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# Transforming Primary Healthcare in Nigeria: Enhancing Universal Health Coverage through Strong and Sustainable Primary Healthcare Laboratories

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## Abstract

**Rationale:** Universal health coverage hinges on the strength and resilience of primary healthcare systems, acting as the foundational access point for healthcare seekers at the grassroots level. Central to this infrastructure are medical laboratory services, pivotal in accurate diagnosis, timely treatment, and patient health monitoring. However, in the context of Nigeria's primary healthcare transformation agenda, there exist critical gaps in optimizing primary healthcare (PHC) laboratories. This paper delves into the role of PHC laboratories within the health services continuum, identifies key shortcomings, and proposes solutions to bridge these gaps.

**Objective:** This paper aims to elucidate the indispensable role of medical laboratory services within primary care settings, particularly in Nigeria's healthcare landscape. It seeks to analyze the current status of PHC laboratories, pinpoint areas for improvement, and offer actionable recommendations for enhancing their efficacy.

**Method:** The study employs a comprehensive literature review coupled with qualitative analysis to examine the significance of PHC laboratories in primary healthcare delivery. It scrutinizes existing literature, policy documents, and empirical studies to identify challenges and potential solutions in optimizing PHC laboratory services.

**Results:** The analysis underscores the vital contribution of PHC laboratories in facilitating early diagnosis, effective disease management, and preventive healthcare measures. It highlights systemic deficiencies in Nigeria's primary healthcare system, particularly the neglect and underutilization of PHC laboratories, hindering the realization of universal health coverage.

**Conclusions:** PHC laboratories are integral to the provision of quality primary healthcare services, yet they are often overlooked in policy frameworks and resource allocation. Addressing this oversight is paramount to enhancing the effectiveness and accessibility of healthcare services, thereby advancing the goal of universal health coverage.

**Recommendations:** To address the shortcomings identified, it is imperative to prioritize PHC laboratories within the Nigeria Primary Healthcare transformation agenda. This entails the recruitment of skilled laboratorians, strategic mapping, and equipping of PHC facilities, in alignment with the Basic Healthcare Provision Fund (BHCPF). Moreover, there is a need for sustained financial provisions and policy support to ensure the inclusion and functionality of PHC laboratories nationwide.

**Significance Statement**: This study underscores the critical role of PHC laboratories in primary healthcare delivery, particularly in the context of Nigeria. By highlighting key challenges and proposing actionable recommendations, it aims to inform policymakers, healthcare practitioners, and stakeholders about the imperative of optimizing PHC laboratory services for the realization of universal health coverage.

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## 1. Introduction

Universal health coverage embodies the noble aspiration to ensure that every individual, irrespective of their socio-economic standing, can avail themselves of high-quality healthcare services without enduring financial hardship. It stands as a cornerstone in the edifice of a just and sustainable healthcare system, fostering equitable access to health and well-being for all members of society (Aigiremolen *et al.,* 2014; Behera *et al.,* 2022; Moreen *et al.,* 2023). This paradigm, also referred to as universal healthcare or social health protection, has been embraced by nations across the globe, each charting its unique course towards implementation. It is imperative to recognize that the journey towards universal health coverage is multifaceted, with initiation varying across nations in terms of timelines and methodologies. A robust and adaptable primary healthcare infrastructure emerges as the linchpin in this endeavor, serving as the primary point of entry into the healthcare system for individuals at the grassroots level. Within this framework, fundamental services such as immunization, management of minor ailments, disease prevention, health education, and malaria treatment constitute the foundational pillars of care (Osaro and Charles, 2010; Raimi *et al.,* 2019a). Thus, the quest for Accelerating Universal Healthcare Coverage (UHC) finds resonance in the discourse surrounding the fortification of primary healthcare laboratories and the comprehensive examination of the National Primary Healthcare Development Agency (NPHCDA) Transformation Agenda. These themes took center stage during the National Scientific Conference and Annual General Meeting of the Association of Medical Laboratory Scientists of Nigeria (AMLSN) in November 2023. This gathering convened a diverse array of national and international luminaries from the scientific community, alongside representatives from various echelons of the Nigerian government, including the Executive and the National Assembly. The deliberations during this event comprehensively scrutinized the intricacies of these topics, recognizing them as pivotal in the realization of universal health coverage. While, the National Primary Healthcare Development Agency (NPHCDA) stands as a pivotal arm of Nigeria's Federal Ministry of Health, entrusted with the mission of bolstering the national health policy by spearheading the advancement of primary healthcare services. Delving into the intricacies of “what is” and “why” Universal Health Coverage (UHC), the agency's role and mandate were meticulously elucidated. Universal health coverage, a beacon of equitable healthcare access, was delineated as the overarching objective aimed at ensuring that every individual, irrespective of their socio-economic standing, can avail themselves of high-quality healthcare services without encountering financial barriers. In the pursuit of a comprehensive understanding of UHC, a comparative analysis was undertaken, scrutinizing the performance and status of other nations, particularly within the African continent (Osaro and Charles, 2010; 2011). Through this examination, gaps in healthcare provision were identified, shedding light on areas ripe for improvement and innovation. Moreover, the evolution and significant milestones of primary healthcare were subjected to critical appraisal, recognizing its foundational role in laying the groundwork for universal health coverage. By delving into the nuanced facets of UHC and primary healthcare, the discourse illuminated pathways towards enhancing healthcare accessibility, quality, and equity, thereby fortifying the overarching goal of fostering health and well-being for all members of society.

## 2. Materials and Method

This work used a variety of appropriate keywords (e.g., Transforming + Primary Health Care + Laboratories; Public Health + Universal Health Coverage; Laboratory Medicines + Global Health Initiatives) to synthesize relevant material about the topic. Using scholarly search engines such as EBSCO Discovery Service (EDS), Google Scholar, Google Books, Microsoft Academic, Pubmed, Proquest Dissertations & Theses, CINHAL EBSCO Host, Web of Knowledge, Mendeley, SSRN, ResearchGate, Worldwide Science, as well as individual blogs, online newspapers, and internet reports, the search process involved sifting through pertinent peer-reviewed journals and books. A methodical approach to content analysis was used to examine the text's content, with a particular emphasis on the reader's subjective interpretation of the data. This approach sought to identify and track emerging trends in laboratory medicine. Discourse analysis has also been used to study text linguistics, which includes tone, phonology, syntax, style, and organization, particularly in scholarly research publications. Through text deconstruction, implicit or hidden content in academic research papers was revealed through critical thinking and reasoning, making it easier to extract trustworthy data that was in line with the goals of the study.

## 3. History of Primary Healthcare in Nigeria: Towards Universal Health Coverage

In the annals of global health history, the seminal year of 1978 marked a watershed moment with the convening of the International Conference on Primary Health Care in Alma Ata, Kazakhstan. Facilitated under the auspices of the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), this landmark gathering drew the participation of 134 nations alongside numerous international agencies, heralding a new era in healthcare advocacy and policy. From this historic assembly emerged the Alma Ata Declaration, a visionary document that delineated the essence of Primary Health Care (PHC) with unparalleled clarity and conviction. PHC was not merely articulated as a theoretical concept but rather as a tangible framework embodying essential healthcare provision grounded in practicality, scientific rigor, and social acceptance. The declaration enshrined the principle of universality, asserting that such healthcare must be made accessible to every individual and family within the community, fostering their active participation and empowerment (Van weel and Kidd, 2018).

Central to the ethos of the Alma Ata Declaration was the principle of affordability, emphasizing that healthcare interventions should be within reach of both the community and the nation, aligning with their respective capacities for sustainable maintenance. This commitment to affordability resonated deeply with the spirit of self-reliance and self-determination, acknowledging the intrinsic link between health and socio-economic development. The Alma Ata Declaration, through its articulation of PHC principles, served as a guiding beacon for nations embarking on the journey towards comprehensive healthcare reform. Its enduring legacy continues to inspire advocacy efforts and policy frameworks aimed at advancing the cause of health equity, community participation, and sustainable development worldwide (Declaration of Alma-Ata, 1978).

Rooted in the foundational principles of the Alma Ata Declaration, which positioned primary healthcare as the cornerstone of healthcare systems, the quest for universal health coverage (UHC) finds resonance in Nigeria's proactive measures towards healthcare reform. Enshrined within the declaration is the vision of primary healthcare as the initial point of contact for individuals, families, and communities with the national health system, emphasizing proximity and accessibility

to healthcare services tailored to local needs. In a significant demonstration of commitment to UHC objectives, the Nigerian Government took decisive action in 1992 by establishing the National Primary Health Care Agency (NPHCDA) through Decree 2, under the stewardship of Prof. Ransome Kuti as the Honorable Minister of Health (NPHCDA, 2007-2012). This landmark initiative underscored the recognition that UHC serves as the overarching goal of any nation's healthcare system, with primary healthcare serving as the conduit for delivering essential care to all segments of society. The establishment of the NPHCDA marked a bold and transformative stride for Nigeria, signaling a dedicated effort to comprehensively organize and manage primary healthcare programming in alignment with the ethos of “Health for All.” through this strategic intervention, Nigeria positioned itself at the vanguard of healthcare reform, setting a precedent for prioritizing equitable access to healthcare services and fostering the health and well-being of its populace. In essence, the creation of the NPHCDA represented not only a bureaucratic maneuver but a visionary commitment to realizing the fundamental human right to health for every Nigerian citizen. It epitomized the nation's collective resolve to transcend barriers, empower communities, and forge a path towards a future where health equity and universal access to quality care are no longer aspirations but lived realities.

At its core, primary healthcare embodies a noble endeavor to extend comprehensive care to every stratum of society, transcending barriers of age, gender, socio-economic standing, and other demographic delineations (Van weel and Kidd, 2018; Nwokoro *et al.,* 2022). Rooted in the principles of accessibility, availability, and cost-effectiveness, primary healthcare aspires to be a beacon of inclusivity, ensuring that essential health services are within reach of all individuals, regardless of their circumstances. Guided by the benchmarks set forth by the World Health Organization (WHO), primary healthcare endeavors to encompass a significant portion of the population, with WHO recommending coverage of at least 80% of a country's populace. This ambitious target reflects a commitment to ensuring that the vast majority of individuals have unfettered access to vital healthcare services, thereby fortifying the foundation of public health (Adias *et al.,* 2012; Uko *et al.,* 2013; Ajugwo *et al.,* 2014). Nevertheless, it is imperative to recognize the nuances inherent in healthcare policies and coverage mechanisms, which may vary markedly across nations. While some countries may strive to attain a broad reach, extending primary healthcare services to a substantial proportion of their population, others may adopt differing strategies based on contextual factors and resource availability. Thus, the pursuit of universal healthcare access unfolds as a dynamic and multifaceted endeavor, shaped by diverse national priorities and healthcare landscapes. In navigating this intricate terrain, it becomes evident that the essence of primary healthcare lies not merely in numerical targets but in the profound impact it wields in enhancing health outcomes, fostering community well-being, and championing health equity. By embracing a holistic approach to healthcare delivery, grounded in the principles of equity and inclusivity, primary healthcare emerges as a potent force in the pursuit of a healthier, more resilient global populace.

