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Immunogenicity of Abdala COVID-19 vaccine in Vietnamese people after primary and booster vaccinations: A prospective observational study in Vietnam

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ABSTRACT

Objectives: We studied the immunogenicity after primary and booster vaccinations of the Abdala COVID-19 vaccine, a receptor-binding domain protein subunit vaccine, in Vietnamese people by determining the level of neutralization and cross-neutralization activities against the ancestral SARS-CoV-2 and its variants and SARS-CoV-1.

Methods: We performed a prospective observational study, enrolling adults aged 19-59 years in Dong Thap province, southern Vietnam, and collected blood samples from baseline until 4 weeks after the booster dose. We measured anti-nucleocapsid, anti-spike, and neutralizing antibodies against SARS-CoV-2 and assessed the cross-neutralization against 14 SARS-CoV-2 variants and SARS-CoV-1. Complementary antibody data came from Vietnamese health care workers fully vaccinated with ChAdOx1-S.

Results: After primary vaccination, anti-spike antibody and neutralizing antibodies were detectable in 98.4% and 87% of 251 study participants, respectively, with neutralizing antibody titers similar to that

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induced by ChAdOx1-S vaccine. Antibody responses after a homologous (Abdala COVID-19) or heterologous (messenger RNA BNT162b2) booster could neutralize 14 SARS-CoV-2 variants (including Omicron) and SARS-CoV-1.

Conclusions: Abdala COVID-19 vaccine is immunogenic in Vietnamese people. Enhanced antibody response after a booster dose could cross-neutralize 14 SARS-CoV-2 variants and SARS-CoV-1. Our results have added to the growing body of knowledge about the contribution of protein subunit vaccine platforms to pandemic control.

Introduction

Abdala COVID-19 vaccine is an alum-adjuvanted recombinant protein subunit vaccine based on the receptor-binding domain (RBD) of the spike protein of SARS-CoV-2 [1]. It was developed by the Center for Genetic Engineering and Biotechnology in Habana, Cuba in early 2021 and has been widely deployed in Cuba since July 2021 [1,2]. The primary series consists of three doses administered intramuscularly on days 0, 14, and 28.

Outside of Cuba, Abdala COVID-19 vaccine has been deployed in five other countries including Mexico, Nicaragua, Saint Vincent and the Grenadines, Venezuela, and Vietnam [3]. Yet, limited data exist regarding the immunogenicity of Abdala COVID-19 vaccine, especially outside of Cuba to date. Reported data from a phase II trial conducted in Cuba demonstrated that Abdala vaccine induced adequate immunogenicity, with a seroconversion rate of >97% in children and adults [4]. Likewise, results from a phase III trial of the primary series in Cuban adults demonstrated an efficacy of 92.3% in protecting against symptomatic COVID-19 [1,2]. In addition, a recent population-based study of over 1.3 million people conducted in Habana, Cuba during the Delta wave demonstrated that real-world effectiveness of Abdala vaccine in fully vaccinated people was 98.2% and 98.7% against severe disease and death, respectively [5]. Outside of Cuba, only one report from Mexico showed that the Abdala COVID-19 vaccine, when used as a booster dose in participants fully vaccinated with non-Abdala vaccine, improved antibody and B- and T-cell responses to SARS-CoV-2 [6].

The emergence and rapid spread of the Omicron variant and its sublineages necessitate further studies about the immunogenicity of COVID-19 vaccines currently deployed worldwide. In this regard, although messenger RNA (mRNA) and adenoviral vector platforms have been extensively studied [7–9], the extent to which antibody responses induced by the Abdala COVID-19 vaccine could neutralize new variants of SARS-CoV-2, especially the Omicron variant, remains unknown. Here, our aim was to fill important gaps in knowledge about the immunogenicity of the Abdala COVID-19 vaccine to inform future research on vaccine development. We, therefore, studied the antibody responses against SARS-CoV-2 and a wide range of its variants, including Omicron, and SARS-CoV-1 in Vietnamese people fully vaccinated with the Abdala COVID-19 vaccine, followed by a homologous (Abdala COVID-19) or heterologous (mRNA BNT162b2) booster. For comparison, we included our previously published antibody data measured at 2 weeks after the primary series from 104 Vietnamese health care workers (HCWs) fully vaccinated with the ChAdOx1-S vaccine [10].

Materials and methods

Study design, setting, Abdala COVID-19 vaccine deployment, and the study participants

At the time of the study being conducted, the Vietnamese Ministry of Health already approved the Abdala COVID-19 vaccine for use against COVID-19. Accordingly, the administration of the vaccine formed part of the Vietnam's national COVID-19 vaccination program. Thus, because the present study aimed to evaluate the immunogenicity of Abdala COVID-19 vaccine in Vietnamese people eligible to receive the vaccine, its design was prospective and observational in nature.

