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TOXICOLOGY VERSUS NUTRITION; PRO-OXIDANTS VERSUS ANTIOXIDANTS; EACH, A COIN WITH TWO SIDES: WHICH ONE IS THE KILLER?

12th

INAUGURAL
LECTURE

TUESDAY, 24TH SEPTEMBER, 2024

Gombe State University

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12th Inaugural lecture Delivered at the New Multipurpose Hall of the Gombe State University on Tuesday, 26th November, 2024

By

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PROTOCOL

The AG. Vice Chancellor, Professor Sani Ahmed Yauta,

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Other HODs

Management and Staff of Other Universities,

Royal Highnesses and Majesties,

Eminent Colleagues - Academic, Non-Academic & Professional,

Representatives and Members of Professional bodies and Staff Unions,

My Parents, family and friends,

Invited guests,

Dear Students,

The Press,

Distinguished Ladies and Gentlemen.

Good day!

I am deeply honoured to welcome you to my inaugural lecture, marking the 12th inaugural lecture of Gombe State University, the 3rd within the College of Medical Sciences, and the 1st from the Department of Chemical Pathology.

SUMMARY OF MY LIFE

Early Years

As a child born in Jekada Fari, Gombe, to parents who did not receive western education, I faced various challenges and identity crises. I wondered about what I should do with my life and what I wanted to become: a farmer like my father, a civil servant like my elder brother, or a trader like my cousin Alhaji Miji, who actually took me to primary school. Even before, and after joining Jankai Primary School, I engaged in various trades, most of which incidentally involved food items and exposures to various toxins—my first, albeit unintentional, introduction to the fields of nutrition and toxicology. I earned the nickname "Sani Mai Kunu" for selling traditional pap made from millet. I also sold water, groundnuts, tomatoes, peppers, sugar cane, cola nuts, among others. Additionally, I helped my father with farming activities and worked in a blacksmith's shop during different stages of my primary and secondary education.

Figure 1: Jankai primary school, 1984

These activities exposed me to various toxins, including insect stings, snake bites, and one notable occasion where I ingested peanuts without knowing they had been treated with chemicals to deter birds and insects. During my secondary school days, I worked as a labourer at construction sites to raise money for my Senior Secondary Certificate Examination (SSCE) fees, exposing myself to hazardous materials like cement dust and silicon. All these activities, like two sides of a coin, brought both benefits and risks.

Coming from the high educational standards of Pilot Junior Secondary School, where I was taught by dedicated educators like Mr. Henry and Malam Galadima, it was challenging to adapt to the lower standards at Government Technical College, Kumo, where I completed my senior secondary education. Despite my efforts to secure a transfer to a better school, my attempts were unsuccessful. Nevertheless, I was celebrated for achieving the best SSCE results in eight years, even though I only managed to get four credits and four passes, with a distinction in Islamic Religious Knowledg, thanks to the extra lessons we took with the likes of Eng Tasiu Adamu Mai Kusa, Auwal Ibrahim (Braza), Shykh Isa Ali and Malam Ibrahim Sale Sadauki. I was the chief Imam and the health prefect at that school (two different roles that are difficult to combine). I had to offer to resign from health prefect due to conflicting interest emanating from the two jobs, if not for the intervention of my principal and father, Malam Danladi Maigari. An incidence I will not forget was when I started joining extra lessons in Government Science Secondary school, Gombe in our quest to pass SSCE. I was not lucky as the principal and the management had noticed a shortage in students' meals and fingers were pointed at the outsiders like us. I was asked about my school and I told them I was from GSS Malam Sidi. Not sooner than I mentioned Malam Sidi, a dirty slap fell upon my cheek by the principal saying this is my Malam Sidi and we were sent away.

University education

My academic journey continued at the University of Maiduguri, where I enrolled in remedial sciences with guidance from esteemed friends like Prof. Manga and Engineer Muhammed Isa Jibrin in my attempt to convert to life sciences from my technical background. It only took the intervention of Professor JD Amin (then coordinator, remedial sciences) to register me due to an error in the admission letter.

Initially, I contemplated pursuing arts instead of sciences due to the numerous challenges I faced. However, a life-changing encounter with a final-year medical student who labelled me as "lazy" for considering a shift to arts motivated me to prove him wrong. This incident led to my determined effort to pursue MBBS, which I ultimately succeeded in achieving with the support of friends like Yuguda, Yusuf, Aminu, Shamaki, Bojude, and Auwal Hamza who were a year ahead.

My journey through the University was not without challenges, including a pivotal moment when I scored only 0.2/6 in my first Continuous Assessment test in biology. This setback became a turning point, driving me to memorize every lecture note and handout, ultimately leading to my success in the remedial program with distinctions in two subjects, including biology.

Through the support of esteemed individuals such as Emeritus Professor Idris Mohammed FAS (Dan Isan Gombe), Imam Goni Gabchiya of Unimaid Central Mosque, and Shaikh Isa Pantami, I was admitted to the MBBS program. Alhamdulillah, I successfully completed my medical education without having to resit any subjects or repeat any classes, a blessing I remain grateful for. But a true confession is that, I still have some bad dreams taking me back to medical school and failing me some examinations. These dreams look real whenever they come.

MBBS journey was very eventful, the highest of which was welcoming my first daughter, Batool on the fifteen of January in my fifth year. She is now a year four medical student.

Figure 2: Myself with Fatima Batool (my 1st Daughter)

Medical Practice

Housemanship

I completed my housemanship at the Federal Medical Centre (FMC), Gombe. I particularly enjoyed my final posting in Obstetrics and Gynaecology due to the high standards of work, teaching, and excellent

organization under Professor Bukar (now Provost, College of Medical Sciences, University of Maiduguri). In my valedictory speech, I mentioned that although Obstetrics and Gynaecology was my last posting, it was the best, and I would have considered my training incomplete without it.

I have vivid memories of the morning presentations in Paediatrics, especially when Professors Jalo and Isaac were present. The presentations were intense, as we had to discuss admissions and mortalities. Even if there were no admissions or mortalities to present, they would still question us, asking what we did during the night. If you said you slept, they would ask you about the physiology of sleep; if you sat down till morning, they would quiz you on the anatomy of the gluteal muscle. I'm thankful that I completed that posting without any extensions.

Mr VC, Sir, during this period, I interacted with, treated, and learned from many people, including my trainers and colleagues—doctors, nurses, pharmacists, record officers, laboratory staff, administrative staff, attendants, security officers, and cleaners—as well as patients and their relatives, and hospital visitors. A particularly emotional aspect of the job was the bond we established with patients and their families. We would often shed tears when we lose a patient, even though we appear strong in front of the relatives. What was even more moving was the gratitude expressed by the relatives of the deceased, even at the moment of receiving the sad news. Many times, they would say, "Thank you, doctor," while crying. I often ask my students whether this

kind of bond is still present in our medical practice today, and if not, what has changed?

NYSC/ Medical officer

My National Youth Service Corps (NYSC) assignment was in Primary Healthcare Centre Iganna, Iwajowa LGA, Oyo State. I recall arriving in Ibadan late one evening and being greeted by a machete on my neck due to the ongoing Tokyo Must Go crisis at that time (Professor Yuguda would remember this). At Iganna, I was the only resident medical doctor in the entire local government, and one can imagine the anxiety I experienced. Nevertheless, it was a successful experience, and I was honored with the title of "Olori Olonje of Oyo State" and "Sibigana of Iganna Land." I was given a warm send-off by a large crowd at a ceremony organized by the head of healthcare services and attended by the LGA Chairman.

Immediately after my NYSC, I reported to the Gombe State Ministry of Health. However, it took about six months before I received a posting to the General Hospital, now Specialist Hospital, Gombe. The delay in my posting letter was because the state government was deliberating on how to handle my appointment due to my unionist activities as a house officer. During my tenure at the General Hospital, I covered both the General Outpatient Department (GOPD) and Accident & Emergency (A&E) units. I also worked in the Surgery, Obstetrics & Gynaecology, and Medicine departments. It was a very hectic period due to the lack of adequate manpower and limited facilities. Nonetheless, we did our best, and I remain grateful for the experience.

Residency training

Choosing Chemical Pathology as my specialty was more by accident than design. During my NYSC, I was contacted by the then MD of FMC, Gombe, Professor Aliyu Usman Elnafaty, who offered me a residency appointment. Without hesitation, I accepted the offer and began my journey in Chemical Pathology. I proceeded to the University College Hospital (UCH), Ibadan, after a significant struggle with the state government, which insisted we repay the bond. Professor Elnafaty was even willing to pay the state government on our behalf to allow us to go. Sir, we are eternally grateful.

Adapting to life in Ibadan was made easier by the support of my good friends, Drs. Yusuf and Bojude, who had already settled there and assisted me and Prof Yuguda significantly. We had heard many stories about the challenging environment at UCH and were prepared for it. We were particularly warned about two female professors in the Department of Haematology. Ironically, these two professors became the greatest supporters during our stay at UCH Ibadan.

Mr. Vice Chancellor, Sir, I was privileged to be taught and mentored by renowned Chemical Pathologists and experts in Metabolic Medicine such as Professors Abiyesuku, Akinosun, Akinlade, and Adadapo. Others who contributed to my training included Drs. Kuti, Osuji, Ghazali, Olawale, and Ekpe. I also received mentorship from Professors Aken'Ova YA, Shokunbi WA, Ogunbiyi JO, and Bakare RA, in other pathology departments at UCH. I also had the privilege of working with wonderful metabolic nurses and laboratory scientists,

such as Mama Olusola (of blessed memory) and Sister Akinola, who treated me as a son and brother, respectively.

