Co-infection of Covid-19 and Malaria among staff and students of Federal University of Technology Owerri, Imo State.

ABSTRACT

Background: Coronavirus disease (COVID-19) and malaria syndemic poses colossal challenge in prompt diagnosis and effective management of both infections especially in tropical regions. Therefore, this survey was conducted in order to ascertain the seroprevalence of SARS-COV-2 antibodies and malaria parasite in a Federal University of Technology Owerri, located in the south-eastern part of Nigeria, shortly after the waves of COVID-19 pandemic in 2020. The study was carried out among staff and students in the School of Biological Sciences, Federal University of Technology Owerri, Imo State, Nigeriawithin the age range of twenty-one (21) and above.

Method: A total of 600 randomly selected participants (400 students and 200 staff) who had provided informed consent, were randomly selected from the School of Biological Sciences, Federal University of Technology Owerri. Questionnaires were administered to collect data on respondents' demographics and clinical history. Then, blood samples were aseptically collected by needle prick and tested for COVID-19 and malaria using the SARS-COV-2 IgM/IgG antibody test kit and the malaria test kit (Malaria Pf (HRP2) respectively.

Results: Malaria and COVID-19 co-infection rates observed among the staff and students in this survey were 5% and 1.8% respectively. Out of the 200 staff tested in this study, 45(22.5%) were IgG positive, 0(0%) were positive for IgM while 10(5%) tested positive to malaria parasite. Although, all IgG positives were junior staff. Then, amongst the 400 students tested, 37(9.25%) tested positive for IgG while none (0%) were IgM positive but, 62(15.5%) were positive for *Plasmodium falciparum* infection. The interrelated symptoms of malaria and COVID-19 mostly observed in our respondents were fever, headache and fatigue.

Conclusion: Results from this study further explained that the level of co-infection prevalence varies directly with the level of malaria prevalence and vice versa.

Keyword: Corona Virus, Malaria, Immunoglobulin G (IgG), Immunoglobulin M (IgM), Pandemic, Nigeria.

Introduction

The novel coronavirus has been implicated as the causative organism of the 2019 covid-19 pandemic outbreak and was first reported in Wuhan, China, in December 8, 2019. By January 30, 2020 it was declared a global health emergency by the World Health Organization and has since spread globally [1]. China informed the WHO about the Covid-19 outbreak on the 31st of December, 2019 and after wards there has been human-human transmission [2]. In October 2023, there were 771,191,203 confirmed cases of Covid-19 globally including 6,961,014 deaths as recorded by World Health Organization [3]. From 3rd January 2020, to 12th October, 2023, two hundred and sixty-seven thousand one hundred and forty-six (267,146) confirmed cases have been recorded in Nigeria with three thousand one hundred and fifty-five deaths [4]. By early September 2022, 600,366,479 million confirmed cases of Covid-19 and over six million deaths were recorded globally [5].

Covid-19 is a zoonotic infectious disease. The virus is said to be of bat origin and was first transferred to human in Hubei province of China through an intermediary host. Inhalation and contact with infected respiratory droplets are means of transmission as well as asymptomatic carriers with incubation period ranging from 2-14 days [6]. Sore throat, cough, fever, breathlessness, malaise, and fever are some of the symptoms of Covid-19. Despite the fact that some individuals could be asymptomatic, others could present mild symptoms while the disease is said to be more severe in the elderly and those with underlying ailments and may proceed to pneumonia, acute respiratory distress syndrome (ARDS) as well as multi organ dysfunction [6]. About 10%–20% of symptomatic patients are said to be at risk of fatality with many of their organ's system being affected [7]. During the first nine months of the pandemic,

numerous mutations were identified, this led to the suggestions that viral genetic diversity, genetic evolution, and variable infectivity, could be attributed to Covid-19 infectivity and fatality [7]. The host and environment are two factors that also influence the course and outcome of the disease [7]. In severe cases of Covid-19, hypertension and diabetes have been reported as the most prevalent comorbidities [8].