The study was conducted in An Phong, My Quy, and Tan Thanh communes, Dong Thap province, southern Vietnam between November 2021 and May 2022. According to the Vietnamese Ministry of Health, unvaccinated healthy adults aged between 19 and 65 years were eligible for the Abdala COVID-19 vaccine. A booster dose was given at 12 weeks after completing the primary series (i.e. after three doses of the Abdala vaccine) using either the homologous (Abdala COVID-19) or heterologous BNT162b vaccine.

We invited any individuals at the study sites who were eligible to receive the Abdala COVID-19 vaccine to participate in our study. To minimize the impact of natural infection on the immunogenicity induced by vaccination, at baseline, we excluded any individuals who knew that they previously had SARS-CoV-2 infection evidenced by antigen rapid test and/or reverse transcription–polymerase chain reaction. Testing was conducted for hospitalized patients with respiratory illness with suspected COVID-19 or contacts of an indexed COVID-19 case as per the zero COVID-19 policy applied in Vietnam at the time [11,12]. We also excluded immunocompromised individuals (e.g. dialysis, cancer, and HIV).

Sample size

Given the exploratory nature of the present study, a formal sample size calculation was not done. However, we had assumed that the seroconversion (a change from undetectable at baseline to detectable levels of antibodies after immunization) rate of the Abdala COVID-19 vaccine, which was unknown at the time of the study protocol development, was ≥60%. Accordingly, a final sample size of ∼200 participants would likely be sufficient for seroconversion rate comparison between neutralizing and anti-spike (anti-S) antibodies induced by primary vaccination. Based on our previous experience, around 30-35% participants would be lost during follow-up; we, thus, aimed to recruit ∼300 participants at baseline.

Data and sample collection

The study participants had blood samples collected for antibody measurements alongside the information about demographics and occupations. Blood sampling was scheduled for a total of six time points, spanning the period from before dose 1 (baseline) to 4 weeks after booster dose administration (Figure 1). At each sampling time point, the participants informed the study team about their SARS-CoV-2 infection status

