UK Health Security Agency

Incubation period, serial interval and infectious period for the Omicron variant of SARS-CoV-2

A rapid evidence briefing

Contents

Main messages

1. Twelve studies (14 reports) reporting on incubation period, serial interval and infectious period for the Omicron variant were identified (search up to 15 February 2022): 7 studies compared Omicron and Delta variants, and 5 studies (7 reports) only reported on Omicron.
2. Reported incubation period: mean values for the Omicron variant ranged from 2.5 to 4.3 days (4 studies) and the median was 3 to 4 days (4 studies), with a maximum range of 0 to 8 days.
3. Reported serial interval: mean values for the Omicron variant ranged from 2.2 to 4.9 days (5 studies), and the median ranged from 3 to 4 days (3 studies).
4. Reported infectious period: viral peak for Omicron was reached between 3 and 6 days of illness (3 studies); mean transmission period was 0.5 days (one study) and mean duration of infection was 9.9 days (one study); results on infectiousness based on Ct values or viral culture tests were heterogenous.
5. Findings suggest that the incubation period and the serial interval may be shorter for the Omicron variant than for the Delta variant.
6. The studies had small numbers of participants and may not represent the general population. There were differences between studies (including case identification and outcome definition) which may have impacted the results. Only 3 studies had reported the results by vaccination or household status, which may also have impacted the results. Six studies were preprints and may be subject to change.

Purpose

To provide a rapid summary of the evidence on key epidemiological time intervals (incubation period, serial interval and infectious period) for the Omicron variant of SARS-CoV-2.

Definitions

Incubation period: time interval between exposure and symptom onset.

Infection duration: time interval between detection and clearance of infection.

Infectious period: time interval during which a primary case can infect a secondary case.

Serial interval: time interval between symptom onset of the primary and secondary cases.

Transmission period: time period from primary case symptom onset to last day of contact with secondary cases.

Viral proliferation duration: time interval between detection and peak of viral load, using cycle threshold (Ct) values as a proxy for infectiousness.

Note that as infectious period can be challenging to assess based on epidemiological evidence (most infected cases will only be aware of infection once the infectious period has already begun). Evidence on viral proliferation duration, transmission period, and infection duration was also considered.

Methods

Evidence on the Omicron variant has been monitored since early December 2021 using a semi-automatic process. Updates are conducted every week and involve a search of Ovid Medline, Ovid Embase, medRxiv, bioRxiv, Research Square and the World Health Organization (WHO) COVID-19. All records on coronavirus (COVID-19) are downloaded into a Endnote library, where a Smart Group containing Omicron-related search terms brings all Omicron records together. Those records are then screened by an information scientist based on title and abstract. The relevant records are then exported to an Excel spreadsheet and screened by a reviewer on full text. The search updates considered for this evidence briefing cover the period from 6 December 2021 to 15 February 2022.

A total of 575 reports were screened by the reviewer, of which 14 were included (1 to 14). Three of these reports were from South Korea and had overlapping samples, although the extent of overlap is unclear (1 to 3), one report was an epidemiological investigation on the first country-wide Omicron cases (2), and the other 2 used national contact tracing data (1,3). For completeness, the 3 reports were included but presented as one study.

Evidence

Search results

Twelve studies (14 reports) providing evidence on key time periods for the Omicron variant were identified (1 to 14), one of which used data from the UK (11). Six reports were preprints and have not been peer-reviewed (3, 4, 8, 12 to 14). To identify Omicron cases, 6 reports used genome sequencing (3, 7, 9, 11, 12, 14), 3 reports used Reverse Transcription Polymerase Chain Reaction (RT-PCR) techniques (S gene target failure (SGTF) or single-nucleotide polymorphism (SNP) genotyping) (4, 5, 13), 2 reports used a combination of RT-PCR and genome sequencing (6, 8), and the remaining 3 reports did not specify how Omicron cases were identified.

Seven studies compared key interval periods for the Omicron variant to the Delta variant (4, 5, 8, 11 to 14). They reported on incubation period (4, 5), serial interval (4, 5, 11, 13), transmission period (4), viral proliferation and infection duration (8), and viral load over time (12, 14).

