The Correlation of Mobility Trend and Situation of COVID-19 by Country, Territory, and Area

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Abstract

Each country around the world has taken several approaches in order to stop the spreading of the virus. This study was conducted to correlate the mobility trend and the situation of COVID-19 by country, territory, and area. This research paper adopts an observational analytic study with a cross-sectional approach for 115 countries from February 17th to August 27th, 2020. Tajikistan (r=0,956) and Italy (r=0,931) has the highest positive correlation for retail and recreations. For grocery, the highest degree of positive correlation is Mongolia (r=0,945) and Tajikistan (r=0,933). Bostwana and Italy showed highest significant positive correlation among countries (r=0,985 and r=0,902, respectively) for transit stations and residential (r=0,994 and r=0,984). Bostwana also has the highest significant positive correlation for the park (r=0.980). Meanwhile, for the workplace, Mauritius (r=0,863) and Dominica (r=0,785) are countries with the highest degree of positive correlation with a cumulative case of COVID-19. Society's behavior plays an important role by following the government policy in order to slow down the spread of the virus. Retail and recreations, groceries and pharmacy stores, transit stations, parks, and workplaces found to have a significant positive correlation while residential have a significant negative correlation with cumulative cases of COVID-19 in most countries.

Keywords: Mobility trend, COVID-19, social distancing, stay at home, policy

1. Introduction

At the end of 2019, the world was faced with a series of cases of a new type of pneumonia in Wuhan, China.[1] This disease was originally referred to as Fever of unknown origin with pneumonia caused by 2019-novel coronavirus (2019-nCoV).[2] WHO stated this situation as International Public Health Emergency of International Concern. On February 11, 2020, after a long analysis, it was discovered that the cause of pneumonia was severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). In February 2020, 26,359 suspected cases were found; 31,225 confirmed cases with 639 deaths. The disease caused by the SARS-Cov-2 is designated by WHO as COVID-19.[3]

The COVID-19 epidemic began to spread in early December from the city of Wuhan, one of the cities in China with the largest population and highest export and import activity. COVID-19 cases were first reported outside China on January 13, 2020 in Bangkok (Thailand). In almost two months, 67 territories outside China reported 8,565 confirmed cases of COVID-19. Reports of confirmed cases of COVID-19 around the world are increasing, especially in Iran and Italy which reported the highest cases. On March 11, 2020, WHO declared COVID-19 a pandemic. 1,250,000 suspected cases have been found in 180 countries, 69,210 cases of death with a crude fatality rate of 5.5% as of April 7, 2020.[1,2,4]

Lock downs along with restrictions on mobility have been implemented around the world to reduce the spread of the COVID-19 epidemic. Without the lockdown in Wuhan, it is estimated that the number of COVID-19 cases will increase by 64.81% in 347 cities in China outside Hubei province, and 52.64% higher in 16 other cities in Hubei. Many countries have strict mobility restrictions, travel bans, minimum distances and quarantines to slow the spread of the virus. Italy, the first country in Europe to experience a large-scale outbreak, imposed restrictions on the mobility of citizens on March 8, and starting March 21 there was a decrease in the number of new cases.[5,6,7]

Since 31 December 2019 to 12 September 2020 the number of COVID-19 cases worldwide reached 28,516,744 with 16,005 deaths.[8] In Indonesia, the number of confirmed COVID-19 cases reached 214,746 cases with 8,650 deaths.[9] The number of new cases continues to increase every day accompanied by an increasing number of deaths. With the increase number of cases of COVID-19, human mobility and order are being enforced. As of 17 August 2020, a total of 219 countries and territories have issued 83,694 trips which represents a 3 percent increase from the 81,843 trips reported on 10 August 2020.[10]

In order to identify the effectiveness of handling the pandemic situation by reducing the society mobility, COVID-19 community mobility reports were presented by Google to measure the numbers of visitors in specific categories everyday. This study was conducted to correlate the mobility trend and the situation of COVID-19 by country, territory and area.

2. Method

Design and sample
This research used observational analytic study with a cross-sectional approach conducted on 115 countries situation of COVID-19 and mobility trend which includes retail and recreation, grocery and pharmacy stores, residential, transit, park and workplace from February 17th, 2020 until August 27th, 2020. Countries with missing data and without mobility trend data was excluded from this research.

Data sources
Data needed in this study included the situation of COVID-19 by country, territory and area, and the mobility trend data of retail and recreation, grocery and pharmacy

stores, residential, transit stations, park and workplace. Cumulative cases of COVID-19 were taken from WHO Coronavirus Disease (COVID-19) Dashboard sited https://covid19.who.int/table. While for the Google Mobility Trends data which a measure taken to see the community movements or activities from specific categories were taken from https://ourworldindata.org/covid-mobility-trends. All the material produced by World in Data, including interactive visualizations and code, are completely open access under the Creative Commons BY license. A total of 115 countries were identified to a complete data for mobility trend from early February, 2020 until August 27th 2020.

Data analysis

The correlation between the cumulative cases and mobility trend were then analyse using STATA Version 15. The cumulative cases of COVID-19 were matched with the data of mobility trend available in each country, territory and area. Spearman correlation test were used to measure the correlation between the variables. A data of p-value <0.05 were noted as significantly correlated.

