

# A Linear Regression Analysis of Factors Affecting Social Determinants of Health Indicators

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## ABSTRACT

**Background.** Social determinants of health are wider set of forces and systems that greatly influence an individual's health outcomes.

**Objective.** This study aims to determine the socio-economic indicators that influence certain health indicators focusing on maternal and children under-5 health.

**Methods.** Selected data from the World Health Organization (WHO), World Bank, and International Labor Organization (ILO) were primarily used to model health outcomes such as mortality rates, disability-adjusted life years, and deaths and injuries due to occupational injuries. A total of 194 countries were considered as respondents in this study. Linear hierarchical multiple regression was used to determine the relationship of social determinants of health on life expectancy at birth, maternal mortality ratio (per 100,000 live births), under-5 years mortality ratio, prevalence of overweight in children under-5 years, and death rate (per 100,000 population).

**Results.** Data from 194 countries shows that the global average life expectancy is 55.7 years. The global average maternal mortality ratio is 1119.509 per 100,000 live births, and maternal mortality is significantly increased by factors such as increase in total vulnerable employment, total unemployment, and CPIA gender equality rating. Focusing on children's health outcomes, the global average under-5 mortality rate was 102.247 per 100,000 live births. Mortality rate for children under-5 increases with total vulnerable employment and total unemployment, while adult literacy rate, 1 medical doctor per 10,000 population, and food safety level decreases under-5 mortality rates. The global overweight prevalence in children under-5 is 10.389%. The increase in average monthly earnings of employees working in service and sales increases its prevalence. For death rate, the global average is 682.818 per 100,000 population. This is further positively affected by an increase in rural population and total unemployment. On the other hand, adult literacy rate decreases death rate.

**Conclusion.** Socio-economic factors such as income, education, employment, and government support influence maternal and children under-5 health indicators. Thus, programs, projects, and activities that aim to positively affect the health of the public should be holistic and should also focus on positively altering the health behavior of the public.

**Keywords:** social determinants of health, maternal mortality, children under-5 mortality, mortality



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## INTRODUCTION

The 125 member-states of the World Health Organization (WHO) in its meeting on October 11, 2022 in Rio de Janeiro made a consensus to address the social determinants of health in order to achieve health inequity globally, hence, the ratification of the Political Declaration on Social Determinants of Health. These determinants include the following – income and social protection, education, unemployment and job insecurity, working life conditions, housing, basic amenities, and the environment, among others.<sup>1</sup> Although there have been measures to address SDH in public policy research, health inequality still exists as it has not fully reached government's policy agenda.

## METHODS

In this study, the databases of three international organizations – the WHO, the World Bank (WB), and the International Labor Organization (ILO) are compiled into one database, and called the Social determinants of Health (SDH). The database comes from the 194 countries with latest measurement of health and socio-economic indicators for each country as of 2021. Socio-economic variables are used as independent variables to project health outcomes including mortality rates, disability-adjusted life years, and deaths and injuries due to occupational injuries.<sup>2</sup>

The SDH categories in the “Social Determinants of Health: used as independent variables the following: 1) Income and Income Distribution; 2) Education; 3) Unemployment and Job Security; 4) Employment and Working Conditions; 5) Early Child Development; 6) Food Insecurity; 7) Housing; 8) Social Exclusion; 9) Social Safety Net; 10) Health Services; 11) Geography; 12) Disability; 13) Indigenous Ancestry; 14) Gender; 15) Immigration; 16) Race; and 17) Globalization.<sup>3</sup>

The WB Open Data was used for socio-economic variables such as poverty rate, illiterate population, GINI index, among others.<sup>4</sup> Data from World Health Organization are extracted from WHO's Global Health Observatory website.<sup>5</sup> Data from the ILO are used for labor statistics such as income, employment rate, among others, and extracted from ILOSTAT.<sup>6</sup> The Global Burden of Disease Study 2019, retrieved from the Global Health Data Exchange website is used for death rate data.<sup>7</sup>

For the Upper-Middle Income Group, there are 54 countries included. Similarly, indicators with a maximum of 10% missing values (5 missing values) are included. Variables with 0 variance are dropped as factor analysis cannot proceed with this variance.

These data sources from the WB Open Data website.<sup>4</sup> Data from WHO provided a wide range of socio-economic indicators and health statistics. The collected data were then merged into a single cohesive dataset, aligning data based on country. To address missing data, an imputation method was employed, using the average of the income classification

(low, lower-middle, upper-middle, and high income) for each country in order to maintain the socio-economic context. The Appendix shows the sources of data for the various variables on social determinants of health used in this study.

Socio-economic variables are assigned the independent variables (or factors), while health outcomes are assigned as dependent variables. Linear regression analysis was conducted independently for each health outcome, specifying health outcomes as dependent variables and socio-economic factors as independent variables. Each regression model specified a health outcome as the dependent variable and included relevant socio-economic factors as independent variables. Regression coefficients were estimated to understand the relationship between socio-economic factors and health outcomes.