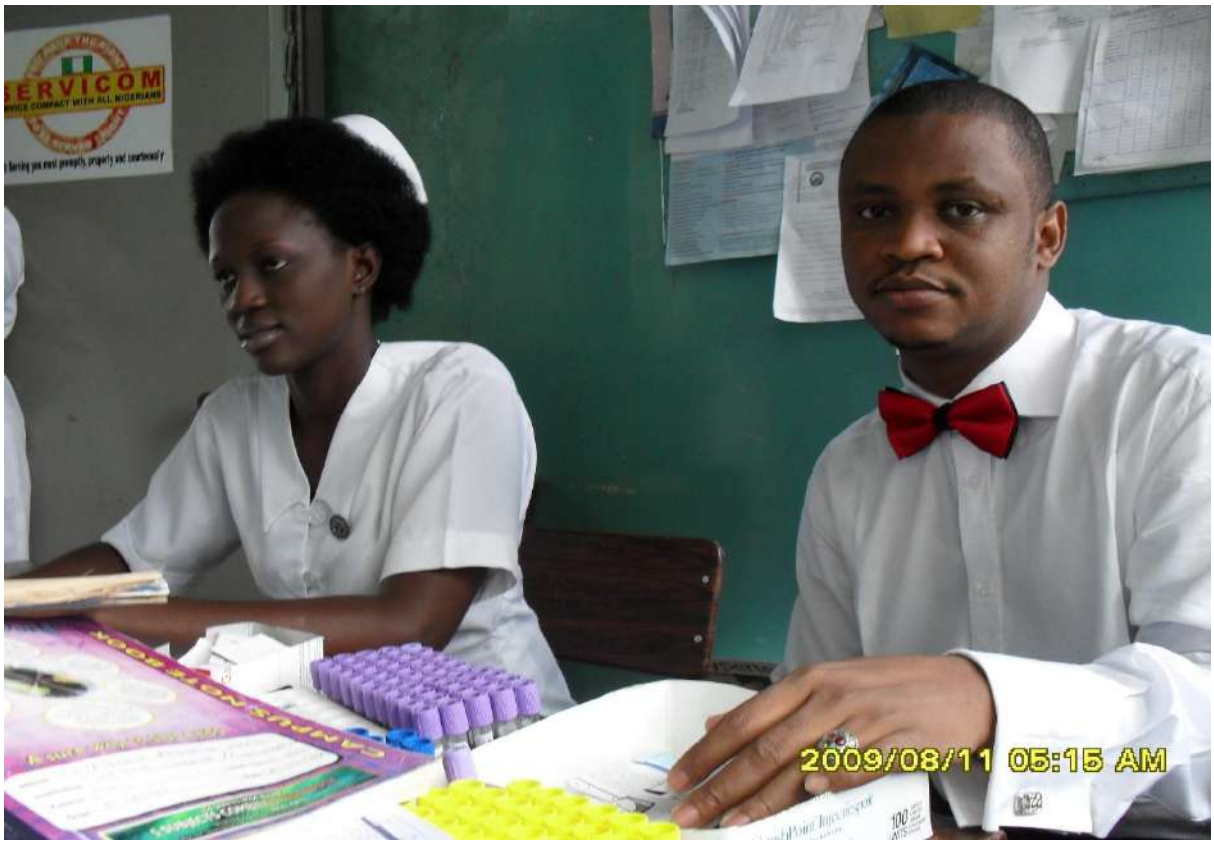

Figure 3: With Sister Akinola at the UCH Metabolic Clinic in 2009

Beyond Ibadan, I was taught, mentored, and examined by (the father of Chemical Pathology in Nigeria), Professor Afonja, who we honored by naming the yearly award for the best graduating medical student in Chemical Pathology after him. My part 2 book assessor was the former President of the National Postgraduate Medical College of Nigeria (NPMCN), Professor Wakwe, I am deeply indebted to him for the mentorship. Other mentors included Professor Aliyu Sambo of ABU Zaria, who is my supervisor in the ongoing MD program of the NPMCN, Professor Dahiru Mishelia of Unimaid, Professor Idogun (Faculty Secretary, NPMCN), Professor Ojo (Faculty Chairman, NPMCN), Professor Adesina, Professor Akande, and Professors

Adebisi. It is impossible to mention everyone who has mentored me in one way or another in the field of pathology.

Figure 4: With my teacher and mentor; Prof FM Abbiyesuku

Chemical pathology practice

I began my residency training in Chemical Pathology as a supernumerary resident at the prestigious University College Hospital (UCH), Ibadan, in 2008, sent by the then FMC Gombe under the leadership of the Former GSU Vice Chancellor, Professor Aliyu Usman El-Nafaty. In 2010, I became a Senior Registrar after passing the Part One exams of the National Postgraduate Medical College, where I was awarded the Dr. Alexander Eyimofe Boyo Award for the best candidate in Part I (Chemical Pathology). This award was particularly emotional for me because I had been disqualified from

writing the exam a few days after failing the West African College of Physicians' exams. The disqualification was said to be due to late submission of my application, despite presenting evidence to the contrary. The college insisted on their decision, stating that they had already procured exam materials for the number of approved candidates. However, this decision was eventually reversed due to the kind intervention of Professor Aken'Ova of the Haematology Department at UCH, who spoke to the Faculty Chairman, Professor Durosinmi.

As a Senior Registrar, I began engaging with the core clinical departments at UCH. Some of the cases I attended to include:

- **Case 1:** An elderly woman in the ICU with a stroke who had a reported potassium level of 30 mmol/L (reference values 3.5-5.5 mmol/L), which was 31 mmol/L upon repeat testing.
- **Case 2:** A 22-year-old patient presenting with acute abdomen and being prepared for surgery had a potassium level of 21 mmol/L.
- **Case 3:** A neonate in the Special Care Baby Unit (SCBU) had a total calcium level of 0.02 mmol/L (reference values 2.2-2.7 mmol/L), ionized calcium of 0.01 mmol/L (reference values 0.9-1.2 mmol/L) and a potassium of 10mmol/L.

These levels were not compatible with life. After investigations, we identified the errors in Cases 1 and 2 as being due to incorrect sample collection (samples collected from an IV line used for potassium correction). The teaching here is that if samples must be collected from an arm vein with IV line, it must be taken below the IV line. The IV line should be shut off using the stopcock, and twice the volume of the

tube should be withdrawn and discarded before any sample is taken to avoid interference from the fluid being infused. After correcting these procedures, the results were reported as follows:

- **Case 1:** Potassium – 3.5 mmol/L
- **Case 2:** Potassium – 2.6 mmol/L

The 3rd case was discovered to be taken into K3 EDTA sample bottle. The potassium in the sample bottle combining with the potassium in the sample produced a falsely elevated potassium while the EDTA being a calcium chelator consumed the calcium in the sample to produce a falsely decreased calcium.

I became a Fellow of the National Postgraduate Medical College of Nigeria (NPMCN) after passing the Part II examinations in the Faculty of Pathology. Upon my return to FMC Gombe in 2013, I was appointed the first resident consultant pathologist in the Department of Chemical Pathology under the leadership of Mr. Aliyu Audu. In this role, I offered clinical chemistry services that bridged the gap between the chemical pathology laboratory and clinicians, trained, and supervised residents on posting from other clinical departments.

At that time, I was the second practicing Chemical Pathologist in the North-East after my teacher, Professor Dahiru Mishelia in Maiduguri. This position placed a significant responsibility on me as I had to assist Professor Mishelia in teaching and maintaining the accreditation of the only existing functional medical college in the region, where I was appointed a visiting lecturer I in 2013. We carried out this work despite the challenges posed by the Boko Haram insurgency during its peak period. We often travelled through exceptionally dangerous routes,

encountering both military checkpoints and Boko Haram operations. On several occasions, we moved from the university to the teaching hospital on deserted roads, with only vigilante and military checkpoints where thorough interrogations were conducted.

Since then, I have been involved in establishing most, if not all, of the medical schools in the North-East. My contributions included curriculum development, teaching, accreditations, and examinations. Additionally, I served as a member of the laboratory subcommittee of the Gombe State Taskforce on Covid-19 during the pandemic. I was also appointed as a visiting lecturer at Abubakar Tafawa Balewa University, Bauchi, as well as a Visiting Consultant at Abubakar Tafawa Balewa University Teaching Hospital, Bauchi.

In 2014, I was appointed the Head of the Department of Chemical Pathology at FTH, Gombe, a position I held until 2019. In 2016, I was appointed as a Senior Lecturer and the pioneer Head of the Department of Chemical Pathology at Gombe State University, where I trained medical students and resident doctors in Chemical Pathology, including toxicology and nutrition. In 2019, I was appointed the second Dean of the Faculty of Basic Clinical Sciences, where I served until 2021. During this period, I spearheaded the establishment of the Department of Chemical Pathology at Gombe State University, including the training laboratory. I also led the establishment of the Metabolic Research Clinic and Laboratory at FTH, Gombe. Furthermore, I introduced new laboratory investigations, improved the turnaround time of various laboratory tests, and conducted research on reducing preanalytical errors responsible for most laboratory errors in hospital settings.[1,2]

I have managed patients with obesity and other metabolic conditions, including consultations from various clinical departments. Additionally, I have served as an external examiner in Chemical Pathology for various medical schools, including Bayero University, Kano and Amadu Bello University, Zaria. I also served as an examiner in the Faculty of Pathology of the NPMCN and have trained and supervised many successful postgraduate candidates for the fellowship of the NPMCN. Moreover, I have assessed numerous dissertation proposals for the National Postgraduate Medical College. I also served as a member of the subspecialisation committee of the Chemical Pathology Department in the NPMCN and was a resource person in the Part Two Update Course of NPMCN on nutritional assessment. Recently, I was appointed as the centre coordinator for the 41st and 42nd convocations of the NPMCN, covering Gombe, Bauchi, Yobe, and Adamawa states.

Healthcare Service Administration and Training of Manpower for Health

In 2021, I was appointed the Deputy Chairman, Medical Advisory Committee (DCMAC), and in 2023, I became the Chairman, Medical Advisory Committee (CMAC). Working under the leadership of my boss, Dr Yusuf M. Abdullahi, the hospital has witnessed unprecedented improvements in infrastructure and manpower development, including the total digitization of patient care. In my capacity as Head of Clinical Services, Training, and Research, I have supported the accreditation and reaccreditation of various clinical departments, as well as the establishment of various schools in the hospital, including the College of Nursing. I have also supported staff training, supervised SIWES

students from different institutions across Nigeria, and provided guidance for NYSC members.

As the Chairman of the Medical Board of FTH Gombe, I have been involved in resolving many cases of staff who were afflicted with various diseases, where their ability to continue working was questioned. I have also been involved in settling numerous disputes, some of them legal, relating to the hospital and sometimes involving non-staff members. Additionally, I have played a role in strengthening the bonds between FTH Gombe and other federal and state government agencies in the state.

Mr VC, Sir, I have served as a member of the editorial boards for the Jewel Journal of Medical Sciences and the Gombe Medical Journal. I also review manuscripts for several journals, including Annals of Tropical Pathology, Nigerian Medical Journal, Jewel Journal of Medical Sciences, and Gombe Medical Journal, among others.

Community Services

In addition to my academic and professional commitments, I have actively participated in community service. I served as a member of the health subcommittee for the transition committee of His Excellency Alhaji Inuwa Yahaya in 2019 and was also a member of the Laboratory Sub-committee for the Gombe State Taskforce on Covid-19. Furthermore, I served as a member of the National Medical Team for the 2016 Hajj in the Kingdom of Saudi Arabia.

My involvement in community organizations includes serving as the National President of the Gombe State Medical Students' Association (GOMSA) in 2002. I was also a member of the National Executive

Committee (NOC) of the Medical and Dental Consultants' Association of Nigeria (MDCAN), where I served as National Auditor. Additionally, I have held various leadership positions within MDCAN, including Assistant Secretary, Secretary, Vice Chairman, and Chairman of the FTH branch. I was also a member of the National MDCAN Committee on Internally Displaced Persons (IDPs) and have chaired and served on numerous Local Organizing Committees (LOCs) for annual general meetings, scientific conferences, and National Executive Council meetings of various professional medical organizations like MDCAN and NMA.

At the departmental, faculty, college, and university levels of Gombe State University, I have served on and chaired many committees, contributing to the institution's growth and development.

Mr. Vice Chancellor, Sir, all the institutions I have mentioned above have provided me with rare privileges to learn and teach, to be mentored and to mentor, to train and be trained, to supervise and be supervised, as well as to facilitate academic, clinical, and research works for undergraduate and postgraduate students in laboratories, at bedsides, in classrooms, and in clinics.

