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Original Article

A retrospective cross-national examination of COVID-19 outbreak in 175 countries: a multiscale geographically weighted regression analysis (January 11-June 28, 2020)

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ABSTRACT

Objective: This study retrospectively examined the health and social determinants of the COVID-19 outbreak in 175 countries from a spatial epidemiological approach.
Methods: We used spatial analysis to examine the cross-national determinants of confirmed cases of COVID-19 based on the World Health Organization official COVID-19 data and the World Bank Indicators of Interest to the COVID-19 outbreak. All models controlled for COVID-19 government measures.
Results: The percentage of the population age between 15-64 years (Age15-64), percentage smokers (SmokTot.), and out-of-pocket expenditure (OOPExp) significantly explained global variation in the current COVID-19 outbreak in 175 countries. The percentage population age group 15-64 and out of pocket expenditure were positively associated with COVID-19. Conversely, the percentage of the total population who smoke was inversely associated with COVID-19 at the global level.
Conclusions: This study is timely and could serve as a potential geospatial guide to developing public health and epidemiological surveillance programs for the outbreak in multiple countries. Removal of catastrophic medical expenditure, smoking cessation, and observing public health guidelines will not only reduce illness related to COVID-19 but also prevent unecessary deaths.
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Introduction

On 11 March 2020, the World Health Organization declared the coronavirus disease (COVID-19) a global pandemic underscoring its growing prevalence, especially its increase in morbidity and mortality over a wide geographic area as well as significant economic, social, and political disruptions arising from it. Although in recent times, there have been outbreaks of some major infectious diseases such as Severe Acute Respiratory Syndrome (SARS), Middle East Respiratory Syndrome (MERS), influenza H1N1/09, and Ebola. These diseases, unlike COVID-19, were limited in their geographic spread with limited numbers of morbidity and mortality. For instance, SARS was prevalent in Asia and North America [1]. Meanwhile, the MERS was limited, mainly in the Middle East, with few reported cases in Africa and Europe [2]. Conversely, Ebola was concentrated mostly in Africa, with a reported case in the United States (US) [3]. At the same time, the HIN1/09 virus was a pandemic more prevalent in Asia, with cases reported in Europe, North and South America, and Africa [4].

Among the recently reported viral diseases in the world (2000 to date), COVID-19 currently ranks second, with the somber landmark of 10 million confirmed cases and 499,913 deaths[1] as of the 29th of June 2020, despite its recent outbreak [5]. HIN1/09, on the other

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[1] This figure was based on the reported data at the time of writing this paper in June, 2020. Worldometer.

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hand, recorded the most significant number of deaths estimated to be about 151 700 – 575 400 people over its activity period. Whereas, the total number of fatalities reported for MERS and SARS was about 858 people and 689 people, respectively [1,6]. In contrast, during the most recent outbreak of Ebola between 2014 and 2016, the estimated death number was over 11 300 people [3].

The impact of COVID-19 is leading to a global economic crisis with travels around the world distorted. According to the United Nations economic analysis, the world economy is projected to shrink by 3.2%; the growth in developed countries' GDP will plunge to –5.0% while the output of developing countries will shrink by 0.7% at the end of 2020 [7]. Similarly, the current projection is that the cumulative output losses during 2020 and 2021 will be around $8.5 trillion. This will likely wipe out nearly all output gains of the previous four years [7]. It has been predicted that the economy of the US may be headed toward a recession, with global output falling by 0.4% in the first quarter of 2020 and by about 12% in the second quarter [8] leading to global job loss [9]. It also has significant impacts on the educational system [10], tourism, and the entertainment world [11].

The incidence of COVID-19 has adversely impacted health facilities and health caregivers. Most medical facilities are overwhelmed by the number of patients presenting with the symptoms of coronavirus due to the availability of space and medical resources [12–14]. Various efforts have been put in place to undertake the chronic global shortage of personal protective equipment (PPE), which is one of the urgent threats to the ability to save lives [15]. Consequently, healthcare workers have a high risk of contracting COVID-19 due to their constant exposure amid PPE shortage [16]. It has been reported that over 1 700 healthcare workers have been affected in Italy while some have died [17].

