The Relationship between the Global Burden of Influenza from 2017-2019 and COVID-19

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Abstract

Background
SARS-CoV-2 and Influenza are lipid-enveloped viruses with differential morbidity and mortality but shared modes of transmission. We assessed whether historical patterns of regional influenza burden are reflected in the observed heterogeneity in COVID-19 cases across and within regions of the world.

Methods
Weekly surveillance data reported in FluNet from January 2017–December 2019 for influenza and World Health Organization for COVID-19 (to May 31, 2020) across the seven World Bank regions were used to assess the total and annual number of influenza and COVID-19 cases per country, within and across all regions, to generate comparative descending ranks from highest to lowest burden of disease.

Results
Across and within regions, rankings of influenza and COVID-19 were relatively consistent. Europe and Central Asia and North America ranked first and second for COVID-19 and second and first for influenza, respectively. East Asia and the Pacific traditionally ranked higher for influenza but to date, has been less affected by COVID-19. Between regions, Sub-Saharan Africa ranked amongst the least affected by both influenza and COVID-19.

Conclusion
Consistency in distribution of the burden of COVID-19 and influenza suggest shared individual, structural, and environmental determinants of transmission. Regions with discrepancies between influenza and COVID-19 burden may provide further insight into the potential impact of non-pharmacologic interventions and intersections with environmental conditions. Ultimately, forecasting trends and informing interventions for novel respiratory pathogens like COVID-19 should leverage patterns in the relative burden of past respiratory pathogens and the relative impact of non-pharmacologic intervention strategies as prior information.

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Introduction

The COVID-19 pandemic has affected each region of the world differently[1]. As of June, 2020, Europe and the Americas regions have registered the highest numbers of COVID-19 cases and deaths while South-East Asia, Sub-Saharan Africa, and the Western Pacific have experienced comparatively milder epidemics[1]. Heterogeneity in COVID-19 burden has also been observed within cities, across cities, and across regions within a country[2,3]. This heterogeneity likely stem from differences in underlying population structure with respect to age distribution, population and housing density, access to health care, burden of comorbidities, socio-economic and structural barriers to engagement in health, and the breadth and intensity of public health interventions. Furthermore, there remains active investigation into the heterogeneity of effects of both COVID-19 and the associated response on potential syndemics including infectious diseases such as HIV and tuberculosis and non-communicable conditions including mental health, reproductive health, and non-communicable diseases.

Similar to SARS-CoV-2, influenza is a lipid-enveloped respiratory virus but with a more established evidence base for both effective non-pharmacologic intervention strategies and transmission dynamics[4-6]. Importantly, influenza is associated with a shorter incubation period and with lower mortality than the currently estimated SARS-CoV-2 infection case fatality rate[7,8]. The relative risks of indoor vs. outdoor transmission, risks for contact, droplet-based, and aerosolization-mediated transmission are better established for influenza[9-11]. Influenza seasonality and spatial distribution are not fully understood but likely reflect individual, population, and environmental determinants[12]. Moreover, the annual burden and associated mortality secondary to pandemic and non-pandemic seasonal influenza strains vary significantly. The 2009 H1N1 pandemic was estimated to cause over 60 million cases in the United States, but resulted in higher mortality among youth but fewer deaths overall as older people were more likely to be immune[13]. In 2017, there were an estimated 45 million cases of mostly H3N2 and Influenza B in the United States but associated with higher mortality particularly among older adults given limited pre-existing immunity and limited vaccine effectiveness[14]. Environmental factors have been shown to explain in part the differences in influenza seasonality between temperate regions where cases peak during winter months, while tropical regions may have multiple peaks or intermittent influenza activity[15,16]. However, even within specific regions, some countries show influenza transmission patterns that are distinct from regional trends[17,18].

There have been early reports suggesting shared determinants of infection between influenza and SARS-CoV-2. In the United States, there is evidence of higher COVID-19 incidence, morbidity and mortality among African American communities secondary to underlying inequities including structural racism[19]. These racial disparities were also observed during the 2009 H1N1 influenza pandemic with similar drivers including higher risk of exposure due to inability to social distance, higher burden of comorbidities and limited access to health care among African American and other racialized communities[20-22]. Similarly, the early trajectories of COVID-19 and 2009 H1N1 have been noted in South Africa[23].

When this novel coronavirus emerged in early 2020, regional and national forecasting exercises drew on emerging data on the trajectory of detected cases of COVID-19 in the epicenters of China and Italy to translate their reproductive rates into best- and worst-case scenarios for local populations. That is, despite early comparison of the average mortality of influenza and SARS-CoV-2, there has not been a systematic evaluation of whether historical distributions in influenza burden are relevant in the prediction of the burden and distribution of SARS-CoV-2 infection. In this study, we comprehensively investigated global influenza transmission patterns from 2017 onwards to assess shared trends with the epidemiology of COVID-19.

Methods

Data abstraction and assessment of eligibility

Influenza

We used publicly available data to characterize temporal patterns of influenza across seven regions between 2017 and 2019. Organization of countries into regions was based on World Bank classifications, namely: East Asia and the Pacific, Europe and Central Asia, Latin America and the Caribbean, Middle East and North Africa, North America, South Asia, and sub-Saharan Africa. Within each region, we assessed country-specific weekly reported cases of influenza, including both Influenza A and B, from 1 January 2017 to 31 December 2019. Data were abstracted from FluNet, a global web-based tool developed by the World Health Organization for influenza virological surveillance, which captures weekly laboratory confirmed influenza cases. FluNet aggregates data from the National Influenza Centres of the Global Influenza Surveillance and Response System and other national influenza reference laboratories. Since more temperate zones in the Northern and Southern Hemispheres have generally opposing seasonal influenza trends, we report influenza case counts by calendar year from January 1 to December 31; which also facilitates comparisons with COVID-19. Finally, influenza case counts for the calendar year of 2020 were excluded given that public health measures focused on COVID-19 prevention and mitigation likely significantly decreased seasonal influenza cases for this time period[24].