I have been fortunate to receive recognition and appreciation from my community through various awards of excellence. I was conferred with the prestigious titles of Sardaunan Lubo and Sarkin Yamman Zambuk, from where my father and mother respectively hailed.

Mr VC, Sir, after giving a brief chronological history of my humble self, I seek your kind permission to briefly introduce the main topic of discussion:

INTRODUCTION

Toxicology and nutrition are two distinct yet interconnected fields that often intersect in ways that significantly impact human health. Although they may appear to be on opposite ends of the spectrum, both play crucial roles in defining who we are—after all, we are what we consume. The intersection between toxicology and nutrition is increasingly recognized as a critical area in modern healthcare, with both contributing to global public health challenges.

What we eat can influence our health in both positive and negative ways. A healthy diet with an optimal balance of nutrients helps people accomplish daily physical activities and mental processes. However, an imbalance—whether due to a deficiency or excess of certain nutrients—can also have detrimental effects.

On the other hand, poisons are substances that produce harmful effects when an organism is exposed to them. The number of poisons is virtually unlimited, with various modes of entry that may cause local or systemic diseases. Despite their dangerous effects, humans have historically exploited poisons for their own benefit, highlighting the complex relationship between toxicology and nutrition.

NUTRITION

Optimal nutritional status is a powerful factor in promoting health and preventing diseases. Good nutrition is associated with numerous health benefits, including safer pregnancy and childbirth, improved infant, child, and maternal health, stronger immune systems, lower risk of non-communicable diseases (such as diabetes and cardiovascular disease), and increased longevity. Well-nourished individuals learn better, are more productive, and can create opportunities to break the cycles of poverty and hunger. For patients, good nutrition reduces hospital stays, lowers the risk of infections and other hospital-acquired diseases, and accelerates wound healing. Optimal nutrition also slows disease progression and enhances the human response to treatment, thereby reducing healthcare-associated costs.[3] Good nutrition also reduces the

harmful health effects of toxins or poisons, further emphasizing its importance in maintaining overall health.

Recent studies have linked various nutrients to the prevention of specific diseases. For example, vitamin D has been associated with asthma prevention, low maternal plasma lead with the prevention of childhood obesity, and B vitamins (folate, B12, B6) with the prevention of DNA damage.

However, the other side of the coin, which I term "toxicology of nutrition," refers to malnutrition and its consequences.

Malnutrition

Malnutrition refers to deficiencies, excesses, or imbalances in energy and nutrient intake. Today, the world faces a double burden of malnutrition, encompassing both undernutrition and overnutrition, particularly in low- and middle-income countries. This has led to serious and lasting developmental, economical, social, and medical impacts on individuals, families, communities, and nations. According to a United Nations report, 1 in 11 people worldwide faced hunger in 2023, with 1 in 5 people in Africa, amounting to nearly a billion people. If current trends continue, about 582 million people will be chronically undernourished by 2030, with half of them being in Africa, thus undermining the Sustainable Development Goal (SDG Goal Number 2) of achieving zero hunger by 2030.[3]

With all the benefits of nutrition mentioned above, the other side of the coin presents a stark reality: undernutrition.

Undernutrition

Undernutrition can lead to severe health outcomes, including death. A weight loss of ≥10% is associated with adverse outcomes and prolonged hospitalization and may result in death when a lean, healthy person loses more than 35% of his body weight.[4,5]

Unfortunately, undernutrition remains highly prevalent in our society, affecting up to 50% of certain populations and contributing to nearly

45% of under-five deaths in some regions[5,5,6]. Some reports suggest that up to 70% of admitted patients are either malnourished or at risk of undernutrition, and 70% of these cases go undiagnosed[4,5].

Several diseases are directly associated with specific nutrient deficiencies. These include conditions such as neuroglycopenia, tetany, kwashiorkor, marasmus, and neonatal mental retardation. For example, in a study we conducted, about 46% of 150 pregnant women were found to have urinary iodine concentrations below the reference value. This is despite widespread claims of iodine supplementation by food industries. The prevalence of low iodine among these pregnant women increased from 36% in the first trimester to more than 49% in the third trimester. Among the 14 cases with cord blood thyroid-stimulating hormone (TSH) levels greater than 20 mIU/L—suggestive of neonatal hypothyroidism—64% were from mothers with inadequate iodine levels[6,7]. This finding has highlighted the relationship between poor nutrition and perinatal morbidity and mortality.

Another critical nutrient related to perinatal morbidity and mortality is serum calcium. At the Federal Teaching Hospital, Gombe, we corroborated the association between hypocalcaemia and pre-eclampsia (PE), a condition also linked to high perinatal morbidity and mortality in our society. We found significantly lower mean calcium levels among patients with pre-eclampsia compared to normotensive pregnant women. Our study further revealed that pregnant women with pre-eclampsia are 14 times more likely to have hypocalcaemia compared to their normotensive counterparts. Consequently, we concluded that calcium supplementation during pregnancy might reduce the high prevalence of pre-eclampsia.[8]

Table 1: Comparison of ionized serum calcium levels in Pre-eclamptic and Normotensive women attending Federal Teaching Hospital and State Specialist Hospital, Gombe

Parameter	Pre-eclamptic	Normotensive	t-test	p-value
Ionised serum calcium (mmol/L)	1.03 ± 0.11	1.14 ±0.09	10.12	< 0.001

When we examined vitamin D—a major regulator of calcium metabolism, as previously discussed in connection with pre-eclampsia (PE)—we conducted a multiregional survey and we found that the prevalence of hypovitaminosis D was above 30% among healthy adults[9]. This raises important questions: Are these findings linked to the high prevalence of pre-eclampsia associated with hypocalcaemia in our society? Could they be connected to the elevated rates of perinatal morbidity and mortality observed in our region? These are critical areas that warrant further investigation to draw definitive conclusions.

Having explored the significant challenges posed by undernutrition, it is now time to discuss the other side of the coin—overnutrition.

Overnutrition

While undernutrition represents one side of the coin, overnutrition is the other side, characterized by excessive nutrient intake leading to adverse health outcomes. Overnutrition has become a prevalent issue, particularly in developed countries, where it is closely associated with an increased risk of non-communicable diseases such as obesity, diabetes, cardiovascular diseases, and certain types of cancer.

Statistics show that in the United States, about one-third of adults (33.8%) and 17% of children aged 2-19 years are obese due to unhealthy eating habits. This overconsumption of food, particularly those high in calories but low in essential nutrients, contributes significantly to the burden of chronic diseases. For instance, obesity is a major risk factor for the development of hypertension, atherosclerosis, heart disease, type 2 diabetes and osteoporosis.

Nutrients overdose

While certain nutrients are essential for maintaining health, an overdose can have toxic effects. Even glucose, which is a primary energy source

for humans, can become toxic at high concentrations. Hyperglycemia, a condition where blood sugar levels are excessively high, is a classic example of nutrient toxicity. Diabetes, which is primarily a result of chronic hyperglycemia, is associated with numerous complications that affect the heart, kidneys, eyes, limbs, and reproductive organs, and can be fatal if not properly managed.

Calcium and potassium are other examples of essential nutrients that can become harmful when consumed in excess. While both minerals are critical for various bodily functions, their toxicity at high levels is well-documented. For instance, high doses of potassium can disrupt the electrical activity of the heart, leading to potentially fatal arrhythmias. Similarly, calcium, when present in excessive amounts, can cause hypercalcemia, which may result in kidney stones, cardiovascular problems, and in severe cases, impaired kidney function.

Fat-soluble vitamins, such as A, D, E, and K, are particularly prone to causing toxicity because they are stored in the body's fatty tissues and liver, with resultant cumulative effect. Hypervitaminosis, a condition resulting from excessive intake of these vitamins, can manifest in various symptoms depending on the specific vitamin involved. For example, excessive vitamin A intake can lead to liver damage, bone pain, and skin changes, while too much vitamin D can cause hypercalcemia and related complications like arrythmias and death.

In the context of public health, it is important to understand that both undernutrition and overnutrition are detrimental to health. While undernutrition is often more visible and immediately life-threatening, overnutrition can lead to chronic conditions that significantly impact the quality of life and increase the burden on healthcare systems.

As we continue to explore the balance between nutrition and toxicology, it becomes clear that maintaining the right intake of nutrients is crucial for preventing both deficiencies and toxicities. The challenge lies in educating the public and healthcare professionals about the risks associated with both ends of the nutritional spectrum and in developing strategies to ensure a balanced, healthy diet for all populations.

TOXICOLOGY

The phrase "everything is a poison; there is nothing which is not" aptly describes the delicate balance between beneficial and harmful substances. Toxicology is the study of poisons and their effects on the body. It encompasses a wide range of substances that, when present in excess or used improperly, can cause harm. The key principle of toxicology is that the dose differentiates a poison; in other words, almost any substance can be toxic if taken in large quantities.

Poisoning can be either intentional or unintentional, and it can occur acutely or chronically. As a global public health concern, poisoning is responsible for significant morbidity and mortality. According to the World Health Organization (WHO), poisoning accounts for the loss of over 7.4 million years of healthy life annually, measured in disability-adjusted life years (DALYs)[13]. This alarming statistic highlights the widespread and often underestimated impact of poisoning on public health.

The rapid industrialization and extensive mining activities worldwide have led to an increased exposure to a variety of toxic substances. It is neither practical nor necessary to study all of the hundreds or thousands of clinical toxins. Fortunately, only a small number of agents—about 24—account for more than 80% of the cases treated in most emergency units. However, in Nigeria, as in many other African countries, studies on poisoning are typically hospital-based, which inherently introduces bias. Additionally, the lack of a coordinated institutional framework for poisoning prevention and management in Nigeria, along with the absence of national guidelines and information control centres, means that poisoning remains largely underdiagnosed, underreported and undertreated.[10,11]

The nature and frequency of poisoning cases vary between localities. For example, in a study conducted at the Federal Teaching Hospital (FTH) in Gombe over a 20-year period, 76 cases of poisoning were recorded. However, this number may grossly underrepresent the true incidence, as the study was hospital-based. The distribution of these cases is detailed in the table below:

Table 2: Pattern of poisoning among children at FTH Gombe 2000-2019[12]

Poison	%	Cumulative
Organophosphate	22.3	22.3
Organic solvents	22.3	44.6
Snake bites	13.1	57.7
Corrosives	11.8	69.8
Others	30.3	99.8

The study highlighted that poisoning may present with variable symptoms depending on the organ affected, and it can often mimic other diseases. Case fatality rates can be as high as 30% depending on the type of poison involved[13].

