Review Article

Epidemiological assessment and challenges of the COVID-19 Pandemic in Nigeria

Abstract

The COVID-19 which belongs to the coronaviridae family has continued to spread in a geometric progression version. The disease that originated from Wuhan, Hubei, China has spread to all the continents of the World except Antarctica continent. As of the 5th of August, 2020 there are over 18 million reported cases of COVID-19 from 214 countries and territories of the world. More than 10 million people have recovered while approximately 696,147 people have died due to COVID-19. This review provides general information on the COVID-19 and gives deep insight into the course of the disease, interventions challenges and possible solutions in Nigeria "the giant of Africa".

Scientific databases including Science Direct, Pub Med, Elsevier, Scopus, and Nature were explored. Data has also been accessed from case reports, newspaper reports, internet data, World Health Organisation (WHO) reports, Centre of Disease Control (CDCs) and Nigerian Centre of Disease Control (NCDCs) reports. US National Library of Medicine, Clinicaltrials.gov, has been accessed to get information about ongoing clinical trials. The literature survey started in the first week of April, 2020 and was completed in the first week of August, 2020. The clinical symptoms of COVID-19 patients are generally categorized as critical, severe, moderate and mild or even asymptomatic in descending order in terms of severity. Predictions from experts in different parts of the World concerning the possible impact of the disease in Africa have been on the downside which is due to a lot of glaring factors including poor health facilities and services.

Keywords: COVID-19, Coronaviridae, Pandemic, Disease, Epidemiology, Nigeria

Introduction

The veterinary, medical and economic importance of diseases of viral aetiologies cannot be overlooked as they continually pose a serious threat to not only public health but also global health. This has been made obvious by the recent pandemic caused by the severe acute respiratory syndrome coronavirus – 2 (SARS-COV-2) [1]. In the past two decades, the world has witnessed several viral epidemics that include severe acute respiratory syndrome coronavirus (SARS-CoV-1) in 2003, Hemagglutinin 1 Neurominidase 1 (H1N1) influenza in 2009 and the Middle East respiratory syndrome coronavirus (MERS-CoV) in 2012 [1], [2].

The World Health Organization declared the novel coronavirus 2019-nCoV outbreak which originated in Wuhan City, the largest metropolitan area in China's Hubei province, a Public Health Emergency of International Concern on the 30th of December, 2019 [3]. The WHO went further to declare the 2019-nCoV a global pandemic on the 11th of March. The disease was officially named as the coronavirus disease 2019 (COVID-19) [4]. In a timeline that reaches the present day, the high transmissibility rate of the disease which has been in high exponential rate leaving no continent spared has left life scientists in awe. Currently, (5th August, 2020) there are over 18 million reported cases of COVID-19 from 214 countries and territories of the world. More than 10 million people have recovered while over **696,147** people have died due to COVID-19. Unfortunately, the number of confirmed cases keeps increasing [5].

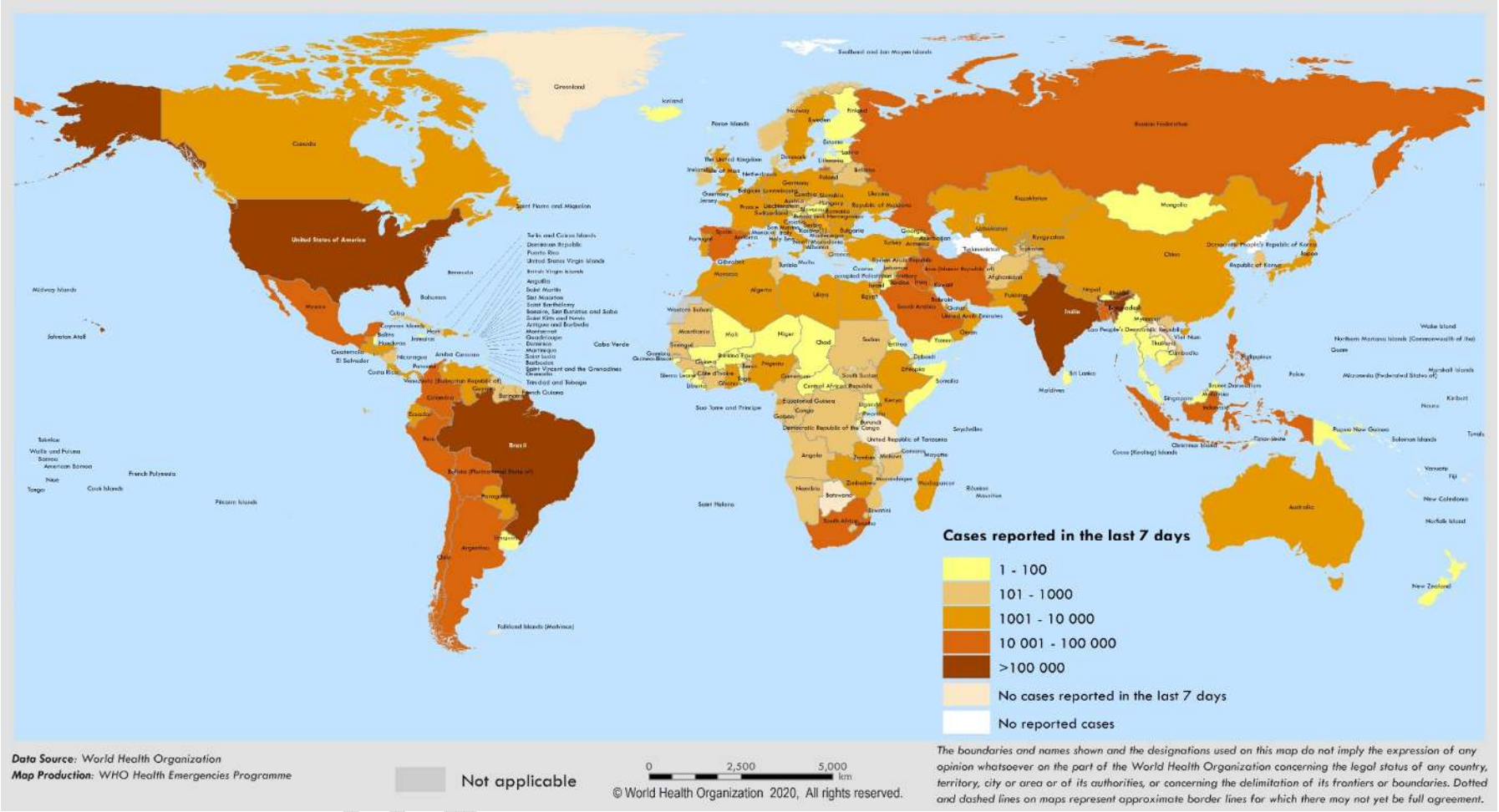

Figure 1a: Epidemiological map of COVID-19 in the World: Number of confirmed COVID-19 cases reported in the last seven days by country, territory or area according to the WHO situation reports.[6].