3. Results

Data was collected from WHO cumulative cases of COVID-19 while mobility trend were taken from Google Mobility Trend website. Data were analyzed and correlated based on six category which are retail, grocery, residential, transit, park, and workplace. We examine correlation between mobility trend and cumulative cases of COVID-19 throughout 115 countries. Based on the table 1, it could be summarized there tren significant positive correlation between retail and recreation, grocery and pharmacy stores, transit station, park and workplace to cumulative case of COVID-19 (p=0,000). There tren significant negative correlation between residential and cumulative cases of COVID-19 (p=0,000). However, there are some countries showing negative correlation on retail and recreation, grocery and

pharmacy stores, transit stations and workplace such as India and Japan. There are also countries that show positive correlation on residential such as Bostwana and Italy.

European countries have park as the highest correlated variable and residential has negative correlation. That results are different in Italy. Countries from Europe continent has retail and recreation as the highest correlated variable.

Tajikistan (r=0,956) and Italy (r=0,931) has the highest retail and recreation correlation around the world followed by Bostwana, Burkina Faso and Dominica with (r=0.889). And Singapore shows the highest significantly negative correlations with (r=-0,205). Mostly countries from West Asian such United Arab Emirates, Kuwait, and Oman shows no significant correlation between retail and recreation with cumulative cases of COVID-19. Others countries also shows same result from retail and recreation such as United States of America, Philippines, Mexico, Cambodia, Chile, Costa Rica, Egypt, Japan, India, and Australia. For grocery and pharmacy stores, countries shown to have the highest degree of positive correlation tren Mongolia (r=0,945) and Tajikistan (r=0,933). There are 9 countries in total showing negative correlation, which are Bostwana (r=-0,990), Italy (r=-0,961), Japan (r=-0,203), Chile (r=-0,187), United States of America (r=--0,124), Costa Rica (r=-0.083), Belgium (r=-0,052), Kuwait (r=-0,010), and India (r=0,033). As for residential, countries with highest degree of positive correlation tren Botswana (r=0,994) and Italy (r=0,984) and on negative correlation is Tajikistan (r=-0,971), Libya (r=-0,959) and Mongolia (r=-0,905). There are other 12 countries showing positive correlation to residential which includes Argentina, Guatemala, Japan, Australia, Oman, Costa Rica, Nepal, India, Bahrain, Singapore and United Arab Emirates. Bostwana and Italy showed highest significant positive correlation among countries (r=0,985 and r=0,902, respectively) for transit stations with ten

other countries shown a negative correlation. Meanwhile for park, Bostwana shows the highest positive correlations with (r=0,98) while six countries show the opposite, negative correlation for park mobility tren. Lastly, for workplace, Mauritas (r=0,863) and Dominica (r=0,785) are countries with the highest degree of positive correlation and there are 22 countries showing negative correlation of workplace towards COVID-19 cumulative cases.

4. Discussion

COVID-19 began to spread in early December from the city of Wuhan, one of the cities in China with the largest population and highest export and import activity.WHO has declared the COVID-19 pandemic as a global health emergency. Since 31 December 2019 to 12 September 2020 the number of COVID-19 cases worldwide reached 28,516,744 with 16,005 deaths.[8] In Indonesia, the number of confirmed COVID-19 cases reached 214,746 cases with 8,650 deaths.[9]

Till date there have been no reports of clinically approved antiviral drugs or vaccines that are effective against COVID-19. World Health Organization (WHO) recommends non-pharmaceutical intervention to bring down the rising number of COVID-19 cases.[11] One of the examples in non-pharmaceutical intervention is social distancing and "stay at home" orders.

COVID-19 has spread rapidly across the globe, posing enormous health, economic, environmental and social challenges for the entire human population. The corona outbreak virus is very disruptive to the global economy. Almost all countries struggle to assist disease transmission by treating and caring for patients, quarantining suspected persons through contact, limiting large gatherings, maintaining full or partial lock downs, etc.

Table 1. Correlation between mobility trend and the cummulative cases of COVID-19 by country, territory and area

