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Gauging the Laboratory Responses to Coronavirus Disease (Covid-19) in Africa [1]

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Research Department

Gauging the Laboratory Responses to Coronavirus Disease (Covid-19) in Africa

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Abstract

The rampaging effect of coronavirus disease (COVID-19) in Africa is huge and have impacted almost every area of life. Across African states, there exist variations in the laboratory measures adopted, and these heterogeneous approaches, in turn, determines the successes or otherwise recorded. In this study, we assessed the various forms of laboratory responses to the containment, risk analyses, structures and features of COVID-19 in high incidence African countries (Nigeria, South Africa, Egypt, Ghana, Algeria, Morocco, etc.) to aid better and efficient laboratory responses to the highly infectious diseases.

Keywords: Laboratory responses, COVID-19, PCR, Sample Pooling, Africa.

1.0 Introduction

The critical roles of laboratory testing cannot be overemphasised in the prevention and management of infectious diseases outbreak (Bedford *et al*., 2020). Laboratory professionals play essential roles in diagnosis, epidemiologic surveillance, and monitoring of patients with suspected and established cases of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, which is the virus strain that causes coronavirus disease (COVID-19) (Lippi &Plebani, 2020). The effort of the laboratory professionals and the country strategies in the containment, risk analysis, structures and features of the novel coronavirus deserves understudying for somereasons. For a disease condition that has been categorised as transmitting from human-to-human, there is a greater need for quick detection and

subsequent isolation inorder to flatten the curve and reduce the strain on the medical facilities that are largely dilapidated in Africa.In other climes, clustering analysis is an essential pre-requisite to epidemic management and care surveillance aimed at the efficacy of treatment procedures. By identifying the cluster or group of society that are most vulnerable and susceptible to viral loads induced by contagion with pathogens from the virus, further care and treatment procedure can be established. In recent findings, O, rhesus D positive (+) individuals are reported to have more excellent antibodies to resist infestation of coronavirus. By assessing the laboratory response to COVID-19 in Africa, this study aims to establish the depth of COVID-19 growth and subsequent policy recommendations, particularly as it relates to easing lockdown directives in place in most Africa countries. It informs the government and stakeholders restrictive measures and the desire to return to a healthy life.

COVID-19 is an infectious disease of the novel coronavirus. The COVID-19 pandemic is the third eventful zoonotic coronavirus disease outbreak in twenty years (Mackenzie & Smith, 2020). The infectious disease succeeded in the Severe Acute Respiratory Syndrome outbreak (SARS) in 2002-2003 and Middle East Respiratory Syndrome (MERS) outbreak in 2012 (Poon & Peiris, 2020). The current pandemic emerged in Wuhan, China and has spread rapidly around the world (Adnan *et al*., 2020) with an estimated over 3 million cases globally with 259,474 deaths, above 1.6 million cases in Europe with around 152,179 deaths, over 634,000 cases in Asia with around 21,501 deaths (WHO, 2020a)[2]. We observed heterogeneous approaches in the laboratory responses across nations in Africa. These variations in the laboratory responses of the containment of COVID-19 were primarily to aid early detection of the virus for prompt isolation, management of the infected individuals, and prevention of community transmission or sporadic cases of the virus (Loeffelholz& Tang, 2020).

The laboratory response of this novel virus comprises of a collection of appropriate samples from patients who meet up with suspect case definitions (as contained in the WHO guidelines) and selection of accurate laboratory methods (WHO, 2020b). The SARS-CoV-2 has been detected from a multifarious of upper and lower respiratory sources, including throat, nasopharyngeal, sputum, etc. (WHO, 2020c). A number of laboratory methods have been adopted in Africa for COVID-19 testing, and they include the Molecular test method of

[2]https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200508covid-19-sitrep-109.pdf?sfvrsn=68f2c632_6

