Spatial Variability of Global Population, Temperature and Covid-19 Pandemic: Implication for Health Care Management

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Abstract:- **This study examined spatial variability of global population, temperature and covid-19 pandemic as it applies to health care management. The study sampled thirty (30) countries in the six (6) inhabitable continents of the world namely Asia, Africa, Europe, North America, South America and Australia/Oceania where Covid-19 has been recorded. However, five (5) countries were randomly selected from each of the continents considering their regional locations (geocodes) of north, south, east, west and center. Data were generated from online sources and reports from World Health Organization (WHO). The Pearson Product Moment Correlation Coefficient was used to analyze the speculations. However, continents of Asia, Africa and Oceania showed relatively low spread of covid-19 having higher temperature. Continents of North America, South America and Europe showed higher Covid-19 spread with relatively low temperature. Countries with moderate mean temperatures between 11-20^{0}C relatively showed higher Covid-19 spread than countries of extreme low and high mean temperature regimes of <0-10^{0}C and 21-30^{0}C respectively. Finally, this study established that temperature and population density do not have any statistically significant effect on the spread of Covid-19. Therefore, health practitioners and individuals should consider stringent health and hygiene practices to curb the deadly Covid-19 infectious disease worldwide.**

Keywords: **Covid-19, Temperature, Populating density**

I. INTRODUCTION

Covid-19 has become a worldwide pandemic threatening and killing millions of humans since its outbreak in Wuhan, Hubei Province of China in December 2019. The new COVID-19 is caused by the virus SARS-CoV-2. The most likely ecological reservoirs for SARS-CoV-2 are bats, but it is believed that the virus jumped the species barrier to humans from another intermediate animal host. This intermediate animal host could be a domestic food animal, a wild animal, or a domesticated wild animal which has not yet been identified (WHO, 2020a). However, on January 3, 2020 only 44 patients were reported of the pneumonia deadly infection which later increased to a global scale up to April 2020 (Isaifan, 2020; WHO, 2020d). Thus, the incubation days of the Covid-19 virus are from 2 to 14 days. As at April 5, 2020, Covid-19 infected 1,133, 758 persons and caused 62,784 deaths globally (WHO, 2020d). In Western Pacific Region it infected 111,396 and caused 3,838 deaths, European Region 621 407 infected and 46,416 deaths, South-East Asia Region infected are 7816 persons and caused 302 deaths, Eastern Mediterranean Region infected persons are 70,293 and caused 3,794 deaths, Region of the Americas infected persons are 315,714 and caused 8187 deaths, African Region infected persons are 6,420 and caused 236 deaths respectively (WHO Situation Report-76, 2020). Since 165 AD of the Antonine Plague, the world has recorded series of disease pandemics till the current Covid-19 in December 2019. These diseases cut across the Plague of Justinian (541-542), The Black Death (1346-1353), Third Cholera Pandemic (1852–1860), Flu Pandemic (1889-1890), Sixth Cholera Pandemic (1910-1911), Flu Pandemic (1918), Asian Flu (1956-1958), Flu Pandemic (1968) and the HIV/AIDS Pandemic with its peak in 2005-2012 (Nicholas, 2020). Many are wandering where this Covid-19 pandemic is taking the world of humanity.

However, population and temperature of the world are rising at exponential proportion. Population, temperature and infectious diseases are interwoven in their characteristics, occurrence and transmission. Thus, the world population has attained 7,794,798,739 with annual growth rate of 1.10% (World Population Review, 2020). The world has population density of 14.7 persons per km^2. The Earth occupies total area of 510,000,000 km2 of both land and water surface areas (Wikipedia, Population Density; United Nations [UN], 2019). Thus, as the world population density is increasing, the rate of infectious diseases will rise, which has resulted to social distancing as one aspect of reducing the spread of global Covid-19 pandemic.