## RESULTS

Table 1 shows the mean and standard deviation for the variables on social determinants of health considered in the analysis for 194 countries.

### Life Expectancy at Birth (years)

The overall regression was statistically significant. The R-Square suggested that 53.4% of the dependent variable was explained by the model. The average life expectancy, considering all factors at zero, was 55.751 years. For every 1% increase in vulnerable employment, life expectancy decreased by 0.05 years. For every 1% increase in access to electricity, life expectancy increased by 0.09. For every 10% increase in total unemployment, life expectancy decreased by 2.19 years. For every 10 units increase in median daily per capita income or consumption expenditure, life expectancy increased by 1 year. For every 1% increase in general government expenditure on health, life expectancy increased by 0.185 years. For every 1% increase in population covered by at least one social protection benefit, life expectancy increased by 0.029 years. For every 1% increase in adult literacy rate (population 15+ years, both sexes), life expectancy increased by 0.066 years. For every 1% increase in population access to clean fuels and technologies for cooking, life expectancy increased by 0.029 years. For every 1% increase in population deprived of drinking water, life expectancy decreased by 0.06 years. (Table 2)

### Maternal Mortality Ratio

The model in Table 3 was also statistically significant where R-square suggested 53.4% of the dependent variable was explained by the model. The average maternal mortality ratio, considering all variables at zero, was 1119.509 per 100,000 live births. A 1% increase in the population with access to electricity, of adult literacy rate (population 15+ years), deprived of educational enrollment, and of the proportion of youth not in education, employment, or training (NEET) decreased the maternal mortality ratio by 2.939, 4.330, 3.651, and 2.62 per 100,000 live births, respectively.

A 1% increase in the population of total vulnerable employment, of total unemployment, and those deprived of electricity increased the maternal mortality ratio by 1.686, 4.262, and 1.229 per 100,000 live births, respectively. A 1 level increase of the CPIA gender equality rating decreased the maternal mortality ratio by 87.466 per 100,000 live births. A 1 unit increase in the food safety level decreased the maternal mortality ratio by 1.355 per 100,000 live births. (Table 3)

### Under-5 Mortality Ratio

The regression model presented in Table 4 was statistically significant where the R-square suggested that 84.3% of the dependent variable was explained by the model. Holding all variables at zero, the average under-5 mortality rate was 102.247 per 100,000 live births. A 1% increase in population with access to electricity, and adult literacy rate (population 15+ years) decreased the under-5 mortalities by 0.288 and 0.344 per 100,000 live births, respectively. A 1% increase in total vulnerable employment, total unemployment, and population deprived of electricity increased under-5 mortalities by 0.298, 0.474, and 0.29 per 100,000 live births, respectively. An increase of 1 medical doctor per 10,000 population decreased under-5 mortalities by 0.229 per 100,000 live births. An increase in the CPIA gender equality

rating by 1 level decreased the under-5 mortalities by 7.85 per 100,000 live births. A 1 unit increase in food safety level decreased under-5 mortalities by 0.13 per 100,000 live births. A 1% growth in adjusted net national income per capita decreased under-5 mortalities by 0.068 per 100,000 live births. (Table 4)

### Overweight in Children Under-5

The overall regression was statistically significant ( $R^2 = 0.259$ ,  $F(4, 189) = 16.505$ ,  $p < 0.0001$ ). R-square suggests that 25.9% of the dependent variable was explained by the model. Holding all variables at zero, the average prevalence of overweight in children under-5 is 10.389%. A 1,000 increase in the non-agriculture informal employment decreased the prevalence of overweight in children under-5 by 0.110%. A 1 dollar increase in the average monthly earnings of employees working in service and sales increased the prevalence of overweight in children under-5 by 0.0003%. An increase of 1 person in every 100,000 dying due to occupational injuries in education increased the prevalence of overweight in children under-5 by 0.308%. An increase of 1 person in every 100,000 dying due to occupational injuries in other service activities increased the prevalence of overweight in children under-5 by 0.104%. (Table 5)