Nucleic Acid Amplification Tests (NAAT), Serological testing, and Viral Genome Sequencing (Loeffelholz& Tang, 2020; Abdullahi *et al*., 2020). Amid these global health challenges which have caused panorama of problems in global medical supply chains, African countries have no options than to result to indigenous (herbal solutions) ways of combatting the pandemic, although in line with international practices. In this study, an attempt is made to unravel the underlying testing procedures adopted by high incidence African nations (Nigeria, South Africa, Egypt, Ghana, Morocco, Algeria) with attendant efficacy relative to their population density. Policy measures, particularly alternative approaches that could induce greater efficiency in the laboratory reactions to the growth curve of COVID-19, are discussed in the study. In Figure 1 and 2, we reported the spatial density of COVID-19 confirmed cases and attributable deaths across African states. Having introduced the study, the other section of the study are as follows; 2.0 gives Nigeria's laboratory response to COVID-19, 3.0 givesSouth Africa's laboratory response to COVID-19, 4.0 gives Egypt's laboratory response to COVID-19, 5.0 gives Algeria's laboratory response to COVID-19, 6.0 gives the Morrocco's laboratory response to COVID-19, 7.0 gives Ghana's laboratory response to COVID-19, while 8.0 concludes.

{Insert Figure 1 & 2 Near Here}

2.0 Nigeria's Laboratory Response to COVID-19

Nigeria has recorded 3,526 confirmed cases of COVID-19 cases with 107 deaths as of 8th May, 2020. So far, 23,835 samples were taken and tested (NCDC, 2020d), which constitute less than 1% tests of the total population of around 200million (World bank, 2018). The Nigeria Centre for Disease Control (NCDC) is the federal government agency with the authorisation for national preparedness, detection, and response to infectious disease outbreaks (NCDC, 2020a). The agency performs the role of coordination of laboratory services in response to the COVID-19 outbreak with the establishment of the laboratory network, which comprises 21 laboratories across states in Nigeria (NCDC, 2020b). NCDC partnered with the Medical Laboratory Science Council of Nigeria (MLSCN) to develop a national strategy for COVID-19 testing, which contained the laboratory techniques which are currently in use and the future ones they hope to adopt to increase access to testing (MLSCN, 2020). Molecular method of Reverse Transcription Polymerase Chain Reaction (RT-PCR)

has been adopted as the gold standard for accurate testing of the pandemic in Nigeria with minimum sensitivity and specificity of 99 % each (MLSCN, 2020).

In the RT-PCR method, a reverse transcriptase approach was employed to convert the RNA template into a complementary DNA (cDNA) with subsequent use of the cDNA as a template for exponential amplification using PCR (Abdullahi *et al*., 2020; Udugama*et al.*, 2020). In the RT-PCR procedure, we confirm the existence of SARS-CoV-2 in a patient when the assay is positive. It should be noted that a laboratory outcome showing negative findings does not entirely rule out the presence of coronavirus in a patient (MLSCN, 2020). By intuition, a negative laboratory finding premediated on a suspected patient implies that the viral density was well below the detection point. In other climes, an RT-PCR assay laboratory finding could show adverse outcomes if the infection has run its cause leading to viral clearance (MLSCN, 2020). NCDC also developed a framework for incorporation of up to high throughput HIV molecular testing laboratories, which are capable of raising national capacity to a minimum of 5,000 tests per day (NCDC, 2020a). 41 GeneXpert machines have also been slated for incorporation into the laboratory network with a capacity of further increasing national capacity to 7,000 tests per day (NCDC, 2020b). Nigeria through a collaboration between Lagos State Ministry of Health, Nigeria Centre for Disease Control (NCDC) African Centre of Excellence for the Genomics of Infectious Disease (ACEGID), College of Medicine University of Lagos/ Lagos University Teaching Hospital (LUTH), Nigerian Institute of Medical Research (NIMR) published the first genome sequence of SARS-CoV-2 from Africa from the first confirmed case of COVID-19 in the country (NCDC, 2020c).

Serology testing helps to investigate the current pandemic and retrospective assessment of the extent of the outbreak. Nigeria's NCDC plan to look into the relevance of this antigen and antibody tests in the future to understand the rate of infectivity of the virus in the country. However, this method is subject to validation by the Medical Laboratory Science Council of Nigeria (MLSCN) before it can be deployed for routine testing in Nigeria (NCDC, 2020). MLSCN specifies that the sensitivity and specificity of this method of the assay must not be less than 95% with RT-PCR as a standard before approval can be given for its complimentary usage with other molecular methods (MLSCN, 2020). Nigeria's Laboratory capacity for COVID 19 testing is being worked on to carry out 2 million tests in the next three (3) months by the utilisation of the maximum capacity of various laboratories within its network to

improve the nation's undesirable testing coverage among countries with over 1000 cases across Africa (NCDC, 2020a).

