Wastewater-Based Epidemiology for SARS-CoV-2 in Nigeria:

Prospects, Pursuits and Challenges

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Professor (Environmental and Public Health Microbiology)

Webinar on:

WASTEWATER SURVEILLANCE IN THE MANAGEMENT OF COVID-19: Experiences from Three Countries

August 31, 2021

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Structure of Talk

- **Me**
- **The Disease**
- **SARS-CoV-2 & its variants**
- **WBE frontiers and prospects**
- **Challenges in setting up the system**
- **What WPHRG and others are doing in Nigeria**

Vincent Chigor

❖ Training & Career:

PhD (Fort Hare; 2013), MSc (ABU), BSc (Nigeria)

University of Nigeria: Asst. Lecturer (2006)

Bangor University: Newton Researcher (2015)

Professor (Environmental & Public Health Microbiology)

Leader: Water & Public Health Research Group (WPHRG)

WPHRG
Water & Public Health Research Group

❖ Research Themes/Interests:

1. Aquatic environments and human health:
2. Water, sanitation and hygiene (WASH)
3. Water education, literacy and awareness
4. Water resources management and governance
5. Water, agriculture and food security
6. Water security and climate change
7. Bioactive agents from aquatic ecosystems
8. Bioenergy and biochemicals from wastewater

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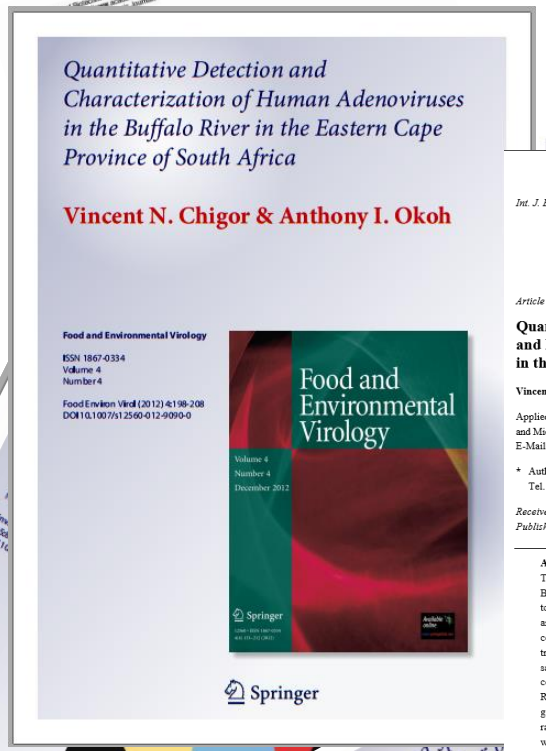
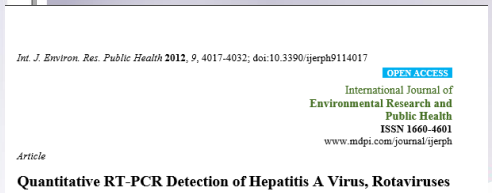
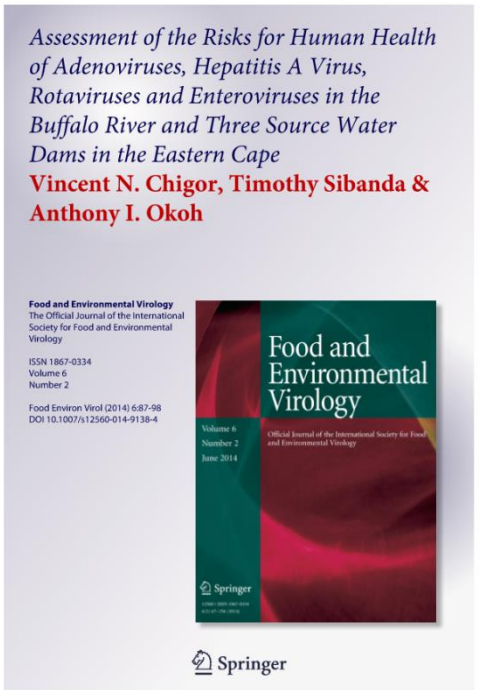
Collaborators/Funders

Publications







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The Disease: COVID 19

COVID-19 CORONAVIRUS PANDEMIC

Last updated: August 30, 2021, 08:54 GMT

Weekly Trends - Graphs - Countries - News

Coronavirus Cases:

217,287,091

view by country

Deaths:

4,516,267

WORLD / COUNTRIES / NIGERIA

Last updated: August 30, 2021, 09:08 GMT

Nigeria 89th

Coronavirus Cases:

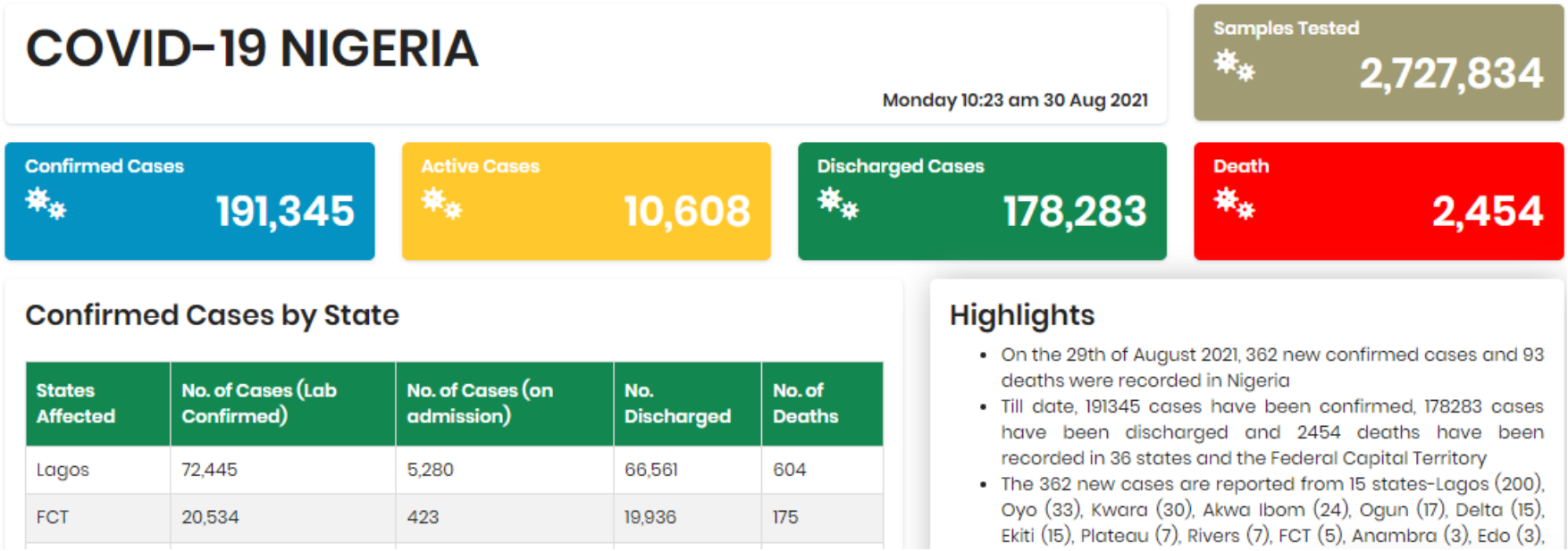
191,345

Deaths:

2,454

https://www.worldometers.info/coronavirus/

The Current Situation in Nigeria



COVID-19 NIGERIA

Monday 10:23 am 30 Aug 2021

Samples Tested	Confirmed Cases	Active Cases	Discharged Cases	Death
2,727,834	191,345	10,608	178,283	2,454

