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Does a Country's Risk Factors Impact in Spreading COVID-19 in African Countries?

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ABSTRACT

The novel coronavirus or COVID-19 has extended its spread across the globe, and most of the countries have reported infections. In what started as a first case single reported in Egypt has now magnified and close to about 355000+ infections have been reported across the African region as on June 26, 2020. The transmission trajectory of COVID-19 across the globe remains a mystery, and much remains to be learned. The fear of spread among nations is a cause for concern, especially among African countries with weaker governance, high poverty levels, weak health systems etc. The density of population in urban areas could be a trigger factor and could be devastating. The management and control of COVID-19 are critical to check the spread, and most of it is reliant on the health facilities in countries to carryout repeated tests. This paper aims to analyses the various parameters and tabulates a risk matrix and places it analysis using Statistical Package for the Social Sciences based on the available data. The analysis also provides potential insight into the vulnerabilities among African countries and a relative review of factors associated with the novel coronavirus.

Keywords: Statistical Package for the Social Sciences, Risk Matrix, Coronavirus-19, Pandemic, Severe Acute Respiratory Syndrome, Middle East Respiratory Syndrome
JEL Classifications: I0; I1; I2; C0

1. INTRODUCTION

COVID-19 or Corona Virus is an issue that the world is struggling to contain. As the numbers rise to 2 million globally, the world is facing an unprecedented crisis which is getting difficult to contain. So far, Africa has been spared by its spread when compared to the European nations, the Americas, Asia. The effects are most likely going to be progressively perceptible in Africa as time propels. Researchers and scientists are anxious and concerned over Africa as the numbers rise across the globe. Africa so far has registered 15000+ cases, and the numbers are increasing (WHO, 2020; UN, 2020). Africa's first case was registered in Egypt on 14 February. The pandemic as it stands is slowly spreading across all regions in the continent. The current outbreak with similar characteristics to Ebola on transmission has exposed the vulnerabilities in the health care system. The African culture is one of a kind, where society blends more uninhibitedly. This, in itself, is a huge introduction to the present pandemic (Gherghel and Bulai, 2020; Instabilitate guvernamentală cronică, 2017).

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Numerous questions remain unanswered concerning the spread, pathogen source, transmission rate, incubation period, mortality rate, and so on. As the pathogen had its impact over the globe, so did the analogies that were drawn from studies and research on the pandemic. In spite of the fact that the Chinese specialists perceived and deciphered the strain in under ten days, a solution to the strain is far off. By the time researchers realised that the disease was spreading with human beings as the source, it was too late as many had travelled from Wuhan where the disease originated (Jiang, 2020).

As the COVID pandemic spread its tentacles across the globe, much remains unknown about the overall transmission in Africa. Many sociologists fear the worst for Africa, given the high levels of poverty, weak health care systems, crowded urban areas, lifestyle, culture, the virus could be hard and devastating. The current circumstance due to coronavirus-19 has caused largescale issues with various countries constraining social principles as social distancing, serious lockdown strategies etc. bringing about a new social change. As we witness the responses by nations driving intense methodologies to improve the infection curve and improve the overall population immunity, which is one of the methods for controlling the pandemic, it is seen affecting society (WHO, 2020).

Against this backdrop, this paper aims to study and provide a risk analysis on the various risk factors Africa is exposed to with respect to the novel Coronavirus and seeks to assess the vulnerability faced by each African country. The paper also aims to provide a statistical analysis of mapping the risk to infectious diseases. Section one introduces the article, with section two providing an overview of the pandemic. The section also highlights the various factors influencing African society. Section three discusses the methodology, and in section four, the risks are modelled.

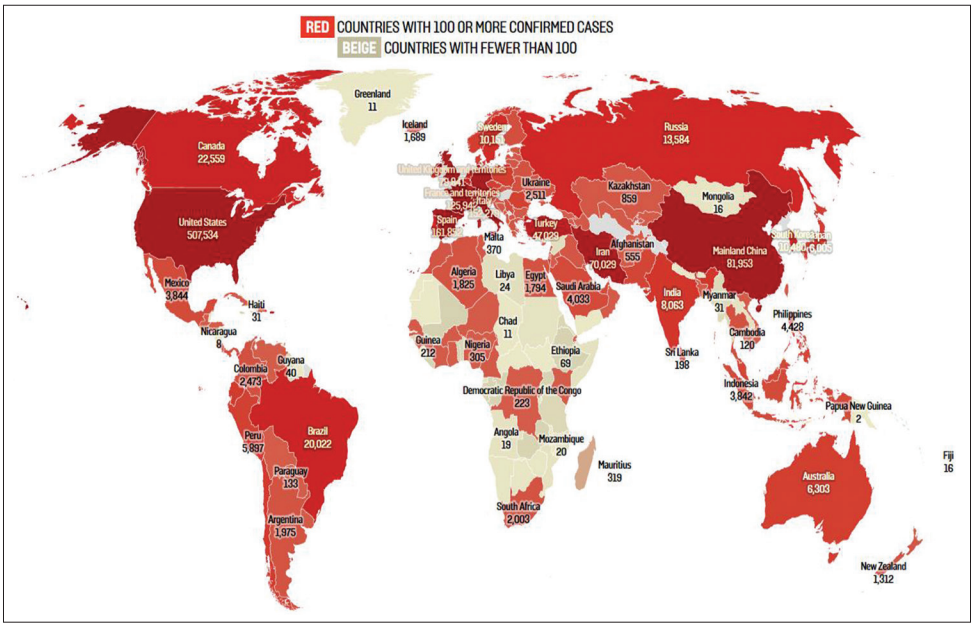
2. OVERVIEW OF PANDEMICS

Six coronaviruses have been distinguished in the group of coronavirus that is known to infect, causing bronchitis, pneumonia. The death scale of disease in coronavirus is far lower than that of the common flu infection, rhinovirus. Of these six infections, SARS and MERS have been a worry that represents around 5-10% contaminations in contrast with 25-35% when contrasted with occasional flu during seasonal outbreaks. Since the spate of SARS in 2002-2003, various diseases affecting the respiratory tracts are credited to the Coronavirus family have been found. One such illness is COVID-19 which causes extreme pneumonia in individuals and individuals who are more fragile, for example, diabetic, HIV positives, particularly among the older population. (Bradburne et al., 1967; Bradburne and Somerset, 1972; Monto, 1974; Patrick et al., 2006; Lieberman et al., 2010; Nickbakhsh et al., 2016; Jiang, 2020)

COVID-19 or Coronavirus 2019 first came to light in the city of Wuhan on 12 December as reported by the Wuhan Health Corporation, Hubei Province in the Peoples Republic of China (Biscayart et al., 2020). The number of reported cases in Wuhan was 27 initially, which later ballooned as more and more frequented the hospitals and health centres. The infections were traced to the wet market of Wuhan. (Lu et al., 2020; Zhou et al., 2020; Biscayart et al., 2020). The population of Wuhan city is about 11 million (Rodriguez-Morales et al., 2020a; Rodriguez-Morales et al., 2020b).

