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Background

- In 2021, Qatar experienced considerable incidence of SARS-CoV-2 infection that was dominated sequentially by the Alpha, Beta, and Delta variants, followed by a large SARS-CoV-2 Omicron wave that started on December 19, 2021 and peaked in mid-January, 2022.
- The real-time reverse-transcription polymerase chain reaction (RT-qPCR) cycle threshold (Ct) value of a SARS-CoV-2-positive test represents the inverse of viral load. Ct value is used as a proxy for SARS-CoV-2 infectiousness. A low Ct value implies high infectiousness.

Objective

To investigate the effects of SARS-CoV-2 variant, previous vaccination, and prior infection on infectiousness of SARS-CoV-2 infections during the Alpha, Beta and Delta outbreaks (March 23-November 6, 2021) and during the Omicron outbreak (December 23, 2021-February 20, 2022).

Methodology

Ascertainment of the Alpha, Beta and Delta variant status was done by RT-qPCR genotyping

Coronavirus disease 2019 laboratory testing, vaccination, clinical infection, and demographic data were extracted from the national, federated SARS-CoV-2 databases

The average RT-qPCR Ct value of the N, ORF1ab, and S gene targets was used as the dependent variable in all analyses

Linear regression analyses were conducted to estimate associations with the Ct value of RT-qPCR-positive tests

A SARS-CoV-2 Omicron infection with the BA.1 subvariant was proxied as an S-gene "target failure" (SGTF). The BA.2 subvariant infection was proxied as a non-SGTF case

Methodology...Continued

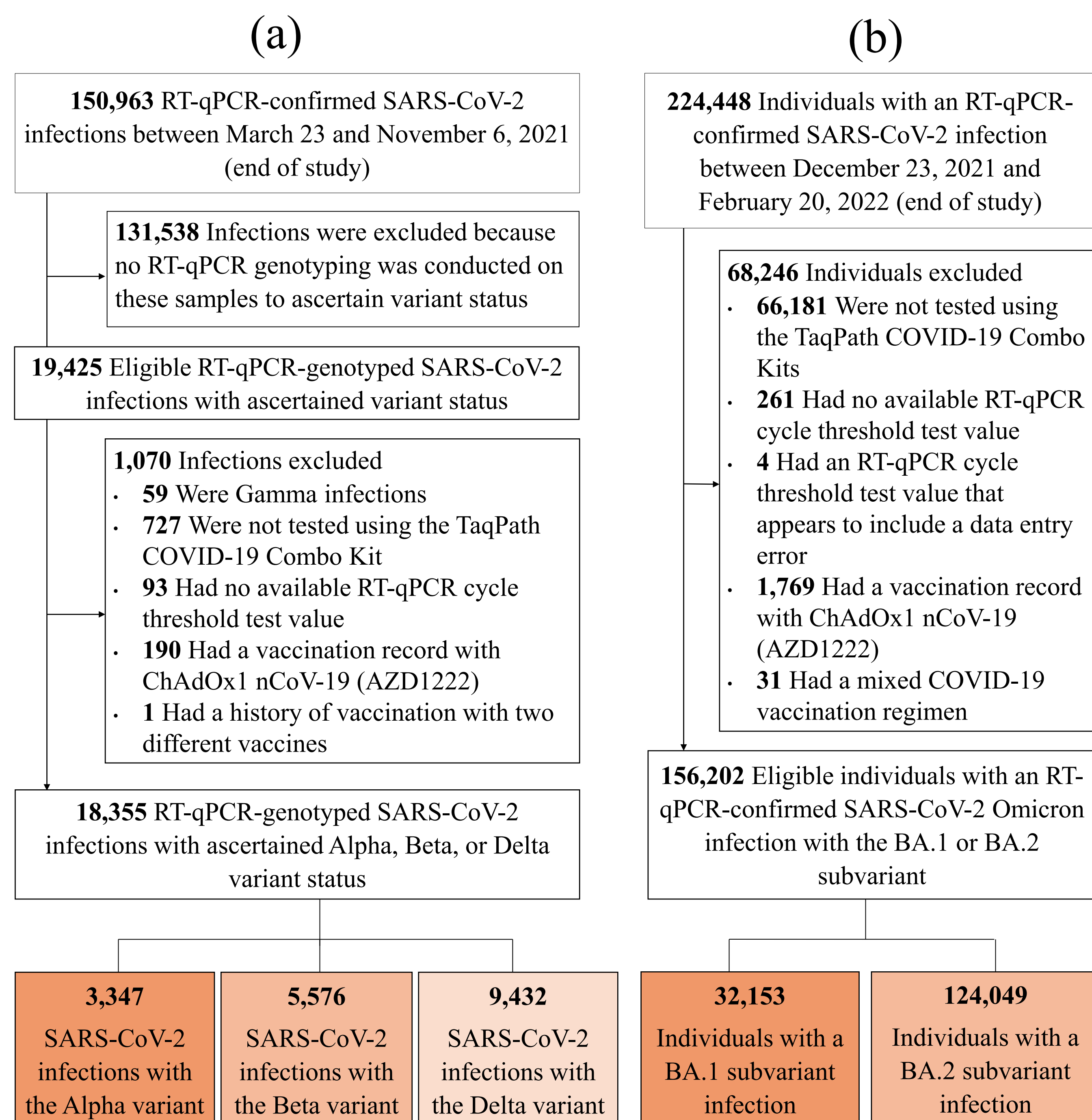


Figure 1. Flowchart describing the population selection process for investigating infectiousness of SARS-CoV-2 Alpha, Beta and Delta infections (a), and SARS-CoV-2 Omicron subvariant infections (b).