There have been some thoughts of the likely connection between climatological variables and populations of the humid climate as they affect Covid-19. Oliveiros et al., (2020) looked at how meteorological variables such as temperature and humidity affect COVID-19 duplication over time. Sajadi et al, (2020) stated that areas with significant community transmission of COVID-19 can be located along latitude 30-50° N' having average temperatures of 5-11° with absolute humidity of 4-7 g/m3 and low specific of 3-6 g/kg. Thus, temperature and humidity along certain latitudes have affected

the patterns of respiratory virus in different seasons. Rocklov and Sjodin (2020) concluded that the recommended more than one-meter distance between people and contact tracing by WHO in a high population density would be difficult to actualize especially among people coughing and sneezing. But their study could not capture the rate of infection cases as influenced by population density and temperature.

Many researches have been conducted on the global temperature rise and the characterization of infectious diseases. A critical view has established that the world temperature has increased to average rate of 14.9^0C and if no mitigation measures are implemented very soon, it will rise to 5^0C in 2100. According to the National Oceanic and Atmospheric Administration [NOAA] (2019), the collection of both land and ocean temperatures has risen to decadal peak of 0.07°C since the year 1880 and has increased to 0.18^0C since 1981 which is more than double of the past years. Thus, five hottest years since 1880 to 2019 occurred since 2015 and nine out of the ten hottest years occurred since 2005. However, 1998 and 2019 have shown their remarkable temperature rise since 1977, nominally above mean temperature of the 20th century (Rebecca and LuAnn, 2020; National Oceanic and Atmospheric Administration [NOAA], 2019).

The interaction of temperature variability with infectious diseases has been severally documented by epidemiologists. Thus, mild temperature over longer period of time will raise the possibility of disease vectors. It has been noted that under warmer temperature, disease carrying vectors will be more infectious by transmitting virus earlier than expected (Cann, Thomas, Salmon, Wyn-Jones, Kay, 2013; Philip and Evelyn, 2018). According to Anthony et al (2017), primary Surgical Site Infection (SSI) admission rose by 2.1% per 2.8°C rise in the average monthly temperature indicating that SSI is a seasonal infection driven by weather that is warmer. Also, Perencevich et al (2008) established that for every 12.2^0C, Gram-Negative Bacterial Infection (P. *aeruginosa* and A. *baumanii)* increased by 17% showing higher rate of infection during summer months. The findings supported that there should be high disease surveillance during warmer months such as summer. Therefore, the purpose of this study is to spatially examine the interaction of global population, temperature and covid-19 pandemic as it applies to health care management. The study scientifically settles the thinking on the role of temperature and population characteristics in the spread of the highly contagious and deadly Covid-19 pandemic worldwide.

II. METHODOLOGY

This study examined spatial variability of population, temperature and covid-19 pandemic across different countries of the world. The study sampled thirty (30) countries in the six (6) inhabitable continents of the world namely Asia, Africa, Europe, North America, South America and Australia/Oceania where Covid-19 has been recorded (Figure 1). However, five (5) countries were randomly selected from each of the continents considering their regional locations (geocodes) of north, south, east, west and center to enable equal representation of data for tabulation. Thus, covid-19 infection cases of the selected countries were generated from Worldometer and validated with World Health Organization (WHO) reports from online sources. Population and its density data were generated from online sources of Wikipedia, Worldometer and World Population Review (Worldometer, 2020; Wikipedia; World Population Review, 2020). The mean temperature data were generated from Weather Base, Wikipedia as well as Weather and Climate online sources (Weather Base, 2020; Wikipedia; Weather and Climate, 2020). In order to establish whether there are differences between Covid-19 and temperature as well as population density, the Pearson Product Moment Correlation Coefficient was used on the SPSS platform for the analyses.