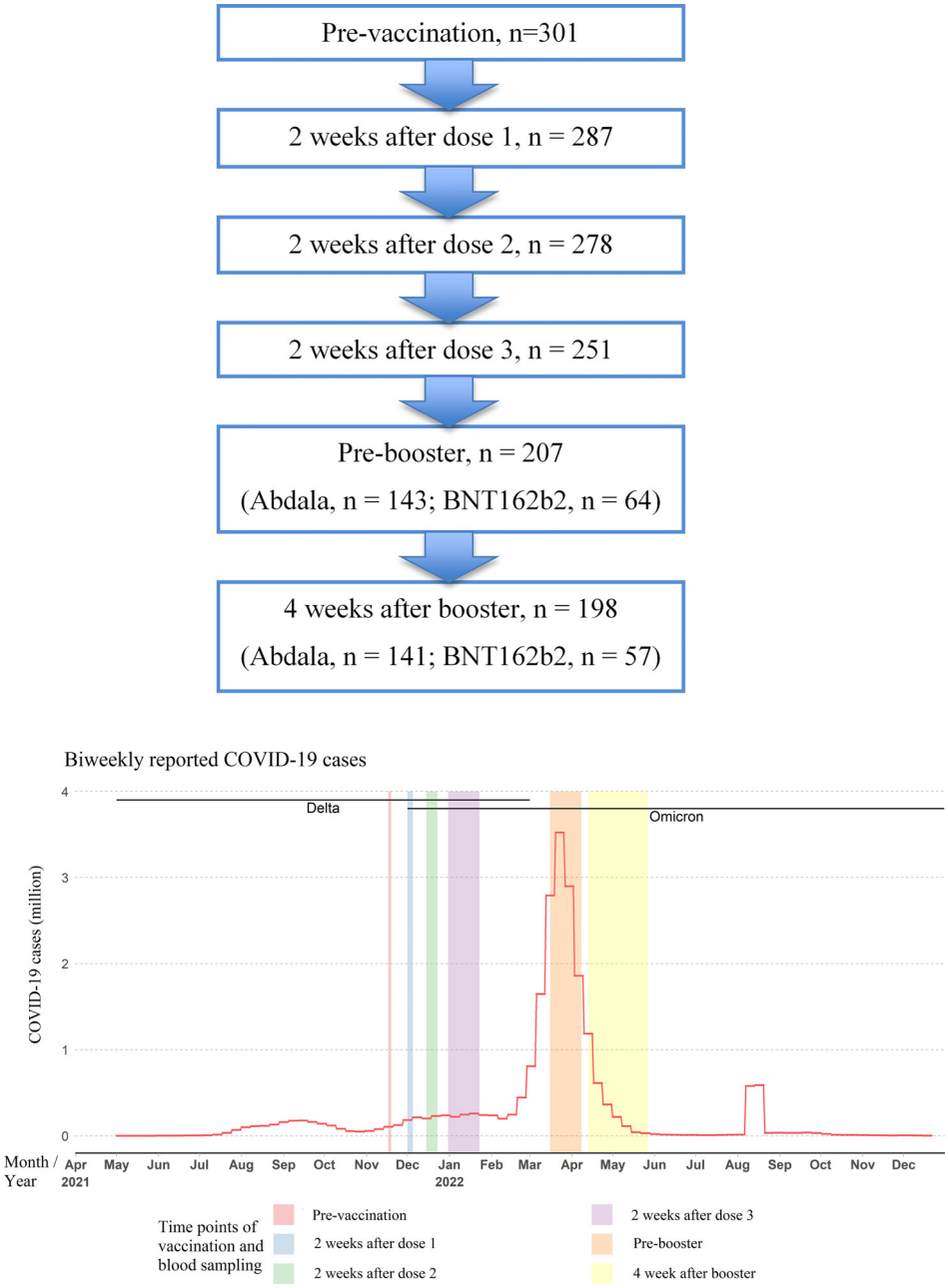

Figure 1. Illustration showing blood sampling and vaccination time points alongside the projection of the COVID-19 pandemic situation in Vietnam during the study period. (a) The number of individuals participating in the study from baseline to 4 weeks after booster dose, and (b) reported COVID-19 cases in Vietnam (red line) during the study period. *Note:* Data were obtained from https://ourworldindata.org/ on June 13, 2024. The number of COVID-19 cases is shown in the Y axis and the time (in month and year) is shown in the X axis. Horizontal black bars denote the circulation period of the Delta and Omicron variants and vertical color bars denote time points of vaccination and blood sampling.

and hospital admission as a consequence (if any) since the last visit.

Measurements of antibodies against SARS-CoV-2

Anti-nucleocapsid (anti-N) and anti-S antibodies were measured using the Elecsys Anti-SARS-CoV-2 and Elecsys Anti-SARS-CoV-2 S assays, respectively (Roche Diagnostics, Basel, Switzerland). The experiments were carried out in an automated COBAS e801 analyzer, following the manufacturer's instructions. For the anti-N antibody assay, a cut-off index of 1.0 was used and as a qualitative assay, the results were expressed as detectable or undetectable. Because the Abdala COVID-19 vaccine is an RBD-based vaccine, anti-N antibodies were used as surrogate of breakthrough infections. For the anti-S antibody assay, a cut-off index of 0.8 was used and as a quantitative assay, the results were presented in U/mL.

Neutralizing antibodies against RBD were measured using a US Food and Drug Administration Emergency Use Authorization–approved assay: namely, the SARS-CoV-2 surrogate virus neutralization test (sVNT) (GenScript, Singapore). The experiments were carried out according to the manufacturer's instructions. The results were expressed as a percentage of inhibition, using a cutoff of 30% [13].

Measurements of antibodies against the SARS-CoV-1 and SARS-CoV-2 variants

Neutralizing antibodies against SARS-CoV-2; its variants, including the Alpha, Beta, Gamma, Delta, Delta plus, Lambda, Mu, and Omicron sublineages (BA.1, BA.2, BA.5, XBB, and XBB.1.5); and SARS-CoV-1 were measured using a multiplex sVNT assay in a MAGPIX platform (Luminex, Austin, TX, USA), as previously described [14]. In brief, the RBD of the corresponding targets were coupled on MagPlex beads (Luminex). The RBD and bead complexes of each antigen were then mixed together in an equivalent molar. A mixture of approximately 600 beads per antigen was mixed 1:1 with serially diluted plasma samples (1:20, 1:80, 1:320, and 1:1280). The mixture was then incubated for 15 minutes at 37°C with agitation. Phycoerythrin-conjugated human angiotensin-converting enzyme 2 (GenScript) was added to the reactions, followed by an incubation step for 15 minutes at 37°C. The beads were then separated from the aqueous phase, washed twice with an assay buffer containing bovine serum albumin in phosphate buffered saline, and were finally re-suspended in the same assay buffer. The plate was then read under the MAGPIX System (Luminex).

Complementary antibody data from Vietnamese health care workers

To further assess the immunogenicity induced after the primary series of the Abdala COVID-19 vaccine, we used anti-S and neutralizing antibody data measured at 2 weeks after the primary series that were obtained from 104 Vietnamese HCWs fully vaccinated with ChAdOx1-S vaccine. We selected this cohort because they previously participated in our ChAdOx1-S vaccine evaluation study and their antibody data were available for comparison [10].

Statistical analysis

The chi-square test and the Fisher exact test were used to compare groups of qualitative data. Assessment for normality of quantitative data was performed using the Shapiro–Wilk test and subsequent comparisons between groups of independent and dependent data were performed using the *t* test or the Mann–Whitney *U* test and the paired *t* test or the Wilcoxon matched-pairs signed rank test, respectively. Likewise, the cross-neutralizing activities between the SARS-CoV-2 ancestral strain and other variants were assessed using the paired *t* test or Wilcoxon matched-pairs signed rank test. Multivariate regression with the type II sum of squares, correcting for potential associated confounding effects of age, and gender was used for the comparison of antibody levels between groups of Abdala vs ChAdOx1-S (after primary series) and Abdala vs BNT162b2 (after the booster dose). All analyses were carried out using SPSS 28.0 (IBM, White Plains, NY, USA) and GraphPad Prism 9.5.1 (GraphPad Software). For the multiplex sVNT, 50% of maximal concentration inhibition was calculated using the non-linear regression model available in the GraphPad Prism v9.5.1 (GraphPad Software, San Diego, CA, USA).