By the time the Chinese government had control measures in place, the disease had spread to many continents (Eder et al., 2020). The point of convergence of the plague moved from China to Iran later to Italy, Spain, the United Kingdom and the vast majority of European Nations and the present point of convergence being U.S.A (Figure 1). As the number of cases soared across the globe, the spread was initially registered as a concern, later as an epidemic and as the threat level increased, was termed a pandemic by WHO in stages (Johns Hopkins School of Public

Figure 1: Spread of Corona Virus (FP, 2020)



Health, 2020; WHO, 2020). With rigours rules guidance by WHO on society, the governments started imposing strict measures and stressed the importance of washing hands, social distancing, and so on. Notwithstanding the way that appreciation of the get-togethers is yet to be perceived deductively, it has added to the understanding the imperative role of transmission and the spread of the disease (Rashid et al., 2008; Ebrahim and Memish, 2020). The proliferation of COVID-19 has mostly been attributed to travellers as careers in many countries as in the case of Iran, Italy, Spain and many other countries (Pullano et al., 2020; Arab-Mazar et al., 2020; Gherghel and Bulai, 2020; Biscayart et al., 2020; Pullano et al., 2020; Rodriguez-Morales, 2020b).

Africa, as a continent, had registered the first case in Egypt and was linked to a traveller who had just entered Egypt. Figure 2 portrays the timeline of virus transmission in Africa while Figure 3, depicts the outbreak across Africa.

2.1. Factors Influencing of COVID-19 on African Society

During the last decade, the world has experienced more than 20 diseases in epidemics or pandemics ranging from measles, Zika to Ebola, SARS, MERS and recent COVID-19 (WHO, 2004; WHO, 2020). These high profile cases such as Zika, Ebola illustrated the importance and exposed the most vulnerable countries which could technically require more support. The RAND report of 2016 identifies the importance of mapping of high-risk countries. The reports highlight 25 most vulnerable countries of which 22 of them are located in Africa, and which could potentially be the hub for transmission of infectious disease unless paid attention to highlighting the importance of technical support. The primary reason attributed to the risks are conflicts, health care facilities, and so on. (Melinda et al., 2016). Africa currently accommodates about 25 million refugees displaced either due to conflict or repression, and roughly 85% of the population belong to DRC, South Sudan, Somalia, Ethiopia, Sudan, Nigeria, CAR and Cameroon (Williams, 2020).

As with every country, the coronavirus was attributed mainly to travel, tourism and business. Egypt, Morocco, Nigeria, South Africa being business hubs were first to be impacted by the virus in the initial stages. As with the spread with the other countries, the African nations also risk from local transmission due to domestic travel and international travel, and it has assumed significance in recent times. It is also important to understand that nearly 60 thousand African students are currently enrolled in various universities across china for studies (Smith, 2020).

WHO's pandemic declaration also was significantly influenced by turn of events and fears of the virus spreading across countries with exposure to weaker health care facilities in Africa like Algeria, Angola, Ivory Coast, DRC, Ethiopia, Ghana, Kenya, Nigeria, Mauritius, Tanzania, Uganda, Zambia and South Africa. They were prioritised based on travel to and from China (Smith, 2020). The second most important factor in the public health system is the skill and the ability of knowledge sharing and communication, which is key to the spread of transmission. Africa as a continent suffers due to lack of skilled medical practitioners, nurses and midwives. Qualified health practitioners are an integral part of maintaining the capacity of these health centres. The converse of this could lead to significant challenges in the form of testing and tracking, which could lead to rapid transmission. The factor that comes

Figure 2: Corona Virus a Timeline in Africa

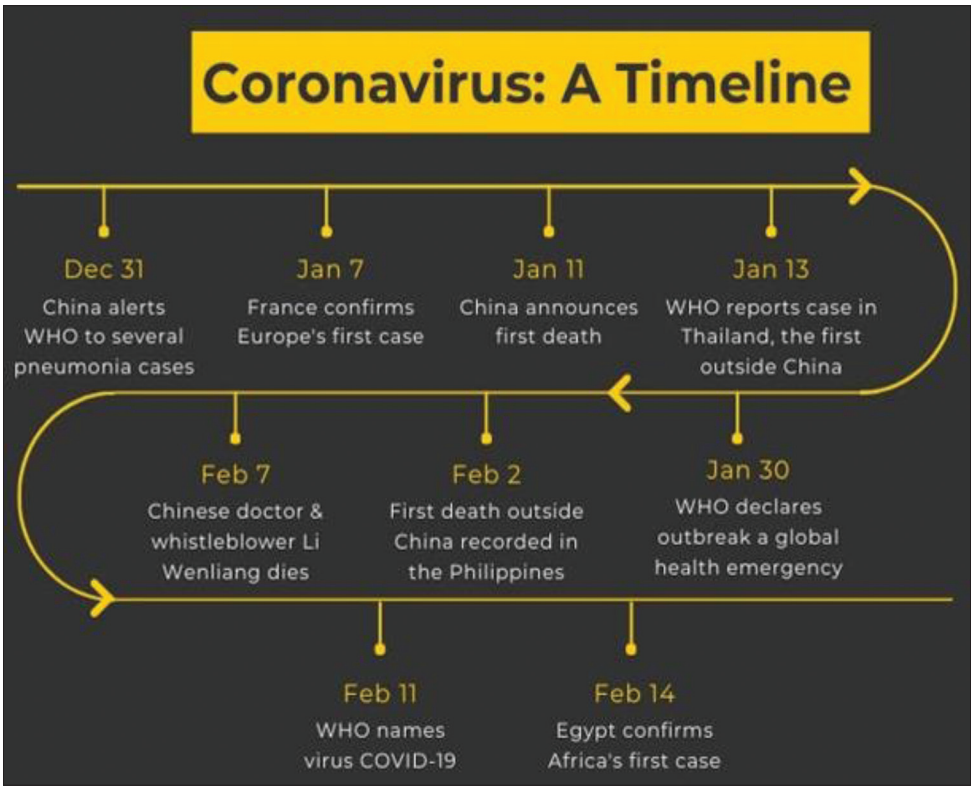
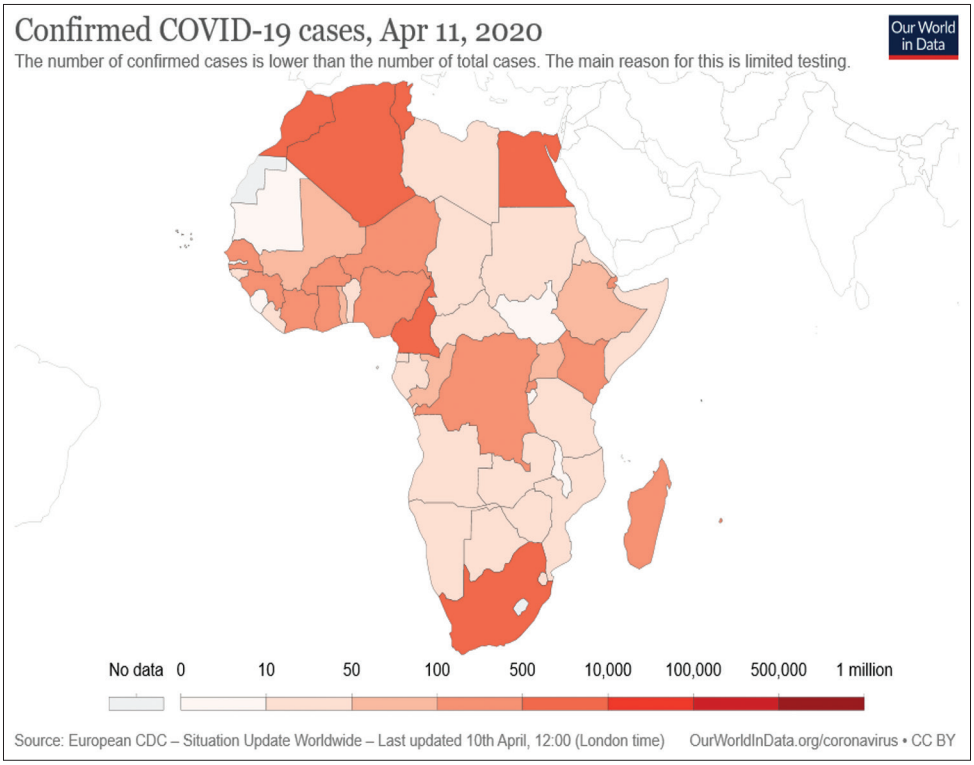