From the ongoing situations across the world, it is clear that COVID-19 has grievous health and socio-economic consequences depending on the political climate in each country. Furthermore, it can also be argued that the various strategies instituted at various times can influence the pattern of the diseases spread and associated mortality. The contagious nature of asymptomatic and presymptomatic COVID-19 cases poses a unique challenge to the whole community of science and policymakers in effectively controlling the disease spread [18,19]. The implementation of non-pharmaceutical intervention measures (NPIM) such as border closure, lockdown policies, social distancing, and adoption of public face mask are all critical factors to curtail the spread of COVID-19 [20], but with gross economic implications. Besides, the recent outbreak also reveals structural inequalities and emergency capitalism, which determines who can get tested, be placed on a ventilator and who cannot. Both structural inequality and emergency capitalism reflect in the COVID-19-related fatality rates.

Further, variation in public health and safety measures will result in the pattern of outbreaks and fatality rates. For example, Sweden has restricted testing for the elder and the sick, kept schools and public activities open, which is generating a high COVID-19 related fatality rate [21]. The country seems to be currently testing the "herd immunity" hypothesis. As of 28 March, Iceland has tested a higher proportion of people than any other country (9 768 individuals), equivalent to 26 762 per million inhabitants, the highest in the world. In contrast, South Korea has tested 6 343 individuals. This variation in testing and preventive measures suggests variation in the spread of the disease. Increasing testing and knowing numbers of infected persons for a more extended period will allow the public health and the responsible agencies to plan for interventions and resources to manage the confirmed cases effectively.

Despite the call for more epidemiological studies of COVID-19 [22], there is no spatial epidemiological study on the social and health determinants of the COVID-19 outbreak. The analysis of COVID-19 on a national scale will enhance the formulation of region-specific policies in curbing the continuous spread of the disease and reinforce our understanding of the spatial epidemiology of the disease. Thus, this article promptly seeks to understand the geographic patterns of COVID-19 and its correlates. Hence, this current study visualized the variation in the outbreak, and identified possible socio-health characteristics that might encourage or prevent the transmission of the disease outbreak, and suggested ways on how to slow down transmission and possible re-emergence of COVID-19 in the future.

Table 1
Summary Statistics for MGWR Parameter Estimates.

	Mean	STD	Min	Median	Max
Intercept	−0.034	0.257	−0.564	−0.04	0.485
Age1564tot	0.456	0.006	0.449	0.454	0.472
OOPExp	0.095	0.064	−0.048	0.094	0.284
SmokTot	−0.232	0.012	−0.258	−0.227	−0.215
LgMeasure	0.03	0.073	−0.141	0.058	0.115

Method

Data and measures

The current study only focused on the confirmed cases of the novel coronavirus disease (COVID-19) in 175 countries. The real-time data were gathered from publicly compiled resources that are updated daily through the WHO COVID-19 surveillance database for all the countries in the world [23]. Hence, data available between 11 January and 28 June 2020 were collected for the ecological analysis of COVID-19 at global scale and aggregated all confirmed cases to respective countries.

To understand factors that may be driving the pattern of COVID-19, the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) compiled a set of 34 health indicators, health economic, and demographic variables (Supplementary Table 1). Retrospective data can help researchers, organizations, and public entities understand past behaviors in order to predict future trends. These data have recently been classified as "World Bank Indicators of Interest to the COVID-19 Outbreak" [24]. In addition, we used data on government measures to develop an index [25]. We referred to the index as non-pharmaceutical intervention measures (NPIM) index. The data collected information based on these five categories, including movement restrictions, public health measures, governance and socio-economic measures, social distancing, and lockdown (e.g., partial, full).

Analytical procedures

Before we conducted spatial modeling, we examined the correlation between the cases and the 34 World Bank COVID-19 indicators using the analog forward removal method to (1) explore multicollinearity and (2) non-responsive variables. Only the percentage of the population ages between 15 and 64 years, total percentage population who smoke cigarettes, and out-of-pocket expenditure calculated based on the current US Dollar. They were chosen primarily because of their low variance inflation factor values (VIF) of less than 3. We used only the three main indicators in the Multiscale Geographically Weighted Regression (MGWR) model. Despite that the COVID-19 government measure index or NPIM was not significant, we used it as a control variable in the spatial and non-spatial analyses.