Ethical declarations

The study was conducted in accordance with the Declaration of Helsinki and was approved by the institutional review board of Dong Thap Centers for Disease Control and Prevention (approval number: 27/QĐ-KSBT) and the Oxford Tropical Research Ethics Committee (OxTREC reference: 570-21), University of Oxford, UK. Written informed consent was obtained from all participants.

Results

Demographics

A total of 301 individuals agreed to participate in the study. Of these, 278 (92.4%) completed the primaries series and 251 (83.4%) were successfully followed up until 2 weeks after the primary series. Subsequently, 207 (68.8%) received a booster dose and 198 (65.8%) (Abdala, n = 141 and BNT162b2, n = 57) were successfully followed up at 4 weeks after the booster dose (Figure 1a). Detailed information about the study participants is presented in Table 1. Overall, the study participants were aged between 19 and 59 years (median: 38 years), and farmers were predominant. There was no difference in demographics, occupation, and the time interval between vaccine doses between the study participants completing the primary series and the booster dose. The characteristics of 104 HCWs included as complementary data are presented in Supplementary Table 1 and Supplementary Figure 1.

Seroconversion and evidence of breakthrough infections

At baseline, only two study participants had anti-N antibodies at detectable levels. Of these, one had anti-S antibodies but none had neutralizing antibodies at detectable levels (Supplementary Table 2). During follow-up, the proportion of the participants with anti-N antibodies at detectable levels reached 8.0% (20 of 251) at 2 weeks after the primary series and 78.8% (156 of 198) after the booster dose (Supplementary Table 3), coinciding with the introduction and spread of the Omicron variants in Vietnam (Figure 1b). In contrast, as of 4 weeks after the booster dose, only 32 (16.2%) participants reported to the study team that they had COVID-19 during the study period; however, none were hospitalized (Supplementary Table 3).

For anti-S antibodies, the seroconversion rate increased from 0.4% (one of 251) before vaccination to 98.4% (247 of 251) at week 2 after the primary series and reached 100% (198 of 198) at 4 weeks after the booster dose (Supplementary Table 2). Likewise, the seroconversion rate of neutralizing antibodies increased from 0% before vaccination to 87.6% (220 of 251) at week 2 after the primary series and reached 97.5% (193 of 198) at 4 weeks after the booster dose (Supplementary Table 2). The seroconversion rates for the anti-S and neutralizing antibodies were comparable between the participants with and without anti-N antibodies detected at the corresponding time points (Supplementary Table 2).

Kinetics of anti-spike and neutralizing antibodies after the primary series

At 2 weeks after the primary series, the levels of anti-S and neutralizing antibodies significantly increased with higher titers recorded in those positive for anti-N antibodies than in those who were negative (Figure 2). Notably, the antibody levels measured at this time point in SARS-CoV-2–naïve participants (i.e. without anti-N antibodies at detectable levels) were comparable with those elicited by the ChAdOx1-S vaccine in SARS-CoV-2–naïve Vietnamese HCWs measured at 2 weeks after the primary series: median titers: 471 U/mL vs 711 U/mL, $P = 0.235$, for anti-S antibodies (Figure 2a) and 88.7% vs 85.1%, $P = 0.093$, for neutralizing antibodies (Figure 2b).

Kinetics of anti-spike and neutralizing antibodies after the booster dose

Of the 198 participants successfully followed up at 4 weeks after the booster dose, the anti-S and neutralizing antibody levels

Table 1
Baseline characteristics of the study population.

Parameters/groups		Pre-vaccination, Group 1 (n = 301)	Two weeks after dose 3, Group 2 (n = 251)	Four weeks after the booster dose, Group 3 (n = 198)				Group 4 (n = 34)[a]	*P*-values		
				All (n = 198)	Abdala (n = 141)	BNT162b2 (n = 57)	*P*-value		*P*1	*P*2	*P*3
Age in year, median (range)		38 (19-59)	37.5 (19-59)	37 (19-59)	38 (19-59)	34 (19-58)	0.048	34.5 (19-57)	0.902	0.860	0.268
Male gender, n (%)		143 (47.5)	112 (44.6)	85 (42.9)	56 (39.7)	29 (50.9)	0.151	15 (44.1)	0.498	0.720	0.897
Occupation	Farmer, n (%)	207 (68.8)	174 (69.3)	150 (75.8)	107 (75.9)	43 (75.4)	0.947	26 (76.5)	0.889	0.131	0.929
	Other, n (%)	94 (31.2)	77 (30.7)	48 (23.2)	34 (24.1)	14 (24.6)		8 (23.5)			
Interval time between vaccine doses (day)	1^{st} to 2^{nd}, median (range)	14 (13-17)	14 (13-17)	14 (13-17)	14 (13-17)	13 (13-17)	0.416	14 (13-17)	0.949	0.978	0.289
	2^{nd} to 3^{rd}, median (range)	15 (12-21)	15 (12-21)	15 (12-21)	15 (12-21)	15 (12-21)	0.633	15 (12-15)	0.918	0.817	0.639
	3^{rd} to 4^{th} (booster dose), median (range)	93 (87-121)	93 (87-121)	93 (87-121)	93 (87-99)	104 (90-121)	<0.001	93 (90-110)	0.704	0.616	0.868

