Qualitative and Quantitative Testing Method

The seroconversion was determined by the technical manual booklet[1] (The S-specific IgG was detected using the chemiluminescence qualitative kit, Anto Biotechnology, China).

The cutoff value = the mean light unit of positive control well * cutoff efficient[1]. The efficient was set as 0.2 in the present lot of qualitative kit according to the manual. The mean light unit of the present study was 26.34±4.24 and therefore the cutoff value equals 5.2 ± 0.85.

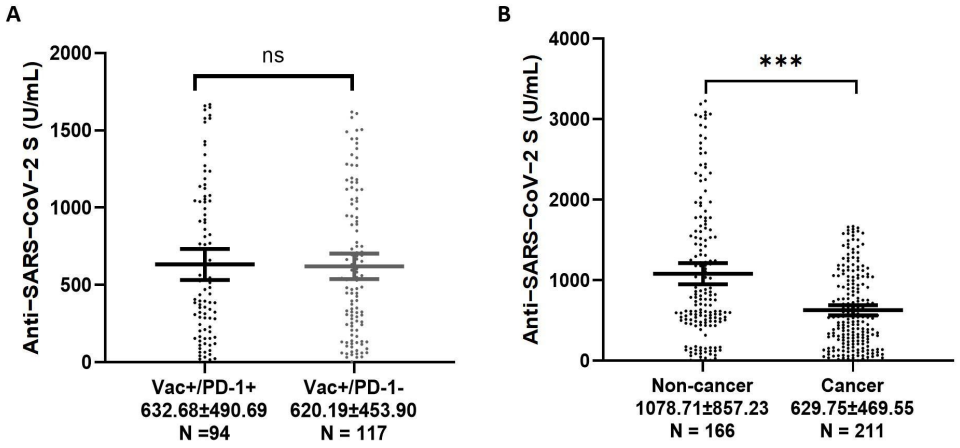
When the light unit (LU) of any specimen > cutoff value (or LU/CO > 1), the result returns positive, and if the value is less than the cutoff value (or LU/CO ≤ 1), the result returns negative. The specimens of all vaccinated patients were tested on the A200 Plus™ machine. All evaluation was done in the same machine in the same laboratory.

The assay kit has been certified by the National Medical Products of China[1] (NMPA number 国械注准 20203400495 for IgG assay kit).

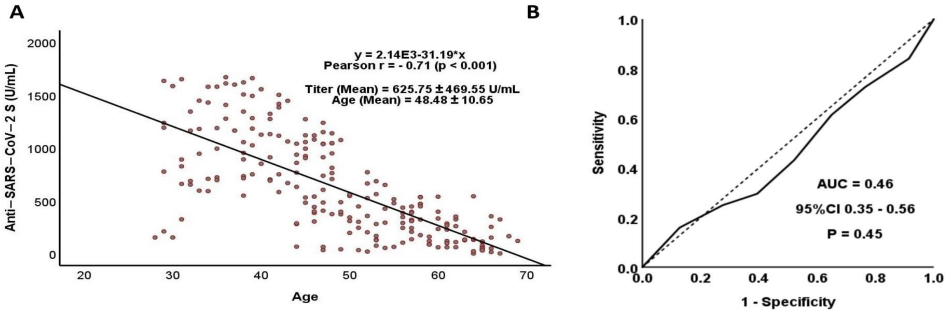
The SARS-CoV-2 RBD antibody titer was tested with the kit[1] (BioScience, China) to quantify total anti-RBD SARS CoV-2 antibodies, performed on the automated Axceed 260 instrument (BioScience, China). The detection is based on competitive test using SARS-CoV-2 anti-RBD antibodies. The SARS-CoV-2 anti-RBD antibodies present in the serum samples compete with the peroxidase-conjugated SARS-CoV-2 anti-RBD antibodies to bind the spike protein RBD region of the S1 subunit fixed to the solid phase support. According to the manual, the higher the serum antibody concentration, the less possible the peroxidase-conjugated SARS-CoV-2 anti-S1 antibody can bind to the fixed antigen. After loading >200 µl of the samples into the well, automated washing deletes the unbound components and the chromogenic agent is added to result in a colorimetric reaction by the enzyme-labeled antibodies. The intensity of the reaction is negatively correlated to the concentration of anti-S1 RBD antibodies in the sample. The results are expressed in arbitrary units/ml (U/ml), and the acceptable range is from 0 to 30000 U/mL.

