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Factors Influencing Life Expectancy: Global Evidence from 125 Countries

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ABSTRACT

The global average lifespan is influenced by a multitude of factors; however, due to limitations in data availability and quality, comprehensive research on their collective impact remains inadequate. Moreover, there is a dearth of studies that concurrently examine the effects of socioeconomic and environmental factors on life expectancy. In certain instances, these factors exhibit conflicting effects, thereby restricting the generalizability of findings across different countries. This paper investigates the associations between various determinants and life expectancy at birth, utilizing 2015 data from 125 nations sourced from the World Health Organization (WHO), the World Bank, and the United Nations (UN). Specifically, it examines the effects of carbon dioxide (CO_2) emissions, air pollution (PM 2.5), per capita alcohol consumption, happiness levels, gross domestic product (GDP), obesity rates measured via Body Mass Index (BMI), corruption levels via corruption perception index, and government health expenditures on life expectancy. Through regression analysis, significant associations are identified between alcohol consumption, happiness levels, CO_2 emissions, and air pollution and life expectancy, illustrating the complex interplay of socioeconomic, environmental, and individual lifestyle elements in determining longevity.
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1. Introduction

Life expectancy serves as a pivotal indicator for evaluating the well-being of populations and the effectiveness of societal systems across various disciplines (Schübel, 2023). In addition to serving as the primary indicator of health, life expectancy also provides a thorough picture of the state of the economic, environmental, healthcare, and educational systems (Wu *et al*., 2020). The World Health Organisation (WHO) considers life expectancy to be one of the most important health indicators. Numerous studies identify multidimensional factors that influence life expectancy (see Powell-Wiley *et al.*, 2022; Zaninotto *et al.*, 2020; Hassan *et al.*, 2017; Ranabhat *et al.*, 2018; Rahman *et al.*, 2022; Redzwan and Ramli, 2024). Each distinguishes the effects of three different dimensions of variables: contextual background (see Yin *et al.*, 2022; Miladinov, 2020; societal environment (Lutz & Kebede, 2018; Rahman *et al.*, 2018), and individual behaviour (see Fontaine *et al.*, 2003; Blanchflower & Oswald, 2019; Mackenbach *et al.*, 2019; Lawrence *et al.*, 2015) (see Figure 1). Individual behaviours that have an impact on an individual's physical and emotional well-being are known as individual behaviour variables. The variables of the sociocultural environment are those that have to do with wellbeing and access to basic amenities. Contextual background elements pertain to the physical surroundings and socioeconomic status of an individual.

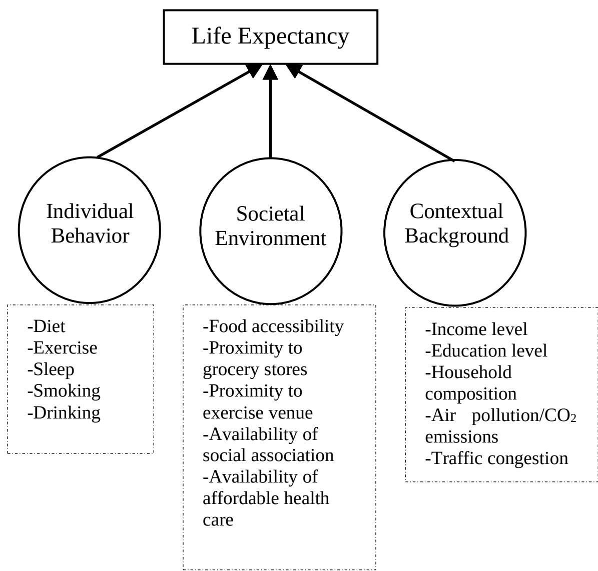

Figure 1. Examples of individual-social-contextual factors influencing life expectancy

The above studies summarize key factors that affect life expectancy, namely body mass index (BMI), alcohol consumption, mental wellbeing and happiness, education and literacy rates, carbon dioxide (CO_2) emissions, gross domestic product (GDP), air pollution levels, corruption and governance, income level and economic stability, and government expenditure on health. Each of these factors plays a distinct role in shaping life expectancy.

Lifestyle choices such as diet, exercise, sleep, smoking, and alcohol consumption have significant impacts on health outcomes (Blanchflower & Oswald, 2019). Obesity is measured using the body mass index (BMI) scale. Overweight people are defined as having a BMI between 25.0 and 30.0, while obese people have a BMI greater than 30.0. Obesity is often associated with a reduced life expectancy. Research has shown that obesity can lead to a decrease in life expectancy by an average of 3 to 10 years, depending on its severity (see more in Fontaine *et al.*, 2003). This is mostly because obesity increases the risk of a number of illnesses, including diabetes, hypertension, heart disease, stroke, and several types of cancer (Malnick and Knobler, 2006). Zaninotto *et al.*, 2020 found that individuals exhibiting multiple risk factors, namely alcohol consumption, smoking, physical inactivity, and obesity have a significantly reduced healthy life expectancy, highlighting the importance of addressing lifestyle behaviors in public health interventions.