**Table 1.** Mean and Standard Deviation of Variables on Social Determinants of Health for 194 Countries<sup>4-7</sup>

| Variables  | Mean      | Std. Deviation |
|--|-----------|----------------|
| Death Rate (per 100k) – GHDE 2019  | 773.3     | 267.7          |
| Life expectancy at birth (years)   | 71.9      | 7.2            |
| Maternal mortality ratio (per 100,000 live births)                                       | 160.8     | 226.7          |
| Under-five mortality rate (per 1,000 live births)  | 28.1      | 28.4           |
| Adult illiterate population, 15+ years, both sexes (number)                              | 5812497.0 | 18985003.5     |
| Median daily per capita income or consumption expenditure (2011 PPP)                     | 21.5      | 11.1           |
| Multidimensional poverty, Drinking water (% of population deprived)                      | 11.5      | 11.9           |
| Multidimensional poverty, Educational attainment (% of population deprived)              | 14.0      | 15.4           |
| Multidimensional poverty, Educational enrollment (% of population deprived)              | 10.2      | 9.2            |
| Access to clean fuels and technologies for cooking (% of population)                     | 67.5      | 37.2           |
| Access to electricity (% of population)  | 85.4      | 24.4           |
| Adjusted net national income per capita (annual % growth)                                | 4.1       | 25.4           |
| CPIA gender equality rating (1=low to 6=high)  | 3.4       | 0.5            |
| Rural population (% of total population)   | 40.5      | 22.8           |
| Unemployment, total (% of total labor force) (modeled ILO estimate)                      | 8.4       | 5.7            |
| Vulnerable employment, total (% of total employment) (modeled ILO estimate)              | 38.4      | 26.2           |
| Population covered by at least one social protection benefit                             | 54.7      | 24.5           |
| Proportion of youth (aged 15-24 years) not in education, employment or training (%)      | 20.1      | 9.7            |
| Non-agriculture Informal employment (thousands)  | 6295.3    | 12993.0        |
| Urban (Average) Concentrations of fine particulate matter (PM <sub>2.5</sub> )           | 25.4      | 16.7           |
| General government expenditure on health as a percentage of total government expenditure | 11.7      | 4.9            |
| Food Safety Level C4   | 64.7      | 25.3           |
| Density of medical doctors (per 10,000 population)                                       | 18.6      | 16.7           |

### Death Rate per 100,000 population

The overall regression model in Table 6 was statistically significant where R-squared suggested that 58.6% of the dependent variable was explained by the model. Holding all variables at zero, the average death rate was 682.818 per 100,000 population. A 1% increase in rural population, population covered by at least one social protection benefit, and total unemployment increased the death rate by 3.846, 2.630, and 8.900 per 100,000 population. An increase of 1 medical doctor per 10,000 population increased the death rate by 7.488 per 100,000 population. A 1 unit increase in average urban concentration of fine particulate matter decreased the death rate by 3.735 per 100,000 population. A 1% increase in adult literacy rate (population 15+ years) decreased the death rate by 3.954 per 100,000 population. (Table 6)

## DISCUSSION

The study has shown that social determinants of health indeed affect or correlate with health outcomes of populations in countries included in this study. Specifically, the findings

are - high sustainable development index including increase in median daily per capita income or consumption expenditure increases life expectancy; adult literacy was found to decrease maternal mortality; under-5 mortality is decreased by access to electricity, and adult literacy rate; increase in employment decreases overweight in children under-5; and death rate per 100,000 population is decreased by total unemployment and adult literacy rate.

### Life Expectancy

Life expectancy has been increasing globally for most countries due to better control of diseases. Countries with higher sustainable development index (SDI) also had higher increases in life expectancy than those with lower SDI.<sup>8</sup> We see this reflected in the analysis of the study as well where economic variables such as median daily per capita income and government health expenditure were all positively associated with increase in life expectancy due to better use and efficiency of health services and care. However, aside from health expenditure, social benefits and other policies that can shift the burden of costs from the individual to the

**Table 2.** Linear Regression Model on Life Expectancy at Birth

| Independent Variables  | Parameter Estimate | Std. Error | p-value | 95% CI for Parameter Estimate |             |
|--|--------------------|------------|---------|-------------------------------|-------------|
|  |                    |            |         | Lower Bound                   | Upper Bound |
| (Constant)   | 55.75              | 3.04       | <0.001  | 49.76                         | 61.75       |
| Vulnerable employment, total (% of total employment) (modeled ILO estimate)              | -0.05              | 0.02       | 0.01    | -0.09                         | -0.01       |
| Access to electricity (% of population)  | 0.09               | 0.02       | <0.001  | 0.05                          | 0.13        |
| Unemployment, total (% of total labor force) (modeled ILO estimate)                      | -0.22              | 0.04       | <0.001  | -0.30                         | -0.14       |
| Median daily per capita income or consumption expenditure (2011 PPP)                     | 0.10               | 0.02       | <0.001  | 0.05                          | 0.15        |
| General government expenditure on health as a percentage of total government expenditure | 0.19               | 0.05       | <0.001  | 0.09                          | 0.28        |
| Population covered by at least one social protection benefit                             | 0.03               | 0.01       | 0.01    | 0.01                          | 0.05        |
| Adult literacy rate, population 15+ years, both sexes (%)                                | 0.07               | 0.02       | <0.001  | 0.02                          | 0.11        |
| Access to clean fuels and technologies for cooking (% of population)                     | 0.03               | 0.01       | 0.03    | 0.00                          | 0.06        |
| Multidimensional poverty, Drinking water (% of population deprived)                      | -0.06              | 0.03       | 0.04    | -0.11                         | 0.00        |