We assessed patterns of missing data for each country and by year to determine eligibility for inclusion in analyses. For each year, countries where ≥90% of available weekly case reports were complete (assessed as the total number of non-missing records over the total number of all included weeks for that year) were included in analyses. For countries where data were <90% complete, we made the following determination: Countries where data missingness appeared to follow a seasonal pattern (e.g, data were missing only for weeks outside of the known influenza season, likely reflecting country-specific seasonal influenza reporting guidelines) were retained in analyses. Countries where weekly case counts were <90% complete and did not appear to follow a seasonal pattern, were denoted as missing.

COVID-19

We abstracted the daily number of COVID-19 cases reported between 1 January 2020 and 31 May 2020 for all countries and corresponding World Bank regions using data from the World Health Organization Coronavirus Situation Report. As we are in the first year of COVID-19, it was not possible to assess missingness of data similar to the methods used for influenza.

Regional rankings of Influenza and COVID-19 burden

Influenza

We assessed the overall burden of influenza for all included countries across and within each region. To do so, we summed the absolute number of influenza cases for each region, country and year (January 1 to December 31 of each year) given the temporal variability in influenza seasons around the world. Regions were ranked in descending order from highest to lowest number of absolute cases for 2017, 2018, and 2019. Countries were similarly ranked within regions, and overall, for each year. For each region, we plotted weekly influenza cases for the five highest ranked countries on a linear scale. Plots were visually inspected to assess for presence of temporal patterns within and across regions. We focused on case counts rather than per-capita rates given the concentration of both burden and testing generally in urban centers. Thus, using the entire country as a denominator inherently masks heterogeneity in the burden of infection within that country. Moreover, the relative proportion of the population residing in urban centers varies by country and by region, further challenging comparisons using per-capita rates. We further included analyses with ranks for influenza also created based on the total number of influenza cases reported for the first 20 weeks of each year (January 1 to May 31), as well as the total number of annual cases per capita of the country's population assuming stable population sizes from 2017-2019.

COVID-19
We assessed, and similarly ranked, in descending order, cumulative cases of COVID-19 as reported through 31 May, for each region. Countries were also ranked within their respective regions and overall.

Comparison of between and within-regional burden of Influenza and COVID-19
We used rankings derived from COVID-19 case counts to anchor cross-pathogen comparisons. The seven World Bank regions were ranked in descending order by total COVID-19 burden. We utilized heat maps to visually represent differences in rank order of regions across influenza years. We employed similar methods to compare rank order of countries within regions and overall. By region, we used heat maps to compare the rank order of the top 15 countries with highest reported COVID-19 burden, to their order in rankings of total influenza cases in 2017, 2018, and 2019, separately. We described similarities or differences across and within all regions.

Results

Influenza cases were assessed for 171 countries. For each year, more than half (ranging from 55.6%-56.7%) of all countries reported ≥90% complete data (**Supplemental Table 1**). The proportion of countries where data were <90% complete, but followed a pattern of seasonal missingness were also included in influenza analyses, ranged from 22.8% in 2017 to 24.0% in 2019. Differences in data completion and patterns of missingness were evident across all regions. The overall influenza burden between 2017 and 2019 varied by region and by countries within all seven identified regions (**Table 1**). Regions with the highest absolute burden of influenza included North America (903,554 cases), Europe and Central Asia (599,820 cases), and East Asia and the Pacific (389,657 cases). Countries with the highest proportion of regional influenza cases were as follows: East Asia and the Pacific (China; 77.5%); Europe and Central Asia (the United Kingdom; 17.7%), Latin America and the Caribbean (Mexico, 20.2%), Middle East and

North Africa (Qatar, 40.5%), North America (the United States, 82.9%), South Asia (India, 46.6%), and Sub-Saharan Africa (South Africa, 18.7%).

Seasonal variation in influenza cases was observed within nearly all regions. Seasonal trends were most pronounced for the Middle East and North Africa, North America, Europe, and East Asia and the Pacific (**Figure 1**). Seasonal trends were less evident for Latin America and the Caribbean, South Asia, and sub-Saharan Africa, where no specific trends in the timing and absolute peak of influenza cases were observed. Across regions, countries with the highest overall burden of influenza from 2017 to 2019, included the United States (749,472 cases), China (302,126 cases), Canada (154,082 cases), the United Kingdom (106,087 cases), and Norway (71,727 cases).

