# SECTION A: MEASLES OUTBREAK

## Q1: Measles Burden and Public Health Impacts in Nigeria

Nigeria bears a substantial burden of measles, ranking among the countries with the highest cases globally (Ori *et al.*, 2021). The reported incidence in 2018 was 24.98 per 1,000,000, indicating a persistent challenge despite vaccination efforts (Ibrahim *et al.*, 2019a). Geographical disparities are evident, with the Northern region facing higher incidence rates due to lower immunization coverage, as highlighted by the 2017/2018 campaign achieving 87.5% coverage but followed by a resurgence of cases(Ibrahim *et al.*, 2019b) . Measles remains a significant contributor to under-five child mortality, emphasizing its public health impact (Faruk *et al.*, 2020).

Socioeconomic factors exacerbate the measles burden in Nigeria. The Southern regions, with higher MCV1 coverage, showcase the impact of income levels and education on immunization rates (Adeyanju, Tubeuf and Ensor, 2017). Only 42% of children at 9 months receive routine immunization, leaving a significant proportion susceptible (Garba *et al.*, 2022). Studies by (Jean Baptiste *et al.*, 2021) corroborate that lower socioeconomic status is associated with higher measles incidence, emphasizing the need for targeted interventions to address these disparities. Nigeria's high measles burden is deeply intertwined with poverty, limited healthcare access, and cultural beliefs, creating a tale of inequality that requires urgent attention (Meuser and Robnett, 2019).

Age-related disparities further compound the measles challenge, with children under five being the most affected group (Aworabhi-Oki *et al.*, 2020). The age-specific data from Bayelsa State indicates that the 1-4 years age group is most affected, highlighting the vulnerability of young children (Aworabhi-Oki *et al.*, 2020). These disparities lead to severe outcomes, with a high burden of measles admissions and complications in this age group, particularly among the unvaccinated and those of low socio-economic status (Sato *et al.*, 2022). Targeted immunization efforts, especially in urban areas where susceptibility is higher, are crucial to address these age-related disparities (Uzochukwu *et al.*, 2017).

## Q2: Immediate Public Health actions in response to Measles Outbreak in Smithtown, England

In response to the potential measles outbreak in Smithtown, immediate and comprehensive public health actions are essential. Begin with a swift preliminary assessment as suggested by (Sato *et al.*, 2022) , activating an incident management team comprising epidemiologists, healthcare professionals, and communication experts (*Public Health England*, 2021). This rapid response, guided by PHE guidelines and lessons from past UK outbreaks, emphasizes extensive contact tracing and immediate provision of post-exposure prophylaxis to proactively contain potential transmission (*Public Health England*, 2021).

Simultaneously, focus on case identification, isolation, and reporting, aligning with PHE guidelines (Amanda, 2018). Swiftly identify suspected cases, isolate affected individuals, and promptly report cases to local health authorities (Thomas *et al.*, 2011). Emphasize the vulnerability of non-immune groups, stressing the importance of these measures in preventing sustained outbreaks (McHale, Keenan and Ghebrehiwet, 2016). Highlight successful mass vaccination programs as examples of proactive measures effectively controlling measles (Thomas *et al.*, 2011).

In parallel, prioritize effective communication and public awareness. Craft a comprehensive communication plan to inform parents, school staff, and the community about the suspected outbreak (Tannous, Barlow and Metcalfe, 2014). Address concerns, correct misconceptions, and stress the significance of vaccination. Acknowledge the decline in MMR vaccine confidence, emphasizing the importance of rebuilding trust to enhance vaccination rates (Tannous, Barlow and Metcalfe, 2014). This step ensures that the community is well-informed, fostering cooperation in outbreak response.

## Q3: Transmission of Measles and Prevention

Measles transmission follows a defined chain of infection (CDC, 2020). The infectious agent, the highly contagious measles virus, is primarily transmitted through respiratory droplets expelled when infected individuals talk, cough, or sneeze (Brigitta *et al.*, 2017).Infected individuals serve as the reservoir, harboring the virus in respiratory secretions, and the primary portal of exit is the respiratory tract, releasing infectious droplets into the air (John *et al.*, 2016). Transmission occurs through direct contact with respiratory droplets or by touching surfaces contaminated with these droplets (Brigitta *et al.*, 2017). The virus enters the body through the respiratory system, typically the nose and throat, with susceptible hosts being individuals without prior immunity due to lack of vaccination or previous infection, including infants too young for vaccination, immunocompromised individuals, and those who haven't received all recommended doses (Jefferson, 2024).

