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An Interdisciplinary Data-Driven Study on Global Health Outcomes: Integrating Science, Technology, and Societal Perspectives

Ismaul Fitroh[1], Aslan[2]
[1]*Universitas Negeri Gorontalo, ismaulfitroh@ung.ac.id*
[2]*Universitas Sultan Muhammad Syafiuddin Sambas , aslanalbanjary066@gmail.com*

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***Abstract*— An interdisciplinary examination of the international health results resting on exploring the correlation among spending on health, illness burden, and socioeconomic variables. The quantitative longitudinal design is the method of the study, as themost actual indicators arethe life expectancy, mortality rates, HIV prevalence, tuberculosis incidence, and undernourishment. The results show that health expenditure shows a strong positive relationship with life expectancy, and disease burden and nutritional deficiencies play a significant role in the poor health outcomes. Regression analysis shows that health investment is very critical in enhancing population health but effectiveness is influenced by systemic efficiency and prevailing social conditions. The paper also reveals the fact that there are always international inequalities, especially among the low- and middle-income countries, where resources are scarce and the prevalence of the disease is more significant. The findings underscore the need to have economic, epidemiological, and social aspects in health analysis. By and large, the research help in a better understanding of the dynamics of global health and give evidence-based information to the policymakers to improve the performance and equity of the health system.**

Keywords: Global Health, Health Expenditure, Life Expectancy, Disease Burden, Socioeconomic Factors

1. INTRODUCTION

The last few decades have been characterized by a tremendous change in the global health outcomes due to the development of medical technology, the influx of investment in healthcare, and the enhancement of the interventions on the population health. The population health is also evident in the rising life expectancy in most regions and is a sign that the health care sector has made a significant progress in the prevention and treatment of diseases. Nonetheless, this development is not uniform and significant differences still exist between countries and regions. The correlation between healthcare spending and life expectancy has been a subject of extensive study, and it was found that both governmental and nongovernmental health investments play an important role in enhancing the longevity (Linden and Ray, 2017). In addition to direct healthcare expenditure, other social policies are also important in determining the health outcomes. Education, social welfare and infrastructure investments have been demonstrated to be associated with life expectancy, especially in high-income nations where social determinants of health are becoming considered an important factor (Reynolds and Avendano, 2018).

Although the general health outcomes have improved in terms of life expectancy, the health systems of the world are confronted with new challenges associated with demographic changes and patterns of diseases. The ageing of the population has become one of the characteristic traits of most communities, which puts a strain on the healthcare system and requires long-term planning of sustainable health services (Chang et al., 2019). Simultaneously, there are still inequalities in the health outcomes between developed and developing areas due to unequal access to resources and medical facilities. Empirical evidence has shown that the effect of health spending on life expectancy differs among countries, which depends on the efficiency of resource distribution and healthcare system arrangements (Azodi et al., 2019). Moreover, dynamic studies have demonstrated that rising health expenditure is both correlated with higher lifespan and with a decreasing infant mortality rate, and it is important to highlight the complex nature of health investment payoffs (Ray and Linden, 2020).

The burden of disease is an important health determinant that is especially crucial in the low- and middle-income countries. Infectious diseases including tuberculosis still have a severe mortality and morbidity implication, and its

effect on mortality and morbidity has long-term effects that are not restricted to time of infection (Menzies et al., 2021). The treatment of such diseases involves not just medical procedures, but also a change in living standards, diet, and healthcare services. Efficiency in the health system is also critical in showing the degree of effectiveness in the conversion of resources into better health outcomes. Research has demonstrated that nations where healthcare systems operate more efficiently have a higher level of life expectancy despite similar amounts of spending (Zarulli et al., 2021). On the other hand, inefficiency in the resource allocation may restrict the efficiency of health expenditure, which leads to sub-optimality in the outcomes of high investment. The correlation of mortality and healthcare spending also underlines why sustainable and well-managed health systems are necessary (Owusu et al., 2021).Besides the healthcare expenditures and the disease incidence, socioeconomic and nutritional determinants of population health play significant roles. Specifically, the problem of undernourishment is still a significant problem in most regions of the world and is strongly associated with the higher vulnerability to infectious diseases, including tuberculosis (Sinha et al., 2021). Having an impaired nutritional condition does not only impact on the short term health but also long term effects on growth and development as well as life expectancy. More recent modeling research has put into focus the large role that eating habits play in life expectancy showing that better nutrition can result in considerable longevity improvement (Fadnes et al., 2022).