Regions with the highest absolute burden of COVID-19 included Europe and Central Asia (2,116,249 cases), North America (1,890,586 cases), and Latin America and Caribbean (852,368 cases) (**Table 2**). Within each region, countries with the highest proportion of COVID-19 regional cases were as follows: East Asia and the Pacific (China; 39.8%); Europe and Central Asia (Russia; 19.2%), Latin America and the Caribbean (Brazil, 49.6%), Middle East and North Africa (Iran, 33.8%), North America (the United States, 95.0%), South Asia (India, 57.1%), and Sub-Saharan Africa (South Africa, 32.3%) (**Table 2)** Specific countries with the highest overall burden of COVID-19 cases as of May 31, 2020 included the United States (1,716,078 cases), Brazil (465,166 cases), Russia (405,843 cases), the United Kingdom (272,830 cases), and Spain (239,600 cases) (**Table 2).**

Regional rankings of total COVID-19 and influenza burden were relatively consistent. For instance, Europe and Central Asia ranked first in COVID-19 and consistently ranked second in influenza burden from 2017-2019, while North America ranked second in COVID-19 and consistently ranked first in influenza burden (**Figure 2**). South Asia which ranked fifth in COVID-19 burden, consistently ranked sixth in influenza burden across all three influenza years. Sub-Saharan Africa ranked lowest both in the burden of COVID-19 and influenza. Latin America and Caribbean, and Middle East and North Africa maintained their position in the middle for both rankings. The exception was East Asia and Pacific that ranked sixth in COVID-19 burden despite a consistent ranking of third for influenza burden (**Figure 2**).

When we compared rankings of the top 15 countries with the highest COVID-19 burden from January 1 to May 31 2020 to those with highest influenza burdens, rankings remained partly conserved across and within all regions. Within regions, countries with the highest COVID-19 burden were similarly ranked as having a high burden of influenza from 2017 to 2019. For instance, South Africa, China, India, the United States, and Brazil had the highest rankings of COVID-19 in their respective regions and similarly within-region higher ranking for influenza burden from 2017-2019. Russia and United Kingdom had the top two rankings in Europe and Central Asia. The United Kingdom has ranked first in influenza from 2017-2019 while Russia ranked always in top five in influenza burden except in 2018 where it ranked seventh. Overall, in all regions, countries that ranked low in influenza burden generally ranked lower in COVID-19 burden as well (**Figure 3**). Influenza rankings restricted to the total number of influenza cases reported for the first 20 weeks of each year (January 1 – May 31), as well as the total number of annual cases per capita, are reported in **Supplemental Figures 2 and 3.**

Discussion

In this study, we found ecological consistency between the burden of influenza from 2017-2019 and the recorded number of COVID-19 cases to date. Specifically, North America, Europe and Central Asia generally reported the highest numbers of influenza cases per year and have also had the highest the highest burden of COVID-19. Outside of East Asia and the Pacific, regions with lower levels of COVID-19 generally ranked lower in influenza burden using historical data. East Asia and the Pacific ranked third in 2017-2019 for influenza burden but is ranked second last above Sub-Saharan Africa for COVID-19. Within regions, there was also general consistency between countries that generally ranked higher in historical influenza cases and those with higher COVID-19 case counts. The ecological consistency in the burden of COVID-19 and the recent burden of influenza is suggestive of likely shared individual, structural, and environmental determinants of infection.

Outside of public health interventions, there is generally less consensus on the determinants that potentiate or inhibit COVID-19 transmission. However, given decades of study, there is more information available on the individual, population-level, and environmental determinants of influenza. At the individual level, underlying immunity is related to previous exposure to similar strains and vaccine uptake and effectiveness. Effectiveness of vaccines depends on circulating influenza strains i.e pandemic and non-pandemic, or seasonal; secondary to antigenic drift and shift of influenza viruses. Population-level characteristics include vaccine coverage and shield immunity, population density, social norms, and health care infrastructure. Finally, environmental factors affecting influenza include temperature, air pollution, and humidity[25,26]. Given how rapidly COVID-19 has emerged, conclusions of different studies exploring the role of environmental conditions have differed significantly. One study found no associations between latitude and temperature with COVID-19 epidemic growth using a two-week exposure period in March across 144 geopolitical areas[27]. However, a “living” review leveraging data from December, 2019 onwards from nearly 4000 locations across the world showed significant differences in COVID-19 burden associated with temperature, humidity, pollution, and other environmental factors[28]. Collectively, these studies suggest the potential for at least some seasonal variation secondary to changes in environmental conditions in the transmission of SARS-CoV-2 similar to other respiratory pathogens, including influenza and other seasonal coronaviruses[29-32].

Influenza seasonality is more pronounced in more temperate areas of the Northern and Southern hemispheres consistent with opposing fall and winter seasons. A recent assessment of the seasonality of infectious pathogens included individual-level determinants. such as growing immunity throughout an influenza season secondary to vaccination or exposure, that results in achieving effective levels of shield immunity limiting transmission[33]. There has been some study of existing immunity to COVID-19 mediated via cross-reactivity with other coronaviruses [33,34]. However, lesser population-wide immunity could mean sustained transmission even during times with less transmission of other respiratory pathogens. Influenza seasonality may also be secondary to population-level changes including potentially higher crowding in colder weathers, increased use of respite care and housing, people returning to work and school, and increased use of transit services that may collectively facilitate transmission. Environmental conditions may further affect individual susceptibility to infection as well as contact or respiratory droplet transmission patterns. The recent increases in COVID-19 in late May and early June in some areas of the Southern hemisphere including countries across South America are consistent with the timing of the traditional influenza season[35]. Moreover, in South Africa, epicenters of COVID-19 appear to be similar to areas with increased influenza transmission[36,37]. In the less temperate areas of Sub-Saharan Africa and Southeast Asia, influenza burden appears to be generally lower. While there is likely a relationship between testing infrastructure and influenza reporting, the consistency in the COVID-19 and influenza burden among countries within each region was notable. East Asia and the Pacific is an exception here with generally higher burdens of influenza and more limited COVID-19 cases. Given that COVID-19 emerged in this region, non-pharmacologic interventions widely implemented and shown to have affected both COVID-19 and influenza burden may explain this finding[24]. In addition, while influenza is endemic in several countries, rapidly decreasing introduction of COVID-19 through the closure of borders likely played a critical role especially in settings experiencing traditional influenza season.