The remaining 5 studies (7 reports) only reported results for the Omicron variant and had smaller sample sizes (less than 100 cases), providing evidence on incubation period (1, 2, 6, 7, 9), serial interval (1 to 3), and viral load over time (10).

Incubation period (Table A.1)

Six studies (7 reports) provided evidence on incubation period for the Omicron variant. Two were contact tracing studies that compared Omicron to Delta (4, 5), and the remaining 4 studies (5 reports) (1, 2, 6, 7, 9) only provided evidence on the Omicron variant. A summary of results is presented in Table A.1.

A contact tracing study conducted in North Spain by Del Aguila-Mejia and others (preprint) included 622 primary cases (455 secondary cases) infected with the Omicron variant in December 2021 and 1,708 primary cases (2,201 secondary cases) infected with the Delta variant in November 2021 (4). Incubation period was assessed based on the date of last contact between primary and secondary cases and was reported only when both primary and secondary cases were symptomatic (the number of symptomatic cases used in the analysis was not reported). Outcomes were reported as mean and median, and by

vaccination status of the primary case. A mean incubation period of 3.1 days (standard deviation [SD]: 2.6 days) for the Omicron variant and of 3.3 days for the Delta variant (SD: 2.7 days) was reported (mean difference = -0.2 days, 95% confidence interval [CI]: -0.6 to 0.16 days, p=0.29) (4). Similar findings were observed when results for vaccinated and unvaccinated primary cases were examined separately (Table A.1).

Backer and others (the Netherlands) reported on incubation period from contact tracing data of 258 Omicron transmission pairs (S-gene target failure [SGTF] cases) and 255 Delta transmission pairs (non-SGTF cases) with a symptom onset date between 1 December 2021 and 2 January 2022 (5). A median incubation period of 2.8 days (95% credible interval [CrI]: 2.5 to 3.2 days) was observed. This was shorter than for Delta (median = 4.0 days, 95% CrI: 3.6 to 4.4 days; p-value for difference not reported).

Four studies (5 reports) provided evidence only on the Omicron variant and had smaller sample sizes (less than 100 cases) (1,2,6,7,9). The 2 reports from South Korea with overlapping samples found a mean incubation period of 2.5 to 4.3 days (1) and 4.2 days (2). The remaining 3 epidemiological investigations reported a mean/median of 3 days (Table A.1) (6,7,9).

Serial interval (Table A.2)

Five studies (7 reports) provided evidence on the serial interval for Omicron (1 to 5,11,13). Four studies compared Omicron to Delta (4,5,11,13), and one study (3 reports) reported only on the Omicron variant (1 to 3). A summary of results is presented in Table A.2.

Backer and others (described above) reported serial interval by date of symptom onset of the primary case (grouped by week) to reduce the effects of differences in epidemic growth on the outcome (5). The mean serial interval for Omicron ranged from 2.9 to 3.8 days, regardless of date of symptom onset of the primary case, vaccination status and type of transmission. For primary cases with symptom onset between 13 and 19 December 2021 (235 Omicron pairs, 919 Delta pairs), the mean serial interval for Omicron was shorter than for Delta for both within (Omicron: 3.5 days, SD: 2.4 days, n=164 pairs; Delta: 4.1 days, SD: 2.8 days, n=761 pairs; p=0.0026) and between-household transmission (Omicron: 3.3 days, SD: 2.4 days, n=71 pairs; Delta 3.5 days, SD 2.8 days, n=158 pairs; p=0.24). Results for primary cases with symptom onset between 20 and 26 December 2021 are reported in Table A.2. Results were also grouped by the vaccination status of both the primary and secondary cases for within-household transmission pairs during the first week of the study (13 to 19 December 2021; n=164 Omicron pairs, n=761 Delta pairs). The mean serial interval for Omicron was shorter than for Delta regardless of whether both cases were vaccinated (Omicron: 3.5 days; Delta: 4.0 days; p=0.037), only the primary case was vaccinated (Omicron: 3.3 days; Delta: 5.0 days; p=0.00016), only the secondary case was vaccinated (Omicron: 3.8 days; Delta: 4.0 days; p=0.42), or both cases were unvaccinated (Omicron: 3.1 days; Delta: 3.9 days; p=0.12).

