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Pre-vaccination seroprevalence of SARS-CoV-2 antibodies in the Volta Region, Ghana

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ABSTRACT

Objectives: Before administration of the first dose of the AstraZeneca 2019 SARS-CoV-2 vaccine to selected prioritized groups in the Volta regional capital of Ghana, we determined the pre-vaccination status of prospective recipients and established the baseline exposure status 1 year after the first case was reported.
Methods: After informed consent, blood samples were collected for the detection of SARS-CoV-2 immunoglobulin (Ig) M/IgG antibodies using rapid diagnostic test kits. A total of 409 individuals (mean age 27 years) consented and participated in the study, comprising 70% students and others were health staff and educators who presented themselves for vaccination.
Results: The overall exposure rate of SARS-CoV-2 was 12.7% (95% confidence interval [CI] 9.6-16.3). The prevalence of SARS-CoV-2 IgM and IgG were 4.2% (95% CI 2.4-6.6) and 5.6% (95% CI 3.6-8.3), respectively. IgM and IgG were detected in 2.9% (95% CI 1.5-5.1) of the respondents. The exposure rates were higher in participants over 40 years old (15.5%). Participants without a history of COVID-19–like symptoms had an exposure rate of 13.0% and those without any chronic diseases was 13.2%.
Conclusion: Pre-vaccination exposure was relatively low and underscored the need for vaccination i to increase protection in communities and disease outcomes.

Introduction

COVID-19 caused by the novel SARS-CoV-2 has spread rapidly worldwide and has caused over 760 million confirmed infections and almost 7 million deaths as of September 27, 2023 [1] since it was first reported in Wuhan Province in China in late 2019 [2]. In Ghana, the first two cases of COVID-19 were reported on March 12, 2020 in two returnees from Norway and Turkey, and as of August 13, 2023, 171,780 cases and 1462 deaths have been reported [3]. In Ghana, adherence to COVID-19 public health preventive measures was low in the general population [4,5]. When the government of Ghana gradually eased COVID-19 restrictions in July 2020, adherence to protective measures, such as social distancing, wearing of face masks, and handwashing practices, gradually decreased over time [4].

Vaccination is one of the key pharmaceutical interventions recommended as part of the public health interventions to precent severe disease and possible transmission of SARS-COV-2 in the communities. SARS-CoV-2 vaccines are recommended because they elicit protection against severe outcomes of COVID-19 such as hospitalization and death [6]. Aside from vaccination, natural infection with SARS-CoV-2 also elicit some level of protection against subsequent infection and severe outcomes such as hospitalization and death [7,8]. Several studies have suggested that the levels and durability of natural infection and vaccine-induced protection vary [9,10]; hence, more studies are needed to shed more insights [11]. The differences in the levels of protection as well as waning could be due to several factors, such as mucosal immunity, mechanism of action, levels and types of neutralizing antibody titers, and circulating variants [12]. After an infection with

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a coronavirus, B cells elicit an early response against the nucleocapsid (N) protein and immunoglobulin (Ig) M antibodies against the spike (S) protein could be detected after a week, whereas SARS-CoV-2 IgG could be detected after 14 days [13]. It has also been established that SARS-CoV-2 IgM decreases to about 30% its initial levels after 12 weeks, whereas SARS-CoV-2 IgG levels remain high for 3 months before beginning to decrease [14]. It is, therefore, important to establish types and levels of protection owing to either natural or vaccine-mediated exposure.

Ghana, as in most other resource-limited settings, were not fortunate to access vaccines on time. Even when vaccines were available, it was rationed first for frontline workers before the general population. This study was designed to assess the pre-vaccination exposure among frontline personnel before receiving COVID-19 vaccines in the Volta Region of Ghana. This study was necessitated because of the hesitancy to receive the vaccine and instituted as a public operational measure. Before administration of the vaccines, some frontline workers and others argued that they had protection and needed evidence of their status before taking the vaccines. The study was also important because in cases where there is previous exposure and antibody presence, those antibodies could serve as primers for the vaccines and hence boost the response after vaccination. In other words, the vaccines will work better as boosters of the existing immune state.

Methods

Study design, study sites, and study populations

A cross-sectional study was conducted in health students and workers at the University of Health and Allied Sciences and the Ho Teaching Hospital between March and May 2021. The two institutions established a joint task force to tackle the pandemic and saw each other contributing to various aspects of the response. The University of Health and Allied Sciences COVID-19 Centre performed all testing and its staff teamed up with the teaching hospital staff to manage cases at the isolation center as well as in the hospital. Convenience sampling was used to recruit participants when they visited the vaccination points in the two institutions.

Sample collection and analysis

From each study participant, 3-5 ml of blood was collected into an ethylenediaminetetraacetic acid tube. The blood was centrifuged, and the plasma was separated and analyzed. The SARS-CoV-2 IgG/IgM antibodies in plasma were detected by the World Health Organization–approved RightSign™ rapid diagnostic test kit (Hangzhou Biotest Biotech Co., Ltd, China) according to the manufacturer's instructions. Epidemiological data, such as demographic information, history of COVID-19–like symptoms, and current chronic medical condition, if any, were obtained.

