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COVID-19 VACCINE COMPETENCE FOR NIGERIAN ENVIRONMENT

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ABSTRACT

Vaccines played tremendous role in the treatment and subsequent eradication of once deadly infectious diseases. They are currently at the fore of the regimen for maintenance and optimization of health in our disease infested world. Vaccines work with the body's natural defences to develop immunity to disease. As long as the natural antibodies to existing disease conditions exist in any physiological system, it will be able to intercept and prevent the virulence of such infecting agents. The current practice of relying mainly on vaccines to contain the infection of coronaviruses during the flu season is maintained with less than convincing proof of reasonableness. This is because the nature of coronaviruses seems to suggest that they are not as vaccine preventable as diseases like polio and rickettsiae. They tend to have rapid conformational changes, which make them not capable of being contained by a specific form of vaccine for a long time, and a lot of funds are spent producing vaccines for different variants in flu seasons. Baring the cost of vaccine production, it is quite unlikely that the world can hold onto the coronavirus and prevent it from further variations while competent vaccines are produced for existing forms. It also seems unrealistic to embark on the production and inoculation of everyone with new vaccines for all strains of a universal virus. When viable vaccines can be produced for all forms of the coronavirus, then their transmission from person to person can be stopped. If this herd immunity is achieved, the virus will over time not exist in isolation and will gradually be eliminated. This is the hope for the Covid-19 vaccines and vaccine candidates, but it continues to look like a mirage. The

vaccine contents may not have full disclosure and they come with side effects which may be compounded by the frequency of inoculation to achieve year round protection; in which case disease treatment and other means of prevention of transmission may hold better prospects for humanity.

KEYWORDS: Covid-19, Vaccine-Specificity, Malnutrition, Content, Hesitancy, Nigeria.

1.0 INTRODUCTION

For a few weeks after birth, babies have some protection from germs that cause diseases. This protection is passed from their mother through the placenta before birth but after a short period, this natural protection goes away.[1] This is a natural instance of protection against infections that is patterned by vaccines and vaccination. Vaccines expose the body to an antigen that trains the immune system to fight a germ in the future. Because vaccines contain weakened, killed versions or components of viruses, one becomes immune without getting sick, with the exception of some weakened vaccines and the immunocompromised.[2]

Vaccines greatly reduce the risk of infection by working with the body's natural defences to safely develop immunity to disease. They facilitate the development of immunity by imitating an infection. This type of infection, however, almost never causes illness, but it does cause the immune system to produce T-lymphocytes and once the simulated infection goes away, the body is left with a supply of "memory" T-lymphocytes, as well as B-lymphocytes that will remember how to fight that disease in the future.[3] However, it typically takes a few weeks for the body to produce T-lymphocytes and B-lymphocytes after vaccination.[3] Therefore, it is possible that people infected with a disease just before or just after vaccination could develop symptoms and get a disease, because the vaccine has not had enough time to provide protection.

The first vaccine was introduced by British physician Edward Jenner, who in 1796 used the cowpox virus (vaccinia) to confer protection against smallpox, a related virus, in humans.[4] Prior to that use, however, the principle of vaccination may have been applied by different indigenous communities all over the world but was recorded of Asian physicians who gave children dried crusts from the lesions of people suffering from smallpox to protect against the disease.[5] While some developed immunity, others developed the disease. Jenner's contribution was to use a substance similar to, but safer than, smallpox to confer immunity. He exploited the relatively rare situation in which immunity to one virus confers protection

against another viral disease. In 1881 French microbiologist Louis Pasteur demonstrated immunization against anthrax by injecting sheep with a preparation containing attenuated forms of the bacillus that causes the disease.[6] Four years later, he developed a protective suspension against rabies.[6]

After Pasteur's time, a widespread and intensive search for new vaccines was conducted, and vaccines against both bacteria and viruses were produced, as well as vaccines against venoms and other toxins.[7] Vaccines help protect against many diseases that used to be much more common. Examples include tetanus, diphtheria, mumps, measles, pertussis, meningitis, and polio. Many of these infections can cause serious or life-threatening illnesses and may lead to life-long health problems. Because of vaccines, many of these illnesses are now rare.[7] But while a single vaccination can confer lifelong protection against small pox or poliovirus, HIV continues to evade protection by vaccination despite a major worldwide effort to develop an effective HIV vaccine.[8]

A vaccines' quality of being adequately or well qualified to elicit the desired immune response and prevent disease is not only a factor of its efficacy and effectiveness but also of its safety and relevancy. But there are concerns that some vaccines are not safe and may have more than the average adverse effects, especially for children and the immunocompromised, in which case the use should be restrained where the burden of disease is minimal or where treatment options are available.[9,10] In areas with a high burden of disease with the absence of better containment or treatment options, the benefits of these vaccines may outweigh their risks.[11]

2.0 THE FUNCTIONAL IMMUNE SYSTEM

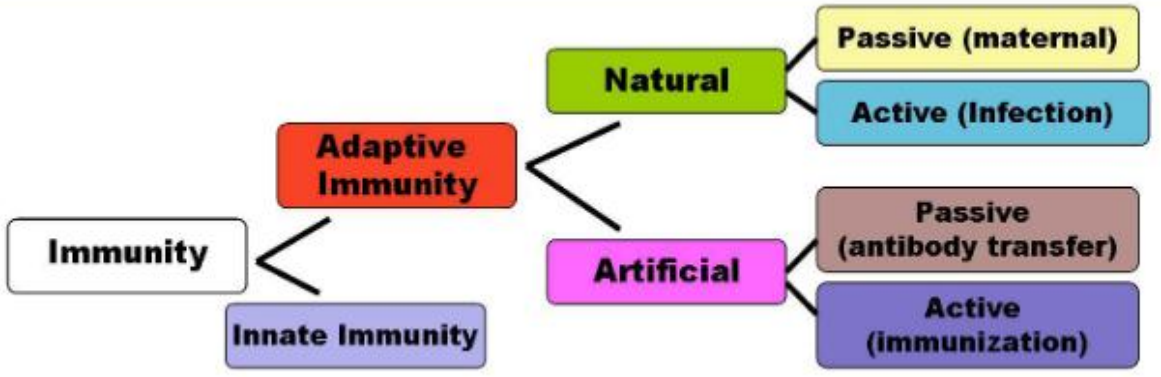

Figure 1: Types of immunity.