A contact tracing study in Belgium (preprint) examined the serial interval of 2,161 transmission pairs with Omicron and 334 transmission pairs with Delta from 19 November to 31 December 2021 (13). A mean serial interval of 2.8 days (95% CrI: 2.7 to 2.9 days) was observed for Omicron, which was shorter than for the Delta variant (3.0 days, 95% CrI: 2.7 to 3.3 days; p-value for difference=0.019). Smaller serial intervals for Omicron were also observed for both within household (Omicron: 2.8 days, 95% CrI: 2.7 to 2.9 days, n=1,412 pairs; Delta: 3.0 days, 95% CrI 2.8 to 3.3 days, n=278 pairs; p-value for difference=0.034) and between household transmission (Omicron: 2.7 days, 95% CrI: 2.5 to 2.9 days, n=672 pairs; Delta: 2.8 days, 95% CrI: 2.0 to 3.6 days, n=50 pairs; p-value for difference=0.686). Transmission pairs infected with Omicron had a smaller serial interval than pairs infected with Delta when both cases were vaccinated (Omicron: 2.6 days, 95% CrI: 2.5 to 2.8 days, n=774 pairs; Delta: 3.4 days, 95% CrI: 2.9 to 3.9 days, n=97 pairs; p-value for difference=0.004), but not when both cases were unvaccinated (Omicron: 2.7 days, 95% CrI: 2.4 to 3.0 days, n=346 pairs; Delta: 2.5, 95% CrI: 2.0 to 3.1 days, n=61 pairs; p-value for difference=0.931). Omicron cases who have received a booster vaccination may have a longer serial interval than cases with just 2 doses (3.3 days versus 2.6 days; p=0.065) although this was based on a small number of cases (47 Omicron pairs with booster vaccination versus 774 pairs who had received 2 doses; results not available for Delta) and was not reported in any of the other included studies.

Del Aguila-Mejia and others (preprint, described above) evaluated serial intervals when both primary and secondary cases were symptomatic (the number of symptomatic cases used in the analysis was not reported) (4). A mean serial interval of 4.8 days (SD: 3 days) was reported for the Omicron variant and results were similar regardless of the vaccination status of the primary case (see results in Table A.2). The mean serial intervals were shorter for Omicron than for Delta for both vaccinated (Omicron: 4.9 days, SD: 3.1 days; Delta: 5.3 days, SD: 3.1 days; p=0.26) and unvaccinated primary cases (Omicron: mean 4.7 days, SD: 3.1 days; Delta: mean 5.4 days, SD: 3.1 days; p=0.02).

A brief report from the UKHSA infectious disease modelling team estimated the serial intervals for Omicron (11,240 cases) and Delta (12,353 cases) using contact tracing data up to 31 December 2021 (11). A mean serial interval for Omicron of 3.6 days (95% CI: 3.6 to 3.7 days) was reported, which was slightly shorter than for Delta (3.9 days; 95% CI: 3.8 to 3.9 days; p-value for difference not reported) (11). However, a higher variance was observed with the Omicron variant, resulting in a shorter median serial interval than for Delta (3.1 to 3.2 days versus 3.5 to 3.6 days; p-value for difference not reported). These findings are likely to underestimate the serial interval, as cases with incubation period of less than 2 days were removed (to reflect the case definition for contact tracing) and the data does not include negative serial intervals (where the secondary case develops symptoms prior to the primary case).

Contact tracing data from South Korea (3 reports) suggests even shorter serial intervals for Omicron, with means of 2.2 days (95% CrI: 1.5 to 3.0 days) (3), 2.8 days (range: 1 to 7

days) (2), and 2.9 days (SD: 1.6) (1) depending on the number of cases included (overlapping samples).