## 4. Primary Healthcare in Nigeria: Operationalizing the Minimum Healthcare Package

As the curtains drew on the 20$^{th}$ century, a pivotal era unfolded in the realm of global health, characterized by a concerted drive towards achieving the ambitious goals of universal health coverage (UHC). Against this backdrop, regional health forums emerged as crucibles of innovation and action, galvanizing efforts to address the pressing healthcare disparities

within their respective spheres of influence. In a momentous gathering convened in Yaoundé, Cameroon, from the 5th to the 9th of February, 1994, member countries of the African Region of the World Health Organization (WHO) convened to deliberate on strategies for accelerating progress towards the noble ideal of Health For All (HFA) through the prism of primary healthcare (PHC). Recognizing the pervasive gaps entrenched within the health systems of Low and Middle Income Countries (LMICs), the imperative of implementing a Minimum District Health For All Package (MDHFA) gained traction among the delegates (NPHCDA, 2007-2012). At the heart of this visionary initiative lay the recognition that the realization of the Health For All aspiration hinges upon the deployment of a comprehensive healthcare package tailored to the specific needs and contexts of district level communities. Endorsing the concept of a minimum healthcare package, the forum envisaged its implementation at the grassroots level within Local Government Areas (LGAs) as a catalyst for advancing the overarching goal of health equity and access. This landmark endorsement epitomized a paradigm shift in health policy discourse, elevating the centrality of primary healthcare in the quest for universal health coverage and health equity. By embracing the principles of inclusivity, accessibility, and context sensitivity, the MDHFA initiative charted a course towards a future where every individual, irrespective of their circumstances, can realize their fundamental right to health and well-being.

In August of 1994, Nigeria embarked on a pivotal endeavor in the realm of healthcare reform by conceptualizing and developing a Minimum District Health For All (MDHFA) package, comprising thirteen (13) vital components. This comprehensive framework was crafted with the aim of guiding healthcare provision and delivery from 1995 to 2000, signifying a concerted effort to bolster primary healthcare infrastructure and services across the nation. However, recognizing the imperative of continuous adaptation and refinement in the face of evolving healthcare landscapes, the Nigerian Government embarked on a journey of introspection and reform in 2001. In a strategic move to enhance the efficacy and granularity of healthcare delivery, the MDHFA package underwent a transformative metamorphosis, culminating in a change in nomenclature to the Ward Minimum Health Care Package (WMHCP). This paradigm shift repositioned the ward as the focal unit for primary healthcare implementation, aligning with the principles of decentralization and community-based care.

Furthermore, the journey towards operationalizing the minimum healthcare package witnessed significant milestones in 2007, as the Nigerian Government, in collaboration with the National Primary Health Care Development Agency (NPHCDA) and with the invaluable support of the World Health Organization (WHO), endorsed the WMHCP for nationwide implementation. This watershed moment underscored a renewed commitment to advancing the principles of equity, accessibility, and quality in healthcare delivery, laying the groundwork for transformative change in Nigeria's healthcare landscape. The collaborative efforts between governmental agencies and international partners during the period from 2005 to 2007, marked by a series of consultative meetings and deliberations, bore fruit in the form of a robust and actionable WMHCP tailored to the needs and realities of Nigeria. This strategic blueprint, spanning the plan period from 2007 to 2012, heralded a new dawn in primary healthcare provision, poised to catalyze improvements in health outcomes and well-being for all Nigerians. In essence, the evolution of Nigeria's healthcare policies and packages reflects a dynamic and iterative process, characterized by adaptability, innovation, and a steadfast commitment to the overarching goal of health for all. Through these concerted efforts, Nigeria charts a course towards a future where equitable access to

quality healthcare services is not merely an aspiration but a tangible reality for every citizen.

## 5. Primary Healthcare Laboratories in Nigeria: Fulfilling the Minimum Healthcare Package

Embedded within the fabric of Nigeria's Minimum Health Care Package lies a pivotal recognition of the indispensable role played by Laboratory Technicians in the effective operation of primary healthcare centers. Within the framework of the Ward Minimum Healthcare Package, stringent provisions are made to ensure the inclusion of basic laboratory infrastructure and equipment in all ward health centers. This strategic allocation encompasses essential tools for disease identification, including microscopes, slides and slide covers, stains, swabs, sterile sputum receptacles, and disposable gloves. Of paramount importance is the prioritization of laboratory reagents among the crucial medical and health supplies to be meticulously managed. This strategic emphasis underscores the pivotal role of medical laboratory services in the healthcare continuum, serving as the linchpin for accurate diagnosis and informed clinical decision-making.

Drawing from a wealth of scholarly research and empirical evidence, including studies by Raimi and colleagues (Raimi and Raimi, 2020; Raimi *et al.,* 2020; Raimi *et al.,* 2021a, b), as well as insights from Opeyemi *et al.* (2024), it becomes evident that medical laboratory services occupy a central position in the healthcare ecosystem. These services are entrusted with the task of meticulously selecting the most efficacious, least invasive, and cost-effective methodologies to deliver timely and accurate test results, thereby underpinning the foundation of clinical care. By integrating Laboratory Technicians and essential laboratory infrastructure within the fabric of primary healthcare centers, Nigeria's healthcare system stands poised to enhance diagnostic capabilities, improve patient outcomes, and bolster overall healthcare delivery. This strategic alignment underscores a commitment to excellence in healthcare provision, ensuring that every individual, irrespective of their circumstances, has access to the highest standards of diagnostic and clinical care.

At the core of any robust primary healthcare system lies the indispensable presence of quality and resilient healthcare laboratories. These facilities stand as the linchpins in the diagnostic, monitoring, and treatment processes for a myriad of diseases. Through their meticulous analysis and interpretation of laboratory tests, they furnish healthcare providers with accurate and timely data crucial for informed decision-making in patient care. In the pursuit of accelerating universal health coverage (UHC), it is imperative to accord primacy to the strengthening and fortification of primary healthcare laboratories. Often positioned as the missing link in the transformation agenda of primary healthcare (PHC), these laboratories assume a pivotal role in bridging gaps and bolstering the efficacy of healthcare delivery systems. By enhancing the quality and resilience of these vital facilities, significant strides can be made in advancing healthcare delivery and improving patient outcomes across diverse populations (Erhabor *et al.,* 2007; Gift and Obindah, 2020). Thus, a concerted examination of primary healthcare laboratories and the formulation of targeted strategies to prioritize their development emerge as imperatives in the quest for comprehensive health coverage. Through strategic investments in infrastructure, technology, and human capital, coupled with robust quality assurance mechanisms, primary healthcare laboratories can emerge as beacons of excellence, ensuring equitable access to high-quality diagnostic services and catalyzing improvements in population health outcomes. In essence, the elevation of primary healthcare laboratories to the forefront of healthcare agendas represents a pivotal step towards realizing the overarching goal of health for all. By

recognizing their indispensable role and investing in their enhancement, nations can lay the groundwork for a more resilient, responsive, and equitable healthcare ecosystem, thereby advancing the collective aspiration of universal health coverage.

Laboratory support stands as an indispensable pillar in the realm of disease surveillance and control programs, serving as a linchpin in both pre-outbreak and outbreak scenarios. Prior to the emergence of an outbreak, the robust infrastructure of laboratory-supported surveillance facilitates the early detection of cases, enabling swift intervention and containment measures. Amidst an ongoing outbreak, laboratories play a pivotal role in confirming cases, elucidating changes in etiological agents, and informing critical decisions regarding interventions and resource allocation (Osaro and Charles, 2012). By providing timely and accurate diagnostic capabilities, laboratories empower healthcare authorities to adopt proactive and targeted approaches to disease management, thereby optimizing the effectiveness of interventions and resource utilization. This strategic utilization of laboratory services not only enhances the efficiency of case management but also renders the Minimum Ward Healthcare package both practicable and realistic. In essence, laboratories serve as the cornerstone of effective disease management strategies, offering invaluable support across the entire spectrum of surveillance, outbreak response, and case management. Through their meticulous analysis and interpretation of diagnostic data, laboratories enable healthcare systems to navigate the complexities of disease control with precision and efficacy, ultimately safeguarding the health and well-being of communities. Provided below are some key points regarding the importance of these services:

1. **Diagnosis and Treatment:** Medical laboratory services play a crucial role in diagnosing a wide range of diseases and conditions by conducting comprehensive tests on samples such as blood, urine, and other bodily fluids. These tests provide invaluable information to healthcare professionals, enabling them to accurately identify the presence of pathogens, abnormalities in organ function, and imbalances in essential biomarkers. By analyzing these results, clinicians can make informed decisions regarding the most appropriate treatment strategies for their patients. Whether it's detecting infectious diseases, assessing organ function, or monitoring the progression of chronic conditions, medical laboratory services are essential for delivering precise and personalized care to patients.
2. **Disease Monitoring:** Regular monitoring of patients' health status through laboratory tests is essential for effectively managing various medical conditions. By tracking key biomarkers and indicators over time, medical professionals can assess the effectiveness of treatment interventions, identify any emerging health concerns, and make timely adjustments to patient care plans. For individuals with chronic diseases such as diabetes, hypertension, or cancer, ongoing laboratory monitoring helps in evaluating disease progression, detecting complications early, and optimizing treatment regimens to achieve better health outcomes. Additionally, in the context of infectious diseases or outbreaks, laboratory-based surveillance systems enable healthcare authorities to monitor disease trends, identify potential outbreaks, and implement targeted intervention measures to prevent further spread within communities. Overall, disease monitoring through medical laboratory services is integral to promoting early detection, proactive management, and improved overall health and well-being for patients.
3. **Preventive Healthcare:** In the realm of preventive medicine, medical laboratory services serve as a cornerstone for early detection and intervention. Through a variety of screening tests, including assessments for cholesterol levels,

blood sugar levels, and cancer markers, healthcare providers can identify potential risk factors before they manifest into full-blown diseases. By catching these warning signs early on, patients can be empowered to make informed decisions about their health and lifestyle choices, while healthcare professionals can devise personalized preventive strategies. Whether it's through dietary modifications, exercise regimens, or targeted medical interventions, the insights gleaned from laboratory tests enable proactive measures aimed at reducing the likelihood of disease development and promoting long-term wellness.

4. **Proactive Management:** For individuals living with chronic diseases such as diabetes, hypertension, and kidney disorders, proactive management is essential for maintaining health and minimizing complications. Medical laboratory services play a pivotal role in this regard by facilitating regular monitoring of key blood parameters and biomarkers associated with these conditions (Charles *et al.,* 2006; Erhabor and Adias, 2011; Jeremiah *et al.,* 2011; Adias *et al.,* 2012; Erhabor *et al.,* 2013). Through routine testing, healthcare providers can closely track disease progression, assess treatment efficacy, and identify any emerging complications or deviations from therapeutic goals. Armed with this vital information, patients and their healthcare teams can collaboratively adjust treatment plans, optimize medication regimens, and implement lifestyle modifications to better manage the disease and enhance overall quality of life. Additionally, proactive management supported by laboratory services may involve patient education, self-monitoring strategies, and coordinated care efforts aimed at empowering individuals to take an active role in managing their health and well-being on a day-to-day basis (Osaro and Charles, 2012). By adopting a proactive approach centered on regular monitoring and timely interventions, individuals with chronic diseases can better control their conditions, reduce the risk of complications, and lead healthier, more fulfilling lives.
5. **Infectious Disease Control:** Laboratory services play a pivotal role in both the diagnosis and management of infectious diseases, encompassing a wide spectrum of communicable illnesses such as HIV/AIDS (Erhabor *et al.,* 2010; Raimi and Ochayi, 2017), tuberculosis, and malaria (Erhabor *et al.,* 2010; Jeremiah *et al.,* 2012). The precision and promptness of diagnostic procedures are instrumental in curbing the spread of these diseases by facilitating early identification of cases, thus enabling swift intervention measures to prevent further transmission within communities. Furthermore, accurate diagnosis not only aids in containing outbreaks but also guides healthcare professionals in implementing targeted treatment regimens tailored to the specific pathogen involved (Ukwandu *et al.,* 2001). Through their indispensable contributions, laboratory services serve as a cornerstone in the comprehensive strategy for infectious disease control, safeguarding public health and mitigating the impact of these formidable health threats.

