibrium relationship between the variables. Finally, ε is the error term, which accounts for random disturbances or unexplained variations in the model.

The short-run dynamic parameters are derived through the estimation of an error correction model (ECM). The details are outlined as follows:

$$\begin{aligned} \Delta LLE_t = & \beta_0 + \sum_{j=0}^q \beta_1 \Delta LLE_{t-j} + \\ & \sum_{i=0}^p \beta_2 \Delta LGDP_{t-i} + \sum_{i=0}^p \beta_3 \Delta LINQ_{t-i} + \\ & \sum_{i=0}^p \beta_4 \Delta LCO2_{t-i} + \sum_{i=0}^p \beta_5 \Delta LIC_{t-i} + \\ & \sum_{i=0}^p \beta_6 \Delta LIQ_{t-i} + \delta ECM_{t-i} + \varepsilon_t \end{aligned} \quad (5)$$

The term ECM_{t-i} represents the lagged error correction term, which captures the deviation from the long-run equilibrium in the previous period. It is derived from the long-run cointegration relationship estimated in the ARDL model. The coefficient δ measures the speed of adjustment, indicating how quickly the system returns to the long-run equilibrium following a shock. A negative and statistically significant value of δ signifies convergence to equilibrium, reflecting the economy's ability to correct deviations over time.

After validating the existence of long-run cointegration, we analyzed the VECM Granger causality to guarantee the reliability of our results. A series of diagnostic tests was conducted to validate the ARDL model. The Jarque-Bera test confirmed that the residuals were normally distributed, while the Breusch-Godfrey test indicated the absence of autocorrelation. Heteroskedasticity was assessed using the Breusch-Pagan-Godfrey test, which confirmed the absence of heteroskedasticity. Finally, the CUSUM and CUSUM of squares tests demonstrated the stability of the model's parameters, further reinforcing the reliability of our results.

4. RESULTS AND DISCUSSIONS

4.1 Descriptive statistics and correlation analysis

The descriptive analysis in Table 2 shows that life expectancy (LLE) has a mean of 3.91 with low variability (std. dev. 0.16), while GDP (LGDP) has the highest variability (std. dev. 0.61), indicating significant fluctuations in economic growth. Internal conflict (LIC) also exhibits notable variation (std. dev. 0.50), suggesting periods of instability. The correlation analysis indicates that GDP (0.472) positively correlates with life expectancy, implying that economic growth enhances well-being. However, internal conflict (-0.607) has a strong negative correlation with life expectancy, suggesting that instability reduces longevity. CO₂ emissions (-0.243) show a weak negative relationship with life expectancy, while income inequality (LINQ) and institutional quality (LIQ) have near-zero correlations, implying minimal direct influence.

Table 2. Descriptive and correlation analysis

Variables	LLE	LGDP	LINQ	LCO ₂	LIQ	LIC
Mean	3.90600	21.8285	-0.583	-0.453	1.9342	1.039
Median	3.925	21.65	-0.582	-0.485	1.945	1.098
Maximum	4.044	22.93	-0.580	0.003	1.945	1.945
Minimum	3.279	21.103	-0.587	-0.741	1.871	0.000
Std. Dev.	0.156	0.607	0.001	0.184	0.027	0.499
Observations	38	38	38	38	38	38
Correlation						
LLE	1					
LDGP	0.472	1				
LINQ	0.027	-0.045	1			
LCO ₂	-0.243	-0.163	-0.756	1		
LIQ	-0.045	0.404	-0.431	0.448	1	
LIC	-0.607	-0.678	0.003	0.140	-0.119	1

Sources: Computed by authors (2025)

4.2 Unit root tests

The unit root test results in Table 3 indicate the stationarity properties of the variables using both the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The lag length for ADF and PP tests was selected based on the Akaike Information Criterion (AIC), which optimizes the balance between model fit and complexity. This ensures that autocorrelation is addressed and the unit root tests are correctly specified. The results show that LLE and LINQ are stationary at the level, as their test statistics are significant at the 5% level or better, rejecting the null hypothesis of a unit root. This means that these variables are integrated of order zero, I(0). On the other hand, LGDP, LCO₂, LIQ, and LIC are non-stationary at the level but become stationary after first differencing, indicating that they are integrated of order one, I(1). These findings suggest that the variables exhibit mixed stationarity, making the ARDL bounds testing approach a

suitable method for analyzing long-run relationships among them.