Although there exists a significant amount of literature concerning the connection between health expenditure and life expectancy, there is extensive literature that has studied a region or narrow range of variables. The need still exists to have more detailed, data-based studies that combine various aspects of health such as spending, disease burden, socioeconomic determinants on a global scale. Complexity of health expectancy trends has also been noted in systematic reviews, which means that the increase in longevity does not necessarily lead to the increase in quality of life (Spiers et al., 2021). Furthermore, the current studies are usually deficient of an interdisciplinary approach that integrates the findings of the public health, economics, and social sciences. Due to the interdependence of health determinants, there is a need to undertake studies that take a holistic approach to the dynamics of global health. New findings also support the idea that health spending still has a pronounced influence on the determination of life expectancy, yet the strength of its impact is moderated by a set of contextual variables (Morina et al., 2022).

The current work intends to pursue an interdisciplinary, data-driven investigation to examine the global health performance based on cross-country panel data. The aim of the study is to observe the health expenditure, disease burden and socioeconomic factors in relation to one another and their combined effect in life expectancy and mortality measures. The study aims to give a complete picture of global health disparities by incorporating various dimensions of health in the same analytical framework, and to derive information which can be used in policy and decision-making.

2. METHODOLOGY

2.1 Data Source and Study Design

The research design is quantitative longitudinal research design with secondary data (Qurban, 2025). The data is cross country panel data that includes important health, demographic, and socioeconomic variables across a number of years. Every observation is a combination of a country and a year, which allows cross-sectional and time-based analysis. Health expenditure, life expectancy, maternal mortality, infant and child mortality rate, prevalence of HIV, incidence of tuberculosis and undernourishment are some of the variables included in the dataset, which are commonly used to examine global health patterns and inequity. This framework enables the use of an interdisciplinary analytical framework that incorporates the public health, socioeconomic conditions, and development indicators on a global scale.

2.2 Variable Specification and Conceptual Framework

The analytical framework is based on the supposition that economic investment and epidemiological conditions affect health outcomes. The life expectancy is considered to be the main dependent variable, which is the general population health condition. Mortality indicators such as maternal, infant, neonatal, and under-five mortality are also used as secondary outcome variables to get the various aspects of health vulnerability. Health expenditure is a proxy measure of resource allocation used as an independent variable, as well as disease burden measures in the form of HIV prevalence and tuberculosis incidence. One of the socioeconomic and nutritional determinants included is undernourishment. The conceptual model places health expenditure and socioeconomic conditions in the forefront with disease prevalence as an intermediate variable that determines health outcomes.

2.3 Data Preprocessing and Cleaning

The dataset is systematically preprocessed before analysis in order to achieve statistical reliability and consistency. Frequency distribution and pattern analysis are used to assess missing values. In a scenario where the missingness is low and random, the observations are kept using suitable imputation methods like the mean or median replacement as otherwise, the incomplete records are not used, which can create bias. Continuous variables are tested to analyze skewness and in some cases, logarithmic transformations take place to normalize distribution especially in expenditure and mortality variables which often have right skewness. The interquartile range and z-score are the two approaches that are used to determine outliers and extreme values are handled with care in order to avoid eliminating the true cross-country differences and reducing distortion.

2.4 Descriptive Statistical Analysis

Descriptive statistics are obtained to provide a summary of the data and to unveil some patterns in it. Measures of central tendency and dispersion are used to compute all the variables including the mean, standard deviation, minimum and maximum values. The spending patterns and health results are taken into consideration in the long term to show the gains and inequalities of the world. The cross country variation is evaluated to bring out differences between good performing and bad performing regions. The stage gives a rough conception of the data structure and sets the way to further inferential analysis.