Consent to participate and ethics

In response to concerns about potential pre-existing antibodies and its impact, informed consent was administered to individuals who wanted their samples tested before vaccination. Because this fell outside the public health response activities, the samples were archived and a study protocol was developed to seek ethics approval before the archived samples could be tested. This study was reviewed and approved by the research ethics committee of the University of Health and Allied sciences, with approval number UHAS-REC A.12 [15] 2021. All participants provided written informed consent before participation. For participants below 18 years old, written parental consent and child ascent were obtained.

Table 1
Demographic characteristics of the study participants.

Variable	Frequency N (%)	SARS-CoV-2 antibody N (%)
Age		
17 - 20	52 (12.7%)	3 (5.8 %)
21 - 39	312 (76.3%)	42 (13.5 %)
> 39	45 (11.0%)	7 (15.6 %)
Gender		
Male	225 (55.0%)	27 (12 %)
Female	184 (45.0%)	25 (13.6 %)
Occupation		
Administrative officer	38 (9.3%)	7 (18.4 %)
Janitor and engineering	31 (7.6%)	5 (16.1 %)
Healthcare worker	18 (4.4%)	2 (11.1 %)
Lecturer	36 (8.8%)	4 (11.1 %)
Student	286 (70.0%)	34 (11.8 %)

Results

Prevalence of SARS-CoV-2 antigens and antibodies

A total of 409 individuals consented and participated in the study. Of these, 52 (12.7%) were exposed to SARS-CoV-2. SARS-CoV-2 IgM was detected in 17 (4.2%) of the participants, whereas SARS-CoV-2 IgG was detected in 23 (5.6%) of the participants. In addition, both SARS-CoV-2 IgM/IgG were detected in 12 (2.9%) of the participants. The exposure rates were higher in participants over 40 years old (15.5%), females (13.6%), administrative officers (18.4%), participants without a history of COVID-19–like symptoms (13.0%), and participants without chronic diseases (13.2%), although the rates did not reach significant levels.

Demographic characteristics and SARS-CoV-2 exposure

The mean and median ages of the participants were 27 years and 23 years, respectively. The minimum age was 17 years, whereas the maximum age was 83 years. The majority of the participants were students (70%). SARS-CoV-2 exposure was relatively higher in participants over 40 years old (15.6%), females (13.6%), and administrative staff (18.4%) (Table 1).

History of COVID-19–like symptoms, co-morbidities, and seropositivity

Of the 409 study participants, 19.3% indicated they have had at least one COVID-19–like symptom within 3 months. Of these, the most common reported symptoms were headache (48.1%), sneezing (43%), cough (41.8%), sore throat (40.5%), fever (25.3%), and anosmia (19%) (Table 2). Most of the study participants with a history of COVID-19–like symptoms (76%) experienced between two and nine COVID-19–like symptoms. Of the participants who previously experienced COVID-19–like symptoms, 11.4% of them were exposed to SARS-CoV-2, whereas 13% of the participants without a history of COVID-19–like symptoms were exposed to SARS-CoV-2. The SARS-CoV-2 exposure rates were higher in participants who previously experienced abdominal pain (66.7%), ageusia (25%), chills (23%), difficulty in breathing (18.1%), fever (15%), and anosmia (13.3%).

In all, 16.4% of the study participants reported to be living with at least one chronic condition that puts them at risk for a severe SARS-CoV-2 infection. The highest reported chronic condition was hypertension (5.1%) and the lowest was gastric ulcer (0.5%). Other conditions and their proportions are presented in Table 2. Nine of the participants had multiple morbidities. Of those participants living with chronic diseases, 10.4% were exposed to SARS-CoV-2, whereas 13.2% of those not living with any chronic disease were exposed to SARS-CoV-2. SARS-CoV-2 antibodies were not detected in participants living with diabetes mellitus, sickle cell, and gastric ulcer. However, SARS-CoV-2 antibodies were detected in participants with hypertension, bronchial asthma, and allergic

Table 2
Spectrum of COVID-19–like symptoms and co-morbidities.