4.3 Lag selection criteria

The lag length selection criteria presented in Table 4 provide different statistical measures to determine the optimal lag order for the model, including the Likelihood Ratio (LR) test, Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan-Quinn Criterion (HQ). Since the Akaike Information Criterion (AIC) is chosen as the selection criterion, the optimal lag length is determined based on the lowest AIC value. The lowest AIC value is -25.07115, which corresponds to lag 2. Therefore, based on the AIC criterion, the optimal lag length for the model is 2, meaning that two lags should be included in the econometric analysis to ensure proper model specification and capture the dynamic relationships among the variables effectively.

4.4 ARDL bound test

The F-Bounds Test results in Table 5 indicate strong evidence of a long-run cointegration relationship among the variables. The computed F-statistic (15.01018) is significantly higher than the upper bound critical values at all significance levels, including the 1% level (4.15). Since the F-statistic exceeds the upper bound, the null hypothesis of no cointegration is rejected, confirming that the variables move together in the long run. This justifies the estimation of a long-run ARDL model, allowing for an analysis of both short-run and long-run relationships between the dependent and independent variables.

Table 3. Unit root tests

VARIABLES	ADF			
	Level		First difference	
	Intercept	Trend and Intercept	Intercept	Trend and Intercept
LLE	-2.920856*	-3.817985**	-	-
LGDP	1.183600	-1.732125	-4.634739***	-5.012943***
LINQ	-3.002459**	-2.763216	-	-
LCO ₂	-1.670232	-1.029189	-3.765464***	-4.176928**
LIQ	-1.966131	-3.180645	-3.464102**	-3.507664*
LIC	-1.617121	-2.546210	-6.353284***	-6.277164***

VARIABLES	PP			
	Level		First difference	
	Intercept	Trend and Intercept	Intercept	Trend and Intercept
LLE	-3.054728**	-3.456964*	-	-
LGDP	0.909421	-1.387117	-4.695795***	-5.012943***
LINQ	-2.998738**	-2.966145	-	-
LCO ₂	-1.750763	-1.190091	-3.732716***	-4.097005**
LIQ	-2.096550	-2.220991	-5.830952***	-5.771365***
LIC	-1.755958	-2.641873	-6.343780***	-6.276000***

Notes: *, **, *** indicate significance at 10, 5, and 1 per cent, respectively

Sources: Computed by authors (2025)

Table 4. Lag length selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	290.0524	NA	5.65e-15	-15.78069	-15.51677	-15.68857
1	480.1261	306.2298	1.12e-18	-24.34034	-22.49290*	-23.69553
2	529.2807	62.80864*	6.39e-19*	-25.07115*	-21.64019	-23.87365*

Notes: * indicates lag order selected by the criterion

Table 5. F-bounds test

Bounds Test Critical Values			
F-Statistics	Significance	Lower bound	Upper bound
15.01018	10%	2.08	3
	5%	2.39	3.38
	2.5%	2.7	3.73
	1%	3.06	4.15

Sources: Computed by authors (2025)

4.5 Long-run and short-run estimates

The ARDL long-run coefficient estimates in Table 6 examine the impact of various factors on life expectancy (LE) in Somalia. The results show that economic growth (GDP) has a positive and significant effect (0.067522, $p = 0.0163$, CI: [0.016, 0.119]), indicating that higher GDP per capita contributes to improved life expectancy. This finding is consistent with Abdulrahman and Chawsheen [17], who reported that increases in per capita GDP significantly enhance life expectancy, particularly in upper-middle, lower-middle, and low-income countries, emphasizing its critical role in promoting better health in these economic contexts. Similar conclusions were drawn by researchers who also found a strong positive relationship between economic growth and life expectancy [48, 67, 68].

However, income inequality (LINQ) (-27.58248, $p = 0.0257$, CI: [-50.366, -4.800]) has a negative and significant impact, suggesting that greater income disparities reduce life expectancy in the long run. This finding is consistent with Sart et al. [69] who reported that income inequality negatively affects life expectancy in new EU member states. Similarly, SenGupta [11] found that income inequality has an adverse effect on life expectancy in African countries, further reinforcing the argument that economic disparities contribute to poorer health outcomes across different regions.

