New Zealand Government

MINISTRY OF HEALTH
MANATŪ HAUORA

COVID-19

Science and Insights

COVID-19 Delta variant secondary attack rates, August–October 2021

19 October 2021

Key points

- The overall secondary attack rate (SAR) among the 41,440 contacts was 2.6% (95% CI 2.4–2.7%).
- SARs were 45.6% for household, 11.1% for close plus, 0.3% for close and 0.0% for casual plus.
- Among exposure settings outside of households, those with SARs above 0.5% were private gatherings (10.4%), non-household accommodation (0.8%), and work-related (0.6%).
- The SAR was 1.4% for transmission from fully vaccinated index cases compared with 2.7% from unvaccinated index cases (no adjustment made for vaccination status of contacts). The SAR was 0.9% within vaccinated contacts and 3.1%, within unvaccinated contacts (no adjustment made for vaccination status of index cases).
- Data stratified by vaccination status are shown for information only. A full analysis of vaccine effectiveness is to follow, which will account for setting and for vaccination status of both index cases and their contacts

Background

The secondary attack rates, so the percent of contacts of an index case that become a secondary case, can be a more useful measure of transmission risk than the reproduction number, which is heavily dependent on the number of contacts. Studies internationally have shown the highest risk is within household settings; the most recent SAR estimate of 45.0% was reported in England (Miller, et al.). Previous reviews had pooled estimates of 16.6% (Madewell, Yang, Longini, Halloran, & Dean, 2020) and 21.1% (Thompson, et al., 2021), however, these reviews were both based on pre-delta studies. Elevated risk has also been reported for private gatherings especially, as well as travel healthcare (Thompson, et al., 2021), and indoor sports exposures (Dougherty, Mannell, Naqvi, Matson, & Stone, 2021); whereas evidence suggests outdoor transmission is negligible (Bulfone, Malekinejad, Rutherford, & Razani, 2021). However, these SARs may not equate well to the risks for transmission in New Zealand's current Delta outbreak given the differences in the background populations and transmission suppression strategies. Therefore, we have estimated the SARs for this current outbreak by contact risk type, setting, vaccination status and demographic characteristics.

This is the exhibit marked **"IT-4"** referred to in the annexed Affidavit of **DR GEORGE IAN TOWN** affirmed at **Wellington** this 4 day of **May** **2022** before me:

Sara Frances Lomaloma
Solicitor
Wellington

Solicitor of the High Court of New Zealand

Methods

Population

The primary data source was the National Contact Tracing Solution (NCTS) cohort. The NCTS was stood up in April 2020 to provide secure management of cases and contacts during New Zealand's first COVID-19 wave. In response to a new positive test (by nasopharyngeal swab during the period this analysis covers), details of the case were recorded in the NCTS, and interviews and contact tracing initiated. This includes contacting those directly reported by case interview, and those self-referred via calling Healthline as they received a notification from the Covid App or had self-identified risk from the published locations of interest. For each exposure event, contact tracing information included (but was not limited to): the index case; event setting details; event start, end time and date; exposure notes; details of contacts; contacts level of exposure; follow up notes on contacts (up to 14 days post-exposure); and infection status of contacts. Where a contact was reviewed and found not to have exposure risk (for example they left the location of interest before arrival of the index case) they were excluded from the data extract. A unique National Health Index (NHI) number was recorded for all cases and almost all contacts. NHI records provided demographic details and were used to link data from EpiSurv to confirm case details. Linking via NHI also provided vaccination dates from the COVID-19 vaccination register.

Data were linked and extracted at 3pm on 11/10/21.

Exclusion criteria

Exclusion criteria were applied in the following sequence: 1) exposure events (and associated contacts) that started less than 14 days before the data extract; 2) cases with no identified onwards exposure events; 3) for contacts with multiple exposure events, additional events considered lower risk were removed; and (4) any remaining contacts with exposure risk classified as casual only.

Variables

Event data included index infection date (exposure date); exposure event start and end date/time, exposure risk classification (contact type); event setting; and contact tracing status.

Exposure risk (contact type) was defined in mutually exclusive groups as: casual (anyone who self-identifies as being at a location of interest or receives a NZ COVID Tracer app notification); casual plus (as for casual but with evidence of higher risk); close (likely to have been within two metres of a case for 15 minutes or more); close plus (as for close but with evidence of higher risk); or household (those residing or having spent at least one night in the household during the exposure event). Other information of contact risk classifications and their respective isolation and testing recommendations can be found on the Ministry of Health website (Health, n.d.).