Spatial analysis

Traditional global predictive models assume a stationary relationship between a dependent variable and a few independent

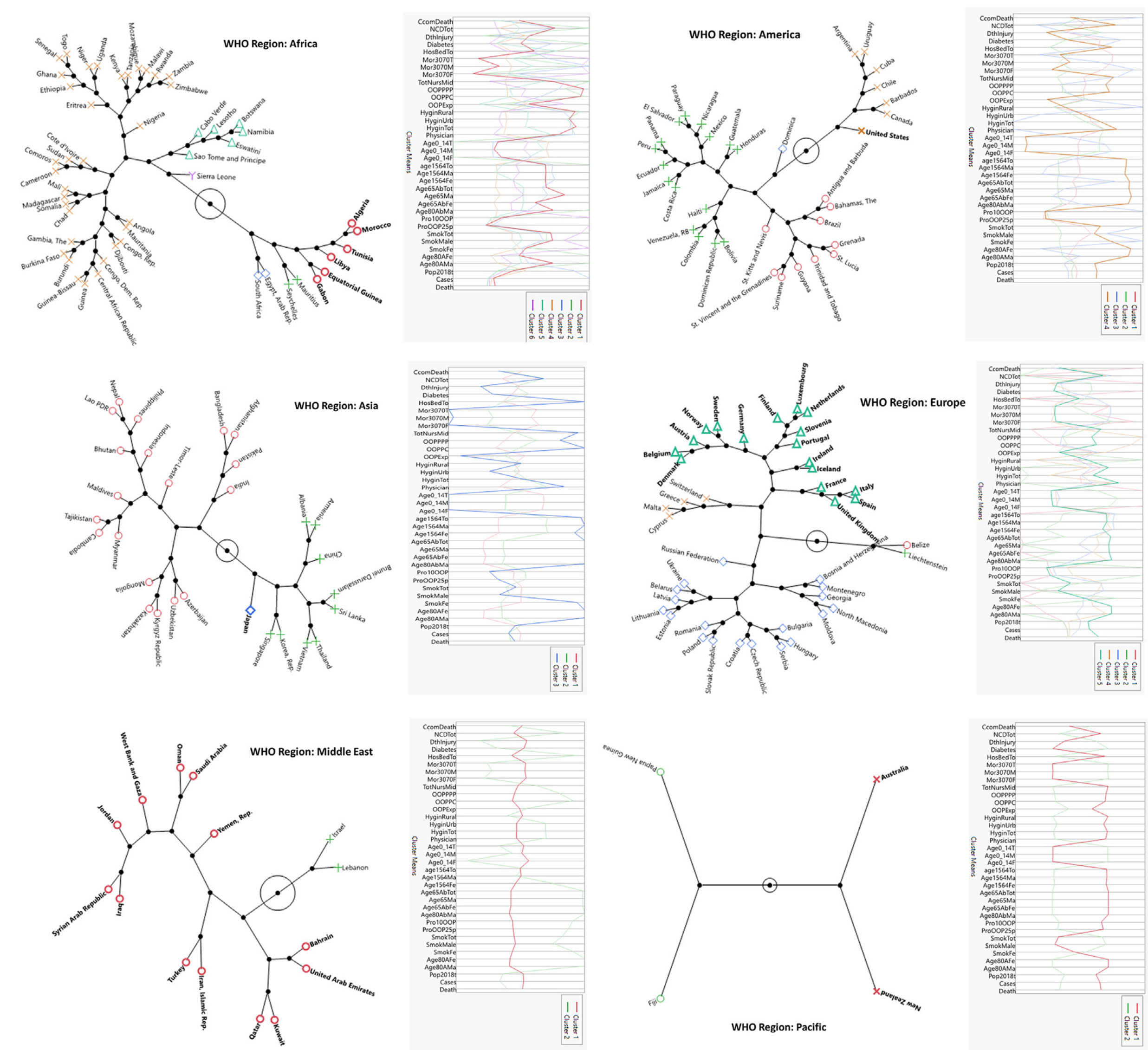

Fig. 1. Geographic Distribution of Confirmed Cases of COVID-19, January 11-June 28, 2020.

variables at a global scale and across all geographic units (countries), which is doubtful. Consequently, spatial scientists have proposed alternative techniques to mitigate this inherent limitation in epidemiological analysis. In addition, the assessment of spatial autocorrelation in the data showed evidence of significant positive spatial clustering. Autoregressive models were employed to assess spatial dependence. There was significant evidence of spatial dependence, hence the need to use a more robust spatial analysis technique.