Figure 3: Spread of COVID 19 in Africa (Spread of COVID-19 in Africa, 2020)



into the picture is the culture in the community, which could lead to underreporting of the cases. This is further complicated by the spread of misinformation in the community. Another critical factor is the community's belief in the traditional medical systems that are not tested and are generally run by community practitioners (Gilbert et al., 2020; Africa Centre for Strategic Studies, 2020). In crux, the public health systems in Africa are prone to challenges of curbing infectious diseases and further complicated depending on the density and population of the area in question.

The third factor is the urban density of the population living. Most African countries are densely populated. This effectively could act as an ideal condition for the virus to spread quickly, undetected. Except for fewer countries like Sahel, Namibia, Sudan, which are sparsely populated, the dense concentration of people crowding a smaller area is ticking timebomb. As noticed from other countries like Italy, Spain, the COVID-19 appears to spread quickly in thriving communities where there are frequent interaction and contact among the people. African cities like Addis Ababa, Lagos, Cairo, Johannesburg, Kinshasa, Abuja etc. where the per people in a square kilometre is high, the disease is likely to spared fast (Gilbert et al., 2020; Africa Centre for Strategic Studies, 2020).

The fourth important factor is the age of the population. Africa has a distributed age population spread, unlike Italy or Spain. In countries like Algeria, South Africa, Morocco etc. have a more significant population in an older age group unlike places like Mali, Niger, Chad, DRC etc. As noticed from the case fatalities, over 70% being in the range of 60+ categories, this could be a factor that is bound to have population immunity due to Africa's population being in the age group of 30-40s (Gilbert et al., 2020; Africa Centre for Strategic Studies, 2020). However, the underlying factors that need to be considered are the factors that many African countries face such as HIV, malnutrition, malaria etc. as the mortality rate varies depending on the country.

The fifth important factor is the food crisis the countries are likely to experience. As millions in countries like Zimbabwe, Sudan, Somalia dive further into hunger, the pandemic endangers millions of lives as the community is driven into desperation. Added to it, is the shortage in essentials the countries are likely to face due to hyperinflation as the crisis looms over the nations. Adding to the issue is the locust swarms, which has destroyed crops worth millions lately (BBC, 2020).

As per the world bank, the resultant effect of COVID-19 on the planet could have sweeping ramifications for many individuals who live in poverty or have just risen out of it. It is evaluated that Africa could be the most terribly affected and may lose half of GDP with food nourishment, medication, joblessness and speculation issues on drawing investments even before the nations face the full-rage of the disease. (World Bank, 2020; Sullivan and Chalkidou, 2020).

3. DATA MODELING AND METHODOLOGY

Data selection (global reported, death and recovered cases) for analysing the impact were collected from the John Hopkins School of public health data portal (Johns Hopkins School of Public Health, 2020). A similar exercise was done to collect the data on patient-bed ratio, patient-doctors ratio and patient-nurse ratio. The information was collected from World Health Organisation database (WHO, 2020). To understand the current scenario, the data collected was mapped into the Tables 1 and 2 as follows

The overall infection rate as on April 9, 2020 for Africa stands at 15,623 number with a recovery percentage of 19.2 and a death percentage of 5.3%. When comparing the same with the data as on June 26, 2020, the total number of reported cases had increased substantially to 352,570 cases with the total recovery percentage standing at 48.15%. While the death percentage as on April 9, 2020 was 5.3%, it had substantially come down to 2.6%. This indicates that there is a positive recovery rate across Africa (Figures 4 and 5). Table 3 details the total number of cases, recovery and the deaths (WorldoMeters, 2020; Johns Hopkins School of Public Health, 2020). However, it is important to note that.

4. THE RISK MODELING

Table 4 shows the risk modelling for the African countries, while Table 5 depicts the legend to the risk. Each of the states was mapped with their exposure to international countries, health care system, the population density in the urban areas, the age of the population, the hospital bed ratio, patient-doctor ratio, patient-nurse/midwife ratio. The risks were then tabulated as low (1) to critical (5). The country's cumulative data indicated the total risk the country is exposed to. The total risk was then mapped to the number of cases reported, recovery and death rate as per the data on April 9, 2020. The model was then analysed using Statistical Package for the Social Sciences (SPSS).

Table 1: Abstract of Total COVID-19 Cases as on 11-4-2020 (Johns Hopkins School of Public Health, 2020)

COVID-19				
Total registered cases in africa				
Total cases	Recovered cases	Total death	Total recovery percentage	Total death percentage
15623	3006	831	19.2	5.3
Total active cases				
Active cases	Serious cases	Percentage of serious cases		
11786	178	1.51		

Table 2: Total number of Cases as on 26-6-2020 (Johns Hopkins School of Public Health, 2020)

COVID-19				
Total registered cases in africa				
Total cases	Recovered cases	Total death	Total recovery percentage	Total death percentage
352570	169797	9147	48.15	2.6
Total active cases				
Active cases	Serious cases	Percentage of serious cases		
173626	882	0.51		

Examining the outlined risk factors, it can be seen that Ethiopia, Nigeria, Senegal, Chad, Ivory Coast, Togo, Tanzania, Mali, Mozambique, Madagascar, Sudan, Burkina Faso, Niger fall under the category of critical risk though most of the countries had minimum interaction with the outside countries with the exception of Nigeria (5). The cumulative risk rating on these countries ranked high due to its availability of hospital beds, patient-doctor and nurse/midwife ratio in relation to the total population. This multilayered risk portfolio technically emphasises the vulnerabilities that these countries face due to the associated availability of the necessary health resources. Another tranche of countries, Morocco, Egypt, CAR, Cameroon, Guinea, DRC, Uganda, Marutiana, is just below the critical level and fall in the very high-risk category. These countries exhibit multiple layers of exposure. Notably, with the exception of Morocco and Egypt, none of the other countries lies in the high exposure category of international travel. Many other countries which lie in the high risk, medium risk and low-risk category benefit from other factors which include access to health care systems, low profile to international exposure with the exception of South Africa, which has high exposure to the international market.