Alcohol consumption can have a significant impact on life expectancy. Studies reveal that the lifespan of an alcoholic may differ by 24 to 28 years compared to the whole population. (Westman *et al.*, 2015). A 2018 study found that drinking more than 100g of alcohol per week could lead to a shorter life. Compared to individuals consuming more than 0 but no more than 100 grams of alcohol per week, those reporting weekly intakes of 101–200 grams, 201–350 grams, and over 350 grams exhibited progressively shorter life expectancies at age 40—by approximately 6 months, 1–2 years, and 4–5 years, respectively. (Wood *et al.*, 2018). Additionally, a 2022 study suggested that compared with non-drinkers, regular drinkers in males could shorten life by 6.86 years (Liu *et al.*, 2022). Alcohol consumption shows a nuanced relationship with life expectancy, where moderation may offer benefits, but excessive consumption leads to adverse health outcomes, such as liver disease and cardiovascular complications (see Case & Deaton, 2018).

Happiness or subjective well-being is increasingly recognized for its significant influence on health outcomes and longevity, with robust social networks and positive psychological states being linked to longer lifespans (Blanchflower & Oswald, 2019; Lee and Singh, 2020; Ruggeri *et al.*, 2020). Additionally, compared to individuals who reported being very happy, those who identified as pretty happy had a 6% higher risk of mortality during the follow-up period, while those who reported not being happy had a 14% higher risk (Lawrence *et al.*, 2015). Dienar and Chan (2011) concluded that high subjective well-being—including life satisfaction, optimism, and positive emotions—contributes to better health and increased longevity. The analysis highlighted that individuals with higher subjective well-being exhibit stronger immune function and lower inflammation levels, which are critical factors in disease prevention and health maintenance.

The CO_2 emissions, primarily from transportation, contribute to climate change and pose multiple health risks, including respiratory and cardiovascular diseases and certain types of cancer (Ivanova & Petrova, 2020). A reduced life expectancy may be linked to higher carbon emissions, according to certain studies. For example, Bressler (2021) introduced the "mortality cost of carbon" (MCC) metric, estimating the number of deaths caused by the emission of one additional metric ton of CO_2. The study concluded that higher CO_2 emissions are associated with increased mortality Another research discovered that life expectancy drops by 0.012% with every 1% increase in carbon emissions (Rahman *et al.*, 2022) and additionally, every degree Celsius increase in global temperature—a consequence of elevated CO_2 levels—life expectancy declines by approximately 0.44 years (See Burnfield-Wiebe, 2024)

There is ample evidence linking GDP to life expectancy. Longer life expectancy is typically correlated with higher GDP per capita (see Gurler and Ozsoy, 2019 relationship between life expectancy at birth and economic growth in 56 developing countries). A comprehensive analysis by *Our World in Data* illustrates this association, showing that countries with higher GDP per capita generally report longer life expectancies. This trend indicates that increased economic resources enable better access to healthcare, improved nutrition, and enhanced living conditions, all contributing to longevity. More specifically, economic growth and development that results in GDP per capita raises life expectancy at birth, improving living standards and health conditions (Miladinov, 2020). Around the GDP per capita median, the life expectancy gap fell significantly, indicating a correlation between higher income and longer lifespans (Bradley *et al.*, 2022).

Life expectancy has been demonstrated to be negatively impacted by corruption where corruption has deeply affected the physical health in developing countries (see Achim *et al.*, 2020). Further studies have shown that corruption exacerbates health disparities, particularly in low-income countries. According to National Academies of Sciences, Engineering, and Medicine (2018), corruption in the health sector leads to substantial financial losses, with approximately \$455 billion of the \$7.35 trillion spent annually on global healthcare lost to fraud and corruption. This diversion of funds results in inadequate healthcare infrastructure, shortages of essential medical supplies, and compromised service delivery, thereby limiting the population's access to necessary care. A study analyzing data from 133 countries found that higher levels of corruption are associated with reduced health expenditures and poorer health outcomes. This correlation suggests that corruption not only depletes resources allocated for healthcare but also diminishes the effectiveness of health interventions, leading to adverse effects on population health (see Factor and Kang, 2015). Various tactics, including bribery, fund diversion, nepotistic appointments in the civil service, restricted access to information about public affairs and government actions are employed to maintain the effect of corruption. (Socoliuc *et al.*, 2022; see also Li *et al.*, 2018). Therefore, corruption can undermine the quality of institutions and economic development, leading to a reduction in life expectancy.