One of the commonly used spatial statistics is geographically weighted regression (GWR), which explores the non-stationarity in data [26]. The regression coefficients in the GWR model are allowed to vary across space. However, this method has recently faced criticism due to its (1) inability to handle spatial multicollinearity [27], (2) use of a **"**single kernel bandwidth**"** for all the variables in a model without considering the variation of the spatial extent of the geographic unit [28–30], and (3) inability to mitigate the presence of outlier and spatial autocorrelation which poses a unique problem and causing instability in its estimates [28,31]. When these limitations are overlooked, results may be exaggerated in areas with few data or population and underestimate in large areas with a dense population [32,33]. Consequently, the multiscale GWR (MGWR) [34], was developed to overcome these known issues and has been used to assess the determinants of obesity and road traffic crash [35,36]. Hence, the cross-country analysis of COVID-19 and its determinants was conducted using MGWR. Note that *mgwr* package standardized all variables for easy interpretation. All analyses were conducted in JMP® v15 and ArcMap v10.7

Results

The spatial pattern of the outbreak

Fig. 1 shows the visualization of COVID-19 confirmed cases and associated deaths based on the World Bank health and social profile for each 175 countries. Countries with similar cases and death were clustered with similar underline profile. Overall, the current epicenter is located in the United States. Papua New Guinea had the least confirmed cases. The region of Africa seems to have the lowest cases with large evidence of disparities within the continent. The dimension of hotspot had shifted from China (Wuhan), where the virus was first reported to Europe, and now the Americas. Notably, the confirmed cases in China has not significantly changed since March, when it reported about 81, 000 cases (estimation excluded

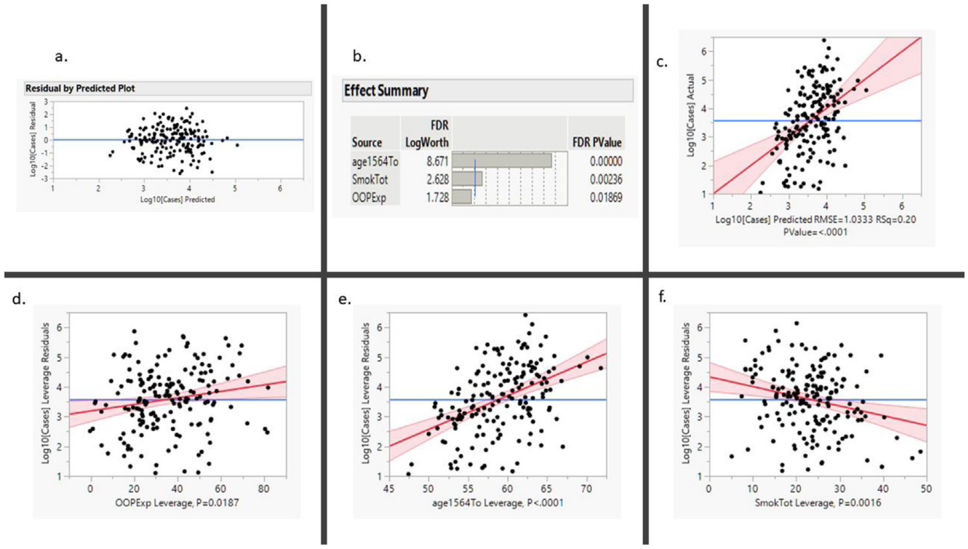

Fig. 2. On the first row are the residuals of predicted cases (a), effect summary (b), multivariate scatterplot (c.). The second row shows the bivariate relationships between transformed confirmed cases Log10(cases) and out-of-pocket expenditure (OOPExp) (d), percent population between 15-64 years (age15-64) (e.), percentage of the population who smoke (f).