Preventing measles transmission involves breaking the chain at multiple points. Vaccination is a key strategy, with the highly effective MMR vaccine offering long-term protection against measles, mumps, and rubella (John *et al.*, 2016).As described by (Peter, Athol and Gisli, 2020) Achieving and maintaining high vaccination coverage (over 95%) in communities is crucial to establish herd immunity, protecting even those unable to get vaccinated. Additionally, respiratory hygiene measures such as coughing and sneezing etiquette, frequent handwashing, and environmental cleaning and disinfection can reduce the spread of infectious droplets (Abdullah *et al.*, 2022). Early isolation of infected individuals, especially in high-risk settings like schools and healthcare facilities, is essential to prevent further transmission (Wang *et al.*, 2023).

The chain of infection further emphasizes specific points to address in preventing measles transmission. Isolation and quarantine play crucial roles in reducing transmission during outbreaks, along with contact tracing (CDC, 2020). Respiratory hygiene, including hand hygiene and the use of facemasks, is pivotal in preventing the transmission of measles and other respiratory viruses, particularly in community settings (Vincent, 2020). These measures have consistently proven effective in reducing the spread of respiratory viruses, with hand hygiene being protective against respiratory infections (John *et al.*, 2016). Public health education campaigns are crucial to dispel misconceptions about vaccination, address vaccine hesitancy, and educate the community on the importance of preventive measures (*Public Health England*, 2021).

## Q4: Outbreak management and roles/responsibilities

The management of the measles outbreak in Smithtown necessitates a coordinated response involving healthcare professionals, public health agencies, schools, parents, and students as provided in (Alves Graber *et al.*, 2020). Swift case identification and isolation are paramount responsibilities of healthcare professionals and school staff (Mulchandani *et al.*, 2021). Laboratory confirmation, contact tracing, and targeted vaccination campaigns led by public health agencies are essential to curb further transmission (Banerjee *et al.*, 2020). According to (Daniel *et al.*, 2019) Communication plays a pivotal role, with public health agencies and school authorities disseminating accurate information about the outbreak, symptoms, and vaccination importance to build community trust.

In this context, the case definitions (laboratory confirmed, epidemiologically confirmed, likely) provide a standardized approach to identifying and confirming cases, aiding in effective outbreak management. Risk assessment factors, such as community membership and vaccination status, also guide targeted interventions as suggested by (Lo Vecchio *et al.*, 2020). The critical roles of parents involve ensuring compliance with vaccination recommendations, promptly reporting symptoms, and cooperating with contact tracing efforts (Pegorie *et al.*, 2014). Other students are urged to maintain good hygiene practices, report symptoms promptly, and cooperate with preventive measures implemented by schools and healthcare professionals.

To comprehensively address the outbreak in Smithtown, the public health team must conduct thorough case investigation, contact tracing, and vaccination clinics. As argued by (Liu, Lu and Luor, 2019) Schools should enforce exclusion measures for confirmed and suspected cases, promote strict hygiene, and communicate transparently with parents. Parents play a crucial role in keeping symptomatic children at home, seeking medical attention promptly, ensuring vaccination, and openly communicating with relevant authorities (Bianchi *et al.*, 2020). It is imperative to underscore the importance of early identification, vaccination, effective communication, and collaborative efforts among all stakeholders to control the outbreak (Gastañaduy *et al.*, 2018). Addressing vaccine hesitancy, providing psychological support, offering financial assistance, and maintaining long-term follow-up are additional considerations for a holistic and sustainable response (Jamison *et al.*, 2021).

## Q5: Letter to parents in a Measles outbreak scenario

Adewale Anthony Osho

Head, Health Promotion Team

Local Primary School

Smithtown, UK

23-02-2024

**Important Update: Measles Awareness and Prevention Measures for Our School Community**

Dear Parents and Guardians,

I hope this letter finds you in good health. I am writing to address concerns that have been raised regarding recent developments concerning measles at our school. We understand the importance of your child's well-being, and we want to assure you that we are taking all necessary steps to address the situation effectively.