Basic laboratory tests that can be carried out at Primary Healthcare Laboratories include:

i. **Complete Blood Count (CBC):** This fundamental laboratory test provides a comprehensive assessment of various components within the bloodstream, offering valuable insights into the overall health and functioning of the body. By analyzing parameters such as red blood cell count, white blood cell count, hemoglobin levels, and platelet count, healthcare professionals gain crucial information about the body's oxygen-carrying capacity, immune response, and blood clotting ability (Abdulraaman *et al.,* 2013). A CBC is instrumental in diagnosing a wide range of conditions, including anemia, infections, inflammation, and blood disorders, guiding clinicians in formulating accurate diagnoses and developing tailored treatment plans to address underlying health concerns effectively (Adias *et al.,* 2006; Erhabor

and Adias, 2011; Jeremiah *et al.,* 2011; Adias *et al.,* 2012).

ii. **Blood Chemistry:** Blood chemistry tests encompass a diverse array of analyses aimed at evaluating the levels of various biochemical substances circulating in the bloodstream. These tests provide critical insights into the functioning of vital organs and metabolic processes, facilitating the early detection of abnormalities and disease states. By measuring parameters such as glucose, cholesterol, electrolytes, liver enzymes, and kidney function markers, blood chemistry tests aid in assessing cardiovascular health, monitoring diabetes, evaluating liver and kidney function, and detecting metabolic disorders. The information gleaned from blood chemistry analyses enables healthcare providers to make informed decisions regarding patient management, medication adjustments, and lifestyle interventions, thereby optimizing health outcomes and reducing the risk of complications (Charles *et al.,* 2006; Erhabor *et al.,* 2013).

iii. **Urinalysis:** Urinalysis is a fundamental diagnostic tool used to evaluate the physical, chemical, and microscopic properties of urine samples, providing valuable insights into renal function and overall health status. By examining parameters such as color, clarity, pH, specific gravity, protein levels, glucose levels, and the presence of abnormal constituents such as blood cells or bacteria, urinalysis helps in the early detection of urinary tract infections, kidney diseases, diabetes, and other systemic conditions (Erhabor *et al.,* 2010). Additionally, urinalysis plays a crucial role in monitoring the effectiveness of treatment interventions and detecting potential complications, guiding healthcare providers in delivering timely and appropriate patient care.

iv. **Stool Analysis:** Stool analysis is a diagnostic procedure aimed at assessing the composition and characteristics of fecal matter to identify gastrointestinal-related issues and underlying health conditions. By examining stool samples for the presence of pathogens, parasites, blood, mucus, or abnormal flora, stool analysis aids in diagnosing gastrointestinal infections, inflammatory bowel diseases, malabsorption disorders, and gastrointestinal bleeding. Moreover, stool analysis can provide valuable information about digestive function, gut microbiota composition, and dietary habits, offering insights into overall gastrointestinal health and wellness. Through comprehensive stool analysis, healthcare providers can identify the root causes of gastrointestinal symptoms, tailor treatment plans to address specific concerns, and monitor patient progress over time.

v. **Basic Microbiology:** Basic microbiology testing encompasses a range of laboratory techniques aimed at identifying and characterizing microbial pathogens, including bacteria, fungi, and viruses, responsible for infectious diseases. By isolating and culturing microorganisms from clinical specimens such as blood, urine, sputum, or tissue samples, microbiology testing enables the accurate diagnosis of bacterial, fungal, and viral infections. Furthermore, microbiology testing plays a crucial role in determining the antimicrobial susceptibility patterns of pathogens, guiding the selection of appropriate antibiotics and treatment strategies. Additionally, advanced molecular techniques such as polymerase chain reaction (PCR) and sequencing facilitate the rapid and precise identification of pathogens, enhancing diagnostic accuracy and enabling timely intervention. Through their indispensable contributions to infectious disease management, basic microbiology tests play a vital role in safeguarding public health, preventing the spread of infections, and optimizing patient outcomes.

## 6. Medical Laboratory Services in Primary Healthcare: Structure and Operation

It is increasingly evident that preventative care, primary healthcare, and acute care constitute integral and interconnected components within the framework of the Nigerian healthcare system. The ongoing reform agenda within the nation duly acknowledges the symbiotic relationship among these facets, recognizing their collective impact on the health and well-being of the populace. Central to this paradigm shift is the acknowledgment that robust health systems, underpinned by the foundational principles of primary healthcare (PHC), offer the most effective avenue for maximizing health outcomes relative to investments in health infrastructure. Studies by Samson *et al.* (2020), Morufu *et al.* (2021a, b), Mordecai *et al.* (2023, 2024), and WHO PAHO (2024) underscore the pivotal role of primary healthcare in driving advancements across the broader healthcare landscape. Emphasizing the holistic nature of primary healthcare, these scholarly insights highlight its transformative potential in repositioning the Nigerian healthcare system towards a paradigm focused on fostering population health and societal well-being. Rather than solely catering to the sick, primary healthcare emerges as a proactive force in cultivating a populace that is empowered to actively engage in life, work, and nation-building endeavors.

Critical to the realization of this vision is the establishment of a primary healthcare system that ensures equitable access to the appropriate healthcare professionals, tailored to individuals' specific health needs, and delivered in a timely and efficient manner. By facilitating access to essential healthcare services at the right place, time, and with the requisite tools, primary healthcare becomes a linchpin in the quest for health equity and universal access to quality care. In essence, the imperative of strengthening primary healthcare resonates as a cornerstone in Nigeria's journey towards building a resilient and responsive healthcare system. Through strategic investments in primary healthcare infrastructure, workforce development, and service delivery models, the nation can lay the groundwork for a future where every individual has the opportunity to thrive and contribute meaningfully to the collective well-being of society (Koleayo *et al.,* 2021a, b).

Aligned with the mandates outlined in the Ward Minimum Health Care Package (WMHCP) formulated by the Agency, the establishment of fully equipped and operationalized laboratories within each primary healthcare center emerges as a cornerstone component. This strategic integration of laboratory services underscores the pivotal role played by diagnostic facilities in bolstering healthcare delivery at the grassroots level. Furthermore, the establishment of a national framework for the maintenance and coordination of a cohesive network of medical and public health laboratories serves to enhance the integrity of the country's disease control and surveillance efforts. Illustrative examples such as the Polio and Measles laboratories dispersed across the nation underscore the indispensable role of laboratories in ensuring the efficacy of case-based interventions and the periodic assessment of vaccine potency. Insights gleaned from studies by Ruth *et al.* (2012), Susann *et al.* (2012), Elemuwa *et al.* (2015; 2023), Holt *et al.* (2016), and Raimi *et al.* (2021a) highlight the instrumental nature of laboratory services in shaping health outcomes and informing evidence-based policymaking.

The presence of peripheral laboratories under the purview of the National Primary Healthcare Development Agency (NPHCDA), alongside laboratory components integrated within model health centers nationwide, attests to the indispensable role of laboratory services in primary healthcare delivery. However, to harness the full potential of these facilities and optimize their contributions to healthcare outcomes, it is imperative to institute robust coordination and monitoring mechanisms. By doing so, gaps stemming from uncoordinated data collation and underutilization of generated data can be mitigated, ensuring that laboratory-generated insights are effectively leveraged in healthcare planning and decision-making processes. In essence, the strategic alignment of laboratory services within primary healthcare

infrastructure represents a pivotal step towards realizing the overarching goal of health for all. Through concerted efforts to strengthen coordination mechanisms and optimize data utilization, Nigeria can harness the transformative potential of laboratory services in driving improvements in healthcare delivery and population health outcomes at the grassroots level.

## 7. Examining Current Gaps against the Critical Import of Medical Laboratory in Primary Health Care

Laboratory services stand as indispensable pillars within the spectrum of healthcare provision (Jain and Rao, 2019). In developed nations, the integration of laboratory-aided preventive, diagnostic, and prognostic testing has revolutionized modern medicine, paving the way for enhanced patient care and health outcomes. Similarly, the potential for reaping similar benefits in developing countries exists, contingent upon the strategic deployment of appropriate technologies that optimize the utilization of limited resources. The pivotal role of adequate medical laboratory services in underpinning the operational efficacy of every primary healthcare center cannot be overstated. However, despite strides made, significant gaps persist in both infrastructural provisions and manpower required to sustainably operate these facilities within Nigeria. Ensuring the quality of laboratory infrastructure, care, and data necessitates the establishment of robust and consolidated laboratory coordinating systems. In this regard, the National Primary Healthcare Development Agency (NPHCDA) assumes a pivotal leadership role, charged with spearheading efforts to address these critical imperatives within Nigeria's healthcare delivery system (Morufu *et al.,* 2021c, d).

By leveraging strategic leadership and concerted action, the NPHCDA can drive transformative improvements in laboratory services across the nation, fostering a healthcare ecosystem characterized by excellence, equity, and efficiency. Through targeted interventions aimed at bolstering infrastructure, enhancing workforce capacity, and implementing quality assurance mechanisms, Nigeria can unlock the full potential of laboratory services as catalysts for advancing population health and well-being. In doing so, the nation can pave the way for a future where every individual, irrespective of their circumstances, has access to high-quality and comprehensive healthcare services.

Despite the inclusion of Laboratory Technicians as essential personnel within the Minimum Health Care Package, the allocation of only one slot for running a 24-hour schedule falls short of recognizing the critical importance of medical laboratory services in primary healthcare. This oversight is compounded by the erroneous classification of Laboratory Technicians as non-clinical staff, as depicted in figures 1 and 2 below. While infrastructural provisions account for accommodation for midwives to facilitate attendance, insufficient attention is directed towards the necessity of common rooms for Laboratory Scientists/Technicians tasked with overnight shifts to ensure the provision of the stipulated 24-hour services. This discrepancy underscores a fundamental gap in the recognition and support afforded to medical laboratory services within the primary healthcare framework. Laboratory Technicians play a pivotal role in diagnostic testing, disease surveillance, and patient care, serving as frontline responders in the identification and management of health conditions. However, the inadequate allocation of personnel and resources undermines their capacity to deliver timely and comprehensive services, compromising the quality and efficacy of healthcare delivery at the grassroots level.

To address this deficiency, concerted efforts are needed to rectify the disparity in staffing allocations and infrastructure provisions within primary healthcare settings. This entails revisiting policies and guidelines to accurately reflect the clinical nature of laboratory services and ensure equitable resource allocation. Additionally, there is a pressing need to prioritize the establishment of common rooms or designated spaces for Laboratory Scientists/Technicians working overnight shifts, thereby facilitating their ability to deliver round-the-clock services as mandated. By rectifying these discrepancies and enhancing support for medical laboratory services within primary healthcare, Nigeria can bolster the effectiveness and inclusivity of its healthcare delivery system. Through strategic investments in personnel, infrastructure, and policy frameworks, the nation can ensure that all individuals have access to comprehensive and high-quality healthcare services, thereby advancing the overarching goal of health for all.