Confirmed Cases by State

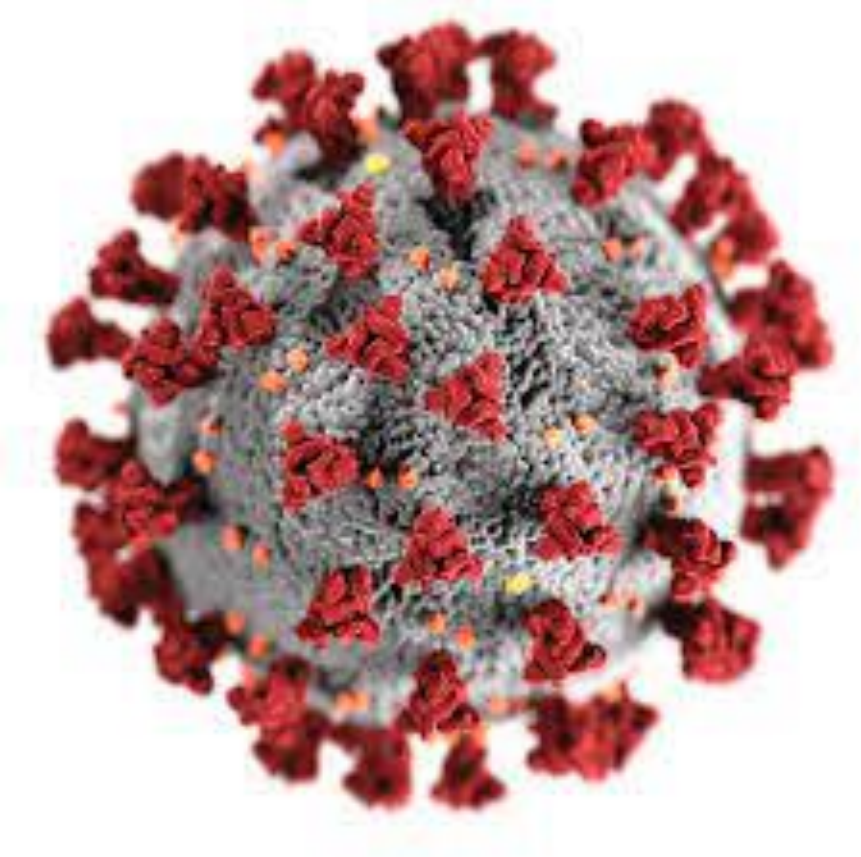
States Affected	No. of Cases (Lab Confirmed)	No. of Cases (on admission)	No. Discharged	No. of Deaths
Lagos	72,445	5,280	66,561	604
FCT	20,534	423	19,936	175

Highlights

- On the 29th of August 2021, 362 new confirmed cases and 93 deaths were recorded in Nigeria
- Till date, 191345 cases have been confirmed, 178283 cases have been discharged and 2454 deaths have been recorded in 36 states and the Federal Capital Territory
- The 362 new cases are reported from 15 states-Lagos (200), Oyo (33), Kwara (30), Akwa Ibom (24), Ogun (17), Delta (15), Ekiti (15), Plateau (7), Rivers (7), FCT (5), Anambra (3), Edo (3),

http://covid19.ncdc.gov.ng/

- Based on the number of confirmed cases, Nigeria is ranked 89th globally. However, only about **1.36%** of the 201 million population tested'



- **The virus: SARS-CoV-2**

  https://www.isglobal.org/en/coronavirus

Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2)

- SARS-CoV-2: The aetiologic agent of COVID 19 (Coronavirus disease 2019)
- Enveloped
- +sense ssRNA
- 30-kb genome
- 120nm in diameter
- Family: *Coronaviridae*

- Mutation results in the emergence of new variants.

  And a SARS-CoV-2 variant of concern is one that has demonstrated:

  - Increase in transmissibility/detrimental change in COVID-19 epidemiology; OR
  - Increase in virulence/change in clinical disease presentation; OR
  - Decrease in effectiveness of public health and social measures or available diagnostics, vaccines, therapeutics

SARS-CoV-2 Variants of Concern

WHO label	Pango lineage	GISAID clade	Nextstrain clade	Additional amino acid changes monitored	Earliest documented samples	Date of designation
Alpha	B.1.1.7	GRY	20I (V1)	+S:484K +S:452R	United Kingdom, Sep-2020	18-Dec-2020
Beta	B.1.351	GH/501Y.V2	20H (V2)	+S:L18F	South Africa, May-2020	18-Dec-2020
Gamma	P.1	GR/501Y.V3	20J (V3)	+S:681H	Brazil, Nov-2020	11-Jan-2021
Delta	B.1.617.2	G/478K.V1	21A	+S:417N	India, Oct-2020	VOI: 4-Apr-2021 VOC: 11-May-2021