Air pollution, encompassing pollutants like particulate matter (PM) and ozone, is another critical factor negatively affecting life expectancy through increased risks of respiratory and cardiovascular issues (Akhmetova & Mukhametzhanova, 2023). Exposure to air pollution, particularly fine particulate matter (PM2.5), has been widely associated with reduced life expectancy (Yin *et al.*, 2022). Research indicates that prolonged exposure to PM2.5 contributes to oxidative stress, systemic inflammation, and heightened risks of chronic diseases, including lung cancer, ischemic heart disease, and stroke (Cohen *et al.*, 2017). Moreover, air pollution exacerbates pre-existing conditions, disproportionately affecting vulnerable populations such as children, the elderly, and individuals with underlying health issues (Lelieveld *et al.*, 2019). A global analysis by Burnett *et al.* (2014) further quantifies the health burden of air pollution, demonstrating that even moderate increases in PM2.5 concentrations correlate with substantial reductions in life expectancy.

Government health expenditure refers to the total financial resources allocated to medical supplies and services within a nation. This encompasses both public and private healthcare spending, including direct government funding for healthcare programs, payments to private health insurance providers, out-of-pocket expenses, and institutional contributions to the healthcare sector (World Health Organization, 2023). The relationship between government health expenditure, measured as a percentage of Gross Domestic Product (GDP), and life expectancy has been extensively examined in empirical studies, with findings generally indicating a positive correlation between increased spending and improved health outcomes.

Rahman *et al.* (2018) conducted a cross-country analysis and found that increased government healthcare spending significantly enhances life expectancy by improving healthcare accessibility, medical infrastructure, and preventive care. The positive effect of government health spending on life expectancy has also been confirmed by Joumard *et al.* (2010), who analyzed OECD countries and found that efficient allocation of healthcare funds contributes to prolonged life expectancy. Moreno-Serra and Smith (2015) further argued that public healthcare investments lead to lower disease prevalence and improved quality of life, supporting the need for sustained government intervention in healthcare financing (see also Reeves *et al.*, 2017).

Despite the extensive body of literature on the determinants of life expectancy, significant research gaps persist. First, due to data limitations, many studies focus primarily on high-income countries, neglecting variations in life expectancy across low- and middle-income nations. Second, there is a lack of comprehensive studies analyzing both socioeconomic and environmental factors simultaneously. Third, the conflicting effects of various determinants limit the direct applicability of findings across different regions. To address these gaps, this study employs a regression model to examine the key drivers of life expectancy disparities across 125 countries, providing a more holistic understanding of the multifaceted influences shaping human longevity. By serving as a predictive framework, this research aims to inform policymakers and facilitate evidence-based strategies to enhance global health outcomes. To provide clearer direction and understanding, eight hypotheses are provided as follows:

H1: Body Mass Index (BMI) (Obesity) and Life Expectancy

Higher BMI (obesity) is negatively associated with life expectancy, as obesity increases the risk of chronic diseases such as cardiovascular diseases, diabetes, and certain cancers (Flegal *et al.*, 2013).

H2: Per Capita Alcohol Consumption (PCAC) and Life Expectancy

Greater per capita alcohol consumption is negatively associated with life expectancy, as excessive alcohol intake contributes to liver disease, cancer, and cardiovascular problems (Rehm *et al.*, 2017).

H3: Happiness Index (HI) and Life Expectancy
A higher happiness index is positively associated with life expectancy, as psychological well-being is linked to lower stress levels, better immune function, and healthier lifestyle choices (Helliwell *et al.*, 2020).

H4: CO_2 Emissions and Life Expectancy
Higher CO_2 emissions are negatively associated with life expectancy, as increased exposure to air pollution contributes to respiratory diseases, cardiovascular conditions, and premature mortality (Lelieveld *et al.*, 2020).

H5: Gross Domestic Product (GDP) per Capita and Life Expectancy
Higher GDP per capita is positively associated with life expectancy, as economic growth enhances access to healthcare, nutrition, and improved living conditions (Preston, 1975).

H6: Corruption Perception Index (CPI) and Life Expectancy
A higher Corruption Perception Index (lower corruption) is positively associated with life expectancy, as reduced corruption enhances healthcare efficiency, equitable resource distribution, and overall public health improvements (Mauro, 1995).

H7: Air Pollution (PM2.5) and Life Expectancy
Higher levels of air pollution (PM2.5) are negatively associated with life expectancy, as prolonged exposure to fine particulate matter increases risks of lung disease, stroke, and cardiovascular conditions (Burnett *et al.*, 2018).

H8: Government Health Expenditure (% of GDP) and Life Expectancy
Higher government health expenditure (as a percentage of GDP) is positively associated with life expectancy, as increased public health funding improves healthcare access, disease prevention, and medical infrastructure (Baltagi & Moscone, 2010).