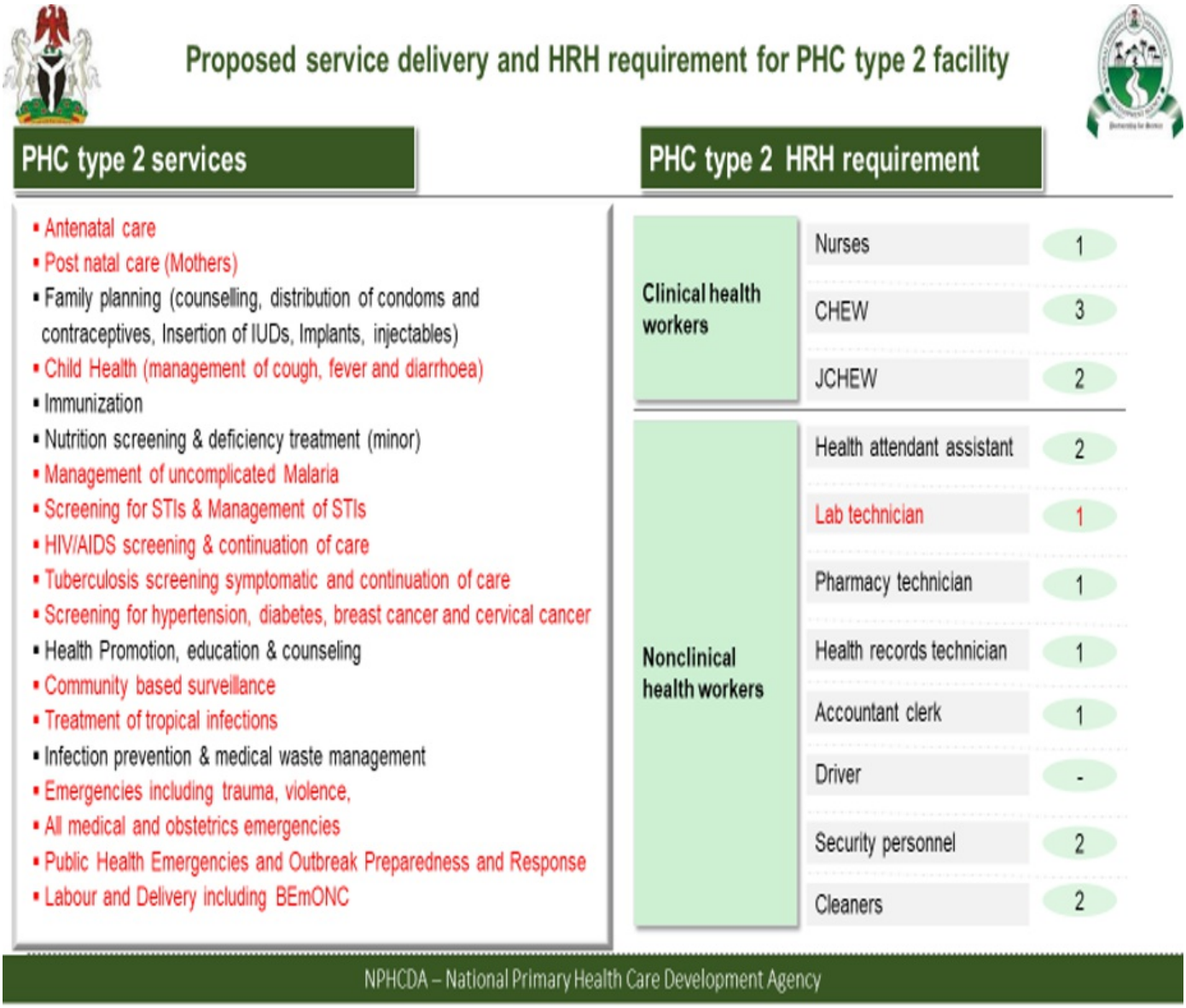


**Figure 1.**

Figure 1 above provides a practical representation of the burden of laboratory related health services provided in a level 2

primary healthcare center against the provision of a single Laboratory Technician expected to run a 24-hour working shift, daily; with concerned items highlighted in red.

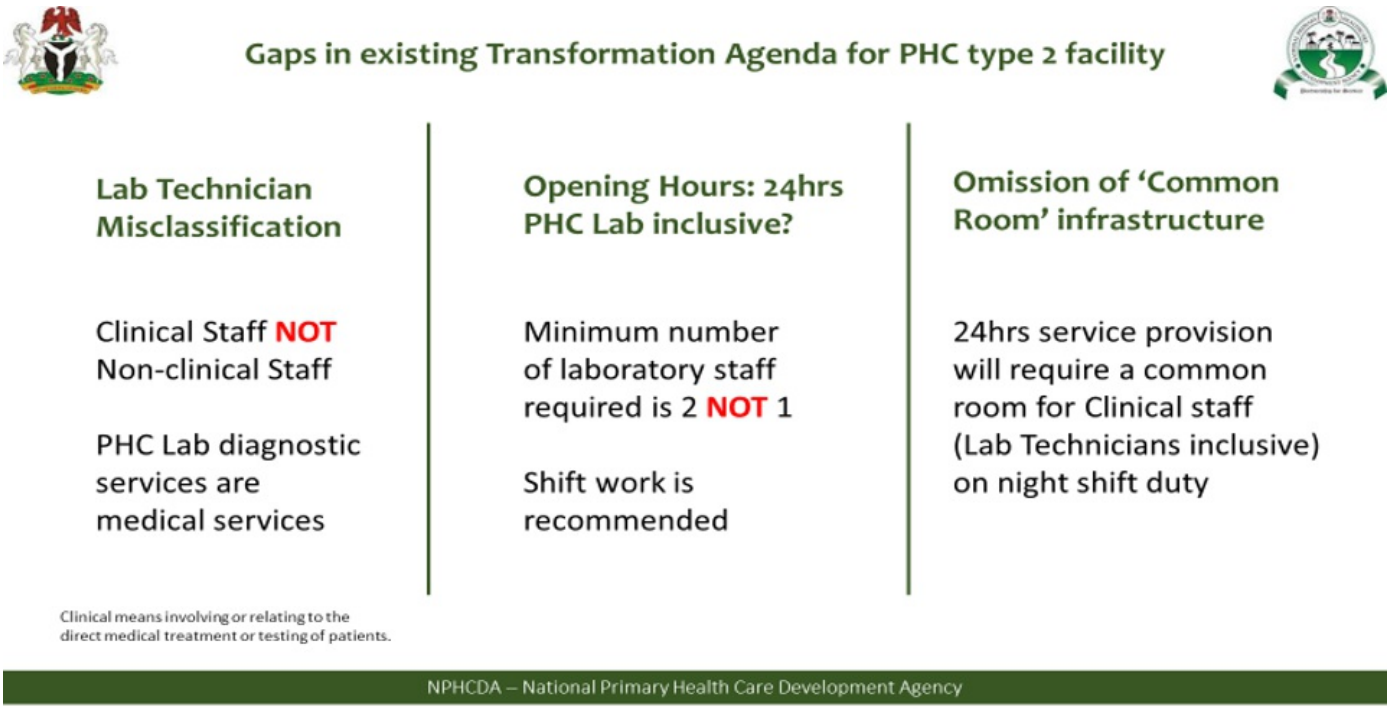


**Figure 2.**

Figure 2 above also provides a simple breakdown of key gaps as the misclassification as non-clinical staff, a mis-matched minimal number of 1 for running 24-hour lab inclusive services etc.

Despite the overwhelming evidence demonstrating the critical importance of laboratory services for achieving the Sustainable Development Goals (SDGs), they persist as one of the most overlooked components within health systems (Barbara *et al.,* 2012). This neglect stems from a multitude of factors, ranging from the failure to engage laboratory staff in key decision-making processes to a predominant focus on technological advancements rather than on fostering effective management systems. The resultant marginalization and chronic neglect of laboratory services have profound implications: inaccurate or unknown results lead to mismanagement of patients, wastage of drugs, and unreliable surveillance data. Unless concerted efforts are made to prioritize the development of reliable laboratory services, the nation will continue to rely on externally funded and therefore unsustainable laboratory technology to monitor disease burden and the efficacy of disease control programs. The acceleration of progress towards health-related SDGs hinges critically upon ensuring accessible and reliable laboratory services within primary healthcare (Jain and Rao, 2019; Mordecai *et al.,* 2024). For instance, the diagnosis of tuberculosis necessitates microscopic examination of sputum smears (Chandra *et al.,* 2015), while confirmation of HIV status and monitoring of treatment response require laboratory tests such as CD4 counts (Elemuwa *et al.,* 2005; Elemuwa *et al.,* 2007; Li *et al.,* 2023). Furthermore, with the advent of combination therapy, the prevalence of over-diagnosis of malaria based solely on presumptive clinical diagnosis cannot be justified. Laboratory confirmation through microscopy or rapid tests proves to be cost-effective, particularly in high

transmission areas and among children under 5 years old.

Anaemia affects over half of all pregnant women and children in poor countries, underscoring the critical need for accurate haemoglobin measurement as the gold standard for diagnosis, rather than relying solely on Conjunctival pallor. Additionally, ensuring an adequate supply of safe, accurately matched blood is essential for preventing deaths from severe anaemia. Conclusively, the transformation of laboratory services from neglected components to integral pillars within health systems is imperative for achieving health-related SDGs. By prioritizing investment in infrastructure, workforce capacity building, and effective management systems, nations can unlock the full potential of laboratory services as catalysts for improving healthcare delivery, enhancing patient outcomes, and ultimately advancing global health equity.

## 8. Prioritizing Primary Healthcare Laboratories: The Missing Link in the Transformation Agenda: A schema showing values the PHC Labs can offer

At the heart of a robust primary healthcare system lies the essential presence of quality and resilient healthcare laboratories (see figure 3 below). These laboratories serve as linchpins in the diagnosis, monitoring, and treatment of diseases, providing invaluable support to healthcare providers in their quest to deliver optimal patient care. By furnishing accurate and timely medical test results, these facilities empower healthcare professionals to make informed decisions that are paramount to the well-being of their patients. The pivotal role of healthcare laboratories extends across the entire spectrum of healthcare delivery, from preventive screenings to the management of acute and chronic conditions. Through meticulous analysis and interpretation of diagnostic tests, laboratories facilitate the early detection of diseases, guide treatment interventions, and monitor the progress of therapeutic regimens. This critical function not only enhances patient outcomes but also optimizes healthcare resource utilization, thereby contributing to the overall efficiency and effectiveness of the healthcare system.

Furthermore, the resilience and quality of healthcare laboratories are indispensable in ensuring healthcare equity and access. By providing reliable diagnostic services, regardless of geographical location or socio-economic status, these facilities bridge gaps in healthcare delivery and facilitate equitable access to quality care for all individuals. In essence, the presence of well-structured and robust healthcare laboratories is foundational to the delivery of comprehensive and patient-centered primary healthcare services. As such, investment in the development and enhancement of laboratory infrastructure, technology, and workforce capacity is paramount to strengthening healthcare systems and advancing the collective goal of promoting health and well-being for all.