Symptoms and Presentations of Poisoning

The clinical presentation of poisoning can vary widely depending on the type of poison, the dose, the route of exposure, and the affected organ systems. Poisoning may manifest with a broad spectrum of symptoms, which can sometimes mimic other medical conditions, making diagnosis challenging. The following are some of the common symptoms observed in poisoning cases, as identified in our study conducted at the Federal Teaching Hospital (FTH) in Gombe:

Table 3: Symptoms of poisoning among patients in FTH, Gombe

Symptoms at presentation		
Vomiting	18	23.7
Fast breathing	12	15.8
Unconsciousness	9	11.8
Cough	8	10.5

Limb swelling & pain	8	10.5
Abdominal pain	8	10.5
Convulsion	6	7.9
Bleeding	2	2.6
Others	5	6.5

These symptoms highlight the complex and multifaceted nature of poisoning cases, which can involve multiple organ systems. Vomiting, a common symptom, often indicates gastrointestinal irritation or central nervous system involvement. Fast breathing may be a sign of respiratory distress, metabolic acidosis, or central nervous system depression. Unconsciousness, observed in some cases, typically suggests severe central nervous system depression or toxic encephalopathy.

In addition to these common symptoms, poisoning can also present with more specific clinical signs depending on the toxic agent involved. For example, poisoning with organophosphates, a common pesticide, often presents with symptoms such as excessive salivation, sweating, muscle twitching, and bradycardia due to the inhibition of acetylcholinesterase, leading to an accumulation of acetylcholine at neuromuscular junctions.

Another example is snakebite envenomation, which can present with a variety of symptoms ranging from local pain and swelling to systemic effects such as coagulopathy, renal failure, and neurotoxicity. In a study we conducted, we found 153 cases of snakebite in a single healthcare centre over a period of less than two years. Given the high rate of false positives and negatives with the current diagnostic method for snakebite envenomation (the 20-minute Whole Blood Clotting Time [WBCT]), we sought to find an alternative diagnostic test. We focused on liver enzymes, given the liver's central role in metabolism and detoxification. Our study found a significant rise in aspartate aminotransferase (AST) and gamma-glutamyl transferase (GGT) levels among patients bitten by venomous snakes (Echis ocellatus) compared to those bitten by non-venomous snakes. We suggested the addition of these biomarkers in the diagnosis of snakebite envenomation to avoid

the false-negative cases that lead to delays in treatment and severe consequences[14].

Toxicology of nutrition

The intersection of toxicology and nutrition is an area of growing concern, particularly with the increasing use of chemicals in food production, food storage and food processing. The potential deleterious effects of toxic chemicals found in food—such as fertilizers, insecticides, pesticides, and food additives—pose significant health risks. Additionally, environmental contaminants in air, water, and soil can also enter the food chain, leading to unintended exposure to harmful substances.

As an example, we conducted a study on sachet water, commonly consumed in Gombe, to assess its safety. Our findings were alarming: out of the 40 randomly selected sachet water samples, none had a date of manufacture, expiry date, batch number, or mineral content listed. Additionally, 25% of the samples lacked a NAFDAC (National Agency for Food and Drug Administration and Control) number, which is required for regulatory compliance. Most concerning, however, was the detection of toxic heavy metals at levels exceeding the World Health Organization (WHO) safety limits. Lead was found in all 40 samples, mercury in 23%, cadmium in 15%, and arsenic in 5% of the samples. These findings raise serious public health concerns, especially considering the widespread consumption of sachet water in both urban and rural areas[15].

The toxic effects of heavy metals are primarily mediated through oxidative stress, either by inhibiting the biocatalytic antioxidant actions of essential trace elements such as copper, zinc, and cobalt or by generating reactive oxygen species (ROS) in exposed individuals. The maximum values of these heavy metals found in the sachet water samples were between 6 to more than 345 times the WHO safety limits.

Table 4: Maximum value of heavy metals (in multiples of WHO safety limit) found in sachet water in Gombe. (N=40)

Heavy metal	Maximum level found
Lead	>6
arsenic	>79
cadmium	>156
mercury	>345

Given the widespread consumption of sachet water in Gombe and the potentially higher contamination levels in rural areas, it is unreasonable to hypothesize that the current surge in the prevalence of chronic diseases such as chronic kidney disease, diabetes, hypertension, and other unexplained illnesses may be linked to the chronic exposure to toxic substances found in consumed products like sachet water? What about the concerns regarding the hygiene of the production process, vendor hygiene, environmental contaminants including other chemicals and more importantly the environmental degradation caused by the dispose sachets? This situation presents a potential public health disaster that requires urgent attention and intervention.

Despite the dangers associated with poisons, it is noteworthy that humans have also exploited and used these substances for various beneficial purposes. This represents another side of the coin, which, due to time constraints, I will only briefly highlight under "Practical Applications of Oxidative Stress."

OXIDATIVE EUSTRESS VS OXIDATIVE DISTRESS: TWO SIDES OF THE SAME COIN

Oxidative eustress/distress

Redox reactions are essential components of nearly all biological processes, from genomics and epigenomics to proteomics, metabolomics, and bioenergetics. Reactive oxygen species (ROS),

often referred to as free radicals, are by-products of these redox reactions. These ROS play critical roles in cellular signalling, metabolic regulation, and the body's adaptation to environmental stress. At physiological levels, ROS are involved in key processes such as antimicrobial activities, wound healing, and the maintenance of redox homeostasis, which is essential for life.

However, while ROS are vital for certain biological functions, they can also cause significant tissue damage when present in excess, leading to the oxidation of nucleic acids, lipids, proteins, and carbohydrates. This oxidative damage can disrupt normal cellular functions and contribute to the development of various diseases. Therefore, the body must maintain a delicate balance, or redox homeostasis, to ensure that ROS levels remain within a safe range. When this balance is maintained, the organism is said to be in a state of "oxidative eustress," where ROS exert positive effects on health[16].

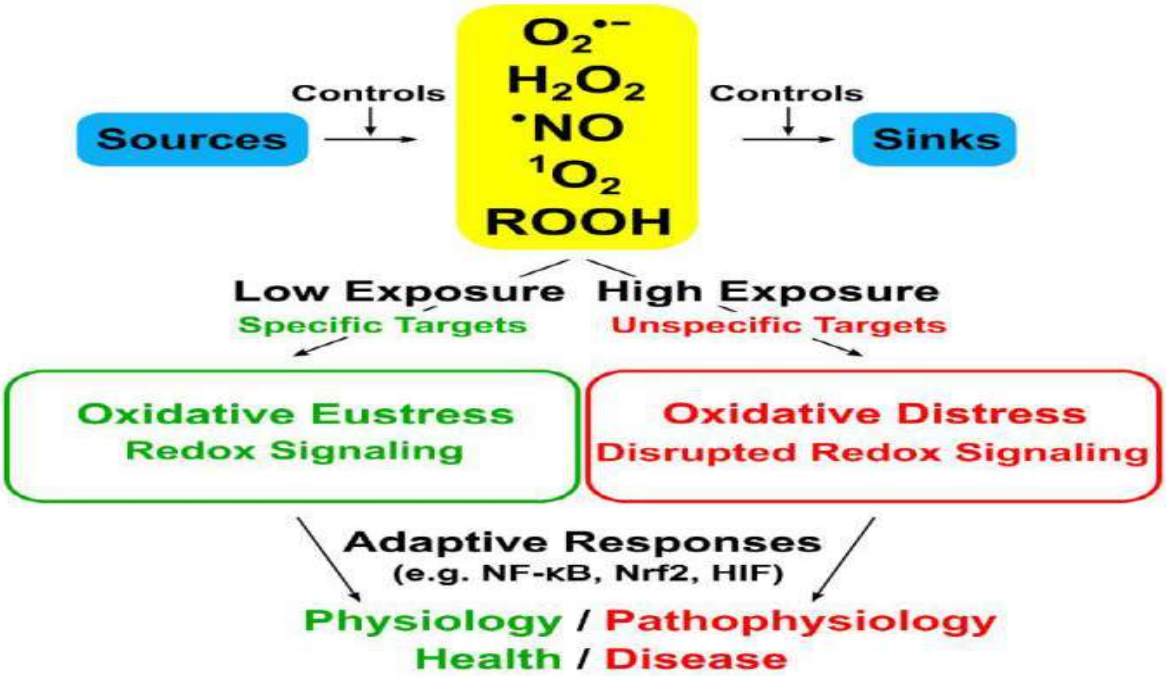

Figure 5. Oxidative stress and its relationship to redox signalling. Physiological (low) oxidant exposure addresses specific (highly-reactive) targets, whereas supraphysiological (high) exposure addresses unspecific targets.[17]

On the other hand, pronounced deviations from this steady state—either through an excess of ROS or a deficiency of antioxidants—can lead to "oxidative distress," a condition that causes molecular damage

and disrupts physiological redox signalling. This imbalance is implicated in the pathogenesis of numerous chronic diseases, including cancer, cardiovascular disease, diabetes, and neurodegenerative disorders.

Given the complexity of redox biology, scientists have attempted to classify oxidative stress into various forms, ranging from physiological oxidative stress (eustress) to excessive and toxic oxidative conditions (distress). These forms can be further categorized into acute, chronic, and repetitive oxidative stress, depending on the duration and intensity of the oxidative challenge.

Free radicals

Free radicals are molecules with unpaired electrons in their outer orbitals, making them highly reactive. In the body, these free radicals can oxidize (remove an electron from) or sometimes reduce (donate an electron to) other atoms or molecules. The most common types of free radicals are reactive oxygen species (ROS), which are by-products of aerobic respiration. Approximately 1-3% of the oxygen consumed by the mitochondria in cells is prematurely reduced, forming these free radicals.

At physiological levels, ROS play crucial roles in redox signaling, where they act as signaling molecules that regulate various metabolic processes and cellular responses to environmental stress. Examples of key signaling redox agents include hydrogen peroxide (H_2O_2), superoxide anion radical ($O_2^{\cdot -}$), nitric oxide (NO), and oxidized lipids. These agents target specific proteins to regulate metabolic pathways, cellular adaptation to stress, and antimicrobial defence mechanisms.

However, when present in excess, free radicals can cause oxidative damage to surrounding tissues by peroxidizing nucleic acids, lipids, proteins, and carbohydrates. This oxidative damage can lead to the initiation and progression of many diseases, including cancers, diabetes, hypertension, atherosclerosis, and liver diseases[18,19].

Reactive Species

In addition to ROS, there are several other reactive species that can cause oxidative damage:

- Reactive Nitrogen Species (RNS): These include nitric oxide ($NO\cdot$), nitrogen dioxide ($NO_2\cdot$), dinitrogen trioxide (N_2O_3), nitroxyl (HNO), and peroxynitrite ($ONOO^-$/ONOOH), among others. RNS are often involved in inflammatory responses and can modify proteins, lipids, and nucleic acids.
- Reactive Sulfur Species (RSS): These include hydrogen sulfide (H_2S) and other sulfur-containing compounds that can modulate redox signaling and cellular functions.
- Reactive Electrophile Species (RES): These species are capable of forming covalent bonds with nucleophilic sites in biomolecules, leading to cellular stress and damage.
- Reactive Halogen Species (RHS): These include hypochlorous acid (HOCl) and other halogenated compounds that can contribute to oxidative damage, particularly in inflammatory conditions.