Source: http://wikipedia.org/wiki/immunological memory.

Bacteria and viruses like the one that causes Covid-19 have proteins called antigens on their surfaces. Each type of germ has its own unique antigen. When germs, such as bacteria or viruses, invade the body, they attack and multiply, causing malfunction of the system. This invasion, called an infection, is what leads to illness. The immune system is equipped to fight infection and contain its virulence. The first line of defense against infection is comprised of Physical barriers (skin and mucous membranes), Chemical barriers (gastric secretions and digestive enzymes) and blood components (phagocytes, macrophages, complement system). These are non specific mechanisms for which "no memory" of protection exists afterwards.[2] Blood contains red blood cells, for carrying oxygen to tissues and organs, and white blood cells, for fighting infection.

These white cells consist primarily of macrophages, B-lymphocytes and T-lymphocytes.[2] Macrophages are white blood cells that destroy, engulf and digest germs, plus dead or dying cells. The macrophages leave behind parts of the invading germs called antigens. The body identifies antigens as causing danger or risk and stimulates antibodies to attack them. B-lymphocytes are defensive white blood cells which also produce antibodies that attack the antigens left behind by the macrophages.[2] T-lymphocytes on the other hand are another type of defensive white blood cell. They attack cells in the body that have already been infected. The first time the body encounters a germ, it can take several days to make and use all the germ-fighting tools needed to get over the infection.[2,12] After the infection, the immune system relies on its memory to protect the body against that disease.

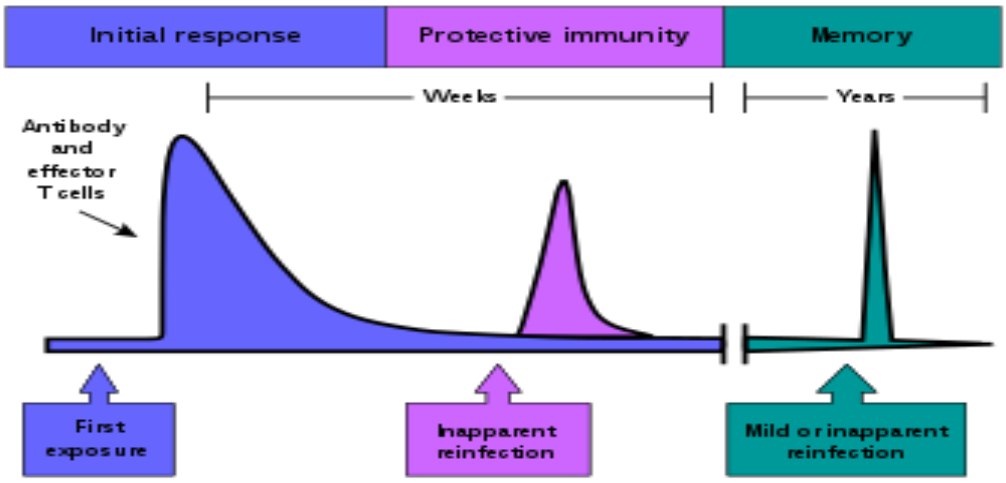

Figure 2: Development of immunological memory.

Source: https://en.wikipedia.org

The body keeps a few T-lymphocytes, called memory cells, which go into action quickly if the body encounters the same germ again. When such familiar antigens are noticed, the memory cells stimulate the B-lymphocytes to produce antibodies against them.[2]

3.0 Nature and Components of Vaccines

A vaccine is a suspension of weakened, killed, or fragmented microorganisms or toxins or of antibodies or lymphocyte that is administered primarily for disease prevention.[2,13] Vaccines are usually administered by injection (parenteral administration), but some are given orally or even nasally (in the case of flu vaccine). Vaccines applied to mucosal surfaces, such as those lining the gut or nasal passages, seem to stimulate a greater antibody response and may be the most effective route of administration. Vaccines contain conjugating agents which are carrier proteins that combine with antigens to improve immunogenicity.[13] They also contain preservatives and adjuvants all suspended in a fluid medium.[14] The preservatives may be stabilizers and antimicrobial agents. Trace amounts of these are used to stabilize the vaccine but may cause allergic reactions. The Adjuvants, an example of which is Aluminum salt, popularly known as "alum", initiate diverse molecular and cellular mechanisms to enhance immunogenicity, including release of proinflammatory cytokines.[14,15] These are used to increase immunogenicity of vaccines containing inactivated micro-organisms or their products e.g. Hepatitis B vaccine, Tetanus Toxoid and Diphtheria Toxoid.[15] The suspension fluid is usually water, saline or a tissue-culture mixture. Components may include Squalene oil (adjuvant), Pork gelatin, Human serum albumin and recombinant albumin, Egg protein and Formaldehyde. Each vaccine component is usually fully disclosed before approval for use.[16]

3.1 Types of Vaccines

Many approaches are taken to develop vaccines. These approaches are based on information about the infections the vaccine will prevent; knowledge about how the germs infect cells and how the immune system responds to it. Practical considerations, such as regions of the world where the vaccine would be used, are also important because the strain of a virus and environmental conditions, such as temperature and risk of exposure, may be different across the globe. The vaccine delivery options available may also differ geographically. There are many types of vaccines, categorized by the antigen used in their preparation.[2] The

formulations affect how they are used, how they are stored, and how they are administered. Vaccines can be classified into two, namely live attenuated vaccines and non live vaccines.

Live attenuated vaccines contain a version of the living virus or bacteria that has been weakened so that it does not cause serious disease in people with healthy immune systems. They produce long lasting immune response after one or two doses. Live virus vaccines use the weakened (attenuated) form of the virus to stimulate the immune system to react as it does to natural infection but can cause mild form of the disease. The measles, mumps, and rubella (MMR) vaccine, Yellow fever and the varicella (chickenpox) vaccine are examples. Live attenuated vaccines cannot be given to immunocompromised persons due to possibility of infection.