2. Methods

2.1 Data Collection and Analysis

This study employs a rigorous quantitative research approach, utilizing secondary data sources to ensure the reliability and validity of findings. The methodology is underpinned by a comprehensive literature review, which serves as the basis for identifying credible and authoritative data sources. Prominent international organizations, including the World Health Organization (WHO), the World Bank, and the United Nations (UN), provide extensive and standardized global data on life expectancy (World Health Report, 2015) (Figure 2). By systematically incorporating data from these sources, the study ensures a robust analytical foundation for examining the multifaceted determinants of life expectancy. The research process involves meticulous data selection, prioritizing relevance, accuracy, and consistency across different countries and time periods to enhance the integrity and comparability of the results. The data collection phase focuses on compiling comprehensive information on life expectancy alongside an array of potential influencing factors, spanning socioeconomic indicators, healthcare metrics, lifestyle behaviors, and environmental conditions. In this study, life expectancy serves as the dependent variable, while the independent variables are derived from established theoretical frameworks and prior empirical research. These variables include, but are not limited to, gross domestic product (GDP), healthcare expenditure, air pollution levels, alcohol consumption, and other critical determinants. This structured methodological approach facilitates a nuanced understanding of the relationships among these factors and their collective impact on life expectancy.

Following data collection, the subsequent critical step involves data cleaning and preparation to ensure accuracy and consistency in the dataset. This process entails identifying and addressing missing values, detecting and managing outliers, and resolving any inconsistencies within the data. For this study, data from 125 countries has been carefully selected, aligning with the established criteria to maintain methodological rigor and comparability. The data analysis is conducted using the Statistical Package for the Social Sciences. The core analytical approach of this study employs regression techniques to investigate the relationships between life expectancy and the selected independent variables. Specifically, multiple linear regression (MLR) is utilized to model the linear associations between the dependent variable (life expectancy) and multiple explanatory factors. MLR is a robust statistical method that allows for the simultaneous assessment of the effects of several predictors on the outcome variable, offering valuable insights into the determinants of life expectancy (Aiken *et al.*, 2012).

The general form of an MLR model is: $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta n X n + \varepsilon$

Where:
- Y is the dependent variable (life expectancy).
- X_1, X_2, …, Xn are the independent variables (BMI, alcohol consumption, etc.).
- β_0 is the intercept.
- β_1, β_2, …, βn are the coefficients representing the impact of each independent variable on life expectancy.
- ε is the error term.

Additionally, this method allows for a detailed understanding of how each factor correlates with life expectancy, assessing the strength and significance of these relationships. The study aims to provide a clear understanding of the observed relationships, supported by statistical evidence such as coefficients, p-values, and effect sizes.