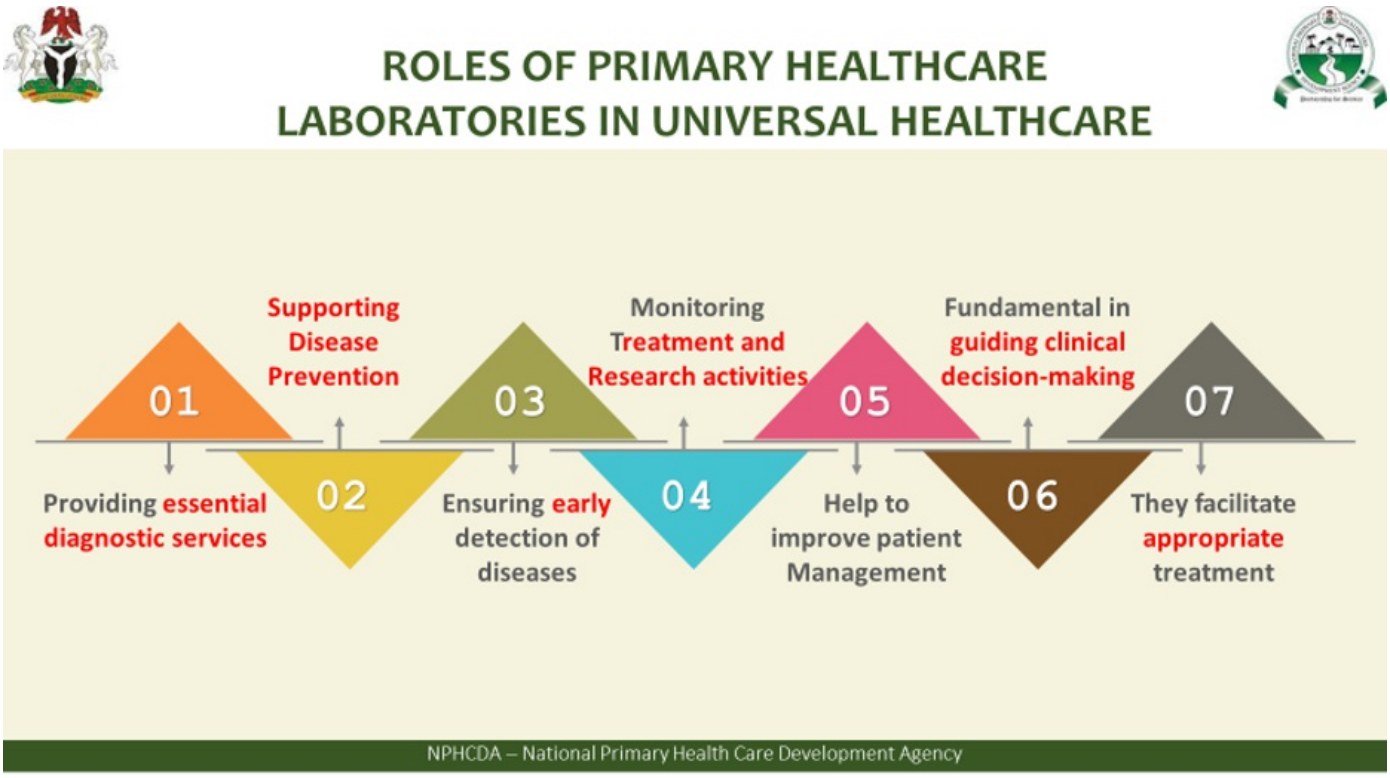


**Figure 3.** A schema showing values the PHC Labs can offer

Maximizing the potential of primary healthcare (PHC) laboratories is paramount for achieving universal health coverage (Jain and Rao, 2019). These laboratories serve as vital hubs for diagnostic services, playing a multifaceted role in disease prevention, early detection, treatment monitoring, and research endeavors (Raimi *et al.,* 2022). By offering essential diagnostic capabilities, PHC laboratories enhance patient management, guide clinical decision-making processes, and facilitate the delivery of appropriate treatment modalities to clients. Research studies have underscored the profound impact of laboratory services on the performance of PHC facilities. For instance, investigations by George (2011) have revealed a robust positive correlation between the level of laboratory services and the number of outpatient department (OPD) visits per day in PHC settings. Facilities offering in-house testing for both malaria and tuberculosis were found to be five times more likely to attract higher numbers (≥ 80) of OPD visits per day. Despite the focused attention on PHC and its performance metrics, PHC laboratory services have encountered a degree of neglect within the Nigerian healthcare landscape.

Addressing the neglect of PHC laboratory services is imperative for optimizing healthcare delivery and advancing health outcomes. By prioritizing investment in laboratory infrastructure, workforce training, and quality assurance mechanisms, Nigeria can unlock the full potential of PHC laboratories as catalysts for improving access to quality care and achieving universal health coverage. Through strategic interventions and concerted action, the nation can pave the way for a future where every individual has equitable access to comprehensive and high-quality healthcare services. Underscoring the need to prioritize them, these laboratory services accelerate the realization of the Universal Health Coverage (UHC) agenda in multiple ways:

a) **Early Diagnosis and Intervention:**

- **Timely Treatment for Improved Outcomes:** Laboratory tests play a pivotal role in the early detection of diseases, enabling healthcare providers to initiate prompt treatment interventions. This proactive approach not only enhances patient outcomes but also reduces the risk of disease progression and associated complications.
- **Promoting Access to Quality Healthcare:** By facilitating early diagnosis, laboratory tests contribute to the realization of Universal Health Coverage (UHC) principles by ensuring equitable access to quality healthcare services without imposing financial burdens on individuals or communities. Timely intervention can prevent the escalation of health conditions, thereby averting the need for costly treatments and hospitalizations.

b) **Effective Disease Management:**

- **Optimizing Chronic Disease Care:** Regular monitoring through laboratory tests enables healthcare professionals to tailor treatment plans and adjust medications based on individual patient responses. This personalized approach to disease management fosters better control of chronic conditions such as diabetes, hypertension, and cardiovascular diseases, ultimately reducing the frequency of hospitalizations and emergency room visits.
- **Promoting Cost-Effective Care:** By facilitating early intervention and preventing disease exacerbations, laboratory tests contribute to cost-effective healthcare delivery by minimizing the need for expensive medical procedures and intensive interventions. This not only benefits patients by reducing out-of-pocket expenses but also alleviates the strain on healthcare systems.

c) **Preventive Measures:**

- **Identifying Risk Factors:** Laboratory tests play a crucial role in identifying risk factors for various diseases, including genetic predispositions, biochemical markers, and lifestyle-related factors. Armed with this information, healthcare providers can implement targeted preventive measures such as lifestyle modifications, vaccination programs, and screening initiatives to mitigate the risk of disease development or progression.
- **Empowering Health Promotion Activities:** By providing actionable insights into individual health status, laboratory tests empower healthcare professionals to design tailored health promotion activities and interventions. These initiatives, ranging from dietary counseling to smoking cessation programs, are integral components of UHC strategies aimed at promoting preventive healthcare and reducing the burden of preventable diseases.

d) **Data-Driven Decision Making:**

- **Informing Policy Development:** Laboratory data serves as a cornerstone for evidence-based policymaking in healthcare, providing valuable insights into disease prevalence, epidemiological trends, and healthcare utilization patterns. This data enables policymakers to prioritize health interventions, allocate resources efficiently, and design targeted strategies to address emerging public health challenges.
- **Enhancing Healthcare Planning:** By facilitating data-driven decision-making, laboratory tests contribute to the advancement of UHC goals by optimizing healthcare planning and resource allocation. Healthcare systems can

proactively address population health needs, strengthen disease surveillance mechanisms, and implement preventive measures to promote the well-being of all individuals, regardless of their socioeconomic status or geographic location.

## 9. Challenges to Optimizing PHC Laboratories Services

In order to expedite the achievement of universal health coverage, it is imperative to place a heightened emphasis on prioritizing and fortifying primary healthcare laboratories, which often serve as the linchpin in the transformational agenda of Nigeria's healthcare system. By enhancing the quality, resilience, and overall capacity of these essential facilities, significant enhancements can be made in healthcare delivery and outcomes. Consequently, it becomes imperative to thoroughly evaluate the challenges confronting primary healthcare laboratories and formulate comprehensive strategies to accelerate their development. A myriad of challenges hampers the effective functioning of primary healthcare laboratories, underscoring the urgent need for targeted interventions. Foremost among these challenges is the pervasive issue of inadequate infrastructure plaguing most, if not all, primary healthcare centers (Chinawa, 2015; Moreen *et al.,* 2023). Insufficient physical infrastructure compromises the ability of laboratories to operate optimally, hindering their capacity to provide timely and accurate diagnostic services to patients. Furthermore, the weak or non-existent budgetary allocation for laboratory facilities exacerbates these challenges, perpetuating a cycle of underinvestment and resource scarcity. Limited financial resources impede efforts to procure essential equipment, maintain infrastructure, and sustain operations, thereby impinging upon the quality and scope of services offered by primary healthcare laboratories.

In addition to infrastructural and financial constraints, the dearth of human resources presents a formidable obstacle to the effective functioning of primary healthcare laboratories. A shortage of skilled personnel, coupled with inadequate training and retraining programs, undermines the proficiency and capacity of laboratory staff to perform their duties effectively (Abdulbasit *et al.,* 2024). Moreover, the absence of standardized quality assurance systems further compounds these challenges, casting doubt on the reliability and accuracy of laboratory test results. Without robust quality assurance mechanisms in place, there is an increased risk of diagnostic errors and misinterpretation of data, jeopardizing patient care and clinical decision-making processes. A comprehensive assessment by Opeyemi *et al.* (2024) underscores the profound impact of these challenges on Nigeria's healthcare landscape. The presence of deteriorating healthcare systems has contributed to the phenomenon of medical tourism, wherein individuals seek healthcare services abroad due to deficiencies in the domestic healthcare infrastructure. Nigeria's ranking of 96$^{th}$ out of 195 countries in the global health security index, with a score of 37.8, underscores the urgent need for remedial action to bolster the resilience and capacity of the healthcare system (Bello *et al.,* 2020). Of particular concern is the lower-than-average score of 50 attributed to the laboratory system capacity, indicative of systemic shortcomings in laboratory infrastructure, governance, and policy support.

Furthermore, the lack of requisite political support for medical laboratory practices in Nigeria, coupled with the absence of a clear policy framework, poses significant challenges to the advancement of primary healthcare laboratories (Abdulbasit *et al.,* 2024). The sluggish expansion of the health labor force, particularly in the realm of primary healthcare laboratory staffing, further exacerbates these challenges, impeding efforts to address existing gaps and scale up service delivery. In

light of these multifaceted challenges, it is imperative for stakeholders at all levels to collaborate and mobilize resources towards the revitalization and strengthening of primary healthcare laboratories. Strategic investments in infrastructure, human resources, training programs, and quality assurance mechanisms are essential to overcoming these obstacles and advancing the overarching goal of universal health coverage in Nigeria. Only through concerted and sustained efforts can the nation overcome these challenges and build a resilient and responsive healthcare system capable of meeting the diverse needs of its populace.

## 10. Recommendations Towards Optimizing PHC Laboratories Services

Recognizing the pivotal roles that laboratory services play in enhancing the performance of primary healthcare (PHC), it is imperative to accord high priority to augmenting the PHC laboratory workforce to enable round-the-clock service delivery and bolster outpatient department (OPD) visits. Additionally, setting minimum standards for essential tests at PHC laboratories in Nigeria is essential to ensure consistent and high-quality diagnostic services across all facilities. Moreover, addressing the infrastructure deficits in PHC laboratory facilities is paramount for optimizing their functionality and effectiveness. This entails establishing minimum standards for both one-room and multi-room PHC laboratory facilities, as well as the associated building and infrastructure. By delineating clear guidelines and benchmarks for laboratory design, layout, equipment, and safety protocols, Nigeria can ensure that PHC laboratories are adequately equipped to meet the diverse healthcare needs of their communities.

Furthermore, investing in the training and capacity-building of PHC laboratory personnel is critical to enhancing their skills, competencies, and professionalism. By providing comprehensive training programs and continuous education opportunities, Nigeria can cultivate a proficient and resilient workforce capable of delivering high-quality laboratory services to patients across the country. In summary, prioritizing the expansion of the PHC laboratory workforce, setting minimum standards for essential tests, and addressing infrastructure deficiencies are vital steps towards strengthening PHC laboratory services in Nigeria. Through concerted efforts and strategic investments in these areas, Nigeria can improve healthcare access, quality, and outcomes, ultimately advancing the overarching goal of universal health coverage for all its citizens. Other objective strategies to prioritize the development of primary healthcare laboratories in Nigeria also include:

i. **Infrastructure and Equipment:** This is a passionate call on Governments and healthcare authorities to invest in the infrastructure of primary healthcare laboratories, ensuring they have adequate space, adequate layout and essential utilities. Also acquiring and maintaining modern laboratory equipment and technologies is vital to enhance diagnostic capabilities, accuracy and efficiency.
ii. **Human Resources and Training:** Strengthening the laboratory workforce is essential for quality and resilient primary healthcare laboratories. Governments should focus on recruiting, training, and retaining skilled laboratory professionals.
iii. **Quality Assurance Systems:** Implementing robust quality assurance systems is essential to ensure the accuracy and reliability of laboratory results. Strong quality management systems should be in place to monitor and evaluate

laboratory processes, identify areas of improvement, and address any deficiencies.

iv. **Resilience and Emergency Preparedness:** There should be contingency plans and protocols in place to respond to emergencies and public health crises. By being prepared, laboratories can contribute effectively to emergency response efforts and minimize disruptions to healthcare services during crises.

v. **Collaboration and Partnership:** Collaboration between public health authorities, healthcare providers, and research institutions is crucial for the success of primary healthcare laboratories. Public-private partnership can help leverage resources and expertise, leading to improved laboratory services.

vi. **Connectivity and Information Systems:** Integration of primary healthcare laboratories into the broader healthcare system is crucial for effective patient management and disease surveillance. Laboratories should be connected to electronic health record systems for seamless sharing of patient information and test results (Raimi *et al.,* 2019b; Olalekan, 2020; Olalekan *et al.,* 2020l Abaya *et al.,* 2023a, b; Erezina *et al.,* 2023a, b; Samuel *et al.,* 2023; Elemuwa *et al.,* 2023).