**Table 3.** Linear Regression Model on Maternal Mortality Ratio (per 100,000 live births)

| Independent Variables   | Parameter Estimate | Std. Error | p-value | 95% CI for Parameter Estimate |             |
|---|--------------------|------------|---------|-------------------------------|-------------|
|   |                    |            |         | Lower Bound                   | Upper Bound |
| (Constant)  | 1119.51            | 108.78     | <0.001  | 904.90                        | 1334.12     |
| Access to electricity (% of population)   | -2.94              | 0.64       | <0.001  | -4.19                         | -1.68       |
| Adult literacy rate, population 15+ years, both sexes (%)                           | -4.33              | 0.71       | <0.001  | -5.74                         | -2.92       |
| Vulnerable employment, total (% of total employment) (modeled ILO estimate)         | 1.69               | 0.49       | <0.001  | 0.72                          | 2.65        |
| CPIA gender equality rating (1=low to 6=high)                                       | -87.47             | 17.81      | <0.001  | -122.59                       | -52.34      |
| Multidimensional poverty, Educational enrollment (% of population deprived)         | -3.65              | 0.95       | <0.001  | -5.53                         | -1.77       |
| Food Safety Level C4  | -1.36              | 0.40       | <0.001  | -2.14                         | -0.57       |
| Proportion of youth (aged 15-24 years) not in education, employment or training (%) | -2.62              | 0.83       | <0.001  | -4.25                         | -0.99       |
| Unemployment, total (% of total labor force) (modeled ILO estimate)                 | 4.26               | 1.44       | <0.001  | 1.42                          | 7.11        |
| Multidimensional poverty, Electricity (% of population deprived)                    | 1.23               | 0.52       | 0.02    | 0.20                          | 2.26        |

government also improve life expectancy. In fact, in the study of Zarulli et al. across 140 countries, they found that countries with the lowest health expenditure have more years added to their life expectancy than those with already high health expenditure.<sup>9</sup> The former can also still significantly increase their life expectancy without increasing health expenditure if efforts are focused towards improving social protection through increased employment and income. This is also observed in the United States where health expenditure is among the highest compared to other countries, yet life expectancy is not as high as expected. Reasons for this may be explained by the presence of welfare and other social policies (i.e., benefits of pension, unemployment, sickness).<sup>10,11</sup> We see these reflected as well in the study's analysis where social

protection benefits and adult literacy led to increases in life expectancy.

An individual's direct environment also plays a role in improving life expectancy as observed in the model. Access to electricity and clean fuels and technologies for cooking improved life expectancy, while deprivation of drinking water decreased life expectancy. These indicators do not only reflect the individual's direct access to healthier option but rather reflect their environment and socioeconomic situation. Those with poorer access to these resources often come from lower socioeconomic statuses where income is unstable and resources are only enough to survive. Moreover, the instability of their situation causes constant worry which negatively affects health.<sup>12</sup> In the study of Rahman et al.

**Table 4.** Linear Regression Model on Under-5 Mortality Ratio (per 100,000 live births)

| Independent Variables   | Parameter Estimate | Std. Error | p-value | 95% CI for Parameter Estimate |             |
|---|--------------------|------------|---------|-------------------------------|-------------|
|   |                    |            |         | Lower Bound                   | Upper Bound |
| (Constant)  | 102.25             | 10.41      | <0.001  | 81.71                         | 122.79      |
| Access to electricity (% of population)                                     | -0.29              | 0.07       | <0.001  | -0.42                         | -0.16       |
| Vulnerable employment, total (% of total employment) (modeled ILO estimate) | 0.30               | 0.06       | <0.001  | 0.18                          | 0.42        |
| Density of medical doctors (per 10,000 population)                          | -0.23              | 0.07       | <0.001  | -0.36                         | -0.10       |
| CPIA gender equality rating (1=low to 6=high)                               | -7.85              | 2.01       | <0.001  | -11.82                        | -3.88       |
| Adult literacy rate, population 15+ years, both sexes (%)                   | -0.34              | 0.08       | <0.001  | -0.50                         | -0.19       |
| Food Safety Level C4  | -0.13              | 0.05       | <0.001  | -0.22                         | -0.04       |
| Unemployment, total (% of total labor force) (modeled ILO estimate)         | 0.47               | 0.16       | <0.001  | 0.17                          | 0.78        |
| Multidimensional poverty, Drinking water (% of population deprived)         | 0.26               | 0.11       | 0.02    | 0.05                          | 0.47        |
| Adjusted net national income per capita (annual % growth)                   | -0.07              | 0.03       | 0.04    | -0.13                         | 0.00        |

**Table 5.** Linear Regression Model on Prevalence of Overweight in Children Under-5

| Independent Variables   | Parameter Estimate | Std. Error | p-value | 95% CI for Parameter Estimate |             |
|---|--------------------|------------|---------|-------------------------------|-------------|
|   |                    |            |         | Lower Bound                   | Upper Bound |
| (Constant)  | 10.39              | 0.88       | <0.0001 | 8.65                          | 12.13       |
| Non-agriculture Informal employment (thousands)   | -0.11              | 0.02       | <0.0001 | -0.15                         | -0.07       |
| Service and sales workers PPP \$ Average monthly earnings of employees                        | 0.00               | 0.00       | <0.0001 | 0.00                          | 0.00        |
| Education Fatal occupational injuries per 100,000 workers by economic activity                | 0.31               | 0.10       | 0.003   | 0.11                          | 0.51        |
| Other service activities Fatal occupational injuries per 100 000 workers by economic activity | 0.10               | 0.05       | 0.05    | 0.00                          | 0.21        |