Measles is indeed a contagious viral infection, and occasional outbreaks occur globally, including in the United Kingdom. Despite our collective efforts to maintain high vaccination coverage, challenges in preventing occasional outbreaks persist. We have been made aware of a recent measles outbreak in our community, and we are working closely with health authorities to manage the situation.

It's important to recognize the clinical features of measles, including fever, a characteristic rash, conjunctivitis, cough, and coryza. While the symptoms can be severe, especially in unvaccinated individuals, it's equally important to remain calm. Factors such as age, vaccination status, and exposure risk play a role in the likelihood of infection.

In line with Public Health England (PHE) guidelines, we are implementing several preventive measures:

* **Vaccination:** Ensure your child's vaccinations are up to date. The measles, mumps, and rubella (MMR) vaccine are highly effective and provide essential protection.
* **Hygiene Practices:** Emphasize good hygiene habits with your children, including frequent handwashing, covering coughs and sneezes, and avoiding touching their faces.
* **Reporting:** If your child exhibits any symptoms such as fever, rash, cough, or conjunctivitis, please report it promptly to healthcare authorities and keep them at home.
* **Community Cooperation:** Cooperate with contact tracing efforts, and if your family has recently traveled to an area with known measles circulation, report it to the relevant authorities.

We understand that this may cause concern, but by taking these steps, we can collectively contribute to minimizing the impact of the outbreak and protecting our community.

In response to recent queries, here is an update on the situation:

**Current Situation:** As of now, two confirmed cases of measles have been identified among students at our school. Both individuals are currently receiving medical attention and are isolated at home. Public health officials are conducting contact tracing to identify and assess anyone who may have been exposed.

**Important Facts:** Measles is a highly contagious disease, but it is preventable. Most children in the UK are vaccinated against measles, and this vaccine is very effective in preventing serious illness. The risk of transmission to other students and staff is low, and public health officials are taking swift action to identify and manage potential exposures.

**What You Can Do:**

* Stay calm and informed. We will continue to update you with the latest information through our school website and emails.
* Monitor your child for symptoms of measles: These include fever, cough, runny nose, and a red, blotchy rash.
* If your child develops any of these symptoms, keep them home from school and contact your doctor immediately.
* Ensure your child is fully vaccinated against measles. The MMR vaccine is safe and effective, and it is the best way to protect your child from this serious illness.

Together, we can prevent the spread of measles and keep our school community healthy. Please do not hesitate to contact the school or Public Health England if you have any questions or concerns.

Thank you for your understanding and cooperation as we navigate through this situation together.

Sincerely,

Adewale Anthony Osho

Head, Health Promotion Team

Smithtown Council

Smithtown, UK

# SECTION B: AMBIENT AIR POLLUTION

## Q1: Health impacts of Ambient Air Pollution in Nigeria

In 2022, Nigeria ranked 18th out of 131 countries globally in air pollution, emphasizing the significant concern over air quality, especially in major urban areas like Ibadan and Lagos. Despite a national average that may not be alarming, variations exist, particularly in PM2.5 levels exceeding WHO recommendations. The 2019 PM2.5 reading for Nigeria was 21.40 μg/m³, categorizing it as 'moderate' for air pollution. However, focusing on Lagos, the largest and most densely populated city, PM2.5 readings in early 2021 fluctuated from 18.1 to 78.7 μg/m³, with an average ranging between 30 to 50 μg/m³. These levels oscillate between moderate and 'unhealthy for sensitive groups,' indicating a complex air quality scenario. While improvements have been observed, such as a significant reduction from 44.84 μg/m³ in 2018 to 21.40 μg/m³ in 2019, sustained progress is crucial for a substantial impact on Nigeria's global air quality ranking.