The formation of these reactive species is influenced by various endogenous and exogenous factors, such as inflammation, exercise, mental stress, environmental pollutants, drugs, heavy metals, and radiation. The damaging effects of ROS and other reactive species on macromolecules, such as nucleic acids, lipids, and proteins, play a central role in the initiation and progression of many diseases.

In order to maintain homeostasis and prevent the injurious effects of ROS, it is essential to keep the levels of these free radicals within a certain safe limit. One of the most important defence strategies that can be employed by the body to detoxify excess free radicals is the production or supplementation and maintenance of an adequate level of antioxidants.

Antioxidants

On the other side of the redox balance, an antioxidant is a molecule, usually a reducing agent, that has the ability to prevent or slow the oxidative effects of free radicals on macromolecules by removing them or by inhibiting the oxidation reaction while getting oxidized themselves. Antioxidants act by preventing free radical generation, scavenging oxidants, converting free radicals to less toxic ones, and repairing oxidative injuries, thereby protecting the body from the harmful effects of free radicals. Antioxidants can be grouped into various classes, including enzymatic and non-enzymatic antioxidants[16,20].

To maintain physiological steady state and prevent the body from the debilitating effects of oxidative injury, nature has provided various means of protection. Some of these include:

Reduced Exposure to Photooxidative Stress by Melanin in Skin: Melanin acts as a natural sunscreen, reducing the oxidative damage caused by UV radiation.

Packaging of Essential DNA into Chromatin: This process, along with proteins providing alternative targets, offers protection. For example, the high content of cysteine and methionine residues in mammalian proteins produces decoys to shield critical active sites from oxidative damage.

Prevention by Diversion: This strategy involves channelling reactive species into less harmful or more readily repairable products, thereby lowering the risk of further damage. In extreme cases, this strategy can involve subcellular structures or whole cells, leading to elimination by autophagy, apoptosis, or related pathways.

Transport of Reactive Species or Their Products Across Biological Membranes: This process is facilitated by proteins such as aquaporins or GSSG exporters.

Specialized Enzymes: iron–containing Heme and copper-containing cytochrome c oxidases, as well as quinone reductases, are enzymes ingeniously designed to avoid the release of radicals.

All of these mechanisms are under transcriptional, translational, and posttranslational control, forming the basis of adaptive responses to oxidative stress.[21]

Other antioxidant enzymes that catalyse antioxidant reactions include catalases, peroxidases, superoxide dismutase (SOD), and the glutathione system, which includes glutathione S-transferases, glutathione peroxidases, and glutathione reductase. The role of SOD is to scavenge superoxide radicals and convert them to H_2O_2. The role of GPx is to reduce hydrogen peroxide, lipid hydroperoxides, and other organic hydroperoxides, while catalase converts hydrogen peroxide to oxygen and water. Substrates and coenzymes for these antioxidants are essential for the action of these enzymes and are therefore included in the list of antioxidants[17,22].

Non-Enzymatic Antioxidants include flavonoids and phenolics, whose antioxidant properties are related to various mechanisms such as metal ion chelation, hydrogen donation, free radical scavenging, and acting as a substrate for radicals such as superoxide and hydroxyl radicals. They play a very important role in protection against oxidative stress.

Thiols, which can be free or protein-bound, serve as cellular reducing agents through their SH-groups, protecting the cell from most organic oxidants.

Lipid-soluble vitamins (A and E) and vitamin C are potent antioxidants that neutralize and remove reactive oxygen species from various systems. Therefore, they are implicated in the prevention and treatment of many diseases, including cancers, cardiovascular disorders, the common cold, and age-related degenerative changes. Other non-enzymatic antioxidants include plasma proteins, uric acid, and bilirubin[23,24].

It is noteworthy that human studies have produced conflicting results regarding the benefits of antioxidants, mostly leaning towards their beneficial and protective effects, though some have suggested otherwise. It is also important to note that most of these nutrients must be provided exogenously, as they are not produced by the body.

Although antioxidants have beneficial effects on the body, they also possess some harmful effects, especially at high doses. This suggests that, like many things in biology, each of the two sides of the coin (oxidants and antioxidants) also has its own dual nature.

Repair

As prevention and interception are not perfect, particularly over extended periods, molecular damage can still occur. This damage is subject to powerful repair mechanisms that the body employs to maintain homeostasis and mitigate the effects of oxidative stress. These repair mechanisms are critical for preserving the integrity of all classes of biomolecules, including DNA, proteins, and lipids.

LIVING CELL LIKENED TO THE WHOLE UNIVERSE

The complexity of oxidative stress within a living cell, with thousands if not millions of reactions and substances involved, can be likened to the vastness of the universe. These reactions occur within one or another cell, within one or many of the various organelles of the cell, sometimes simultaneously or in succession. These actions can be similar, synergistic, competitive, antagonistic, or even completely opposite to each other. This intricate network of processes within the cell mirrors the dynamic and interconnected nature of the universe itself.

Consider the different planets and galaxies with all the activities occurring within them. Compare this with the activities occurring in our planet: various processes happening simultaneously, in succession, or at different times. These processes also have direct or indirect effects on one another. For me, the only difference is the scale: while the universe's activities occur in vast spaces with distances measured in millions of light-years, those within a cell happen in a tiny space, often within the confines of a single organelle. This resemblance underscores the idea that what God created in the large universe, He has replicated within the very tiny space of a cell. This reflection aligns with the verse in the Qur'an:

"Sanureehim aayatina fee al-afaqi wafee anfusihim hatta yatabayyana lahum annahu al-Haqqu."

Meaning, "We will show them Our signs in the horizon, and within themselves, until it becomes clear to them that it is the truth. But is it not sufficient concerning your Lord that He is over all things, A Witness?" (Qur'an 41:53)

NUTRITIONAL SOURCES OF ANTIOXIDANTS

Fortunately, and coincidentally, naturally occurring antioxidants are found in a wide variety of foods that are common in our environment. These antioxidants strengthen the body's endogenous defences against free radicals and help restore the optimal balance by neutralizing excess reactive species.

- **Flavonoids and Phenolics:** These compounds are widespread in beverages and foods, including honey, vegetables, red wine, fruit, cocoa, and tea. They possess strong antioxidant properties, attributed to their ability to chelate metal ions, donate hydrogen, scavenge free radicals, and act as substrates for radicals such as superoxide and hydroxyl radicals.
- **Ascorbic Acid (Vitamin C):** Found abundantly in various fruits and vegetables, particularly citrus fruits, tomatoes, oranges, grapes, potatoes, and red pepper, ascorbic acid is a potent antioxidant. It plays a critical role in neutralizing free radicals and supporting the immune system.
- **Vitamin A and Carotenoids:** Vitamin A is found primarily in animal sources such as liver, egg yolk, milk, and butter, while its precursor, beta-carotene, is present in plant sources like spinach, carrots, tomatoes, and grain. Both vitamin A and carotenoids are essential for vision, immune function, and skin health.
- **Vitamin E:** As the most abundant lipid-soluble antioxidant in the body, vitamin E is found in plant-based oils, nuts, seeds, fruits, and vegetables, including avocado, blackberries, cranberries, kiwi, asparagus, broccoli, and spinach. It protects cell membranes from oxidative damage by neutralizing free radicals.

The concentration of these nutrients can vary based on their sources and methods of extraction. Moreover, they are heat-labile and may be destroyed by excessive cooking, emphasizing the importance of proper food preparation to retain their antioxidant properties[23–26].

PRACTICAL APPLICATIONS

Redox reactions are essential and integral parts of our lives from fertilization through birth, and cell death—from conception to death. Most diseases, at early, intermediate, or late stages, also have a redox component. Whether redox processes are the cause, modifiers, or the consequence of disease states is not always clear. However, it is generally accepted among researchers that oxidative stress is involved at one stage or another in every disease.

Redox Medicine: The Future of Therapeutics

The development of redox medicine offers a golden opportunity for the future of a more refined therapeutic approach. By selectively targeting specific ROS-mediated signalling pathways, redox medicine can be tailored to individual needs. This includes:

- **Enzymatic Defence Systems:** Enhancing the body's natural antioxidant enzymes to combat oxidative stress more effectively.
- **Role of Trace Elements:** Elements like selenium, zinc, and copper play crucial roles in maintaining redox balance and are being explored as therapeutic agents.
- **Use of Redox Drugs:** Drugs that either increase or attenuate oxidative stress are being developed, depending on the disease stage and type.
- **Modulation of Environmental Factors:** Collectively known as the exposome, factors such as poisons, nutrition, lifestyle, and irradiation are being considered in developing personalized redox medicine.

Therapeutics

The categorization of therapeutics into those that increase oxidative stress versus those that attenuate it is not always clear-cut. The need to modulate oxidative challenges depends on the type of disease and its stage. Example is the need to increase the oxidative challenges through host mechanisms to kill a microbe and the need to minimizing tissue damage at later stage using antioxidant systems. Similarly, tumour initiation, promotion and progression may involve different roles of oxidants and antioxidants[27,28].

For example:

- **Ionizing Radiation and Chemotherapeutics**: Ionizing radiation is a well-documented cause of cancer. However, its medical application lies in generating the highly reactive hydroxyl radical through radiation for cancer treatment (radiotherapy). Most cytotoxic drugs follow a similar pattern, producing reactive oxygen species to target and destroy DNA in cancerous cells.
- **Photodynamic Therapy**: Tumors tend to selectively take up precursors of porphyrins, which are utilized as photosensitizers to generate cytotoxic singlet molecular oxygen (i.e., exert photooxidative stress). This therapy not only induces cell death by apoptosis but also triggers immunological and inflammatory responses to localized oxidative stress.
- **Wound Healing**: Hydrogen peroxide, while cytotoxic at high doses, is essential during wound healing and cell proliferation. It plays a role in tissue regeneration and repair.

Antioxidants as therapeutics

Many researchers have demonstrated the benefits of antioxidants in treating various conditions, including cancer, cardiovascular disease, and diabetes. However, clinical trials have yielded conflicting results. For example:

- Cardiovascular Diseases: Drugs like carvedilol and nebivolol, which have both antihypertensive and antioxidant properties, are considered promising in treating hypertension.
- Neuropathology: Most neurodegenerative disorders, such as Alzheimer's disease, Parkinson's disease, and Huntington's disease, have been linked to oxidative stress. This has prompted researchers to explore antioxidants as potential therapies. For instance, vitamin E is commonly used in treating stroke, despite uncertainties about its effectiveness. Dimethylfumarate (DMF), a drug used in multiple sclerosis, has potential in neuroprotection and immunomodulation, and may have therapeutic potential in Parkinson disease.
- Diabetes and Obesity: Reactive oxygen species at eustress levels may enhance insulin sensitivity and even have insulin-like effects. Conversely, hyperglycemia-induced ROS and postprandial oxidative stress are associated with glycotoxic effects, leading some researchers to describe diabetes as a redox disease.

Others applications include circulation medicine, gastrointestinal disorders, infectious diseases, immunology, hearing loss, sleep deprivation (chronobiology), as well as areas of comorbidity/multimorbidity. It also includes the flourishing fields looking into aging and senescence among others.