5. MODEL COMPARISON, ANALYSIS AND RESULTS

The mapping of the total Coronavirus cases against data indicated some exciting results. Notably, as on April 9, 2020, countries like Egypt, Morocco rated as high risk has more number of cases registered, with morocco registering 1374 cases as against the total deaths of 97. However, the number of cases rose to 11,465 numbers in a span of 77 days this despite the country announcing lockdown since March 20 (Ahmed, 2020). Egypt registered 1699 cases and reported 118 deaths as on April 9, 2020. However,

Figure 4: Recovery rate a comparison as on 9/4 and 26/6

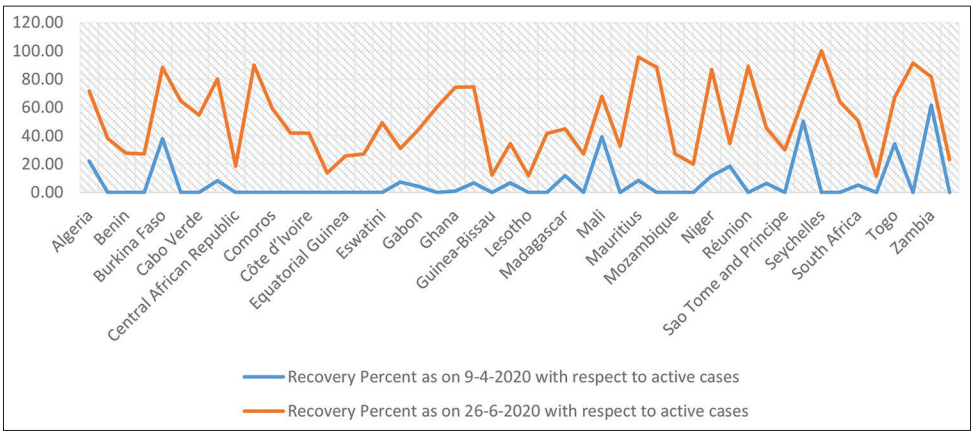


Table 3: Total cases as on 9-4-2020 and 26-6-2020 (Johns Hopkins School of Public Health, 2020; WorldoMeters, 2020)

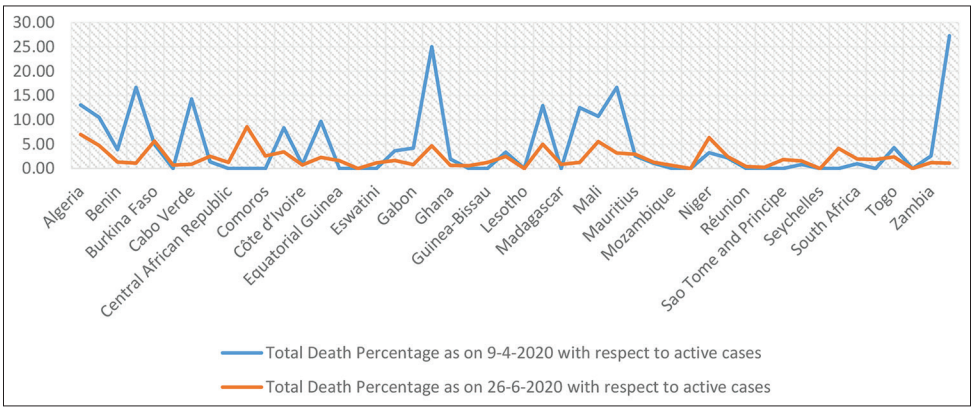
Countries	Total cases as on 9-4-2020	Total cases as on 26-6-2020	Increase (77 days 9-4-2020 to 26-6-2020)	Total death as on 9-4-2020	Total deaths as on 26-6-2020	Total recovery as on 9-4-2020	Total recovery as on 22-6-2020	Recovery percent as on 9-4-2020 with respect to tot cases	Recovery percent as on 26-6-2020 with respect to tot cases	Total death percentage as on 9-4-2020 with respect to tot cases	Total death percentage as on 26-6-2020 with respect to tot cases
Algeria	1572	12685	11113	205	885	347	9066	22.07	71.47	13.04	6.98
Angola	19	212	193	2	10	0	81	0.00	38.21	10.53	4.72
Benin	26	1053	1027	1	14	0	292	0.00	27.73	3.85	1.33
Botswana	6	92	86	1	1	0	25	0.00	27.17	16.67	1.09
Burkina Faso	384	941	557	19	53	146	830	38.02	88.20	4.95	5.63
Burundi	3	144	141	0	1	0	93	0.00	64.58	0.00	0.69
Cabo Verde	7	1027	1020	1	9	0	562	0.00	54.72	14.29	0.88
Cameroon	730	12592	11862	10	313	60	10100	8.22	80.21	1.37	2.49
Central African Republic	10	3244	3234	0	40	0	607	0.00	18.71	0.00	1.23
Chad	10	865	855	0	74	0	778	0.00	89.94	0.00	8.55
Comoros	1	272	271	0	7	0	161	0.00	59.19	0.00	2.57
Congo	60	1087	1027	5	37	0	456	0.00	41.95	8.33	3.40
Democratic Republic of the Congo	207	6552	6345	20	149	0	900	0.00	13.74	9.66	2.27
Djibouti	135	4643	4508	0	52	25	4348	18.52	93.65	0.00	1.12
Egypt	1699	61130	59431	118	348	95	2433	5.59	3.98	6.95	0.57
Equatorial Guinea	16	2001	1985	0	32	0	515	0.00	25.74	0.00	1.60
Eritrea	33	144	111	0	0	0	39	0.00	27.08	0.00	0.00
Eswatini	12	706	694	0	8	0	347	0.00	49.15	0.00	1.13
Ethiopia	55	5425	5370	2	89	4	1688	7.27	31.12	3.64	1.64
Gabon	24	5087	5063	1	40	1	2270	4.17	44.62	4.17	0.79
Gambia	4	43	39	1	2	0	26	0.00	60.47	25.00	4.65
Ghana	313	15834	15521	6	103	3	11755	0.96	74.24	1.92	0.65
Guinea	164	5174	5010	0	29	11	3861	6.71	74.62	0.00	0.56
Guinea-Bissau	33	1556	1523	0	19	0	191	0.00	12.28	0.00	1.22
Ivory Coast	384	8334	7950	3	60	0	3487	0.00	41.84	0.78	0.72
Kenya	179	5533	5354	6	137	12	1905	6.70	34.43	3.35	2.48
Lesotho	0	17	17	0	0	0	2	0.00	11.76	0.00	0.00
Liberia	31	684	653	4	34	0	285	0.00	41.67	12.90	4.97
Libya	24	698	674	1	18	0	140	0.00	20.06	4.17	2.58
Madagascar	93	1922	1829	0	16	11	862	11.83	44.85	0.00	0.83
Malawi	8	960	952	1	12	0	260	0.00	27.08	12.50	1.25
Mali	56	2039	1983	6	113	22	1383	39.29	67.83	10.71	5.54
Mauritania	6	3739	3733	1	119	0	1225	0.00	32.76	16.67	3.18
Mauritius	273	341	68	7	10	23	326	8.42	95.60	2.56	2.93
Mayotte	186	2508	2322	2	32	0	2218	0.00	88.44	1.08	1.28
Morocco	1374	11465	10091	97	217	109	8560	7.93	74.66	7.06	1.89
Mozambique	17	816	799	0	5	0	223	0.00	27.33	0.00	0.61
Namibia	16	105	89	0	0	0	21	0.00	20.00	0.00	0.00
Niger	342	1059	717	11	67	40	919	11.70	86.78	3.22	6.33
Nigeria	276	22614	22338	6	549	51	7822	18.48	34.59	2.17	2.43
Réunion	362	516	154	0	2	0	460	0.00	89.15	0.00	0.39
Rwanda	110	850	740	0	2	7	385	6.36	45.29	0.00	0.24
Sao Tome and Principe	4	711	707	0	13	0	214	0.00	30.10	0.00	1.83
Senegal	244	6354	6110	2	98	123	4193	50.41	65.99	0.82	1.54
Seychelles	11	11	0	0	0	0	11	0.00	100.00	0.00	0.00
Sierra Leone	7	1354	1347	0	56	0	869	0.00	64.18	0.00	4.14
Somalia	12	2878	2866	1	90	0	868	0.00	30.16	8.33	3.13
South Africa	1845	118375	116530	18	2292	95	59974	5.15	50.66	0.98	1.94
South Sudan	1	1942	1941	0	36	0	224	0.00	11.53	0.00	1.85
Sudan	17	9084	9067	2	559	0	3912	0.00	43.06	11.76	6.15
Tanzania	25	509	484	7	21	0	183	0.00	35.95	28.00	4.13

