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Cross-Cultural Interpersonal Distance Preferences and COVID-19 Case Frequency

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ABSTRACT: During the initial spread of COVID-19, countries varied in their ability to control the virus. Research shows this variability is due, in part, to sociocultural factors. One sociocultural factor that differs among countries is the distance at which social interactions take place, also called interpersonal distance. Because COVID-19 transmits through social interaction, better understanding the relationship between cross-cultural interpersonal distance preferences and COVID-19 transmission would be helpful in recommending culturally effective preventive measures to help slow transmission.

Multivariable linear regression analysis was used to identify the relationship between interpersonal distance and COVID-19 transmission. This study hypothesized that during the initial period of spread within countries, the frequency of COVID-19 cases in countries where people interacted at closer interpersonal distances would be greater compared to countries where people interacted at more remote interpersonal distances.

The results of the multivariable regression analysis, with various controls, including total population, median age, and gross domestic product (GDP), indicated that the variation of interpersonal distance among countries did not affect COVID-19 case frequency. The models showed that total population, median age, GDP, and individualism were significant predictors of COVID-19 case frequency at different times during the initial spread within countries.

KEYWORDS: Computational Biology and Bioinformatics; Computational Epidemiology; Biostatistics; Infectious Diseases; COVID-19; Interpersonal Distance: Proxemics.

Introduction

In early 2020, COVID-19 spread quickly across the world, creating a global health crisis. The World Health Organization (WHO) declared COVID-19, the disease caused by the SARS-CoV-2 virus, a global pandemic on March 11, 2020.[1] By mid-April of 2020, the virus had infected over 2 million people killing at least 128,000 worldwide.[2] As of March 1, 2021, the virus infected 114.48 million people and caused 2.54 million deaths across the globe.[2] Among different countries, there was great variability in reported case numbers during the initial spread of COVID-19. This leads to the question, why did some countries struggle to contain the initial spread while others fared better?

Research has found that COVID-19 spreads through fomites, airborne droplets, and airborne aerosols, all of which are produced through breathing and vocalizations.[3] Due to gravity, most large and medium-sized airborne droplets fall to the ground quickly and do not travel far from their origin. However, smaller droplets and aerosols stay suspended in the air for longer periods of time.[3] This is why social distancing measures are so important in decreasing transmission of diseases such as COVID-19.

An area of study that is closely related to social distancing is proxemics, the study of how people use space when communicating with each other. Edward Hall, the founder of proxemics, defined interpersonal distance (IPD) as the amount of space that people feel is necessary to set between themselves and others.[4] It is interesting to note that these distances are primarily based on sensory input, such as, vision, hearing, touch, and smell. IPD may be evolutionarily derived - distance and perceptions can protect an organism from possible danger. For example, sensory discomfort due to crowding prevents overpopulation, disrupted social function, and the negative physiological and psychological effects of stress due to crowds.[5] Although IPD emerged through evolution and biology, it is also influenced by feelings towards others, conditioned situational responses, age, and gender.[6] According to Hall, cultural norms are the most significant factor that predict preferred interpersonal distances. Proxemics is supported by research showing that IPD varies among countries.[6]

Proxemics divides IPD into four categories: intimate distance, personal distance, social distance, and public distance (Figure 1). These distances are categorized by differences in visual, auditory, tactile, and olfactory stimulation. Intimate distance (0-18in.) is the closest distance at which people interact and is reserved for close friends and family. This distance is categorized by blurred vision, sensation of breath, low vocalizations, and increased perception of heat and olfaction. Personal distance (18in. - 4ft.) is the distance at which people conduct routine social interactions. At this distance, body heat is no longer detectable, but cues from a person's facial muscles and eyes are appreciable, and odor is detectable. People tend to vocalize at a moderate voice level. Since the individuals who are interacting are within reach of each other, physical contact is possible. Social distance (4-12 ft.) is the distance at which most formal interactions take place. At this distance people can engage and disengage at will, physical contact is not expected, facial details are less discernible, heat and odor are no longer detectable, and a moderate voice level is expected. Hall's final category, public distance (12-25 ft), is the distance where teaching and public speaking usually occur. At this distance the only expected sensory input is visual and auditory.