Moreover, there exists an urgent imperative to advocate for the comprehensive review of both the Ward Minimum Healthcare Package (WMHCP) and Minimum Service Provisions (MSP). This review process is essential for identifying gaps, addressing evolving healthcare needs, and aligning these frameworks with contemporary best practices in healthcare delivery. Equally critical is the necessity to foster deeper engagement with health leadership at all levels to underscore the transformative potential of primary healthcare laboratories in enhancing PHC care and services. By fostering a nuanced understanding of the pivotal role played by PHC labs, health leaders can be empowered to prioritize and integrate laboratory services into the broader health transformation agenda effectively. Furthermore, concerted efforts are needed to engage with relevant stakeholders, particularly those involved in laboratory strengthening services, to garner their support and commitment towards this vision. Building consensus and fostering collaboration among diverse stakeholders is essential for driving sustainable progress and effecting meaningful change in PHC laboratory services. This necessitates ongoing dialogue, high-level advocacy efforts, and proactive outreach initiatives aimed at mobilizing support from key individuals and organizations.

Additionally, it is imperative to embrace and adapt to global technological dynamics in healthcare. By leveraging emerging technologies and innovative solutions, Nigeria can enhance the efficiency, effectiveness, and reach of its PHC laboratory services, thereby advancing towards universal health coverage and better health outcomes for all. Lastly, ensuring the active participation of critical PHC laboratory stakeholders in the development of annual operational plans (AOPs) at all levels of the healthcare system is paramount. This inclusive approach facilitates the alignment of strategic priorities, resource allocation, and implementation strategies with the needs and realities of PHC laboratory services on the ground. By fostering a culture of collaboration, transparency, and accountability, Nigeria can catalyze meaningful progress towards strengthening PHC laboratory services and achieving its broader healthcare goals. Thus, against this backdrop, possible strategies which can be prioritized to fast-track and accelerate the functionality of Primary Healthcare Laboratories in Nigeria include to:

1. **Enhance Funding for Laboratory Equipment and Supplies:**

- Allocate increased financial resources towards procuring state-of-the-art laboratory equipment and high-quality supplies.
- Prioritize investments in advanced technologies that facilitate a comprehensive range of diagnostic tests, ensuring laboratories remain at the forefront of medical advancements.
- Establish robust procurement processes to ensure the timely acquisition and maintenance of essential equipment and supplies, thereby minimizing disruptions to laboratory operations.

2. **Offer Comprehensive Training and Support for Laboratory Staff:**

- Develop structured training programs tailored to the specific needs of laboratory personnel, encompassing both technical competencies and proficiency in new technologies.
- Foster a culture of continuous learning and professional development through workshops, seminars, and access to online resources.
- Provide ongoing mentorship and support to staff members, empowering them to confidently execute accurate and timely tests while adhering to stringent quality standards.

3. **Enhance Infrastructure and Logistics for Efficient Sample Processing:**

- Upgrade laboratory facilities to optimize workflow efficiency and accommodate growing sample volumes.
- Implement standardized protocols for sample collection, transportation, and storage to minimize potential errors and ensure sample integrity.
- Leverage technology-driven solutions, such as automated sample tracking systems and real-time monitoring tools, to streamline logistics and enhance overall operational efficiency.

4. **Enforce Stringent Quality Control Measures:**

- Establish robust quality assurance frameworks encompassing regular calibration, proficiency testing, and external quality assessment programs.
- Conduct rigorous audits and inspections to identify potential areas for improvement and ensure compliance with regulatory standards.
- Foster a culture of accountability and transparency, where staff members are actively engaged in identifying and addressing quality-related issues to uphold the reliability and accuracy of test results.

5. **Invest in Advanced Information Technology Systems:**

- Deploy integrated laboratory information management systems (LIMS) to digitize and automate various laboratory processes, including sample tracking, data analysis, and result reporting.
- Enhance interoperability between healthcare providers and laboratory systems to facilitate seamless data exchange and timely communication of critical findings.
- Implement robust cybersecurity measures to safeguard sensitive patient information and prevent unauthorized access or data breaches.

6. **Forge Strategic Collaborations with Public Health Authorities:**
    - Foster partnerships with governmental agencies, academic institutions, and industry stakeholders to identify emerging public health priorities and allocate resources accordingly.
    - Participate in collaborative research initiatives aimed at developing novel diagnostic tools and methodologies for the detection and surveillance of key diseases and conditions.
    - Engage in regular dialogue and knowledge-sharing forums to align laboratory testing priorities with broader public health objectives and ensure effective coordination of efforts.
7. **Promote Public Awareness and Education Initiatives:**
    - Launch targeted awareness campaigns to educate healthcare providers and patients about the pivotal role of laboratory testing in disease diagnosis and management.
    - Disseminate accurate and accessible information regarding the benefits of early detection, proper test utilization, and interpretation of test results.
    - Encourage proactive engagement with laboratory services through community outreach programs, health fairs, and digital media platforms to foster a culture of health literacy and informed decision-making.

By implementing these strategies, we can help to ensure that Primary Healthcare Laboratories are able to provide accurate and timely diagnostic services, thereby avoiding guesswork and syndromic management of patients.

## 11. Conclusion

Ensuring proper surveillance through a robust network of laboratories is paramount to meet the multifaceted components of healthcare, encompassing preventive, promotive, diagnostic, therapeutic, and rehabilitative aspects. Regrettably, the current state of laboratory support at the primary healthcare level in Nigeria is far from optimal. Therefore, a radical approach must be adopted to rectify this deficiency and ensure that healthcare quality in communities is equitable, scientifically sound, and cost-effective. Medical laboratory services wield significant potential to bolster various healthcare domains, including maternal and child health services, HIV/AIDS management, malaria control, tuberculosis detection, blood and blood products safety, parasitic diseases surveillance, and management of diarrheal diseases, among others. Emphasizing the imperative for infrastructure and equipment upgrades, there is a pressing call on governments and healthcare authorities to invest in the modernization of primary healthcare laboratories. This entails providing adequate space, optimizing layout, and ensuring essential utilities to facilitate seamless operations. Moreover, the acquisition and maintenance of state-of-the-art laboratory equipment and technologies are indispensable for enhancing diagnostic capabilities, accuracy, and efficiency. Strengthening the laboratory workforce through recruitment, training, and retention of skilled professionals is equally paramount to ensure the quality and resilience of primary healthcare laboratories.

Building upon these foundations, implementing robust quality assurance systems is crucial to safeguard the accuracy and reliability of laboratory results. This necessitates the establishment of strong quality management systems to oversee

laboratory processes, identify areas for improvement, and rectify deficiencies promptly. Additionally, contingency plans and protocols must be developed to respond effectively to emergencies and public health crises (Raimi and Raimi, 2020; Samson *et al.,* 2020; Raimi *et al.,* 2020; Morufu *et al.,* 2021a, b; Raimi *et al.,* 2021a, b; Elemuwa *et al.,* 2023; Emma *et al.,* 2023; Emma *et al.,* 2024). By cultivating preparedness, laboratories can contribute significantly to emergency response efforts and minimize disruptions to healthcare services during crises. To achieve these objectives, collaboration among public health authorities, healthcare providers, and research institutions is indispensable. Public-private partnerships can harness resources and expertise, leading to tangible improvements in laboratory services. Furthermore, integrating primary healthcare laboratories into the broader healthcare system is pivotal for seamless patient management and disease surveillance. Connectivity with electronic health record systems enables the seamless sharing of patient information and test results, thereby facilitating comprehensive and coordinated care delivery (Abaya *et al.,* 2023a, b; Erezina *et al.,* 2023a, b; Samuel *et al.,* 2023).

Prioritizing quality and resilient primary healthcare laboratories constitutes a pivotal stride towards accelerating the attainment of universal health coverage. Through strategic investments in infrastructure, workforce capacity building, establishment of quality assurance systems, and collaborative initiatives, Nigeria can foster a resilient and functional laboratory system. This endeavor will culminate in improved access to essential diagnostic services, enhanced patient outcomes, more effective disease management structures, and ultimately, the realization of universal health coverage. Primary healthcare clinics stand to benefit immensely from the availability of appropriate tests, provided there is concurrent improvement in the quality, capacity, and training of laboratory staff, supported by adequate provisions of infrastructure and supplies. Medical laboratory services in primary healthcare are therefore indispensable components of a comprehensive and effective healthcare ecosystem, serving as the bedrock upon which equitable and accessible healthcare services are built.

## List of Abbreviation

- UHC Universal Healthcare Coverage
- NPHCDA National Primary Healthcare Development Agency
- AMLSN Association of Medical Laboratory Scientists of Nigeria
- UHC Universal Health Coverage
- WHO World Health Organization
- UNICEF United Nations Children's Fund (UNICEF)
- LMICs Low- and Middle-Income Countries (LMICs)
- HFA Health For All
- PCR Polymerase Chain Reaction
- OPD Outpatient Department
- PHC Primary Health Care
- AOPs Annual Operational Plans

- SDGs Sustainable Development Goals
- MSP Minimum Service Provisions
- LIMS Laboratory Information Management Systems
- MDHFA Minimum District Health For All Package
- WMHCP Ward Minimum Health Care Package

## Statements and Declarations

### Conflict of Interests

The authors declare no conflict of interest.

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### Authors Contribution

All authors contributed equally to conceptualization, validation, writing review and editing.

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### Significance Statement

The significance of bolstering primary healthcare laboratories in Nigeria cannot be overstated, as they serve as critical pillars supporting the multifaceted aspects of healthcare delivery. With a concerted effort to enhance infrastructure, equip laboratories with modern technologies, and strengthen the workforce through training and recruitment, Nigeria can ensure equitable access to high-quality diagnostic services. By implementing robust quality assurance systems and fostering collaboration among stakeholders, including public health authorities, healthcare providers, and research institutions, Nigeria can achieve tangible progress towards universal health coverage. This investment in primary healthcare laboratories not only improves patient outcomes and disease management but also contributes to a more resilient healthcare system capable of effectively responding to emergencies and public health crises, ultimately leading to healthier communities and sustainable healthcare advancements.

Furthermore, integrating primary healthcare laboratories into the broader healthcare system facilitates seamless coordination of patient care and disease surveillance, enabling comprehensive and patient-centered healthcare delivery.

Through public-private partnerships and the utilization of electronic health record systems, Nigeria can leverage resources and expertise to drive meaningful improvements in laboratory services. By prioritizing the development of quality and resilient primary healthcare laboratories, Nigeria can lay the foundation for a more equitable, accessible, and efficient healthcare system, wherein every individual can access essential diagnostic services regardless of their geographic location or socioeconomic status.