[a] Anti-N antibodies negative individuals at the time of receiving the booster dose, selected for assessment of cross-neutralizing antibodies induced by the booster dose. P1, P2, and P3 denote the comparison between Group 1 vs Group 2, Group 2 vs Group 3, and Group 3 vs Group 4, respectively.

further increased (Figure 3a and b), with higher antibody titers observed in those with anti-N antibody at detectable than in those without anti-N antibody at detectable (Supplementary Figure 2a and b). Specifically, for anti-S antibodies, the median titers increased from 1044 U/mL before booster to 14,466 U/mL at 4 weeks after booster (P <0.001) in the participants without anti-N antibodies at detectable levels and from 11,616 U/mL to 22,436 U/mL (P <0.001) in those with anti-N antibodies at detectable levels (Supplementary Figure 2a). For neutralizing antibodies, the median percentage of inhibition increased from 90.4 to 96.9 (P <0.001) in participants without anti-N antibodies at detectable levels and from 96.8 to 97.2 (P = 0.002) in participants with anti-N antibodies at detectable levels (Supplementary Figure 2b).

Homologous vs heterologous booster

To assess the development of antibody levels induced by the homologous (Abdala COVID-19 vaccine, n = 141) and heterologous (BNT162b, n = 57) boosters, we compared the levels of anti-S and neutralizing antibodies measured at 4 weeks after the booster dose. The demographic information and interval time between the administration of vaccine doses between the two groups are shown in Table 1. At 4 weeks after the booster, the levels of anti-S and neutralizing antibodies induced by the Abdala and BNT162b2 vaccines were comparable; median titers: 23,211 U/mL vs 34,366 U/mL (P = 0.086) (Figure 3a) and median inhibition percentage: 97.1 vs 97.0 (P = 0.594) (Figure 3b), respectively. These findings were consistent for the groups of participants with and without anti-N antibodies detected, receiving either the Abdala or BNT162b vaccine (Supplementary Figure 2c and d), although there were marginal differences in the anti-S antibody levels in participants without anti-N antibodies boosted with the BNT162b2 vs those boosted with Abdala; median: 34,496 U/mL vs 13,045 U/mL, respectively (P = 0.017) (Supplementary Figure 2c).

Cross-neutralization

A subset of 34 participants who had anti-N antibodies at undetectable levels measured at the pre-booster dose was selected for analysis. This included 19 boosted by the Abdala and 15 boosted by the BNT162b2 vaccines were selected for assessment of cross-neutralization against SARS-CoV-1 and a wide range of SARS-CoV-2 variants, including the sublineages of Omicron variants. For this analysis, we focused on plasma samples collected at four time points: before vaccination (baseline), 2 weeks after the primary series, before the booster, and 4 weeks after the booster. The characteristics of the selected participants and seroconversion status are presented in Table 1 and Supplementary Table 4.

At baseline, none of the participants had neutralizing antibodies against all the tested viruses. At 2 weeks after the primary series, neutralizing antibodies could broadly neutralize a wide range of SARS-CoV-2 variants (Delta plus, Delta, Lambda, Alpha, Gamma, Beta, and Mu) but not Omicron (i.e. a complete immune escape of Omicron variant) (Figure 4a and Supplementary Tables 5 and 6). At this time point, weak neutralizing antibody responses against SARS-CoV-1 were, however, documented in five individuals (Figure 4a and Supplementary Tables 5 and 6).

At 4 weeks after the booster dose, neutralizing antibodies against all tested SARS-CoV-2 variants, including sublineages of Omicron variants, were significantly increased and were detectable in all participants, with the lowest titers documented for all sublineages of Omicron variants (Figure 4a and Supplementary Tables 5 and 6), reflecting the high immune escape capacity of the Omicron variants. Neutralizing antibodies against SARS-CoV-1 were detectable in 27 (79.4 %) participants but at a lower level than that of SARS-CoV-2 and its variants (Figure 4a and Supplementary Table 5 and 6). There was no difference in the levels of neutralizing antibodies against all the tested viruses in participants receiving homologous Abdala and heterologous BNT162b2 booster and those with or without anti-N at detectable levels (Figure 4b and Supplementary Figure 3).