Countries	Retail & Recreation		Grocery & Pharmacy		Residential		Transit Stations		Park		Workplace	
	r	p-value	r	p-value	r	p-value	r	p-value	r	p-value	r	p-value
Angola	0.745	0.000	0.607	0.000	-0.683	0.000	0.680	0.000	0.816	0.000	0.582	0.000
Antigua	0.419	0.000	0.245	0.001	-0.347	0.000	0.228	0.003	0.620	0.000	0.240	0.002
Argentina	0.383	0.000	0.378	0.000	0.390	0.000	0.313	0.000	0.110	0.142	0.377	0.000
Aruba	0.704	0.000	0.594	0.000	-0.682	0.000	0.684	0.000	0.815	0.000	0.534	0.000
Australia	-0.085	0.236	0.350	0.000	0,109	0.131	-0.162	0.024	0.010	0.887	-0.142	0.048
Austria	0.448	0.000	0.291	0.000	-0.453	0.000	0.407	0.000	0.860	0.000	0.178	0.015
Bahamas	0.183	0.019	0.272	0.000	-0.360	0.000	0.271	0.000	0.356	0.000	0.237	0.002
Bahrain	0.221	0.002	0.088	0.230	0.003	0.962	0.108	0.140	0.179	0.014	-0.217	0.003
Bangladesh	0.411	0.000	0.418	0.000	-0.390	0.000	0.390	0.000	0.398	0.000	0.339	0.000
Barbados	0.689	0.000	0.504	0.000	-0.616	0.000	0.556	0.000	0.766	0.000	0.560	0.000
Belarus	0.145	0.051	0.277	0.000	-0.705	0.000	0.008	0.919	0.808	0.000	-0.689	0.000
Belgium	0.179	0.013	-0.052	0.475	-0.137	0.057	0.089	0.216	0.818	0.000	0.012	0.867
Belize	0.608	0.000	0.525	0.000	-0.589	0.000	0.458	0.000	0.569	0.000	0.559	0.000
Benin	0.782	0.000	0.647	0.000	-0.454	0.000	0.442	0.000	0.497	0.000	0.122	0.118
Bolivia	0.551	0.000	0.515	0.000	-0.532	0.000	0.535	0.000	0.522	0.000	0.512	0.000
Bosnia	0.578	0.000	0.611	0.000	-0.690	0.000	0.515	0.000	0.926	0.000	0.233	0.002
Botswana	0.889	0.000	-0.990	0.000	0.994	0.000	0.985	0.000	0.980	0.000	0.274	0.000
Brazil	0.670	0.000	0.732	0.000	-0.597	0.000	0.741	0.000	0.858	0.000	0.634	0.000
Bulgaria	0.860	0.000	0.683	0.000	-0.889	0.000	0.742	0.000	0.935	0.000	0.379	0.000
Burkina Faso	0.889	0.000	0.820	0.000	-0.729	0.000	0.733	0.000	0.890	0.000	0.410	0.000
Cambodia	0.136	0.059	0.080	0.265	-0.059	0.415	-0.002	0.973	0.009	0.906	-0.317	0.000
Cameron	0.667	0.000	0.593	0.000	-0.388	0.000	0.735	0.000	0.195	0.009	0.027	0.721
Canada	0.170	0.018	0.256	0.000	-0.160	0.026	0.113	0.117	0.869	0.000	0.053	0.465
Chile	-0.023	0.757	-0.187	0.012	0.304	0.000	-0.246	0.001	-0.209	0.005	0.037	0.626
Colombia	0.374	0.000	0.319	0.000	-0.361	0.000	0.250	0.001	0.377	0.000	0.308	0.000
Costa Rica	0.006	0.934	-0.083	0.274	0.019	0.801	-0.185	0.015	-0.019	0.807	-0.107	0.161
Croatia	0.772	0.000	0.707	0.000	-0.577	0.000	0.540	0.000	0.922	0.000	0.136	0.161
Denmark	0.677	0.000	0.672	0.000	-0.518	0.000	0.479	0.000	0.895	0.000	0.126	0.088
Dominica	0.889	0.000	0.865	0.000	-0.875	0.000	0.849	0.000	0.882	0.000	0.785	0.000
Ecuador	0.418	0.000	0.388	0.000	-0.392	0.000	0.387	0.000	0.415	0.000	0.398	0.000
Egypt	0.094	0.190	0.644	0.000	-0.080	0.270	0.103	0.155	0.379	0.000	-0.033	0.647
El savador	0.706	0.000	0.628	0.000	-0.739	0.000	0.608	0.000	0.683	0.000	0.729	0.000
Estonia	0.686	0.000	0.701	0.000	-0.697	0.000	0.515	0.000	0.895	0.000	0.122	0.099
Fiji	0.786	0.000	0.812	0.000	-0.738	0.000	0.616	0.000	0.550	0.000	0.650	0.000
Finland	0.235	0.001	0.507	0.000	-0.504	0.000	0.155	0.031	0.900	0.000	-0.100	0.165
France	0.242	0.001	0.533	0.000	-0.163	0.023	0.179	0.013	0.775	0.000	0.004	0.960
Gabon	0.746	0.000	0.713	0.000	-0.424	0.000	0.704	0.000	0.664	0.000	0.560	0.000
Germany	0.218	0.002	0.164	0.023	-0.199	0.005	0.192	0.007	0.919	0.000	-0.049	0.497
Ghana	0.758	0.000	0.864	0.000	-0.582	0.000	0.715	0.000	0.728	0.000	0.409	0.000
Greece	0.725	0.000	0.824	0.000	-0.735	0.000	0.517	0.000	0.911	0.000	0.206	0.005
Guatemala	0.577	0.000	0.310	0.000	0.310	0.000	0.492	0.000	0.393	0.000	0.362	0.000