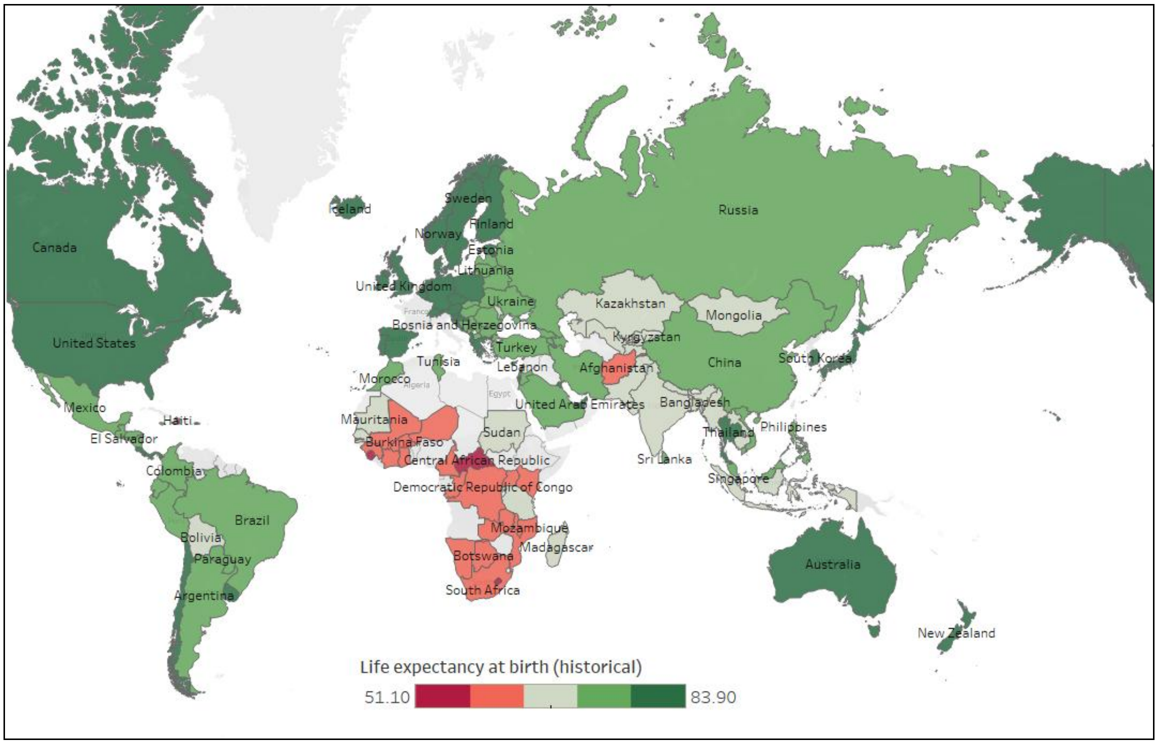

Figure 2. Distribution of life expectancy globally 2015

3. Results and Discussion

The multiple R statistics in a regression model (Table 1 below) indicate the strength and direction of the linear relationship between the dependent variable and the set of independent variables. The multiple R's value can range from -1 to 1, where values near -1 signify a strong negative association, values near 1 a strong positive relationship, and values near 0 little to no relationship. The multiple R is frequently used to evaluate the regression model's goodness of fit, compare several models, and identify significant predictors of the dependent variable.

Table 1. Model summary

Model	R	R Square	Adjusted R Square	Std Error of the Estimate	Change Statistics				
					R Square	F	df1	df2	Sig. F Change
1	0.911[a]	0.83	0.819	3.3164	0.83	70.92	8	118	.000

[a] Predictors: (Constant), PCAC, HI, CO_2, PM2.5, BMI, GDP, CPI, Government Health Expenditure

The multiple R statistics in a regression model (Table 1) measure the strength and direction of the linear relationship between the dependent variable and the set of independent variables. The value of multiple R ranges from -1 to 1, where values close to -1 indicate a strong negative correlation, values near 1 suggest a strong positive relationship, and values around 0 imply little to no linear association. Multiple R is frequently employed to assess the model's goodness of fit, compare different models, and identify significant predictors of the dependent variable. The results indicate that the regression model demonstrates a strong association between the dependent and independent variables, with an R value of 0.911.

Another crucial measure in regression analysis is R-squared (R^2), also known as the coefficient of determination, which quantifies the proportion of variance in the dependent variable that is explained by the independent variables in the model. R-squared values range from 0 to 1, where an R^2 value of 1 indicates that the model explains all the variance in the dependent variable, while an R^2 value of 0 signifies that none of the variance is explained by the model.

R-squared is widely used to assess the goodness of fit of a regression model, with higher values suggesting a stronger explanatory power. In this study, the R-squared value obtained was 0.830, indicating that 83% of the variance in the dependent variable is accounted for by the independent variables. This suggests that the model has strong explanatory power and may serve as a reliable predictor of the dependent variable or a robust representation of the relationships among the studied factors.

Table 2. ANOVA[a]

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	6240.041	8	780.005	70.92	.000[b]
Residual	1275.82	116	10.998		
Total	7515.86	124			

[a.] Dependent Variable: Life Expectancy
[b.] Predictors: (Constant), PCAC, HI, CO_2, PM2.5, BMI, GDP, CPI, Government Health Expenditure

3.1 Happiness and Life Expectancy

The analysis indicates that for every unit increase in the happiness index, life expectancy rises by approximately 1.294 years. As illustrated in Table 2, the statistical findings demonstrate a strong positive correlation ($r = 0.762$) between life expectancy and happiness, reinforcing the association between subjective well-being and longevity. This result aligns with existing literature, which suggests that individuals who report higher levels of happiness, satisfaction, and positive emotions tend to experience better health outcomes, and an extended lifespan compared to those who frequently encounter negative psychological states such as stress, anxiety, and depression.

However, while happiness serves as an influential factor in promoting well-being and longevity, it is not the sole determinant of life expectancy. A comprehensive understanding of lifespan variation requires consideration of multiple intersecting factors, including genetic predispositions, lifestyle choices, healthcare accessibility, socioeconomic conditions, and environmental influences. These variables collectively shape an individual's health trajectory and overall lifespan, demonstrating that happiness alone cannot fully account for variations in longevity.

The relationship between happiness and physical health, though complex, is well-documented in the literature. Happiness may not directly ensure the absence of disease, but it does provide protective effects that enhance an individual’s ability to maintain health and mitigate illness. In societies with robust healthcare systems and favorable living conditions, the correlation between happiness and increased life expectancy appears stronger, underscoring the importance of fostering positive well-being as a key component of public health initiatives. Nonetheless, the impact of happiness on lifespan may be attenuated in populations experiencing high disease burdens or significant socioeconomic disparities.