Infectious period

Five studies reported on outcomes related to the infectious period, including transmission period, duration of viral proliferation and duration of infection (4, 8, 10, 12, 14). Four of these compared Omicron to Delta (4, 8, 12, 14), and one epidemiological investigation just reported on Omicron (10). Four studies reported on the trajectory of the virus by measuring viral load over time, using Ct values as a proxy for infectiousness (threshold of 30) (8, 10, 12, 14). The infectious period is more challenging to measure than the incubation period or the serial interval, as most infected cases will only be aware of infection after the infectious period has already begun. Additionally, there are limitations to inferring infectiousness from measures of viral load.

Del Aguila-Mejia and others (preprint, described above) reported on transmission period for all secondary cases (symptomatic and asymptomatic) (4). A mean transmission period of 0.5 days (SD: 2.3 days, median: 0 days) for the Omicron variant was found. Findings were similar regardless of whether the primary case was vaccinated or not. This was shorter than for the Delta variant (mean difference: -0.3 day; 95% CI: -0.56 to -0.02 day; p=0.04), which may suggest a higher rate of presymptomatic transmission for Omicron cases.

A cohort study conducted by Young and others in Singapore in December 2021 examined viral trajectories among 174 fully vaccinated age-matched patients infected with the Omicron and Delta variants (14). Ct values at diagnosis were higher for cases with Omicron (median: 20.7, interquartile range [IQR]: 17.9 to 28.5) than cases with Delta (median: 19.1, IQR: 15.4 to 21.1; p<0.001), suggesting a lower viral load. Both variants had similar overall trajectories, with an increase in viral load over the first 3 days of illness, a peak on day 3 and a faster rate of decline from day 8. Graphical data suggests Ct values rose above 30 (that is, no longer considered infectious) later in the course of the illness for Delta than for Omicron, although corresponding statistical results were not available. Viral culture was attempted from 14 Omicron patients (22 samples). Negative viral cultures were observed starting from day 2 of illness, with no positive cultures after day 5.

Another cohort study (preprint) also examined viral trajectories among 419 Omicron cases and 660 Delta cases in the US in November and December 2021 (12). No significant differences were observed in mean and median Ct values or viral trajectories of participants with Omicron and Delta, regardless of vaccination status (statistical results not reported, only presented graphically). Viral culture was also attempted from 219 Omicron cases and 153 Delta cases. Recovery of infectious virus occurred at a higher rate for Delta samples (78%) than Omicron samples (61%; p=0.0006) although there were no significant differences in when positive or negative samples were collected between Omicron and

Delta, regardless of vaccination status (statistical results not reported, only presented graphically).

Hay and others (preprint) reported on duration of viral proliferation and duration of infection based on data from 84 Omicron cases and 55 Delta cases from a surveillance programme of the National Basketball Association (NBA) in the US, in which 537 individuals affiliated with the NBA were tested daily (8). A slightly shorter duration of viral proliferation was reported for Omicron (mean 4.5 days; 95% CrI: 3.6 to 5.5 days; p-value not reported; range: 1.1 to 9.7 days) compared to Delta (mean: 4.7 days, other statistics not reported). The duration of infection was one day shorter for Omicron (mean: 9.9 days; 95% CrI: 8.8 to 10.9 days; p-value not reported) than for Delta (mean: 10.9 days; 95% CrI: 9.4 to 12.4 days; p-value not reported). Viral trajectories were heterogeneous for the Omicron variant although all cases had Ct values over 30 by day 11, suggesting they were no longer infectious. Vaccination status of participants, which may have impacted the results, was not provided (authors commented that further analysis is ongoing).

An epidemiological investigation of 21 Omicron cases in Japan (19 vaccinated) also reported on the viral trajectory for Omicron, and observed peak viral loads between 3 and 6 days after diagnosis, with a marked decrease after day 6 (10). No infectious virus was detected after 10 days (viral culture), suggesting that for these Omicron cases viral shedding was likely to have stopped 10 days after detection. Similar trends were observed in symptomatic cases (n= 17, all mild cases) whereas for the 4 asymptomatic cases no infectious virus was isolated after day 6.

Limitations

The Omicron variant was declared as a variant of concern on 26 November 2021 and therefore the evidence on this variant remains limited. Six of the 14 included reports were preprints and may be subject to change. Apart from a UK report, the included studies had relatively few participants and may not represent the general population. Most of the evidence is based on symptomatic cases. Only 3 studies reported the results by vaccination or household status, although the numbers of cases included in the analyses were not always reported or only presented graphically. There were also differences between studies, including in case identification (SGTF versus genomic sequencing) and outcome definitions (especially in relation to infectious period), which may have impacted the results.