The study covers the entire world with total human population of 7,794,798,739 and annual growth rate of 1.10% (World Population Review, 2020). Population of Asia is 4,436,224,000 with land mass of 44,579,000 sq. km having 48 countries. Africa has population of 1,216,130,000, land mass of 30,221,532 sq. km and 54 countries. The Australia/ Oceania has population of 39,901,000, land size of 8,525,989 sq. km and 23 countries and territories. Europe has population of 738,849,000, land mas of 10,180,000 sq. km and 50 countries. North America has population of 579,024,000, land mass of 24,709,000 sq. km and 23 countries. South America has population of 422,535,000, land mass of 17,840,000 sq. km with 12 countries (Facts you need to know; Worldometer, 2020). The world has average temperature of 14.51^0C and mean rainfall of 990mm per annum (Liz Osborn; Wikipedia). The oceans of the world are Atlantic, Arctic, Indian, Pacific and Southern which support the global atmospheric circulation and influence the global temperature.

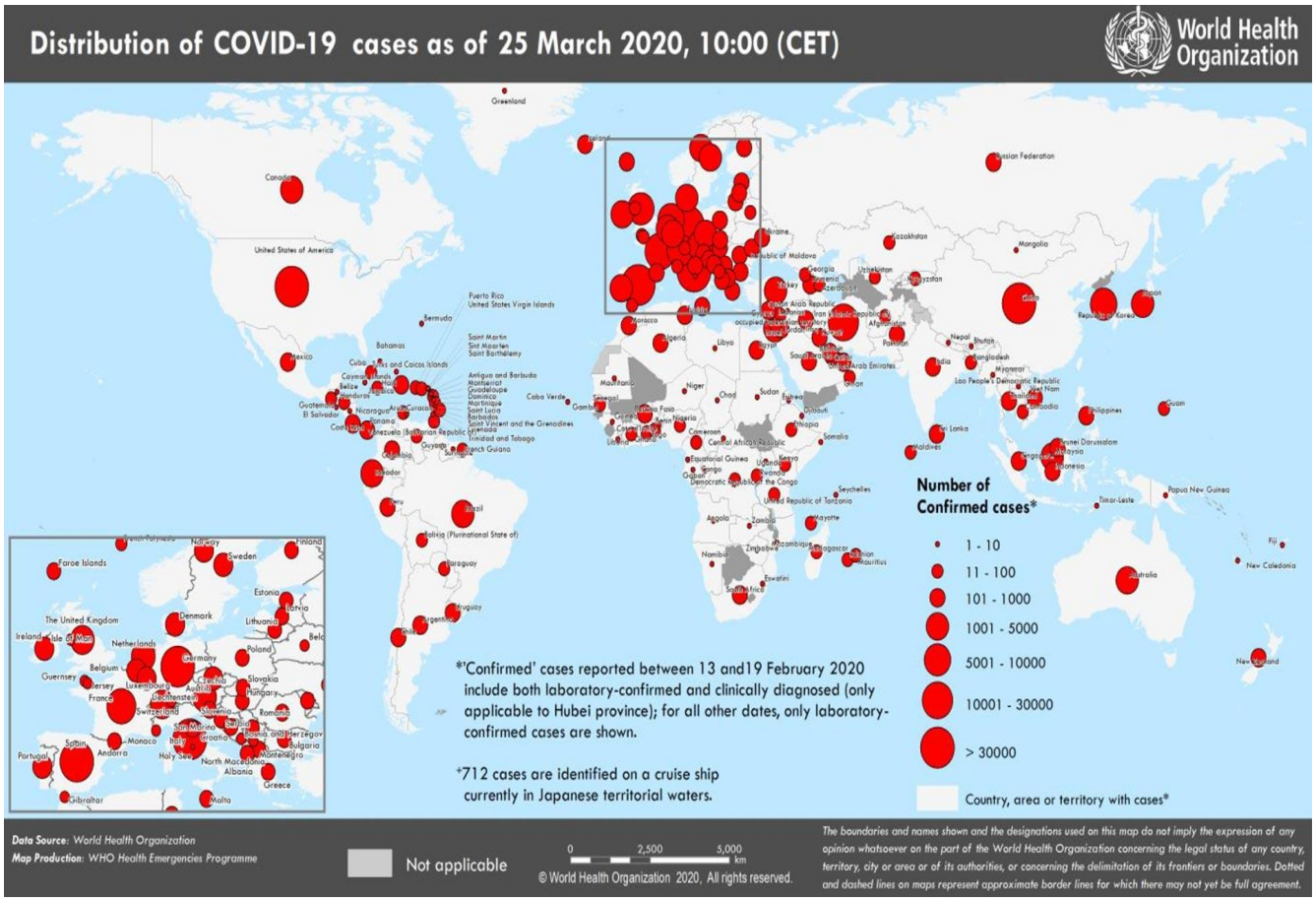

Figure 1: World Distribution of Covid-19

Source: World Health Organization (WHO), 2020

III. RESULTS AND DISCUSSION

The sample indicated that the proportion of total Covid-19 infection cases (1,294,764) to the total population (3,329,385,616) showed 0.04% globally during the study period (Table 1). On continental bases, it showed that increase in temperature resulted to reduced Covid-19 infection cases (Figure 2). For instance, continents of Asia, Africa and Australia/Oceania had high mean percentage temperatures of 18.1^0C, 22.5^0C and 18.5^0C and low percentage Covid-19 of 7.8%, 0.5% and 0.6% respectively against continents of Europe, North and South America recording low temperatures of 8.7^0C, 16^0C and 16.2^0C and high rate Covid-19 of 33%, 