**Table 6.** Linear Regression Model on Death Rate per 100,000 Population

| Independent Variables  | Parameter Estimate | Std. Error | p-value | 95% CI for Parameter Estimate |             |
|--|--------------------|------------|---------|-------------------------------|-------------|
|  |                    |            |         | Lower Bound                   | Upper Bound |
| (Constant)   | 682.82             | 138.90     | <0.001  | 408.80                        | 956.83      |
| Density of medical doctors (per 10,000 population)                             | 7.49               | 1.28       | <0.001  | 4.96                          | 10.02       |
| Rural population (% of total population)                                       | 3.85               | 0.90       | <0.001  | 2.07                          | 5.62        |
| Population covered by at least one social protection benefit                   | 2.63               | 0.81       | <0.001  | 1.03                          | 4.23        |
| Urban (Average) Concentrations of fine particulate matter (PM <sub>2.5</sub> ) | -3.74              | 1.02       | <0.001  | -5.74                         | -1.73       |
| Unemployment, total (% of total labor force) (modeled ILO estimate)            | 8.90               | 2.85       | <0.001  | 3.28                          | 14.52       |
| Adult literacy rate, population 15+ years, both sexes (%)                      | -3.95              | 1.27       | <0.001  | -6.45                         | -1.46       |



which looked at the most polluted countries, they found that access to clean water and improved sanitation contributed to an increase in life expectancy.<sup>13</sup> In another study by Tafran et al., drinking water, cooking fuel, and access to electricity were all associated with improved life expectancy.<sup>14</sup>

In terms of employment, the analysis in this study found negative association between vulnerable employment and unemployment with life expectancy. Although a reduction in unemployment may improve life expectancy, from this analysis, it was observed that employment alone does not necessarily lead to improved life expectancy, contrary to popular belief. This was also observed in the study of Assari where the effect of employment on life expectancy was influenced by race, sex, and education due to its subsequent influence on the type of employment gained.<sup>15</sup> In this study, vulnerable and informal forms of employment were associated with poorer life expectancy. This may be due to greater occupational hazards and poorer employment protection which can lead to higher rates of occupational injuries.<sup>16,17</sup> Those employed in the informal sector also use health services less which may be spurred from poorer pay and lack of employment benefits.<sup>18</sup>

### Maternal Mortality Ratio

Multiple factors which span biological, social, economic, and political spheres can contribute to maternal mortality. Globally, the common causes of maternal mortality are hemorrhage, hypertensive disorders, sepsis, abortion, embolism, and other complications directly causing death. However, these causes are often a reflection of the lack of skilled health delivery and clean health facilities to oversee an individual's maternal health.<sup>19</sup> This is especially evident in the disparity of maternal mortality ratio among higher income countries compared to lower income countries.<sup>20,21</sup> It is also clear that maternal mortality ratio is largely driven by socioeconomic and political factors as high income countries with better health care services than most countries still experience disparities in maternal mortalities between certain populations.<sup>21</sup> This notion is also supported by the associations yielded in the study's analyses. Among the political issues faced by women is gender inequality. In the study's analysis, an increase in gender equality reduced maternal mortality rates. Gender inequality is associated with decreased women empowerment, access to economic opportunities, and restricted decision-making. These translate into the lack of policies that support the needs of women, including those concerning their maternal health.<sup>22-24</sup>

Vulnerable employment and unemployment increased the rates of maternal mortality ratio in the analysis done. As previously mentioned, these types of employment tend to be associated with more hazardous working environment and poor to no employment benefits. In a study in the United States, lack of insurance or public insurance was associated with higher risk of severe maternal morbidity such as a pre-eclampsia. They were also more likely to be hospitalized and readmitted.<sup>25</sup> Maternal outcome is not only affected by the

employment status of the mother but those of the father since employment is found to be associated with better health care service use.<sup>26</sup> Unemployed women were more likely to become pregnant at a younger age where their bodies are still growing, and engage in risky behavior such as smoking and alcohol use. Additionally, unemployed mother and father is associated with higher risks of diabetes and anemia during pregnancy.<sup>27</sup> Income plays a role in improving one's socioeconomic status which is associated with better health.<sup>28,29</sup> Better socioeconomic status also allows them better access to basic needs such as electricity and safe food products. In fact, food insecure households were found to be associated with greater risk of post-partum depression in addition to poorer health.<sup>30</sup> Pregnant women with unstable housing situations, where access to basic utilities is lacking, were more likely to experience birth complications and compromised infant survival.<sup>31</sup> Among pregnant women, knowledge on food safety practices (i.e., hand hygiene, food purchase, storage, preparation) are important in maintaining health and preventing foodborne diseases.<sup>32</sup>