A hallmark of COVID-19 has been the role of social determinants of health with socioeconomic status, living conditions, access to health care, and underlying comorbidities being consistent predictors of COVID-19 incidence and mortality around the world[38,39]. Moreover, structural racism has been documented in several settings including the United States, United Kingdom, and Canada, but likely relevant in many more settings not reporting on racial identity of those affected[40,41]. Notably, similar disparities were observed in the 2009 H1N1 pandemic in the United States though there has been limited documentation of socioeconomic disparities of influenza in most settings[20,42]. While disparities are well documented for other infectious diseases such as HIV, these disparities evolve across cycles of transmission spanning years. Given how rapidly disparities emerged with COVID-19, interventions to address disparities may be observable over shorter time horizons and provide insight into effective interventions to address pervasive social health inequities. Secondary to intersections of differential access to health care and medical mistrust, the development of a generally effective vaccine has not mitigated disparities[43-45]. Leveraging frameworks focused on optimizing implementation of influenza vaccination strategies including increased equity will be critical in informing SARS-CoV-2 vaccines when available[46,47]. COVID-19 is also rapidly increasing our understanding of post-viral morbidities including cardiovascular complications[48]. While post-viral complications have been described for other viruses, the mechanisms of consequences may be elucidated based on the research into COVID-19 broadening the potential impact of these studies[49-53].

This study has several limitations. Risk of ecological fallacy is relevant where individuals in generally lower ranking regions or countries may have high risks of acquisition and transmission secondary to micro-epidemics, including in those in congregate living settings, refugee and migrant work camps, long term care facilities, homeless shelters, and prisons. Missingness in data aggregated by FluNet is another limitation. We assumed that countries where influenza data was missing in a seasonal pattern was a reflection of very few case counts and/or reduced reporting outside of the typical influenza season, and indeed seasonal “missingness” was most apparent for countries in the European region, where the influenza season has been well documented. However, by excluding countries with > 10% data missingness that did not follow a seasonal influenza pattern, several sub-Saharan African countries (e.g. Sudan) were not included in the comparison of rankings despite high COVID-19 and influenza burden. Absolute influenza and COVID-19 case counts were reported, rather than positivity rates given that testing eligibility and subsequent testing rates may have varied dramatically within and across countries. Biases present in interpreting positivity rates, such as availability of infrastructure to implement broad testing strategies, may be reflected in total number of case counts, across both influenza and COVID-19.

The results presented here suggest that the distribution in the global burden of COVID-19 reflects that of influenza. This ecological overlap suggests that the underlying dynamics of transmission of influenza and COVID-19 are similar as they relate to spatial, seasonal, population structure and the disparities that lead to disproportionate vulnerabilities in various population groups. In considering the host-pathogen-environment framework commonly used for infectious diseases, emerging infections represent novel pathogens, but the populations and environment under which they emerge and spread are the same. Similarly, the similarities observed here suggest the potential utility of informing COVID-19 prevention and mitigation interventions with the vast data available characterizing critical issues including the relative risks of indoor vs. outdoor transmission, risks of aerosolization for influenza, and even optimal delivery of vaccines and chemoprophylaxis and treatment strategies when developed. Ultimately, regional and national public health systems preparing and responding to the current and future waves of COVID-19 may benefit from evaluating the relative burden of past respiratory pathogens and the impact of non-pharmacologic intervention strategies as prior information when forecasting and implementing interventions.

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FIGURE 1. Weekly trends in total influenza cases between January 1 2017 and December 31 2019 extracted from FluNet. **A**=Middle East and North Africa; **B**=Latin America and the Caribbean; **C**=South Asia; **D**=Sub-Saharan Africa; **E**=North America; **F**=East Asia Pacific; **G**=Europe and Central Asia