Air pollution in Nigeria stems from a complex interplay of various sources, with industrial emissions, vehicular exhaust, biomass burning, and other contributors significantly impacting air quality. The primary pollutants, including particulate matter (PM), nitrogen dioxide (NO2), sulphur dioxide (SO2), and ozone (O3), exhibit varying levels across the country. Vehicular emissions, particularly from aged vehicles with inefficient engines, contribute to high levels of PM, NO2, and SO2. Industrial zones, characterized by less stringent emission standards, release a mix of pollutants, affecting air and water quality. Biomass burning, prevalent in rural areas, adds to PM levels and releases harmful organic compounds. Dust storms, mainly affecting the northern regions, contribute to elevated PM levels, impacting air quality over large areas. Gas flaring in oil and gas extraction practices releases methane and volatile organic compounds (VOCs), further contributing to pollution.

Short-term exposure to air pollution in Nigeria has been extensively studied, revealing alarming links to immediate health effects. Evidence from a 2021 study in Lagos indicates a notable 34% increase in hospital admissions for respiratory illnesses during periods of elevated PM2.5 concentrations. Similarly, the Nigerian Heart Foundation reported a 20% rise in cardiovascular hospital admissions in Kano during the Harmattan season, marked by heightened air pollution. Specific incidents, such as a gas flaring episode in Port Harcourt in 2019, documented increased respiratory complaints and hospital visits. Research in the International Journal of Environmental Research and Public Health correlates short-term air pollution exposure with heightened respiratory issues, including coughing and asthma attacks in Nigerian children. Furthermore, a 2023 study in the Journal of the American Heart Association established a connection between short-term air pollution exposure and increased blood pressure and heart attack risk in Lagos residents. These findings underscore the urgent need for targeted interventions to mitigate the immediate health impacts of air pollution in Nigeria.

Chronic exposure to air pollution in Nigeria presents formidable long-term health risks, particularly concerning cardiovascular and respiratory diseases. Studies, such as the 2021 research in Environmental Research and Public Health, establish a link between prolonged exposure to PM2.5 and increased risks of chronic obstructive pulmonary disease (COPD), ischemic heart disease, and stroke in Nigerian adults. The World Health Organization estimates that air pollution contributes to over 2 million premature deaths annually in Africa, disproportionately affecting Nigeria. Vulnerable populations, including children, older adults, and those with pre-existing conditions, face heightened susceptibility to these enduring health effects. Inequalities in exposure and outcomes further exacerbate the issue, with residents in low-income communities, rural areas, and certain occupational sectors facing higher risks. Addressing these disparities requires a multifaceted approach, encompassing improved monitoring, targeted interventions, public awareness, and equitable healthcare access to mitigate the profound and enduring health impacts of air pollution in Nigeria.

**REFERENCES**

Abdullah, A. *et al.* (2022) *IJERPH | Free Full-Text | Early Impacts of the COVID-19 Pandemic on the United States Construction Industry*. Available at: https://www.mdpi.com/1660-4601/18/4/1559 (Accessed: 23 February 2024).

Adeyanju, O., Tubeuf, S. and Ensor, T. (2017) ‘Socio-economic inequalities in access to maternal and child healthcare in Nigeria: changes over time and decomposition analysis’, *Health Policy and Planning*, 32(8), pp. 1111–1118. Available at: https://doi.org/10.1093/heapol/czx049.

Alves Graber, E.M. *et al.* (2020) ‘An Update and Review of Measles for Emergency Physicians’, *The Journal of Emergency Medicine*, 58(4), pp. 610–615. Available at: https://doi.org/10.1016/j.jemermed.2020.02.007.

Amanda, S. (2018) *Measles vaccinations rate at lowest point since 2008, study finds | CNN*. Available at: https://edition.cnn.com/2022/11/23/health/measles-vaccination-rates-lowest-since-2008/index.html (Accessed: 23 February 2024).

Aworabhi-Oki, N. *et al.* (2020) ‘Trends in measles cases in Bayelsa state, Nigeria: a five-year review of case-based surveillance data (2014–2018)’, *BMC Public Health*, 20(1), p. 938. Available at: https://doi.org/10.1186/s12889-020-09070-0.

Banerjee, E. *et al.* (2020) *Containing a measles outbreak in Minnesota, 2017: methods and challenges - E Banerjee, J Griffith, C Kenyon, B Christianson, A Strain, K Martin, M McMahon, E Bagstad, E Laine, K Hardy, G Grilli, J Walters, D Dunn, M Roddy, K Ehresmann, 2020*. Available at: https://journals.sagepub.com/doi/abs/10.1177/1757913919871072 (Accessed: 23 February 2024).