Vaccine Details

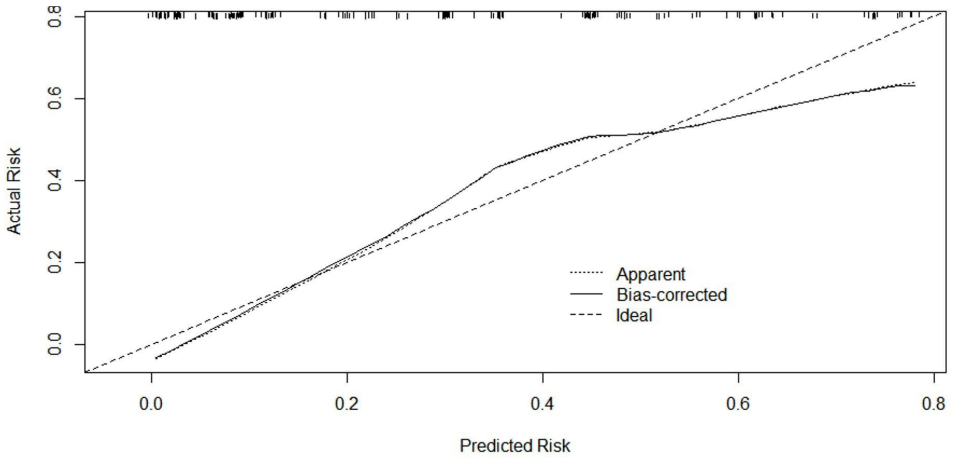
The vaccine reported in the present study belongs to the inactivated vaccine type manufactured by two institutions approved by the National Medical Products of China (NMPA)[1]: SinoPharm (Beijing Institute of Biological Products Co.,Ltd.) and SinoVac (Sinovac Life Sciences Co.,Ltd.). Almost all included patients and non-cancer controls received the vaccination from the SinoPharm (96.6%), and only 17 patients received the vaccines from SinoVac. Both vaccines have been on the EUAL list (Emergency Use Assessment and Listing). the approval NMPA Number is S20200030 for SinoPharm and S20210003 for SinoVac. [1]



Supplementary Figure 1. The distribution of antibody titers and comparison. 1A. no significant difference in antibody titers between the PD-1B+/vac+ group and the PD-1B-/vac+ group (p=0.75). 1B. the antibody titers of all patients with cancers were significantly lower than the non-cancer control group (p<0.001).



Supplementary Figure 2. Clinical relevance of qualitative and quantitative testing. 1A. the antibody titers negatively correlated with age in all cancer patients (Pearson r = -0.71, p < 0.001). 1B. ROC analysis to investigate the relationship between seroconversion rate (qualitative) and ICI treatment duration.



Supplementary Figure 3. Nomogram calibration curve in an independent cohort.

Supplementary Table 1. Detailed Balance Test Results of Propensity Score Matching of Each Group

Covariates	Treated (mean)		Control (mean)		Standardized Difference (Mean)	
	Before Matching	After Matching	Before Matching	After Matching	Before Matching	After Matching

ICI+/vax+ versus ICI-/vax+						
Sex	0.75	0.75	0.73	0.74	0.05	0.02
Age	51.17	50.92	49.87	50.94	0.12	0
Pathology	1.86	1.87	1.9	1.87	-0.06	0
Chemotherapy	0.2	0.21	0.26	0.21	-0.13	0
ECOG	0.33	0.31	0.27	0.28	0.14	0.08
Metastasis	0.07	0.07	0.07	0.07	0	0.03
Vaccine Dose	0.42	0.43	0.44	0.4	-0.04	0.05
Comorbidity	0.23	0.24	0.24	0.22	-0.03	0.03
ICI+/vax+ versus ICI+/vax-						
Sex	0.75	0.74	0.75	0.76	0.01	-0.05
Age	51.17	51.23	49.93	50.62	0.12	0.06
Pathology	1.86	1.86	1.87	1.87	-0.02	-0.02
Chemotherapy	0.2	0.21	0.27	0.21	-0.17	0
ECOG	0.33	0.33	0.3	0.31	0.08	0.05
Metastasis	0.07	0.08	0.19	0.08	-0.45	0
ICI Duration	6.54	6.48	6.49	6.47	0.02	0
ICI+/vax+ versus non-cancer patients						
Sex	0.75	0.75	0.75	0.72	0	0.07
Age	51.17	51.17	48.65	50.08	0.24	0.1
Vaccine Dose	0.42	0.42	0.48	0.46	-0.12	-0.07
Comorbidity	0.23	0.23	0.19	0.21	0.09	0.05
ICI-/vax+ versus non-cancer patients						
Sex	0.73	0.73	0.75	0.74	-0.05	-0.01
Age	49.87	49.63	48.65	48.26	0.11	0.13
Vaccine Dose	0.44	0.44	0.48	0.49	-0.08	-0.09
Comorbidity	0.24	0.23	0.19	0.22	0.12	0.03

Note: ICI, immune checkpoint inhibitor.