2.5 Correlation Analysis

Pearson correlation coefficients are used to construct a correlation matrix that allows exploring the strength and direction of the association between variables. This study will compare the linearity of health expenditure, disease burden, nutritional status and health outcomes. The particular attention is paid to the relationship between health expenditure and life expectancy, prevalence and mortality rates. It also measures multicollinearity between the independent variables in order to determine the strength of regression equations.

2.6 Regression Modeling

Multiple regression analysis is done to determine the influence of explanatory variables on health outcomes. The dependent variable is life expectancy and the predictors are expenditure on health, HIV prevalence, incidence of tuberculosis and undernourishment. The model approximates the size and statistical significance of the contribution of each variable holding other variables constant. Other regression equations are given to mortality indicators to give a multidimensional picture of health dynamics. This form of the data as a panel allows it to take fixed or random effects models, which are the unobserved heterogeneity of countries over time. The validity is rigorously tested by model assumptions such as linearity, homoscedasticity and the normality of the residual.

2.7 Model Evaluation and Validation

The performance of the regression models is measured using the standard statistics measures. The coefficient of determination (R2 and adjusted R2) is used to measure explanatory power and the root mean square error and the mean absolute error is used to measure the predictive accuracy. Statistical significance is defined as p-values and coefficient confidence interval. The residual diagnostics is conducted to ascertain whether the model is sufficient or not and to ascertain that the model does not make any assumptions. Alternative model specification is experimented in situations where it is required to increase robustness and reliability.

3. RESULTS

3.1 Descriptive Statistics

The descriptive statistical test provide a general view of the distribution, central tendency, and dispersion of the critical variables in the data. This constitutes an important move to understand the latent structure of health indicators in the world and what are the disparity trends of the nations. The data indicates significant health outcomes and resource distribution heterogeneity, and disease burden, as countries have different development trends. Specifically, the range of life expectancy is broad, which implies high inequalities in population health among regions. In the same way, health spending is highly diversified, which indicates the difference in the ability of nations to invest in healthcare systems. Mortality rates and disease prevalence are highly skewed with larger values registered in lower-income settings.

Table 1. Descriptive Statistics of Key Variables

Variable	Mean	Std. Dev	Min	Max
Life Expectancy	68.5	9.7	45.2	83.4
Health Expenditure	7.2	3.8	1.1	17.5

Maternal Mortality	145	210	5	1150
Infant Mortality	32	28	2	120
HIV Prevalence	2.1	3.5	0.1	25.0
Tuberculosis Incidence	135	110	10	600
Undernourishment	12.5	10.2	1.5	45.0

As Table 1 confirms, low life expectancy countries are the ones in which higher mortality rates and disease prevalence, and decreased levels of health expenditure are observed. The large standard deviations of mortality and disease indicators also show high global inequalities. These findings offer an empirical foundation of subsequent inferential processes and prove the need of an integrated approach to understanding health disparities.