(*Contd...*)

Table 3: (*Contiuned*)

Countries	Total cases as on 9-4-2020	Total cases as on 26-6-2020	Increase (77 days 9-4-2020 to 26-6-2020)	Total death as on 9-4-2020	Total deaths as on 26-6-2020	Total recovery as on 9-4-2020	Total recovery as on 22-6-2020	Recovery percent as on 9-4-2020 with respect to tot cases	Recovery percent as on 26-6-2020 with respect to tot cases	Total death percentage as on 9-4-2020 with respect to tot cases	Total death percentage as on 26-6-2020 with respect to tot cases
Togo	70	588	518	3	14	24	394	34.29	67.01	4.29	2.38
Tunisia	643	1164	521	25	50	25	1023	3.89	87.89	3.89	4.30
Uganda	53	833	780	0	0	0	761	0.00	91.36	0.00	0.00
Western Sahara	4	10	6	0	1	0	8	0.00	80.00	0.00	10.00
Zambia	39	1497	1458	1	18	24	1223	61.54	81.70	2.56	1.20
Zimbabwe	11	551	540	3	6	0	128	0.00	23.23	27.27	1.09

Figure 5: Death rate a comparison as on 9/4 and 26/6



the total number of cases stood at 61,130 as on June 26, 2020, indicating steep increase despite lockdown measures announced by the Egyptian government. Both these countries notably are more exposed to international travel. Egypt also has a high population density in urban areas as opposed to Morocco. Cameroon, one other country which falls in the very high-risk category, reports only 730 cases and a recovery rate of 9% as on April 9, 2020. Similarly, DRC Congo, which is conflict-prone, has reported only 60 cases and a recovery rate of 8%. Another interesting fact data is on Nigeria and Senegal. Nigeria is listed and falls in the critical risk category. However, the country has reported less number of cases with 288, with only seven deaths and a recovery of 51 cases with an impressive recovery rate of 18%. In contrast, Senegal, which has 250 cases, reports recovery rate of 49%. Except for Nigeria, which has a high exposure rate to international travel, Senegal ranks on the risk rate of 3. Both Nigeria and Senegal have lower hospital-bed, patient-physician and midwife ratio. In the critical risk category, Ivory coast reports 444 cases with only three deaths and has an impressive 12% recovery rate.

Both South Africa and Algeria, which fall in the middle-risk category as per the mapping chart, reported more cases. South Africa ranks high on international exposure as opposed to Algeria. The total number of registered cases stands at 1934 number and reports 18 death and 95 recovered with a recovery rate of only 5.5%, given the hospital-bed, patient-physician, patient-nurse ratio. In contrast, the total cases in SA stood at 118,375 cases with a steep increase. Similarly, Algeria reports 1666 cases with the highest death rate for Africa with 235 and a recovery rate of 21%. South Africa has one of the best health infrastructures when compared to the rest of the African nations. Mauritius, which ranks low in the risk template reports 314 cases with seven deaths and a recovery rate of 7.3%. Similarly, Tunisia reports 643 instances with a recovery rate of 3.8%.

Figure 6 shows a detailed graph of countries exposed to the outside world and the number of cases reported. The factor is relevant as it reflects a timely address of the testing issue. The mapping of the number of reported cases indicates the pertinent reality across the African continent. There is a strong correlation between the reported cases and exposure to the outside world. Except for Nigeria which has reported lesser number of cases, the rest of the countries which rank high on exposure to the outside world like South Africa, Morocco, Egypt, Algeria all have high reporting incidents when compared to the rest of Africa. The ability to test the large influx of population in the urban areas has also seen a sharp rise in these countries. Notably, Critical, Very/high-risk countries like Zimbabwe, Uganda, Ethiopia, Kenya have reported far fewer cases though the risk to initial transmission was recorded high.

As the COVID-19 widens it spread, it is essential to watch all the countries which fall in the domain of critical, very high or high risk. It is likely that the countries such as Sudan, DRC, Cameroon, Somalia, Zimbabwe register as vulnerable to the spread of the COVID-19. Therefore, it is essential to ensure proper attention to these countries and towns and providing continued support to the public