3.0 South Africa's laboratory Response to COVID-19

Confirmed cases of COVID-19 in South Africa stand at 8,895 with 178 mortalities as the time of writing (8th May, 2020). A total of 307,752 tests has been done in all provinces of the country, but less than 1% of the South African population, which is over 57 million (Statistics South Africa, 2019), has been covered in COVID-19 testing (National Department of Health, 2020). Testing coordination for the novel coronavirus in South Africa is led by the National Health Laboratory Service (NHLS), which is the biggest diagnostic pathology service provider with roles of assisting the national and provincial health authorities in healthcare delivery in South Africa (NHLS, 2020). 80% of the South African population is served through the National Network of Laboratories. NHLS has National Institute for Communicable Diseases (NICD), National Institute for Occupational Health (NIOH), and the South African Vaccine Producers (SAVP) as subsidiaries (NHLS, 2020).

NHLS has eleven laboratories in nine provinces across South Africa designated for Coronavirus testing (NHLS, 2020). NHLS procured 67 mobile sampling and testing units which were deployed nationwide to join 180 testing sites and 320 testing units already in place across the country. NHLS is currently using the molecular method of Reverse transcription-polymerase chain reaction (RT-PCR) for COVID testing across its network of regional laboratories and mobile testing sites. South Africa planned to deploy the mobile laboratories for rapid serological kits for population surveillance when they are available in the country (UN, 2020c). National Institute of Communicable Diseases (NICD) partnered with the South African National Bioinformatics Institute at the University of Western Cape to publish a complete genome sequence of SARS-CoV-2 isolated from a South African patient with coronavirus disease 2019 who had returned to South Africa after travelling to Italy (Allam *et al*., 2020). With this, South Africa is on the verge of increasing her current 50,00 tests for COVID 19 daily by six-folds (National Department of Health, 2020).

4.0 Egypt's Laboratory Response to COVID-19

Egypt has recorded 8,478 COVID-19 laboratory-confirmed cases and 503 deaths from the novel Coronavirus disease (WHO, 2020a) as at the time of writing 8th May, 2020. COVID-19

tests have been done on 90,000 samples (Worldometer, 2020) out of 102 million populace a share representation of less than 1 % of the country population (UN, 2020b). Covid-19 outbreak management, testing, and control are coordinated through the Ministry of health and population of Egypt (MOHP). Combined method of RT-PCR and serological use of a rapid diagnostic test for anti-severe acute respiratory syndrome coronavirus 2 IgM and IgG are deployed in Egypt (Hassany*et al*., 2020). RT-PCR method is used across the laboratory network on symptomatic patients and contacts of confirmed cases while screening at points of entry are done with Rapid diagnostic kits (Hassany*et al*., 2020). Egypt's laboratory network includes seventeen (17) laboratories with the plan to augment with another four (4) and University hospital laboratories, which can increase national capacity to 200,000 in a total testing frame (WHO, 2020d).

5.0 Algeria's Laboratory Response to COVID-19

Algeria has recorded 5,182 confirmed cases of COVID 19 cases with 483 deaths as of 8 May, 2020 (WHO, 2020a) having conducted tests on 6,500 samples, which constitute 0.01% of the total population of over 42 million (UN, 2020a). Laboratory response to COVID-19 management in Algeria is anchored by the Institut Pasteur Algeria (IPA). The Institut Pasteur Algeria (IPA) based out of capital Algiers was testing samples from across the country (WHO, 2020e). The Institut Pasteur Algeria (IPA) also invited hospital laboratories with the equipment to get involved in screening for the virus to meet the demand for more tests (Kezzal, 2020). RT-PCR is the method of choice for testing for the SARS COV 2 virus in Institut Pasteur Algeria (IPA) Laboratory Network (Kezzal, 2020). IPA laboratory network is being expanded to accommodate other annexes in Oran, Constantine, and Ouargla, which is capable of increasing the testing capacity to 400 tests per day.