Non live vaccines cannot cause diseases they are designed to protect against. These can be further classified as inactivated, conjugate, recombinant and sub unit vaccines. Inactivated vaccines and toxoids are made from a protein or other small pieces taken from a virus or bacteria. Here the native virus is inactivated with heat or chemical treatments, which also fight viruses and bacteria. These vaccines are made by inactivating, or killing, the germ during the process of making the vaccine. The inactivated polio vaccine is an example of this type of vaccine. Inactivated vaccines produce immune responses in different ways than live, attenuated vaccines. Often, multiple doses are necessary to build up and/or maintain immunity. Toxoid vaccines prevent diseases caused by bacteria that produce toxins (poisons) in the body. In the process of making these vaccines, the toxins are weakened so they cannot cause illness. Weakened toxins are called toxoids. When the immune system receives a vaccine containing a toxoid, it learns how to fight off the natural toxin.

Conjugate vaccine is where a protein or polysaccharide antigen is linked to a carrier protein. Conjugate vaccines fight a different type of bacteria that have antigens with an outer coating of sugar-like substances called polysaccharides. This type of coating disguises the antigen, making it hard for immature immune system to recognize it and respond to it. Conjugate vaccines are effective for these types of bacteria because they connect (or conjugate) the polysaccharides to antigens that the immune system responds to very well. This linkage helps the immature immune system react to the coating and develop an immune response. An example of this type of vaccine is the Haemophilus influenzae type B (Hib) vaccine and the meningococcal C conjugate vaccine.

Recombinant vaccines are produced through recombinant DNA technology e.g. hepatitis B and HPV vaccine.

Sub unit vaccine contains only specific antigenic proteins of an infectious agent. They are vaccine types utilizing portions of the virus as antigens to produce an immune response. They include only parts of the virus or bacteria, or subunits, instead of the entire germ. Because these vaccines contain only the essential antigens and not all the other molecules that make up the germ, side effects are less common. The pertussis (whooping cough) component of the DTaP vaccine is an example of a subunit vaccine. Other examples are the acellular pertussis and some influenza vaccines.

New Approaches to Vaccines Development include mRNA vaccines which were adopted by Pfizer and some other vaccine manufacturers. COVID-19 mRNA vaccines are a new type of vaccine given in the upper arm muscle to protect against infectious diseases. They are made to give instructions for cells to make a harmless piece of what is called the spike protein.[17] The spike protein is found on the surface of the virus that causes Covid-19. Once the instructions (mRNA) are inside the immune cells, the cells use them to make the protein piece. After the protein piece is made, the cell breaks down the instructions and gets rid of them. Next, the cell displays the protein piece on its surface. The immune systems recognize that the protein doesn't belong there and begin building an immune response and making antibodies, like what happens in natural infection against COVID-19.[18]

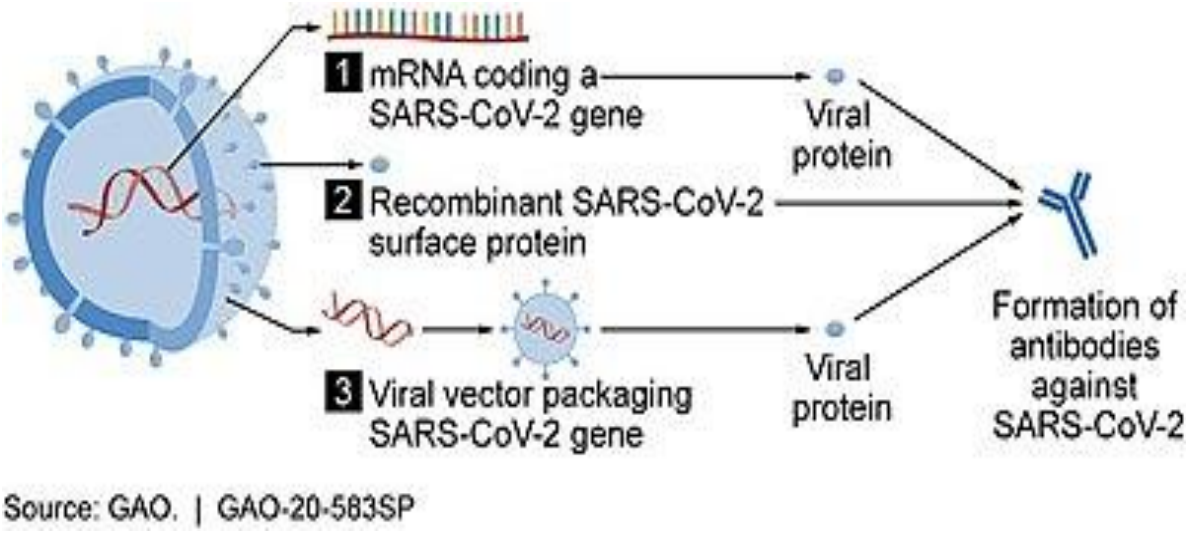

Figure 3: Potential candidates for forming SARS-CoV-2 proteins to prompt an immune response.

The benefit of mRNA vaccines, like some other vaccines, is that those vaccinated gain this protection without ever having to risk the serious consequences of getting sick with COVID-19. This is because mRNA vaccines do not use the live virus that causes COVID-19.

These vaccines do not affect or interact with DNA in any way as they never enter the nucleus of the cell, which is the location of the genetic material.[17] The cell breaks down and gets rid of the mRNA soon after it is finished using the instructions. Researchers have been studying mRNA vaccines for decades for diseases like flu, Zika, rabies, and cytomegalovirus.[17] Interest has grown in these vaccines because they can be developed in a laboratory using readily available materials.

The Janssen vaccine from Johnson & Johnson uses a more traditional method by introducing a modified version of an adenovirus, a common cause of respiratory infections, to instruct the cell to make the spike protein.

