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with COVID-2019 cases? Findings from
a Philippine study**

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Abstract

Background: A wide spectrum of indicators has been postulated to associate with Coronavirus Disease 2019 (Covid-2019) cases. Among which were demographic profile, latitude, humidity, temperature, and ozone concentration. Despite obtaining significant results, there is still a dearth of research exploring other substantial determinants of Covid-2019 cases. The Philippine government is currently challenged to address issues pertaining to poverty and substinance. Empirical evidence of these studies suggests how identification of potential indicators could aid in the formulation of targeted strategies to mitigate future health problems. In this study, seven socio-economic indicators were associated with Covid-2019 cases across 17 regions in the Philippines.

Methods: This is a retrospective study utilizing readily accessible public data in the analysis. Socio-economic indicators used were poverty incidence, magnitude of poor families, substinance incidence, and magnitude of substinance poor population. In addition, the income, expenditure, and savings recorded per Philippine region were taken for the analysis. A single Philippine region was the sampling unit; hence, a total of 17 regions were assessed. Covid-2019 cases as of April 7, 2020 were considered for the analysis. Descriptive statistics, Kendall rank correlation, and stepwise regression were used to determine if the seven socio-economic indicators were associated with Covid-2019 cases.

Findings: Substinance incidence and income were retained for the regression model, which explained 87.2 percent of the variance in the Covid-2019 cases ($R^2 = .872$). The results indicated that for every 1,000 PhP increase in income, there was a decrease of 3.99 Covid-2019 cases in each Philippine region. Meanwhile, for every 1.0 percent increase in substinance incidence, there was an increase of 3.34 Covid-2019 cases in each Philippine region.

Interpretation: High income and low substinance incidence are associated with significant reductions in Covid-2019 cases across the 17 regions of the Philippines. This provides additional knowledge to policy makers and health officials in formulating targeted strategies to regions that could potentially record high number of Covid-2019 cases in the future. Early identification of these high-risk regions would warrant prompt preventive measures. Given the seasonal and recurring nature of Covid-2019 with respect to previous outbreaks, it is essential for the Philippine government to formulate directed policies and innovate programs that would decrease substinance and increase income. Concerted multi-region efforts should be made to prepare for possible infection outbreaks in the future. Additional studies could be explored in the future to capture significant changes in the socio-economic indicators.

Keywords: Covid-2019, SARS-CoV-2, novel coronavirus, socio-economic, poverty, substinance, income, expenditure, savings

Research in Context

Evidence before the study

Before conducting the study, original articles and published reviews in PubMed, Google Scholar, and PubMed Central (PMC) were searched describing the indicators significantly associated with Covid-2019 cases. Among the indicators of Covid-2019 cases extracted were demographic profile, latitude, humidity, temperature, and ozone concentration. In particular, age and sex were risk factors of the disease. The disease prevalence was high in areas with high latitude and humidity, extreme temperature, and sufficient ozone concentration. In the Philippines, one study reported that majority of Covid-2019 cases were male and elderly. Based on the review, there appears to be no published study that has assessed socio-economic indicators of Covid-2019 cases. Empirical evidence suggests how identification of potential socio-economic indicators could aid in the formulation of targeted strategies to mitigate future health problems.

Added value in this study

Income and subsistence incidence are potential indicators of Covid-2019 case surges in the Philippines. In particular, high income and low subsistence incidence are associated with significant reductions in Covid-2019 cases across the 17 regions of the Philippines. This provides novelty of the study as it firstly reports the association of the seven socio-economic indicators, namely, poverty incidence, magnitude of poor families, subsistence incidence, magnitude of subsistence poor population, income, expenditure, and savings with Covid-2019 cases.

Implications of all the available evidence

Targeted strategies of the policymakers and health officials to regions that could potentially record high number of Covid-2019 cases in the future could be formulated. Early identification of these high-risk regions would warrant prompt preventive measures. Given the seasonal and recurring nature of Covid-2019 with respect to previous outbreaks, it is essential for the Philippine government to formulate directed policies and innovate programs that would decrease subsistence and increase income. Concerted multi-region efforts should be made to prepare for possible infection outbreaks in the future.

Background

A wide spectrum of indicators has been postulated to associate with Coronavirus Disease 2019 (Covid-2019) cases. Among which were demographic profile, latitude, humidity, temperature, and ozone concentration. In particular, age and sex were risk factors of the disease.¹⁻² The disease prevalence was high in areas with high latitude and humidity³, extreme temperature³, and sufficient ozone concentration⁴. In the Philippines, majority of Covid-2019 cases were male and elderly.² Despite obtaining significant results, there is still a dearth of research exploring other substantial determinants of Covid-2019 cases.