On the 27th of February 2020, Nigeria diagnosed her first case of the coronavirus disease 2019 (COVID-19) in an international immigrant and by 23rd of March, 2020, it recorded its first death case [9]. To reduce its transmission, governments enforced the shutdown of borders, travel restrictions, and quarantine[10]. In order to significantly minimize the impact of the virus, the Nigerian government joined the global lockdown. The national lockdown was announced on the 30th of March 2020, schools, religious houses, clubs and hotels were closed, gatherings involving more than 20 people were also prohibited [11]. Prior to the shutdown of schools in Nigeria, the Niger Delta Development Commission (NCDC) had set guidelines for schools to reduce the spread of the infection in schools which include; frequent washing of hands by teachers and students, body temperature check, cleaning and disinfecting of environment and staying at home when sick [12]. World Health Organization (WHO) had proposed health and safety measures to prevent the spread of the disease, it was however noted that majority of people residing in sub-Saharan Africa were non-compliant to these measures [13]. These measures include the use of personal protective equipment (PPE), washing of hands, observing physical distancing, workplace restrictions, cleaning of environment, and stay-at-home orders for those who have been exposed and remained asymptomatic [14].

Covid-19 pandemic affected the education system at all levels of schools, ranging from pre-school to tertiary education. The schools were either completely shut down or targeted shut down [15]. By April 2020, it was estimated that appropriately 900 million learners were affected by the closure of schools [16]. The lockdown affected the economy of the nation which led to the gradual easing off of the lockdown by 5th May 2020 [17]. People's adherence to preventive measures against the spread of Covid-19 is affected by their knowledge, attitudes, and practices (KAP) [14].

Immune cells and proteins which are part of the immune system components have been found in people who recovered from the virus responsible for Covid-19. The antibodies vary among individuals and decline over time between 6-8 months after infection. However, the antibodies might not be durable as a result of reinfection with the virus [18]. Nucleic acid-based polymerase chain reaction (PCR) is a widely used standard test for detecting acute cases of the virus. In addition to PCR, serology testing has emerged for determining community prevalence of immunoglobulin M (IgM), and immunoglobulin G (IgG) [14]. Serological testing can be used to determine the number of individuals in a particular population that have the Covid-19 antibodies against SARS-CoV-2, as well as the number of people that were previously infected. The antibodies can be detected in blood 1-3 weeks after infection. In some individuals, it could take more than 3 weeks for the antibodies to develop while some do not develop at all [19]. Immunoglobulin G (IgG) antibodies could be detected 14 days after onset of symptoms and is said to play a role in neutralizing the infection [20]. According to WHO reports, there are two variants associated with the Covid-19 which are; the Delta variant, first identified in the United Kingdom and the Omicron which was first identified in South Africa. Due to the the different variants, the composition of the antigens in the vaccines are changed. It is expected that the vaccines produced should protect against these variants [21]. However, vaccinated individuals could still get infected. Irrespective of the variants, the virus still behaves and spreads in the same way. In order to contain the spread of the virus and prevent the development of new variants, it is important to adhere strictly to the Covid-19 guidelines and get vaccinated [22]. An epidemiological end to Covid-19 is expected when herd immunity is achieved by having a greater number of the society, immuned to Covid-19 [22].

In Nigeria, malaria is a major public health problem with 97% of its population at risk. The Covid-19 pandemic added to this already existing burden, that malaria poses in Nigeria. Malaria is responsible for approximately 128 deaths per 1,000 live births for children under 5 years and 576 maternal mortalities per 100,000 [23]. It imposes economic burden as Africa spends about $12 billion per annum on malaria [24]. In 2019, approximately 229 million cases of malaria with 409,000 deaths were recorded globally [25]. The female anopheles mosquito is responsible for