6.0 Morrocco's Laboratory Response to COVID-19

Confirmed cases of COVID-19 in Morocco stand at 5,548, with 183 deaths (WHO, 2020a) as at the time of writing (8th May, 2020) . A total of 42,112 tests has been carried out across the country, but just 0.1% of the Morocco population has been covered in COVID-19 laboratory testing (Worldometer, 2020). Laboratory testing for SARS COV 2 virus started in Morocco in The National Institute of Hygiene in Rabat (INH), the Pasteur Institute in Casablanca, and

the Laboratory of the Mohamed V military training hospital in Rabat with a combined daily capacity of 200 to 300 tests. An effort is on to include University Hospital Centres network in order to increase accessibility to the COVID 19 testing with procurements of tens of thousands of Reverse transcription-polymerase chain reaction (RT-PCR) kits (Amuedo, 2020). Also, Moroccan health authorities are planning to diversify its laboratory expertise by adopting a more straightforward diagnostic techniques for more comprehensive national coverage and expansion of the COVID-19 laboratory network without the inclusion of private laboratories for the time being (Kasraoui, 2020). Reverse transcription-polymerase chain reaction (RT-PCR) is the only method of analysis currently in use for COVID 19 testing in the country. Morocco is currently deploying all machinery to achieve 10,000 tests daily capacity to curb the spread of the virus in the Arab peninsula (Amuedo, 2020).

7.0 Ghana's Laboratory Response to COVID-19

Ghana has recorded 3,091 confirmed cases of COVID 19 cases with 18 deaths as of 8th May, 2020 (WHO, 2020a) having conducted tests on 149,948 samples, which constitute 0.5% of the total population of 29 million (Ghana Health Services, 2020). The novel Coronavirus testing started in Ghana in The Noguchi Memorial Institute for Medical Research (NMIMR), a medical research institute of the University of Ghana. NMIMR is the primary testing facility accounting for 80 % of the COVID 19 tests done in the country (Abbey *et al.*, 2020). Noguchi Memorial Institute for Medical Research along with Kumasi Centre for Collaborative Research (KCCR) was initially designated for testing the virus before other testing centres like National Public Health Reference Laboratories, Council for Scientific and Industrial Research (CSIR), etc. was added to the laboratory network (Ghana News Agency, 2020). Ghana government has invested in Reverse transcription-polymerase chain reaction (RT-PCR) technology in these laboratories to expand its testing capacity and increase access for the Ghanaian populace.

Ghana has also adopted the pooled testing algorithm for the RT-PCR method to increase its laboratory network efficiency and increase cost-saving measures. One thousand (1000) samples are grouped into 10, and 100 pools test are done at a time. If there is a positive result in a mini-pool, individual testing is then carried out on the original samples that were put in the pool. In the case of a negative result, all included samples have a negative result, but this method is capable of giving false-negative results in the large pool of samples (Shani-

Narkiss*et al.*, 2020). Almost 130,000 tests have been carried out in all provinces making Ghana the second country after South Africa, which has done most tests in Africa (Ghana Health Services, 2020). An effort is also in place to add 100 Regional and District Tuberculosis Gene Expert Laboratories, which will make each region have at least one testing centre for COVID 19 screening (Ghana News Agency, 2020).

8.0 Conclusion

Despite the rampaging nature of coronavirus disease (COVID-19) across the world, laboratory responses in Africa's high incidence nations have remained heterogeneous and inadequate in the fight against the wide-spreading infectious disease. Across cities and regions in Africa, various forms of laboratory response to the identification, epidemiological surveillance, and subsequent management of patients include Reverse transcription-polymerase chain reaction (RT-PCR), Serological testing, and viral genome sequencing. The various laboratory testing procedures are discussed in their regional specific domains. Beyond the identifications, we advanced arguments for the efficacy of each of these tests and discuss alternative and efficient laboratory measures that could aid the fight against COVID-19 in Africa. We found that these high incidence Africa countries adopt RT PCR majorly with slight modification in sampling method, mode of deployment and pre-analytical conditions. However, the number of tests which stand at an average percentage of 1% of their respective population indicates sub-optimal success recorded in the fight against COVID-19 in Africa. To prevent the emergence of new cases and abate sporadic community transmission that could stretch the capacity of the healthcare facilities in Africa, there is a need for increase testing capacity such that we can detect early and isolate affected patients. We recommend that greater and improved health care financing, adoption of a mobile testing laboratory to make an inroad into rural communities, re-assessment of the remuneration and incentives packages to be extended to laboratory professionals such that they do not surrender the fight against this fast-spreading and deadly diseases. In other climes, the African manufacturing sector should do more in terms of the development of homemade solutions to complement existing health infrastructures at this time of the global pandemic.