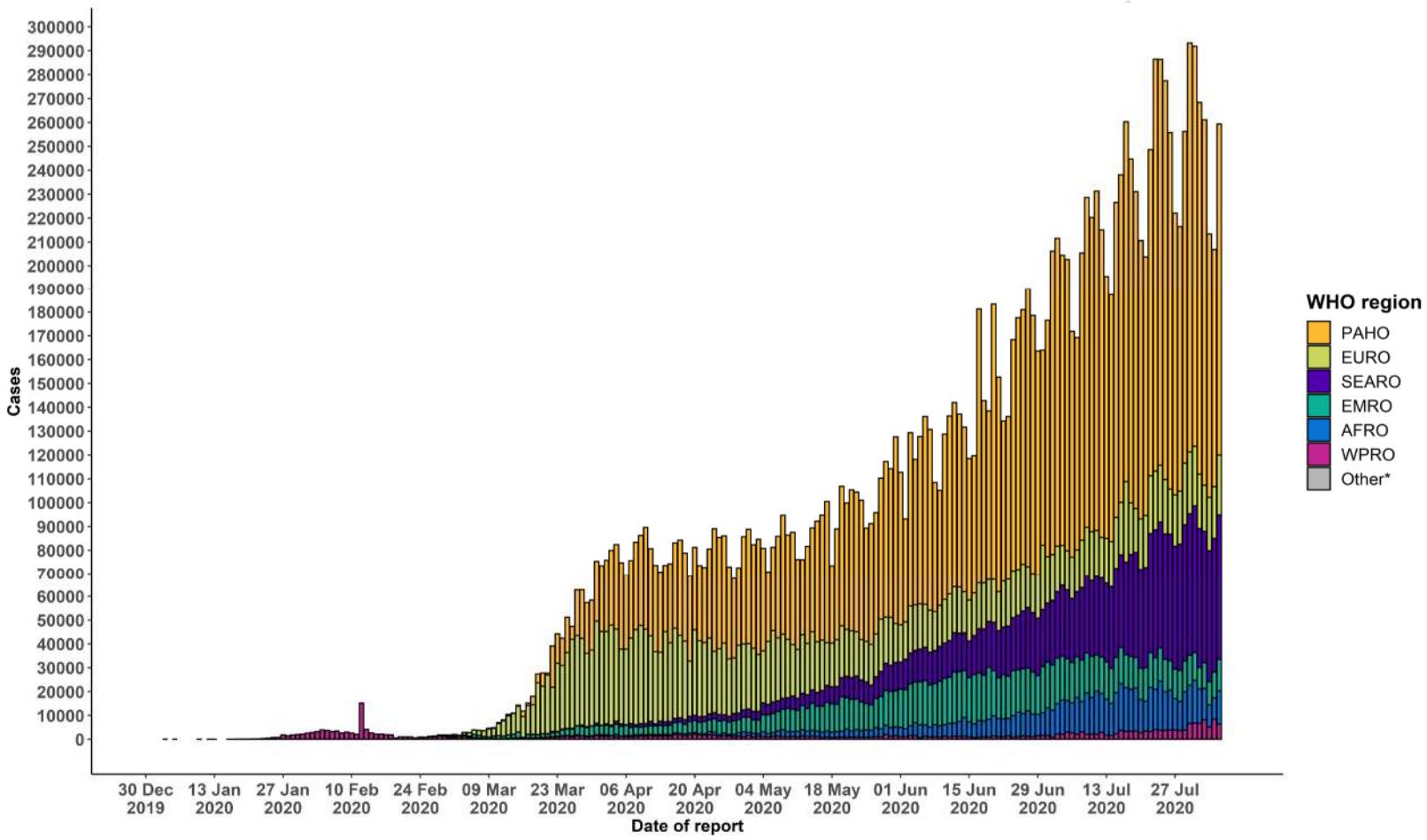

Figure 1b: Number of confirmed COVID-19 cases, by date of report and WHO region according to the situation reports of the WHO. [6]

Africa's first case of coronavirus was detected in Egypt on 14th February, the rest of the continent prepared for the brunt of a pandemic that has engulfed Europe and spread to the United States, infecting more than 1.6 million worldwide as at the time. The devastation the deadly virus could cause in Africa was glaring, where most hospitals are desperately short of equipment and trained staff [7].

The COVID-19 has since spread to all the African countries with more than 996, 018 positive cases and over 21,687 deaths with 676,594 recoveries recorded as on 5th August, 2020 [8] with the initial cases reported being importations from other countries and few community transmissions in those who do not have recent travel history [9], but despite a steady rise in the number of confirmed cases, the continent continues to lag behind the global curve for infections and deaths. Howbeit, factors such as silent unreported cases due to poor monitoring of disease and its progression, poor access to diagnostic facilities, inadequate and overstretched health care facilities and services as well as poor feedback systems make the current statistic a debatable subject[10].