Exposure risk (contact type) was defined in mutually exclusive groups as: public transport (including buses, trains and flights); outdoor gathering & exercise (such as sports/team events, going to a park or for a run); indoor event (such as attendance at a large event such as a university call or a conference); food, alcohol, service station & retail (includes all shopping related setting such as supermarkets, trade stores and smaller outlets such as fashion retail and dairies); education (all settings related to primary, secondary, and tertiary

education, including accommodation); indoor exercise & personal care (includes gymnasiums, indoor sports, and close contact personal care such as hairdressers and beauty salons); healthcare (includes primary, secondary and tertiary health services, and related stetting, such as ambulance transport); hospitality & convenience food (includes bars, restaurants, convenience food, which may be eat in or take away, such as McDonalds, Subway and bakeries); work (any work setting where staff members have been exposed); private gathering (including family gatherings, household visits and shared private transport); accommodation (excludes household and education hostels, includes motels and lodges); or household (with definition as above). For index cases and contacts demographic information included: gender (male or female); age (calculated from date of birth and exposure event date, and then grouped as 0–19, 20–30, 40–59 or >=60 years); prioritised ethnicity (Māori, Pacific, Asian or other); and deprivation (low – deciles 1–3, medium – deciles 4–7 or high – deciles 8–10). Index cases were defined as vaccinated if a second vaccination was recorded 14 days before infection; for contacts this was 14 days before exposure event date.

Analysis

Total source cases, contacts and secondary cases were calculated; and secondary attack rates (SAR) with 95% confidence intervals (CIs) calculated as secondary cases/contacts*100. SARs were calculated overall, and by contact risk, interaction setting and vaccination status (overall and by contact risk). SARs were calculated by demographic and vaccination status restricted to contact risk or interactions settings with >5% SAR; and a univariable analysis was conducted to estimate relative risk (RR) using Poisson regression. An initial multivariable regression to estimate adjusted relative risk (ARR) was modelled including all available demographic and vaccination variables. Those not associated were removed stepwise until only statistically significant ($P<0.05$) variables remained. All variables removed from the model were then re-checked individually to re-include if statistically significant following other non-significant variables having been removed from the model.

Results and interpretation

Eligibility

As of 11am 11/10/21 there have been 44,912 records identified, 3,472 were ineligible: 2,304 sources were exposed less than 14 days ago (so may still be linked to contacts/cases). There were 860 cases excluded who did not have any identified contacts; 603 contacts were duplicated as they had multiple exposure events; and five contacts were casual.

Characteristics of the NCTS cohort

There were 697 index cases and 41,440 contacts eligible for the analysis. The majority of contacts were classified as having close contact; and the most common exposure setting were education and retail (See Table 1). Just over half of index cases were of Pacific ethnicity. Pacific Peoples were also over-represented among contacts (22.4%) compared with the Auckland general population (15%). Mean age in the index cases was 26.6 and in contacts was 32.1 years. The prevalence of vaccination in index cases was low (7%), but substantially higher amongst all contacts (22.6%). The mean age of vaccinated index cases was 30.4 compared with 26.3 years in those unvaccinated. Among contacts this was 30.1 and 25.5 years, respectively.