## References


- Abaya, ST., Enuma, EU., Chukwueze, BC., Raimi, AG., Kakwi, DJ., & Raimi, MO. (2023a). Prevalence, Determinants and Benefits of Use of Internet for Health-Related Information among Adults in Abuja, Nigeria. *AfricArXiv*. https://doi.org/10.21428/3b2160cd.14740987.
- Abaya, ST; Orga, C; Raimi, AG; Raimi, MO; Kakwi, DJ (2023b): Assessment of the Implementation of Electronic Records Management System in Bayelsa State. Lippincott® Preprints. Preprint. https://doi.org/10.1097/preprints.22643812.v1.
- Abdulrahaman, Y., Isaac, ZI., Erhabor, O., Sanusi, BM., Udomah, F. P., Ezimah, AC., Usman, S., Adias, TC., & Mainasara, AS. (2013). Hemoglobin electrophoretic pattern among residents in Sokoto, Nigeria. *Journal of Medical Disorders*. http://dx.doi.org/10.7243/2053-3659-1-2.
- Abdulbasit, A., Abdulrahman, A., & Obeagu, E. (2024). Enhancing quality healthcare in Nigeria through medical laboratory services: A review. *Medicine, 103*, e36869. https://doi.org/10.1097/MD.0000000000036869.
- Adias, TC., Uko, E., & Erhabor, O. (2006). Anaemia in human immunodeficiency virus infection: a review.*Nigerian Journal of Medicine*.
- Adias, TC., Moore-Igwe, B., & Jeremiah, ZA. (2012). Storage-related hematological and biochemical changes of CPDA-1 whole blood in a resource-limited setting. *Journal of Blood Disorders & Transfusion*.
- Aigiremolen AO & Alenoghena I & Eboreime, Ejemai & Chukwuyem, Abejegah. (2014). Primary Health Care in Nigeria: From Conceptualization to Implementation. *Journal of Medical and Applied Biosciences* 6. 2277-54.
- Ajugwo, AO., Adias, TC., Aghatise, K., Fadairo, JK., & Nyenke, CU. (2014). Reduced haematological indices in auto-mechanics and fuel attendants in Elele, Nigeria. *American Journal of Medical and Biological Research, 2*, 1-4.
- Barbara R, Mohammad A, Gabriela C, Chris E, Ali K, Wolfgang M, Edison M, Gabrielle R, Shirly V, Sonali K (2012), Promoting Evidence-based Vaccine Safety Research and Communication. The Vienna Vaccine Safety Initiative, *Journal of Tropical Pediatrics*, Volume 58, Issue 3, June, Pages 167–169,https://doi.org/10.1093/tropej/fms022.
- Behera BK, Prasad R, Shyambhavee (2022). Primary health-care goal and principles. Healthcare Strategies and Planning for Social Inclusion and Development. 221–39. doi: 10.1016/B978-0-323-90446-9.00008-3. Epub 2021 Nov 19. PMCID: PMC8607883.
- Bello, S., Adebowale, AS., Dairo, MD., *et al.* (2020) Strategies for rapid scale up of laboratory capacity in a public health emergency in a resource-constrained setting: The SARS-CoV-2 Nigeria response experience. *Research Square, 2020*(3), 1–14.
- Chandra, TJ., Selvaraj, R., & Sharma, YV. (2015). Same day sputum smear microscopy for the diagnosis of pulmonary

tuberculosis: Ziehl-Neelsen versus fluorescent staining. *Journal of Family Medicine and Primary Care, 4*(4), 525–528. https://doi.org/10.4103/2249-4863.174273

- Chinawa, J. (2015). Factors militating against effective implementation of primary health care (PHC) system in Nigeria. *Annals of Tropical Medicine and Public Health, 8*, 5–9. https://doi.org/10.4103/1755-6783.156701.
- Charles, T., Jeremiah, Z., Uko, E., & Osaro, E. (2006). Autologous blood transfusion-a review. *South African Journal of Surgery*.
- Croke, K., & Ogbuoji, O. (2024). Health reform in Nigeria: The politics of primary health care and universal health coverage. *Health Policy and Planning, 39*(1), 22–31. https://doi.org/10.1093/heapol/czad107.
- Declaration of Alma-Ata. (1978). *International Conference on Primary Health Care, Alma-Ata, USSR, 6-12 September 1978*.
- Elemuwa UG, Enato E and Elemuwa CO (2023) Assessment of Factors Related to Reporting AEFIs and Parameters for Vaccine Safety Surveillance Improvement: Healthcare Workers Perspective in FCT, Nigeria. Am *J Biomed.Sci.&Res*.19(3).AJBSR.MS.ID.002584.DOI:10.34297/AJBSR.2023.19.00254
- Elemuwa CO, Elemuwa GU, Omoregie R, Adebowale AS, Akpan E and Olaniyan O (2023). Global Lessons of COVID-19: Nigerian Perspective. *Am J Biomed Sci & Res.* 19(2) AJBSR.MS.ID.002569, DOI: 10.34297/AJBSR.2023.19.002569.
- Elemuwa CO, Akalonu O, Azodoh V, Elemuwa GU, Oweibia LM, Aideyan DO, Tochukwu Daniel E (2023) A Ten-Year Retrospective Study Evaluating the Effectiveness of the Maternal Newborn and Child Health Weeks Intervention among Pregnant Women in Nigeria. *International Journal of Advanced Multidisciplinary Research and Studies* Volume 3, Issue 5.
- Elemuwa C, Kutalek R, Ali M, Mworozi E, Kochhar S, Rath B (2015); Vienna Vaccine Safety Initiative. Global lessons from Nigeria's ebolavirus control strategy. *Expert Rev Vaccines*. 14(11):1397-400. doi: 10.1586/14760584.2015.1064313. Epub 2015 Jul 18. PMID: 26190046.
- Elemuwa CO, Uche LN, Ukwandu NC, Nmorsi OP, Anyanwu LC (2007). Human immunodeficiency virus type-1 (HIV-1) and the associated clinical features among sero-positive Nigerian subjects. *J Commun Dis*. Mar;39(1):13-9. PMID: 18338711.
- Elemuwa CO, Bassey BE, Olaleye DO (2005). The problems of indeterminate HIV results in blood transfusion services in Nigeria. *Trop Doct.* Jul;35(3):166-7. doi: 10.1258/0049475054620798. PMID: 16105345.
- Emma A, Chris OE, Irene E, Uchenna GE, Tochukwu E, OnukwuliVivian O, Victoria EU, Josephine OE, Andrew A, Nne P, Bitrus B (2024) Current Practices and Risk Assessment in COVID-19 Vaccine Procurement in Nigeria. *International Journal of Medical Science and Dental Health*. Volume 10, Issue 01, January 2024, Doi https://doi.org/10.55640/ijmsdh-10-01-06. *www.ijmsh.org.*
- Emma A. Chris OE, Irene E, Uchenna GE, Elemuwa, TD., Onukwuli VO, Victoria EU, Josephine OE, Nne P (2023): Optimizing Covid-19 Vaccine Procurement and Management In Nigeria: Procedures, Risk Reduction, And International Comparisons. IOSR *Journal of Dental and Medical Sciences* (IOSR-JDMS) e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 22, Issue 12 Ser.5 (December. 2023), PP 52-64 www.iosrjournals.org.
- Erezina, AE., Gift, RA., Odipe, OE., Raimi, MO., Abaya, ST., & Kakwi, DJ. (2023a). Level of Professional Awareness

among Health Record Officers in Bayelsa State and Their Implications for Patient Care, Health Systems, and Health Policy. *American Journal of Physical Education and Health Science*, *1*(1), 19–30. DOI: https://doi.org/10.54536/ajpehs.v1i1.1582. Retrieved from https://journals.e-palli.com/home/index.php/ajpehs/article/view/1582.

- Erezina, AE; Raimi, AG; Emmanuel, OO; Raimi, MO; Abaya, ST; Kakwi, DJ (2023b): Level of Professional Awareness among Health Record Officers in Bayelsa State and their Implications for Patient Care, Health Systems, and Health Policy. Lippincott® Preprints. Preprint. https://doi.org/10.1097/preprints.22637689.v1
- Erhabor, O., Ok, O., Awah, I., Uko, KE., & Charles, AT. (2007). The prevalence of Plasmodia parasitemia among donors in the Niger Delta of Nigeria. *Tropical Doctor*.
- Erhabor, O., Jeremiah, ZA., Adias, TC., & Okere, CE. (2010). The prevalence of human immunodeficiency virus infection among TB patients in Port Harcourt, Nigeria. *HIV/AIDS Research and Palliative Care*.
- Erhabor, O., Adias, TC., Jeremiah, ZA., & Hart, ML. (2010). Abnormal hemoglobin variants, ABO, and Rhesus blood group distribution among students in the Niger Delta of Nigeria. *Pathology and Laboratory Medicine International*.
- Erhabor, O., Adias, TC., & Hart, ML. (2010). Effects of falciparum malaria on the indices of anaemia among pregnant women in the Niger Delta of Nigeria. *Journal of Clinical Medicine and Research*.
- Erhabor, O., & Adias, TC. (2011). From whole blood to component therapy: the economic, supply/demand need for implementation of component therapy in sub-Saharan Africa. *Transfusion clinique et biologique*.
- Erhabor, O., Adias, TC., & Mainasara, AS. (2013). Provisions of safe blood transfusion services in low-income settings in West Africa, case study of Nigeria. *Advances in Medical Biology*.
- George, M. (2011). The role of basic laboratory services in strengthening primary health centres.*Indian Journal of Medical Ethics, 8*, 161–163. https://doi.org/10.20529/IJME.2011.064.
- Gift RA, Obindah F (2020). Examining the influence of motivation on organizational productivity in Bayelsa state private hospitals. Open *Access Journal of Science.* 2020;4(3):94–108. DOI: 10.15406/oajs.2020.04.00157.
- Holt D, Bouder F, Elemuwa C, Gaedicke G, Khamesipour A, Kisler B, Kochhar S, Kutalek R, Maurer W, Obermeier P, Seeber L, Trusko B, Gould S, Rath B (2016). The importance of the patient voice in vaccination and vaccine safety-are we listening? Clin Microbiol Infect. Dec 1;22 Suppl 5:S146-S153. doi: 10.1016/j.cmi.2016.09.027. Epub 2016 Dec 6. PMID: 27939015.
- Jain, R., & Rao, B. (2019). Role of laboratory services in primary health center (PHC) outpatient department performance: An Indian case study. *Primary Health Care Research & Development, 20*, e112. https://doi.org/10.1017/S1463423619000537.
- Jeremiah, ZA., Mordi, A., Buseri, FI., & Adias, TC. (2011). Frequencies of maternal red blood cell alloantibodies in Port Harcourt, Nigeria. *Asian Journal of Transfusion Science*.
- Jeremiah, ZA., Adias, TC., Opiah, M., George, SP., Mgbere, O., & Essien, EJ. (2012). Elevation in D-dimer concentrations is positively correlated with gestation in normal uncomplicated pregnancy. *International Journal of Women's Health, 4*, 437–443.
- Koleayo O, Susan E, Adeyemi A, Sunday A, Kolawole O, Andrew O, Olapeju A, Aziba-anyam G.R (2021a) Drivers of Telecommuting Policy in Nigerian Organisations. *International Journal of Business, Technology, and Organizational*

*Behavior (IJBTOB)* ISSN: 2775-4936. Vol. 1 No. 4, August 2021. DOI:https://doi.org/10.52218/ijbtob.v1i4.105. https://ijbtob.org.