53% and 4.5% respectively. It indicated that in any environment of high dryness of surface area and air, there would be low spread of Covid-19 infection cases. According to Mordecai et al. (2017), the temperature that will support disease carrying vectors and infections must be at "just right" level to replicate them; if too hot the disease causing infections' life span will decrease and if too cold the virus will take too long to replicate thereby reducing the rate of spread. For instance in Table 2 and Figure 3, countries of Categories A and B which had lower temperatures between $0\text{-}10^0$C, the rate of infection cases was low compared to Categories C and D which had higher temperatures between $11\text{-}20^0$C showing more infection cases. On the other hand, infection cases lowered at extreme temperatures between $21\text{-}30^0$C in Categories E and F countries. Generally, extremely high and low temperatures influence the rate of spread of infection cases of Covid-19 globally and moderate temperature regimes favor infectious diseases. Seasonal temperature changes have the capacity to affect the rate of disease spread including Covid-19 infection cases across the globe (Peterson, Polgreen, Cavanaugh, Polgreen, 2017; Peterson, Polgreen, Sewell, Polgreen, 2017; Nwaerema, 2020). In addition, the spread of chronic pulmonary coccidioidomycosis can be influenced by seasonality caused by weather variability, indicating that in such vein, Covid-19 an infectious pulmonary disease can be influenced by weather variability across the continents (Tamerius and Comrie, 2011; Comrie, 2005). Also, dry and windy environment will make surfaces dry and blow away contaminants but wet surfaces will retain contaminants. Though, in the struggle to contain the spread Covid-19 other measures are medically required globally.