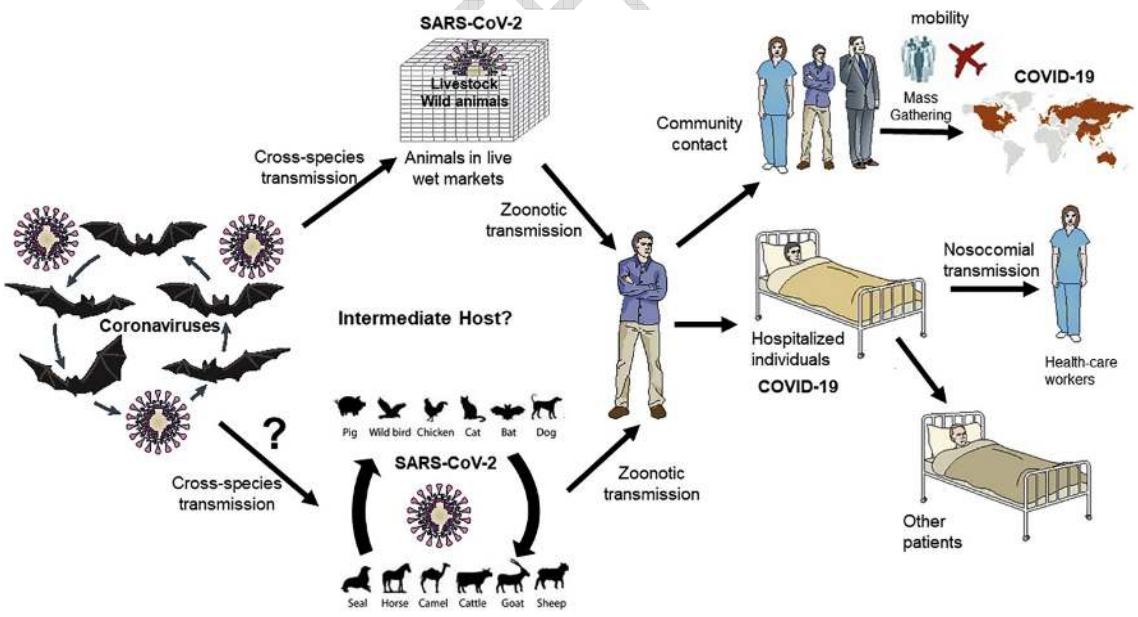

Fig. 2. The emergence of SARS-CoV-2 and the outbreak of COVID-19. The figure depicts a hypothesized origin of the virus and a generalised route of transmission of the epidemic zoonotic coronavirus. [11].

A question stands out in the analysis of coronavirus in Africa which is compounded by a global lack of testing capacity as to whether the numbers are underestimated. South Africa which has the most advanced healthcare system as well as the most industrialized country in the continent has so far tested around 3 million of its 57 million inhabitants. Although this is a significant scaling up as this wasn't the case at the initial period of the pandemic as of 28th of April, 2020 had only managed to test around 73,000 of its population [12]. However, though this is a welcome development, the same cannot be said of most countries in the continent.

Nigeria, Africa's biggest economy, has only carried out 306,894 coronavirus tests to date for a country of approximately 200 million people. Of these numbers 44,890 tested positive in all the 36 states of the federation including the Federal Capital Territory (FCT) with slightly over 32,165 recovery cases and 927 case fatality as on 5th August, 2020. However, 2% of the cases were gotten via travel history, 25 % by contacts and 73% with no epidemiologic link[13].

This review gives insight on the COVID-19 and gives a description of some of the actions taken by the Nigerian government in spite of the glaring challenges faced by the government and also details required actions that should be urgently implemented in Nigeria and other African countries.

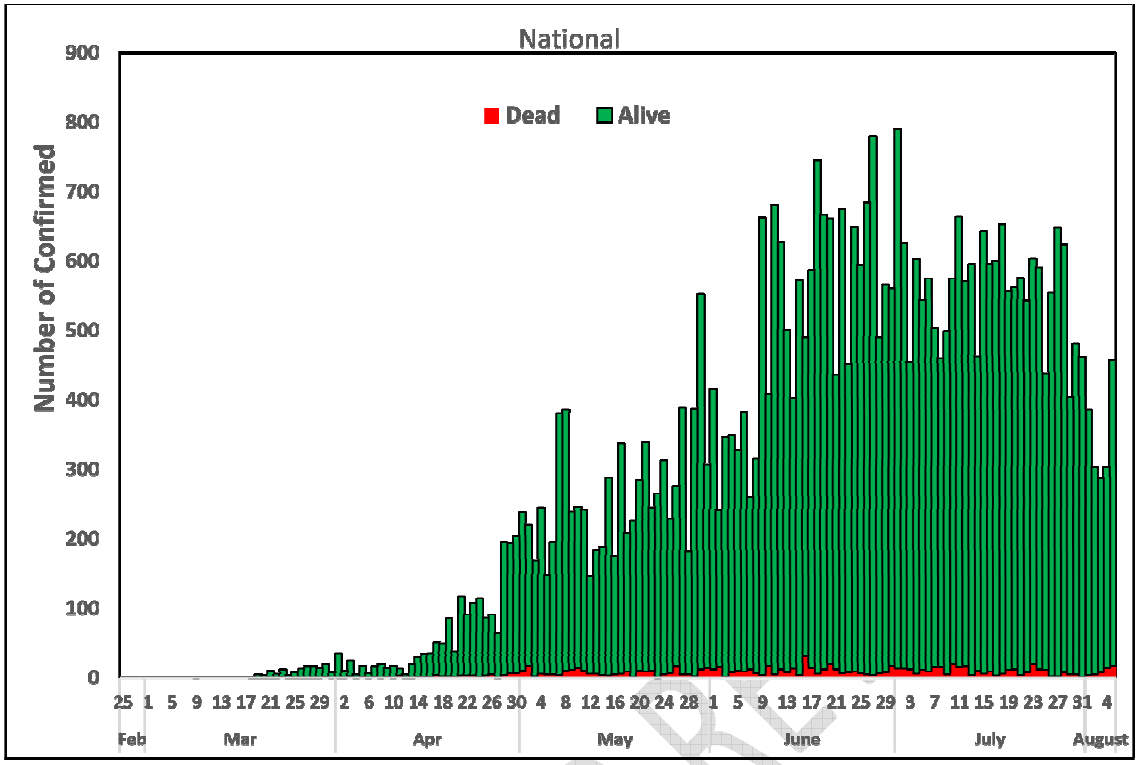

Figure 3: Daily Epidemic Curve of Confirmed Cases from 25th February to 4th August, 2020. [13]

Aetiology and Virology.