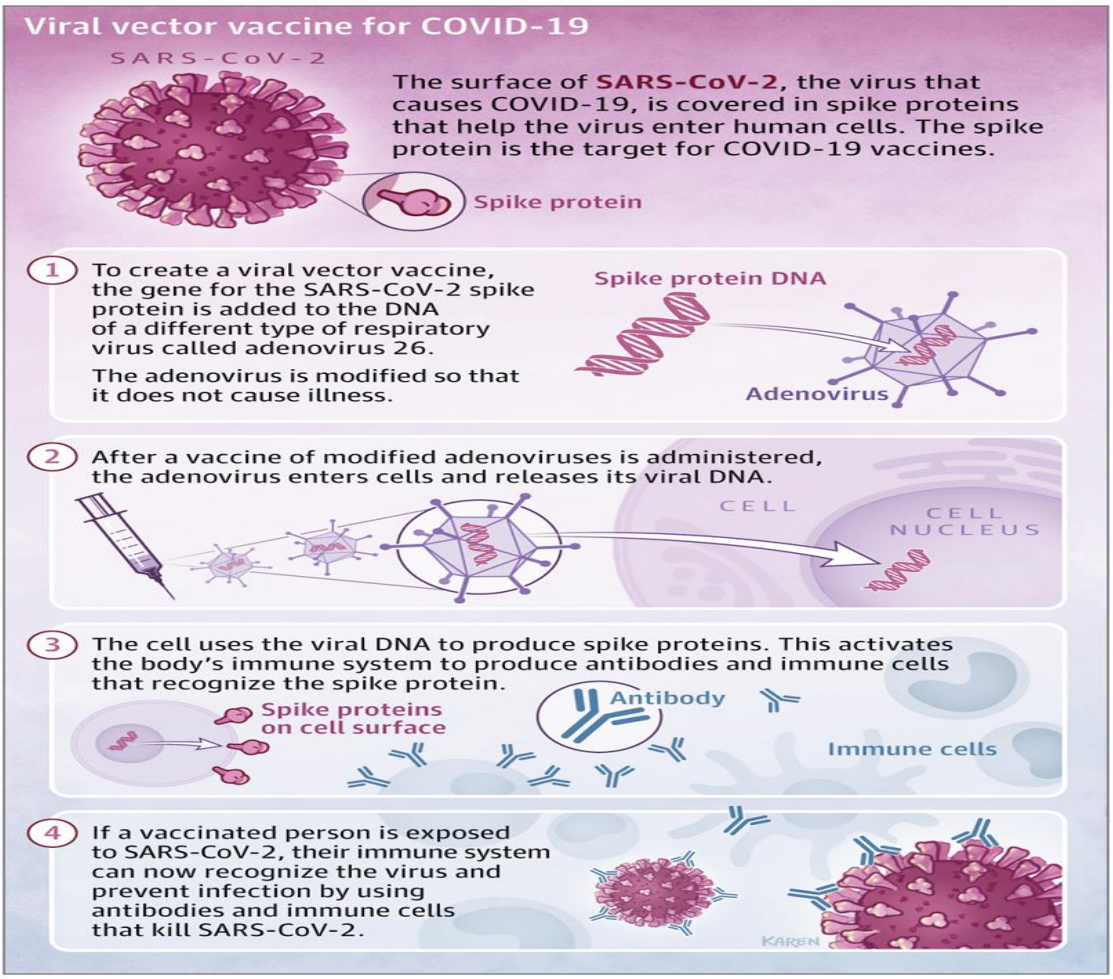

Figure 4: A schematic diagram depicting immune response from the Johnson & Johnson vaccine.

Source: JAMA. 2021; 325(15):1575. doi:10.1001/jama.2021.2927

The DNA in the adenovirus is modified so that it produces a key part of the SARS-CoV-2 virus particle to which the body then develops an immune response. The adenovirus that delivers the SARS-CoV-2 DNA particle cannot multiply, so it does not cause infection.[19]

3.2 Dosing With Vaccines

Vaccines require more than one dose for improved effectiveness. There are main reasons that people who receive a vaccine for the first time usually need more than one dose.[20,21]: Immunity begins to wear off after a while with some vaccines. At that point, a "booster" dose is needed to bring immunity levels to a standard level. This booster dose usually occurs several years after the initial series of vaccine doses is given. For example, in the case of the DTaP vaccine, which protects against diphtheria, tetanus and pertussis, the initial series of four shots that children receive as part of their infant immunizations helps build immunity, but a booster dose is needed at 4 years through 6 years old.[20,21] Another booster against these diseases is needed at 11 years or 12 years of age.[21]

For some vaccines (primarily live vaccines), studies have shown that more than one dose is needed for everyone to develop the best immune response. For example, after one dose of the MMR vaccine, some people may not develop enough antibodies to fight off infection. The second dose helps make sure that almost everyone is protected. In the case of flu vaccines, adults and children (6 months and older) need to get a dose every year. Children 6 months through 8 years old who have never gotten a flu vaccine in the past or have only gotten one dose in past years need two doses the first year they are vaccinated. Then, an annual flu vaccine is needed because the flu viruses causing disease may be different from season to season. Every year, flu vaccines are made to protect against the viruses that research suggests will be most common. Also, the immunity a child gets from a flu vaccination wears off over time. Getting a flu vaccine every year helps keep people protected, even if there are no new variants of the vaccine viruses from one season to the next.[21]

4.0 Development of Imunity to Contagious Respiratory Diseases

4.1: Immune response to the coronavirus

Severe acute respiratory syndrome (SARS) represents the first pandemic transmissible disease to emerge in this century. It was caused by a previously unknown coronavirus, the SARS-associated coronavirus (SARS-CoV).[22] SARS-CoV spreads from animals to humans by a rapid adaptation and evolution process.[23,24] A large number of closely related viruses

are present in wildlife reservoir populations.[25-27] Therefore, due to cross-species transmission of the same or a similar coronavirus, SARS could recur. Immune protection against infection with other human coronaviruses, such as OC43 and 229E, is short-lived.[28] To assess SARS patients' risk for future reinfection, one research group conducted a longitudinal study of immunity in convalescent patients.[29]

Among 176 patients who had had severe acute respiratory syndrome (SARS), SARS-specific antibodies were maintained for an average of 2 years, and significant reduction of immunoglobulin G–positive percentage and titers occurred in the third year. Thus, SARS patients might be susceptible to reinfection >3 years after initial exposure.[29]

All of the immune-system components have been found in people who recover from SARS-CoV-2, the virus that causes COVID-19.[30] Some researchers found durable immune responses in a majority of people studied. Antibodies against the spike protein of SARS-CoV-2, which the virus uses to get inside cells, were found in 98% of participants one month after symptom onset. As seen in previous studies, the number of antibodies ranged widely between individuals. But, promisingly, their levels remained fairly stable over time, declining only modestly at 6 to 8 months after infection.[30]

Virus-specific B cells increased over time. People had more memory B cells six months after symptom onset than at one month afterwards. Although the number of these cells appeared to reach a plateau after a few months, levels didn't decline over the period studied.[30] Levels of T cells for the virus also remained high after infection. Six months after symptom onset, 92% of participants had CD4+ T cells that recognized the virus. These cells help coordinate the immune response. About half the participants had CD8+ T cells, which kill cells that are infected by the virus.[30]

As with antibodies, the numbers of different immune cell types varied substantially between individuals. Neither gender nor differences in disease severity could account for this variability. However, 95% of the people had at least 3 out of 5 immune-system components that could recognize SARS-CoV-2 up to 8 months after infection.[30] This study showed that natural infection induced a strong and lasting response. It is hopeful that a similar pattern of responses lasting over time will also emerge for the vaccine-induced responses.