Table 1: Variability of Population, Temperature and Covid-19 Cases

S/N	Country	Population	Pop. Density (Pers. Per Km^2)	No. of Covid-19 Cases	Annual Mean Temperature (^0C)
Asia					
1	China	1,439,323,776	148	82,719	18.6
2	Japan	126,476,461	335	9,787	23.1
3	India	1,380,004,385	420	14,425	27.1
4	Iraq	40,222,493	92	1,482	22.8
5	Kazakhstan	18,776,707	7	1,591	10.0
	Total	**3,004,803,822**	**1002**	**110,004**	**Ave. 20.3**
Africa					
6	Egypt	102,334,404	102	2,844	21.4
7	Kenya	53,771,296	93	246	29.3
8	South Africa	59,308,690	49	2,783	20.6
9	Nigeria	206,139,589	223	493	28.0
10	Cen. Afr. Rep	4,829,767	8	12	26.5
	Total	**426,383,746**	**475**	**6,378**	**Ave. 25.2**
Australia/Oceania					
11	Australia	25,499,884	3	6,565	17.3
12	New Caledonia	284,060	15	18	19.5
13	French Polynesia	280,576	67	55	27.0
14	New Zealand	4,822,233	18	1,422	13.0
15	Papua New Guinea	8,911,530	19	7	26.9
	Total	**39,798,283**	**122**	**8,067**	**Ave. 20.7**
Europe					
16	Russia	145,934,462	9	36,793	6.3
17	Norway	5,421,241	17	6,992	7.7
18	United Kingdom	67,886,011	279	108,692	9.8
19	Italy	60,461,826	201	172,434	15.2
20	Germany	83,783,942	235	141,397	10.2
	Total	**363,487,482**	**741**	**466,308**	**Ave. 9.8**
North America					
21	USA	331,002,651	35	710,272	15.0
22	Canada	37,742,154	4	31,927	3.7
23	Mexico	128,932,753	66	6,875	18.0
24	Honduras	9,904,607	88	457	26.2
25	Nicaragua	6,608,366	51	9	27.3
	Total	**514,190,531**	**244**	**749,540**	**Ave. 18**
South America					
26	Brazil	212,559,417	25	34,221	23.5
27	Peru	32,971,854	26	13,489	18.7
28	Argentina	45,195,774	16	2,758	15.0
29	Chile	19,116,201	25	9,252	12.5
30	Colombia	50,882,891	45	3,439	21.4
	Total	**360,726,137**	**137**	**63,159**	**Ave. 18.2**
	Grand Total	**3,329,385,616**		**1,294,764**	**Ave. 18.7**

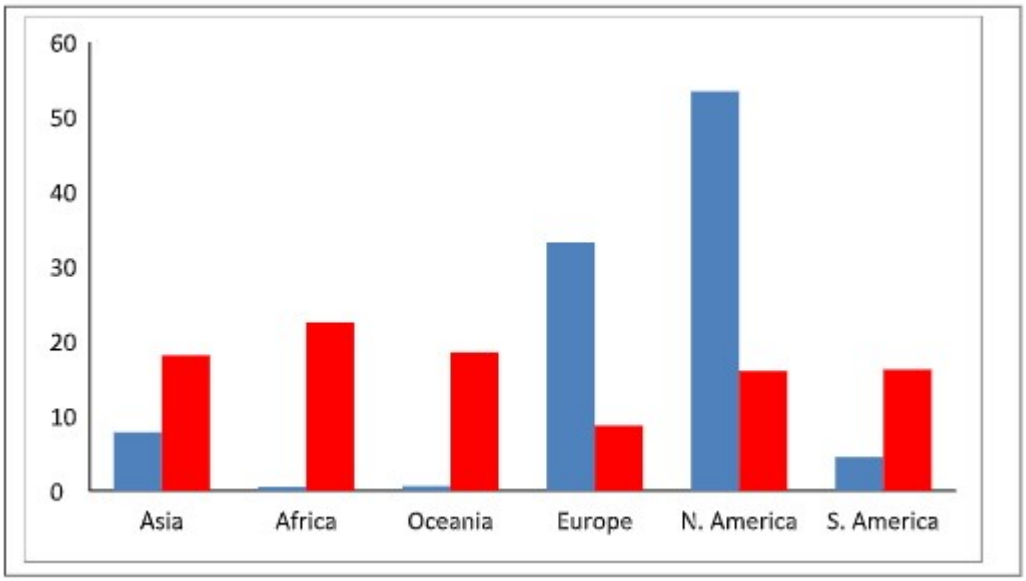

Figure 2: Percentage of Covid-19 Cases and Annual Mean Temperature of the Continents

Table 2: Countries, Temperature and Covid-19 Cases

Categories of Countries	Temperature (0C) of Countries	No. of Countries	No. of Infection Case	% of Countries	% of Infection
A	<0 - 5	1	31,927	3.3	2.3
B	6 – 10	4	154,068	13.3	11
C	11 – 15	5	865,101	16.7	61.6
D	16 – 20	6	282,100	20	20.1
E	21 - 25	6	54,556	20	3.9
F	26 - 30	8	15,704	26.7	1.1
		30	**1,403,456**	**100**	**100**