3.2 BMI and Life Expectancy

The multiple linear regression analysis indicates that BMI is not a significant predictor of life expectancy, as evidenced by a p-value of 0.385, which exceeds the conventional threshold of 0.05. While previous studies have established a link between obesity and reduced life expectancy, these analyses often incorporate lifestyle factors such as smoking and alcohol consumption. In contrast, this study focuses solely on BMI, which, in isolation, does not directly impact longevity. The adverse effects of obesity on life expectancy arise when it contributes to health conditions such as heart disease and diabetes rather than from elevated BMI alone.

A key limitation of this model is that BMI data does not account for obesity-related health complications. Consequently, the findings should be interpreted with caution, as they do not imply that obesity has no effect on life expectancy. Future research should incorporate variables such as cardiovascular disease, cancer, and diabetes to provide a more comprehensive understanding of obesity’s impact on longevity.

3.3 Corruption and Life Expectancy

The regression analysis indicates that the Corruption Perception Index (CPI) is not a statistically significant predictor of life expectancy, despite the correlation analysis showing a relatively strong association ($r = 0.672$). This suggests that while corruption may be linked to life expectancy in a broader context, its direct impact is not evident within the multiple linear regression model. One possible explanation is that, in some nations, corruption is normalized as a routine aspect of economic and cultural practices, often perceived as an unavoidable cost of doing business. In such cases, its effects on public health and governance may be obscured or mitigated by other socioeconomic factors.

However, extensive research and global reports highlight the severe consequences of corruption, particularly in the healthcare sector. Corruption is a major impediment to equitable healthcare distribution and efficient public service delivery. High levels of corruption have been strongly associated with negative health outcomes, including increased infant and child mortality rates. It is estimated that around 140,000 children die each year due to healthcare system corruption, as funds meant for medical infrastructure, essential medicines, and life-saving interventions are misallocated or siphoned off. While corruption itself may not be a direct cause of mortality, it acts as a compounding factor that exacerbates existing health risks, weakens healthcare institutions, and undermines public trust. Its indirect consequences, such as inadequate medical care, resource misallocation, and systemic inefficiencies, contribute to hazardous health conditions that ultimately lead to preventable deaths. Future research should explore more nuanced mechanisms through which corruption influences life expectancy, incorporating mediating variables such as healthcare accessibility, government efficiency, and policy enforcement to better understand its indirect but substantial role in shaping public health outcomes.

3.4 Air Pollution and Life Expectancy

The analysis reveals a strong negative correlation between air pollution and life expectancy, with a correlation value of -0.879, indicating that as air pollution increases, life expectancy decreases. Specifically, for every rise in the mortality rate due to air pollution, life expectancy is reduced by 0.072 years. This finding underscores the significant relationship between air quality and public health, emphasizing that lower levels of air pollution contribute to improved health outcomes and longevity. However, the extent to which air pollution affects life expectancy varies based on several factors, including age, pre-existing health conditions, and the duration and intensity of exposure.

Certain populations, such as children, older adults, and individuals with respiratory or cardiovascular diseases, are particularly vulnerable to the adverse health effects of air pollution. Reducing air pollution can have substantial public health benefits, including prolonged life expectancy and a reduction in pollution-related diseases. Effective mitigation strategies include controlling emissions from industrial and transportation sectors, improving indoor air quality, and promoting cleaner and more sustainable energy sources.

A growing body of research provides compelling evidence of the direct impact of air pollution on the human respiratory system. Exposure to particulate matter (PM) and harmful chemicals has been linked to the development and exacerbation of respiratory conditions such as asthma and chronic obstructive pulmonary disease (COPD), as well as an increased risk of lung cancer.

3.5 Alcohol Consumption and Life Expectancy

The analysis indicates that for every increase of 1 liter in alcohol consumption per capita, life expectancy is reduced by 0.208 years. Long-term excessive alcohol consumption is associated with a range of serious health conditions, including liver disease, cardiovascular diseases, stroke, cancer, and mental health disorders such as depression and anxiety. These conditions collectively contribute to premature mortality and a significant reduction in life expectancy. The multiple linear regression model confirms the significant impact of alcohol consumption on life expectancy, with a p-value of 0.016. This finding aligns with existing literature that identifies alcohol consumption as a key determinant of disease burden and mortality (Kossova *et al*., 2020). Prior studies by Ranabhat *et al*. (2020) and Mackenbach *et al*. (2019) further corroborate the negative association between alcohol consumption and life expectancy, indicating that its impact may be even more severe than that of other lifestyle risk factors such as smoking, low income, or high body weight.