- Koleayo OO, Adeyemi AA, Mary AA, Grace OE, Allen E, Kolawole AO; Aziba-anyam GR (2021b) Assessment of Factors Underpinning Employee's Interest and Preference for Telecommuting in Lagos Island, Lagos, Nigeria. *International Journal of Business, Technology, and Organizational Behavior (IJBTOB)*ISSN: 2775-4936. Vol. 1 No. 4, August 2021. DOI: https://doi.org/10.52218/ijbtob.v1i4.104. https://ijbtob.org.
- Li, R., Duffee, D., & Gbadamosi-Akindele, MF. (2024). CD4 Count. [Updated 2023 May 1st]. In:*StatPearls* [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 January-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK470231/
- Mordecai O, Uchenna GE, Emma A, Elemuwa TD; Gabriel JO; Egberipou T; Etim EO;Christopher OE; Morufu OR; Anuoluwapo B (2024). Analyzing Nigeria's Journey Towards Sustainable Development Goals: A Comprehensive Review From Inception to Present. Qeios. doi:10.32388/8O5QEG.
- Mordecai O, Gabriel JO, Chris OE, Emma A, Elemuwa DT, Azodoh V (2023) The Impact of Poverty on Under 5 Children in Rural Communities of the West African Region. *International Journal of Advanced Multidisciplinary Research and Studies*. 3(5): 644-650.
- Moreen Kamateeka, C. Elemuwa, T. Okwor, AS. Faruk, I. Suleiman1, D. Chukwuma, E. Adedire, C. Ameh, K. Ibrahim, D. Gazama, O. Surajudeen, S. Kozikott, C. Lee, P. Nguku (2023) Strengthening infection prevention and control in primary health care: An assessment of a multimodal intervention programme in Nigeria: -- In -Press.
- Morufu OR, Aziba-anyam GR and Teddy CA (2021a) 'Silent Pandemic': Evidence-Based Environmental and Public Health Practices to Respond to the Covid-19 Crisis. *IntechOpen.* DOI: http://dx.doi.org/10.5772/intechopen.100204. ISBN 978-1-83969-144-7. https://www.intechopen.com/online-first/silent-pandemic-evidence-based-environmental-and-public-health-practices-to-respond-to-the-covid-19-Published: December 1st 2021; ISBN: 978-1-83969-144-7; Print ISBN: 978-1-83969-143-0; eBook (PDF) ISBN: 978-1-83969-145-4. Copyright year: 2021.
- Morufu OR, Aziba-anyam GR, Teddy CA (2021b). Evidence-based Environmental and Public Health Practices to Respond to the COVID-19 Crisis, 07 May 2021, PREPRINT (Version 1) available at Research Square [https://doi.org/10.21203/rs.3.rs-504983/v1] https://europepmc.org/article/PPRID/PPR335534; EMSID:EMS123969.
- Morufu OR, Ebikapaye O, Tuebi M, Aziba-anyam GR, Adedoyin OO, Aishat FA, Mariam OR, Beatrice OJ (2021c) Do Weak Institutions Prolong Crises? [#ENDSARs] in the Light of the Challenges and opportunities beyond COVID-19 Pandemic and the Next Normal in Nigeria. *Communication, Society and Media.* ISSN 2576-5388 (Print) ISSN 2576-5396 (Online) Vol. 4, No. 2, DOI: https://doi.org/10.22158/csm.v4n2p1. http://www.scholink.org/ojs/index.php/csm/article/view/3790.
- Morufu OR, Tonye VO & Adedoyin OO (2021d) Creating the Healthiest Nation: Climate Change and Environmental Health Impacts in Nigeria: A Narrative Review. *Scholink Sustainability in Environment.*ISSN 2470-637X (Print) ISSN 2470-6388 (Online) Vol. 6, No. 1, 2021 www.scholink.org/ojs/index.php/se. URL: http://dx.doi.org/10.22158/se.v6n1p61. http://www.scholink.org/ojs/index.php/se/article/view/3684.
- National Primary Health Care Development Agency. (2007-2012). *Ward Minimum Health Care Package*.
- Nwokoro, UU., Ugwa, OM., Ekenna, AC., Obi, IF., Onwuliri, CD., & Agunwa, C. (2022). Determinants of primary

healthcare services utilization in an under-resourced rural community in Enugu State, Nigeria: A cross-sectional study. *Pan African Medical Journal, 42*, 209. https://doi.org/10.11604/pamj.42.209.33317.

- Olalekan RM (2020). “What we learn today is how we behave tomorrow”: a study on satisfaction level and implementation of environmental health ethics in Nigeria institutions. *Open Access Journal of Science*; 4(3):82–92. DOI: 10.15406/oajs.2020.04.00156.
- Olalekan RM, Olawale SH, Christian A, Simeon AO (2020). Practitioners Perspective of Ethical Cases and Policy Responses by Professional Regulator: The Case of Environmental Health Officers Registration Council of Nigeria (EHORECON). *American Journal of Epidemiology & Public Health*. 2020;4(1): 016-023. https://www.scireslit.com/PublicHealth/AJEPH-ID23.pdf https://www.scireslit.com/PublicHealth/articles.php?volume=4&issue=1.
- Opeyemi, AA. BMLS, Abdulbasit, A., Obeagu, EI. Ph.D., & Hassan, AO. Ph.D. (2024). Enhancing quality healthcare in Nigeria through medical laboratory services: A review. *Medicine, 103*(2), e36869. https://doi.org/10.1097/MD.0000000000036869.
- Osaro, E., & Charles, AT. (2010). Rh isoimmunization in Sub-Saharan Africa indicates need for universal access to anti-RhD immunoglobulin and effective management of D-negative pregnancies. *International Journal of Women's Health*.
- Osaro, E., & Charles, AT. (2011). The challenges of meeting the blood transfusion requirements in Sub-Saharan Africa: The need for the development of alternatives to allogenic blood. *Journal of Blood Medicine*.
- Osaro, E., & Charles, AT. (2012). Laboratory total quality management for practitioners and students of medical laboratory science. Paperback.Author house, UK, ISBN: 9781477231104.
- Osaro, E., & Charles, AT. (2014). Harmony in health sector: A requirement for effective healthcare delivery in Nigeria. *Asian Pacific Journal of Tropical Medicine*.
- Raimi, OM., Sunday, OA., Mcfubara, KG., Adias, TC., Raimi, GA., Daniel, AA., Izah, SC., Okoyen, E., Ogbointuwei, C., Clement, A., Godspower, A., & Funmilayo, AA. (2022). Perspective Chapter: Applying Innovative Research as a Tool to Advance Immunization Coverage in Bayelsa State, Nigeria. In M. O. Raimi, O. A. Sunday, H. O. Sawyerr, & T. C. Adias (Eds.), Emerging Issues in Environmental Epidemiology and Its Reflection [Working Title]. IntechOpen. https://doi.org/10.5772/intechopen.106513.
- Raimi OM, Lucky EC, Okoyen E, Clement A, Ogbointuwei C, *et al.* (2021a) Making Better Informed, More Confident COVID-19 Decisions: Vaccine Hesitancy, Its Barriers and Impact Studies: Taking Bayelsa State as an Example. Int J Vaccine Immunizat 5(1): dx.doi. org/10.16966/2470-9948.126. https://sciforschenonline.org/journals/vaccines/IJVI126.php.
- Raimi, MO., Mcfubara, KG., Abisoye, OS., Ifeanyichukwu EC., Henry SO., & Raimi, GA (2021b) Responding to the call through Translating Science into Impact: Building an Evidence-Based Approaches to Effectively Curb Public Health Emergencies [COVID-19 Crisis]. *Global Journal of Epidemiology and Infectious Disease*; 1(1). DOI: 10.31586/gjeid.2021.010102. Retrieved from https://www.scipublications.com/journal/index.php/gjeid/article/view/72.
- Raimi MO & Raimi AG (2020). The Toughest Triage in Decision Impacts: Rethinking Scientific Evidence for Environmental and Human Health Action in the Times of Concomitant Global Crises. *CPQ Medicine,* 11(1), 01-05.

- Raimi MO, Moses T, Okoyen E, Sawyerr HO, Joseph BO, Oyinlola BO (2020) “A Beacon for Dark Times: Rethinking Scientific Evidence for Environmental and Public Health Action in the Coronavirus Diseases 2019 Era” *Medical and Research Microbiology,* Vol. 1, Issues 3.
- Raimi MO, Omidiji AO, Ebikapaye O, Moses T, Adeolu TA, Makanjuola Bosede C (2019a), Situational Analysis of National Immunization Programme in Nigeria, *Journal of Immunology and Inflammation Diseases Therapy.* Doi: http://dx.doi.org/10.31579/2637-8876.2019/008.
- Raimi MO, Ochayi EO, Babatunde A, Okolosi-Patani IE, Oluwaseun EO, Adio ZO and Bilewu OO (2019b) “Environmental Ethics Relevance to Public Health: Current Narratives and Implications for Policy”. *EC Emergency Medicine and Critical Care* 3.12:01-09.
- Raimi MO, and Ochayi EO. (2017) Assessment of the Rate of Sexually Transmitted Diseases in Kubwa F.C.T. Abuja, Nigeria, *Science Journal of Public Health*. Vol. 5, No. 5, 2017, Pp. 365-376. DOI: 10.11648/J.Sjph.20170505.12.
- Rath B, Ali M, Elemuwa C, Maurer W, Bouder F, Mworozi E, Diedrich S, Khamesipour A, Chitwood I, Kochhar S (2012); Vienna Vaccine Safety Initiative. Prioritizing polio. Expert Rev Vaccines. 2012 Dec;11(12):1389-92. doi: 10.1586/erv.12.128. PMID: 23252381.
- Samson TK, Ogunlaran OM, Raimi OM (2020); A Predictive Model for Confirmed Cases of COVID-19 in Nigeria. *European Journal of Applied Sciences*; Volume 8, No 4, Aug 2020;pp:1-10. DOI: 10.14738/aivp.84.8705. DOI: https://doi.org/10.14738/aivp.84.8705.
- Samuel TA, Chris O, Aziba-anyam GR, Morufu OR, & Daniel JK (2023) Implementation Assessment of Electronic Records Management System in Bayelsa State, Nigeria. *Communication, Society and Media.* ISSN 2576-5388 (Print) ISSN 2576-5396 (Online) Vol. 6, No. 3, 2023. URL: http://dx.doi.org/10.22158/csm.v6n3p69 www.scholink.org/ojs/index.php/csm.
- Susann M, Georgina R, Mohammad A, Gabriela C, Chris E, Ali K, Wolfgang M, Edison M, Sonali K, Gabriella R, Dominique V, Barbara R (2012), Safety reporting in developing country vaccine clinical trials. A systematic review, Vaccine, Volume 30, Issue 22, 2012, Pages 3255-3265, ISSN 0264-410X, https://doi.org/10.1016/j.vaccine.2012.02.059.
- Ukwandu NC, Nmorsi OP, Oyahkire GK, Nwaosu SC, Adebayo IA, Elemuwa CO (2001). The evaluation of non-specific cellular immunological parameters amongst children with Schistosoma haematobium infection in Nigeria. *J Trop Pediatr.* Oct;47(5):260-5. doi: 10.1093/tropej/47.5.260. PMID: 11695723.
- Uko, Emmanuel K., Erhabor, Osaro, Isaac, Isaac Z., Abdulrahaman, Yakubu, & Ahmed, Mohammed. (2013). Some hematological parameters in patients with type-1 diabetes in Sokoto, North Western Nigeria. *Journal of Blood & Lymph.*
- Van Weel C, Kidd MR (2018). Why strengthening primary health care is essential to achieving universal health coverage. CMAJ. 2018 Apr 16;190(15):E463-E466. doi: 10.1503/cmaj.170784. PMID: 29661815; PMCID: PMC5903888.
- WHO PAHO. (2024). Primary health care. Retrieved from https://www.paho.org/en/topics/Primary-health-care#:~:text=PHC%20is%20also%20critical%20to,%20surges%20in%20demand%20for%20services. Accessed March 10, 2024.