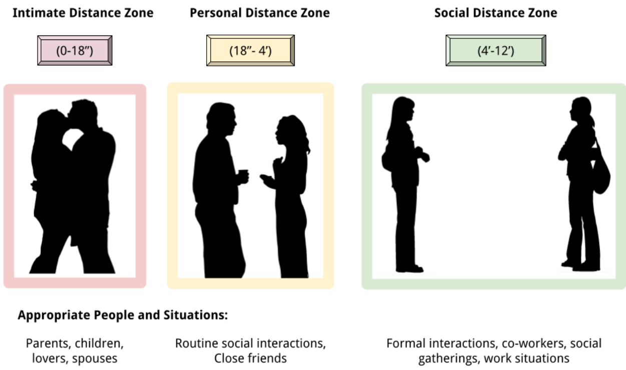

Figure 1: Depiction of interpersonal distance zones.

Sorokowska, in a cross-cultural comparison study done in 2017, concluded that IPD preferences differ across the globe.[6] This study measured social, personal, and intimate distance preferences in 42 countries. Distance preferences were determined through a questionnaire that used simple graphics. Participants from each country were asked to rate the distance at which they felt comfortable having a conversation with a stranger, an acquaintance, and a close friend or family member. This study's results support both Hall's conjecture that IPD does differ across various types of social interaction and that IPD differs among cultures.

Little research has been done on the relationship between proxemics and disease transmission. One very recent study looked into the effect of national preferred IPD and the spread of COVID-19.[7] Instead of using Sorokowska's raw data, IPD data was determined using a "pixel/millimetric coordinate system approach" based on the scaled graphic presented in the Sorokowska study. This recent study concluded that as national IPD preferences increase, COVID-19 growth rates decrease. It is important to note that this study did not attempt to take other factors that have been linked to the spread of COVID-19 into account. Other scientific research has identified various factors that impact COVID-19 case frequency or growth rate, thus highlighting the importance of control variables in epidemiological studies regarding COVID-19.

Recent studies have found that sociocultural factors, such as government efficiency and relational mobility, contribute to the spread of COVID-19.[8,9] This study assesses cross-cultural preferred interpersonal distance as a sociocultural factor impacting the early spread of COVID-19. Because COVID-19 can be transmitted through social interaction, a better understanding of the effects of cross-cultural IPD preferences on COVID-19 transmission would be helpful in determining preventive measures against COVID-19 transmission. This study addresses the gap in research regarding the effect of proxemics on disease transmission.

It is hypothesized that, during the initial period of spread within countries, the frequency of COVID-19 transmission in countries where people interact at closer interpersonal distances would be greater compared to countries where people interact at more remote interpersonal distances.

■ Methods

Statistical Analysis:

Multivariable linear regression is widely used to account for the strength of the relationship between a dependent variable and multiple independent variables simultaneously, and thus was used to determine which variables were significant in accounting for the number of COVID-19 cases within a country. In a regression model, independent variables must be independent of each other. Personal and social distance were found to be highly correlated ($r = 0.898$), as were personal and intimate distance ($r = 0.841$), and therefore could not be included in the same model. Therefore, a separate model was run for each interpersonal distance variable at each time period (15, 30, and 60 days).

Dependent Variable :

Data on the cumulative number of COVID-19 cases per country was collected from a public online database, Our World in Data, which is an international project that collects data on multiple topics, including COVID-19.[2] As a starting point for data collection, the day of the 100th reported COVID-19 case was determined for each country and designated as Day 0. The number of COVID-19 cases in each country was recorded at 15, 30, and 60 days after Day 0. These three timepoints made it possible to determine if interpersonal distance impacted the transmission of COVID-19 at different time points during the initial spread within each country. Data was not collected beyond 60 days after day 0 to avoid the potential impact of government mandates, such as, lockdowns, facial coverings, and social distancing. Although several countries had imposed lockdowns between Day 0 - Day 60, an analysis of the 1918 influenza pandemic suggests that lockdowns do not produce measurable effects for several weeks, and therefore lockdowns have been eliminated as a factor in this study.[10]

Independent Variable of Interest :

The source of all IPD data was Sorokowska's previously mentioned study on intimate, personal, and social distance preferences in 42 countries.[6] Data regarding public distance was not collected by Sorokowska's study. However, because COVID-19 transmission is not likely to occur at this distance (12 - 25 ft), it was not necessary to include it in the current study.