SARS-COV (COVID-19) belongs to the family called coronaviridae, subfamily ***Orthocoronavirinae,*** order *Nidovirales*, and realm *Riboviria* [2], [14]. The Coronaviruses were first mentioned in the mid-1960s by Tyrell and Bynoe, after the viruses were isolated from patients supposedly suffering from the common cold [15]. The nomenclature coronaviruses were ascribed to them because of the spherical shape of their virions with a core shell and projections on the surface which protrudes to the periphery resembling a solar corona[16]. Genetically, members of this orthocoronavirinae were classified into four major genera using the Greek alphabets: *α-coronavirus*, *β-coronavirus*, *δ-coronavirus* and *γ-coronavirus* [17], [18]

As of today, existing knowledge from different literatures supports that *α-coronavirus* and *β-coronaviruses* infect only mammals and are responsible for causing illness associated with

the upper and lower respiratory tracts in humans and inflammation of the stomach and intestines in animals[14], [19]. To date, seven types of coronavirus have been identified in humans (HCoVs) [20], The first two belong to the α-coronavirus genus and the latter five to the β-coronaviruses genus[21]. These groups are further classified into three sub groups. The A lineage of β-coronaviruses (such as HCoV-OC43 and HCoV-HKU1) as well as α-coronaviruses (such as HCoV-229E and HCoV-NL63), responsible for causing self-limiting infections of the respiratory tract as well as common colds[18]. In contrast, the B lineage of β-coronaviruses causes SARS-CoV-1, SARS-CoV-2, while C lineage of β-coronaviruses causes MERS-CoV. The B and C lineage of the β-coronaviruses are behind the 2012 epidemic and the ongoing pandemic with mild to critical clinical severity of pulmonary and extra-pulmonary involvement and are associated with the significant rise in death cases across the globe. [13, 19, 20].

SARS-COV-2 is a single-stranded, positive sense RNA viral particle of 26–32 kb with a 5′-cap structure and 3 ′-poly A tail that interacts with the nucleoprotein, having a diameter of 60 -160 nm, however, it often exists in pleomorphic form. Genome sequencing reveals that the RNA genome contains 29891 nucleotides, encoding for 9860 amino acids and shares 99.9% sequence identity, which suggests a very novel shift into humans as host [23], [24]. A complete genome sequencing indicated that the SARS-CoV-2 genome shares 79.6% sequence identity with that of SARS-CoV. Similarity is seen in all the coronaviridae family in terms of genome organization and expression [22], [48][13]. When compared to the genome size of other viruses of RNA structure, coronaviruses genome is the largest of them. It consists of two untranslated regions at the 5′ and 3′ ends and 11 open reading frames (ORFs) that encode at least 27 proteins. Worthy of mention are sixteen proteins termed as non-structural proteins, encoded by open reading frame (ORF) 1a/b at the 5′-end which makes up for two-third of the entire genome, following are the structural and accessory proteins, which are encoded by other ORFs at the 3 ′-end [14], [24]–[26]. These structural proteins include the nucleocapsid (N), spike (S), envelope (E) and membrane (M) The M protein binds the nucleocapsid and enhances viral assembly and budding; the E protein is involved in viral morphogenesis, release and pathogenesis; and the S protein contributes to the spikes (homotrimeric) that recognise the cell receptor, thus helping the virus invade the host cells. [14].

In humans, SARS-CoV and MERS-CoV cause severe respiratory syndrome, while the other human coronaviruses induce only mild upper respiratory diseases in immunocompetent hosts [25], [27]. The 2003 SARS epidemic was what gave popularity to the coronaviridae family, followed by the MERS-COV outbreak in 2012 and, most recently, the novel coronavirus pandemic which started in late 2019. Notably, the SARS-COV-2 infects human lung alveolar epithelial cells through receptor-mediated endocytosis using angiotensin-converting enzyme II (ACE2) [28], [29] as an entry receptor[30]. Adhesion to the entry receptor mediates the fusion between the viral envelope and host cell membrane, subsequently resulting in viral entry into the host cell [31], [32].

In the spread of SARS-CoV-2 globally, numerous cases have been reported that cannot be traced to the putative source of the infection giving credence to the fact that the source of infection is mainly infected patients, but the possibility of asymptomatic infection should not be ignored. Respiratory droplets and close contacts are the key routes of transmission. The possibility of aerosol transmission in a relatively closed environment for a long-time exposure to high concentrations of aerosol also exists [33]. Recently, faecal-oral route transmission possibility is been considered since the SARS-CoV-2 RNA has been traced in the faeces of some confirmed patients with pneumonia, [14]. ACE2 cell receptors have been found to be highly expressed on type II alveolar epithelial cells, stratified epithelial cells, oesophageal epithelium, and even in absorptive epithelial cells from parts of the small intestine (ileum) and large intestine (colon) [1], [34]. Bioinformatics tools which relies on analysing single-cell transcriptomes suggests that several parts of the digestive tract may serve as an infectious route for SARS-CoV-2 [35]. The spread and infection of the virus are complex problems requiring multidisciplinary approaches including but not limited to fluid mechanics, biology and medicine to get a holistic picture. It's been established that the SARS-COV-2 are sensitive to lipid solvents such as ether, 75% ethanol, chlorine-containing disinfectant, peracetic acid and chloroform as well as ultraviolet rays and heat which can effectively inactivate the virus [22], [31], [36].

Table 1. Differences in epidemiological characteristics and clinical features between SARS-COV-1, MERS-COV and 2019 novel coronavirus (SARS-CoV-2) [1], [2], [14], [22], [31], [33], [34], [37], [38], [39].