However, a critical limitation of the current analysis lies in the accuracy and representativeness of the dataset. The data on alcohol consumption may present national or regional averages, potentially obscuring variations in individual drinking behaviors across different demographic and socioeconomic groups. Additionally, certain countries, particularly those in the Middle East, report significantly lower alcohol consumption due to cultural or legal prohibitions, which may lead to an oversimplified interpretation of the overall relationship between alcohol use and life expectancy

3.6 CO_2 and Life Expectancy

The analysis reveals a negative correlation between CO_2 emissions and life expectancy, with a 1,000-ton increase in CO_2 linked to a 0.048-year reduction in life expectancy. High CO_2 exposure contributes to respiratory, cardiovascular, and neurological disorders, exacerbating health risks. Additionally, rising CO_2 levels drive climate change, increasing heat-related illnesses and worsening air quality through secondary pollutants, further reducing longevity (Jacobson *et al*., 2019).

However, the CO_2-life expectancy relationship is complex. Some studies (e.g., Redzwan & Ramli, 2024) suggest a positive correlation due to economic growth improving healthcare and living conditions. Yet, in high-emission countries like India, pollution's adverse effects outweigh economic benefits, leading to decreased life expectancy.

Reducing CO_2 emissions is essential for mitigating climate-related health risks. Fossil fuel combustion not only drives CO_2 levels but also releases harmful pollutants linked to chronic diseases. Implementing clean energy policies and improving air quality are critical steps toward enhancing public health and increasing life expectancy.

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3.7 GDP and Life Expectancy

The analysis reveals a weak positive correlation ($r = 0.194$) between GDP and public health, indicating that while economic growth contributes to better health outcomes, its direct influence is limited. This suggests that GDP alone is not a definitive determinant of public health or life expectancy, as multiple socio-economic, healthcare, and environmental factors collectively shape health outcomes.

Higher GDP levels often lead to increased public and private investments in healthcare infrastructure, medical research, and technological advancements, making healthcare services more accessible and effective. Countries with growing economies can afford improved sanitation systems, vaccination programs, and better nutrition, which collectively enhance population health. Moreover, economic prosperity allows governments to allocate more resources toward social services, such as education and disease prevention initiatives, further supporting public health improvements.

However, the relationship between GDP and life expectancy is non-linear. While initial increases in GDP significantly improve health outcomes—especially in low-income countries—higher economic levels do not always guarantee continued progress in life expectancy. Beyond a certain point, diminishing returns emerge, requiring nations to focus on broader systemic improvements, such as equitable healthcare access, environmental sustainability, and policies that address social determinants of health. Therefore, while economic growth provides a foundation for public health advancement, long-term improvements require strategic investments in healthcare, education, and social welfare to ensure a sustainable increase in life expectancy.

3.8 Government Health Expenditure

The analysis of the relationship between government health expenditure and life expectancy reveals a Pearson correlation value of 0.687, indicating a moderate positive association. However, correlation alone does not establish statistical significance. The p-value of 0.375 suggest that government health spending does not have a statistically significant impact on life expectancy within the scope of this study.

While existing literature often highlights a strong link between healthcare investment and improved health outcomes, the findings of this study contrast with such conclusions. Several factors may account for this discrepancy, including regional differences, variations in healthcare accessibility, disparities in the quality of medical services, and methodological distinctions in data collection. In some regions, government healthcare spending may not directly translate into better health outcomes due to inefficiencies in resource allocation, inequitable access, or external socio-economic influences such as mental health conditions, stress, and delayed diagnoses.

Table 3. Pearson's correlation values

Variables	Life expectancy at birth (historical)	BMI, 25(age standardized estimate) (%)- Sex: Both sexes (Obesity)	Total alcohol consumption per capita (liters of pure alcohol, projected estimates, 15+ years of age)	Cantril Ladder score (Happiness)	CO_2 Indicator	GDP (current US$)	Corruption Perception-Transparency International Index	Deaths - Cause: All causes - Air pollution - Sex: Both - Age: Age-standardized (Rate)	Domestic general government health Expenditure (% of GDP)
Life expectancy at birth (historical)	1	0.684	0.407	0.762	-0.294	0.194	0.672	-0.879	0.687
BMI, 25 (age-standardized estimates) - Sex: Both sexes (Obesity)	0.684	1	0.317	0.638	-0.222	0.07	0.462	-0.705	0.638
Total alcohol consumption per capita (liters of pure alcohol, projected estimates, 15+ years of age)	0.407	0.317	1	0.373	-0.281	0.123	0.478	-0.525	0.522
Cantril ladder score (Happiness)	0.762	0.638	0.373	1	-0.138	0.17	0.715	-0.741	0.679
CO_2 indicator	-0.294	-0.222	-0.281	-0.138	1	-0.185	-0.108	0.184	-0.205
GDP (current US$)	0.194	0.07	0.123	0.17	-0.185	1	0.203	-0.166	0.279
Corruption Perception-Transparency International Index	0.672	0.462	0.478	0.715	-0.108	0.203	1	-0.693	0.75
Deaths - Cause: All causes - Air pollution - Sex: Both - Age: Age-standardized (Rate)	-0.879	-0.705	-0.525	-0.741	0.184	-0.166	-0.693	1	-0.751
Domestic general government health Expenditure (% of GDP)	0.687	0.638	0.522	0.679	-0.205	0.279	0.75	-0.75	1