the transmission of the infecting agent; *Plasmodium* a unicellular parasite or protozoa with 5 different species that infect humans; *Plasmodium malaria*, *Plasmodium vivax*, *Plasmodium falciparum*,*Plasmodium ovalae* and *Plasmodium knowlesi*. In the sub-Saharan region, *Plasmodium falciparum* is the causative agent [26]. The first symptoms of malaria are similar to minor systemic viral ailment which include lassitude, headache, abdominal discomfort, fatigue, muscle and joint aches, perspiration, chills, vomiting, fever, anorexia and worsening malaise. As a result of its non-specific symptoms, malaria is said to be over-diagnosed on symptoms alone in endemic regions like Nigeria [27&28]. In the case of delayed or ineffective treatment, and in people with no or low immunity, there could be progression to severe malaria, leading to coma (cerebral malaria), severe anaemia, acute renal failure, acute pulmonary oedema and hypoglycemia. However, there is rapid recovery when prompt and effective treatment is given [29&30]. To reduce morbidity and mortality in *P. falciparum* malaria endemic countries, WHO recommends artemisinin-based combination therapies (ACT) that are highly effective and well tolerated [28]. However, in South-East Asia, resistance to artemisinin has been recorded [30]. The two routine methods used for malaria diagnosis are light microscopy and immunochromatographic RTDs [30]. RDT is used for the detection of parasite-specific antigens or enzymes. In cases of positive results, antimalaria drugs are administered while in negative results, further analysis are done to find out causes of fever [30]. The proactive screening for malaria and Covid-19 in African countries was prompted as a result of the extra burden which the recent Covid-19 has added to the already existing burden.

Seroprevalence studies provide relevant information on the proportion of individuals who have experienced a recent or past Covid- 19 and malaria infection in a community. COVID 19 and malaria have a common symptom of pyrexia and maybe confused for each other. There is, need for sensitization on the potential of COVID-19/malaria co-infections for early detection and isolation of Covid-19. This will support the global attempt to rule out this comorbidity through the administration of adequate treatment.

This study was carried out to ascertain the seroprevalence of IgM and IgG antibodies in Covid-19 patients as well as, the malaria histidine-rich-protein 2 of *Plasmodium falciparum* infection in human whole blood sample qualitatively, among the staff and students of School of Biological Sciences, Federal University of Technology, Owerri (FUTO).

Methodology

Study Area and Subjects

This study was carried out among staff and students in the School of Biological Sciences, Federal University of Technology Owerri, Imo State, Nigeria. The departments in this faculty include Biotechnology, Biology, Biochemistry, Microbiology, and Forensic Science.

Study Design

This study was carried out using qualitative and quantitative approach. Semi-structured interviewee-administered questionnaires which were reviewed/validated by experts were used to collect data on subjects' demographics, as well as details pertaining to symptoms and their clinical history, COVID-19 exposure status. Then, blood samples were collected from participants who gave their consents, and the questionnaires were filled immediately the collection of samples.

Study Population

The study population comprised a total of 600 participants that were randomly selected, and they all gave their consent. Among the 600 participants were 400 full time students and 200 full time staff all in the School of Biological Sciences, Federal University of Technology Owerri.

Inclusion Criteria

Subjects must:

- Be a full-time staff or student of any of the ten departments in the faculties of interest.
- Not have any serious symptom of COVID -19 and malaria.
- Give his/her informed consent.

Ethical Permission and Informed Consent

Ethical permission was sought and obtained from the Ethical Committee in School of BiologicalSciences, Federal University of Technology, Owerri, Imo State, Nigeria.

Prior to subject recruitment, informed consent was obtained from the Dean of the faculty of BiologicalSciences as well as participants/subjects.

Sample Technique and Data Collection

Random sampling technique was used to recruit the respondents. On gathering the students, they were duly informed/briefed on the research. This was done in FUTO, (School of Biological Sciences). A total of 400 students gave their consent to participate. Staff were also randomly selected from the different Departments and a total of 200 staff gave their consent to participate. A total of 600 questionnaires were administered after, the subjects' blood samples were collected.

SAMPLE COLLECTION AND TESTING

Sample Collection

Blood samples were aseptically collected from the participants who gave their consents. This was done by carefully pricking the thumb of the participants with a capped lancet and blood was retrieved using a micropipette.