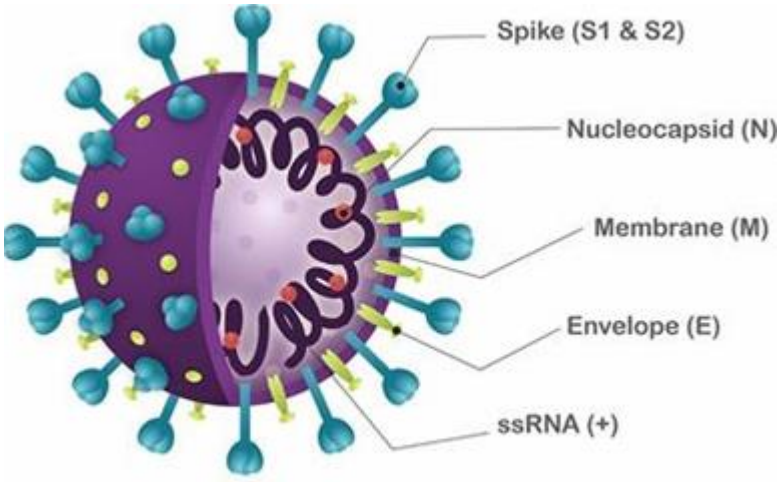
https://www.who.int/en/activities/tracking-SARS-CoV-2-variants/

SARS-CoV-2: Viral Structure

- **SARS-CoV-2 contains**
- **Four structural proteins**

(S, E, M, and N)

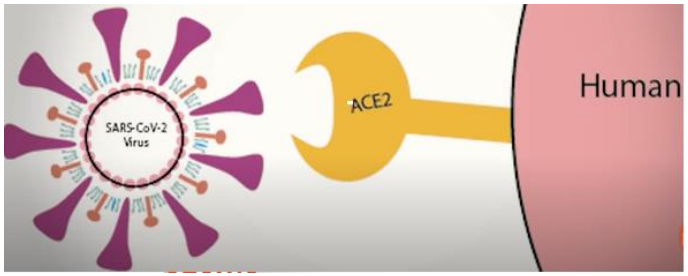
  - **Spike**
  - **Envelope**
  - **Membrane**
  - **Nucleocapsid**



- **Sixteen non-structural proteins** (nsp1−16).
  - Nsp1 mediates RNA processing and replication.
  - Nsp2 modulates the survival signalling pathway of host cell.
  - Nsp3 is believed to separate the translated protein.

SARS-CoV-2: Infection and shedding

- Entry point: Infects via protein, ACE2 receptor
- Angiotensin-converting enzyme 2, or ACE2 “receptor,”
- ACE2 is expressed in the
    - Respiratory tact (RT)
    - Renal system (RS) and
    - Gastrointestinal tract GIT)



- So, SARS-CoV-2 can attach to and infect a wide range of human cells: the cells of our noses, mouth, lungs, and in many other organs.
- https://www.youtube.com/watch?v=GQUCCkHNjN8

- RNA in the sputum or saliva of 85% of those infected
- RNA in the urine of 5% of those infected

- **WBE prospects and frontiers**

Wastewater-Based Epidemiology (WBE)

- Environmental surveillance by testing of wastewater for evidence of pathogens and monitoring disease has been in use in public health,
    - Poliovirus surveillance
    - Antimicrobial resistance (AMR)
    - Step in the One Health framework

- Disease agents are excreted in the urine and faeces of infected individuals, regardless of disease symptom severity (Thompson et al., 2020)

- In the context of the ongoing COVID-19 pandemic, WBE is being used for the detection of SARS-CoV-2 shed into wastewater (WHO, 2020).

- In WBE, the prevalence of SARS-CoV-2 infections in a community could be estimated by enumerating the virus RNA in that community's sewage.

- Changes in SARS-CoV-2 RNA concentrations in wastewater samples collected from wastewater treatment plant influent have been shown to correlate with trends in reported cases.

- Prospects for deploying WBE in COVID 19 management:
    - Early warning of the occurrence of infection in populations
    - Detection of asymptomatic infections within populations
    - Detection of SARS-CoV-2 in locations with limited clinical surveillance
    - Complementing clinical approaches for spatial tracking of COVID-19 cases

- Early detection and warning and the consequent early-stage implementation of intervention approaches will block the critical pathways of exposure and hinder disease spread (O'Brien and Xagoraraki, 2019), and:
    - save human lives
    - minimize social disruptions
    - reduce economic devastations

- **Challenges in setting up the system**

1. The Nigeria Matters:

- **Open defecation:**
  - Currently, Nigeria has the highest number of people practicing open defecation; 14 out of the 774 LGAs in Nigeria are open defecation-free

