**Report: Modeling and Simulating the Relationship Between Life Expectancy and Socio-Economic Factors**

1. Introduction

This report presents the results of a multiple linear regression analysis conducted to model the relationship between life expectancy and key socio-economic factors, such as GDP, Adult Mortality, and Immunization Rates, using the Life Expectancy (WHO) dataset. Additionally, simulations were performed to estimate the impact of changes in these factors on life expectancy. The goal is to provide insights into how improvements in socio-economic conditions could potentially influence public health outcomes.

2. Methodology

Data Source: The data was sourced from the Life Expectancy (WHO) dataset, which includes global data on health, socio-economic factors, and life expectancy.

Variables Used:

Dependent Variable: Life Expectancy.

Independent Variables: GDP per capita: Represents the economic wealth of a country.

Adult Mortality: The probability of dying between the ages of 15 and 60, expressed per 1,000 individuals.

Immunization Rate: The percentage of the population that received important immunizations (e.g., DPT).

Multiple Linear Regression: The relationship between life expectancy and the socio-economic factors was modeled using multiple linear regression in SPSS. This method allowed us to quantify the influence of each factor on life expectancy and assess the overall fit of the model.

3. Regression Analysis Results

The multiple regression analysis provided the following key insights:

R-Squared Value: The R-squared value for the model was 0.76, indicating that 76% of the variance in life expectancy can be explained by the socio-economic factors included in the model. This suggests a strong relationship between these variables and life expectancy.

Significant Variables:

GDP: A significant positive relationship with life expectancy (p < 0.01). For every 10% increase in GDP, life expectancy increases by approximately 2.5 years.

Adult Mortality: A significant negative relationship with life expectancy (p < 0.01). A decrease of 20 deaths per 1,000 in adult mortality leads to an increase of about 3.1 years in life expectancy.

Immunization Rate: A positive but smaller effect compared to GDP and mortality. Increasing immunization coverage by 10% increases life expectancy by 1.2 years.

4. Simulation Outcomes

To simulate the potential impact of socio-economic changes on life expectancy, we modeled various scenarios:

Scenario 1: GDP Increase by 10%:

Predicted life expectancy increases by 2.5 years.

Scenario 2: Adult Mortality Decrease by 20 deaths per 1,000:

Predicted life expectancy increases by 3.1 years.

Scenario 3: Immunization Rate Increase by 10%:

Predicted life expectancy increases by 1.2 years.

Combined Scenario:

If all three improvements occur simultaneously (i.e., 10% increase in GDP, 20-death reduction in adult mortality, and 10% increase in immunization rates), life expectancy would increase by approximately

6.8 years. This demonstrates the substantial benefits of multi-pronged policy interventions focused on economic development, healthcare improvement, and immunization coverage.

5. Validation and Sensitivity Analysis

To validate the model, predicted life expectancy values were compared with actual values from the dataset:

Mean Absolute Error (MAE): The average error between the predicted and actual life expectancy was relatively low, indicating that the model fits well. The residuals analysis showed no significant patterns, confirming that the model was appropriately specified.

Sensitivity Analysis:

The adult mortality rate had the largest effect on life expectancy, followed by GDP. This highlights the importance of reducing preventable deaths in adulthood through healthcare interventions.

The immunization rate also plays a role, but its influence is smaller compared to the other factors, suggesting that while important, immunization alone may not lead to large improvements in life expectancy without addressing other critical factors.

6. Policy Implications

The findings from the regression analysis and simulation suggest several important implications for public health policy:

1.Investment in Healthcare: The reduction of adult mortality has the largest effect on life expectancy. Policies focused on improving healthcare infrastructure, preventing non-communicable diseases, and increasing access to treatment for infectious diseases should be prioritized. Investment in public health systems can reduce adult mortality and improve life expectancy across countries.

2.Economic Growth: The positive relationship between GDP and life expectancy highlights the importance of economic development. Policies that boost economic growth, reduce poverty, and improve the standard of living can have long-term health benefits.

3. Immunization Programs: Although immunization rates showed a smaller effect on life expectancy, increasing immunization coverage can still lead to healthier populations, especially in low-income countries where preventable diseases are still prevalent. Immunization programs must remain a cornerstone of public health policy.

4.Integrated Approach: The combined scenario shows that addressing multiple socio-economic factors simultaneously can have a substantial impact on life expectancy. Policies that integrate economic, healthcare, and public health interventions are likely to be the most effective.

7. Conclusion

This analysis provides valuable insights into the complex relationship between life expectancy and socio-economic factors. Reducing adult mortality, boosting GDP, and increasing immunization rates can significantly enhance life expectancy. The model emphasizes the need for a holistic approach to public health policy, where socio-economic development and healthcare improvements go hand in hand to improve population health.

Governments and public health organizations can use these findings to guide policy decisions, focusing on areas with the highest potential impact to maximize health outcomes and increase life expectancy.