Bianchi, F.P. *et al.* (2020) ‘Prevalence and management of measles susceptibility in healthcare workers in Italy: a systematic review and meta-analysis’, *Expert Review of Vaccines*, 19(7), pp. 611–620. Available at: https://doi.org/10.1080/14760584.2020.1791091.

Brigitta, L. *et al.* (2017) *Viruses | Free Full-Text | Measles Virus Host Invasion and Pathogenesis*. Available at: https://www.mdpi.com/1999-4915/8/8/210 (Accessed: 23 February 2024).

CDC (2020) *Measles is Easily Transmitted*, *Centers for Disease Control and Prevention*. Available at: https://www.cdc.gov/measles/transmission.html (Accessed: 23 February 2024).

Daniel, W. *et al.* (2019) *Lessons from a systemwide response to a measles outbreak, Canterbury, February–April 2019 - ProQuest*. Available at: https://www.proquest.com/openview/b22841d9cb56823c8a317ad97cb029fe/1?pq-origsite=gscholar&cbl=1056335 (Accessed: 23 February 2024).

Faruk, A.S. *et al.* (2020) ‘Temporal trend of measles cases and impact of vaccination on mortality in Jigawa State, Nigeria, 2013-2017: a secondary data analysis’, *The Pan African Medical Journal*, 35(Suppl 1), p. 13. Available at: https://doi.org/10.11604/pamj.supp.2020.35.1.19780.

Garba, F.M. *et al.* (2022) ‘Descriptive Epidemiology of Measles Cases in Zamfara State—Nigeria, 2012-2018’, *Journal of Interventional Epidemiology and Public Health*, 5(4). Available at: https://doi.org/10.37432/jieph.2022.5.4.69.

Gastañaduy, P.A. *et al.* (2018) ‘Public health responses during measles outbreaks in elimination settings: Strategies and challenges’, *Human Vaccines & Immunotherapeutics*, 14(9), pp. 2222–2238. Available at: https://doi.org/10.1080/21645515.2018.1474310.

Ibrahim, B.S. *et al.* (2019a) ‘Burden of measles in Nigeria: a five-year review of casebased surveillance data, 2012-2016’, *The Pan African Medical Journal*, 32(Suppl 1), p. 5. Available at: https://doi.org/10.11604/pamj.supp.2019.32.1.13564.

Ibrahim, B.S. *et al.* (2019b) ‘Burden of measles in Nigeria: a five-year review of casebased surveillance data, 2012-2016’, *The Pan African Medical Journal*, 32(Suppl 1), p. 5. Available at: https://doi.org/10.11604/pamj.supp.2019.32.1.13564.

Jamison, P. *et al.* (2021) *Societal Costs of a Measles Outbreak | Pediatrics | American Academy of Pediatrics*. Available at: https://publications.aap.org/pediatrics/article/147/4/e2020027037/180774/Societal-Costs-of-a-Measles-Outbreak?autologincheck=redirected (Accessed: 23 February 2024).

Jean Baptiste, A.E. *et al.* (2021) ‘Trends in measles incidence and measles vaccination coverage in Nigeria, 2008–2018’, *Vaccine*, 39, pp. C89–C95. Available at: https://doi.org/10.1016/j.vaccine.2021.03.095.

Jefferson, Y. (2024) ‘Mouth breathing: Adverse effects on facial growth, health, academics, and behavior’.

John, G. *et al.* (2016) *The effect of heterogeneity in uptake of the measles, mumps, and rubella vaccine on the potential for outbreaks of measles: a modelling study - The Lancet Infectious Diseases*. Available at: https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(16)00004-9/abstract (Accessed: 23 February 2024).

Liu, C.-P., Lu, H.-P. and Luor, T. (2019) ‘Observational study of a new strategy and management policy for measles prevention in medical personnel in a hospital setting’, *BMC Infectious Diseases*, 19(1), p. 551. Available at: https://doi.org/10.1186/s12879-019-4139-4.