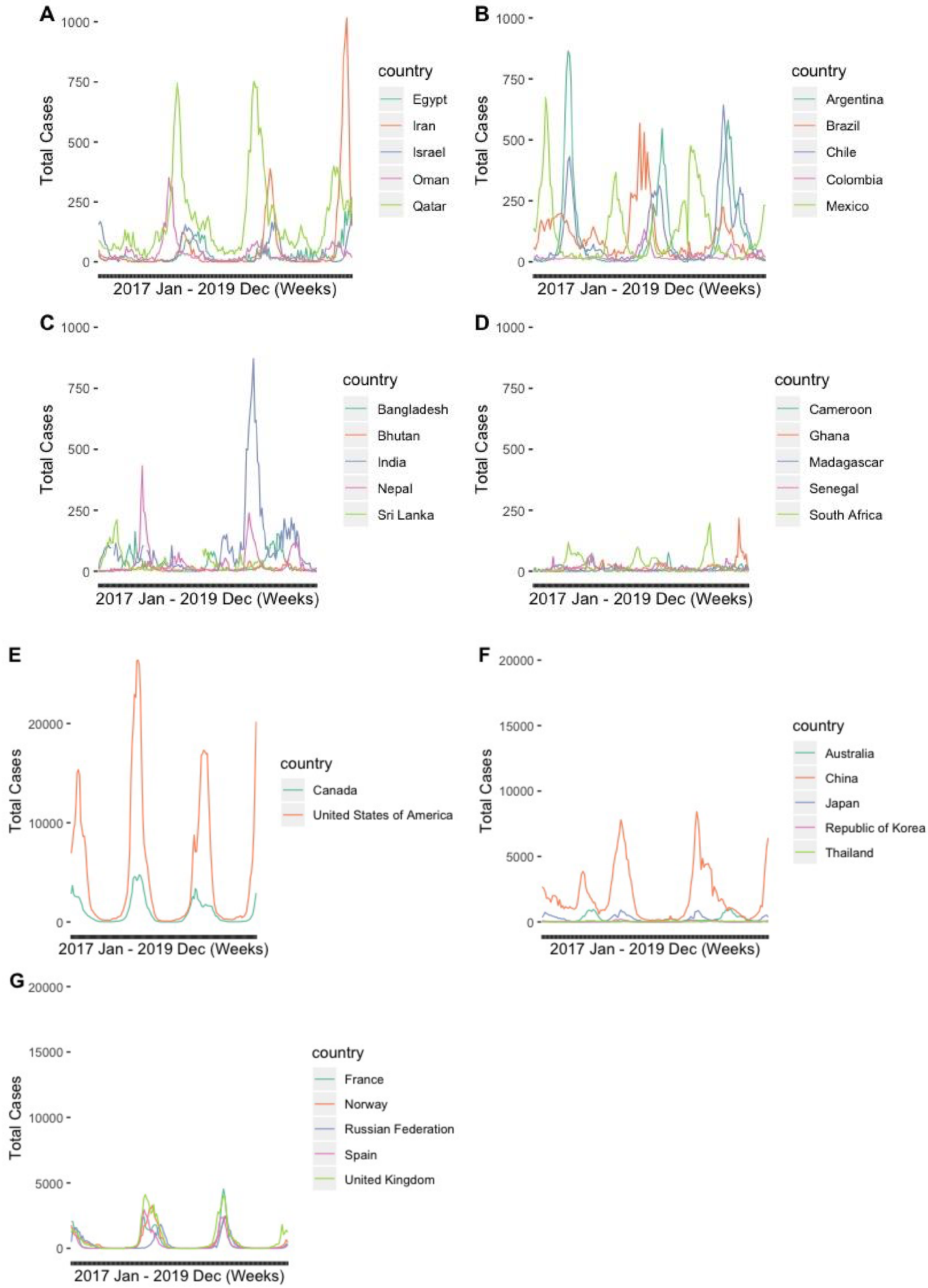

FIGURE 2. Rank order of seven World Bank regions by COVID-19 burden from January 1 to May 31 2020 and influenza cases from January 1 2017 to December 31 2019

Region	COVID-19	2019 Influenza	2018 Influenza	2017 Influenza
Europe & Central Asia	1	2	2	2
North America	2	1	1	1
Latin America & Caribbean	3	4	4	4
Middle East & North Africa	4	5	5	5
South Asia	5	6	7	6
East Asia & Pacific	6	3	3	3
Sub-Saharan Africa	7	7	6	7

Ranking Scale
1
3
6
Missing data

FIGURE 3. Rank order of top 15 countries by COVID-19 burden from January 1 to May 31 2020 and influenza cases within seven World Bank regions, from January 1 2017 to December 31 2019

World Bank Classification	Country	COVID-19	2019 Influenza	2018 Influenza	2017 Influenza
Sub-Saharan Africa	South Africa	1	2	1	1
	Nigeria	2	19	18	24
	Ghana	3	1	2	3
	Cameroon	4	9	6	4
	Sudan	5			
	Guinea	6	16	20	
	Senegal	7	5	3	2
	Democratic Republic of the Congo	8	21	21	18
	Cote d'Ivoire	9	6	9	7
	Gabon	10			
	Somalia	11			
	Kenya	12	12	12	20
	Guinea-Bissau	13			
	Mali	14	11	15	10
	Ethiopia	15	13	13	13
East Asia and Pacific	China	1	1	1	1
	Singapore	2	6	5	7
	Indonesia	3	13	7	6
	Philippines	4	15	16	14
	Japan	5	3	2	3
	Republic of Korea	6	4	4	4
	Malaysia	7	7	9	11
	Australia	8	2	3	2
	Thailand	9	5	6	5
	New Zealand	10	8	10	8
	Vietnam	11	14	12	9
	Myanmar	12	10	18	13
	Mongolia	13	9	13	12

Ranking Scale	
1	
8	
15	
Missing data	

	Guam	14			
	Brunei Darussalam	15			
South Asia	India	1	1	1	1
	Pakistan	2	4		
	Bangladesh	3	3	5	4
	Afghanistan	4	7	8	8
	Maldives	5	8	6	6
	Sri Lanka	6	6	3	2
	Nepal	7	2	2	3
	Bhutan	8	5	7	5
Middle East & North Africa	Iran	1	2	5	6
	Saudi Arabia	2	4	7	5
	Qatar	3	1	1	1
	United Arab Emirates	4			
	Kuwait	5	3		
	Egypt	6	5	2	7
	Israel	7	6	4	4
	Bahrain	8	16	15	15
	Oman	9	7	6	3
	Algeria	10	17	11	13
	Morocco	11	9	14	11
	Iraq	12			
	Djibouti	13			
	Lebanon	14	13	16	14
	Tunisia	15	15	10	9
Latin America & Caribbean	Brazil	1	3	1	3
	Peru	2	15	8	13
	Chile	3	1	4	4
	Mexico	4	2	2	2
	Ecuador	5	8	10	
	Colombia	6	7	6	7
	Dominican Republic	7		16	
	Argentina	8	3	3	1