From our discussion, it is now clear that the widespread belief that antioxidants are always beneficial is not universally true. This misconception has been propagated by the multinational, multibillion-dollar nutritional supplement industry. It is now evident that antioxidants can either prevent or cause injury, depending on the context, and some may act as prooxidants at certain levels.

At this point, I would ask the question about **Who is the killer?**

Toxins or nutrients?

Oxidants or antioxidants?

Mr VC, Sir, I would like to leave this for the audience to answer.

BIOMARKERS OF OXIDATIVE STRESS

Given the enormous variety of reactive oxygen species (ROS) and the complex network of antioxidant defences, identifying reliable biomarkers of oxidative stress is a challenging yet essential task for advancing redox medicine. Biomarkers are crucial for diagnosing diseases, monitoring therapeutic outcomes, and predicting the risk of oxidative damage. However, the heterogeneity of oxidative stress markers and the lack of standardized methods for their measurement make this field particularly challenging.

Key Biomarkers of Oxidative Stress[29–31]

1. **Protein Carbonyls and Advanced Glycation End Products (AGEs):**
   - **Protein Carbonyls:** These are formed when ROS oxidize protein backbones or modify amino acid residues. Due to their relative abundance compared to other oxidative stress markers, protein carbonyls are considered reliable indicators of oxidative protein damage.
   - **AGEs:** These compounds result from the non-enzymatic reaction between reducing sugars and proteins, lipids, or DNA, leading to the formation of stable, often irreversible, end products. AGEs have been implicated in the pathogenesis of several chronic diseases, including diabetes, cardiovascular diseases, and neurodegenerative disorders.
2. **Oxidized Lipids:**
   - **Oxidized LDL (oxLDL) and Oxidized Phospholipids (OxPl):** These biomarkers originate from the oxidative modification of low-density lipoproteins and phospholipids, respectively. Both are linked to the development of atherosclerosis and are considered significant markers of cardiovascular disease.
   - **Lipid Peroxidation Products:** Lipid hydroperoxides can be converted into reactive aldehydes such as 4-hydroxynonenal (4-HNE) and malondialdehyde (MDA), which further contribute to cellular damage. Isoprostanes, derived from the free radical-catalysed oxidation of arachidonic acid, are also considered reliable markers of lipid peroxidation.

3. **Other Biomarkers:**
   - **Nitrotyrosine:** Formed by the reaction of ROS with tyrosine residues in proteins, nitrotyrosine is a marker of nitrosative stress and is associated with various inflammatory and neurodegenerative diseases.
   - **Thiols (Glutathione, Cysteine):** Thiols are sulfur-containing compounds that play a vital role in maintaining the redox state of cells. Depletion of reduced thiols is a hallmark of oxidative stress, and their levels can serve as biomarkers.
   - **Oxidized Nucleosides:** Markers like 8-hydroxydeoxyguanosine (8-OHdG) are formed when ROS damage DNA, and their presence is indicative of oxidative DNA damage.
   - **Markers of ROS Generation:** Myeloperoxidase (MPO) is an enzyme that generates ROS during inflammation and can be used as a biomarker for oxidative stress, particularly in cardiovascular diseases.
4. **Heavy Metals as Biomarkers:**
   - **Lead, Cadmium, and Other Metals:** These metals can induce oxidative stress by generating ROS or by depleting antioxidant defences. Their levels in biological samples can serve as indirect markers of oxidative stress.

Deficiency of antioxidant enzyme or its cofactor may also serve as a marker of oxidative stress. Other biomarkers may be a deficiency of antioxidant vitamins or antioxidant trace metals. This is the area we have explored most. We looked at the levels of antioxidants vitamins and minerals among roadside petrol dispensers in Gombe where we found lower levels compared to the general population. Total antioxidant status was also found to be lower among the roadside petrol dispensers compared to general population.[23,24,32]

Table 5: Biomarkers of oxidative stress among roadside petrol dispensers compared to controls in Gombe.[41,62,97,98]

Biomarker	Exposed mean (SD)	Control mean (SD)	p-value
Manganese (ug/dl)	7.93(1.32)	9.22(1.19)	.000
Copper (ug/dl)	77.8(7.38)	103.8(20.09)	.000
Zinc (ug/dl)	64.7(6.09)	100.2(9.58)	.000
Selenium (ug/dl)	0.03(0.0075)	0.01(0.0023)	.000
Vit A (ug/dl)	54.45(6.4)	69.82(5.4)	.000
Vit C (ug/dl)	0.68(0.13)	1.06(0.13)	.000
Vit E (ug/dl)	0.72(0.10)	1.01(0.13)	.000
TAS (mmol/L)	0.60 (0.33)	1.29 (0.25)	0.01
Lead (ug/dl)	20(0.54)	10(0.24)	.000
Cadmium (ug/dl)	20(0.45)	10 (0.19)	.000

Total Antioxidant Status (TAS) as a Biomarker

Considering the challenges in measuring individual oxidative stress markers, Total Antioxidant Status (TAS) has emerged as a comprehensive and cost-effective biomarker. TAS measures the combined effect of all antioxidants present in plasma, reflecting the overall ability of the body to counteract oxidative stress. This approach is advantageous as it captures the synergistic effects of various antioxidants and may include those that have not yet been identified.[20]

Conclusion on Biomarkers

While significant progress has been made in identifying biomarkers of oxidative stress, much work remains to be done. The development of more sensitive, specific, and clinically relevant biomarkers will be crucial for advancing the field of redox medicine. These biomarkers will enable more accurate diagnosis, better monitoring of therapeutic interventions, and more personalized treatment strategies in the future.

FUTURE INTEREST

Let me quote a seventh century philosopher, Amirul mumineena, Aliyu bin Abi Talib, 'The self-admiring one has no intelligence and being impressed with yourself stops you from growing'. We did not do much and we have a long way to go if we are blessed with Allah's favour. We have started discussing with partners on the need to establish a centre for clinical nutrition and toxicology. We pray for Allah's favour in achieving our goal.

RECOMMENDATIONS

1. **Strengthening Redox Medicine Research:**
   - Dramatic advances in methodologies for redox exposomics, redox imaging/genomics, redox epigenomics, redox proteomics, and redox metabolomics are essential for refining our understanding of health and disease processes. Improved quantitation and spatiotemporal resolution of the numerous reactions involved will facilitate specific, as opposed to global, redox medicine.
2. **Establishment of Poison and Nutrition Information Centres/Laboratory:**
   - There is considerable development in the area of nutrition, with many governmental and non-governmental partners doing so much. However, toxicology has not been as fortunate. In the absence of a coordinated institutional framework for clinical nutrition and poisoning in Nigeria, cases of malnutrition and toxicology will remain largely underdiagnosed and underreported.
   - These centres should engage in nutrition/toxicovigilance to identify, evaluate, and monitor the malnutrition and toxic risks existing in a community. They should also disseminate information on the risks and sources of malnutrition and poisoning through various media channels.
   - Additionally, robust laboratory services are needed to permit the identification, characterization, and quantification of toxic substances in both biological and non-biological samples.

3. **Education and Training:**
   - It's crucial to teach and train medical practitioners and other healthcare workers who are likely to encounter cases of poisoning, malnutrition, and substance abuse. This training should be integrated into both undergraduate and postgraduate medical education to ensure that future generations of healthcare providers are well-equipped to handle these challenges.

CONCLUSION

The interplay between nutrition, toxicology, pro-oxidants and antioxidants is an endless affair in both health and diseases affecting the life of human beings. The role of a chemical pathologist, though relatively neglected in our setting will remain central in ensuring a balance between each side of the coins.

APPRECIATIONS AND ACKNOWLEDGEMENTS

Mr. Vice Chancellor sir, all glory, praises and gratitude are to the Almighty Allah alone – The Most Gracious! The Most Merciful!

Let me quote the Almighty Allah, in His Book, Chapter31, Luqman (the Wise), verse 14. ***'And We commanded people to 'honour' their parents. Their mothers bore them through hardship upon hardship, and their weaning takes two years. So be grateful to Me and your parents.*** Oh Allah, bear me witness, I am grateful to my parents.

To my Father, Alhaji Adamu Manga who has shown me unlimited love without sparing any chance to correct me at any point I show signs of deviation from the right path, sometimes with cane as a child. He carefully guided, moulded and inspired me to face the challenges of this life. He has given me financial support to go to school even at times when the family struggle to eat. He gave me access to harvest from his

farm, whatever I can, to support my education even at the time when the whole family was going through difficulties. Sometimes I wonder where he got this inspiration from, since he did not attend any western education himself. Baba, only Allah will reward you.

Figure 6: My Father; Alhaji Adamu Manga Daba (Aged >100)

And to my mother, Goggomamma, words can't express my gratitude to you. As first son, you never call my name in accordance with Fulani tradition. In fact, you did for me what many mothers could not do for their children. You sold almost all your belongings, including the cows you inherited from your dad, and even your bed to make sure I succeed.

My step mothers, Hajja Nenne and Hajja Yawo deserve special gratitude and respect. As mothers, both of you have touched my life in immensely including rescue missions when I crossed my Mum's red lines. I have enjoyed tremendous love from my grandparents, Mamma (my paternal grannie), who I ran to, whenever I committed any misdemeanor against my mum and she was ready to beat up my mum whenever my mum tried to beat me. Mama (my maternal grand Ma), has shown me true love and I will not forget the memories of the good times I had in your room in Zambuk and even when you relocated to Wuro Ynebbe. May Allah have mercy on their souls and grant them Jannatul Firdausi.

Figure 7: My Mum and other family members during one of our visits to the village.

Late Malam Musa Dan Bauchi and his late mum (Baba) (and his family) were very kind to me. He was just like a father to me. He paid my school fees and provided me uniforms and books in primary school. He asked me to choose first from clothes he bought for us even before his first son Abdullahi. May Allah grant him Jannatul Firdausi.

I am greatly indebted to my elder brothers: Yaya Yaro who supported me and provided for the family at the time of need; Yaya Dr Haruna of blessed memory was a pillar and inspiration behind my becoming a medical doctor; Yaya Aminu was our discipline master and a house keeper when we were growing, he provided guidance and leadership when the elders had moved on. My elder sisters, Dada and Innawuro deserve my commendation. Dada was a protective figure for us during our primary school and would always have her sugar, garri, omo and some pocket money ready for me whenever I bid her farewell on my way to school in Kumo. Umma, who is older than me by one year provided friendship and companionship during my primary school. She had endured a lot of my juvenile excesses as I describe her as the most patient of all people I came across, an attribute she still maintains.

Nasiru (closest to me by age and friendship) and others deserved my gratitude. I will not forget Abdullahi, Usman and Balkisu mai gadon zinari. Allah sa masu ceton iyaye ne.

Numerous uncles, aunts, cousins and extended family members, in the villages and towns are too many to enumerate. All have contributed for my decent upbringing and support all the way.

I am particularly and immensely grateful to my late cousin, Alhaji Miji (and his family). He took me to primary school and was instrumental to my university education. He paid my first registration when I had given up for lack of money from my immediate family and he continued to support me until I started earning medical students' allowances.