Epidemiological Characteristics			
Feature	SARS-CoV-2	SARS-CoV-1	MERS-CoV
Origin	Wuhan, China	Guangdong, China	Jeddah, Saudi Arabia
Year of Epidemic	2019	2003	2012
Total cases (global)	18, 000 000+	8096	2229
Total Deaths (global)	696, 000+	774	791
Asymptomatic viral load	High	Less	Less
Long period of infectivity	Yes	No	No
Estimated R_0	2.2-3.28	2.0-5.0	<1
Median Incubation (days)	6.4 (0-24)	4.6 (3.8-5.8)	5.2(1.9-14.7)
Serial interval (days)	2.6-7.5	8.4	12.6
Case-fatality rate (%)	3-3.5	9.6	35.5
Case-fatality rate with comorbidities (%)	73.3	46.0	60.0
Host	Bats	Chinese horseshoe bats	Bats
Natural Host			
Intermediate Host	Pangolin	Civet	Camel
Terminal Host	Humans	Humans	Humans
Transmission			
Respiratory droplets	Yes	Yes	Yes
Fomites, Contact	Yes	No	No
Zoonotic	Yes	Sporadic	Sporadic
Aerosol	High Possibility	Yes	Yes
Faeco-Oral	High Possibility	Yes	No
Human to human	Yes	Yes	Limited
Nosocomial	Yes	Yes	Yes
Cell entry receptor	ACE2	ACE2	DPP-4/CD26
Clinical Features			
Feature	SARS-CoV-2	SARS-CoV-1	MERS-CoV

Mild	80%	61%	21%
Severe/Critical	14-15%/4-5%	11%	46%
Fever	Yes, Mild	Yes	Yes
Chills	No	Yes	Yes
Dry Cough	Yes	Yes	Yes
Rhinorrhoea	May be	Yes	May not
Sputum	Rare	Yes	May be
Diarrhoea	Less	Yes	Yes
MOF	Renal, Liver, Testes	Liver	Liver
Critical	ARDS	ARDS	ARDS, ARF

Clinical Manifestations

There are many classifications used for the clinical manifestations COVID-19 based on whether it is as asymptomatic or symptomatic, carrier or infective state, from mild prodrome to profusely symptomatic and exacerbated forms; depending chiefly upon the patient's immunocompetence[40].

Depending on the clinical features of COVID-19, patients are generally categorized as critical, severe, moderate and mild in a descending order in terms of severity [10].

i. Critical COVID-19: usually develops after a week in patients with mild/moderate/severe COVID-19 with features of acute respiratory distress syndrome (ARDS) requiring artificial ventilation along with presence of multiple organ dysfunction and failure, coagulation dysfunction and metabolic acidosis[41].
ii. Severe COVID-19: dyspnoea, respiratory frequency of more than 30 per minute, blood oxygen saturation of less than 93%, PaO2/FiO2 ratio less than 300mmHg, and/or lung infiltrates greater than half of the lung field within the first two days. Patients require respiratory support within the intensive therapy facilities[42].
iii. Moderate COVID-19: fever, respiratory symptoms including dry cough and dyspnoea that may emerge together with the radiological features.

iv. Mild COVID-19: low grade fever, cough, malaise, rhinorrhoea, sore throat with or without haemoptysis, nausea, vomiting, diarrhoea, but without any radiological features of pneumonia and absence of neuropsychiatric pathologies.

Poor prognostic risk factors in infected patients include older age, male sex, smokers and associated comorbidities including obesity, hypertension[43], diabetes, chronic pulmonary diseases, cardiovascular disease[44] and chronic kidney disease [1], [14]. The more the number of risk factors, the more the severity at presentation[45], [46]. Most patients have a good prognosis, but it is poor for the elderly and those with chronic underlying diseases. Symptoms in children are comparatively mild.

There are reports of conjunctivitis, gastrointestinal symptoms like diarrhoea, vomiting, nausea, abdominal pain. Some critically ill may present without fever but with abdominal pain, anorexia and dyspnoea. Notably, Less prevalent symptoms were gastrointestinal, [1], [31], [47] also there are compelling evidence from different articles which associates SARS-CoV-2 infection with different ranges of neurological symptoms (headache, dizziness, nausea, loss of consciousness, seizures, encephalitis etc.)[48]

Other clinical symptoms observed at a lower frequency include elevated troponin levels, myalgia and myocarditis[41], [49]. Patients gradually develop initial symptoms in the cardiovascular system, digestive system and nervous system, which increases the difficulty of diagnosis. This correlates with findings from other studies.

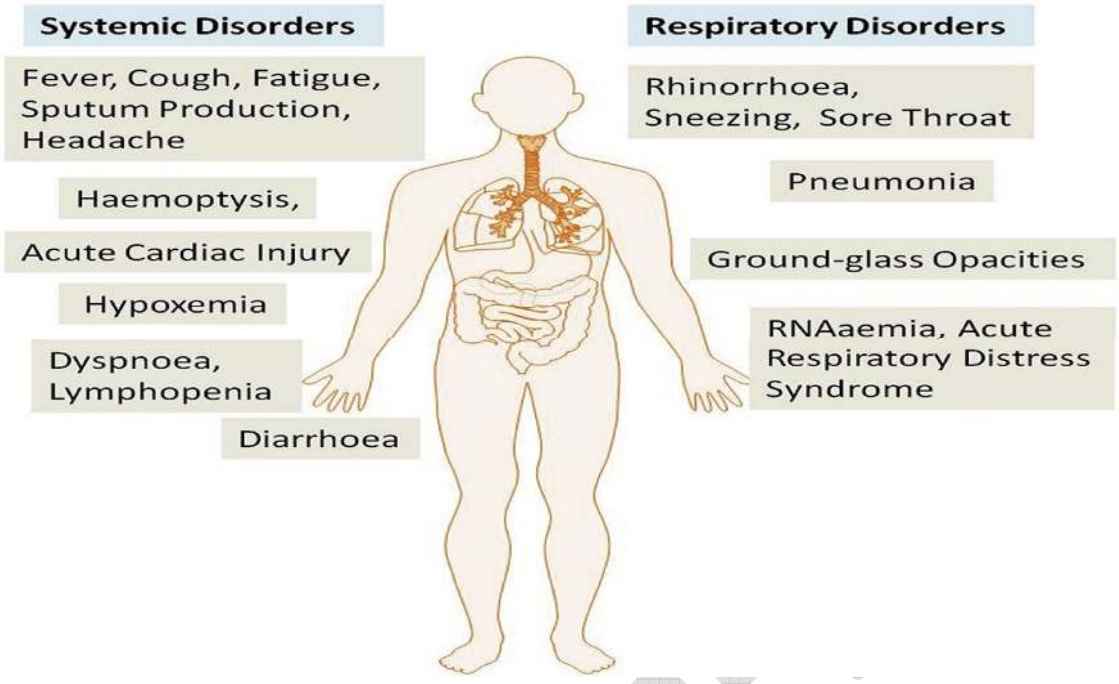

Fig. 4. The systemic and respiratory disorders caused by COVID-19 infection [22], [50].