4.2 Reinfection after initial exposure to Covid-19

Immunity and time value of immunity to Covid -19 after infection are still being studied. It has been reported that some discharged patients in China and elsewhere were testing positive after recovering.[31]

A longitudinal tracking of re-exposure after the disappeared symptoms of the SARS-CoV-2-infected monkeys was performed in one study. It was found that weight loss in some monkeys, viral replication mainly in nose, pharynx, lung and gut, as well as moderate interstitial pneumonia at 7 days post-infection (dpi) were clearly observed in rhesus monkeys after the primary infection.[32] The results indicated that the primary SARS-CoV-2 infection could protect from subsequent exposures.

5.0 Mortality To Covid-19

In December 2019, the World Health Organization (WHO) Country Office in China was first alerted to an unknown outbreak of contagious and often severe lower respiratory illnesses originating from the city of Wuhan, the biggest city in and capital of China's Hubei province.[33] The cause of the respiratory illness is a virus of the betacoronavirus class now termed coronavirus infectious disease-19 (COVID-19). The virus was named SARS-CoV-2 due to its genetic and structural similarity with SARS-CoV.[33, 34] On March 11, 2020, the WHO officially identified SARS-CoV-2 as a pandemic due to its quick global spread.[33] As of June 3rd, 2021, there were 171 292 827 confirmed cases worldwide and 3 687 589 Confirmed deaths recorded deaths due to SARS-CoV-2.[11] The continued rise of both cases and deaths necessitates the rapid deployment of effective SARS-CoV-2 vaccines to endemic areas.[35]

There is no evidence to support that Sub Sahara Africans have some immunity to COVID-19 apart from the observation of minimal spread and mortality. SARS-CoV-2 is unusual for a respiratory virus in that it binds to a receptor, angiotensin converting enzyme 2 (ACE2), expressed in virtually all organs[36], but especially in the lungs[37], brain[38], and gut.[39] Therefore, unlike most respiratory viruses, SARS-CoV-2 has broader biodistribution and can cause considerable damage outside the respiratory system. It adversely affects the digestive, urogenital, central nervous, and circulatory systems, and the pervasiveness of the ACE2 receptor is why symptoms are highly variable and include dyspnea, diarrhea, headache, high blood pressure, venous thromboembolism.[40]

Covid-19 has changed disease indices since 2019. At a global level, 7 of the 10 leading causes of deaths in 2019 were non communicable diseases. These seven causes accounted for 44% of all deaths or 80% of the top 10. However, all non communicable diseases together accounted for 74% of deaths globally in 2019.[41]

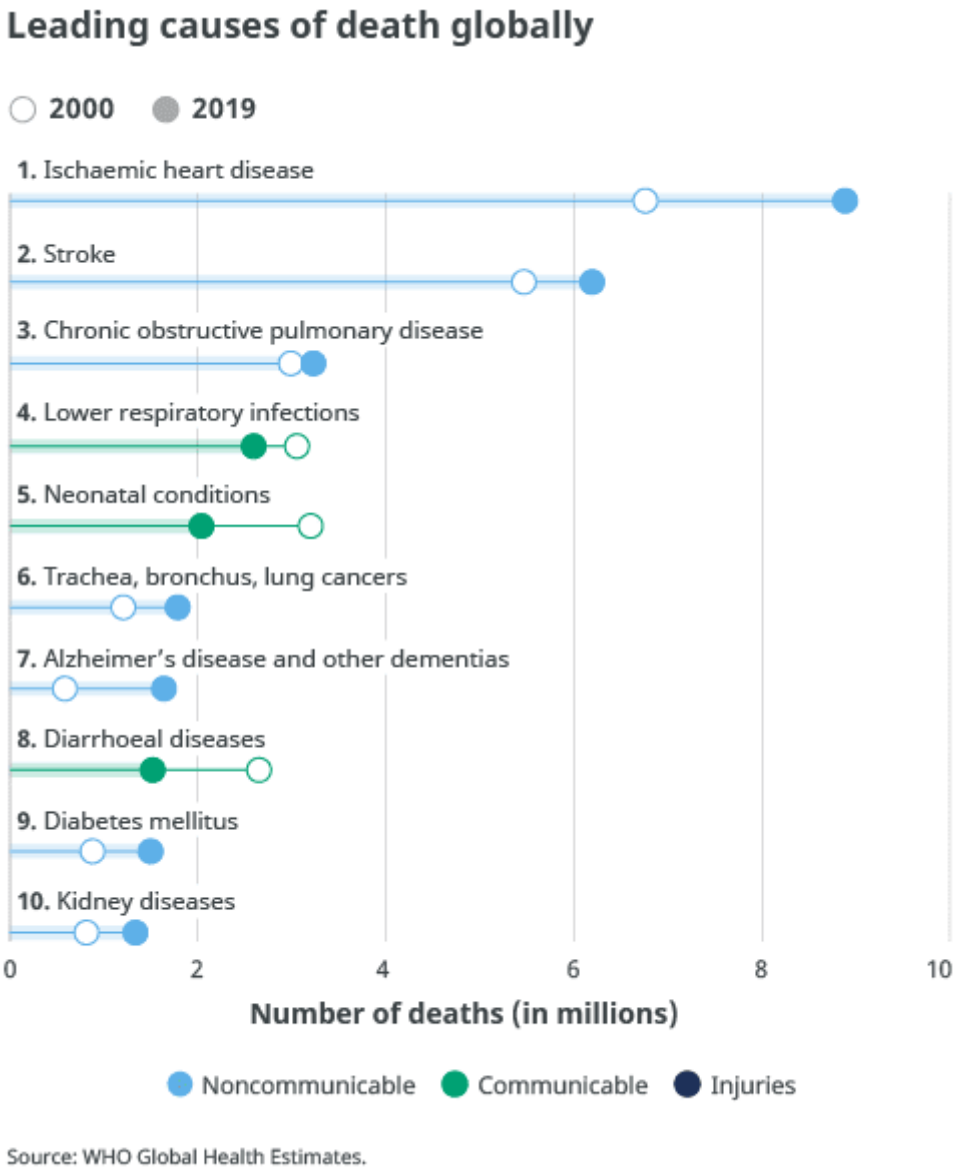

Figure 5.