SAMPLE TESTING

Testing:

Covid-19 antibody testing was done immediately using the antibody test kit (SARS-COV-2 IgM/IgG Antibody Rapid Test by High Top) according to the protocol stipulated by the kit manufacturer.
The malaria testing was also done immediately using the malaria test kit (Malaria Pf (HRP2) Ag Rapid Diagnostic Test by CareStart^{TM}), designed for the diagnosis of *P. falciparum* infection.

Test principle:

The Covid-19 test kit is an immune-chromatographic assay, using capture method for rapid, qualitative detection of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) IgM/IgG antibody in human serum, plasma or whole blood sample [31].

The malaria test kit contained a membrane strip, which was pre-coated with a monoclonal antibody as a single line across the test strip. The monoclonal antibody is specific to HRP2 (histidine-rich protein 2) of the *P. falciparum* [32].

Test method:

The method for testing for the antibodies to SARS-CoV-2 was done as follows:

The cassette was removed from the sealed pouch, numbered and placed on a clean and level surface with the sample wells facing up. Two (2) full drops of whole blood (20 microlitres) aseptically collected using the micropipette were vertically added into the sample well of IgM and IgG separately, after which the used micropipette was appropriately discarded. Then two (2) drops (80 – 100 microlitre) of the sample buffer composed of 20 mM phosphate buffer solution (PBS) were added into the sample well of IgM and IgG separately. The test results were observed immediately within 15 - 20 minutes, after 20 minutes the result was noted invalid [31]

The method for testing for P*lasmodium falciparum* was done in the following way:

The cassette was removed from the sealed aluminum pouch, numbered, and placed on a clean and level surface, with the sample wells facing up. Then 5 microlitres of whole blood was aseptically collected using the micropipette, and added into the "S" well, after which the used micropipette was discarded. Two (2) drops (60 microlitres) of buffer (Borax buffered SDS and saponin solution) were added into the "A" well. The test result was read after 20 minutes.

RESULT INTERPRETATION:

Positive: Presence of two distinct red lines: one at the control region © and the other at the test region was indicative of positive result. **Negative:** One red line appeared in the control region (C); no red line appeared in the test region (T).

Invalid: No red line appeared, or control line failed to appear, indicating operator error or reagent failure. The test procedure would then be verified and repeated with a new test kit.

Positive Negative Invalid

DATA ANALYSIS:

The data collected were statistically analyzed using Chi- Square test and presented using Tables and Bar charts. Frequencies and percentages of the variables of interest were analysed to determine prevalence of infection.The returned questionnaires were reviewed for completeness. Only appropriately completed questionnaires were used for analysis.

CALCULATION:

Sero-prevalence (%) = $\frac{\text{Total number tested positive}}{\text{Total sample number}} \times \frac{100}{1}$

Results

Out of the 200 staff participants, 105(52.5%) were academic staff while 95(47.5%) were non-academic staff, 24(12%) were senior staff, 176(88%) were junior staff. Based on academic qualifications, 56(28%) were secondary school leavers, 144(72%) were at least degree holder. Of the participants, 55 (27.5%) were single, 145(72.5%) were married. Among the 200 staff tested in the study, 32 were between the ages of 21-30 years (16%), 104 staff were within the age range 31-40 (52%), 28 staff were from 41-50 years (14%), while 36 staff were 51 and above (18%). The number of male staff was 83 (41.5%) while the female was 117 (58.5%). The staff were recruited from Biology (40), Biochemistry (50), Biotechnology (60) and Microbiology (50) Departments. Overall, 45(22.5%) were IgG positive, 0(0%) were positive for IgM while 10(5%) tested positive to malaria parasite (mp). All IgG positives were junior staff **(Table 1).**

Table 1: Sociodemographic characteristics of SAR-CoV-2 and Malaria parasite seroprevalence among staff participants in the study.