The Philippine government is currently challenged to address issues pertaining to poverty and substinence. Based on a recent report, poverty incidence or the proportion of poor Filipinos was approximately 16.6 percent in 2018.⁵ Also, substinence incidence or the proportion of Filipinos whose income is not enough to meet even the basic food needs was 5.2 percent in the same year. Studies show that poverty and income were the strongest indicators of disease risk⁶⁻⁷ and infection prevalence⁸. Empirical evidence of these studies suggests how identification of potential indicators could aid in the formulation of targeted strategies to mitigate future health problems. In this study, seven socio-economic indicators were associated with Covid-2019 cases across 17 regions in the Philippines.

Methods

This is a retrospective study utilizing prior data in the analysis. Socio-economic indicators used were poverty incidence, magnitude of poor families, substinence incidence, and magnitude of substinence poor population. In addition, the income, expenditure, and savings recorded per Philippine region were taken for

the analysis. A single Philippine region was the sampling unit; hence, a total of 17 regions were assessed. Data pertaining to the socio-economic indicators were taken from the open-access database of the Philippine Statistics Authority. The measurements were estimates collected in 2018 and posted in the online website (<https://psa.gov.ph/>) in December 2019. Poverty and subistence incidences were expressed in percentage, while magnitudes of poor families and subistence poor population were expressed in thousands. Income, expenditure, and savings were expressed in Thousand Philippine Peso (PhP).

Data of Covid-2019 cases in the Philippines were extracted from the University of the Philippines Tracker (<https://endcov.ph/cases/>). Cases as of April 7, 2020 were considered for the analysis. Complete data were presented in the supplementary section of this paper. Ethics approval was considered exempt because all records used are taken from publicly available archives.

For the data analysis, R statistical package was used. Descriptive statistics (mean and SD) was used for continuous variables. Due to small sample size, Kendall rank correlation was used to determine if socio-economic indicators were associated with Covid-2019 cases across 17 regions in the Philippines. Stepwise regression was used to determine significant predictors of Covid-2019 cases across regions. Fitting of regression model was done by adding or removing predictor variables via a series of F-tests. Added or removed variables were chosen based on test statistics of estimated coefficients. A p-value of less than 0.05 was considered significant.

Results

Mean and SD of socio-economic indicators and Covid-2019 cases are shown in **Table 1**. Kendall rank correlation revealed that poverty incidence, substinance incidence, and expenditure are positively related with Covid-2019 cases ($p < 0.05$); however, income was negatively related with Covid-2019 cases among Philippine regions ($p < 0.01$) (**Table 1**). No significant associations were noted in both magnitudes of poor families and substinance poor population, and savings ($p > 0.05$).

A stepwise regression removed previously significant variables, poverty incidence and expenditure, after yielding nonsignificant p -value (**Table 2**). Substinance incidence and income were retained for the regression model, which explained 87.2 percent of the variance in the Covid-2019 cases ($R^2 = .872$). The results indicated that for every 1,000 PhP increase in income, there was a decrease of 3.99 Covid-2019 cases in each Philippine region. Meanwhile, for every 1.0 percent increase in substinance incidence, there was an increase of 3.34 Covid-2019 cases in each Philippine region.

Discussion

The main objective of this study was to determine if seven socio-economic indicators were associated with Covid-2019 cases across 17 regions in the Philippines. Among the seven socio-economic indicators, only four were significantly related to Covid-2019 cases. Poverty incidence, substinance incidence, and expenditure were positively related to the disease cases per Philippine region. This implies that Philippine regions with high poverty incidence, substinance incidence, and expenditure had most likely high Covid-2019 cases. In other words, Philippine regions with high proportions of poor Filipinos whose income is not

enough to meet even the basic food needs, would most likely have high cases of Covid-2019. Alternatively, Philippine regions with low proportions of poor Filipinos whose income is not enough to meet even the basic food needs, would most likely have low cases of Covid-2019. Regions which spend more funds had most likely high number of Covid-2019 cases and vice versa.

On the other hand, income was negatively correlated with Covid-2019 cases suggesting that Philippine regions with low annual accumulated income, had high cases of Covid-2019. Conversely, Philippine regions with high annual accumulated income, had most likely low cases of Covid-2019.

Further analysis was employed to determine which variables could significantly influence Covid-2019 cases. The analysis has shown that high income and low substance incidence are associated with significant reductions in Covid-2019 cases across the 17 regions of the Philippines. An increase in 1,000 PhP income per region would result to a reduction of 3.99 Covid-2019 cases while a decrease in 1.0% substance incidence would result to a reduction of 3.34 Covid-2019 cases in each Philippine region. These data offer essential insights into the significance of several socio-economic indicators to manage surges of Covid-2019 cases in the Philippines.