- **Near absence of municipal wastewater treatment plants**
  - Only about 4 municipal WWTPs; 3 actually in universities

- **Discharging of untreated sewage into natural bodies of water.**

- Poor funding of research and lack of equipment

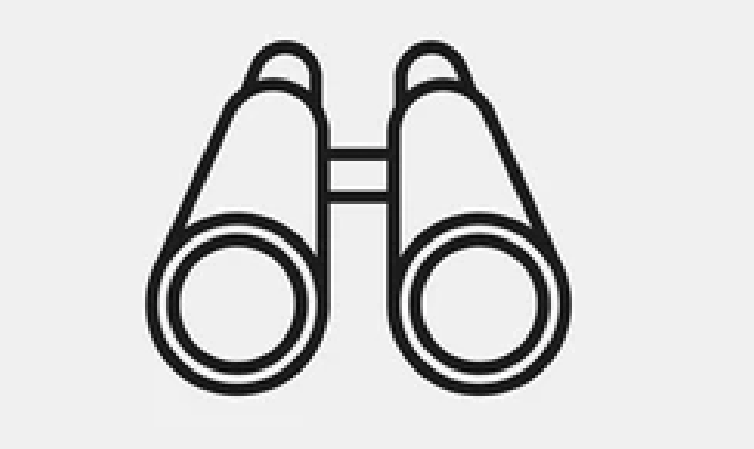
- Lack of institutional support for grant preparation

2. Technical Aspects:

- Reported low prevalence of COVID-19 in Nigerian communities
- Primary concentration: Environmental water samples
- Prolonged and poor sample storage: -20°C / -80°C
- WBE for SARS-CoV-2 surveillance is a rapidly developing.

Dealing with the challenges

- Expanding beyond WWTP samples to surface water samples
- Doing co-surveillance for SARS-CoV-2 and pathogenic viruses
- Collaborative research efforts to maximize contributions: Going beyond the ‘sample collector’ to scientific contributor
- Institutions/universities of South Africa (and the global North) should proactively engage other institutions of sub-Saharan Africa in collaborative research. This needs to be intentional, and the Academy of Science of South Africa (ASSAf) can play a key role



What we are doing in Nigeria

- As the world struggles with the biggest global public health crises in recent times,

- We established a collaborative relationship with Abuja Environmental Protection Board (AEPB) and the WWTP at Wupa, and networked locally and internationally

- We made three grant applications, and one turned out successful
  - UKRI GCRF/Newton Fund Agile Response COVID-19 Grant (EP/V044613/1). Project title: Co-surveillance of Wastewater and Environmental Water Samples for SARS-CoV-2 and Other Pathogenic Viruses in South Africa and Nigeria: Incidence and Risks.

- We recruited a postdoc into this UKRI/GCRF project
  - But for funding/budget issues, not much has happened in the lab
  - A couple of review articles on virology are about to be submitted, and a third one has just been conceived.

- There are two wastewater surveillance sample types:
  - untreated wastewater & primary sludge

- We are collecting **untreated wastewater** and **surface water** samples from the Enugu State and Abuja FCT. We hope to extend to cover Lagos
    - University WWTP, Nsukka
    - Wupa WWTP, Abuja and
    - Rivers/streams/drains

- At Nsukka, there is the prospect of checking the impact of sudden demographic changes associated with vacations/resumptions

- No sample analysis has been done to date
  - What effect would storage have on the results of our SARS-CoV-2 RNA detection?
  - Freezing and thawing, due to unstable electricity will lead to a marked decrease in the copy number of SARS-CoV-2 RNA
  - The comparability of our studies with stored samples with others in this project team will be, without doubt, low

- But we are not giving up:
  - We will contribute to the global effort and WBE-derived data on SARS-CoV-2 and other viruses

  - We will find funding and collaborator; Aquatic Virology will progress in Nigeria

  - The University of Ibadan is partnering with Rice University (US) to design and build an automatic wastewater sampler at UI.

Water, water, everywhere;
Nor any drop to drink!

Samuel T. Coleridge
The Rime of the Ancient Mariner

Water is critical, fit for drinking or wastewater; so, water-focused approaches are key for detecting viral outbreaks early in populations and preventing spread to everywhere.

THANK YOU VRY MUCH!

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