Discussion

We report the immunogenicity induced by the Abdala COVID-19 vaccine, a recombinant protein subunit RBD-based vaccine platform, when used as primary and booster doses in Vietnamese people. Although existing literature has been dominated by evaluation studies concerning other vaccine platforms (mRNA and viral vector), our study represents the first reported data of the Abdala COVID-19 vaccine outside of Cuba [6]. Our results showed that the Abdala COVID-19 vaccine is immunogenic in Vietnamese people. Three doses of the primary series induced immunogenicity that is comparable to that of the ChAdOx1-S vaccine obtained from Vietnamese HCWs [10]. In addition, a booster dose given at 12 weeks after primary series enhanced antibody responses that could also cross-neutralize a broad range of SARS-CoV-2 variants, especially Omicron lineages (including BA.1, BA.2, BA.5, XBB, and XBB.1.5) and SARS-CoV-1. Importantly, homologous booster with the Abdala vaccine and heterologous booster with BNT162b2 produced comparable neutralizing antibody titers, regardless of the antibody levels before the administration the booster dose. This demonstrated that from the immunogenicity perspective, either the BNT162b2 or Abdala vaccine can be used as a booster dose in people fully vaccinated with the Abdala COVID-19 vaccine.

Limited data exist regarding the immunogenicity of the Abdala COVID-19 vaccines. The only data reported in adults to date were from a phase II trial conducted in Cuba, which also showed the seroconversion rates of 95.5% for anti-RBD immunoglobulin G and

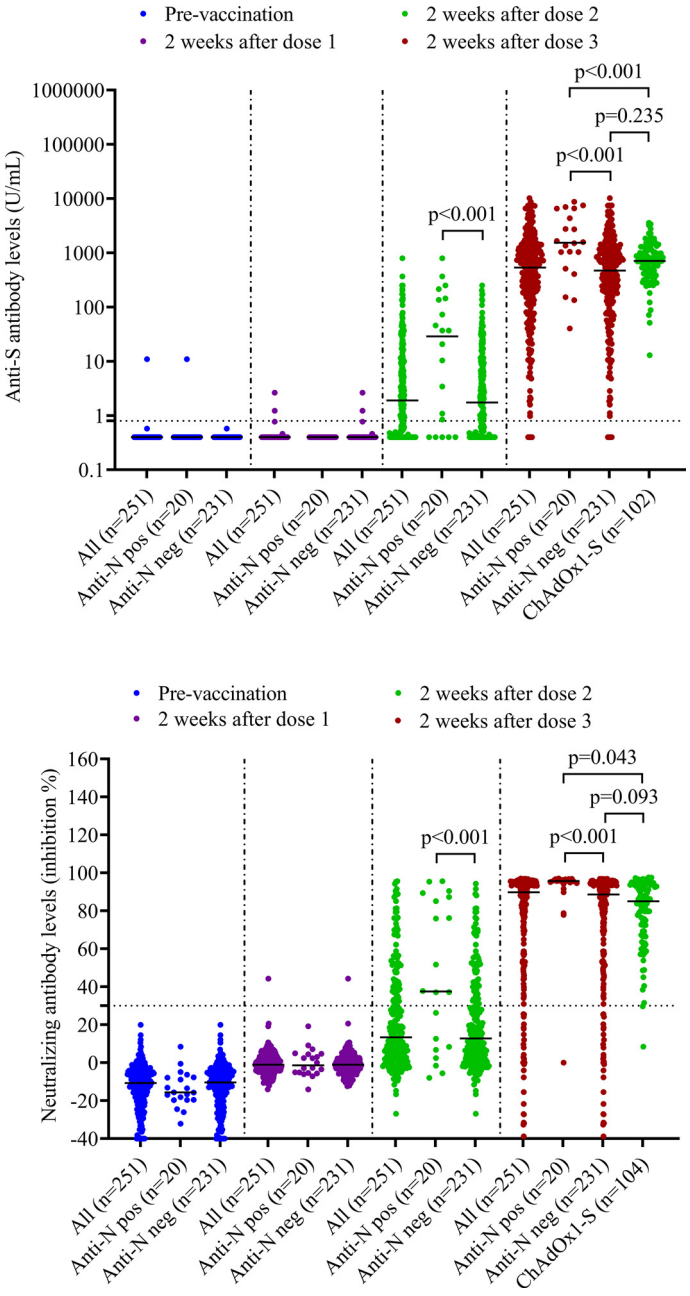

Figure 2. Kinetics of anti-S (a) and neutralizing (b) antibodies induced by primary vaccination.
Note: Data of each time point are separated by vertical dashed lines in which data from the left to the right corresponds to the whole group, those with anti-N, and without anti-N antibody detection during primary vaccination. Horizontal bars indicate median values and horizontal dashed lines indicate the assay's cutoff.
Anti-S, anti-spike; anti-N, anti-nucleocapsid; neg, negative; pos, positive.