Table 4: Risk *matrix* for Africa COVID 19

Countries	Exposure to outside world	Available health system	Density of urban areas	Total population in urban areas	Population age	Risk range for beds	Risk range for no of physicians	Risk range for no of nurses and midwives	Risk total	Risk type	Total number of cases	Total death	Total recovery
Ethiopia	3	3	4	5	2	5	4	4	30	Critical risk	56	2	4
Nigeria	5	5	2	5	2	4	4	3	30	Critical risk	288	7	51
Senegal	3	2	5	3	2	5	5	5	30	Critical risk	250	2	123
Chad	1	5	5	3	1	5	5	5	30	Critical risk	11	0	2
Côte d'Ivoire	4	4	2	3	3	5	4	4	29	Critical risk	444	3	52
Togo	3	4	3	2	3	4	5	5	29	Critical risk	#N/A	#N/A	#N/A
Tanzania	3	3	3	4	2	4	5	5	29	Critical risk	25	1	5
Mali	2	5	4	3	1	5	4	5	29	Critical risk	74	7	22
Mozambique	4	4	3	3	1	4	5	5	29	Critical risk	17	0	1
Madagascar	2	3	3	3	3	5	4	5	28	Critical risk	93	0	11
Sudan	3	3	4	4	2	4	4	4	28	Critical risk	15	2	2
Burkina Faso	2	4	3	3	2	5	5	4	28	Critical risk	#N/A	#N/A	#N/A
Niger	1	4	4	3	1	5	5	5	28	Critical risk	410	11	40
Morocco	5	1	3	4	5	3	3	3	27	Very high risk	1374	97	109
Egypt	5	1	3	5	4	3	3	3	27	Very high risk	1699	118	348
Central African Republic	1	5	3	2	3	3	5	5	27	Very high risk	8	0	0
Cameroon	3	4	3	3	2	3	5	4	27	Very high risk	730	10	60
Guinea-Bissau	1	4	4	1	2	5	5	5	27	Very high risk	36	0	0
DRC	3	5	3	5	1	3	2	5	27	Very high risk	60	5	5
Uganda	3	2	4	4	1	4	5	4	27	Very high risk	53	0	0
Mauritania	1	4	4	2	3	5	4	3	26	Very high risk	7	1	2
Equatorial Guinea	4	5	3	1	3	2	4	4	26	Very high risk	18	0	3
Angola	3	4	4	3	1	4	4	3	26	Very high risk	19	2	2
Djibouti	1	4	4	1	4	3	4	4	25	High risk	135	0	25
Lesotho	2	5	1	1	4	3	5	4	25	High risk	#N/A	#N/A	#N/A
Ghana	3	3	2	3	3	4	4	3	25	High risk	378	6	3
Sierra Leone	1	5	2	2	2	5	5	3	25	High risk	7	0	0
Somalia	1	5	1	2	2	4	5	5	25	High risk	12	1	1
Liberia	2	4	1	2	2	4	5	5	25	High risk	31	4	3
Kenya	4	2	1	4	3	3	4	3	24	High risk	184	7	12
Zimbabwe	3	2	2	3	3	3	5	3	24	High risk	11	3	0
Republic of congo (Kinshasa)	3	3	4	2	2	3	4	3	24	High risk	180	18	9
Burundi	1	3	3	2	2	4	5	4	24	High risk	3	0	0
Zambia	3	3	3	3	1	2	5	4	24	High risk	39	1	24
Algeria	4	1	2	4	5	3	2	2	23	Medium risk	1666	235	347
South Africa	5	2	1	4	5	2	3	1	23	Medium risk	1934	18	95
Eritrea	1	2	2	2	3	4	5	4	23	Medium risk	33	0	0
Guinea-Bissau	2	5	2	2	2	3	4	3	23	Medium risk	36	0	0
Comoros	1	4	3	1	3	2	4	4	22	Medium risk	#N/A	#N/A	#N/A
Gambia	2	3	3	1	3	3	4	3	22	Medium risk	4	1	2
Rwanda	2	2	2	3	2	3	4	4	22	Medium risk	110	0	7
Benin	1	4	2	2	1	4	4	4	22	Medium risk	26	1	5
Malawi	2	3	1	2	1	3	5	5	22	Medium risk	8	1	0

(*Contd...*)

Table 4: (*Continued*)

Countries	Exposure to outside world	Available health system	Density of urban areas	Total population in urban areas	Population age	Risk range for beds	Risk range for no of physicians	Risk range for no of nurses and midwives	Risk total	Risk type	Total number of cases	Total death	Total recovery
Cabo Verde	2	1	4	1	5	2	3	3	21	Medium risk	#N/A	#N/A	#N/A
Tunisia	4	1	2	2	5	2	2	2	20	Medium risk	643	25	25
Eswatini	2	3	1	1	4	2	5	2	20	Medium risk	12	0	7
Botswana	4	2	1	1	4	3	4	1	20	Medium risk	13	1	0
Namibia	4	2	2	1	3	2	4	2	20	Medium risk	16	0	3
South Sudan	2	5	5	3	2	1	1	1	20	Medium risk	3	0	0
Gabon	3	2	2	1	3	1	4	2	18	Low risk	44	1	1
São Tomé and Príncipe	1	1	3	1	2	2	4	2	16	Low risk	4	0	0
Seychelles	2	1	1	1	5	1	3	1	15	Low risk	11	0	0
Mauritius	3	1	1	1	5	1	1	1	14	Low risk	314	7	23
Libya	3	1	1	2	4	1	1	1	14	Low risk	24	1	8

administration, health institutions etc., though each of the states has its challenges and unique set of associated vulnerabilities or risks.

Based on the observations, the data for April 9, 2020 was fed into the SPSS package for better analysis. The risk rating was considered as the dependent variable and the reported cases, total death and total recovery as an independent variable. Two sets of studies were performed. The first analysis included data for all countries for the African continent. In the second analysis, the countries which had null values were removed. That is countries with zero reported cases or zero deaths or zero recoveries. The results are as follows

5.1. First Analysis (Data for All Countries Included)

The analysis provides a deep insight into the various aspects of the countries. The regression analysis indicates that there is a positive correlation when assessing the risk-total, total number of cases, total death and total recovery. The correlation against death indicates that there is a strong correlation relationship when risk is associated with the number of deaths and a very moderate relationship when comparing the cases registered and the total recovery though statistically not significant. Similarly, when assessing the relationship between the total number of cases registered against the total death and recovery, the relationship is weaker, and 25% and 18% of the death cases can be explained.

5.1.1. Regression

Descriptive statistics			
	Mean	Std. deviation	N
Risk-total	24.265	4.2070	49
Total number of cases	236.08	465.266	49
Total death	12.22	39.010	49
Total recovery	29.43	72.041	49

Correlations				
	Risk-total	Total number of cases	Total death	Total recovery
Pearson correlation				
Risk-total	1.000	0.080	0.035	0.137
Total number of cases	0.080	1.000	0.758	0.826
Total death	0.035	0.758	1.000	0.892
Total recovery	0.137	0.826	0.892	1.000
Sig. (1-tailed)				
Risk-total	.	0.293	0.407	0.174
Total number of cases	0.293	.	0.000	0.000
Total death	0.407	0.000	.	0.000
Total recovery	0.174	0.000	0.000	.

Model summary							
Model	R	R square	Adjusted R square	Std. error of the estimate	Change statistics		
					R SQUARE CHANGE	F change	df[1]
1	0.242[a]	0.059	−0.004	4.2158	0.059	0.933	3