Diagnostics Testing in Nigeria for COVID-19.

Diagnostic testing is an essential response strategy to interrupt the transmission of any epidemic, the COVID-19 pandemic inclusive. This helps patient management and identifying positive cases, which can then be isolated. According to the NCDC website, testing is one of the key interventions to the COVID-19 response in Nigeria. In order to rapidly contain the outbreak, the Government of Nigeria rapidly scaled up diagnostic testing to cover all 36 States plus the FCT. As at 5th August, 2020, molecular rRT-PCR testing is the gold standard technique for COVID-19 diagnostics in the country with 62 laboratories providing national testing capacity with an increased number of testing output of samples daily. This is an improvement on the existing five diagnostic laboratories at the beginning of the COVID-19 pandemic in the country.

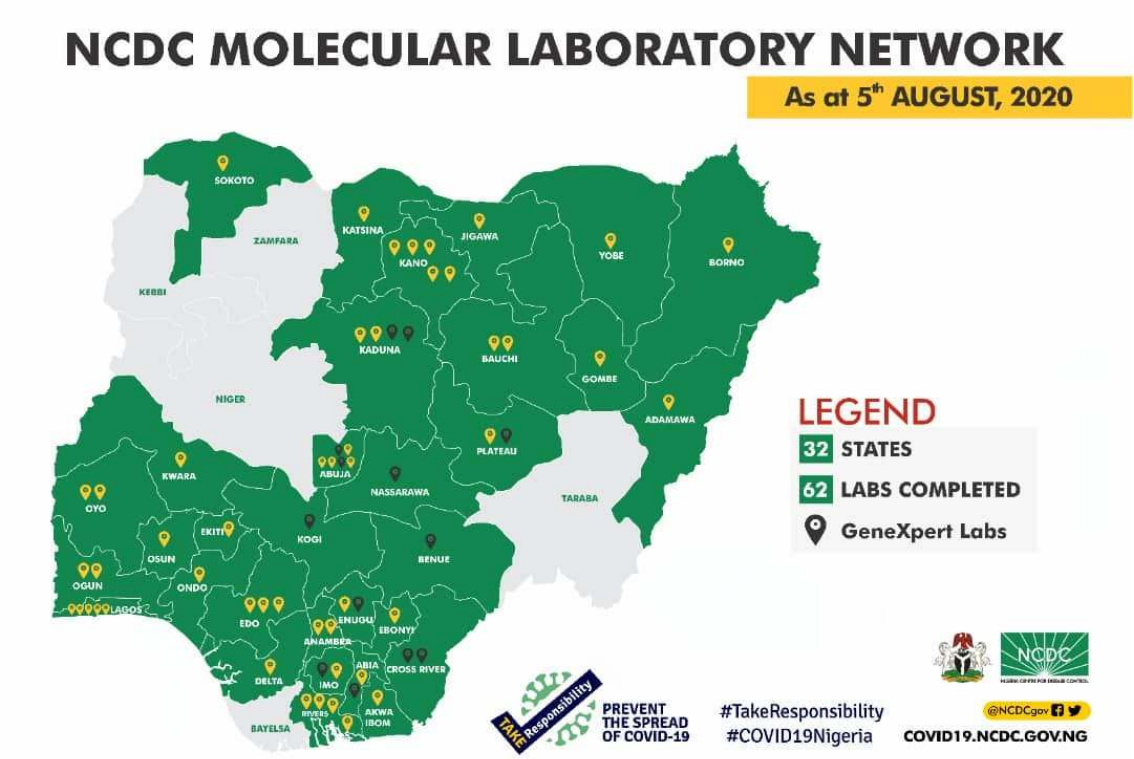

Fig 5: Molecular diagnostic sites across the length and breadth of Nigeria culled from the NCDC website [13].

The real-time reverse transcription-polymerase chain reaction (rRT-PCR).

The current standard molecular technique that is now being used to detect COVID-19 is the real-time reverse transcription-polymerase chain reaction (rRT-PCR). This protocol has been documented and made readily available on the WHO website. The procedure includes:

(i) Collection of specimen;

(ii) Packing (storage) and transport of the clinical specimens;

(iii) (Good) communication with the laboratory and providing needed information;

(iv) Laboratory testing;

(v) Results reporting.

To carry out rRT-PCR technique, highly sophisticated laboratory equipment is needed which is often located at a central laboratory of greater than or equal to the biosafety level 2 [4]. Thereby making sample transportation unavoidable culminating in a time delay. In the case of the COVID-19 outbreak a public health emergency, this time-consuming process of

sample testing is not only extremely disadvantageous, but also dangerous since the virus needs to be contained[51].

In addition, commercial PCR-based methods are expensive for a third world country like Nigeria. It also depends upon technical expertise, there is also an issue with the specificity and sensitivity of the test as the presence of viral RNA or DNA does not always reflect acute disease. [4], [49–51] among some other challenges.

With this challenge, there is need for the Nigerian government to look for an alternative but efficient diagnostic approach in the diagnosis of the COVID-19.

Alternatives for the rapid detection of SARS-CoV-2 include Loop-Mediated Isothermal Amplification (LAMP) Assays in point of care Devices, *Enzyme-Linked Immunosorbent Assay (ELISA), Neutralizer Assay.*

Table 2. The comparison of different alternative test kits[14], [26], [52], [55].