Carbon emissions (LCO₂) (-0.176244, $p = 0.0324$, CI: [-0.334, -0.018]) have a negative and significant impact on life expectancy, underscoring the detrimental health effects of environmental degradation. In the context of Somalia, rapid environmental degradation, including deforestation,

desertification, and pollution, has worsened air quality and increased health risks such as respiratory diseases, which contribute to lower life expectancy [70]. This finding aligns with Szymańska [71], who reported a statistically significant negative relationship between CO₂ emissions and life expectancy in 27 EU countries, and Khan et al. [72], who found similar results in developing nations.

Moreover, institutional quality (LIQ) (-2.187165, $p = 0.0000$, CI: [-3.056, -1.318]) and internal conflict (LIC) (-0.103137, $p = 0.0020$, CI: [-0.164, -0.042]) show strong negative effects, indicating that weak governance and persistent instability significantly reduce life expectancy in Somalia. In Somalia, decades of political instability, armed conflict, and weak governance have severely impacted public health services, displaced millions, and hindered access to clean water and sanitation, further exacerbating health crises and lowering life expectancy [73, 74]. This finding is consistent with Omosuyi [75], who found that poor institutional quality negatively affects life expectancy in Nigeria, and Alhiraki et al. [76], who reported that internal conflicts, such as the Syrian war, have led to a dramatic rise in mortality rates, significantly reducing life expectancy.

Table 6 shows that GDP has a positive and significant impact on life expectancy (0.0675, 95% CI: [0.016, 0.119]), confirming that economic growth improves health outcomes. Income inequality has a strong negative effect (-27.582, CI: [-50.366, -4.800]), meaning higher inequality reduces life expectancy. CO₂ emissions also have a negative and significant effect (-0.176, CI: [-0.334, -0.018]), highlighting the health risks of environmental degradation. Similarly, internal conflict (-0.103, CI: [-0.164, -0.042]) and weak institutional quality (-2.187, CI: [-3.056, -1.318]) reduce life expectancy. All key variables have confidence intervals that do not cross zero, confirming the robustness of the long-run results.

Overall, the findings suggest that economic growth enhances life expectancy, whereas income inequality, environmental degradation, weak institutions, and internal conflict significantly deteriorate health outcomes in Somalia over the long run.

Table 6. ARDL long-run coefficient estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.	95% Confidence Interval
LGDP	0.067522	0.026214	2.57577	0.0163	[0.013, 0.122]
LINQ	-27.58248	11.63103	-2.37146	0.0257	[-51.523, -3.641]
LCO ₂	-0.176244	0.077776	-2.26605	0.0324	[-0.334, -0.018]
LIQ	-2.187165	0.428250	-5.10721	0.0000	[-3.056, -1.318]
LIC	-0.103137	0.029854	-3.45477	0.0020	[-0.164, -0.042]
C	-9.390297	6.622558	-1.41792	0.1686	[-23.020, 4.240]

Sources: Computed by authors (2025)

Table 7. ARDL short-run coefficient estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.	95% Confidence Interval
D(LLE(-1))	0.753200	0.103270	7.29347	0.0000	[0.543, 0.963]
D(LCO ₂)	-0.016045	0.221093	-0.07257	0.9427	[-0.473, 0.441]
D(LCO ₂ (-1))	1.396242	0.222512	6.27492	0.0000	[0.943, 1.849]
D(LIC)	0.017782	0.039750	0.44734	0.6585	[-0.064, 0.100]
CointEq(-1)*	-1.536006	0.134567	-11.414	0.0000	[-1.811, -1.261]

Sources: Computed by authors (2025)

The ARDL short-run coefficient estimates in Table 7 analyze the short-term dynamics influencing life expectancy (LLE) in Somalia. The lagged dependent variable D(LLE(-1))