	Panama	9	13	17	12
	Bolivia	10	12	5	6
	Honduras	11	17	13	22
	Guatemala	12	16	12	14
	Puerto Rico	13			
	El Salvador	14	20	18	11
	Cuba	15	11	14	16
North America	United States of America	1	1	1	1
	Canada	2	2	2	2
	Bermuda	3			
Europe & Central Asia	Russian Federation	1	4	7	4
	United Kingdom	2	1	1	1
	Spain	3	5	5	5
	Italy	4	10	11	12
	Germany	5	24	19	18
	Turkey	6	23	20	16
	France	7	2	3	3
	Belgium	8	42	37	33
	Netherlands	9	11	14	10
	Belarus	10	27	35	24
	Sweden	11	7	4	6
	Portugal	12	9	12	19
	Switzerland	13	6	8	7
	Ireland	14	13	10	15
	Ukraine	15	28	23	27

TABLE 1. Influenza cases for top 15 countries by World Bank region, overall and by year from January 1 2017 to December 31 2019*
*Rankings exclude countries with missing influenza data

	Overall Influenza			2019 Influenza			2018 Influenza			2017 Influenza		
		Cases	% of regional total		Cases	% of regional total		Cases	% of regional total		Cases	% of regional total
Sub-Saharan Africa		**18,930**	**100.0**		**7,521**	**100.0**		**5,785**	**100.0**		**5,624**	**100.0**
	South Africa	3,534	18.7	Ghana	1,172	15.6	South Africa	1,160	20.1	South Africa	1,210	21.5
	Ghana	2,383	12.6	South Africa	1,164	15.5	Ghana	742	12.8	Senegal	820	14.6
	Senegal	1,783	9.4	Mauritius	570	7.6	Senegal	480	8.3	Ghana	469	8.3
	Madagascar	1,117	5.9	Togo	501	6.7	Zambia	391	6.8	Cameroon	447	7.9
	Cameroon	1,098	5.8	Senegal	483	6.4	Tanzania	330	5.7	Uganda	404	7.2
	Ivory Coast	1,057	5.6	Ivory Coast	458	6.1	Cameroon	319	5.5	Madagascar	368	6.5
	Togo	988	5.2	Madagascar	451	6.0	Madagascar	298	5.2	Ivory Coast	337	6.0
	Zambia	971	5.1	Zambia	426	5.7	Ivory Coast	262	4.5	Tanzania	304	5.4
	Tanzania	876	4.6	Cameroon	332	4.4	Togo	254	4.4	Togo	233	4.1
	Mauritius	767	4.1	Tanzania	242	3.2	Burkina Faso	236	4.1	Mali	165	2.9
	Uganda	621	3.3	Mali	235	3.1	Kenya	216	3.7	Zambia	154	2.7
	Mali	544	2.9	Kenya	220	2.9	Ethiopia	203	3.5	Ethiopia	117	2.1
	Ethiopia	534	2.8	Ethiopia	214	2.8	Central African Republic	177	3.1	Niger	117	2.1
	Kenya	461	2.4	Uganda	179	2.4	Mali	144	2.5	Central African Republic	109	1.9
	Burkina Faso	398	2.1	Niger	144	1.9	Mauritius	102	1.8	Mauritius	95	1.7
East Asia & Pacific		**389,657**	**100.0**		**158,173**	**100.0**		**101,937**	**100.0**		**129,547**	**100.0**
	China	302,126	77.5	China	122,757	77.6	China	80,297	78.8	China	99,072	76.5
	Japan	29,449	7.6	Australia	14,002	8.9	Japan	9,076	8.9	Australia	10,509	8.1
	Australia	28,775	7.4	Japan	10,029	6.3	Australia	4,264	4.2	Japan	10,344	8.0
	Republic of Korea	4,958	1.3	Republic of Korea	1,702	1.1	Republic of Korea	1,952	1.9	Republic of Korea	1,304	1.0
	Thailand	3,640	0.9	Thailand	1,568	1.0	Singapore	1,106	1.1	Thailand	1,288	1.0
	Singapore	3,258	0.8	Singapore	1,154	0.7	Thailand	784	0.8	Indonesia	1,045	0.8
	New Zealand	2,377	0.6	Malaysia	1,115	0.7	Indonesia	710	0.7	Singapore	998	0.8
	Malaysia	2,270	0.6	New Zealand	957	0.6	Lao PDR	661	0.6	New Zealand	945	0.7
	Indonesia	2,251	0.6	Mongolia	909	0.6	Malaysia	493	0.5	Vietnam	793	0.6
	Lao PDR	2,039	0.5	Myanmar	806	0.5	New Zealand	475	0.5	Lao PDR	788	0.6
	Mongolia	1,746	0.4	Lao PDR	590	0.4	Korea, Dem. People's Rep.	474	0.5	Malaysia	662	0.5
	Vietnam	1,493	0.4	New Caledonia	541	0.3	Vietnam	345	0.3	Mongolia	533	0.4
	Myanmar	1,340	0.3	Indonesia	496	0.3	Mongolia	304	0.3	Myanmar	431	0.3
	New	1,036	0.3	Vietnam	355	0.2	New	291	0.3	Philippines	268	0.2