To my dear wife, Saf, you deserve a special gratitude for rescuing me when I felt like a stranger in the mids of my family. You supported me morally, socially, academically and even financially during my period

of need. You trusted me with your life when on several occasions we drove to and from Ibadan and Lagos. To my dear wife Daiyibatu, thank you for all the sacrifices, support and understanding.

To my ex-wife Aisha, I say a big thank you for the love and sacrifices you made in my life. Even though destiny has separated us, I still believe you are a very good person and God will continue to guide your path. To my children; Fatima Batool (umm Abeeha, Lula, Toy toy), Aliyu Mueen (Mueenud duafa'i wal fuqara'i), Muhammad Al-Anwar, Muhammad AaleYaseen, Fatima Salsabeel, Fatima Mudahharah and Aliyu Mustaqeem, I love you and I owe you a lot. Allah will bless you and guide your path.

Figure 8: Some of my children at Eid Al-Adha, 2024

Mr. Vice Chancellor sir, thank you for being my father, teacher, mentor and a role model. You have been a pillar in my career both professionally and academically. Like my inaugural predecessor Colleagues from the college, I was also contacted by you as the MD of FMC Gombe, while I was doing NYSC, to offer me a chance for residency training in Chemical Pathology which I accepted without

hesitation, even though I have started preparing for another specialty. You gave me a residency appointment, sponsored my primary exams and sent me and paid for my supernumerary residency training in UCH Ibadan together with my friends. Sir, the vision you had at that time made me, now, wonder if you are one of the people who receives revelation like the mother of Moses (AS) yet they were not prophets. Sir, how did you know that training us in these rare areas of medicine will be the saving grace during the establishment of our medical school and other medical colleges in the North-East and beyond. I wonder what happens if we were not trained. It is also important to deposit, here, that my joining the University was because of the respect and trust I have for you, even though I know the huge sacrifice I have to make in terms of salary (which runs into hundreds of thousands monthly) and some privileges. I believe it is the same with my other medical colleagues. Sir, what more will you ask from Allah than this ‘‘sadaqatul jaria’’ you have established for your tomorrow. May Allah reward you abundantly and continue to increase you in wisdom and bless you and your family.

Figure 9: My teacher and mentor, Prof. Aliyu Usman El-Nafaty, Former Vice-Chancellor, Gombe State University and former Medical Director Federal Medical Centre Gombe.

Emeritus Professor Idris Mohammed FAS, OON (Dan Isan Gombe), our grandfather, you provided me the platform on which I stood to read medicine by facilitating my admission into MBBS. I know you have forgotten, because I am just one out of so many that you have mentored and still mentoring. May the Almighty Allah continue to bless you and reward you with Jannatul Firdaus. I also appreciate Professor H.U Pindiga for his fatherly role in the life. May Allah continue to bless you.

To my medical doctor friends (Yuguda, Taniya, Aminu, Manga, Bojude, Lawan and Musa), many thanks to you and your families for the support and friendship all the way from undergraduate level to date. You are, to me, more than friends.

Figure 10: My UCH Ibadan Pathology family posing with our mother, Prof. YA Aken'Ova

To all my teachers, classmates and all associates in Jankai Primary School, Pilot Junior Secondary School and GTC, Kumo as well as Unimaid, I say a big thank you., I also thank all my seniors, colleagues

and friends in these schools, with whom I have shared good memories that I will never forget. Notable among them are late Auwalu justice, Shehu Sani Labaran, Tasi'u, Auwal Braza, Isa Ali, Salisu Hassan, Musa Gombi, Barrister Sani, Abubakar Yerima, Abudullahi Ustaz, Ado Sulaiman, Aisha, Adama, Hasiya Kolo and Aisa. Others are late Shehu Sambo, Usman Garkuwa, Bobo and Mamas. I will not forget Abdul hakeem, Abdulqadeer, and Mohammed Gafa.

The Jekada Fari community, where everything started, is worthy of my highest gratitude, including the women in their houses who tolerated my early morning sales of koko, kosai, tasoyu, kayan miya and many more at different intervals of my growth.

To Igana community, I say a big thank you for the love and kindness you showed me as the only resident doctor in Iwajowa LGA. Notable is the family of the traditional ruler (the Shabigana of Igana land year 2007), and the families of Alhaji Adedibu and Bale Ikiya (2007). You introduced me to your families as your son and insisted I share your meals even though I told you it is against my culture for a child to eat with elders. The staff of the Igana PHC centre were exceptionally kind to me and I appreciate all of you.

To my mentors, teachers, colleagues and friends during residency, word can't express my gratitude. Professor Abiyesuku, Professor Akinlade, Dr Akinosun and Dr Kuti. My teachers from the other departments are well appreciated, notably the ''angels in human skin'' Professor Yetunde Aken'ova and her late Husband and Professors Ogunbiyi, Bakare and Shokunbi. May almighty Allah reward you abundantly. Dr Olawale, his dear wife Titi, his daughter Onyedamola as well as Drs Ghazali and Osuji are all appreciated.

The GSU community is worthy of my commendation and gratitude. Special thanks to the former Vice Chancellor, Prof Aliyu Usman El-Nafaty OFR, former DVC Prof Mahmood, current DVCs Prof Sani Yauta and Danladi. I thank my provost, Prof Manga, former provosts Prof Bako and Prof Kalayi, my Dean Prof Lawan for your kind assistance towards the success of this lecture.

Special appreciation goes to my boss, Dr Yusuf Mohammed Abdullahi, words cannot express my gratitude for the love and kindness you have shown me and the opportunity you gave me to learn a lot from you and the encouragement you give me to express myself.

Figure 11: My boss Dr Yusuf M. Abdullahi at one of the official assignments in FTH, Gombe

I thank all the past CMDs and MDs; Dr Ali Gombe, Dr Sa'idu (both are still providing guidance and mentorship) and Dr Alkali of blessed memory. Special thanks to my boss, Dr Esin for your kindness and guidance. I thank all past CMACs, present and past DCMACs. Special thank you to former DA Malam Dan Ummaru and former director of finance Alh. Soye, both for their mentorship and guidance which they still provide. Many thanks to my colleagues in the department of Chemical pathology and other pathology departments as well as other departments in the hospital. Notable among them Ado, ABM, Raji, Ochacha, Gatuwa, Lanzai and Abdussalam.

Figure 12: Chemical pathology family at FTH, Gombe

I also thank my colleagues, office of the HOD, DCMAC and CMAC, Notable are malam Kaloma of blessed memory, Malam Marafa, Malam Suleiman, Malam Hina and Ahmad Dala. All Admin staff led by Alhaji Bala Sani, finance staff ably led by Hajiya Zainab, staff of engineering led by Eng. Lawan and all other departments in FTH, Gombe.

To my teachers, mentors and friends in MDCAN, NCS and NMA. Special thanks to MDCAN president Prof. Aminu Muhammad, All past presidents and NOC of MDCAN, notably Prof Ngim Ngim, Prof Balarabe Sani Garko, Prof Ozoilo, prof Chingle, and all MDCAN family. Prof. Sadiq Adamu Abubakar (VC LINCOLN Uni.) also deserve my gratitude for his unwavering support and mentorship.

To my students, patients, I say a big thank you for trusting me with your lives and giving me the opportunity to learn from you.

Many appreciations to the University Ceremonies Committee chaired by our father and mentor, Prof MG Dukku, for this befitting event.

I will end my inaugural lecture with the saying of the Mentor of mentors, the greatest of all that Allah has created and the most loved by Him (Prophet Muhammad S.A.W), 'The stomach is the house of all ailments, diet control is the fountain head of remedies. Verily, health and overeating cannot be together'. Thank you everyone.

References

1. **Adamu S**, Mohammed A, El-Bashir JM, Abubakar JD, Mshelia DS. Incomplete Patient Data on Chemical Pathology Laboratory Forms in a Tertiary Hospital in Nigeria. Annals of Tropical Pathology. 2018;9(1):47–9.

2. **Sani A**, Kaltingo Z Y, Yuguda S. Distribution and Cost Analysis of Unclaimed Laboratory Results in Federal Teaching Hospital, Gombe, Nigeria. Jewel Journal of Medical Sciences. 2020;1(1):61–5.

3. Nutrition [Internet]. [cited 2024 Aug 8]. Available from: https://www.who.int/health-topics/nutrition

4. Otegbayo J. Evaluation of nutritional status of patients attending two tertiary hospitals in south-west, Nigeria. Nigerian Journal of Gastroenterology and Hepatology. 2017 Jul 1;9:31–7.

5. Adigun T, Ogundoyin OO. Prevalence of malnutrition and its correlates among children coming for elective general surgical procedures in a tertiary hospital of a developing country. *Ann Med Res Pract 2020;1:1*.

6. Jibril MEB, Abbiyesuku FM, Aliyu IS, Randawa AJ, Adamu R, Akuyam SA, **Adamu S,** et al. Nutritional Iodine Status of Pregnant Women in Zaria, North-Western Nigeria. Sub-Saharan African Journal of Medicine. 2016 Mar;3(1):41.

7. Jibril MEB, Abbiyesuku FM, **Adamu S**G, Randawa AJ, Abdurrahman MB, Aliyu IS, et al. Relationship Between Maternal Iodine Status and Cord Blood Thyroid Function Profile in an Iodine Sufficient Environment. J Med & Bas Sci Res. 2023;4(3-4):33-42. DOI: 10.5281/zenodo.8088250

8. Oyeniyi CF, El-Nafaty AU, Bako B, Yahaya UR, **Adamu S.** Comparative Study of Ionised Serum Calcium Levels in Pregnant Normotensive and Pre-Eclamptic Women in Gombe, North-Eastern Nigeria. Nigerian Journal of Basic and Applied Sciences. 2022;30(2):105–11.

9. MY, Abubakar, SO, Idris, Raheem, Quadri, JO, Yussuf, Biliaminu, SA, **S. Adamu,** et al. Multiregional Survey of Serum Vitamin D Levels among apparently healthy Nigerians – Prevalence and Risk Factors of Hypovitaminosis D.2023. *Tropical Journal of Health Sciences* 30(1):1 - 510.

10. Adejumo OA, Owolade SS, Lawal OM, Junaid OA, Egbi OG, Enikuomehin AC, et al. Review of the demographic pattern and outcomes of acute chemical poisoning in patients in a tertiary hospital in South-western Nigeria. Res J of Health Sci. 9(4):359–67.

11. Igbinosa IH, Igharo OG, Okoh AI. An Appraisal of Poisoning Patterns among Adolescent Patients Admitted into Tertiary Care Hospitals in Nigeria. University of Lagos Journal of Basic Medical Sciences,2022: 10 (1 & 2).

12. Areprekumor TE, Joboy-Okei E, Amadin NO, Kalu SU. Patterns and clinical outcomes of childhood poisoning presenting to a children's emergency department in Yenagoa, Nigeria: a 10-year retrospective study. BMJ Paediatrics Open. 2024 May 1;8(1):e002433.