In the analysis of this study, adult literacy was found to decrease maternal mortality. However, an increased proportion of youth NEET and population deprived of education enrollment led to a decrease in maternal mortality. The UNICEF also reported that 15% of women deliver a baby before they reach the age of 18 years, and maternal conditions are among the top 5 causes of DALYs and mortalities among women aged 15-19 years.<sup>33</sup> This is consistent with studies that have observed higher risk of maternal mortality and poor health during pregnancy among the female adolescent population.<sup>34,35</sup> However, the study of Azevedo et al., also observed that higher educational attainment was associated with lower teen pregnancy prevalence.<sup>34</sup> In this study, education itself may not necessarily prevent pregnancy, rather the form of sex education being taught in schools. Therefore, even if education enrollment were to increase, poor sex education may still lead to increased adolescent pregnancies.<sup>36,37</sup>

### Under-5 Mortality Ratio

Under-5 mortalities still prevail due to infectious and vaccine-preventable causes. Incidences further increase in areas with poor sanitation, poor hygiene practices, and unpotable water.<sup>38,39</sup> It is worthy to note that similar factors found to increase maternal mortality rates also increased under-5 mortality. Although these were not exactly alike, they reflect similar socioeconomic needs. Examples of such are vulnerable employment, income, electricity, employment status, gender equality, food safety, and adult literacy. This is not surprising because children rely greatly on their mother for their physical health and development. Often times, a mother at risk for poor health is also at risk of delivering sickly infants.<sup>27,40</sup> The mother's socioeconomic and political situation also determines her access to health care services and proper health education for child raising.<sup>41,42</sup> It is

possible that these factors serve as mediator to the health of a child due to its influence to household socioeconomic status and health-seeking behavior.<sup>43</sup> Studies have observed that the socioeconomic status of the mother and father can contribute to a child's risk for disease and malnutrition.<sup>42-44</sup>

Added variables that influenced under-5 mortality in the analysis of this study were density of medical doctors and population deprived of drinking water. The latter increases under-5 childhood mortality due to its role in spreading waterborne diseases. This is especially evident with the high rates of under-5 mortality due to diarrhea.<sup>39</sup> Communities with little to no access to clean water are also more likely to experience higher infant and child mortality rates.<sup>45</sup> In this study, an increase in the density of medical doctors led to a decrease in under-5 mortality rates. This is consistent with other findings where an increase in physicians was associated with a reduction of infant and child mortalities.<sup>46-48</sup> Aside from having increased access to a skilled medical professional, physicians play a crucial role in encouraging community organization for better health.<sup>49</sup>

### Overweight in Children Under-5

Among overweight children under-5, factors that contributed to an increased prevalence of overweight were increases in monthly earnings (service and sales workers), education, fatal occupational injuries, and other service fatal occupational injuries. Only an increase in non-agricultural informal employment decreased prevalence of overweight in children under-5. Among children under-5, 5.7% globally were overweight.<sup>50,51</sup> According to the study of Brophy et al., risk factors for obesity by the age of 5 were low income and low education of the family.<sup>52</sup> Introducing solid foods by three months was also found to contribute to obesity prevalence. Fatal occupational injuries, which may reflect a loss of income for affected families, led to an increase in overweight prevalence for children under-5. Low-income status and decreased ability to spend for their children's needs were commonly found to be associated with higher prevalence of overweight by other studies.<sup>53,54</sup> The inequality in prevalence between children from high and low socioeconomic backgrounds boiled down to the health promoting practices of the parents. Those from lower socioeconomic backgrounds were more likely to practice risky health practices and be at risk themselves.<sup>55</sup> The role of the parents plays an influence in the occurrence of obesity among children under-5. Parents with increased BMI and who practiced restrictive feeding on their child were likely to increase the risk of childhood obesity.<sup>56,57</sup> As previously mentioned, informal employment is associated with poor to no benefits. It also does not guarantee a steady stream of income due to its informal, unregulated and, sometimes, illegal nature.<sup>58</sup> It is not unlikely that a more prevalent health concern among families with unstable income and decreased access to food sources, such as in the case of non-agricultural informal employment, is undernutrition.