	Caledonia						Caledonia					
	Korea, Dem. People's Rep.	851	0.2	Philippines	346	0.2	Cambodia	234	0.2	Cambodia	226	0.2
South Asia		**31,992**	**100.0**		**17,313**	**100.0**		**5,401**	**100.0**		**9,278**	**100.0**
	India	14,895	46.6	India	10,428	60.2	India	1,880	34.8	India	2,587	27.9
	Nepal	5,678	17.7	Nepal	2,569	14.8	Nepal	957	17.7	Sri Lanka	2,361	25.4
	Sri Lanka	3,794	11.9	Bangladesh	1,783	10.3	Sri Lanka	947	17.5	Nepal	2,152	23.2
	Bangladesh	3,647	11.4	Pakistan	1,002	5.8	Bangladesh	673	12.5	Bangladesh	1,191	12.8
	Bhutan	1,487	4.6	Bhutan	679	3.9	Maldives	393	7.3	Bhutan	444	4.8
	Pakistan	1,002	3.1	Sri Lanka	486	2.8	Bhutan	364	6.7	Maldives	435	4.7
	Maldives	916	2.9	Afghanistan	278	1.6	Afghanistan	187	3.5	Afghanistan	108	1.2
	Afghanistan	573	1.8	Maldives	88	0.5						
Middle East & North Africa		**67,610**	**100.0**		**31,348**	**100.0**		**21,224**	**100.0**		**15,038**	**100.0**
	Qatar	27,363	40.5	Qatar	8,365	26.7	Qatar	11,450	53.9	Qatar	7,548	50.2
	Iran	9,445	14.0	Iran	7,387	23.6	Egypt	2,072	9.8	Oman	3,024	20.1
	Kuwait	6,601	9.8	Kuwait	6,601	21.1	Israel	1,602	7.5	Israel	1,145	7.6
	Oman	5,788	8.6	Saudi Arabia	2,423	7.7	Iran	1,430	6.7	Saudi Arabia	700	4.7
	Egypt	4,986	7.4	Egypt	2,339	7.5	Oman	1,388	6.5	Iran	628	4.2
	Israel	4,543	6.7	Israel	1,796	5.7	Saudi Arabia	1,179	5.6	Egypt	575	3.8
	Saudi Arabia	4,302	6.4	Oman	1,376	4.4	Malta	880	4.1	Malta	505	3.4
	Malta	1,385	2.0	Jordan	366	1.2	Tunisia	315	1.5	Tunisia	342	2.3
	Jordan	891	1.3	Lebanon	262	0.8	Algeria	310	1.5	Jordan	252	1.7
	Tunisia	860	1.3	Tunisia	203	0.6	Jordan	273	1.3	Algeria	134	0.9
	Bahrain	488	0.7	Bahrain	197	0.6	Bahrain	202	1.0	Lebanon	96	0.6
	Lebanon	481	0.7	Algeria	33	0.1	Lebanon	123	0.6	Bahrain	89	0.6
	Algeria	477	0.7									
Latin America & Caribbean		**93,712**	**100.0**		**33,308**	**100.0**		**31,606**	**100.0**		**28,798**	**100.0**
	Mexico	18,976	20.2	Chile	7,371	22.1	Brazil	7,012	22.2	Argentina	6,566	22.8
	Argentina	17,658	18.8	Mexico	6,963	20.9	Mexico	5,667	17.9	Mexico	6,346	22.0
	Brazil	16,477	17.6	Argentina	6,477	19.4	Argentina	4,615	14.6	Brazil	6,006	20.9
	Chile	15,783	16.8	Brazil	3,459	10.4	Chile	4,192	13.3	Chile	4,220	14.7
	Colombia	3,549	3.8	Paraguay	1,498	4.5	Bolivia	2,068	6.5	Paraguay	948	3.3
	Nicaragua	3,501	3.7	Nicaragua	1,419	4.3	Colombia	1,425	4.5	Bolivia	873	3.0
	Paraguay	3,378	3.6	Colombia	1,316	4.0	Nicaragua	1,320	4.2	Colombia	808	2.8
	Bolivia	3,371	3.6	Ecuador	615	1.8	Peru	1,061	3.4	Nicaragua	762	2.6
	Peru	1,651	1.8	Costa Rica	505	1.5	Paraguay	932	2.9	Costa Rica	591	2.1
	Ecuador	1,393	1.5	Jamaica	479	1.4	Ecuador	778	2.5	El Salvador	288	1.0
	Costa Rica	1,266	1.4	Cuba	463	1.4	Haiti	340	1.1	Panama	262	0.9
	Guatemala	863	0.9	Bolivia	430	1.3	Honduras	322	1.0	Peru	241	0.8
	Cuba	846	0.9	Panama	382	1.1	Guatemala	322	1.0	Guatemala	228	0.8
	Panama	846	0.9	Haiti	358	1.1	Cuba	238	0.8	Uruguay	197	0.7
	Haiti	809	0.9	Peru	349	1.0	Dominican	203	0.6	Cuba	145	0.5