Hong Kong data). On the 29 June 2020, the global case crossed 10 million with about half a million deaths.

Multivariate analysis of world bank indicators of COVID-19 outbreak

Fig. 2 presents the parameters used to model the confirmed cases of COVID-19. Out of the three predictors, age was the best predictor, followed by the percentage rate of the population who smokes, and out-of-pocket expenditure. The residuals of the standard least squares (global) indicated a good model fit, but the R-squared was small. We also compared the result from the autoregressive models (SEM, SLM) with the OLS model. Table 2 indicates significant evidence of spatial dependence in the model. Both the spatial error model (SEM) and the spatial lag model (SLM) produced significant Log-Likelihood Ratios at an acceptable 95% significant level. This suggested that a robust analysis is needed to overcome the spatial dependence in the model. Consequently, a multiscale geographically weighted regression was implemented. In addition, Moran's index of spatial autocorrelation was significant which also confirmed the multivariate autocorrelation on the data (MI = 0.1344, Z-score = 2.4213, p = 0.015).

Spatial Modelling

The result of multiscale geographically weighted regression, which assessed the spatial variation of the three indicators of COVID-19, indicates that the three parameters varied spatially at a similar geographic scale of the process (bandwidth). The summary of the MGWR coefficients is described in Table 1. Table 2 presents the model diagnostic parameters comparing the OLS, GWR, and MGWR. The main emphasis is that MGWR allows each of the variables to operate at flexible spatial bandwidths. With MGWR, each of the three variables was revealed to operate at a global level. OOP-EXP operated at 174 nearest neighbors [NN], Age15-64 at 136 NN, SmokTot at 174 NN, and NPIM at 133 NN, compared to GWR that operate on single bandwidth 126 N N. OLS model operated at a constant or infinite scale. Overall, MGWR performed better than GWR. The adjusted R-squared in the GWR was lower than the MGWR (Adj. R^2 = 30% and MGWR = 37%). The AICc and AIC for MGWR were smaller than the GWR, which indicated an improved and better model than both the GWR and OLS models.

The findings from this study are presented based on the three social-health indicators used in the comparative multivariate models (Table 2). The results indicate a significant relationship of out of pocket health expenditure, demographic age between 15 and 64 years, and the percentage rate of smokers with COVID-19. The age group represents the most active population that may characterize the active working-age group of a population. This age group corresponds with the reported age groups are currently testing positive for COVID-19, globally. In addition, Fig. 3a shows that the percentage of people between 15 and 64 was associated with cases of COVID-19 in countries in the Americas, Southeast Asia, and the Pacific regions. The coefficient sign for the age group remained negative in all countries, as indicated in the global OLS model. Fig. 3b shows that the percentage rate of smokers was significantly and inversely associated with COVID-19 in Asia, the Arab world, and the Pacific countries. The coefficients of smokers in predicting the cases were less in the Americas. The percentage rate of out-of-pocket health expenditures per capita was positively associated with COVID-19 cases in most countries except in Canada, where the dimension of the association was negative. The three variables predicted high scores of COVID-19 in Canada, India, Sri Lanka, Kazakhstan, Iran, United Arab Emirates, China, Spain, Iceland, Russia, Finland, Georgi, Armenia, Azerbaijan. Appendix A1 shows the standardized Y, standardized predicted values of Y (yhat), and the intercept (null model). The contribution of all the three explanatory variables in terms of the country by country R-Squared distribution, model residuals, and condition number (CN) are presented in Appendix A2. The test of spatial autocorrelation of the residual indicated an insignificant value (Moran's I = 0.1147, Z-score = 1.8098, p > 0.05).

Discussion

A global cross-analysis of the COVID-19 outbreak was carried with glaring disparities in its prevalence across the world, with the highest prevalence rate in the Americas. This shows that COVID-19, like other diseases, varies significantly by geographies [37,38]. The Americas, as an epicenter of the pandemic during the study period, show that a combination of factors could be responsible for

Table 2
Model Diagnostics: OLS, GWR, and MGWR.