Table 4. Regression model

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence		Correlation			Collinearity Statistic	
	B	Std. Error	Beta			Interval Lower Bound	Interval Upper Bound	Zero -order	Partial	Part	Tolerance	VIF
(Constant)	73.7	3.115	-	23.662	-	67.531	79.869	-	-	-	-	-
BMI, 25 (age-standardized estimates) - Sex: Both sexes (Obesity)	0.032	0.03	0.066	1.095	0.276	-0.276	0.091	0.684	0.101	0.042	0.402	2.489
Total alcohol consumption per capita (liters of pure alcohol, projected estimates, 15+ years of age)	-0.208	0.091	-0.111	-2.297	0.023	-0.387	-0.029	0.407	-0.209	-0.088	0.625	1.6
Cantril ladder score (Happiness)	1.294	0.441	0.193	2.933	0.004	0.42	2.168	0.762	0.263	0.112	0.337	2.966
CO_2 indicator	-0.048	0.013	-0.154	-3.744	0.000	-0.073	-0.023	-0.294	-0.328	-0.143	0.865	1.156
GDP (current US$)	9.498E -14	0	0.024	0.588	0.557	0.000	0.000	0.194	0.055	0.23	0.875	1.142
Corruption Perception-Transparency International Index	0.04	0.026	0.104	1.545	0.125	-0.011	0.092	0.672	0.142	0.059	0.321	3.111
Deaths - Cause: All causes - Air pollution - Sex: Both - Age: Age-standardized (Rate)	-0.072	0.008	-0.691	-9.329	0.000	-0.087	-0.056	-0.879	-0.655	-0.357	0.266	3.752
Domestic general government health Expenditure (% of GDP)	-0.225	0.253	-0.065	-0.89	0.375	-0.727	0.276	0.687	-0.082	-0.034	0.278	3.599

4. Conclusion

This study systematically examined the relationships between eight key determinants and life expectancy through the application of Pearson correlation and multiple linear regression analysis. By leveraging a comprehensive dataset encompassing socioeconomic, demographic, healthcare, and lifestyle variables, this research has yielded valuable insights into the predictors that significantly influence life expectancy, as well as those that do not exhibit a significant association within the multiple linear regression model.

The findings underscore the substantial influence of alcohol consumption (H2), happiness (H3), carbon dioxide (CO_2) emissions (H4), and air pollution due to particulate matter (PM2.5) (H7) on life expectancy. These results highlight the necessity of implementing targeted policy interventions to address these determinants effectively. Specifically, stricter alcohol regulation policies are crucial in mitigating alcohol-related health risks, while strategies aimed at enhancing societal happiness—such as fostering sustainable and livable urban environments—can contribute to improved longevity. Additionally, policies that curtail CO_2 emissions and promote carbon neutrality are essential to mitigate climate-related health risks. Effective air pollution control measures are also imperative to reduce exposure to harmful pollutants that contribute to premature mortality.

Furthermore, while certain variables—namely body mass index (BMI), gross domestic product (GDP) per capita, the corruption perception index, and government health expenditure—did not emerge as statistically significant predictors in the multiple regression analysis, their influence cannot be entirely discounted. These factors may still play a role in shaping life expectancy when examined through different methodological approaches, such as linear correlation analyses, or in alternative contextual and regional settings. Future research should further explore these variables, considering potential interactions and non-linear relationships that may provide deeper insights into their roles in determining life expectancy.

Despite the robust methodological framework employed in this study, several limitations should be acknowledged. Firstly, the analysis relies on secondary data obtained from open-access sources, which may be subject to measurement errors and inconsistencies in data collection methodologies. Secondly, the study does not apply specific inclusion criteria for country selection; rather, the dataset was filtered to ensure completeness across the selected variables. As a result, the study's findings are constrained to a specific timeframe and a subset of countries, potentially limiting the generalizability of the results to other geographical regions and time periods. To enhance the robustness of future research, it is recommended that studies incorporate a more extensive dataset covering a broader range of countries and time periods, as well as additional variables that may further elucidate the determinants of life expectancy.

In conclusion, this study contributes to the existing body of knowledge by offering a comprehensive analysis of the intricate relationships between socioeconomic, healthcare, lifestyle, and demographic factors and their impact on life expectancy. The findings reinforce the necessity of adopting a multidimensional approach in policymaking to effectively improve population health and extend life expectancy. Future research should continue to investigate these determinants within diverse contexts and explore novel methodological frameworks to refine our understanding of the mechanisms that underpin variations in life expectancy across different populations.

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