Countries	Retil,recreation		Grocery & Pharmacy		Residential		Transit Stations		Park		Workplace	
	r	p-value	r	p-value	r	p-value	r	p-value	r	p-value	r	p-value
Haiti	0.813	0.000	0.699	0.000	-0.719	0.000	0.798	0.000	0.705	0.000	0.433	0.000
Honduras	0.658	0.000	0.619	0.000	-0.648	0.000	0.584	0.000	0.616	0.000	0.603	0.000
Huungary	0.691	0.000	0.451	0.000	-0.561	0.000	0.538	0.000	0.919	0.000	0.254	0.001
India	-0.030	0.680	-0.033	0.645	0.006	0.937	-0.040	0.584	-0.307	0.000	-0.029	0.692
Indonesia	0.301	0.000	0.305	0.000	-0.213	0.004	0.239	0.001	0.397	0.000	0.130	0.081
Iraq	0.232	0.001	0.220	0.002	-0.141	0.054	0.170	0.020	0.197	0.007	-0.027	0.709
Ireland	0.397	0.000	0.265	0.000	-0.428	0.000	0.392	0.000	0.591	0.000	0.387	0.000
Israel	0.266	0.000	0.190	0.009	-0.181	0.013	0.087	0.232	0.558	0.000	0.006	0.936
Italy	0.931	0.000	-0.961	0.000	0.984	0.000	0.902	0.000	0.788	0.000	0.499	0.000
Jamaica	0.608	0.000	0.522	0.000	-0.541	0.000	0.585	0.000	0.596	0.000	0.378	0.000
Japan	-0.072	0.318	-0.203	0.005	0.296	0.000	-0.239	0.001	-0.035	0.630	-0.432	0.000
Jordan	0.521	0.000	0.639	0.000	-0.448	0.000	0.364	0.000	0.647	0.000	0.376	0.000
Kazakhstan	0.378	0.000	0.398	0.000	-0.492	0.000	0.566	0.000	0.765	0.000	0.245	0.001
Kenya	0.571	0.000	0.533	0.000	-0.524	0.000	0.569	0.000	0.634	0.000	0.454	0.000
Kuwait	0.118	0.107	-0.010	0.894	-0.039	0.598	0.077	0.297	0.080	0.277	0.008	0.914
Kyrgyzstan	0.551	0.000	0.527	0.000	-0.731	0.000	0.517	0.000	0.729	0.000	0.453	0.000
Latvia	0.776	0.000	0.807	0.000	-0.758	0.000	0.590	0.000	0.917	0.000	0.220	0.003
Lebanon	0.252	0.000	0.283	0.000	-0.381	0.000	0.229	0.001	0.685	0.000	0.119	0.103
Libya	0.816	0.000	0.718	0.000	-0.959	0.000	0.407	0.000	0.945	0.000	0.519	0.000
Lithuania	0.432	0.000	0.844	0.000	-0.785	0.000	0.484	0.000	0.935	0.000	0.249	0.001
Luxembourg	0.405	0.000	0.236	0.001	-0.418	0.000	0.414	0.000	0.869	0.000	0.241	0.001
Malaysia	0.141	0.050	0.501	0.000	-0.153	0.033	0.069	0.340	0.290	0.000	0.111	0.123
Mali	0.810	0.000	0.615	0.000	-0.659	0.000	0.299	0.000	0.568	0.000	0.142	0.076
Malta	0.709	0.000	0.568	0.000	-0.648	0.000	0.662	0.000	0.911	0.000	0.502	0.000
Mauritas	0.846	0.000	0.792	0.000	-0.894	0.000	0.824	0.000	0.839	0.000	0.863	0.000
Mexico	0.081	0.278	0.118	0.113	-0.099	0.181	0.073	0.326	0.086	0.245	0.117	0.114
Mongolia	0.907	0.000	0.945	0.000	-0.905	0.000	0.875	0.000	0.946	0.000	-0.098	0.200
Mozambique	0.785	0.000	0.800	0.000	-0.670	0.000	0.344	0.000	0.566	0.000	0.240	0.002
Myanmar	0.837	0.000	0.813	0.000	-0.674	0.000	0.759	0.000	0.670	0.000	0.690	0.000
Namibia	0.277	0.000	0.318	0.000	-0.216	0.005	0.138	0.075	0.087	0.261	0.290	0.000
Nepal	0.009	0.906	0.009	0.902	0.012	0.864	-0.017	0.818	0.000	0.996	0.010	0.886
Netherland	0.590	0.000	0.121	0.102	-0.418	0.000	0.367	0.000	0.935	0.000	0.128	0.084
New Zealand	0.185	0.012	0.079	0.287	-0.137	0.064	0.111	0.134	0.253	0.001	0.081	0.273
Nicaraguay	0.472	0.000	0.392	0.000	-0.004	0.958	-0.092	0.244	0.233	0.003	-0.203	0.009
Niger	0.813	0.000	0.524	0.000	-0.647	0.000	0.657	0.000	0.815	0.000	-0.053	0.498
Nigeria	0.188	0.011	0.296	0.000	-0.143	0.054	0.231	0.002	0.141	0.057	0.164	0.027
Norway	0.711	0.000	0.737	0.000	-0.446	0.000	0.363	0.000	0.875	0.000	-0.009	0.907
Oman	0.107	0.145	0.028	0.704	0.024	0.742	0.052	0.479	0.060	0.412	-0.089	0.226
Pakistan	0.241	0.001	0.214	0.003	-0.232	0.001	0.217	0.003	0.353	0.000	0.139	0.058
Panama	0.365	0.000	0.256	0.001	-0.394	0.000	0.239	0.002	0.295	0.000	0.304	0.000
Papua New Guinea	0.790	0.000	0.753	0.000	-0.418	0.000	0.583	0.000	0.792	0.000	0.257	0.001

Cont Table 1. Correlation between mobility trend and the cummulative cases of COVID-19 by country, territory and area