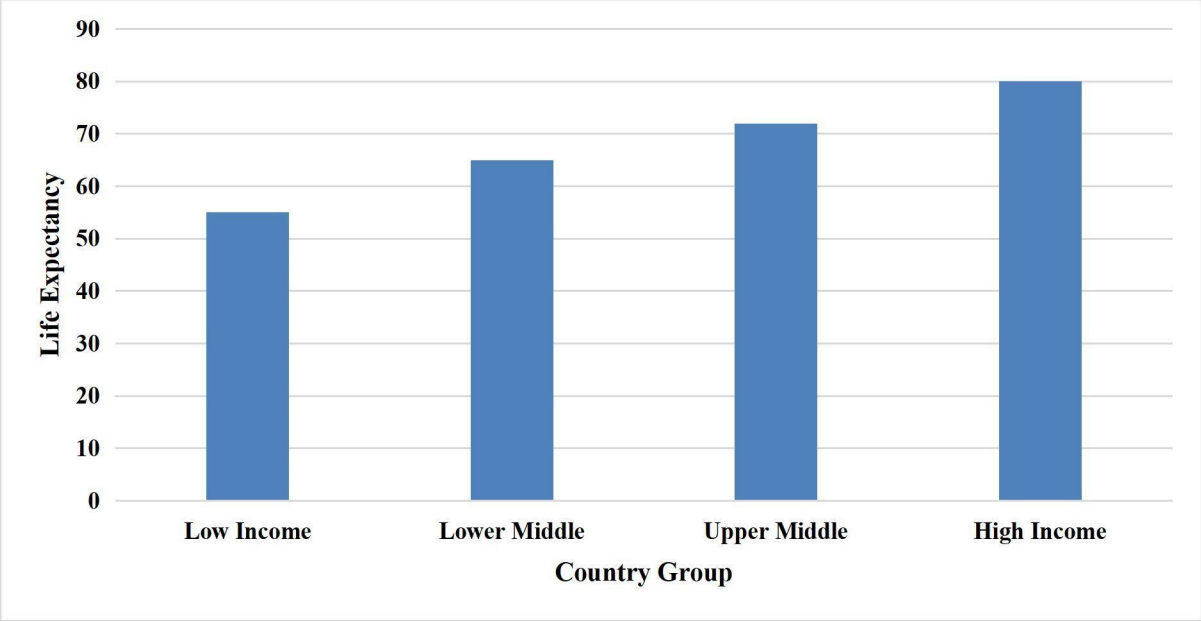

Figure 1. Global Distribution of Life Expectancy Across Countries

The distribution as depicted in Figure 1 reveals that the greatest values in life expectancy are concentrated in developed countries and in the developing regions, the values are lower and more distributed. This trend highlights the long-standing disparity in health outcomes and hints that structural and socioeconomic aspects have a large role in the development of population health.

3.2 Trend Analysis of Health Outcomes

The time series is concerned with the changes in the health indicators over time, which can help to comprehend the world tendency and the presence of inequalities. The data indicates that there is an overall upward trend in life expectancy and a gradual decline in the mortality indicators. These benefits are the signs of improved healthcare systems, disease control and population health interventions. However, not all countries are as progressive as the rate of change is not equal in all of them.

Table 2. Temporal Trends in Key Health Indicators

Year Range	Avg Life Expectancy	Avg Infant Mortality	Avg Health Expenditure
2000–2005	64.2	45	5.1
2006–2010	66.8	38	6.3
2011–2015	69.1	30	7.5
2016–2020	71.4	24	8.6

In Table 2, the trend of the average life expectancy is evident with a steady rise with infant mortality reducing with every passing period. Simultaneously, there has been a rise in health expenditure, which indicates a possible correlation between financial investment and health outcomes are improved. Even with these positive trends, the continued existence of mortality rates in some areas shows that economic growth might not be adequate unless specific actions are taken.