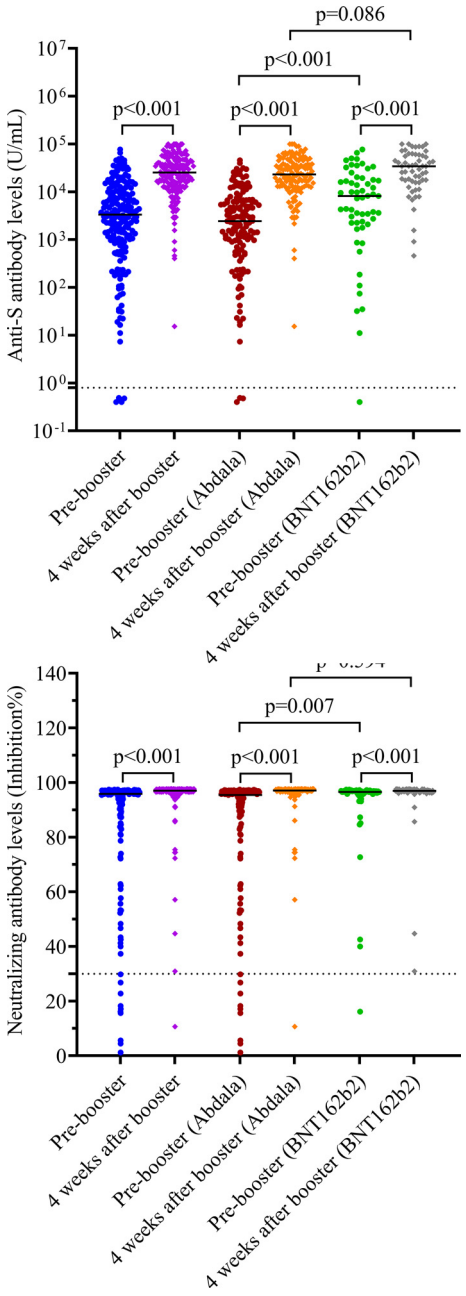

Figure 3. Kinetics of anti-S (a) and neutralizing (b) antibodies induced by booster dose of vaccination.
Note: Antibody data are shown in pairs before the booster and 4 weeks after booster for the whole group of 198 participants and the subgroups of Abdala (n = 141) and BNT162b2 (n = 57) boosted. Horizontal bars indicate median values and horizontal dashed lines indicate the assay's cutoff.
Anti-S, anti-spike.

86.4% for neutralizing antibodies measured at 2 weeks after the primary series [1]. Although the differences in the methods used to measure the antibodies and the heterogeneity of the population under investigation hindered comprehensive back-to-back in terms of findings between the two studies, the obtained data demonstrated marginal differences in antibody responses between Cuban and Vietnamese people.

Using anti-N antibodies as a surrogate of SARS-CoV-2 infection, the proportion of breakthrough infection increased over the course of the study, with 78.8% (156 of 198) documented at 4 weeks after the booster dose (i.e. May-June 2022). This was attributed to the relaxation of the public health measures applied in Vietnam from late 2021 onward [12], coinciding with the emergence and rapid spread of the highly transmissible Omicron variant and its sublineages worldwide. Yet, despite a high breakthrough infection rate evidenced by anti-N antibodies, only 32 of 198 (16.2%) of the study participants reported to the study team that they had breakthrough infections and none were hospitalized. Although this might reflect a low reporting rate from the study participants, the data suggested that the participants may have had only asymptomatic or mildly symptomatic infections that could have gone unnoticeable. We could not assess the clinical consequences of