Country Selection :

Since IPD is the variable of interest in this study, the selection of countries was limited to the 40 countries in Sorokowska's study with data available for each control variable.

Control Variables :

Total population was included as a control variable because a greater population will likely have more infections simply because there are more people who are at risk of becoming infected or spreading the disease. Since the transmission of COVID-19 occurs primarily during human interactions at a close distance, population density (persons/km2) was controlled for as a variable that likely affected COVID-19 case frequency. Median age of the total population within a country was set as a control because older people are more susceptible to respiratory infections, such as COVID-19.[16] Net migration (per 1,000 population) was also controlled for to account for movement of a population which has been found to increase COVID-19 growth rates,[9] therefore impacting case frequency. Data for these four variables was obtained from the United Nations Department of Economic and Social Affairs World Population Prospects.[11]

Outside of general population factor, economic factors can also play a role in the spread of COVID-19, and therefore must be controlled for in this study. Gross domestic product (GDP) was included to control for economic development. Countries with a larger GDP are better equipped to handle a global pandemic because they have more resources. The percent of urbanization within a country was included as a control because people living in urban areas are more susceptible to transmission due to higher densities. International tourism (number of arrivals) was included as a control for movement of people into a population. Data for these three variables was obtained from The World Bank.[12]

On top of population demographics and economic factors, social differences between nations can play a role in the spread of infectious diseases. Individualism was set as a control because one study suggested that more individualistic countries reported more COVID-19 cases, as opposed to more collectivist countries.9 Individualism data was gathered from Hofstede's index of individualism. This index rates countries on a scale from 0-100 where 0 represents the most collectivist countries and 100 represents the most individualistic countries.[13] This index is part of a respected database regarding sociocultural factors which has been validated over time. Hofstede defined individualistic societies as "societies in which the ties between individuals are loose: everyone is expected to look after themselves and their immediate family." On the other side of the spectrum, collectivist societies were defined as "societies in which people from birth onward are integrated into strong, cohesive in-groups, which throughout people's lifetime continue to protect them in exchange for unquestioning loyalty".[14] This study hypothesized that citizens from more individualistic countries would not place a high priority on protecting the health of their communities, and would therefore have more COVID-19 cases, as compared to collectivist countries where citizens would be more willing to take actions to protect the health of their communities.

Finally, a recent study found that countries with mandated Bacillus Calamette-Guerin (BCG) vaccines were impacted less by COVID-19,[15] so BCG was included as a dichotomous control variable. The data was coded as 0 for countries without mandatory BCG vaccines and 1 for countries with mandatory BCG vaccines.

Results and Discussion

Interpersonal Distance :

The models at 15, 30, and 60 days all demonstrated that Sorokowska's measured interpersonal distance preferences did not account for the COVID-19 case frequencies during the early stages of country-wide outbreaks (Table 1). Interestingly, the models uncovered a set of variables that did, in fact, impact COVID-19 case frequency at each point in time.

Table 1: Linear regressions models of COVID-19 case frequency. The cells in the table below contain regressions coefficients for each variable. The legend explaining the meaning of the colors is located in the bottom row.