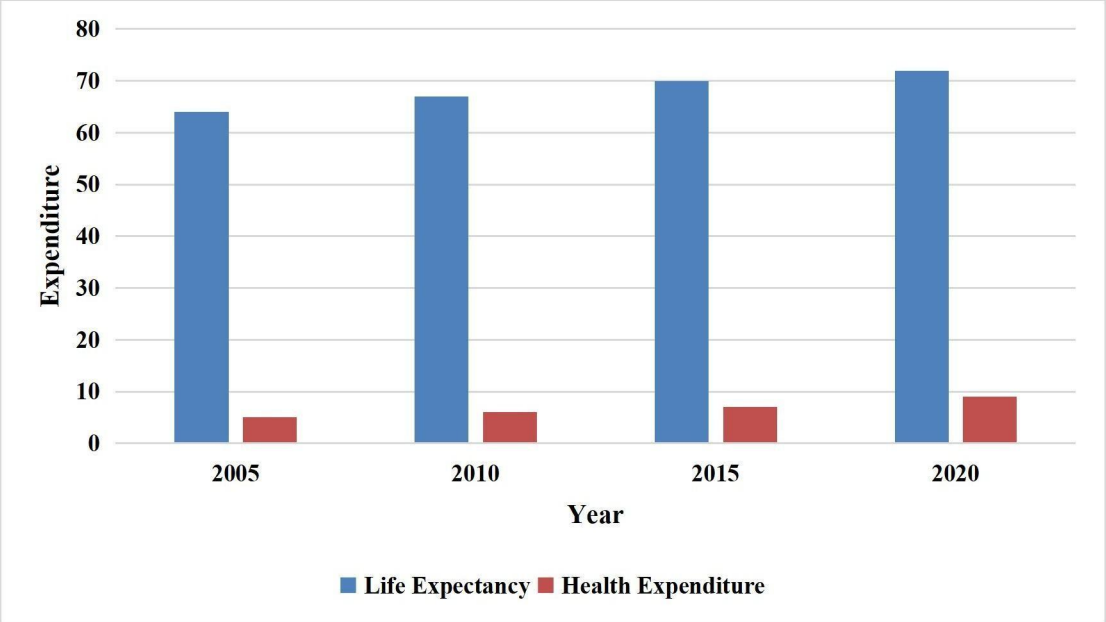

Figure 2. Trend of Life Expectancy and Health Expenditure Over Time

Figure 2 supports the noted correlation between increased health spending and gains in life expectancy. These trends go hand in hand, pointing to the idea that long-term investment in healthcare systems is associated with long-term benefits in population health, although the strength of this impact might be context-specific.

3.3 Correlation Analysis

The correlation analysis gives a comprehensive test of the relationships between the major variables, which gives the insight of the direction and strength of associations. The step is necessary to define possible predictors of health outcomes as well as to determine multicollinearity before regression modeling. The findings indicate that health expenditure, disease burden, nutritional status and health outcomes have strong and statistically significant relationships.

Table 3. Correlation Matrix

Variable	Life Exp	Health Exp	Infant Mort	HIV Prev	Undernourishment
Life Expectancy	1.00	0.72	-0.81	-0.65	-0.74
Health Expenditure	0.72	1.00	-0.68	-0.52	-0.60
Infant Mortality	-0.81	-0.68	1.00	0.70	0.76
HIV Prevalence	-0.65	-0.52	0.70	1.00	0.58
Undernourishment	-0.74	-0.60	0.76	0.58	1.00

Table 3 shows that there is a significant positive relationship between expenditure on health and life expectancy, which means that more spending on healthcare is associated with better results. On the other hand, there is a strong negative correlation between mortality indicators, disease prevalence, and undernourishment and life expectancy, which underline the negative influence on the state of population health. These results support the interdependence between health, economic and social aspects.A clear visualization of the relations found in Table 3 with the focus on groups of strong positive and negative correlations. These patterns were also predominant, which again justifies the choice of variables to be used in regression analysis and also facilitates the interdisciplinary approach to analysis chosen in this research.

3.4 Regression Analysis

The regression analysis measures the effect of the main explanatory variables on the life expectancy and it is possible to observe the causal relationships more accurately. The model has a high explanatory power, which means that the chosen predictors together explain a significant percentage of the variation of the health outcomes. All the variables are unique to the model because of the complexity of global health dynamics.

Table 4. Regression Results for Life Expectancy

Variable	Coefficient	Std. Error	p-value
Health Expenditure	+1.85	0.32	<0.001
HIV Prevalence	-0.90	0.21	<0.001
Tuberculosis Incidence	-0.04	0.01	<0.01
Undernourishment	-0.65	0.18	<0.001
Constant	52.3	2.5	<0.001

Model Fit: $R^2 = 0.78$, Adjusted $R^2 = 0.76$

Table 4 shows that health expenditure has a positive and statistically significant impact on life expectancy, which supports the significance of financial spending on healthcare systems. Conversely, HIV prevalence, tuberculosis incidence, and undernourishment have great adverse consequences, emphasizing the contribution of disease burden and nutritional deficits to the development of health outcomes. The fact that the value of R 2 is relatively high indicates that the model is very strong when explaining global health variation.