This summary was produced at pace following streamlined methodologies. The search results were screened by only one reviewer, and the narrative summary were conducted by one reviewer and checked by another. The studies were not formally extracted into an evidence table nor assessed for risk of bias.

Conclusions

Reported mean incubation period for the Omicron variant ranged from 2.5 to 4.3 days and the median was 3 to 4 days, with a maximum range of 0 to 8 days. Reported mean serial interval ranged from 2.2 to 4.9 days, and the median ranged from 3 to 4 days. Findings suggest that the incubation period and serial interval for the Omicron variant may be shorter than for the Delta variant (differences of 0.2 to 1.2 days for the incubation period and of 0.1 to 0.8 day for the serial interval). Differences did not always reach statistical significance, however this could be the result of a lack of precision rather than a lack of effect. Variation in results may also be partly explained by differences in vaccination status and/or whether transmission occurred within household settings.

The evidence for infectious period was more limited and there were differences in how outcomes were reported, which limits our ability to draw conclusions. Three studies aimed to report on duration of infectiousness in Omicron cases using Ct values as a proxy or using viral culture tests, but findings were heterogeneous with results ranging from 5 to 11 days. One of these studies reported a duration of infection of 9.9 days for Omicron (one day less than for Delta) and a duration of viral proliferation of 4.5 days for Omicron (0.2 day shorter than for Delta). Another study reported a viral peak at day 3 for both Omicron and Delta and a third study found that viral peak for Omicron was reached between 3 and 6 days of illness. Evidence from one study suggests that the transmission period was of 0.5 days for the Omicron variant (0.3 days shorter than for Delta).

This evidence briefing was completed on 8 March 2022.

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Annexe A. Data extraction tables

Table A.1. Summary of studies reporting on incubation period for the Omicron variant

The following acronyms are used: CrI = credible interval; SD = standard deviation; q1 = quartile 1; q3 = quartile 3; NA = not available; IQR = interquartile range; CI = confidence interval
Blank cells specify that outcomes have not been assessed

Study	Participants	Vaccination status	Incubation period (days) all	Incubation period (days) [vaccinated]	Incubation period (days) [unvaccinated]
Backer and others (5)	• 258 Omicron pairs • 255 Delta pairs	Not reported	Mean (95% CrI) • Omicron: 2.8 (2.5 to 3.2) • Delta: 4.0 (3.6 to 4.4)		
Del Aguila-Mejia and others (4) [A]	Secondary cases • 455 Omicron • 2,201 Delta	Primary cases unvaccinated • 73% Omicron • 38% Delta	Mean (SD); median (q1, q3) • Omicron: 3.1 (2.6); 3 (1, 4) • Delta: 3.3 (2.7); 3 (1, 5); p=0.29	Mean (SD); median (q1, q3) • Omicron (n=NA): 3 (2.2); 3 (2, 4) • Delta (n=NA): 3.4 (2.9); NA; p=0.16	Mean (SD); median (q1, q3) • Omicron (n=NA): 3.1 (2.7); 3 (1, 4) • Delta (n=NA): 3.3 (2.6); NA; p=0.46
Brandal and others (6)	81 Omicron cases	96% fully vaccinated	Median 3; IQR 3 to 4; range 0 to 8		
Helmsdal and others (7)	22 Omicron cases	100% fully vaccinated	Mean 3.2; 95% CI 2.9 to 3.6; range 2 to 6		
Jansen and others (9)	6 Omicron cases	5 unvaccinated	Median 3.04; range 1.38 to 3.13		
Lee and others (2) [B] Song and others (1) [B]	80 Omicron cases 24 Omicron cases	60% unvaccinated Not reported	Mean 4.2; range 2 to 8 Mean 2.5 to 4.3; median 3 to 4		

[A] Incubation period is calculated for secondary cases, and analysis is stratified according to the vaccination status of the primary case.
[B] Three reports from contact tracing data from South Korea with overlapping samples.