Variables	**Category**	**Gender**		**Frequency (%)**
		Male	**Female**	
Age range(years)	21-30	16	16	32(16)
	31-40	49	55	104(52)
	41-50	8	20	28(14)
	51 and above	10	26	36(18)
	Total			200
Departments	Biology			40(20)
	Biochemistry			50(25)
	Biotechnology			60(30)
	Microbiology			50(25)
	Total			200
IgMIgG	Negative			155(77.5)
	Positive			45(22.5)
Malaria parasite	Negative			190(95)
	Positive			10(5)

Out of the 45 staff who tested positive to IgG, 23(11.5%) were females while 22(11%) were males, 13.5% of the 45 that tested positive were within the ages of 31-40, while the rest fell between the ages of 21-30 and 41-50. All malaria parasite positive subjects were females and were IgG positive too, they were married, 5 held secondary school certificate and the rest were at least degree holders **(Table 2)**.

Table 2: SAR-CoV-2 and Malaria parasite seroprevalence among staff participants in the study.

Variables	Gender	Category	Frequency(%)
IgG positive	Male		22(11)

	Female				23(11.5)
			Gender		
			Male	Female	
		21-30	8	5	13(6.5)
		31-40	14	13	27(13.5)
		41-50	0	5	5(2.5)
		51 and above			0(0)
Malaria parasite Positive	Male	0			0(0)
	Female				
		21-30	0	0	0
		31-40	0	5	5(2.5)
		41-50	0	5	5(2.5)
		51 and above	0	0	0(0)

The common symptoms among those that tested positive for IgG were fatigue, fever, headache runny nose and cough. More than half had either travelled or been in mass gathering, visited hospital, or tested positive to Covid-19 and were isolated. About one-fourth of the test population experienced loss of taste, loss of smell and shivering within the last three months.

All of those that tested malaria positive have had fever, headache and loss of taste. Five experienced fatigue, loss of smell, been in mass gathering, travelled, came in contact with suspected case, visited hospital, tested positive to Covid-19 and were isolated.

Out of the 400 students tested in the study, 181 students (45.3%) were less than 20 years of age, students within ages 21 to 30 years were 219 (54.8%) in number. The female students were more than male students with a total number of 207 (51.8), while male students had a total number of 193 (48.3). Students who tested positive for IgG only, were 37, giving a sero-prevalence of 9.25%, no student tested positive for IgM. The demographic characteristics, clinical characteristics (symptoms) and human exposure (30 days before illness onset) of the respondents for recorded IgG seropositivity are summarized in **Table 3.**

Table 3: Sociodemographic and clinical characteristics of the students' respondents positive for antibody (IgG) to SARS-CoV-2 infection.

Demographic characteristic	**Category**	**Frequency**	**Percentage (%)**
Age	Less than 20	21	5.25
	21-30	16	4

Gender	Male	12	3
	Female	25	6.25
Symptoms	Fever	22	5.5
	Fatigue	16	4
	Headache	17	4.25
	Runny nose	17	4.25
	Loss of smell	9	2.25
	Loss of taste	7	1.75
	Shortness of breath	9	2.25
	Abdominal pain	4	1
	Nausea	1	0.25
	Sore throat	10	2.5
Exposure	Exposed to ones with similar illness	Unknown	Unknown
	Travelled domestically	24	6
	Travelled internationally	0	0
	Attended festival/mass gathering	12	3
	Visited inpatient facility	1	0.25
	Visited outpatient facility	0	0
Total		**37**	**9.25**