Supplementary Table 2. Multivariate Regression Analysis of Seroconversion in Cancer Patients

Variables	Unstandardized		Standardized Beta	*t*	*p*
	Beta	Error			
Constant	-.011	0.12	-	-0.90	0.37
Ages	0.14	0.02	0.31	5.75	0.00
Pathology, NSCLC / GI / HN	0.05	0.02	0.17	3.07	0.01
PD-1B, Yes / no	0.03	0.05	0.04	0.65	0.52
Chemotherapy, Yes / no	0.15	0.06	0.14	2.53	0.01
Comorbidity, Yes / no	0.07	0.06	0.07	1.26	0.21
ECOG-PS, 0 / 1	0.02	0.06	0.02	0.33	0.74
Metastasis, Yes / no	-0.03	0.10	-0.02	-0.28	0.78
Doses, 1 / 2	-0.08	0.05	-0.08	-1.47	0.14
Gender, Male / female	-0.02	0.06	-0.02	-0.39	0.70

Note: PD-1B, PD-1 blockers. SD, standard deviation; NSCLC, Non-small cell lung cancer; GI, gastrointestinal cancers; HN, head and neck cancers; ECOG-PS, Eastern Cooperative Oncology Group-Performance Score.

Supplementary Table 3. Detailed Adverse Event of The Four Groups

Adverse Events	Grade Level	PD-1B+/Vac+	PD-1B-/Vac+	PD-1B+/Vac-	Non-cancer Control
Fatigue	1	16 (80%)	16 (59.2%)	—	14 (45.1%)
	2	4 (20%)	11 (40.8%)		17 (54.9%)
Fever	1	11 (91.6%)	6 (50.0%)	—	20 (76.9%)
	2	1 (8.3%)	4 (33.3%)		5 (19.2%)
	3	0 (0%)	2 (16.7%)		1 (3.8%)
Nausea	1	10 (66.6%)	4 (22.2%)	—	10 (34.5%)
	2	5 (33.3%)	14 (77.8%)		19 (65.5%)
Headache	1	8 (61.5%)	9 (64.2%)	—	10 (71.4%)
	2	5 (38.5%)	5 (35.8%)		4 (28.6%)
Diarrhea	1	7 (58.3%)	—	9 (69.2%)	—
	2	8 (41.7%)		4 (30.8%)	
Pneumonitis	1	8 (88.8%)	—	7 (70.0%)	—
	2	1 (11.2%)		3 (30.0%)	
Rash	1	18 (51.4%)	10 (100%)	8 (24.2%)	7 (36.8%)
	2	17 (48.5%)	0 (0%)	20 (60.6%)	9 (47.5%)
	3	0 (0.0%)	0 (0%)	5 (15.1%)	3 (15.7%)
Arthralgia	1	10 (52.6%)	15 (83.3%)	15 (75.0%)	12 (63.1%)
	2	9 (47.4%)	3 (16.7%)	4 (20.0%)	7 (36.8%)
	3	0 (0.0%)	0 (0.0%)	1 (5.0%)	0 (0.0%)
↑LFT	1	9 (47.4%)	—	9 (45.0%)	—
	2	10 (52.6%)		11 (55.0%)	

Note: LFT, liver function test.

Supplementary Table 4. Baseline Variables of the Validation Cohort

Factor		Total	PD-1B+/Vac+	PD-1B-/Vac+
Age		42.90±10.31	43.39±10.60	42.64±10.19
Gender	Male	115 (59.0%)	40 (60.6%)	75 (58.1%)
	Female	80 (41.0%)	26 (39.4%)	54 (41.9%)
Pathology	NSCLC	71 (36.4%)	26 (39.4%)	45 (34.9%)
	GI	95 (48.7%)	38 (57.2%)	57 (44.2%)
	HN	29 (13.9%)	2 (3.0%)	27 (20.9%)
Chemotherapy	Yes	33 (16.9%)	10 (15.2%)	23 (17.8%)
	No	162 (83.1%)	56 (84.8%)	106 (82.2%)
ECOG-PS	0	163 (83.6%)	57 (86.4%)	106 (82.2%)
	1	20 (10.3%)	4 (6.1%)	16 (12.4%)
	2	12 (6.2%)	5 (7.6%)	7 (5.4%)
Metastasis	Yes	9 (4.6%)	3 (4.5%)	6 (4.7%)
	No	186 (95.4%)	63 (95.5%)	123 (95.3%)
Dose of Vaccine	1	85 (43.6%)	28 (42.4%)	57 (44.2%)
	2	110 (56.4%)	38 (57.6%)	72 (55.8%)
Comorbidity with Rheumatic Disease	Yes	14 (7.2%)	5 (7.6%)	9 (7.0%)
	No	181 (92.8%)	61 (92.4%)	120 (93.0%)
Seroconversion	Positive	135 (69.2%)	43 (65.2%)	92 (71.3%)
	Negative	60 (30.8%)	23 (34.8%)	37 (28.7%)

Note: ECOG-PS, Eastern Cooperative Oncology Group-Performance Score.

Reference

1, *National Medical Products Administration Database (Chinese)* http://app1.nmpa.gov.cn/data_nmpa/face3/base.jsp?tableId=26&tableName=TABLE26&title=%B9%FA%B2%FA%D2%BD%C1%C6%C6%F7%D0%B5%B2%FA%C6%B7%A3%A8%D7%A2%B2%E1%A3%A9&bcId=152904417281669781044048234789