	SEM	SLM	OLS	GWR/BW	MGWR/BW
OOPEXP	0.011*	0.009*	0.011*	vv (126)	vv (174)
Age15-64	0.111***	0.111***	.115***	vv (126)	vv (136)
SmokTot	−0.026**	−0.033**	-.0327**	vv (126)	vv (174)
LgMeasure	−0.021	−0.001	−0.198	vv (126)	vv (133)
LAMDA (Rho)	0.249**	0.196***	-	-	-
LLR(Dependence)	6.091*	26.553***	-	-	-
R-2	24%	32.05%	20%	30.30%	37%
AIC	507	489.454	514.007	465.943	451.901
AICc	-	-	-	469.469	457.221
Log -LL	−248.958	−238.727	−252.003	−228.771	−210.538
ENP (trace (S))	-	-	-	-	16.87

vv indicates coefficients vary across space. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$
Note: BW is bandwidth; AIC is Akaike Information Criterion; AICc is corrected Akaike Information Criterion. ENP is Effective Number of Parameters; Age15-64 is the percentage of the population between 15 and 64 years. SmokeTot is the percentage of the total population that smokes. OOPExp is the out-of-pocket expenditure on health care per capita. LagMeasure is the transformed variable of the non-pharmaceutical intervention measures index.

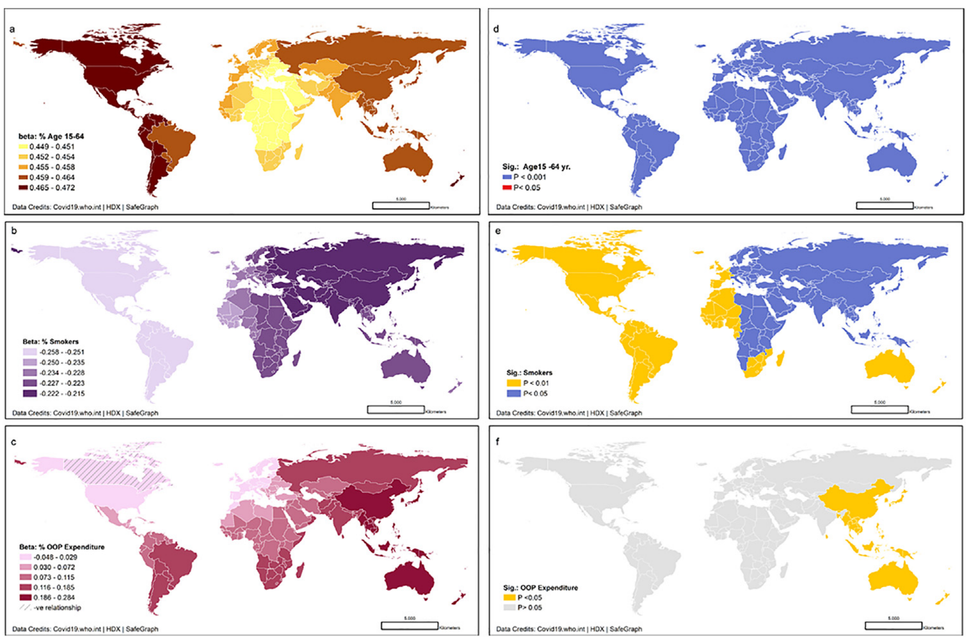

Fig. 3. The coefficients of determinants of COVID-19 outbreak (a-c) and their corresponding p-values (e-f).

the increased risk in the continent. These include late response to the outbreak and late implementation of public health measures such as social distancing, movement restriction, and face masking. The trend pattern of the outbreak is worrisome as the rate is growing exponentially, particularly in the US. As of the time of writing this paper, the record from the US is alarming as the rate of new confirmed cases continues to soar.

Presently, the incidence in the US has substantially surpassed that of China, Italy, and Spain.[2] However, this pattern may continue to rise [39]. CDC officials, based on the extensive investigation, opined that the current strategy of testing only the symptomatic patients might not lower the incidence. Among the 23 people who were tested positive in a long-term care skilled nursing facility study in King County, Washington State, only ten of them had symptoms [40]. Ten of the 13 cases that tested negative were found to be positive seven days after, and they were later categorized as pre-symptomatic.[3] This evidence shows that the outbreak across the world may continue, especially in countries with limited healthcare resources to test all their citizens. South Korea has been able to fight and bring the outbreak to a lower rate by adopting a massive scale of drive-through testing. Until the rest of the world adopts a similar testing approach, especially where the pandemic is very active, the infestation may continue to threaten us all.