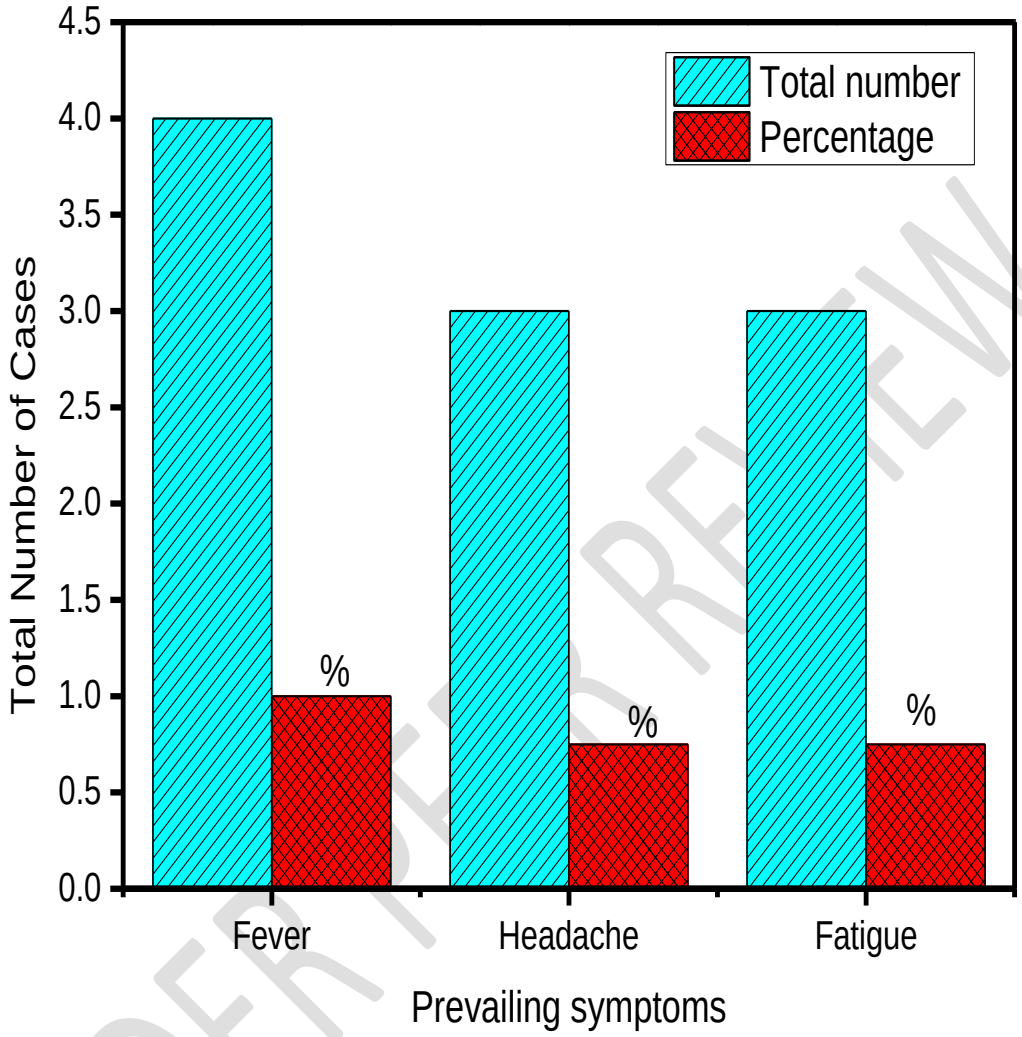
Furthermore, a total of 62 students tested positive for *Plasmodium falciparum* infection, showing a sero-prevalence of 15.5%. The demographic characteristics, clinical characteristics (symptoms) and human exposure (30 days before illness onset) of the respondents for recorded *Plasmodium falciparum* infection are summarized in **Table 4.**

Table 4: Sociodemographic **and clinical characteristics of the students' respondents positive for *Plasmodium falciparum* infection.**

Demographic characteristics	Category	Frequency	Percentage
Age	Less than 20	26	6.5
	21-30	36	9
Gender	Male	29	7.3
	Female	33	8.3
Symptoms	Fever	25	6.3
	Fatigue	25	6.3
	Headache	25	6.3
	Runny nose	12	3
	Loss of smell	13	3.3
	Loss of taste	7	1.8
	Shortness of breath	14	3.5
	Sore throat	4	1
	Nausea	23	5.8
Exposures	Exposed to one with similar illness	4	1
	Travelled Domestically	26	6.5
	Travelled Internationally	0	0
	Attended festival/mass gathering	24	6
	Visited inpatient facility	0	0
	Visited outpatient facility	0	0
Total		**62**	**15.5**