### Death Rate per 100,000 Population

This study observed that an increase in the density of medical doctors increased the death rate per 100,000 population. However, this is inconsistent with findings of other studies where they observed a general decrease in unfavorable health outcomes (i.e., under-5 mortality, maternal mortality, infant mortality) due to an increase in doctors.<sup>59-61</sup> An increase in the percentage of the total rural population was also associated with an increase in mortality. An increase in rural mortality compared to urban mortalities were observed in Sub-Saharan Africa for under-5 mortality and infant mortality.<sup>62,63</sup> However, other countries, such as Indonesia, observed a reduction in mortality among the adult population in rural areas in terms of life expectancy.<sup>64</sup> The increase in death rate for every increase in the rural population observed in this study may be explained due to lack of access to advanced health care facilities and better performance services, especially in terms of emergency medical services. In fact, emergency patients are more likely to survive in urban settings rather than rural settings.<sup>65</sup> Injury rates and its severity were also observed to occur more often in rural areas compared to urban areas which may contribute to the observed increase in death rates in rural areas.<sup>66</sup>

An increase in the population covered by at least one social protection benefit was observed to increase the death rate per 100,000 population. This is consistent with the finding among high income countries where those receiving social assistance were more likely to report poorer health and experience more adverse health outcomes. This may be because those needing social assistance were more likely to already have health problems and come from lower socioeconomic backgrounds.<sup>67</sup> The systematic review of Hillier-Brown et al. also observed low evidence to support the effect of any social policy in the improvement of health.<sup>68</sup> Courtin et al. observed varying evidence supporting the presence of social welfare programs and health improvement with a few even associated with worsening health.<sup>69</sup> However, they observed an improvement of health for those receiving income maintenance and health insurance benefits. Therefore, it is important to specify the social protection benefit as effects vary depending on the type.

Total unemployment was observed to increase the death rate per 100,000 for every increase; while an increase in adult literacy, which can reflect educational attainment, was observed to reduce the death rate per 100,000. Unemployment can affect health by reducing access to basic needs and encourage harmful coping responses. In the study of Vagero and Garcy, unemployed individuals were more likely to engage in alcohol consumption and consider suicide.<sup>70</sup> Another study reported that the negative effects of unemployment are further compounded when educational attainment is high due to the occurrence of status inconsistency. This occurs when a highly educated individual is in a position lower than what their skills qualify for.<sup>71</sup> This is interesting to note, as the present study found that adult literacy can reduce mortality rates.

Adult literacy may also improve health by encouraging health literacy. Factors that affect health literacy included variables such as education attained by the individual and income. When both these variables were low, health literacy was also low translating to poor health practices.<sup>72,73</sup>

This study also observed that average concentrations of fine particulate matter in urban areas lead to a reduction in death rate. This may be due to varying forms of fine particulate matter abundant in rural areas compared to urban areas. In England, rural areas recorded higher concentrations of ozone and nitrate. However, rather than the type of area, the level of deprivation was associated with PM<sub>2.5</sub> concentrations.<sup>74</sup> Findings from China also observed that PM<sub>2.5</sub> attributable mortalities were higher in urban areas rather than rural areas.<sup>60</sup> However, a reduction of mortalities due to urban concentration of fine particulate matter rather than rural may be due to increased household particulate matter in the latter. This is due to biomass cooking, which is a common practice in rural areas.<sup>75,76</sup>

The potential impact of the study results show the need to incorporate the social determinants of health in the policy agenda of governments in order to achieve better health outcomes and health equity. The SDH approach is vital in assessing the health risks among farmers and fishermen for the following reasons- 1.) Public health framework inclusion of social determinants of health is better than the mere “treat and cure” approach. Hence, social scientists and policy experts should be part of any health policy formulation; 2.) Policy coordination among various actors and players is important. There are various agencies and actors within the complex of stakeholder interactions. The coordination among different policy levels (local, regional, and national), and across agencies (labor and productivity, health, agriculture, and fisheries), as well as policy types (programs, funding, information, and regulation) is desirable and can be useful in achieving universal and targeted goals; 3.) Examination of the local context for health programs is essential in order to cater to the specific needs of population groups given their specific environmental, structural, cultural, and political milieu; and 4.) Researches should aim for policy action and their adoption for government policy agenda.

## CONCLUSION

This study looked into certain health indicators and a possible association with various socioeconomic indicators. What was clear to see was that socioeconomic factors, especially those pertaining to income, education, and employment, were constantly associated with significant increases in poor health outcomes and mortalities.

As such, factors like median daily capita income or consumption expenditure, general government expenditure on health, and social protection benefits affect life expectancy. Maternal and children under-5 mortality rates increase with an increase in both total vulnerable employment and total

employment while death rate decreases with an increase in adult literacy rate. This shows the importance of giving national programs that are holistic in approach and also aim to provide positive behavior change in terms of health for sustainability.

A limitation of this study was the lack of an aggregate analysis specific for urban and rural indicators. It is recommended that studies look into the effects of specific employment status and the occurrence of health outcomes. Studies should also look into unique factors that influence the health in higher income countries versus lower income countries as this may provide a unique perspective on the health disparities plaguing each country.

## Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

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## APPENDIX

### Variables Considered in the Analysis of Social Determinants of Health

| Variables  | Data Source                         |
|--|-------------------------------------|
| Death Rate (per 100,000 population)*   | Global Burden of Disease Study 2019 |
| Life expectancy at birth (years)*  | World Health Organization           |
| Maternal mortality ratio (per 100,000 live births)*  | World Health Organization           |
| Under-five mortality rate (per 1,000 live births)*   | World Health Organization           |
| Chronic obstructive pulmonary disease death rate (per 100,000 population, age-standardized)* | World Health Organization           |
| Ischaemic heart disease death rate (per 100,000 population, age-standardized)*               | World Health Organization           |
| Stroke death rate (per 100,000 population)*  | World Health Organization           |
| Trachea, bronchus, lung cancers death rate (per 100,000 population, age-standardized)*       | World Health Organization           |
| Total Disability-adjusted life years (DALYs) attributable to the environment*                | World Health Organization           |
| Total Deaths attributable to the environment (%)*  | World Health Organization           |
| Total Cases of non-fatal occupational injury*  | International Labor Organization    |
| Total Cases of fatal occupational injury*  | International Labor Organization    |
| Adult illiterate population, 15+ years, both sexes (number)                                  | World Bank                          |
| Adult illiterate population, 15+ years, female (number)                                      | World Bank                          |
| Adult illiterate population, 15+ years, male (number)  | World Bank                          |
| Adult literacy rate, population 15+ years, both sexes (%)                                    | World Bank                          |
| Gini index (World Bank estimate)   | World Bank                          |
| Median daily per capita income or consumption expenditure (2011 PPP)                         | World Bank                          |
| Multidimensional poverty, Drinking water (% of population deprived)                          | World Bank                          |
| Multidimensional poverty, Educational attainment (% of population deprived)                  | World Bank                          |
| Multidimensional poverty, Educational enrollment (% of population deprived)                  | World Bank                          |
| Multidimensional poverty, Electricity (% of population deprived)                             | World Bank                          |
| Multidimensional poverty, Headcount ratio (% of population)                                  | World Bank                          |
| Multidimensional poverty, Monetary poverty (% of population deprived)                        | World Bank                          |
| Multidimensional poverty, Sanitation (% of population deprived)                              | World Bank                          |
| Number of poor at \$3.10 a day (2011 PPP) (millions)   | World Bank                          |
| Access to clean fuels and technologies for cooking (% of population)                         | World Bank                          |
| Access to electricity (% of population)  | World Bank                          |
| Adjusted net national income (annual % growth)   | World Bank                          |
| Adjusted net national income per capita (annual % growth)                                    | World Bank                          |
| CPIA gender equality rating (1=low to 6=high)  | World Bank                          |
| Rural population   | World Bank                          |
| Rural population (% of total population)   | World Bank                          |
| Strength of legal rights index (0=weak to 12=strong)   | World Bank                          |
| Surface area (sq. km)  | World Bank                          |
| Unemployment, total (% of total labor force) (modeled ILO estimate)                          | World Bank                          |
| Urban population   | World Bank                          |
| Urban population (% of total population)   | World Bank                          |
| Vulnerable employment, total (% of total employment) (modeled ILO estimate)                  | World Bank                          |
| Population covered by at least one social protection benefit                                 | International Labor Organization    |
| Persons above retirement age receiving a pension   | International Labor Organization    |

Variables Considered in the Analysis of Social Determinants of Health (*continued*)

| Variables  | Data Source                      |
|--|----------------------------------|
| Unemployed receiving unemployment benefits   | International Labor Organization |
| Poor persons covered by social protection systems  | International Labor Organization |
| Vulnerable persons covered by social assistance  | International Labor Organization |
| Proportion of youth (aged 15-24 years) not in education, employment or training (%)      | International Labor Organization |
| Total U.S. dollars Average monthly earnings of employees                                 | International Labor Organization |
| Total Informal employment (thousands)  | International Labor Organization |
| Agriculture Informal employment (thousands)  | International Labor Organization |
| Non-agriculture Informal employment (thousands)  | International Labor Organization |
| Total Employment outside the formal sector (thousands)                                   | International Labor Organization |
| Agriculture Employment outside the formal sector (thousands)                             | International Labor Organization |
| Non-agriculture Employment outside the formal sector (thousands)                         | International Labor Organization |
| Agriculture Informal employment (thousands)  | International Labor Organization |
| Non-Agriculture Informal employment (thousands)  | International Labor Organization |
| Total (Average) Concentrations of fine particulate matter (PM <sub>2.5</sub> )           | World Health Organization        |
| Urban (Average) Concentrations of fine particulate matter (PM <sub>2.5</sub> )           | World Health Organization        |
| Rural (Average) Concentrations of fine particulate matter (PM <sub>2.5</sub> )           | World Health Organization        |
| General government expenditure on health as a percentage of total government expenditure | World Health Organization        |
| Food Safety Level C4   | World Health Organization        |
| Density of medical doctors (per 10,000 population)                                       | World Health Organization        |
| Density of nursing and midwifery personnel (per 10,000 population)                       | World Health Organization        |
| Density of dentists (per 10,000 population)  | World Health Organization        |
| Density of pharmacists (per 10,000 population)   | World Health Organization        |

\*Dependent Variable

Have you read the current trends in  
Medical and Health Research in the Philippines?

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