Before the advent of Covid-19 pandemic lower respiratory tract infections ranked fourth at 10.85% as a cause of death in Nigeria and even with the 2020 estimate, respiratory diseases are still not a major burden to Nigeria in terms of mortality rate.[42] The main causes of death in Nigeria in 2019 were neonatal disorders. More specifically, 12.25 percent of all deaths

were caused by neonatal disorders. Other common causes included malaria, diarrheal diseases, and lower respiratory infects.[42]

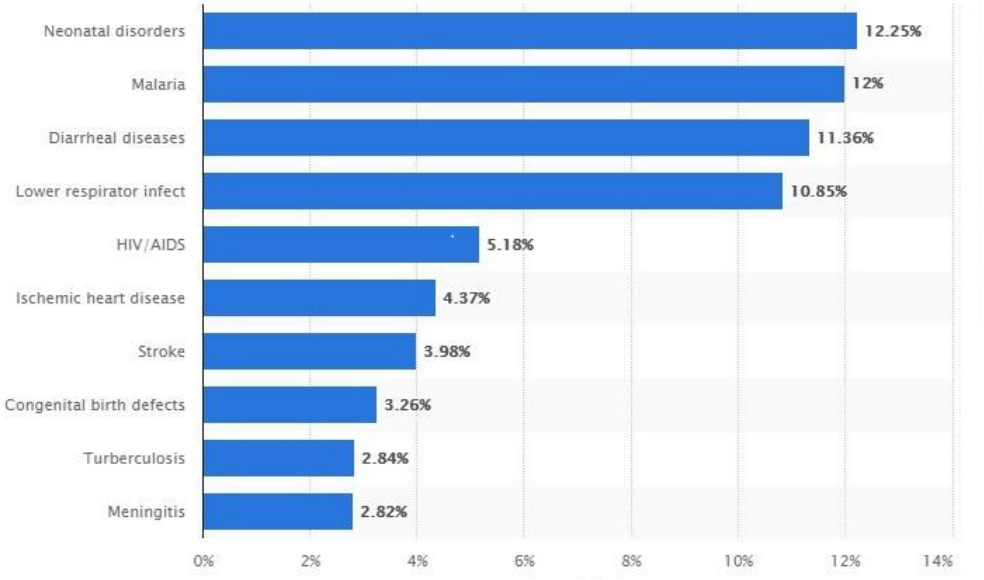

Figure 6: Main causes of death in Nigeria 2019.

Share of deaths

Source:https://www.statista.com/statistics/1122916/main-causes-of-death-and-disability-in-nigeria/

6.0 Vaccine Efficacy and Effctiveness

A vaccine's effectiveness and efficacy are two different things. Efficacy refers to how well a vaccine works under controlled circumstance such as a clinical trial. While effectiveness refers to how well that vaccine works in the real world.[43] Case-control studies assess effectiveness by comparing the vaccination status of individuals who develop the disease (cases) with a group of individuals without the disease (controls) who are also representative of the population from which the cases arise.[44] A lower efficacy rate does not always mean a low level of effectiveness in the real world and the same is true for vaccines of high efficacy. The efficacy numbers for vaccines tend to be higher than effectiveness due to variables happening in the real world that can't be accounted for during a clinical trial. Clinical trials are carefully designed to help mitigate inconsistencies between efficacy and effectiveness. Many clinical trials have exclusion criteria such as pregnancy, particular health conditions, and age. Trials involving experimental vaccines rarely include children or seniors until scientists have collected a

significant amount of safety data to protect these groups from potential harm. Vaccine efficacy only provides information about how well a vaccine works under the conditions of the clinical trial. Scientists usually base it on factors that they can quantify, called the primary endpoints, such as numbers of laboratory-confirmed cases of COVID-19. However, in practice, the effectiveness numbers are modestly lower than the efficacy numbers. Many factors can influence how a vaccine performs outside of clinical trials. One of these is the health of those receiving the vaccine. Underlying health conditions can affect vaccine effectiveness.[45] Another factor is how the disease-causing pathogen changes with time.[46, 47] The viruses that cause the flu are prone to mutations that make vaccines less effective.[46, 47]

The Pfizer-BioNTech COVID-19 vaccine for example, was reported to show a 95 percent effectiveness in preventing symptomatic infection and 100 percent effective in preventing severe disease, according to the Centers for Disease Control and Prevention (CDC).[48] Moderna's vaccine is 94 percent effective and 89 percent effective in preventing hospitalization, says the CDC.[49] According to a March 2021 article published in The Journal of the American Medical Association[50], the Janssen vaccine was 66 percent effective in preventing moderate to severe infection, and 100 percent effective at preventing hospitalization and death related to COVID-19.

Statisticians worked out the fundamental logic behind present day vaccine trials a long time ago. Researchers vaccinate some people and give a placebo to others. They then wait for participants to get sick and look at how many of the illnesses came from each group.[51] The scientists then determined the relative difference between those two fractions. Scientists express that difference with a value they call efficacy. If there's no difference between the vaccine and placebo groups, the efficacy is zero. If none of the sick people had been vaccinated, the efficacy is 100 percent.[51] In the case of Pfizer, for example, the company recruited 43,661 volunteers and waited for 170 people to come down with symptoms of Covid-19 and then get a positive test. Out of these 170, 162 had received a placebo shot, and just eight had received the real vaccine.[52] From these numbers, Pfizer's researchers calculated the fraction of volunteers in each group who got sick. Both fractions were small, but the fraction of unvaccinated volunteers who got sick was much bigger than the fraction of vaccinated ones. Pfizer/BioNTech reported an efficacy of 95% for the Covid-19 vaccine.[52] This means a 95% reduction in new cases of the disease in the vaccine group compared with the placebo group. A 95 percent efficacy for the Pfizer/BioNTech vaccine is sure evidence

that the vaccine works well. But that number doesn't tell what the chances are of becoming sick if one gets vaccinated. And on its own, it also doesn't say how well the vaccine will bring down Covid-19 across the globe. Despite the vaccines' different efficacy rates, research is still emerging on how they perform when faced with infection from newer strains of COVID-19. Though efficacy and effectiveness are related to each other, they're not the same thing and it's crucial not to mix them up.