S/No	**rRT-PCR**	**Loop-Mediated Isothermal Amplification (LAMP) Assays**	***Enzyme-Linked Immunosorbent Assay (ELISA)***	***Neutralizer Assay (NA).***
1	Thermal cycling (Multiple heating and cooling cycle; hence, bulky and cumbersome).	Isothermal and continuous amplification (Smaller, simpler, hence portable).	Isothermal and continuous amplification (Smaller, simpler, hence portable).	Isothermal and continuous amplification (Smaller, simpler, hence portable).
2	Time-consuming. Always requires sample concentration and preparation. (2-3 days)	For virus detection, for example, influenza or human norovirus, LAMP assay offers one-step detection. Sample preparation	Sample preparation steps are simplified. Results comes out in 2-4 hours	Time-consuming. Always requires sample concentration and preparation. (2-3 days)

		steps are simplified.		
3	Multiple protocols (Complicated and requires a skilled technician).	Single protocol (Faster).	Multiple protocols but less complicated	Multiple protocols (Complicated and requires a skilled technician).
4.	Inhibitors hinder the reaction.	Tolerate inhibitors and more stable.	Tolerate inhibitors and more stable.	Tolerate inhibitors and more stable.
5.	Diagnostic sensitivity (95%).	Diagnostic sensitivity 95%.	Diagnostic sensitivity 95%.	Diagnostic sensitivity 95%.
6.	Established technique.	Applications using LAMP assays are being researched upon extensively.	Applications using ELISA are being explored.	Applications using NA are being explored.
7.	The presence or absence (qualitative) of antibodies against the virus present in patient serum	The presence or absence (qualitative) of antibodies against the virus present in patient serum	The presence or absence (quantitative) of antibodies against the virus present in patient serum.	The presence of active antibodies in patient serum that are able to inhibit virus growth ex vivo, in a cell culture system. Indicates if the patient is protected against future infection.

Radiology diagnostics usage in Nigeria

Chest X-ray (CXR), Computed tomography (CT) and point-of-care lung sonography are radiological tools that are important in this pandemic era, done on a case by case basis. These methods are used by all affected regions of the World including Nigeria. High chances of

droplet infection make pulmonary functions tests unreliable[14]. CXR findings are non-specific, normal in initial phases to patchy unilateral or bilateral involvement to lobar/multi-lobar/bilateral consolidation[56]. The CT changes are of four stages: The first stage also known as the early stage of ground glass opacities (GGO) in sub-pleural distribution involving mainly the lower lobes of the lungs [24]. In the second stage also called the progressive stage, multi-lobar distribution with GGO is observed, resulting in the bilateral consolidation of airspaces. The third stage or peak phase is characterized by dense consolidation in almost all cases and the last stage is the absorption stage which shows GGO without haphazard paving pattern[35].

Having these radiological techniques at every point of care remains the main challenge to the Nigerian Healthcare System, although at present, there are low amount of positive cases most of which do not exhibit symptoms relating to pulmonary dysfunction. It is very easy to conduct testing using these radiological techniques. Fortunately, radiological techniques isn't the first point of call in terms of COVID-19 diagnosis. Hence, medical expertise and professionalism among health care workers becomes a handy tool in the management of cases relating to respiratory dysfunction in the eventuality that the health care system becomes overwhelmed[10].

Treatment of COVID-19 in Nigeria

COVID-19 vaccine is the new goldmine in the scientific World as all efforts round the globe is geared towards finding a vaccine for the COVID-19. However, there's being a lot of set back due to the peculiarity of the SARS-COV-2. The most noteworthy is the fact that it can cause reinfection in previously infected patients and also due to the required clinical testing associated with vaccine production. As at today, there is no vaccine. However, the recent attempt by researchers in South Africa to start working on developing vaccines from COVID-19 pandemic isolates [57] as well as the acclaimed effective anti-COVID-19 drug produced by the Madagascar government is an open call for other African nations including the Nigerian government to engage biomedical Scientists at her various Universities and Institutes for local contents on possible antiviral drugs and vaccine developments along with partners from other parts of the World.

Nigeria follows NCDC guidelines for treatment of Covid-19 patients. Medical interventions are purely based on case management. For patient's whose exacerbation haven't reached the severe or critical case; active symptomatic support remains key for treatment, such as maintaining hydration nutrition and controlling fever and cough. For patients with severe infection or those with respiratory failure, oxygen inhalation through a mask, high nasal oxygen flow inhalation, non-invasive ventilation, or mechanical ventilation is needed.

Extracorporeal membrane oxygenation (ECMO) is often used when other methods have failed[58]. Hemodynamic support is essential in the case of patient with septic shock [59]. Antibiotics and antifungals are administered in cases with bacteria and/or mycoses coinfection. As corticosteroid therapy is commonly used among critically ill MERS patients, short courses of corticosteroids at low-to-moderate doses are used with extreme care in COVID-19 cases [54–56]. Psychoanalytic strategies are also used to monitor patient's mental health as anxiety and fear are common symptoms among COVID-19 patients [63].

Nigeria as a country has always known there will be a high competition for the available ventilators in the COVID-19 era as ventilators are in short supply most especially at the time of the beginning of the outbreak. In fact, one of the many highlights of the COVID-19 era is the plea of a ministry under the Nigerian government pleading with a well-known automobile company for the supply of ventilators on one of the social media accounts. However, it must be noted that there've been donations from both individual and corporate entities for the procurement of ventilators both in cash and kind.

Pharmacological treatments are divided into four categories which include general treatment, coronavirus specific treatments, antiviral treatments and others[64]. The general treatments being used include but are not restricted to nutritional interventions, immuno-enhancer and interferons [65].

The search for effective antiviral treatments for coronavirus infection is still ongoing[66]. Antiviral medications such as lopinavir/ritonavir and abidol exhibited no significant effect on clinical improvement [48], [67]. The efficacy of the old antimalaria and anti-arthritis medicine: Chloroquine and hydroxychloroquine as an antiviral agent had been proven since the late 1960 [63–66], recent studies demonstrated remarkable inhibition in the spread of SARS-CoV-2 by interfering with ACE2 in Vero E6 cell lines [60–62]. Different studies that

have been made available to the public have demonstrated that chloroquine functioned at both entry and post-entry stages of the SARS-COV-2 infection in Vero E6 cells[75], as well as an immune-modulating activity that enhanced the antiviral effect *in vivo*[76]. Recent clinical trials conducted in different parts of the World have reported efficacy and acceptable safety of this pharmacological agent in COVID- 19 patients which was shown to have promoted the remission of pneumonia, improved CXR and chest CT imaging findings, promoted a serum negative conversion, and reduced the time period and span of the disease[72]. The statistics available to the populace have shown significant recovery rate[68, 69].

Clinical trials on redemsivir, a nucleotide analogue prodrug currently considered for treatment of Ebola virus infections (EBV), shows promise[42], [79]. Since preclinical studies have suggested that remdesivir may be effective for both prophylactic and therapeutic treatment of the HCoV infections [41], [80], [81].