Variable	Frequency N (%)	SARS-CoV-2 antibodies N (%)
COVID-19 like symptoms		
Headache	38 (48.1%)	4 (10.5 %)
Sneezing	34 (43.0%)	1 (2.9 %)
Cough	33 (41.8%)	2 (6.1 %)
Sore throat	32 (40.5%)	3 (9.4 %)
Fever	20 (25.3%)	3 (15.0 %)
Anosmia	15 (19.0%)	2 (13.3 %)
Muscle ache	14 (17.7%)	1 (7.1 %)
Chills	13 (16.5%)	3 (23.0 %)
Difficulty in breathing	11 (14.0%)	2 (18.1 %)
Ageusia	8 (10.1%)	2 (25.0 %)
Abdominal disturbances	3 (3.8%)	2 (66.7 %)
Chronic co-morbidities at risk of severe SARS-CoV-2 illness		
Hypertension	21 (5.1%)	3 (14.3%)
Bronchial asthma	19 (4.6%)	3 (15.8%)
Sickle cell disease	14 (3.4%)	0 (0.0%)
Allergy	16 (3.9%)	3 (18.8%)
Diabetes mellitus	6 (1.5%)	0 (0.0%)
Gastric ulcer	2 (0.5%)	0 (0.0%)
Two or more chronic morbidity	9 (2.2%)	1 (11.1%)

reactions. Nine (13.4%) of the participants were living with multiple chronic diseases and SARS-CoV-2 antibodies were detected in only one of them (participant with hypertension and allergic reactions).

Discussion

The rate of exposure to SARS-CoV-2 in the study participants in this study was lower than that reported for the Greater Accra Region (29%) but higher than that reported for the Upper East Region (2%) [16]. The seroprevalence from the previously mentioned studies mirror the case ratios in all the locations [3]. Beyond Ghana, the seroprevalence reported in other places was lower than in our study. This includes Virginia, USA (2.4%) [17], Spain (5.0%) [15], Switzerland (10.8%) [18], Denmark (2.0%) [19], and Togo (1.6%) [20]. Our finding was marginally higher than the seroprevalence reported in Italy (11%) [21] and Indonesia (11.4%) [22]. In addition, similar rates were reported in Malawi 12.3% [23]. In other locations, significantly higher prevalence rates have been reported: 16.5% in Pakistan (15.6%) [24], 17.6% in the Republic of the Congo [25], 17.6% in Nigeria [26], and 42·3% prevalence in Kenya [27]. Antibody seropositivity from natural infection is necessary for building protection against severe disease and death [7].

Based on the IgM and IgG results, it can be deduced that some of the participants were carrying the infection at the time of vaccination. Several cases of asymptomatic infections were reported during the pandemic worldwide. In a systematic review and meta-analysis of 350 studies, asymptomatic infections were found to be 35.1% (95% confidence interval 30.7-39.9%) [28], whereas another conducted on 38 studies reported asymptomatic infections in 44.1% (6556 of 14,850, 95% confidence interval 43.3-45.0%) [29]. Considering that majority of our study participants were young people, our study aligns with other studies that have reported that asymptomatic infection is high in that age group [29]. The levels of exposure based on antibody presence in our study were, however, lower than those who had reported one or more symptoms that were associated with COVID-19 at the time. This is not surprising because the symptoms, which were used as primary pointers of suspicion, were largely generic and will show if anyone has an infection or other respiratory infections. It is worth noting that headache, sneezing, cough, sore throat, and fever were the most commonly reported symptoms. Interpreting such data, however, should be done with caution because, at the time of the pandemic, there was widespread education on these symptoms and people were likely going to take note of them when they occurred rather than if they had occurred in the past when there was no COVID-19. Furthermore, it is also worth noting that hypertension, bronchial asthma, and sickle cell disease were the most common co-morbidities reported. In a sample drawn from the same community, the prevalence of hypertension was reported to be 31.28% [30] and, therefore, not surprising that it was one of the commonly reported co-morbidity in the participants drawn into this study.

In conclusion, the COVID-19 pandemic has taught us many lessons and the way forward at present is to take stock, learn from the occurrences, and be better prepared for future pandemics. Several studies have found that natural infections provide better and longer lasting protection against re-infection and severe disease than vaccine-induced protection [7,10]. It is, however, important to also note that, there are contrasting results and, hence, more analyses are needed to get a better and more accurate picture [11]. The message from our study is that there was some level of protection from natural infection before the introduction of the vaccines; however, this was in a relatively small proportion of individuals. Hence, to achieve high levels of protection, it was necessary to administer the vaccines. In future pandemics (and for public health purposes), however, it will be necessary to assess natural infections at large scales before vaccine introductions as well as post-introduction of vaccines so that well informed assessments of the impact of the vaccines could be performed.

Declarations of competing interest

The authors have no competing interest to declare.

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Ethical approval

This study was reviewed and approved by the research ethics committee of the University of Health and Allied sciences with approval number UHAS-REC A.12 [15] 2021. All participants provided written informed consent before participation. For participants below 18 years old, written parental consent and child ascent were obtained.

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Author contributions

EA: study design, investigation, data analysis, writing. RAD: conceptualization, study design, data collection, review and editing. JG: conceptualization, study design, data collection, review and editing. MEA: data collection, investigation. GSK: study design, data collection. WKA: data analysis, review & editing. JOG: conceptualization, study design, review and editing, supervision. KOD: conceptualization, study design, data collection, data analysis, writing, supervision.

Data availability

All data have been reported in the manuscript. Any further information may be requested.

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