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Results

Table 1. Associations with RT-qPCR Ct value among the 18,355 RT-qPCR-genotyped Alpha, Beta, and Delta SARS-CoV-2 infections between March 23 and November 6, 2021.

Characteristics	RT-qPCR Ct value Mean (SD)	Univariable analysis β coefficient [95% CI]	Multivariable analysis ^a β coefficient [95% CI]
SARS-CoV-2 variant			
Beta	23.72 (5.14)	Ref.	Ref.
Alpha	27.89 (5.65)	4.17 [3.94, 4.39]	2.56 [2.35, 2.78]
Delta	22.31 (5.21)	-1.41 [-1.59, -1.24]	-4.92 [-5.16, -4.67]
Vaccination status			
Unvaccinated	23.98 (5.65)	Ref.	Ref.
One dose	23.93 (5.71)	-0.05 [-0.40, 0.31]	0.57 [0.26, 0.87]
Two doses			
<3 months before the RT-qPCR test	24.43 (5.86)	0.45 [0.14, 0.77]	0.86 [0.59, 1.13]
3-<6 months before the RT-qPCR test	22.59 (5.40)	-1.39 [-1.63, -1.15]	0.08 [-0.17, 0.32]
6-<9 months before the RT-qPCR test	21.79 (5.12)	-2.19 [-2.66, -1.71]	-0.26 [-0.72, 0.19]
≥9 months before the RT-qPCR test	18.81 (2.22)	-5.17 [-10.68, 0.34]	-3.23 [-7.89, 1.42]
Three doses			
≤1 month before the RT-qPCR test	22.99 (5.40)	-0.99 [-5.92, 3.94]	-1.36 [-5.52, 2.79]
>1 month before the RT-qPCR test	19.80 (2.97)	-4.18 [-9.69, 1.33]	-1.83 [-6.47, 2.81]
Prior SARS-CoV-2 infection			
Never	23.14 (5.51)	Ref.	Ref.
<90 days before the study RT-qPCR test	27.65 (4.93)	4.51 [4.27, 4.74]	3.95 [3.73, 4.17]
Prior infection ^b	25.88 (5.93)	2.74 [1.99, 3.48]	2.07 [1.42, 2.72]

Table 2. Associations with RT-qPCR Ct value among 156,202 individuals with SARS-CoV-2 Omicron infections between December 23, 2021 and February 20, 2022.

Characteristics	RT-qPCR Ct value Mean (SD)	Univariable analysis β coefficient [95% CI]	Multivariable analysis ^a β coefficient [95% CI]
Omicron subvariant			
BA.1	27.11 (6.60)	Ref.	Ref.
BA.2	23.46 (5.82)	-3.65 [-3.73, -3.58]	-3.53 [-3.60, -3.46]
Vaccination status			
Unvaccinated	25.38 (6.27)	Ref.	Ref.
One dose	23.92 (6.05)	-1.46 [-1.82, -1.09]	-0.34 [-0.67, -0.00]
Two doses			
<3 months before the RT-qPCR test	24.69 (6.25)	-0.69 [-0.93, -0.44]	0.23 [0.00, 0.46]
3-<6 months before the RT-qPCR test	24.07 (6.16)	-1.31 [-1.42, -1.20]	-0.05 [-0.15, 0.06]
6-<9 months before the RT-qPCR test	23.43 (5.96)	-1.95 [-2.02, -1.87]	-0.48 [-0.56, -0.40]
≥9 months before the RT-qPCR test	23.47 (5.97)	-1.91 [-2.00, -1.81]	-0.43 [-0.53, -0.33]
Three doses			
≤1 month before the RT-qPCR test	24.98 (6.30)	-0.39 [-0.54, -0.25]	0.86 [0.72, 1.00]
>1 month before the RT-qPCR test	24.21 (6.23)	-1.17 [-1.31, -1.02]	0.28 [0.14, 0.42]
Previous SARS-CoV-2 infection			
Never	24.09 (6.16)	Ref.	Ref.
<90 days before the study RT-qPCR test	29.18 (5.41)	5.09 [4.58, 5.60]	4.23 [3.77, 4.69]
Prior infection ^b	25.22 (6.07)	1.12 [1.01, 1.23]	1.30 [1.20, 1.39]

^aRT-qPCR Ct value was adjusted for age-group, sex, nationality, SARS-CoV-2 variant, reason for RT-qPCR test, RT-qPCR test study-period time, vaccination status, and prior SARS-CoV-2 infection.

^bPrior infection was defined as an RT-qPCR-positive test that occurred ≥90 days before the RT-qPCR-positive test that is included in the study.

Conclusions

- Delta appears substantially more infectious than Beta.
- BA.2 subvariant appears substantially more infectious than BA.1 subvariant.
- Prior immunity, whether due to vaccination or prior infection, is associated with lower infectiousness of breakthrough infections.