Countries	Retail & Recreation		Grocery & Pharmacy Stores		Residential		Transit Stations		Park		Workplace	
	r	p-value	r	p-value	r	p-value	r	p-value	r	p-value	r	p-value
Paraguay	0.624	0.000	0.575	0.000	-0.502	0.000	0.488	0.000	0.614	0.000	0.476	0.000
Peru	0.495	0.000	0.465	0.000	-0.541	0.000	0.507	0.000	0.542	0.000	0.524	0.000
Philippines	0.060	0.405	0.022	0.760	-0.027	0.712	-0.022	0.757	0.072	0.319	0.055	0.442
Poland	0.730	0.000	0.687	0.000	-0.708	0.000	0.593	0.000	0.934	0.000	0.282	0.000
Portugal	0.559	0.000	0.492	0.000	-0.517	0.000	0.477	0.000	0.864	0.000	0.323	0.000
Puerto Rico	0.711	0.000	0.557	0.000	-0.680	0.000	0.592	0.000	0.687	0.000	0.629	0.000
Qatar	0.440	0.000	0.736	0.000	-0.266	0.000	0.316	0.000	0.567	0.000	0.267	0.000
Romania	0.414	0.000	0.369	0.000	-0.445	0.000	0.308	0.000	0.731	0.000	0.137	0.063
Rwanda	0.692	0.000	0.654	0.000	-0.645	0.000	0.722	0.000	0.719	0.000	R.416	0.000
Saudi Arabia	0.376	0.000	0.230	0.002	-0.313	0.000	0.314	0.000	0.424	0.000	0.207	0.005
Senegal	0.323	0.000	0.241	0.001	-0.318	0.994	0.237	0.001	0.289	0.994	-0.001	0.994
Singapore	-0.205	0.004	0.345	0.000	0.229	0.001	-0.196	0.006	-0.204	0.004	-0.235	0.001
Slovakia	0.834	0.000	0.648	0.000	-0.830	0.000	0.719	0.000	0.940	0.000	0.380	0.010
Slovenia	0.631	0.000	0.447	0.000	-0.722	0.000	0.593	0.000	0.942	0.000	0.192	0.010
South Africa	0.259	0.001	0.206	0.006	-0.257	0.001	0.224	0.003	0.338	0.000	0.220	0.003
Spain	0.227	0.001	0.180	0.012	-0.207	0.004	0.144	0.045	0.710	0.000	0.113	0.118
Sri Lanka	0.168	0.019	0.153	0.033	-0.171	0.017	0.153	0.034	0.179	0.012	0.147	0.041
Sweden	0.421	0.000	0.444	0.000	-0.139	0.053	0.121	0.094	0.929	0.000	-0.556	0.000
Switzerland	0.340	0.000	0.149	0.042	-0.439	0.000	0.325	0.000	0.773	0.000	0.116	0.115
Tajikistan	0.956	0.000	0.933	0.000	-0.971	0.000	0.901	0.000	0.945	0.000	0.716	0.000
Thailand	0.229	0.001	0.432	0.000	-0.114	0.113	0.029	0.689	0.191	,008	-0.055	0.449
Togo	0.509	0.000	0.495	0.000	-0.348	0.000	0.366	0.000	0.722	0.000	0.227	0.003
Trinidad and Tobago	0.623	0.000	0.520	0.000	-0.563	0.000	0.508	0.000	0.649	0.000	0.505	0.000
Turkey	0.613	0.000	0.465	0.000	-0.678	0.000	0.629	0.000	0.856	0.000	0.392	0.000
Uganda	0.706	0.000	0.685	0.000	-0.715	0.000	0.649	0.000	0.614	0.000	0.722	0.000
United Arab Emirates	0.057	0.426	0.023	0.750	0.002	0.981	0.022	0.758	-0.045	0.537	-0.055	0.443
United States of America	0.108	0.134	-0.124	0.085	-0.131	0.069	0.030	0.676	0.778	0.000	-0.057	0.429
Uruguay	0.810	0.000	0.665	0.000	-0.804	0.000	0.758	0.000	0.779	0.000	0.710	0.000
Venezuela	0.655	0.000	0.621	0.000	-0.391	0.000	0.567	0.000	0.659	0.000	0.608	0.000
Vietnam	0.193	0.007	0.647	0.000	-0.394	0.000	0.345	0.000	0.011	0.884	0.066	0.359
Yemen	0.736	0.065	0.848	0.065	-0.564	0.065	0.810	0.065	0.847	0.065	0.156	0.065
Zambia	0.824	0.000	0.851	0.000	-0.456	0.000	0.743	0.000	0.909	0.000	0.243	0.002
Zimbabwe	0.516	0.000	0.443	0.000	-0.288	0.000	0.480	0.000	0.788	0.000	0.396	0.000

Many countries have strict mobility restrictions, travel bans, minimum distances and quarantines to slow the spread of the virus. Italy, the first country in Europe to experience a large-scale outbreak, imposed restrictions on the mobility of citizens on March 8, and starting March 21 there was a decrease in the number of new cases.[6,7] Without the lockdown in Wuhan, it is estimated that the number of COVID-19 cases will increase by 64.81% in 347 cities in China outside Hubei province, and 52.64% higher in 16 other cities in Hubei.[5]

Several countries have misled aggressive policies and directed their resources to the reality of this global health emergency, based on the experiences of countries that suffered from the initial onslaught of this pandemic. However, not all country has the same capability to maintain economy stability within this crisis period. Many developing countries are unable to take the same action as developed or wealthy developing countries.[12]

Reported data prove that total mobility in many countries of the world has decreased as a result of sudden cessation of human activities due to lock downs. This causes an extreme breakdown of mobility patterns. Human mobility is one of the major factor in the spread of a diseases. High human mobility may introduce one diseases to another area where the diseases may have not been transmitted. Therefore, high human mobility has an association to high transmission of a disease.[13] We use mobility data from Google to elucidate the role of mobility have on cumulative cases of COVID-19.