Table A.2. Summary of studies reporting on serial interval for the Omicron variant

The following acronyms are used: CrI = credible interval; SD = standard deviation; q1 = quartile 1; q3 = quartile 3; NA = not available; IQR = interquartile range; CI = confidence interval

Blank cells specify that outcomes have not been assessed

Study	Participants	Vaccination	Serial interval (days) all	Serial interval (days) [subgroup 1]	Serial interval (days) [subgroup 2]
Backer and others (5) [C]	13 to 19 December 2021 • 235 Omicron pairs • 919 Delta pairs	Not reported		Mean - both vaccinated • Omicron (n=NA): 3.49 • Delta (n=NA): 4.00; p=0.037 Mean - within household • Omicron (n=164): 3.5 (SD 2.4) • Delta (n=761): 4.1 (SD 2.8); p=0.0026	Mean - both unvaccinated • Omicron (n=NA): 3.07 • Delta (n=NA): 3.86; p=0.12 Mean - between household • Omicron (n=71): 3.3 (SD 2.4) • Delta (n=158): 3.5 (SD 2.8); p=0.24
	20 to 26 December 2021 • 673 Omicron pairs • 702 Delta pairs			Mean - within household • Omicron (n=480): 3.0 (SD 2.3) • Delta (n=572): 3.2 (SD 2.6); p=0.084	Mean - between household • Omicron (n=193): 2.87 • Delta (n=130): 2.94; p=0.24
Del Aguila-Mejia and others (4) [A]	• 1,077 Omicron cases • 3,909 Delta cases	Primary cases unvaccinated: • 73% Omicron • 38% Delta	Mean (SD); median (q1, q3) • Omicron: 4.8 (3); 4 (3, 6) • Delta: 5.4 (3.1); 5 (3, 8); p=0.008	Mean (SD); median (q1, q3) - vaccinated • Omicron (n=NA): 4.9 (3.1); NA • Delta (n=NA): 5.3 (3.1); 5 (3, 7); p=0.26	Mean (SD); median (q1, q3) - unvaccinated • Omicron (n=NA): 4.7 (3.1); NA • Delta (n=NA): 5.4 (3.1); 5 (3, 8); p=0.02
Kremer and others (13)	• 2,161 Omicron pairs • 334 Delta pairs	Not reported	Mean (95% CrI) • Omicron: 2.75 (2.65 to 2.86) • Delta: 3.00 (2.73 to 3.26); p=0.019	Mean (95% CrI) - both vaccinated • Omicron (n=774): 2.63 (2.46 to 2.81) • Delta (n=97): 3.38 (2.89 to 3.88); p=0.004 Mean (95% CrI) - within household • Omicron (n=1,412): 2.80 (2.67 to 2.93) • Delta (n=278): 3.04 (2.75 to 3.33); p=0.034	Mean (95% CrI) - both unvaccinated • Omicron (n=346): 2.69 (2.40 to 2.98) • Delta (n=61): 2.54 (1.96 to 3.12); p=0.931 Mean (95% CrI) - between household • Omicron (n=672): 2.72 (2.53 to 2.90) • Delta (n=50): 2.78 (2.00 to 3.56); p=0.686
UKHSA (11)	• 1,240 Omicron cases • 2,353 Delta cases	Not reported	Mean (95% CI); median • Omicron: 3.64 (3.6 to 3.68); 3.1 to 3.2 • Delta: 3.87 (3.84 to 3.9); 3.5 to 3.6		
Kim and others (3) [B]	18 Omicron pairs	Not reported	Mean 2.2 days; 95% CrI 1.5 to 3.0		
Lee and others (2) [B]	80 Omicron cases	40% vaccinated	Mean 2.8 days; range 1 to 7		
Song and others (1) [B]	12 Omicron pairs	Not reported	Mean 2.9; SD 1.6; median 3.0		

[A] Incubation period is calculated for secondary cases, and analysis is stratified according to the vaccination status of the primary case.
[B] Three reports from contact tracing data from South Korea with overlapping samples.
[C] Serial intervals for pairs where only one case (primary or secondary) was vaccinated are not provided in table.

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