13. Isaac WE, Iliya J, **Adamu S**, Apllos D, Oyeniyi C. Spectrum of Poisoning and Outcome among Children in a Tertiary Hospital, North-East Nigeria: A 20 Years Restrospective Review, 2000-2019. Open Journal of Pediatrics. 2022 Jan 6;12(1):100–24.

14. Longwap A, Emmanuel I, Affi A, Imoh L, Mbwas M, Dajel T, **Adamu S** et al. Effect of Envenomation on Serum Hepatic Biomarkers in Snake (Echis Ocellatus) Bitten Individuals in Zamko Comprehensive Health Centre of the Jos University Teaching Hospital, North Central Nigeria. Niger Med J. 65(2):142–52.

15. **Adamu S** et al Heavy metal contents of sachet water in Gombe, Nigeria. | Kanem J Med Sci 2021; 15(2): 86-91

16. Adwas A, Elsayed A, Azab A. Oxidative stress and antioxidant mechanisms in human body. J Appl Biotechnol Bioeng. 2019;6(1):43–5.

17. Sies H. Oxidative Stress: Concept and Some Practical Aspects. Antioxidants (Basel). 2020 Sep 10;9(9):852.

18. Frijhoff J, Winyard PG, Zarkovic N, Davies SS, Stocker R, Cheng D, et al. Clinical Relevance of Biomarkers of Oxidative Stress. Antioxid Redox Signal. 2015 Nov 10;23(14):1144–70.

19. Zarkovic N. 4-hydroxynonenal as a bioactive marker of pathophysiological processes. Mol Aspects Med. 2003;24(4–5):281–91.

20. **Adamu S,** Akinosun OM, Abbiyesuku FM, O Kuti MA, El-Bashir JM, Abubakar JD. Are roadside petrol dispensers at risk of oxidative stress? a study from gombe, North East Nigeria. Niger J Clin Pract. 2018 Mar;21(3):276–9.

21. Sies H, Berndt C, Jones DP. Oxidative Stress. Annu Rev Biochem. 2017 Jun 20;86:715–48.

22. Valko M, Leibfritz D, Moncol J, Cronin MTD, Mazur M, Telser J. Free radicals and antioxidants in normal physiological functions and human disease. Int J Biochem Cell Biol. 2007;39(1):44–84.

23. **Adamu S**, Akinosun OM, Abbiyesuku FM, Kuti MA, El-Bashir JM, Marafa BG. Evaluation of antioxidant vitamins among roadside gasoline dispensers in Gombe, Nigeria. *J Environ Occup Sci.* 2015; 4(3): 145-149.

24. **Adamu S**, Akinosun O, Abbiyesuku F, Kuti M, Jibril MEB, Abubakar J, et al. Antioxidant Trace Metals among Roadside Petrol Dispensers in Gombe State, Nigeria. British Journal of Medicine and Medical Research. 2016 Mar 2;14:1–7.

25. H Mukhtar, N Ahmed. Tea polyphenols: prevention of cancer and optimizing health. The American journal of clinical nutrition [Internet]. 2000 Jun [cited 2024 Jul 17];71(6 Suppl). Available from: https://pubmed.ncbi.nlm.nih.gov/10837321/

26. Miura Y, Chiba T, Tomita I, Koizumi H, Miura S, Umegaki K, et al. Tea catechins prevent the development of atherosclerosis in apoprotein E-deficient mice. J Nutr. 2001 Jan;131(1):27–32.

27. Dougherty TJ, Gomer CJ, Henderson BW, Jori G, Kessel D, Korbelik M, et al. Photodynamic therapy. J Natl Cancer Inst. 1998 Jun 17;90(12):889–905.

28. Wondrak GT. Redox-directed cancer therapeutics: molecular mechanisms and opportunities. Antioxid Redox Signal. 2009 Dec;11(12):3013–69.

29. Dalle-Donne I, Rossi R, Giustarini D, Milzani A, Colombo R. Protein carbonyl groups as biomarkers of oxidative stress. Clin Chim Acta. 2003 Mar;329(1–2):23–38.

30. Steinberg D, Parthasarathy S, Carew TE, Khoo JC, Witztum JL. Beyond cholesterol. Modifications of low-density lipoprotein that increase its atherogenicity. N Engl J Med. 1989 Apr 6;320(14):915–24.

31. Fu MX, Requena JR, Jenkins AJ, Lyons TJ, Baynes JW, Thorpe SR. The advanced glycation end product, Nepsilon-(carboxymethyl)lysine, is a product of both lipid peroxidation and glycoxidation reactions. J Biol Chem. 1996 Apr 26;271(17):9982–6.

32. **Adamu S,** Akinosun OM, Abbiyesuku, El-Bashir JM, Abubakar JD. Are roadside petrol dispensers at higher risk of lead and cadmium toxicity? A study from Gombe State, North – East, Nigeria. *Gombe Med J.* Dec.2019;1(2): 27-31.

CITATION OF PROFESSOR SANI ADAMU, MBBS, FMCPath

Born in Jeka-da-fari Gombe on the 1st day of February 1977, Professor Sani Adamu attended Jankai primary school Gombe and Government Technical College, Kumo to obtain his first school leaving certificate and senior school certificate in 1988 and 1994 respectively. He proceeded to the prestigious University of Maiduguri and graduated with MBBS degree in 2004. Prof Sani did his internship at the then Federal Medical Centre (FMC) Gombe between 2004 and 2005 before proceeding for the National Youth Service Corps (NYSC) in Igana, Iwajowa L.G.A, Oyo State in 2006.

In 2007, he returned to Gombe to continue serving as a medical officer in the Gombe State Specialist Hospital Gombe. Prof Sani's passion for clinical and academic excellence saw him moving back to FMC Gombe and commencing postgraduate medical training as a supernumerary resident at the premier teaching hospital in Nigeria, the University College Hospital Ibadan. In record time, he qualified as a specialist chemical pathologist with the prestigious fellowship of the National Postgraduate Medical College of Nigeria (FMCPath) in 2013.

Upon his return to FMC Gombe in 2013, Prof Sani was appointed as a consultant in the hospital and later head of department before taking up visiting appointment with the University of Maiduguri to support his alma-mater in teaching chemical pathology even at the peak of "Boko-Haram" insurgency. With the commencement of clinical postings by the 1st set of GSU medical students, Prof Sani took up the challenge and joined the services of Gombe State University and rose through the ranks to become the first Professor of Chemical Pathology from Gombe and Gombe State University in 2021.

Prof Sani served as pioneer head in the department of Chemical Pathology and later became the second dean in the faculty of basic

clinical sciences in 2019. He spearheaded and laid the foundation for the takeoff of academic activities in his department. His competence and commitment to duty saw him becoming appointed as the Deputy Chairman Medical Advisory Committee (DCMAC), in charge of clinical services before stepping up as the Chairman Medical Advisory Committee (CMAC) of the Federal Teaching Hospital, Gombe in 2023; a position he still meritoriously and diligently continues to serve up to this moment.

Professor Sani Adamu had been a visiting lecturer and subsequently Professor at the College of Medical Sciences, Abubakar Tafawa Balewa University since 2019. He is an external examiner to the Departments of Chemical Pathology, Bayero University, Kano and Ahmadu Bello University, Zaria.

Prof Sani had been a trainer and mentor and had supervised five postgraduate fellowship research projects to successful completion. He serves as a reviewer to many local and international journals and is a member of the editorial board of the Gombe Medical Journal and Jewel Journal of Medical Sciences (JJMEDSCI).

Prof Sani belongs to many professional organizations and had served as a member and executive on different occasions. He was a member of the laboratory sub-committee of the popular Gombe State Taskforce on Covid-19 under the leadership of Professor Emeritus Idris Mohammed which initiated and established three molecular laboratories in Gombe state.

Both locally and internationally, Prof Sani has attended numerous conferences and workshops and had published many peer-reviewed articles and presented abstracts most of which are in the areas of toxicology and nutrition.

He is member of many professional organizations including but not limited to:

Medical and Dental Consultants, Association of Nigeria (MDCAN)

Nigerian Medical Association (NMA)

Islamic Medical Association (IMAN)

American Association of Clinical Chemists (AACC)

College of Nigerian Pathologists (CNP)

International Committee of the Red Cross (ICRC)

Prof Sani had served as the Chairman of the MDCAN Gombe branch and a Member, Committee on Internally Displaced Persons (IDPs), at the national level. He had also served as the Chairman Local Organizing Committee, Annual General Meeting & Scientific Conference of the Nigerian Medical Association, Gombe State in 2018. In his early days, he was a one-time Secretary General, Association of Resident Doctors (ARD), Gombe State and National President of the Gombe State Medical Students' Association (GOMSA). He was Member, National Medical Team for the 2016 Hajj (Pilgrimage to Makka).

In 2010, Prof Sani won the Dr. Alexader Eyimofe Boyo Award for best candidate in part I Chemical Pathology examination of the National Postgraduate Medical College of Nigeria and 2013 he was awarded the International Travel Grant of the American Association of Clinical Chemists (AACC).

As a person deeply committed to community service and passionately attached to his roots, Prof Sani holds the traditional titles of Sardaunan Lubo and Sarkin Yamman Zambuk.

Prof. Sani is happily married with children and enjoys playing badminton, travelling, reading and research.

INAUGURAL LECTURES OF GOMBE STATE UNIVERSITY

LECTURE SERIES	NAME	TITLE	DATE
1st	Prof. Ibrahim Waziri Abubakar	Western Healthcare System in Northern Nigeria: An outline of its Foundation and Development	27th January, 2022
2nd	Prof. Oluwasanumi Adedimeji Adepoju	The Infrangible Nature of Knowledge: The need for Researchers to be Multipotentialities	15th December ,2022
3rd	Prof. Mahmoud Umar	Public Sector Reforms in Nigeria: The Imperatives of New Public Governance Model	25th May, 2023
4th	Prof. Adewale Olukayode Ogunrinade	Aladura and the Perpetuation of Indigenous Christianity Among the Yoruba	13th July, 2023
5th	Prof. Rasheed Abdulganiy	Academicizing the Hadith: Comprehensive Exploration of Prophetic Guidance in Addressing Human Multi-Dimensional Challenges	26th September , 2023
6th	Prof. Halima Mohammed Abba	Green Solutions for a Sustainable Future	7th March, 2024
7th	Prof. Mohammed M. Manga	A Privileged Nomadic Microbial Warrior: Battles in Health and Medical Education	23rd April,2024
8th	Professor Bulus Wayar	Demographically Undetermined, Territorially Boundless, Linguistically Attritional: The Lifeline of Fulfulde in Africa	28th May, 2024
9th	Professor Seydou Hankouraou	Physics, Health and Sustainable Development	25th June, 2024

10th	Professor Danladi Adamu Bojude	Championing Community Oncology: Saving Lives, Empowering Communities	30th July 2024
11th	Professor Kennedy Poloma Yoriyo	The Lady Mosquito Which Underdeveloped and Kept Africans in A Poverty Vicious Circle	27th August,2024
12th	Professor Sani Adamu	Toxicology Versus Nutrition; Pro-Oxidants Versus Antioxidants; Each, A Coin with Two Sides: Which One Is the Killer?	26th November, 2024