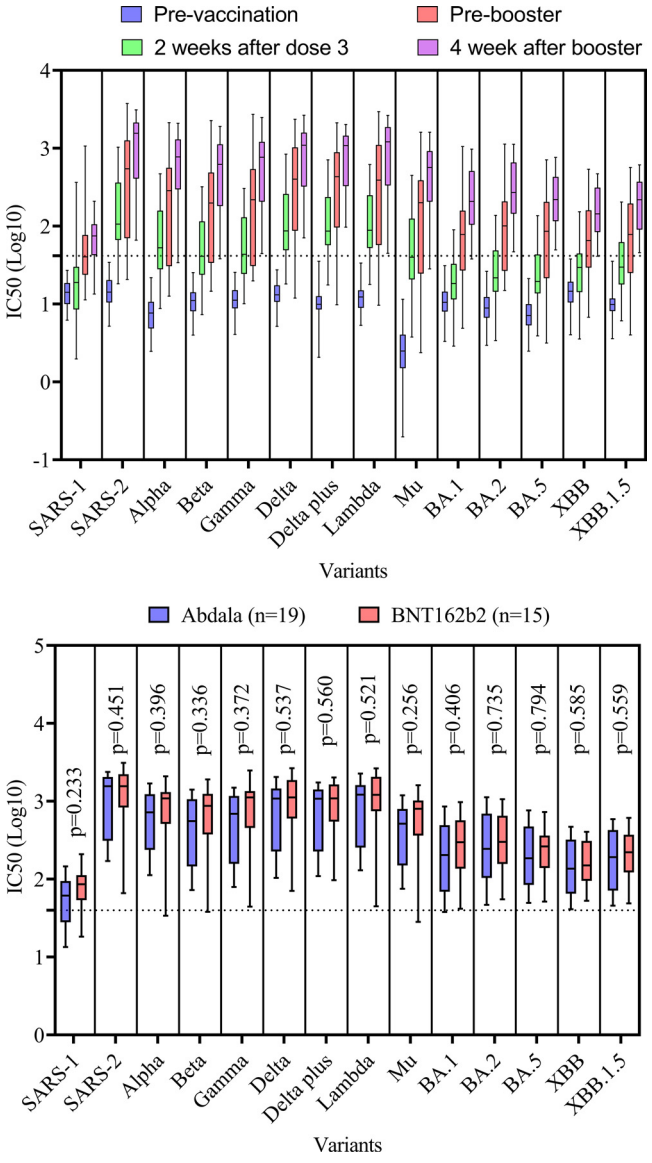

Figure 4. Cross-lineage neutralizing antibody titers for specific variants. (a) Data captured at four different time points from pre-vaccination to 4 weeks after the booster dose obtained from both participant groups who were boosted with either the Abdala or BNT162b2 vaccine and (b) showing the difference in antibody levels induced by either the homologous (Abdala COVID-19) or heterologous (messenger RNA BNT162b2) booster.
Note: Horizontal bars indicate geometric mean titers, and the dashed lines indicate the assay cutoff.
IC50, 50% of maximal concentration inhibition.

breakthrough infection (if any) in those lost to follow-up. However, together with observational data from Cuba during the Omicron wave in early 2022 [15], the data point to the efficacy of the Abdala COVID-19 vaccine in preventing symptomatic disease and deaths [2,5].

The immune escape of the Omicron variant necessitates a booster dose to improve the breadth of vaccine-induced neutralizing antibodies in those with and without hybrid immunity [16,17], consistent with findings from the present study. However, because previous studies only focused on mRNA or adenoviral vector vaccines [17–19], our study, therefore, has provided novel insights into the cross-neutralization against SARS-CoV-1 and SARS-CoV-2 variants, especially the Omicron, that a recombinant protein subunit RBD-based vaccine could offer. Mutations in the RBD region does seem to favor the improved infectivity and transmission of SARS-CoV-2 by enhancing the virus capacity to bind to the human angiotensin-converting enzyme 2 receptor rather than the immune escape properties [20]. Therefore, the data suggest that RBD could be a potential protein target for the next generation vaccines, especially against diverse sarbecoviruses [21].

Our study has some limitations. First, owing the nature of the Abdala COVID-19 vaccine deployment policies in Vietnam, we were not able to assess the immunogenicity in people aged over 59 and below 19 years. Second, we did not assess the cross-neutralization against the most recent Omicron sublineages, especially hypermutation BA.2.86 and its variant, JN.1. Third, the participants of the HCW cohort were included for comparison based on the availability of antibody data rather any matching criteria, resulting in potential biases due to the heterogeneity of the study populations. Fourth, we did not assess T-cell responses. Although this represents a gap in knowledge for the Abdala COVID-19 vaccine, the reported data on protein subunit RBD vaccines showed strong a T-cell response and its preservation against Omicron variants [22].

In summary, three doses of the Abdala COVID-19 vaccine given as the primary series stimulated strong antibody responses in Vietnamese people. Enhanced immunogenicity after a booster dose could cross-neutralize SARS-CoV-1 and a wide range of SARS-CoV-2 variants, especially the Omicron and its sublineages. To the best of our knowledge, our findings represent the first report outside of Cuba regarding the immunogenicity to the Abdala COVID-19 vaccine and thus have added to the growing body of knowledge about the contribution of protein subunit vaccine platforms to pandemic control.

Declarations of competing interest

The authors have no competing interests to declare.

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Author contribution

TTT, NTKT, NLTT, NTT, NTD, NVVC, LMY, GT, LFW, CWT, and LVT designed the study. NTKT, PVE, NPT, NVT, and PHT enrolled participants and collected demographic data. LAN, CTT, NTHN, LNTN, LKT, NTTH, NTA, WCY, and TTT involved in the measurement of antibodies. RP, SY, RW, JM, WD, RLH, NC, GS, SJD, EYJ, DIS, LFW, and CWT contributed reagents/materials/analysis tools. TTT and LVT analyzed the data and wrote the manuscript. LFW and RLH contributed to the writing. All authors have read and approved the manuscript.

Ethical approvals

The study was approved by the institutional review board of Dong Thap CDC (approval number: 27/QĐ-KSBT) and the Oxford Tropical Research Ethics Committee (OxTREC reference: 570-21), University of Oxford, UK. Written informed consent was obtained from all participants.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ijid.2024.107173.

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