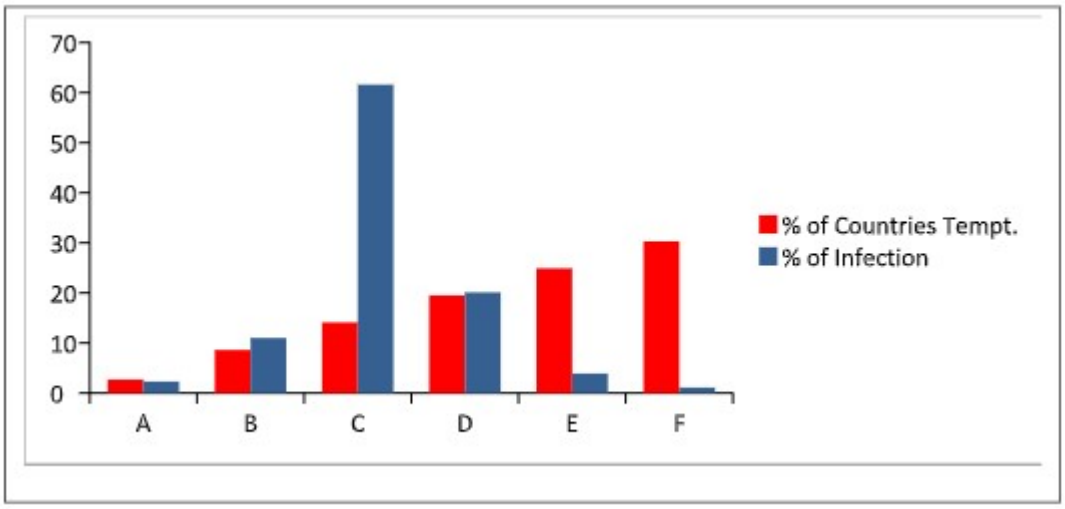

Figure 3: Temperature Variability and levels of Covid-19 Infection across Countries

Population density is the number of persons living per kilometer square which could support social distancing across various countries as indicated that countries with low population density had high Covid-19 infection cases (Table 3 and Figure 4). The figure showed that the higher the concentration of people per square kilometer the lower the

Covid-19 infection cases. This outcome indicated that people in high population density countries had low infection rate which means that these countries had other health practices other than social distancing of space as approaches to reduce the spread of Covid-19 infection but will put more effort in contact tracing of infected cases. For instance, countries in Categories A and C had Covid-19 cases of 870,665 and 314,324 with population density of 1 to 100 persons and 201 to 300 persons respectively. Categories B, D and E countries had Covid-19 infection cases of 85,563, 9,787 and 14,425 respectively. Thus Category A had 22 countries with total population of 1,242,979,607 having 67.2% indicating highest infected Category. This was followed by Category C made up of 4 countries having total population of 418,271,368 and 24.3% of infection cases. Categories B, D and E had relatively low population figures of 1,541,658,180 (2 countries), 126,476,461 (one country) and 1,380,004,385 (one country) having 6.6%, 0.8% and 1.1% infection cases.

Table 3: Population Density, Covid-19 Cases and Number of Affected Countries

Category	Population Density	Population	No. of Covid-19 Cases	% of Infected Countries	% of Infection Cases
A	1 - 100	1,242,979,607	870,665	22	67.2
B	101– 200	1,541,658,180	85,563	2	6.6
C	201 – 300	418,271,368	314,324	4	24.3
D	301 – 400	126,476,461	9,787	1	0.8
E	401 - 500	1,380,004,385	14,425	1	1.1
		3,329,385,616	**1,294,764**	**30**	**100**