We collected 115 countries mobility data from Google then examine correlation between mobility trend and cumulative cases of COVID-19. It was found majority of countries have positive correlation to retail, grocery, transit, park and have negative correlation on residential.

Majority of countries have enacted various orders as responses to COVID-19. One strategy that is particularly important is social distancing that may be assessed indirectly by our mobility patterns data. We found positive correlation on high visit to retail, grocery, transit and park on cumulative cases of COVID-19.

However, even during a pandemic, foodstuffs are still a basic human need. In fact, consumer spending on groceries continues in every kind of grocery store. By far, the biggest increase in consumer spending on groceries is making online retailers.[14] The COVID-19 lockdown improved food shopping performances.

In line with our findings, Delen et al used the cross-national mobility trends to analyses the efficacy of social distancing and found 47% variation in COVID-19 transmission is due to change in mobility patterns from enforcing social distancing with mobility in public places such as restaurants, grocery stores, public transport being the most important determinants of transmission rate.[15]

Study from Badr et al also confirmed the same findings that mobility patterns are strongly correlated (r=0,7) with decreased COVID-19 case growth rates for 20 of the 25 most affected counties in USA. All these results point out that increase visit to public places also increase COVID-19 infection significantly.[16]

Similarly, Valenti et al found in the mathematical model made to predict effects of social distancing on estimated death in Brazil, it was predicted that on May 24 there would be 32,825 total number of deaths related to COVID-19 compared to actual numbers 22,965.[17] This suggest social distancing has curb down the number and saved approximately 10 thousand of Brazilian lives.

Other studies by Jianhong Wu found reproduction number estimate decreasing during time interval from 3.25 to 2.97 to 2.84 indicating a gradually efficacy of interventions adopted.[18] The study also predicted the number of cumulative confirmed cases per 7 April to be 6132 (95%ci 4250-8000) and could be reduced further by decreasing contact rates further by 90%.

Study by VoPham et al on association of social distancing and COVID-19

incidence found higher social distancing was associated with 29% reduction of COVID-19 incidence (adjusted IRR 0.71;95% CI 0,57-0,87) and 35% reduction of COVID-19 mortality (adjusted IRR 0,65; 95% CI 0,55-0,76).[19] Overall, individuals made about 1.62 trips/day/person during COVID-19 compared to about 3.33 trips/day/person in the pre-pandemic period, which is down more than 50%.[20]

For residential, we found negative correlation to cumulative case of COVID-19. Residential indicates how long an individual stay within non-public places such as home,etc. Increase duration on stay at home mean decreased mobility within public places that potentially has many people. This decrease risk of transmission of COVID-19 as it can be transmitted via droplet.

Tran PhuocBao found social distancing has worked on 10 countries although the effect may be showed delayed, that is after 1-4 weeks.[21] Courthemanche also supported the same findings that without social distancing being issued, there would be 10 times greater the number of COVID-19 infection and more than 35 times transmission.[22]

However, there are some countries such as Philippines, Thailand, Oman, Mexico, Bahrain, Costa Rica, India, Nigeria, Nepal and Nicaraguay that shows no significant correlation on residential and cumulative cases of COVID-19. This is maybe because lack of active strategies such as testing, isolation and contact tracing. Passive social distancing is not enough to flatten the curve of COVID-19 as the infection may still occur somewhere else, for example in household.[23]

Majority of Europe countries has correlation to COVID-19 cases. Italy is one of Europe countries with highest degree of positive correlation to retail and park and highest negative correlation to grocery. Italy is one of Europe countries with highest elderly population, only second after Japan.[24]

COVID-19 is virus with severity and risk of death that is dependent on age. This may have an impact particularly for the residents of Italy. Family members that continue with their daily activities may be infected and transmit the virus to their family. Asymptomatic infections complicate

the matter even further. High negative correlation on grocery is puzzling however it can be explained by the number of COVID-19 cases that has been going down on Italy. Therefore it is shown as false negative correlation.

There are also some countries that showed no significant correlation between mobility change and COVID-19 cumulative cases. In this study, there were some countries with cumulative cases of COVID-19 that begin to decline such as Japan. Some lesson to be learned from the country success dealing with the pandemic involve innovative strategies to test and trace, transparency of government decision and citizen behaviour as one of the most important factor. Thus, to achieve success in curbing COVID-19 cases, there needs to be many factors to had, however these combinations are often lacking in most developing countries.[25]

Mobility change is implicated in social distancing, that is a method to minimize crowd interaction and therefore decrease the spread of a disease within people.[26] COVID-19 outbreak isn't the first time social distancing has been implemented. Previous occurrence includes 1918 influenza pandemic in which, 50-100 million deaths were reported worldwide. Due to the risk carried by the virus, every individual of a community needs to protect the vulnerable groups such as comorbid group, homeless, etc to decrease transmission of COVID-19 by reducing mobility to public places.[27]