Inequality in access to testing and efficiency in testing are separate concerns that drive the geographic pattern of cases of COVID-19. For instance, the change in the trend of reported cases in the US can be attributed to changes in regulations. The regulations allowed commercial and academic labs to participate in testing by using their reagents under the Clinical Laboratory Improvement Amendments of 1988 (CLIA), 42 USC. § 263a, to perform moderate and high complexity tests [41]. According to BioSpace [42], one Cobas instrument can run 4 128 tests daily. At the early stage of the pandemic, some countries rely solely on manual isolation. This is laborious, and in realistic settings of the pandemic, it takes eight

[2] The coronavirus COVID-19 is affecting 199 countries and territories around the world and 1 international conveyance (the Diamond Princess cruise ship harbored in Yokohama, Japan). Worldometer.

[3] The condition for eligible for testing in the United States is when a patient show any sign of high fever, cough, shortness of breath, or other forms of symptoms on the day of testing of during the preceding 14 days.

hours to analyze a set of samples. The capacity to carry out extensive testing also drives differences in mortality rate. In Sweden, for example, testing is reserved only for severe cases, leading to a recorded mortality rate of 11% [43]. The more people are tested, the more we know about the spread of the disease. Currently, fewer testings are being done in developing countries. We expect that reported cases will rise as people get tested based on the dimension and uncharted behavior of the virus.

With regard to age, earlier evidence indicated that the older population were at higher risk. However, since around mid-May and early-June 2020, young people are increasingly being infected with the virus leading to a high rate of hospitalization and isolation worldwide. However, the result from China and India indicates that the entire age group may be at risk [44–46]. In this study, we found that countries with a population age 15 and 65, who represent the working-age groups are more likely to be infected to COVID-19. Unfortunately, we have seen a rise in cases in America since most countries relaxed the government measures, such as the systematic opening of the economy in the US. This does not mean that the older population is no more at risk of virus attack; substantial evidence demonstrates that the risk is very much high among the older age group [47]. The current pattern of the outbreak in the Americas could be directly related to relaxed government intervention policies.

The study's finding on the relationship between smoking and COVID-19 cases is hard to ascertain because previous studies remain inclusive about this topic. For example, a systematic review based on five studies concluded that smoking is most likely associated with negative progression and adverse outcomes of COVID-19." [48]. Meanwhile, other studies, including a short metal-analysis, reported no association of smoking with the severity of coronavirus symptoms among patients [49,50]. However, the case series studies were local, and they did not reflect the global dimension of the association between smoking and COVID-19. In this study, however, we found a significant association in all 175 countries investigated. This finding contributes to the accumulated knowledge of the risks of COVID-19.

Out-of-pocket expenditure was found as a risk factor of COVID-19. Financial protection is critical for achieving adequate health care during the COVID-19 era and beyond. It implies that countries, where access to medical care is cost dependent, are likely to have higher cases of the virus. Consequently, economically less privileged may be unable to access medical care since access to quality care will be based on purchasing power and not medical needs. This argument further adds to the fact that nearly 40 percent of the world's population has no health insurance or access to national health services [51]. It has been reported that about 800 million people spend at least 80 percent of their household budget on health care every year. Consequently, about 100 million people fall into poverty due to their medical expenses [51].

Furthermore, the findings on out-of-pocket expenditure is an indicator of global health inequality as well as inequity. The finding buttressed the structural inequality mentioned in the introduction of this paper. Paying out of pocket for testing and treatment may contribute to delay for early testing among those without or limited insurance coverage, particularly the immigrants and the unemployed. Government subsidy will help symptomatic and suspected people to be able to test and get treatment [52]. Unexpectedly, MGWR showed that out-of-pocket in Canada was negatively associated with the predicted cases of COVID-19. This kind of association is hard to explain at this point because we expected that the government of Canada should make COVID-19 testing and treatment free. The findings on healthcare expenditure resound the current shortage in healthcare facility equipment needed to treat victims of COVID-19, particularly in the US [54] and worldwide [55]. Cases of coronavirus death because of a lack of health insurance have been reported in the US.[4]