		15 Days			30 Days			60 Days		
		Intimate	Personal	Social	Intimate	Personal	Social	Intimate	Personal	Social
	Constant	-1273.695	-5020.181	-7347.121	47636.494	41180.174	33371.355	276393.083	301668.014	324126.513
β	IPD	2.286	46.788	58.804	-233.273	-85.511	6.812	-1280.228	-1201.491	-1156.686
	GDP at PPP	-9.31E-05	-6.63E-05	-9.22E-05	0.006	0.006	0.006	0.052	0.052	0.052
	Tourism	0.147	1.40E-01	0.137	0.903	0.906	0.893	0.377	0.496	0.52
	Net Migration	350.837	308.353	280.443	-273.582	-348.995	-437.763	-14082.399	-13807.529	-13523.019
	Total Pop.	0.003	0.003	0.003	-0.065	-0.067	-0.067	-0.576	-0.580	-0.588
	Pop. Density	2.444	1.893	1.835	16.708	15.745	14.629	115.868	119.52	117.227
	% Urbanization	14.418	20.876	31.085	-39.446	-69.451	-56.071	681.469	418.585	255.494
	Median Age	59.38	70.147	62.876	-871.919	-819.061	-797.572	-7885.649	-7775.379	-7563.297
	Individualism	-52.418	-55.6	-54.624	225.28	224.197	217.993	2918.84	2963.77	2925.04
	BCG	-92.712	-516.284	-1014.93	-14775.783	-14072.351	-14954.69	-63685.74	-53185.556	-45926.869
	R-Squared	0.533	0.546	0.564	0.887	0.883	0.882	0.818	0.816	0.817
	Legend	$p \leq .1$	$p \leq .05$	$p \leq .01$	$p \leq .001$					

15 Days :

The R-Squared values of the models at 15 days demonstrated that models at this time point did not explain the variance. The only independent variable that was statistically significant at 15 days was the amount of international tourism (Table 1). As expected, a greater amount of international tourism resulted in more COVID-19 cases. It makes sense that international tourism was significant during the initial spread because the risks associated with travel had not yet been realized and tourism facilitates movement between countries, which has been linked to accelerating the spread of COVID-19.[9] At 15 days, it is likely that none of the other independent variables had sufficient time to impact case numbers, which might explain why the R-Squared values are low.

30 Days :

At 30 days R-Squared values demonstrated that the models explained a large portion of the variance. Interestingly, the models showed that international tourism, GDP, median age, and total population were statistically significant (Table 1). Similar to the data at 15 days, as international tourism increased, the amount of reported COVID-19 cases also increased, presumably due to the continued lack of awareness that tourism accelerates the spread of COVID-19. Again, this relationship is not surprising because tourism facilitates movement throughout and between countries, which has been linked to accelerating the spread of COVID-19.[9]

As GDP increased, the amount of reported COVID-19 cases also increased. Although this relationship was not expected, it could be explained by the fact that higher GDP may give affluent countries more resources to track COVID-19, leading to more reported cases. As median age increased, the number of reported cases decreased. This relationship was not expected because older individuals are more susceptible to disease.[16] This may be because younger people are more mobile within their communities, leading to more interactions and transmissions. Last, as the total population of a country increased the number of reported COVID-19 cases decreased. This relationship was not expected, but it is possible that countries with greater populations faced more hurdles testing their large populations compared to countries with smaller populations.

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60 Days :

At 60 days R-Squared values demonstrated that the models explained a large portion of the variance. The models showed that total population, median age of the total population, GDP, and individualism were statistically significant predictors of COVID-19 case frequency (Table 1). In contrast to 15 and 30 days, international tourism was no longer significant 60 days into the pandemic, most likely due to the emerging recognition of the risks associated with international travel and a subsequent reduction in travel. As the total population and median age of a population increased, the number of reported COVID-19 cases decreased. As before, these relationships were not expected.

The models at 60 days showed that a previously insignificant independent variable was significantly related to COVID-19 case frequency. More individualistic countries reported more COVID-19 cases, as a corollary this means that more collectivist countries reported fewer cases. This relationship is as expected because citizens from individualistic countries are more likely to prioritize themselves over their communities. It is probable that individualism was not significant at 15 and 30 days because citizens were not aware of safety measures they could choose to take to protect their community that early on in the pandemic. As GDP increased, the amount of reported COVID-19 cases also increased. Again, this relationship was not expected, but makes sense in combination with the significance of individualism. Higher GDP means higher consumer demand, and higher individualism suggests more determination to meet that demand, even if it involves moving about.

■ Conclusion

At 15, 30, and 60 days into the COVID-19 pandemic, interpersonal distance did not account for the number of reported COVID-19 cases in a country. This indicates that significant consideration of cultural norms regarding IPD may not be needed when devising strategies for decreasing the initial spread of COVID-19.