Study of the effect of mobility habits on the spread of the Coronavirus in Italy. Daily COVID-19 cases are directly related to mobility habits carried out 21 days earlier. Population density, PM pollutants and number of tests per day are directly related to infection. Temperature has an inverse relationship with the spread of viruses. Areas close to the outbreak have a higher risk of transmission (time decay phenomenon).[28]

The public health response to COVID-19 in China has illustrated that it is possible to contain COVID-19 if the government focuses on a tried and tested public health outbreak response. Isolation, quarantine, social distancing and community containment measures were swiftly implemented. In China, patients with COVID-19 are immediately isolated in existing hospitals, and new hospitals are rapidly being built to handle the increasing number of cases in the hardest-hit areas. Home quarantine for contact began and large gatherings were canceled. In addition, community incarceration for an estimated 40 million to 60 million inhabitants has been institutionalized. A significant positive relationship between the incidence of COVID-19 cases and mortality is evident in China's response.[29]

Most of the COVID-19 cases associated with local transmission have been identified in countries located in the northern hemisphere, which are experiencing the "flu" winter season. Likewise, the global SARS-CoV-2 outbreak in February 2003 did not affect Africa or South America on a large scale, suggesting that the respiratory virus spreads more effectively in winter and, therefore, the southern hemisphere will be affected later in the year, if at all. Climate-specific culture differences (living more outdoors than indoors), effects of UV light on viral survival at surface, differences in population immunity (innate immunity), pre-exposure to the coronavirus, or higher temperatures can all contribute. To date, all identified cases of COVID-19 in Africa have originated in Europe and not from China.[29]

Areas with higher population densities have a higher probability of contagion, being less able to guarantee social distancing (increase in social activities with overcrowding). Respect to air quality impacts upon the spread of COVID-19, some recent research has shown that people living with long-term exposure to air pollution are more likely to become infected by coronavirus.[28]

Areas of the country with the highest PM pollution are mainly located the industrial areas and/or most of the population live, according to with the circumstance that PMs are mainly generated by industries, heating (e.g., home, office) and transport sector (e.g. mobility habits). The opposite area with lower PM pollution characterized by an economy mainly based on tourism and agriculture.[28]

Our study has several strength. This study has the most countries to examine so far. However, this study also have several limitations. First, the mobility data on this study were obtained from Google Mobility data. However, this data couldn't represent the entire population in the countries since there were only 57% of 7 billion people around the world that use the internet.[30] Thus, we may underestimate the impact of mobility change in some countries. Second, this study evaluate mobility change as the only factor affecting COVID-19 cases. Mobility change may be mediated by several factor such as massive test and trace, community behaviour that is not yet assessed in this study. Besides, mobility trend change may also be affected by internet shopping, especially on goods transport. Due to desire to avoid crowded stores out of fear of contracting coronavirus, consumers turned to the internet to do grocery shopping. However, internet shopping may increase online transport mobility to buy consumer needs and deliver them to respective place. Moreover "Park & Pickup" program, a non-contact shopping service allowing customers to have groceries delivered to designated parking lots, and other programs offered for public shopping alternatives which are not assessed and taken into measure in this study. This may potentially give an impact towards the results. Future work should keep in mind of these factors.

Our study may elucidate the evidence for effectiveness of social distancing policies by mobility change data. We believe this study shed light on high potential of technology to study the pandemic. Even though we only took retrospective approach by using provided mobility trend data, study in the future may

use proactive approach that use tracking technologies to identify people and location at risk to help the government and policy makers. Our result may provide an illustration to the government that still had not implemented mobility restriction. Finally, further research is still needed to examine behaviour predictive to reduce mobility and possible implementation to policy.

5. Conclusion

Mobility trend among countries are variable during the COVID-19 pandemic. Society behavior plays an important role in order to slow down the spread of the virus. In which the society needs to obey the government order such as "stay at home", social distancing, avoid going to public places to reduce society mobility accordingly to their own country policy made while facing this pandemic. This study shows that the mobility trend gives an impact towards the COVID-19 cases.