(0.753200, $p = 0.0000$) is positive and highly significant, indicating a strong persistence of life expectancy over time. Carbon emissions (D(LCO₂)) (-0.016045, $p = 0.9427$) have an

insignificant effect in the short run, but the lagged carbon emissions ($D(LCO_2(-1))$) (1.396242, $p = 0.0000$) are positive and significant, suggesting that the lagged CO_2 emissions in the short run may reflect the role of increased economic activities associated with higher emissions, such as energy use, construction, and manufacturing, which temporarily improve income, employment, and access to healthcare. However, the long-run negative impact confirms that these gains are unsustainable when environmental degradation persists. Internal conflict ($D(LIC)$) (0.017782, $p = 0.6585$) is statistically insignificant, indicating no immediate short-run impact on life expectancy. This finding contrasts with Li and Wen [58], who argue that intrastate conflict has a significant immediate negative effect on both male and female mortality rates, though they note that it does not have strong lingering effects. The error correction term $CoinEq(-1)$ (-1.536006, $p = 0.0000$, CI: [-1.811, -1.261]) is negative, significant, and greater than one in absolute value, confirming a strong adjustment process toward the long-run equilibrium. This suggests that deviations from the long-run relationship are corrected at a fast rate of 153.6% per period, implying a stable long-run relationship where shocks to life expectancy are quickly adjusted.

4.6 Diagnostics of estimated ARDL model

The diagnostic test results in Table 8 assess the validity and reliability of the estimated ARDL model. The serial correlation test yields an F-statistic of 0.837941 with a p-value of 0.3691, indicating that the model does not suffer from autocorrelation, meaning the residuals are uncorrelated over time. The heteroskedasticity test results in an F-statistic of 1.555321 with a p-value of 0.2211, suggesting that the variance of the errors is constant, meaning there is no heteroskedasticity issue. The normality test produces a test statistic of 0.648734 with a p-value of 0.722985, showing that the residuals follow a normal distribution. Since all p-values are above the conventional significance levels (1%, 5%, and 10%), the null hypotheses of no serial correlation, homoscedasticity, and normality cannot be rejected, confirming that the model satisfies the key diagnostic checks and is robust for inference and policy analysis.

In Figure 1, the CUSUM plot shows that the blue line consistently remains within the 5% significance thresholds (red dashed lines) throughout the sample period, indicating parameter stability. Similarly, in Figure 2, the CUSUM of Squares plot indicates that the squared residuals remain below critical bounds, indicating that the ARDL model is structurally stable.

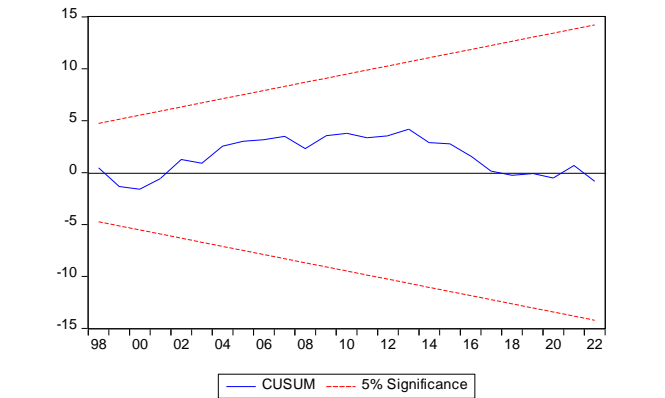


Figure 1. CUSUM test

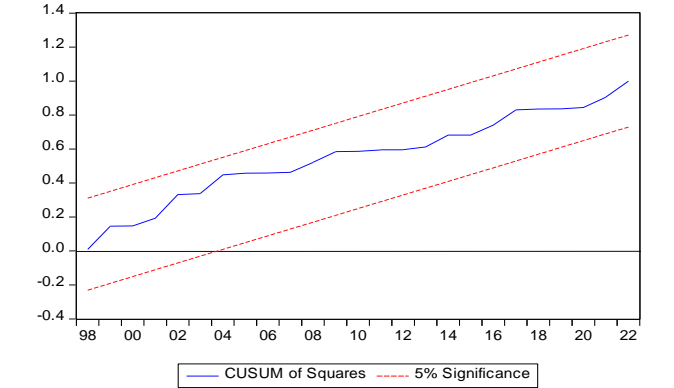


Figure 2. CUSM of square tests

Table 8. The results of diagnostic tests

Diagnostic Results		
	F-statistic	Prob.
Serial Correlation	0.837941	0.3691
Heteroskedasticity	1.555321	0.2211
Normality	0.648734	0.722985

Sources: Computed by authors (2025)

4.7 VECM Granger causality robustness checking

The Johansen cointegration test results presented in Table 9 confirm the presence of a long-run relationship among the variables. Both the Trace test and Maximum Eigenvalue test indicate the rejection of the null hypothesis of no cointegration at the 1% significance level, as the trace statistic (186.4629) and max-eigen statistic (67.41757) exceed their respective critical values, with p-values of 0.0000. The tests further suggest that there are three cointegrating equations, as indicated by significant test statistics up to "at most 2", after which the null hypothesis fails to be rejected (p-values above 0.05). This implies that the variables share a stable long-run equilibrium, meaning they move together over time.