7.0 Vaccine Failure and Adverse Events

Vaccines are said to fail primarily when there is inadequate immune response to vaccine. In this case, infection is possible at any time post vaccination. A secondary case of vaccine failure is when there is adequate antibody response immediately after vaccination but level of antibodies decrease with time. In this case booster doses are usually required to bring the immune response back to a quality level. This is a prominent attribute of many inactivated vaccines. There is indication that respiratory viruses are especially difficult to protect against with vaccines. The respiratory syncytial virus is a prime example in which there are no approved vaccines, despite considerable efforts to develop one.[53]

One reason for vaccine failure against respiratory viruses is that the respiratory tract, including the lungs, is an external mucosal surface that is protected by the generation of secreted IgA antibodies; yet, the antibodies measured to determine whether an experimental subject has "responded" to a vaccine often focus on IgG, IgM, or total immunoglobulin in the blood.[54, 55] Most vaccines are delivered intramuscularly, and mucosal immunity and IgA secretion is thereby minimal.[56] Furthermore, eliciting IgA production from conventional vaccines is difficult, and vaccines may lack the immunogenicity required to elicit necessary IgA protection.[57]

The fast pace in the development of new vaccines raises many questions that address the specific and nonspecific impacts of such vaccines on the immune system and, thus, on health in general. These immune-related concerns have largely spread into the population, and questions related to the immunological safety of vaccines—that is, their capacity for triggering non–antigen-specific responses possibly leading to allergy, autoimmunity, or even premature death—are being raised. Certain "off-targets effects" of vaccines have also been recognized. For live vaccines the frequency of adverse events falls with number of doses. When antibody is made it neutralizes small amount of vaccine virus in any subsequent vaccine dose.[58] In the case of non live vaccines the frequency of adverse events increases

with number of doses. Adverse events may be inflammatory (i.e. produce a sore arm) or fever e.g. tetanus, pertussis.[59]

Side effects are to be expected and are acceptable for a majority of people based on explanation. The five main side effects people are experiencing - fatigue, headache, muscle pain, chills and diarrhoea are to be expected with pretty much any vaccine. It's common to experience some mild-to-moderate side effects when receiving vaccinations. This is because the immune system is instructing the body to react in certain ways: it increases blood flow so that more immune cells can circulate, and it raises body temperature in order to kill the pathogen. Reported side effects of COVID-19 vaccines have lasted no longer than a few days. The chances of any of these side effects occurring after vaccination differ according to the specific vaccine.

Experiencing mild side effects after getting vaccinated means the vaccine is working and the immune system is responding as it should. The adverse events from the Covid-19 vaccines are not yet taken to be serious enough to warrant termination of vaccine use.[60] This is reasonable in areas where Covid-19 is a major disease burden.

8.0 Risk and Benefit Ratio of Covid-19 Vaccination to Average Nigerians

8.1 Vaccine Use and Nutrition

Good nutrition is crucial for the coronavirus vaccine to work effectively and the vaccine companies and policy makers seem not to take into consideration the nutritional status of persons in their calculation of efficacy and projected effectiveness. For the immune system to fight off infection or generate good protection against a disease following vaccination, it needs a variety of micronutrients.[61] Vaccines are harder to deliver and potentially less effective at stimulating an immune response in those who are undernourished. This is likely to be just as true for COVID-19 as for other diseases. Given that malnutrition is common among Sub- Sahara Africa people, raising their vitamin and mineral levels before they get vaccinated could be a way of boosting the effectiveness of COVID-19 vaccines where necessary. Good nutrition is crucial for the coronavirus vaccine to work effectively and there are further risks for hungry persons when they take vaccines.[62] Vaccines are harder to deliver and potentially less effective at stimulating an immune response in those who are undernourished.[63] To get the best out of a new Covid-19 vaccine, tackling the scourge of all forms of malnutrition will be critical especially in Nigeria. Initiatives that can improve the efficacy of the vaccine for the common man in Nigeria should have been taken by

policy makers. Multiple studies indicate that nutrition provides a cost-effective yet significant impact on vaccination outcomes, and can, therefore, improve vaccine efficacy.[64] Malnutrition-induced immunodeficiency is known to reduce effective response to vaccines.[62] Malnutrition threatens to drive increased mortality during the COVID-19 pandemic and, in the long-term, potentially undermine the efficacy of vaccines.

8.2 Herd Immunity For Covid-19

The demand to vaccinate every human on earth, by the world health organization, stems from the need for global herd immunity to Covid-19 as the only solution to stop the spread of Covid-19 and ensure its containment.[65] Herd immunity happens when a large part of the population - the herd - is immune to a virus. This can occur either because these people got vaccinated or had already been infected. Herd immunity makes it harder for a virus to spread.

Herd immunity means enough people are protected from the disease to slow down or stop the pathogen's spread. This implies that people who have not had the vaccine or cannot have the vaccine receive indirect protection.[65] Herd Immunity can only apply to diseases which are passed from person to person. For each disease, a certain level of immunity in the population protects the whole population because the disease stops spreading in the community. This provides indirect protection of unvaccinated as well as vaccinated individuals.[65] The more contagious a virus is, the more people need to be immune for herd immunity to kick in. Attainment of herd immunity may be the most important aspect of why vaccines for contagious diseases like Covid-19 are deployed. But the urge for herd immunity for Covid-19 seems to disregard the existing variants of the disease and possibility of continuous mutations in the Covid-19 genome. There is no existing vaccine with claim to all possible strains of the disease. The race for covid-19 vaccines to be deployed all over the world is understandably intense but the vaccine propagators seem to only focus more on the efficacy and projected effectiveness of the vaccine than on the frequency of vaccination to achieve year round protection from the disease and its necessity for certain societies.[11]. Consideration for the long term effect of an annual or biannual Covid-19 vaccination can only be visualized when it is already in use by humans. Like thalidomide and many other drugs that were approved with disastrous consequences in history[66], Covid-19 vaccines should be viewed and approved for use with restraint in some environments.[9] Considering the ravaging intensity of Covid-19 disease in some countries in Europe, Asia and America, the benefits of this