Nigeria, just like most African countries is well known for her richness in herbal therapy as an alternative to medical therapy and have always used herbal therapy in the treatment of several diseases [82]. However, there are no sufficient record to prove that herbal therapy has been effective against any of the epidemics of viral aetiology that has once plagued the nation for example lassa fever. There are also no documented clinical trials with herbal therapy at the moment[83]. The Nigerian government through the country's health ministry and the Nigeria agency for food and drug administration control (NAFDAC) as well as her many other health agencies have always shown restraint in the promotion of herbal therapy which may not be unconnected with the associated dosage related issues and the concern for contempt for western medicine by most of the advocates for herbal therapy. However, a balanced and holistic approach must be taken in the fight against COVID-19.

Prevention and Control of COVID-19 in Nigeria

The most advocated as well as confirmed means of prevention of the COVID-19 pandemic at the moment are non-pharmacological [84] in terms of approach, particularly isolation and social distancing [85]. In light of this, the Nigerian government at both the Federal and State level officially took the following measures at different points in time to curtail the pandemic:

1. Movements cessation in key states with high population index as well as states where there is low population index but high risk of transmission such as Lagos, FCT Abuja and Ogun state, Rivers state, Kano state Other states followed suit at some points [46].

2. Closure of all businesses and offices in the said states with exception of businesses involved in essential services such as hospitals or related medical establishment, food processing distribution and retail companies, petroleum distribution and retail entities and power distribution companies.

3.The suspension of inter-state travelling including travel by aircraft, buses, trains.

4. A travel ban on countries considered to be high risk for COVID-19 on the 18th of March, an action considered as better late than never. The countries included: China, Italy, Iran, South Korea, Spain, Japan, France, Germany, Norway, the USA, the UK, Netherlands, and Switzerland. This was the first of its kind since Nigeria's independence at approximately 60 years ago.

5. Training of healthcare workers in prevention and treatment of COVID-19 by appropriate governmental and non-governmental organizations across the length and breadth of the country.

The immediate and initial action of some State governments in Nigeria on social distancing by ordering closure of primary and secondary schools and reducing number of individuals at different gatherings including places of worships, the Nigerian University's Commission (NUC) memo on the closure of tertiary institutions, asking the junior staff of the civil service to stay at home as well as the lockdowns of three high risks states and the federal capital territory (FCT) by the Federal government are all steps taken in the right direction but not without its attending issues. However, the delay in the closure of air and territorial borders till a little over three weeks after the recorded index case of an Italian and intercity movement up till the present despite continuous spikes in the number of imported COVID-19 pandemic cases and community transmission in the country, spreading into different states deserves some high-level critique [8].

Nosocomial transmission also known as hospital acquired infection is also a severe problem in Nigeria in terms of the COVID-19 transmission, this is because healthcare professionals are a potential vehicle for the diffusion of the COVID-19, considering that a large portion of infected subjects are able to spread the pandemic despite an asymptomatic status[11]. Quite a number of health workers have been infected, although there are no sufficient records to

categorically state the number. Personal protective equipment (PPE), including fluid-resistant gown, gloves, eye protection, full face shield, and N95 respirators, as well as extreme caution is necessary to maximize the safety of all healthcare workers who need to be in contact with critically ill patients with confirmed or suspected SARS-CoV-2 infection.

Although at the moment, lockdown has been lifted in all parts of the country even as there is a steady rate of increased number of confirmed cases. The need for continued consciousness and awareness of the COVID-19 pandemic among the general populace must be reiterated. Special care of children to prevent exposure to COVID-19 must be ensured by parents and guardians. Vulnerable persons and immunocompromised individuals including pregnant women, old people [86], persons living with HIV/AIDS, cancer, tuberculosis, hypertension and diabetes that are considered high risk to the COVID-19 pandemic due to their impaired immune status must be taken care of. Fumigation of places considered to have harboured infected people must be done to contain the virus.

Telemedicine in COVID-19 Era in Nigeria

One aspect of medicine that has blossomed and gained global patronage in this COVID-19 pandemic era is telemedicine which is the use of technology to access better health care. This is not surprising as everything is done to limit doctor-patient physical contact. For instance, in Israel, a medical centre reported the use of telemedical services (TMS) to effectively care for the dozen COVID-19 patients received from the quarantined cruise ship in Japan [87]. This was done using remote patient examination without medical staff presence, robot's laden camera use, screen and medical equipment controlled by health care practitioners, and remote monitoring using a thermometer, sphygmomanometer and pulse oximeter, with no doctor patient physical contact[88]. In Italy, different articles have highlighted the use of Telemedicine services in the treatment of vulnerable patients such as elderly people, oncological patients and so on [89]

In Nigeria, some progress were made in this COVID-19 pandemic era, For example, in the course of the lockdown introduced by the Federal government and State government of high risk states, Lagos State_one of the COVID-19 high risk states via its Health Management Agency (LASHMA) introduced the "Eko Telemed" which is an initiative to cater for Health issues not related to COVID-19 during the pandemic. Howbeit, as at the time of writing this article, not much is known on how effective the telemedical services have been.

Also, a lot of public health training for health care workers as well as health care promotion particularly on COVID-19 happened via the internet space this period.

When compared to the rest of the developed World, telemedicine is still at infancy as the country's healthcare sector is still in a traditional phase and still grapples with a lot of challenges relating to technological accessibility since a large percentage of the country's population still indwell rural areas[90], with the prevalence of issues relating to internet network connectivity and affordability of smartphones[91], lack of patient's awareness and so on. Unfortunately, the potential application of telemedicine to different sphere of medicine is been elaborately studied but not much has been done to convert theory into practice. Nonetheless, the COVID-19 has exposed the country's elite to the tremendous benefits of TMS and an upward trend is expected.

Conclusion

The COVID-19 pandemic has become a clinical threat to the general population and healthcare workers worldwide, Nigeria inclusive. Although all members of the populace are susceptible to SARS-CoV-2, particular attention and efforts to protect or reduce transmission should be directed at vulnerable groups such as children, health care providers, pregnant women, and the elderly.

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