This study acknowledges some limitations and inherent challenges due to data dynamism and the ecological approach adopted in this study. The first limitation we must recognize is the highly dynamic nature of the data we used. At the time of this writing, data on COVID-19 keeps increasing, and therefore figures are not static. Therefore, the audience should retrospectively interpret the results of this study within the context and data used between 11 January and 28 June 2020. Indeed, the trend and dimension of COVID-19 spread have changed, and follow-up studies should be conducted as data unfolds. Notably, the cases reported for the US keep soaring.

Retrospectively, the present study will serve as a reference study to future research of COVID-19 that will follow in the long run. The analysis we presented is not devoid of the ecological fallacy, modifiable areal unit problems (MAUP), and uncertain geographic context problems (UGCoP)[5] [56]. Because we solely relied on aggregated data for the country-level analysis, the within-country disparity is concealed. To address the first two issues, the future study must use disaggregated data available at a higher spatial resolution contingent on the availability of such data. The third issue is a complex one, though scholars suggest its usefulness in monitoring exposure to environmental insults such as the current COVID-19 situation; its applicability to a larger population is questionable. It is best used for a small group of people or individual monitoring [56]. Concerning the present pandemic, there are issues related to asymptomatic and symptomatic groups. The question will be who should be monitored, the former or the latter? Lastly, our ecological analysis failed to incorporate the differences in the socio-cultural context of the individual countries. The local analysis should capture this limitation in future studies.

Despite these caveats and the inherent limitations, this study is the first to examine the country-level determinants of COVID-19 using a very robust geospatial intelligence. The spatial method helped us examined the multiscale variation in the predicting powers of the three selected variables. Furthermore, it offers a profound understanding of the dimension of the pandemic revealing the complexity in factors that may be driving the global outbreak. This research has public health and epidemiological implications that can serve as a guide toward country-specific intervention by international organizations such as WHO. The predictive model also indicated that the outbreak is likely to take a new critical upturn in parts of the Americas, Asia, and countries in Europe. Hence, taking a cue from the current trend, public health preparedness for the future outbreak in areas that are currently experiencing the low intensity of the pandemic should be taken with urgent seriousness. The problem might be severe in low resource countries with limited emergency [medical] response systems, and necessary amenities/ infrastructure (e.g., electricity and transportation) to adequately respond like the developed countries.

Conclusion

Using a robust geospatial technique, this paper presents the national cross-analysis of COVID-19 in 175 countries. Also, it has been able to determine the geographical spread based on three social-health factors (Population age between 15-64 years,

[4] MSN News.

[5] UGCoP is the problem that results about how contextual units or neighborhoods are geographically delineated and the extent to which these areal units deviate from the true geographic context. The problem arises because of the spatial uncertainty in the actual areas that exert the contextual influences under study and the temporal uncertainty in the timing and duration in which individuals experienced these contextual influences. (See the paper by Kwan, 2012, 2018 cited in this for more detail).

percentage of smokers, and out-of-pocket expenditure). In this study, the COVID-19 government measures index was not significant with cases of COVID-19. Based on the finding of this study, we recommend that: (1) Public health officials, epidemiologists, and the entire community of science should prevent the continuous outbreak of the infection. (2) Strict enforcement of non-pharmaceutical interventions, particularly in the Americas. (3) Nevertheless, countries with a high proportion of the aging population should continue to be under close monitoring to reduce infection and transmission rates, even after the pandemic subsides. We believe the adoption of 3T-approach, which includes extended testing, contact tracing, and treatment, will allow us to understand the magnitude of the infection. (4) More importantly, this is the time the national governments need to improve healthcare expenditure to curtail the spread of the disease, especially in developing countries (Asia and Africa), where the rate of infection is relatively minimal compared to Europe and the Americas. (5) Lastly, it is imperative to increase the installation of testing centers, followed by systematic testing for all citizens in developing and developed countries. We will leave our readers with this motto: 'the more you test, the more you know.'

Appendix B. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.jiph.2020.07.006.

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