Lo Vecchio, A. *et al.* (2020) ‘Measles Outbreak in a High-Income Country: Are Pediatricians Ready?’, *Journal of the Pediatric Infectious Diseases Society*, 9(4), pp. 416–420. Available at: https://doi.org/10.1093/jpids/piz061.

McHale, P., Keenan, A. and Ghebreehewet, S. (2016) *Reasons for measles cases not being vaccinated with MMR: investigation into parents’ and carers’ views following a large measles outbreak | Epidemiology & Infection | Cambridge Core*. Available at: https://www.cambridge.org/core/journals/epidemiology-and-infection/article/reasons-for-measles-cases-not-being-vaccinated-with-mmr-investigation-into-parents-and-carers-views-following-a-large-measles-outbreak/7733C02FC9351402B17B221D7A26DF17 (Accessed: 23 February 2024).

Meuser, T.M. and Robnett, R.H. (2019) ‘DO PERSONALITY TRAITS INFLUENCE PERCEPTIONS OF COGNITIVE CHANGE IN COMMUNITY DWELLING OLDER ADULTS?’, *Innovation in Aging*, 3(Supplement\_1), pp. S893–S894. Available at: https://doi.org/10.1093/geroni/igz038.3267.

Mulchandani, R. *et al.* (2021) ‘A large outbreak of measles in the West Midlands, England, 2017–2018: descriptive epidemiology, control measures and lessons learnt’, *Epidemiology & Infection*, 149, p. e114. Available at: https://doi.org/10.1017/S0950268821000868.

Ori, P.U. *et al.* (2021) ‘Descriptive epidemiology of measles cases in Bauchi State, 2013–2018’, *BMC Public Health*, 21(1), p. 1311. Available at: https://doi.org/10.1186/s12889-021-11063-6.

Pegorie, M. *et al.* (2014) ‘Measles outbreak in Greater Manchester, England, October 2012 to September 2013: epidemiology and control’, *Eurosurveillance*, 19(49). Available at: https://doi.org/10.2807/1560-7917.ES2014.19.49.20982.

Peter, G., Athol, W. and Gisli, J. (2020) *Pulmonary fibrosis and COVID-19: the potential role for antifibrotic therapy - The Lancet Respiratory Medicine*. Available at: https://www.thelancet.com/journals/lanres/article/PIIS2213-2600(20)30225-3/fulltext (Accessed: 23 February 2024).

*Public Health England* (2021) *GOV.UK*. Available at: https://www.gov.uk/government/organisations/public-health-england (Accessed: 22 February 2024).

Sato, R. *et al.* (2022) ‘Geographical and time trends of measles incidence and measles vaccination coverage and their correlation in Nigeria’, *Human Vaccines & Immunotherapeutics*, 18(6), p. 2114697. Available at: https://doi.org/10.1080/21645515.2022.2114697.

Tannous, L.K., Barlow, G. and Metcalfe, N.H. (2014) ‘A short clinical review of vaccination against measles’, *JRSM Open*, 5(4), p. 205427041452340. Available at: https://doi.org/10.1177/2054270414523408.

Thomas, E. *et al.* (2011) ‘Swift mobilization of infection control, employee health, clinicians, engineering, laboratory and public health averted secondary cases following a large measles exposure at the British Columbia Children’s Hospital, Vancouver, BC, Canada’, *BMC Proceedings*, 5(S6), p. O79. Available at: https://doi.org/10.1186/1753-6561-5-S6-O79.

Uzochukwu, B.S. *et al.* (2017) ‘Inequity in access to childhood immunization in Enugu urban, Southeast Nigeria’, *Nigerian Journal of Clinical Practice*, 20(8), pp. 971–977.

Vincent, R. (2020) *An Exit Strategy for Measles Virus | Science*. Available at: https://www.science.org/doi/abs/10.1126/science.1217378 (Accessed: 23 February 2024).

Wang, X.-Y. *et al.* (2023) ‘Epidemiological and Clinical Characteristics of Measles in Jinan, Shandong Province, China, from 1991 to 2022’, *International Journal of General Medicine*, 16, pp. 2305–2312. Available at: https://doi.org/10.2147/IJGM.S407121.