Droplet Distance :

One reason that IPD did not account for COVID-19 transmission may be that airborne coronavirus droplets travel within the span of all three interpersonal distances. Measured intimate distance, social distance, and personal distance are all less than 2.5 meters.[6] Recent evidence indicates that airborne droplets can travel over 2.5 meters from their origin.[3] Thus, airborne droplets could travel within the range of all three interpersonal distances around the world. IPD might not account for droplet distance because droplet distance is affected by other factors, such as, size, relative humidity, air current, and evaporation, which are not included in this study.[3]

Aerosol Distance :

Recent research suggests that the coronavirus can also travel as an aerosol, which is defined as an airborne particle 5 μm or smaller.[3] The distance these aerosols travel is difficult to determine not only because of their small size, but also because of the lack of data documenting how their movement is affected by factors such as air current, relative humidity, and evaporation. It is likely that the smaller nature of aerosolized particles allows them to linger in the air for longer periods of time, leading to travel distances that are longer than those of airborne droplets, and potentially well beyond all three measured IPD preferences. At this point in time however, little is known about the risk of transmission of COVID-19 due to virus-containing aerosolized particles.

Implications :

This study revealed that 15 and 30 days into a countries outbreak, international tourism was linked to higher case frequency (Table 1). This indicates that if there are signs of a dangerous respiratory virus in the future, countries should act quickly to close their borders to tourism. Further, the models indicated that 30 days into a countries spread, total population, GDP, and median age were significantly linked to reported COVID-19 case frequency. This result suggests that countries, in planning for the next epidemic, could develop a risk assessment of disease transmission based on easily accessible data.

Data Limitations :

It is important to note that this study was limited by data on interpersonal distance that was available for 40 countries (n = 40). This limits the statistical power of the models. Models with more data points would have more power and likely more statistical validity. Also, this study is only representative of COVID-19 during the first 60 days of country-wide outbreaks.

Further, this study does not control for the amount of time countries had to prepare for the pandemic. For example, China did not have time to prepare for the outbreak because the global pandemic originated there, while other countries had weeks to watch, learn, and take preventive actions. However, the amount of time a country had to prepare for the pandemic does not necessarily indicate that a country used that time to prepare.

There is no consistent measure of COVID-19 cases within countries due to differences in testing methods, testing availability, and asymptomatic cases. It is probable that cases were especially underreported during the initial spread of COVID-19 when countries were scrambling to come up with testing protocols. This research would have benefitted from controlling for this by incorporating a test to case ratio for each country. Measuring the ratio of tests to confirmed cases (# of tests : 1 confirmed case) indicates testing coverage within a country.[17] If a country has a low test to confirmed case ratio it suggests that the country is not testing enough and in turn is underreporting the number of cases.[17] Unfortunately, test-to-case ratios could not be used to control for underreporting due to lack of data.

Interpersonal Distance Data :

The Sorokowska study that collected IPD data has limitations of its own. It is uncertain whether Sorokowska's results are representative of an accurate cross section of a country's culture(s). The Sorokowska study collected demographic data on age, location, and sex of its participants, but not on other important cultural demographics, such as ethnicity or immigration status. It is not clear whether this study includes pockets of cultural variability within countries, which means that data on IPD may not represent a country as a whole. Finally, the study on interpersonal distance is recent (2017), and it is one of the first of its kind, and therefore, it has not yet been tested for validity through replication.

Future Research :

This study helps to guide future research on the connection between IPD and respiratory disease transmission. First, to better understand the true nature of this relationship, it would be important to expand the scope of study to include more than 40 countries to have a larger sample size. Other considerations include incorporation of the most up to date understanding transmission, as well as measures of government efficiency, cultural tightness, underreporting, and relational mobility.

Another related line of research could focus on Hall's categorization of cultures as either "contact" of "non-contact." Contact cultures are defined as "societies in which people stand closer together while talking, engage in more direct eye contact, use face-to-face body orientations more often while talking, touch more frequently, and speak in louder voices," whereas in non-contact cultures, "people tend to stand farther apart when conversing, maintain less eye contact, and touch less often."[20] It would be informative to compare the transmission of respiratory disease in these two categories of cultures.

Finally, while this study focuses on the effect of cross-cultural interpersonal distance on the transmission of COVID-19, it would be intriguing to determine if the COVID-19 pandemic has had an effect on cultural interpersonal distance norms.

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