Table 9. VECM Granger causality robustness checking

Hypothesized No. of CE(s)	Unrestricted Cointegration Rank Test (Trace)		Unrestricted Cointegration Rank Test (Maximum Eigenvalue)	
	Trace Statistic	Prob.**	Max-Eigen Statistic	Prob.**
None *	186.4629	0.0000	67.41757	0.0000
At most 1 *	119.0453	0.0000	61.20417	0.0000
At most 2 *	57.84113	0.0044	35.78028	0.0036
At most 3	22.06085	0.2951	15.59171	0.2496
At most 4	6.469137	0.6400	6.451765	0.5559
At most 5	0.017372	0.8950	0.017372	0.8950

Sources: Computed by authors (2025)

5. CONCLUSIONS AND RECOMMENDATIONS

Life expectancy in Somalia remains critically low due to the complex interplay of economic, environmental, and political factors. This study employs the Autoregressive Distributed Lag (ARDL) model to analyze the relationship between these factors and life expectancy in Somalia from 1985 to 2022. Descriptive statistics indicate a positive correlation between GDP and life expectancy, while internal conflict and CO_2 emissions have negative effects. Unit root tests reveal a mix of

stationary and non-stationary variables, justifying the use of the ARDL approach. The optimal lag length for capturing dynamic relationships is determined to be two. The ARDL bounds test confirms the existence of long-run cointegration among the variables, highlighting their sustained influence on life expectancy. Long-run estimates show that while GDP significantly increases life expectancy, income inequality, CO₂ emissions, weak institutional quality, and internal conflict reduce it. In the short run, past CO₂ emissions appear to have a positive effect on life expectancy, whereas internal conflict has no immediate impact. Diagnostic tests confirm the model's reliability, showing no issues related to serial correlation, heteroskedasticity, or non-normality, while stability tests validate the consistency of the estimated parameters. Additionally, the VECM Granger causality test supports the presence of long-run relationships, reinforcing the idea that economic, political, and environmental factors collectively shape life expectancy trends in Somalia.

To improve life expectancy in Somalia, policymakers should prioritize inclusive economic growth by investing in healthcare infrastructure, social services, and equitable income distribution to mitigate the negative effects of income inequality. Strengthening governance and institutional quality is essential for enhancing public health services and ensuring effective policy implementation. Addressing environmental degradation through stricter regulations on CO₂ emissions, promoting renewable energy, and adopting climate adaptation strategies will help mitigate health risks associated with pollution. Furthermore, efforts to resolve conflicts and promote political stability should be reinforced to reduce the adverse impact of instability on healthcare systems and overall well-being. International partnerships should also be leveraged to support healthcare capacity building, while targeted social policies should focus on vulnerable populations to ensure equitable access to essential services.

Despite its contributions, this study has certain limitations. First, it relies on annual time-series data, which may not fully capture short-term fluctuations or seasonal variations in the determinants of life expectancy. Second, the analysis focuses on macro-level indicators such as GDP, CO₂ emissions, income inequality, and institutional quality, while micro-level factors like healthcare accessibility, dietary patterns, and disease prevalence are not explicitly considered. Additionally, while the ARDL model effectively analyzes both short-run and long-run relationships, it does not fully address potential endogeneity issues, which could affect the causal interpretations of the findings.

For future research, scholars could examine disaggregated regional data to assess variations in life expectancy across different parts of Somalia, taking rural-urban disparities into account. Expanding the scope to include healthcare system efficiency, nutritional factors, and disease prevalence could provide a more comprehensive understanding of health outcomes. Moreover, employing alternative econometric techniques, such as Structural Equation Modeling (SEM) or machine learning approaches, could enhance the robustness of the results and offer deeper insights into the complex determinants of life expectancy in Somalia.

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