As of April 11, 2020, the Philippines is one of the top 50 countries with the most number of Covid-2019 cases. Cases burgeoned to 4,195 while case fatality rate was 5.27 percent, which is greater than neighboring Southeast Asian countries such as Malaysia, Singapore, Brunei, and Thailand.^{2,9} With these high infectivity and fatality rates, the Philippines need to respond quickly by practicing infection control guidelines and recognizing infection spread indicators. Studies have shown several possible treatments for the disease such as Vitamin D supplementation¹⁰; however, at the present time, no vaccines have been formulated to fight against the causative virus. Indicators of Covid-2019 incidence such as humidity, ozone concentration, and

temperature have merited exploration. In the study, income and sustenance incidence are potential indicators of Covid-2019 case surges in the Philippines. This provides additional knowledge to policy makers and health officials in formulating targeted strategies to regions that could potentially record high number of Covid-2019 cases in the future. Early identification of these high-risk regions would warrant prompt preventive measures.

Existing evidence indicated a seasonal and recurring nature of Covid-2019 with respect to previous outbreaks, MERS and SARS. Hence, it is essential for the Philippine government to formulate directed policies and innovate programs that would decrease the proportion of Filipinos who cannot meet the basic food needs while increasing the income of each Philippine region. Sustainable provision of source of income to the most marginalized Filipinos should be considered to mitigate problems pertaining to food sustenance. Concerted multi-region efforts should be made to prepare for possible infection outbreaks in the future.

Limitations

This study should note several limitations. Data extracted were analyzed at only one point of time; hence, longitudinal studies could be explored in the future to capture significant changes in the socio-economic indicators. The reporting of cases across 17 regions in the Philippines may be biased due to confounding factors that might affect the high or low number of Covid-2019 cases such as not but limited to the presence of testing kits and clinical laboratory of the region which could increase testing capability of the region. Finally, other socio-economic indicators were unaccounted for in the study and could be included in the analysis in the future research.

Conclusion

In conclusion, high income and low substance incidence are associated with significant reductions in Covid-2019 cases across the 17 regions of the Philippines. Data extracted were analyzed at only one point of time; hence, additional studies could be explored in the future to capture significant changes in the socio-economic indicators. Nevertheless, the study reported income and substance incidence as potential indicators of Covid-2019 case surges in the Philippines. This provides additional knowledge to policy makers and health officials in formulating targeted strategies to regions that could potentially record high number of Covid-2019 cases in the future. Early identification of these high-risk regions would warrant prompt preventive measures. Given the seasonal and recurring nature of Covid-2019 with respect to previous outbreaks, it is essential for the Philippine government to formulate directed policies and innovate programs that would decrease substance and increase income. Concerted multi-region efforts should be made to prepare for possible infection outbreaks in the future.

Table 1. Descriptive statistics and Kendall rank correlation

| Variables | Mean | SD | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---------------------------------------------|---------|--------|---|-------|-------|-------|--------|--------|--------|--------|
| 1. Poverty incidence | 20.92 | 13.88 | - | .54** | .93** | .68** | -.75** | -.65** | -.50** | .46* |
| 2. Magnitude of poor families | 1034.98 | 554.89 | | - | .50** | .84** | -.50** | -.28 | -.63** | .15 |
| 3. Substinence incidence | 6.95 | 6.87 | | | - | .66** | -.77** | -.63** | -.46* | .56** |
| 4. Magnitude of substinence poor population | 324.93 | 267.64 | | | | - | -.60** | -.41* | -.59** | .30 |
| 5. Income | 280.54 | 70.32 | | | | | - | .69** | .60** | -.60** |
| 6. Expenditure | 207.48 | 58.20 | | | | | | - | .29 | .43* |
| 7. Savings | 73.05 | 22.69 | | | | | | | - | -.31 |
| 8. Total confirmed cases | 99.76 | 293.74 | | | | | | | | - |

Note: * $p < 0.05$ ** $p < 0.01$.

Table 2. Stepwise regression analysis summary predicting Covid-2019 cases

| Variables | B | β | t | p-value |
|-----------------------|--------|---------|-------|---------|
| (Constant) | 728.64 | | 4.25 | .001 |
| Income | -3.99 | -.79 | -5.01 | <0.001 |
| Substinence incidence | 3.34 | .65 | 4.87 | <0.001 |

Note: $R^2 = 0.872$.

Supplementary Data

Table 3. Covid-2019 cases (as of April 7, 2020) of the 17 Philippine regions

| Region | Cases |
|----------------------------------|--------------|
| National Capital Region | 1227 |
| Cordillera Administrative Region | 13 |
| I - Ilocos | 11 |
| II - Cagayan Valley | 22 |
| III - Central Luzon | 85 |
| IVA - CALABARZON | 174 |
| MIMAROPA Region | 4 |
| V - Bicol | 11 |
| VI - Western Visayas | 25 |
| VII - Central Visayas | 33 |
| VIII - Eastern Visayas | 2 |
| IX - Zamboanga Peninsula | 7 |
| X - Northern Mindanao | 6 |
| XI - Davao | 62 |
| XII - SOCCSKSARGEN | 2 |
| XIII - Caraga | 1 |
| Bangsamoro | 11 |

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