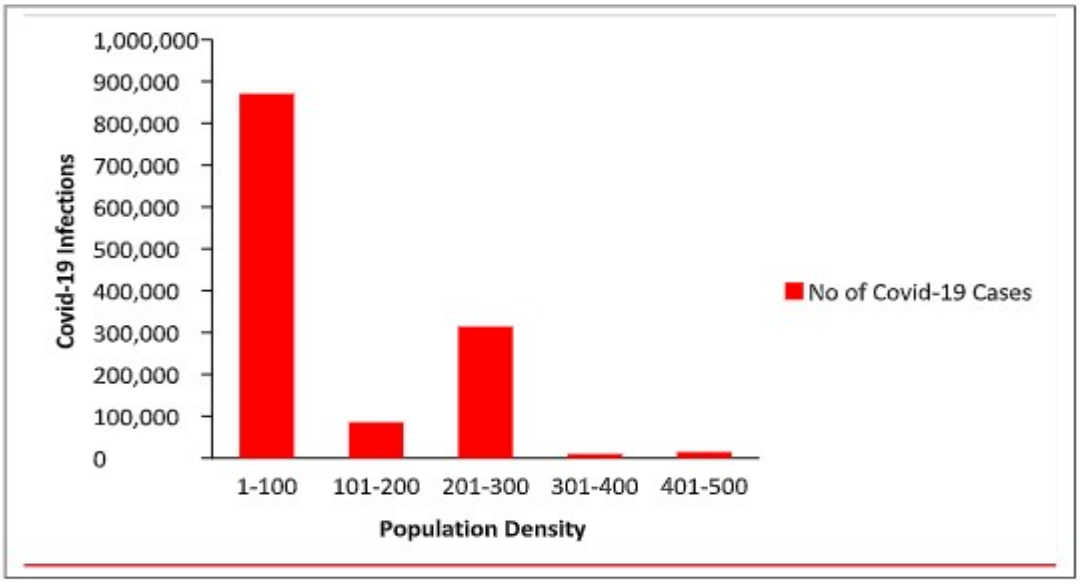

Figure 4: Population Density and Covid-19 Infected Cases

The overall objectives of this study are to understand whether there is difference between Covid-19 infection cases and temperature variability as well as population density. The first null hypothesis (Ho) that guided this study shows that there is no statistical significant difference between Covid-19 infection cases and temperature variations across different countries of the world. The analysis indicates calculated t-stat of 1.817399208 and critical P-value of 0.07987317 in a test of two-tailed at 0.05 Significant Levels (S.L). The computation shows calculated t-stat value of 1.277002014 being bigger than critical P-value of 0.212090296. This exposed the fact that Covid-19 infection cases differ statistically significant from temperature across the countries of the world. The second null hypothesis (Ho) shows that there is no statistical significant difference between Covid-19 infection cases and population density across different countries of the world. The analysis indicates calculated t-stat of 1.277002014 and critical P-value of 0.212090296 in a test of two-tailed at 0.05 Significant Levels (S.L). The computation shows calculated t-stat of 1.277002014 being bigger than critical P-value of 0.212090296. This proves the fact that Covid-19 infection cases differ statistically significant from population density.

IV. CONCLUSION

In certain parts of the world, there is popular opinion that temperature influences the spread of Covid-19. Also, that concentration of people in a geographic location could increase Covid-19 spread by means of social distancing form one another. Therefore, this study investigated spatial variability of population, temperature and covid-19 pandemic: implication for health care management. The study has shown some level of interaction between temperature and Covid-19 as well population density. However, continents of Asia, Africa and Australia/Oceania showed relatively low spread of covid-19 having higher temperature. Continents of North America, South America and Europe showed higher Covid-19 spread having relatively low temperature. Generally, countries with moderate temperature relatively showed higher Covid-19 spread than other countries of extreme low and high temperature regimes. Finally, this study showed that temperature does not have any statistically significant effect on the spread of Covid-19. Also, population density does not significantly influence the spread of Covid-19 worldwide. It is therefore pertinent for health practitioners, government, companies and development agencies and individuals to consider stringent health and hygiene measures as the stronghold to combat the deadly Covid-19 infectious disease that has claimed the lives of many in the world. By so doing it is expected that in the very near future, Covid-19 infection cases will be reduced and finally kicked out of humanity.

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