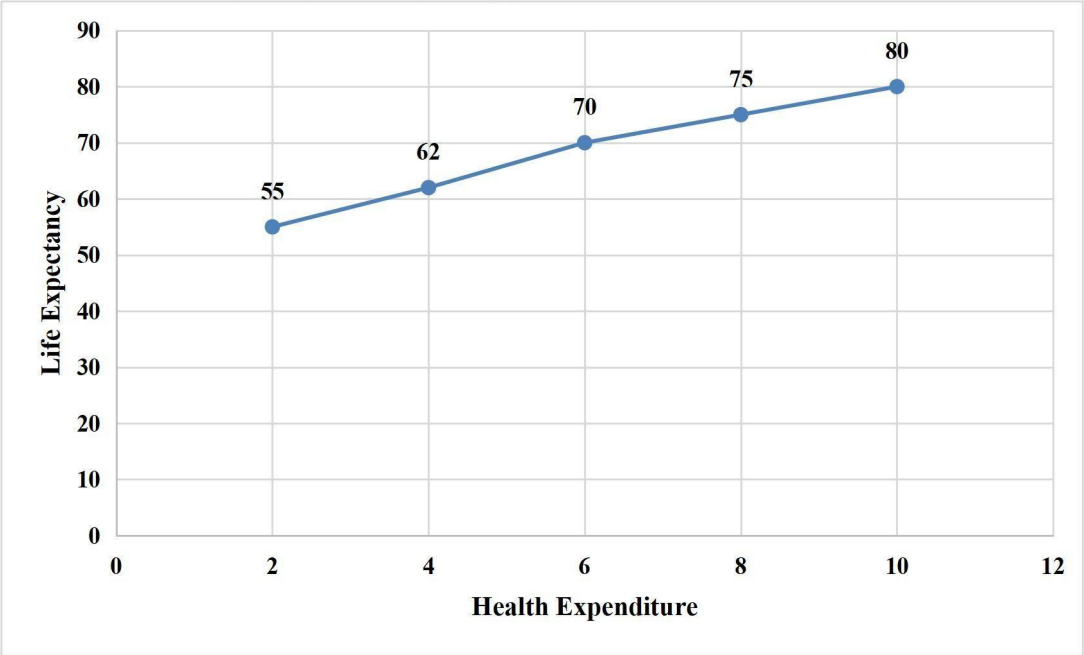

Figure 3. Scatter Plot of Health Expenditure vs Life Expectancy

The regression outcomes are also validated in Figure 3 that proves the existence of an apparent positive trend according to which countries invest more in healthcare are more likely to have a higher life expectancy. However, the trend line is somehow diffused; that is, other factors such as the efficacy of policies and social circumstances are at work.

3.5 Synthesis of Findings

The general results depict that economic, epidemiological, and social factors interact in a complex way to determine the world health outcomes. The association between a higher health spending and the resultant positive life expectancy and reduced mortality is always positive but is moderate by other underlying factors such as disease prevalence and nutrition status. These relations are holistically interpreted with the application of descriptive, correlational and regression analysis. Combined, the results underscore the significance of an interdisciplinary and evidence-based strategy in dealing with health disparities in the world. They underline the fact that in spite of the fact that financial investment is needed, it should be followed by certain interventions that will help to eradicate the disease burden and socioeconomic inequalities to change the population health on the long run basis.

4. DISCUSSION

This research illustrates that health spending, the burden of diseases and socioeconomic status play a major part in determining the global health outcomes. The argument that financial investment in healthcare systems is a key determinant of better population health is supported by the positive association between expenditure on health and

life expectancy in the results. This is consistent with the recent findings that show that government spending on health is directly associated with improved health, especially in developed economies with more organized resource allocation (Anwar et al., 2023). Nevertheless, the findings also show that higher expenditure is not enough to ensure better health outcomes. Health expenditure is effective when resources are used efficiently in a healthcare system. It helps to argue that the realization of universal health coverage cannot be done without the need to invest more but also to allocate resources in a way that maximize health benefits (Pichon-Riviere et al., 2023).

One of the lessons of the analysis is that global health inequalities still persist even though the general health life expectancy has increased. The difference in mortality rates and disease burden among countries implies that there is unequal distribution of gains in health. This observation is consistent with the research of the healthy lifespan inequality that demonstrates that the longevity gain does not necessarily contribute to equitable health outcomes among individuals (Permanyer et al., 2023). The presence of the inequalities demonstrates the importance of addressing the structural inequalities that influence the access to the healthcare and other essential services. Mortality and decrease in the life expectancy remain higher in the low-resource countries, which also evidences the need of certain interventions that may target at both the economic and social factors influencing health.