vaccination seem to outweigh the risk of use and all approved Covid-19 vaccine can be deployed with haste to these climes.[11] But for countries where the incidence and mortality to Covid-19 is not significant, it will seem cruel to deploy Covid-19 vaccines for use without thinking of other containment measures. Sub Saharan African countries like Nigeria, for instance, currently have infinitesimal and often politically inflated numbers of Covid-19 cases for not quite explicable reasons[9]; and already have a burden of mostly localized diseases like malaria, microfilaria and other helminthic infections, in addition to diseases associated with under nutrition and poor environmental conditions.[42] For these and other such countries, Covid-19 vaccines should not be recommended for use; as the risks far outweigh the benefit. With immeasurably small virulence and mortality to Covid-19 in Sub-Sahara Africa herd immunity can be achieved over time without the deployment of vaccines. Although vaccine development relies on studies of naturally acquired immune responses, there are still no conclusive comparative analyses of the natural and vaccine immunity against SARS-CoV-2. An exploration of the benefits of infection-acquired and vaccine-induced immunity against COVID-19, suggests that the latter outweighs the former.[67]

Efforts at increasing longevity should concentrate at both the containment of endemic diseases and improved quality of life by increased economic realities for better environmental health. Scarce economic resources should be spent for the benefit of the local populace, and not just to allay fears in more economically balanced societies who do not generally have the added burden of poor nutrition. Vaccinations can be recommended when persons from these environments have a need to travel to Covid-19 endemic populations, if they are discovered not to have antibodies to Covid-19 at levels comparable with those that have already received the Covid-19 vaccine.[68] In this case antibodies rather than vaccine passports will be used to confirm immunity to Covid-19.

8.3 Vaccine Hesitancy In Sub-Sahara Africa

Vaccines with questionable and undisclosed content have been recommended for African countries in times past and this was only discovered by providence and diligence. A case in point is when Kenyan Doctors in 2015 reported that they found an anti-fertility agent in tetanus vaccine.[69] The Kenya Catholic Doctors Association charged two separate United Nations organizations with knowingly sterilizing millions of women and young girls under their care without the patient's consent. The association claimed that an anti-fertility drug was found in all batches of the new tetanus vaccine that were tested then.[69] The Kenya Catholic

Doctors Association had a concern with a WHO/UNICEF sponsored tetanus immunization campaign launched in October 2015 seemingly to eradicate neonatal tetanus.[69] The campaign was intended for women of child-bearing age in 60 specific districts spread all around Kenya. The tetanus vaccine being used in that campaign had been imported into the country specifically for this purpose, and bears a different batch number from the regular tetanus shot.[69] The new vaccine campaign presented a number of red flags to the organization, so they decided to research the vaccine further. What they found led Dr Wahome Ngare, a gynaecologist and obstetrician for and on behalf of the Kenya Catholic Doctors Association to warn young girls and women to stay away from the new tetanus vaccine and stick with the old one.[69]

In a related development, Indian doctors blamed a vaccine campaign for a devastating non-polio acute flaccid paralysis (NPAFP) epidemic that paralyzed 490,000 children beyond expected rates between 2000 and 2017.[70] The World Health Organization (WHO) later reluctantly admitted that the global explosion in polio is predominantly vaccine strain.[71] Frightening epidemics in Congo, Afghanistan, and the Philippines, have been linked to vaccines.[72] By the year 2018, 70% of global polio cases were vaccine strain.[73] In 2014, a funded test of experimental HPV vaccines, developed by Glaxo Smith Kline (GSK) and Merck, on 23,000 young girls in remote Indian provinces was carried out. Approximately 1,200 of participants suffered severe side effects, including autoimmune and fertility disorders.[74] A phase 3 trial of GSK's experimental malaria vaccine, in 2010 killed 151 African infants and causing serious adverse effects including paralysis, seizure, and febrile convulsions to 1,048 of the 5,949 children.[75]

Earlier in a 2002 MenAfriVac campaign in Sub-Saharan Africa, thousands of African children were forcibly vaccinated against meningitis. Approximately 50 of the 500 children vaccinated developed paralysis.[76] A 2017 study[77] showed that WHO's popular DTP vaccine is killing more African children than the diseases it prevents. DTP-vaccinated girls suffered ten times the death rate of children who had not yet received the vaccine.[77]

The haste in the deployment of the Covid-19 vaccine based on Emergency Use Approval occasioned by the fast spread and virulence of covid-19 did not give much time for African countries to carry out independent assessment of the suitability of the approved vaccines.[78] This is coupled with the paucity of standard indigenous and independent facilities to carry out the quality and content assessment of the recommended vaccines and their suitability for the

indigenous populace that's mostly hungry for food.[9]. There is no reason to trust the vaccines beyond its recommendation by the World Health Organization (WHO); that left other disease burdens like malnutrition and malaria with less attention. The feeling is that if malaria and hunger were to attain pandemic proportions like Covid-19, chances are that permanent solution would have long been found for them by WHO, especially if the epicenter is not Sub Sahara Africa as is the case with Covid-19.

9.0 CONCLUSION

Vaccines provide immunity better than naturally acquired immunity from having the disease itself.[68] Covid-19 has not been confirmed to be natural and may not promise to follow patterns of natural infections. All natural infections can cause severe complications and be deadly; which can be weighed with the side effects of the vaccines. A vaccine's efficacy differs from its effectiveness and an assessment of the competency should take into account the safety, unique consideration and necessity for any population. It may prove wrong to promote the belief that vaccines offer the only hope for eradication of Covid-19.

This review concludes with the sense of expectancy that strive for containment and possible eradication of the Covid-19 pandemic should better be directed more to treatment of the disease and its comobidities than to the production of vaccines; for it to make universal sense. Countries should have recommendations for containment of diseases tailored to their individual requirement instead of the one formula fits all represented by the global Covid-19 vaccination scheme. The seasonal flu has neither been eradicated nor reasonably contained with vaccines over the years especially due to the evolution of variants and the Influenza pandemic of a century ago was not eradicated by vaccines. Apprehension fuels vaccine hesitancy with the knowledge of possible side effects of the Covid-19 vaccines and trust for the content of the vaccines shipped to some parts of the world. This is because the delivery of the Covid-19 vaccine may in the long run deliver more existential challenges to humanity than Covid-19, especially in environments where Covid-19 is not the major disease burden as in our country Nigeria.

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