							Republic					
North America		**903,554**	**100.0**		**310,724**	**100.0**		**334,093**	**100.0**		**258,737**	**100.0**
	United States of America	749,472	82.9	United States of America	267,528	86.1	United States of America	267,611	80.1	United States of America	214,333	82.8
	Canada	154,082	17.1	Canada	43,196	13.9	Canada	66,482	19.9	Canada	44,404	17.2
Europe & Central Asia		**599,020**	**100.0**		**224,554**	**100.0**		**235,606**			**138,870**	**100.0**
	United Kingdom	106,087	17.7	United Kingdom	42,448	18.9	United Kingdom	44,120	18.7	United Kingdom	19,519	14.1
	Norway	71,727	12.0	France	25,405	11.3	Norway	32,966	14.0	Norway	16,479	11.9
	France	62,672	10.5	Norway	22,282	9.9	France	21,610	9.2	France	15,657	11.3
	Spain	49,971	8.3	Russian Federation	19,340	8.6	Sweden	21,407	9.1	Russian Federation	14,635	10.5
	Russian Federation	49,289	8.2	Spain	17,232	7.7	Spain	19,973	8.5	Spain	12,766	9.2
	Sweden	46,472	7.8	Switzerland	14,096	6.3	Denmark	17,120	7.3	Sweden	11,242	8.1
	Switzerland	35,856	6.0	Sweden	13,823	6.2	Russian Federation	15,314	6.5	Switzerland	9,842	7.1
	Denmark	33,599	5.6	Denmark	11,835	5.3	Switzerland	11,918	5.1	Denmark	4,644	3.3
	Italy	13,539	2.3	Portugal	6,634	3.0	Austria	5,143	2.2	Slovenia	3,906	2.8
	Portugal	11,904	2.0	Italy	6,361	2.8	Ireland	4,984	2.1	Netherlands	3,428	2.5
	Netherlands	11,430	1.9	Netherlands	5,166	2.3	Italy	4,382	1.9	Latvia	3,121	2.2
	Austria	11,311	1.9	Croatia	4,823	2.1	Portugal	3,984	1.7	Italy	2,796	2.0
	Ireland	10,964	1.8	Ireland	4,201	1.9	Slovenia	3,020	1.3	Austria	2,071	1.5
	Slovenia	10,502	1.8	Austria	4,097	1.8	Netherlands	2,836	1.2	Croatia	1,796	1.3
	Croatia	9,216	1.5	Slovenia	3,576	1.6	Latvia	2,785	1.2	Ireland	1,779	1.3

TABLE 2. COVID-19 cases for top 15 countries by World Bank region, overall and by year from January 1 2020 to May 31 2020

		COVID-19 cases	% of regional total
Sub-Saharan Africa		**95,845**	**100.0**
	South Africa	30,967	32.3
	Nigeria	9,855	10.3
	Ghana	7,768	8.1
	Cameroon	5,659	5.9
	Sudan	4,800	5.0
	Guinea	3,706	3.9
	Senegal	3,535	3.7
	Democratic Republic of the Congo	2,965	3.1
	Cote d'Ivoire	2,799	2.9
	Gabon	2,613	2.7
	Somalia	1,916	2.0
	Kenya	1,888	2.0
	Guinea-Bissau	1,256	1.3
	Mali	1,250	1.3
	Ethiopia	1,063	1.1
East Asia & Pacific		**212,329**	**100.0**
	China	84,570	39.8
	Singapore	34,366	16.2
	Indonesia	26,473	12.5
	Philippines	18,086	8.5
	Japan	16,851	7.9
	Republic of Korea	11,468	5.4
	Malaysia	7,762	3.7
	Australia	7,185	3.4
	Thailand	3,081	1.5
	New Zealand	1,154	0.5
	Vietnam	328	0.2
	Myanmar	224	0.1
	Mongolia	179	0.1
	Guam	166	0.1
	Brunei Darussalam	141	0.1
South Asia		**318,803**	**100.0**
	India	182,143	57.1
	Pakistan	69,496	21.8
	Bangladesh	47,153	14.8
	Afghanistan	15,094	4.7
	Maldives	1,672	0.5
	Sri Lanka	1,630	0.5
	Nepal	1,572	0.5
	Bhutan	43	0.0
Middle East & North Africa		**440,590**	**100.0**
	Iran	148,950	33.8

	Saudi Arabia	83,384	18.9
	Qatar	55,262	12.5
	United Arab Emirates	33,896	7.7
	Kuwait	26,192	5.9
	Egypt	23,449	5.3
	Israel	17,012	3.9
	Bahrain	10,793	2.4
	Oman	10,423	2.4
	Algeria	9,267	2.1
	Morocco	7,780	1.8
	Iraq	6,179	1.4
	Djibouti	3,194	0.7
	Lebanon	1,191	0.3
	Tunisia	1,076	0.2
Latin America & Caribbean		**936,995**	**100.0**
	Brazil	465,166	49.6
	Peru	148,285	15.8
	Chile	94,858	10.1
	Mexico	84,627	9.0
	Ecuador	38,571	4.1
	Colombia	26,688	2.8
	Dominican Republic	16,908	1.8
	Argentina	14,702	1.6
	Panama	12,531	1.3
	Bolivia	8,731	0.9
	Honduras	4,886	0.5
	Guatemala	4,607	0.5
	Puerto Rico	3,718	0.4
	El Salvador	2,395	0.3
	Cuba	2,025	0.2
North America		**1,805,959**	**100.0**
	United States of America	1,716,078	95.0
	Canada	89,741	5.0
	Bermuda	140	0.0
Europe & Central Asia		**2,116,249**	**100.0**
	Russia	405,843	19.2
	United Kingdom	272,830	12.9
	Spain	239,600	11.3
	Italy	232,664	11.0
	Germany	181,482	8.6
	Turkey	163,103	7.7
	France	148,436	7.0
	Belgium	58,186	2.7
	Netherlands	46,257	2.2
	Belarus	41,658	2.0
	Sweden	37,113	1.8

	Portugal	32,203	1.5
	Switzerland	30,762	1.5
	Ireland	24,929	1.2
	Ukraine	23,672	1.1