In Figure 3, we reported the laboratory testing conducted in the six (6) high incidence countries in Africa based on indices in Table 1 following.

{Insert Figure 3 Near Here}

{Insert Table 1 Near Here}

The pictorial representation and the tabular information apparently reveals that in all high incidence countries in Africa, less than one (1) per cent of the total population has been tested. The implications of this are many, and the consequences are immense. A large number of the populace who could have been in contact with an infected person has not been detected. Thus, scaling up the risk of community transmission that could eventually strain already dilapidated and inadequate health facilities in Africa. It remains to be seen what the dimension of COVID-19 spread could take in Africa in the coming days and months. We reported test per population in all African countries in Table 2.

{Insert Table 2 Near Here}

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Figure 1: African Countries COVID-19 cases.
Figure 2: African Countries COVID-19 fatalities.
Figure 3: Laboratory Testing Conducted In Six (6) High Incidence African Countries (As at 8th May, 2020)

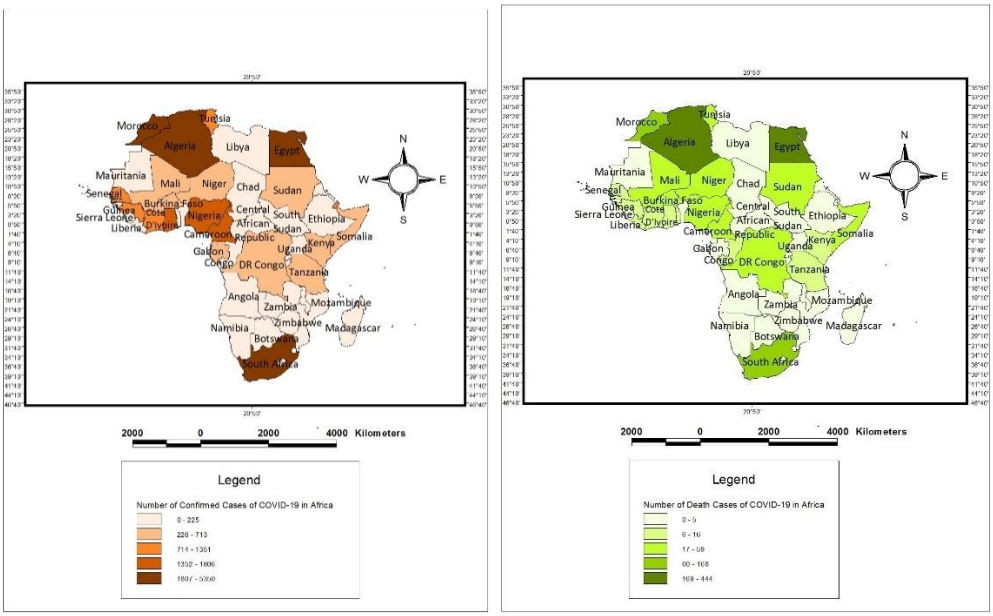

Figure 1&2: Africa COVID-19 exposure and fatalities

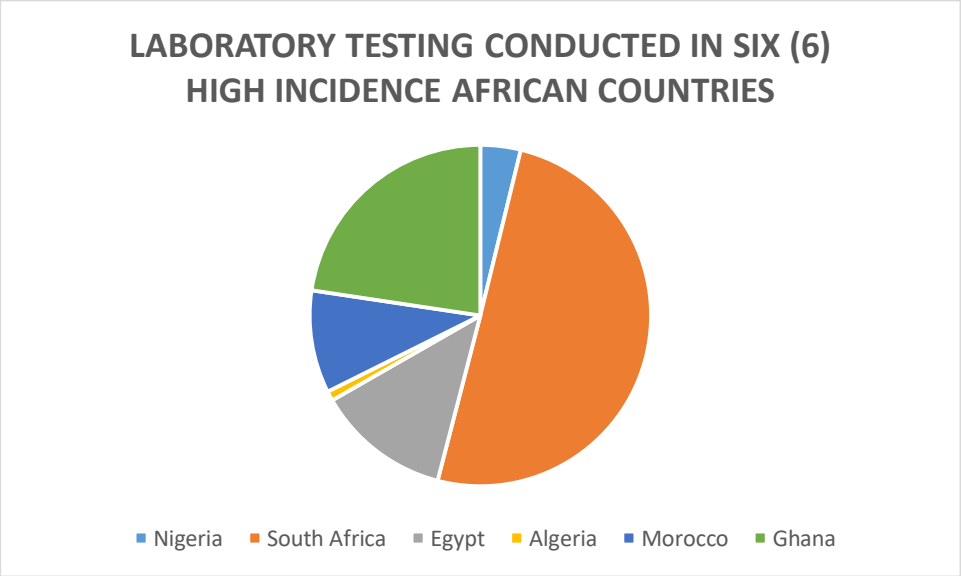

Figure 3: Laboratory Testing Conducted In Six (6) High Incidence African Countries (As at 8th May, 2020)

Table 1: Test per population in High Incidence African Countries

Countries	Confirmed Cases	Death cases	Total Number Recoveries	Number of Laboratory Test Carried out so far	Population Density (In Millions)	Test Per Population Percentage
Nigeria	4,641	150	902	27078	200	0.01
South Africa	10,652	206	4,357	356,067	57	0.62
Egypt	9,746	533	2172	90000	102	0.09
Algeria	5,891	507	2,841	6500	42	0.02
Morocco	6,281	188	2811	68,980	36	0.19