However, of the total 99 students who were positive for the individual infections, 7(7.07%) were positive for both, with four (4) students less than 20 years and three (3) students between the ages 21-30. Females were 5 in number and males were 2. Similar symptoms among the respondents for both infections were recorded and illustrated using bar chat, with high body temperature (fever), headache and fatigue as the most common symptoms in **Fig 1**

Fig 1:Seroprevalence of common symptoms for both SARS-CoV-2 and ***Plasmodium falciparum*infections among student participants**



Discussion

This serological survey was carried out between 1st March and 30th April of 2021, in order to ascertain the seroprevalence of IgM and IgG antibodies to Severe Acute Respiratory Syndrome Corona Virus 2, as well as the malaria histidine-rich-protein 2 of *plasmodium falciparum* infection in human whole blood samples qualitatively, among the staff and students of School of Biological Sciences, Federal University of Technology, Owerri (FUTO) in Imo State, Nigeria. Our findings connote that less than a quarter percentage of staff and close to one-tenth of the students in our study population had either experienced an active but asymptomatic infection or a previous exposure to SARS-CoV-2, thus, supporting the already established fact that SARS-COV-2 IgG antibody continues to exist for

months or even years in infected humans but, IgM antibody disappears few weeks after its development [33 & 34]. The null seroprevalence of IgM recorded in our study, may therefore signify a tremendous decrease in the fresh spread of SARS-COV-2 virus within the study period. Furthermore, the reduction in the rates of seropositivity to SARS-COV-2 antibodies in this research, confirms the decline in the number of COVID 19 active cases and deaths, as reported by Nigeria Centre for Disease Control (NCDC) within the timeline of the study (March and April, 2021) [35 & 36]. Consequently, the NCDC report as at that period, could have insinuated that greater number of asymptomatic COVID patients escaped testing; as only individuals with high suspicious indication for the virus were tested. In contrast to our study, a research survey carried out during the heat of the pandemic in August, 2020 at two Nigerian cities (Abuja and Enugu) deduced that almost a half proportion of accepted blood donors in Nigeria had been exposed to SARS CoV-2 infection, with seroprevalence rates of 42% and 41% for IgG and IgM respectively [37].

All individuals who tested IgG positive amongst the staff members were junior personnel. Unsurprisingly, this could be linked to the economic lifestyles of these respondents; as majority of them may not be able to afford decent accommodation, balanced meals and good medical care relatively needed to prevent COVID infection. In line with the reports of some other authors [38, 39, & 40], gender seems to have little or no effect on the spread of the corona virus, as we got similar prevalence rates of approximately 23(11.5%) for females and 22(11%) for males, amongst the 45 staff that tested positive to IgG antibody. Contradictorily, a significant disparity was observed in the prevalence rates of the 37 students that tested positive to IgG; in which, 25(6.3%) females and 12(3%) males were affected.

Observations from our study, showed the age range of staff mostly affected by SARS-COV-2 virus (IgG) to be (31-40 years of age) with a prevalence rate of 13.5%, followed by (21-30 years of age) having a prevalence of 6.5%, (41-50 years of age) with 2.5% prevalence and then (51 and above) having zero (0%) prevalence. The age range of students mostly affected by SARS-COV-2 virus (IgG) in this study were those (below 20 years) with a prevalence rate of 5.3% and those (between 21-30 years) with 4% prevalence. This further explains the role of age in COVID-19 infection as prevalence rates seem to increase in younger adults within the working class and socially active age but with lower risk of death whereas, the severity of the disease increases with old age with higher death risk [40]. In contrast to our findings, a study conducted in December 2020 in Anambra state, Nigeria [34] reported that the highest percentage of COVID-19 infection occurred among its residents above the age of 39. Apparently, our results directly confirmed the predominance of vibrant adults in our study area since, the number of children and elders mostly found in campuses are few and thus limiting our survey to the available sets of participants. However, about 10(5%) of the staff tested positive to malaria parasite whereas, a total of 62 students tested positive to *Plasmodium falciparum* infection, showing a seroprevalence of 15.5%. This justifies the known fact that malaria prevalence rate decreases during dry season [41] (usually within November to April in West Africa), which coincides with the time of the present study. The malaria prevalence in our study is very low compared to that of a cross-sectional study conducted during rainy season (September to October) in the capital of Togo, Lomé; which recorded prevalence rates of 25.1% and 30.4% respectively [42]. In addition, the low prevalence is comparable to the postulations that malaria is less endemic in urban settings than in rural settings [43] and our study area is not an exception, as affirmed by our results.