Model summary		
Model	Change statistics	
	df[2]	Sig. F change
1	45[a]	.432

a. Predictors: (Constant), total recovery, total number of cases, total death

Figure 6: Exposure to outside world vs. reported cases analysis

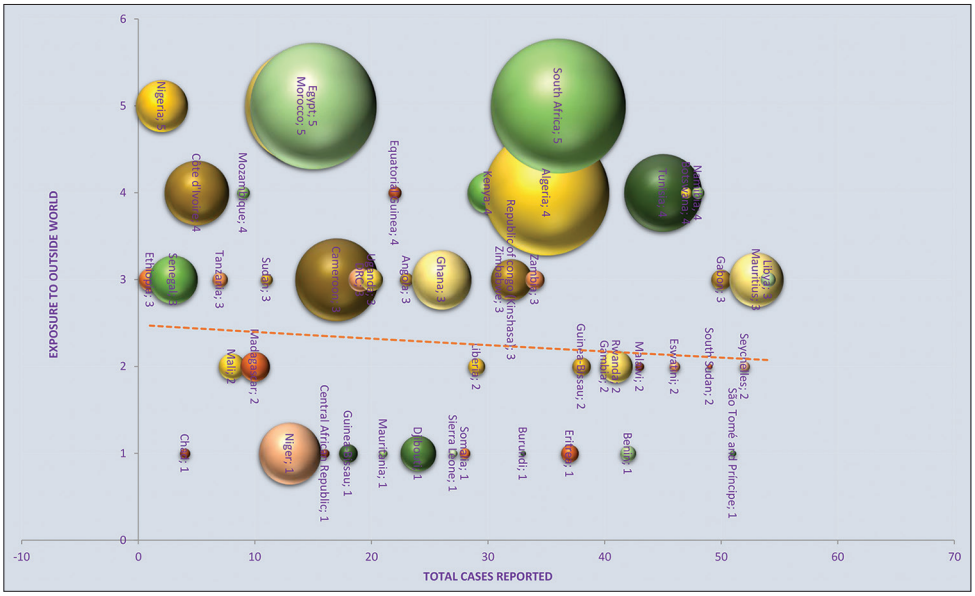


Table 5: Legend to table risk matrix

Risk range in nos	Risk range for no of beds	Range-(0.10-6.30)	Total countries
5	Critical risk	0.10-0.40	11
4	Very high risk	0.50-0.90	13
3	High risk	1.0-1.9	16
2	Medium risk	2.0-2.9	9
1	Low risk	3.4-6.30	5
		Total Sum	54
Risk range in nos	**Risk range for no of physicians**	**Range-(0.10-6.30)**	**Total countries**
5	Critical risk	0.02-0.09	21
4	Very high risk	0.10-0.41	22
3	High risk	0.73-0.95	5
2	Medium risk	1.27-1.83	3
1	Low risk	2.02-2.16	3
		Total sum	54
Risk range in nos	**Risk range for no of nurses and midwives**	**Range-(0.10-6.30)**	**Total countries**
5	Critical risk	0.06-0.44	14
4	Very high risk	0.50-0.93	15
3	High risk	1.0-1.74	13
2	Medium risk	2.0-2.78	6
1	Low risk	3.26-6.74	6
		Total sum	54
Risk range in nos	**Overall risk range**	**Range**	
5	Critical risk	30-28	13
4	Very high risk	27-26	10
3	High risk	25-24	11
2	Medium risk	23-20	15
1	Low risk	19-14	5
		Total sum	54

ANOVA[a]						
Model		**Sum of squares**	**df**	**Mean square**	**F**	**Sig.**
1	Regression	49.760	3	16.587	0.933	0.432[b]
	Residual	799.791	45	17.773		
	Total	849.551	48			

Coefficients[a]						
Model		**Unstandardised coefficients**		**Standardised coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	Total number of cases	−0.001	0.002	−0.077	−0.300	0.765
	Total death	−0.046	0.035	−0.423	−1.315	0.195
	Total recovery	0.034	0.022	0.578	1.556	0.127

a. Dependent variable: Risk-total

The regression coefficients on the total number of cases indicate that there would be a decease .01% against the risk rate. Similarly, there is a decrease of 0.46% and is not statistically significant. The total recovery rate against the risk has a positive relationship, and for every one point, there would be an increase of by 0.34%.

5.2. Second Analysis (Cases with Null Values Removed)

The second analysis, which was carried out after removing the null values provides a different insight into the various aspects of the countries. The regression analysis indicates that there is a negative correlation when assessing the risk total and total death rate and a positive relationship for risk total and recovery rate, number of recorded cases. The correlation against death indicates that there is a decrease in death cases in the countries. The correlation relationship when risk is associated with the number of the total number of cases is significant. At the same time, there is a very moderate relationship when comparing the total recovery, though statistically not significant.

5.2.1. Regression

Descriptive statistics			
	Mean	**Std. deviation**	**n**
Risk-total	24.857	4.3180	28
Total number of cases	390.36	571.154	28
Total death	21.21	50.095	28
Total recovery	49.39	90.753	28

Correlations				
	Risk-total	Total number of cases	Total death	Total recovery
Pearson correlation				
Risk-total	1.000	0.012	−0.012	0.109
Total number of cases	0.012	1.000	0.738	0.803
Total death	−0.012	0.738	1.000	0.885
Total recovery	0.109	0.803	0.885	1.000
Sig. (1-tailed)				
Risk-total	.	0.476	0.475	0.290
Total number of cases	0.476	.	0.000	0.000
Total death	0.475	0.000	.	0.000
Total recovery	0.290	0.000	0.000	.

Model summary[b]							
Model	R	R square	Adjusted R square	Std. error of the estimate	Change statistics		
					R square change	F change	df1
1	0.279[a]	0.078	−0.038	4.3986	0.078	0.673	3

ANOVA					
Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	39.083	3	13.028	0.673	0.577[b]
	Residual	464.346	24	19.348		
	Total	503.429	27			

Coefficients					
Model		Unstandardised coefficients		Standardised coefficients	t	Sig.
		B	Std. Error	Beta		
1	Total number of cases	−0.001	0.002	−0.176	−0.532	0.600
	Totwal death	−0.041	0.037	−0.481	−1.136	0.267
	Total recovery	0.032	0.023	0.676	1.411	0.171

5.2.2. Bivariate correlations for variables without null value

Correlations			
	Risk-total	No of death against case registered	No of recover against case registered
Kendall's tau_b			
Risk-total			
Correlation coefficient	1.000	−0.098	0.186
Sig. (2-tailed)	.	0.474	0.177
n	28	28	28
No of death against case registered			
Correlation coefficient	−0.098	1.000	0.252
Sig. (2-tailed)	0.474	.	0.060
n	28	28	28
No of recover against case registered			
Correlation coefficient	0.186	0.252	1.000
Sig. (2-tailed)	0.177	0.060	.
n	28	28	28
Spearman's rho			
Risk-total			
Correlation coefficient	1.000	−0.115	0.206
Sig. (2-tailed)	.	0.561	0.292
n	28	28	28
No of death against case registered			
Correlation coefficient	−0.115	1.000	0.321
Sig. (2-tailed)	0.561	.	0.096
n	28	28	28
No of recover against case registered			
Correlation coefficient	0.206	0.321	1.000
Sig. (2-tailed)	0.292	0.096	.
n	28	28	28

The third type of analysis that was performed for further analysis to understand the significance of the model using Bivariate analysis. This was carried on the countries which had reported the cases, number death and recovery. The study included 28 countries. Though there was a positive correlation, they were not statistically significant.

5.2.3. Bivariate correlations for variables with the null value

As there was positive correlation on the data for the countries which had reported positive cases, death, and recovery the analysis was extended to include all the variables and included the countries which had not reported any death or recovery. The data was then analysed for bivariate correlations. There were some significant findings for both Kendall's and Spearman's correlations.

Correlations			
	Risk-total	Total death vs. no of cases	Total death vs. recovery of cases
Kendall's tau_b			
Risk-total			
Correlation coefficient	1.000	0.013	0.174
Sig. (2-tailed)	.	0.901	0.083
n	54	54	54
Total death vs. no of cases			
Correlation coefficient	0.013	1.000	0.337**
Sig. (2-tailed)	0.901	.	0.001
n	54	54	54
Total death vs. recovery of cases			
Correlation coefficient	0.174	0.337**	1.000
Sig. (2-tailed)	0.083	0.001	.
n	54	54	54
Spearman's rho			
Risk-total			
Correlation coefficient	1.000	0.027	0.218
Sig. (2-tailed)	.	0.848	0.113
n	54	54	54
Total death vs.no of cases			
Correlation coefficient	0.027	1.000	0.415**
Sig. (2-tailed)	0.848	.	0.002
n	54	54	54
Total death vs. recovery of cases			
Correlation coefficient	0.218	0.415**	1.000
Sig. (2-tailed)	0.113	0.002	.
n	54	54	54

**Correlation is significant at the 0.01 level (2-tailed)

5.2.4. Conclusion on analysis

The study indicated that the model though is not statistically significant at this point due to data on reported cases, death and recovered are variables and are varying, it can be concluded that the model will result in a significant finding when the data for the reported cases, death and recovery stabilise. The model also indicated that the risk exposure of the country had a direct impact on the number of reported cases, death, and recovery, though there are other influential factors like the number of tests conducted, available ventilators or life-saving equipment, treatment methods, medications, immunity level of the patient, age etc. that influence the findings.