References

1. Di Gennaro F, Pizzol D, Marotta C, Antunes M, Racalbuto V, Veronese N, Smith L. Coronavirus Diseases (COVID-19) Current Status and Future Perspectives: A Narrative Review. International Journal of Environmental Research and Public Health. 2020; 17(8): 2690.
2. Park SE. Epidemiology, virology, and clinical features of severe acute respiratory syndrome -coronavirus-2 (SARS-CoV-2; Coronavirus Disease-19). Clin Exp Pediatr. 2020; 63(4): 119-124.
3. Hafees A, Ahmad A, Siddqui SA, Ahmad M, Mishra S. A Review of COVID-19 (Coronavirus Disease-2019) Diagnosis, Treatment and Prevention. EJMO. 2020;4(2):116-25.
4. Ha HD, Duc NM, Thong PM. The current update of vaccines for SARS-CoV-2. Electronic Journal of General Medicine. 2020; 17(5): 1-4.
5. Fang H, Wang L, Yang Y. Human Mobility Restrictions and the Spread of the Novel Coronavirus (2019-ncov) in China. National Bureau of Economic Research. 2020; 191: 1-39.
6. Muller SA, Balmer M, Neumann A, Nagel K. Mobility Traces and Spreading of COVID-19. 2020.
7. Wells CR, Sah P, Moghadas SM, Pandey A, Shoukat A, Wang Y, Wang Z, Meyers LA, Singer BH, Galvani AP. Impact of international travel and border control measures on the global spread of the novel 2019 coronavirus outbreak. Proc Natl Acad Sci U S A. 2020;117(13): 7504-7509.
8. ECDC. COVID-19 situation updates worldwide, as of 12 September 2020. https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases accessed at 12 September 2020.
9. The Jakarta Post. Indonesia's latest official COVID-19 figures. https://www.thejakartapost.com/news/2020/03/23/indonesias-latest-covid-19-figures.html accessed at 12 September 2020.
10. International Organization for Migration. Global Mobility Restriction Overview Bi-Weekly Update 17th August 2020 COVID-19 Mobility Impacts Update Series. 2020, IOM.
11. Cheng HY, Jian SW, Liu DP, Ng TC, Huang WT, Lin HH. Contact Tracing Assessment of COVID-19 Transmission Dynamics in Taiwan and Risk at Different Exposure Periods Before and After Symptom Onset. JAMA Intern Med. 2020; 180(9): 1156–1163.
12. Buheji M, Cunha KDC, Beka G, Mavric B, De Souza YL, Silva SS, Hanafi M, Yein TC. The extent of COVID-19 pandemic socio-economic impact on global poverty. A global integrative multidisciplinary review. American Journal of Economics. 2020; 10(4): 213-24.
13. Gondauri D, Batiashvili M. The Study

of the Effects of Mobility Trends on the Statistical Models of the COVID-19 Virus Spreading. 2020; 17(6): 17–20.

14. Grashuis J, Skevas T, Segovia MS. Grocery Shopping Preference during the COVID-19 pandemic. Sustainability MDPI. 2020; 12(13): 5369.

15. Delen D, Eryarsoy E, Davazdahemami B. No Place Like Home: Cross-National Data Analysis of the Efficacy of Social Distancing During the COVID-19 Pandemic. JMIR Public Health Surveill. 2020; 6(2): 19862.

16. Badr H, Du H, Marshall M, Dong E, Squire MM, Gardiner LM. Association Between Mobility Patterns and COVID-19 Transmission in the USA: A Mathematical Modelling Study. The Lancet. 2020; 20(11): 1247-1254.

17. Valenti VE, Menezes PDL, Carolina A, Abreu G De, Vieira NA, Garner DM. Social distancing measures could have reduced estimated deaths related to COVID-19 in Brazil. 2020; 30(2): 164–9.

18. Wu J, Tang B, Bragazzi NL, Nah K, McCarthy Z. Quantifying the role of social distancing, personal protection and case detection in mitigating COVID-19 outbreak in Ontario, Canada. J Math Ind. 2020; 10(1): 15.

19. VoPham T, Weaver MD, Hart JE, Ton M, White E, Newcomb PA. Effect of social distancing on COVID-19 incidence and mortality in the US. MedRxiv. 2020; 1–10.

20. Fatmi MR. COVID-19 impact on urban mobility. Journal of Urban Management. 2020; 9(3): 270-275.

21. Thu TPB, Ngoc PNH, Hai NM, Tuan LA. Effect of the social distancing measures on the spread of COVID-19 in 10 highly infected countries. Sci Total Environ. 2020; 742: 140430.

22. Courtemanche BC, Garuccio J, Le A, Pinkston J, Yelowitz A. Strong Social Distancing Measures in The United States Reduced The COVID-19 Growth Rate. 2020; 39(7): 1-7.

23. Martín-calvo D, Aleta A, Pentland A, Moreno Y, Moro E. Effectiveness of social distancing strategies for protecting a community from a pandemic with a data-driven contact network based on census and real-world mobility data. 2020.

24. Population Reference Bureau. Countries with the Oldest Population in the World [Internet]. 2020 [cited 2020 Sep 13]. Available from: www.prb.org/countries-with-the-oldest-populations/

25. Shaw R, Kim YK, Hua J. Governance, technology and citizen behavior in pandemic: Lessons from COVID-19 in East Asia. Progress in Disaster Science. 2020; 6: 100090.

26. World Health Organisation. Novel Coronavirus (2019-ncov) [Internet]. 2020 [cited 2020 Jun 29]. Available from: https://www.who.int/emergencies/diseases/%0Anovel- coronavirus-2019

27. Yu D, Lin Q, Chiu AP, He D. Effects of reactive social distancing on the 1918 influenza pandemic. PLoS One. 2017; 12(7): 0180545.

28. Cartenì A, Di Francesco L, Martino M. How mobility habits influenced the spread of the COVID-19 pandemic: Results from the Italian case study. Sci Total Environ. 2020; 741: 140489.

29. Hopman J, Allegranzi B, Mehtar S. Managing COVID-19 in Low- and Middle-Income Countries. JAMA. 2020; 323(16): 1549–1550.

30. Kemp S. Global Internet Use Accelerate, Special Report [Internet]. Internet Use Acccelerate. 2020 [cited 2020 Sep 13]. Available from: wearesocial.com/nlog/2019/01/digital-2019-global-internet-use-accelerates.