Ghana	4,700	22	323	160,501	29	0.55

Table 2: Test per population in African Countries

Countries	Confirmed Cases	Death cases	Recoveries	No of Tests	Population (in Millions)	TEST PER POPULATION PERCENTAGE
Nigeria	4,641	150	902	27,078	200,963,599	0.01
South Africa	10,652	206	4,357	356,067	58,558,270	0.61
Egypt	9,746	533	2172	90,000	100,388,073	0.09
Algeria	5,891	507	2,841	6,500	43,053,054	0.02
Morocco	6,281	188	2,811	68,980	36,471,769	0.19
Ghana	4,700	22	323	160,501	30,417,856	0.53
Senegal	1,886	19	715	18,969	16,296,364	0.12
Ivory Coast	1,730	21	818	13,663	25,716,544	0.05
Djibouti	1,227	3	872	15,790	973,560	1.62
Tunisia	1,032	45	700	33,266	11,694,719	0.28
Niger	832	46	637	5,598	23,310,715	0.02
Mali	712	39	377	2,172	19,658,031	0.01
Mayotte	1,023	11	492	4,000	266,150	1.50
Kenya	700	33	251	32,938	52573973	0.06
Gabon	802	9	127	5,337	2,172,579	0.25
Mauritius	332	10	322	69,773	1,269,668	5.50
Equatorial Guinea	439	4	13	854	1,355,986	0.06
Rwanda	285	0	150	42,805	12,626,950	0.34
Guinea Bissau	761	3	26	1,500	1,920,922	0.08
Cape Verde	260	2	58	791	549,935	0.14
Madagascar	186	0	101	3,968	26,969,307	0.01
Ethiopia	250	5	105	36624	112,078,730	0.03
Togo	181	11	89	10,561	8,082,366	0.13
Zambia	267	7	117	10,270	17,861,030	0.06
Eswatini	175	2	28	714	1,148,130	0.06

Benin	319	2	62	22,808	11,801,151	0.19
Uganda	121	0	55	58,608	44,269,594	0.13
Mozambique	103	0	34	4,173	30,366,036	0.01
CAR	143	0	10	3,498	4,745,185	0.07
Libya	64	3	28	3,253	6,777,452	0.04
South Sudan	156	0	2	1,247	11,062,113	0.01
Malawi	57	3	24	1,337	18,628,747	0.01
Angola	45	2	13	3,000	31,825,295	0.01
Zimbabwe	36	4	9	20,537	14,645,468	0.14
Botswana	24	1	12	9,540	2,303,697	0.41
Gambia	22	1	10	1,238	2,347,706	0.05
Sao Tome and Principe	208	5	4	175	215,056	0.08
Namibia	16	0	11	1,543	2,494,530	0.06
Burundi	15	1	7	284	11,530,580	0.00
Mauritania	8	1	6	2,015	4,525,696	0.04