6. DISCUSSION AND SUGGESTIONS

Though it is too early to provide complete information, the early detection of COVID-19 is crucial to prevent the spread. However,

Bivariate correlations						
Correlations						
	Risk-total	Total death vs. noofcases	Total death vs. recovery of cases	Total number of cases	Total death	Total recovery
Kendall's tau_b						
Risk-total						
Correlation coefficient	1.000	−0.324	0.417*	−0.046	−0.271	0.185
Sig. (2−tailed)	.	0.119	0.045	0.824	0.199	0.374
n	14	14	14	14	14	14
Total death vs. no of cases						
Correlation coefficient	−0.324	1.000	−0.209	−0.033	0.469*	−0.099
Sig. (2−tailed)	0.119	.	0.298	0.870	0.021	0.622
n	14	14	14	14	14	14
Total death vs. recovery of cases						
Correlation Coefficient	0.417*	−0.209	1.000	0.121	0.045	0.495*
Sig. (2-tailed)	0.045	0.298	.	0.547	0.826	0.014
n	14	14	14	14	14	14
Total number of cases						
Correlation Coefficient	−0.046	−0.033	0.121	1.000	0.514*	0.626**
Sig. (2-tailed)	0.824	0.870	0.547	.	0.011	0.002
n	14	14	14	14	14	14
Total death						
Correlation Coefficient	−0.271	0.469*	0.045	0.514*	1.000	0.402*
Sig. (2-tailed)	0.199	0.021	0.826	0.011	.	0.048
n	14	14	14	14	14	14
Total recovery						
Correlation coefficient	0.185	−0.099	0.495*	0.626**	0.402*	1.000
Sig. (2-tailed)	0.374	0.622	0.014	0.002	0.048	.
n	14	14	14	14	14	14
Spearman's rho						
Risk-total						
Correlation coefficient	1.000	−0.425	0.472	−0.033	−0.344	0.218
Sig. (2-tailed)	.	0.130	0.089	0.910	0.229	0.454
n	14	14	14	14	14	14
Total death vs. no of cases						
Correlation Coefficient	−0.425	1.000	−0.270	−0.024	0.589*	−0.090
Sig. (2-tailed)	0.130	.	0.350	0.935	0.027	0.759
n	14	14	14	14	14	14
Total death vs. recovery of cases						
Correlation Coefficient	0.472	−0.270	1.000	0.204	0.024	0.697**
Sig. (2-tailed)	0.089	0.350	.	0.483	0.934	0.006
n	14	14	14	14	14	14
Total number of cases						
Correlation coefficient	−0.033	−0.024	0.204	1.000	0.701**	0.763**
Sig. (2-tailed)	0.910	0.935	0.483	.	0.005	0.002
n	14	14	14	14	14	14
Total death						
Correlation Coefficient	−0.344	0.589*	0.024	0.701**	1.000	0.498
Sig. (2-tailed)	0.229	0.027	0.934	0.005	.	0.070
n	14	14	14	14	14	14
Total recovery						
Correlation Coefficient	0.218	−0.090	0.697**	0.763**	0.498	1.000
Sig. (2-tailed)	0.454	0.759	0.006	0.002	0.070	.
n	14	14	14	14	14	14

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

the exposure to many markets from African nations like South Africa, Algeria, Ethiopia, Morocco, which are categorised high-risk countries, is highly heterogeneous. As the second wave of onward transmission is active, it potentially risks the weaker health systems across the globe and as indicated the infrastructure in Africa is more or less requires improvement in all phase. As much as it is essential to identify, isolate and provide treatment to those infected with the disease, it is also vital to prioritise the health workers safety. This is especially true for African countries with weaker health infrastructure. Algeria, Ethiopia, South Africa, Nigeria were part of the highest risk countries as identified by WHO based on direct business links and volume. Egypt, which has been identified as a very high risk in the risk matrix, was not part of the WHO's 13 risk identified countries. Thus, this assessment strongly reflects on the spatial pattern of the way the virus has transmitted due to importation. In as much as the data segregates

and places risk based on the volume, it does not provide complete insight into the business or tourism travels across the African nations either from China or Europe and is beyond the scope of this research article.

Though some countries are ill-equipped and lack enough resources like rapid testing kits, the states have so far managed to get it done in facilities at adjoining nations or abroad. This delay could prove to be a challenge as the suspected cases need to wait for the test results confirmation, which could result in disease transmission. To avoid this, the governments have restored to stringent self-quarantine procedures. WHO is also stepping up its efforts to support and improve the diagnostic capacities in these countries. (WHO, 2020; Steenhuysen and Nebehay, 2020). Africa has as CDC and has strengthened its capacity and capability to assist countries during the COVID-19 pandemic (Africa CDC, 2020). Most African countries have a plan for disease preparedness plan like the H1N1 pandemic which could be inadequate given the seriousness of this pandemic (Sambala et al., 2018). The consequences of the outbreaks SARS, MERS have indicated the importance of enforcing national public health programs, strengthening laboratories, improving and building on the human resources and ensure proper training programs (Marston et al., 2017; Sands et al., 2016).

It is also essential that the results in this paper should be interpreted carefully. Though the overall risk importation in African countries is much lower than the rest of the countries, it is essential for the states not to let their guard down. The preparedness by African countries towards COVID-19 has so far been adequate with many countries strengthening surveillance measures and screen at ports of entry (Monde 2020; WHO, 2020; Nkengasong, 2020; Gilbert et al., 2020).

The strengthening of the combating COVID-19 in Africa is phenomenal. Thanks to the Ebola epidemic. The critical advantage that Africa relies on is handling and fighting off infectious diseases like cholera, measles and recent plague like Ebola has so far been a boon and help in fighting off the current pandemic in a positive way. With most governments enhancing communication campaigns with guidelines from WHO, the fight towards the pandemic has intensified.

7. CONCLUSION

Though it is too early to provide complete information and arrive at a conclusion on the COVID-19 pandemic, the early detection of COVID-19 is crucial to prevent the spread across the globe. Africa is no exception. The exposure of states to the outer market considered as risky could also provide a deep insight into the pandemic itself. Though it is crucial to identify and find a suitable treatment for the infection, it is also vital to strengthen the fight against the pandemic in all possible ways including providing the utmost protection for the health and safety of the frontline workers.

The research analysis on the epidemic on various factors indicates that the countries in Africa are likely to be less exposed, unlike their counterparts in America's or Asia or the European countries. Although it is too early to conclude the statistical significance of the research, the trend indicates that once the pandemic stabilises, the results will likely show high relevance and correlations between the variables. The future course of this work will be to analyse the data as the pandemic subsides to provide a detailed insight into the pandemic, especially on the recovery and the mortality rate.

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