The results also contribute important roles in demographic transitions in the world. Ageing populations are normally accompanied by extended life span, and this can be a strain on the healthcare systems. Though longevity may be seen as a desirable outcome; it also leads to threats of poor quality life in old age. It has been indicated that increased age does not necessarily imply better health since numerous people incur prolonged morbidity (Choi et al., 2024). This leads to the significance of healthcare systems being able to adjust to the dynamic demographic trends which focus not only on the increased lifespan but also on the improvement of the quality of health. The policies supporting healthy ageing and preventing chronic diseases are critical to ensure that the growth of life expectancy is accompanied by enhanced well-being.

The high incidence of undernourishment that was found in the research highlights the role of socioeconomic factors in influencing health outcomes. In most low and middle-income countries, undernutrition is a serious issue that can result in increased mortality and a shorter life expectancy. Recent studies have revealed that undernutrition is closely linked to the inequalities related to wealth, which further confirms the connection between socioeconomic status and health (Birhanu et al., 2024). These data indicate that it should be a main focus of the public health policy to tackle nutritional deficiencies. There should be improvements in food security, access to healthy food and reduction of poverty to ensure sustainable health outcomes. Combining nutritional interventions with health care policies lead to higher effectiveness of health systems.

Recent events in the global health scene have also been complicated with the disruptions of the COVID-19 pandemic, which has impacted life expectancy and healthcare systems across the globe. The interaction of health spending, economic activity, and death has gained more significance in the post-pandemic environment. Research has shown that both economically based and healthcare investment strategies are needed to restore life expectancy in low-income countries (Karunarathne et al., 2025). This view is reinforced by the results of this research which show that economic and epidemiological factors interact and affect health outcomes. Healthcare systems should be strengthened to achieve long-term population health improvements by establishing resilience in the wake of global crises.

Besides the general life expectancy, the healthy life expectancy has become more and more popular in recent years. Findings of the present research indicate that longevity gains should be considered alongside the quality of health. It is observed that population ageing lowers the share of good health, so interventions that facilitate healthy lifespan living are required (Xi et al., 2025). This view supports the need to take a holistic view on health policy and one that takes into consideration longevity and quality of life. Prevention, early diagnosis and lifestyle interventions are very important in the health maintenance of the ageing populations.

The effectiveness of healthcare systems becomes one of the key elements in converting spending into better health outcomes. The results show that the differences in the life expectancy between countries cannot be attributed exclusively to differences in the level of spending. Rather, the effects of investment can be curtailed by inefficiencies both in the delivery of healthcare and the allocation of resources. Recent international evaluations affirm that healthcare inefficiency is a major issue, both in developed and developing nations (Lastuka et al., 2025). Moreover, the correlation of the relationship between public debt and health expenditure shows that financial sustainability is

significant in healthcare systems. There is evidence that excessive public indebtedness may affect the efficiency of health expenditure, especially in the low-income areas (Boundioa, 2025). These results provide strong support to balanced fiscal policies that can be aimed to achieve sustainable investment in health. Careful and personalized healthcare systems are crucial towards equity in health outcomes. The increased accessibility and effectiveness of health services may be achieved by reducing fragmentation in healthcare financing and delivery (Gatome-Munyua et al., 2025). To deal with the multifaceted determinants of global health, policymakers should consider a holistic approach, which is integrating economic, social, and health interventions.

5. CONCLUSION

An in-depth examination of health outcomes around the globe through the combination of health spending, disease burden, and socioeconomic determinants in a data and interdisciplinary approach. The results reveal that there is a strong relationship between higher health spending and better life expectancy and lower mortality rates. The findings, however, also show that financial investment is not effective enough to guarantee the best health outcomes since its effectiveness is highly determined by the prevalence of the disease, nutritional status, and the effectiveness of the health system. The research points out that there are constant inequalities in health outcomes around the globe, with the necessity of specific interventions when the settings are low-resource. Undernutrition and infectious diseases also play a major role in supporting the need to reduce social and economic inequalities and improve healthcare. Moreover, the increased effects of population ageing demand the policies that do not simply increase life expectancy but also improve life quality. On the whole, the results support the need to implement combined and evidence-based health policy and planning. To generate sustainable and equitable changes in the global health outcomes, the issues of strengthening healthcare systems, better resource allocation, and broader determinants of health must be tackled.

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