This study showed that a higher number of female respondents in our study population yielded positive to malaria parasite than their male counterparts; as only 5% of the staff had *Plasmodium falciparum* and they were all females while 8.3% and 7.3% malaria prevalence rates were recorded amongst the female and male students respectively. This result, in conformation with most literature reviews [28, 41 & 42], entail that women and children are more susceptible to malaria infection than men though, Onosakponome&Wogu stated in their work that men experienced more malaria symptoms than females due to their higher rate of travelling [43]. Subsequently, it could be traced to the fact that our study participants were more of females than males and based on age factor, our respondents comprised more of the younger population as the number of students tested were far more than the staff tested in this

research. We also documented 6.5% malaria prevalence for students below age 20 and 9% prevalence for students between the age of 21-30 while the same prevalence rates of 2.5% each, were recorded for the staff in our study population within the ages of 31-40 and 41-50 respectively.

Our findings provided additional facts to the general postulations that malaria mostly infects the population of children, adolescents and younger adults compared to the older adults [39]. The interrelated symptoms of malaria and COVID-19 mostly observed in our respondents were fever, headache and fatigue. This complies with a lot of authors' reports that either infections may be misdiagnosed or their possible co-infection may be overlooked, as many patients usually exhibit similar symptoms [43, 44, 45, 46, 47 & 48]. The rates of malaria and COVID-19 co-infection deduced from the staff and students in our research were 5% and 1.8% respectively. The results were notably lower compared to the 7% co-infection rate reported by Fowotade*et al*., [41]. However, the 5% co-infection rate shown by the staff in our survey directly coincides with the report from an Indian study, which hinted a possible elevated recovery from COVID-19 with glycosylphosphatidylinositol (GPI) antibodies performing virus clearance during malaria and COVID-19 co-infection [48]. Hence, we can join Matangila *et al*., [47] to conclude that the level of co-infection prevalence varies directly with the level of malaria prevalence and vice versa.

The limitations encountered in this survey include the limited number of participants and biased selection criteria, which is likely shown by the predominant active population in our study location and their probable high level of exposure to either or both infections, due to their unavoidable age and social status.

Therefore, we recommend firstly, that more qualitative and quantitative studies be conducted in universities to investigate the seroprevalence of IgM and IgG antibodies to SARS-COV-2, as well as the malaria parasite in the whole blood samples of the university community. Secondly, university staff and students should constantly undergo tests for malaria and corona virus, in order to ascertain their current status for the individual infection and/or co-infection. Thereby, strongly limiting the level of negligence in the diagnosis, treatment and management of both diseases.

Conclusion

The rates of malaria and COVID-19 co-infection observed among the staff and students in this survey were 5% and 1.8% respectively. This further explained that, the level of co-infection prevalence varies directly with the level of malaria prevalence and vice versa. This survey is considered pertinent, as it provided qualitative information on the seroprevalence of SARS-COV-2 antibodies and malaria parasite in a university located in the south-eastern part of Nigeria, shortly after the waves of corona virus in 2020. This would help the authorities and policymakers to devise epidemiological measures needed to mitigate the economic burden of these diseases and improve our healthcare system.

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