Table 1: Characteristics of index cases and contacts, August–October 2021

	Index cases		Contacts	
Total	**697**		**41140**	
Contact risk type, n (%)				
Casual plus	–		4052	(9.8)
Close	–		34733	(84.4)
Close plus	–		379	(0.9)
Household	–		1976	(4.8)
Exposure setting, n (%)				
Household			1976	(4.8)
Private gathering	–		691	(1.7)
Other indoor events/gatherings	–		522	(1.3)
Indoor exercise & personal care	–		5303	(12.9)
Other accommodation	–		637	(1.5)
Healthcare	–		1659	(4.0)
Public transport	–		1619	(3.9)
Hospitality & convenience food	–		2705	(6.6)
Food, alcohol, service station & retail	–		8997	(21.9)
Education	–		11798	(28.7)
Work-related	–		4414	(10.7)
Outdoor gathering & exercise	–		747	(1.8)
Missing			*72*	*(0.2)*
Gender, n (%)				
Male	321	(46.1)	18214	(44.3)
Female	374	(53.7)	21813	(53.0)
Missing	*2*	*(0.3)*	*1113*	*(2.7)*
Age (years), mean (sd)	26.6	(14.7)	32.1	(17.6)
Age group (years), n (%)				
0–19	148	(21.2)	13418	(32.6)
20–39	295	(42.3)	14177	(34.5)
40–59	191	(27.4)	9235	(22.4)
60+	43	(6.2)	3253	(7.9)
Missing	*20*	*(2.9)*	*1057*	*(2.6)*
Priortised ethnicity, n (%)				
Māori	159	(22.8)	4450	(10.8)
Pacific	369	(52.9)	9196	(22.4)
Asian	61	(8.8)	9672	(23.5)
Other	103	(14.8)	16491	(40.1)
Missing	*5*	*(0.7)*	*1331*	*(3.2)*

Deprivation, n (%)				
Low	50	(7.2)	9174	(22.3)
Medium	157	(22.5)	14698	(35.7)
High	444	(63.7)	15124	(36.8)
Missing	*46*	*(6.6)*	*2144*	*(5.2)*
Fully vaccinated, n (%)				
Yes	49	(7.0)	9290	(22.6)
No	646	(92.7)	30793	(74.8)
Missing	*2*	*(0.3)*	*1057*	*(2.6)*

Among 697 index cases, the median number of contacts per case was 1 (range 1 – 3,549), and the median number of secondary cases was 1 (range 0-13). The average number of secondary cases, the R_{eff}, was 1.5; there were four source cases who infected 10 or more of their contacts, these cases were all aged 20–39 years. Three of these source cases infected contacts across two or more different settings; however, most cases were in households contacts, and 33 of their 38 household contacts became secondary cases.

Secondary attack rates overall, by contact event risk and setting

There were 1,051 secondary cases among the 41,440 contacts (SAR 2.6%, 95% CI 2.4–2.7%).

Among types of index case-contact interactions, households gave rise to the majority of secondary cases and had the highest SAR: 45.6% (95% CI 42.7–48.7%), close plus had the next highest SAR (11.1%) (see Table 2). Contacts defined as close had a SAR of 0.3%, but as almost 90% of all contacts were defined as close, this risk group gave rise to 2.5 times more secondary cases than the close plus contacts.

Settings other than household giving rise to the higher SARs were private gatherings (10.4%, 95% CI 8.0–13.1%), non-household accommodation exposures (0.8%) and work-related (0.6%). Hospitality/convenience food, healthcare, indoor sports/exercise, education, and food supply/other retails type settings were all associated with secondary cases, but the SARs were less than 0.5%.

Table 2: Secondary cases, contacts and secondary attack rates for COVID-19 Delta infection by interaction risks, August–October 2021

	Secondary cases, n	Contacts, N	SAR %	(95% CI)
Total	**1,051**	**40,089**	**2.6**	**(2.4–2.7)**
Contact risk type				
Casual plus	0	4052	0.0	(0.0–0.1)
Close	107	34733	0.3	(0.3–0.4)
Close plus	42	379	11.1	(8.0–15.0)
Household	902	1976	45.6	(42.7–48.7)
Settings (excluding household)*				
Public transport	0	1619	0	(0.0–0.2)
Outdoor gathering & exercise	0	747	0	(0.0–0.5)
Indoor event	0	522	0	(0.0–0.7)

Food, alcohol, service station & retail	2	8997	0	(0.0–0.1)
Education	14	11798	0.1	(0.1–0.2)
Indoor exercise & sport	4	1659	0.2	(0.1–0.6)
Healthcare	9	5303	0.2	(0.1–0.3)
Hospitality & convenience food	11	2705	0.4	(0.2–0.7)
Work	28	4414	0.6	(0.4–0.9)
Accommodation	5	637	0.8	(0.3–1.8)
Private gathering	72	691	10.4	(8.2–13.1)

Extracted from the NCTS and EpiSurv databases on 11am 11/10/21

* *These data should be considered cautiously as over half of the categorisation of contacts into settings based on interview notes was done by Science and Intel and has not been internally quality controlled, or peer reviewed by NCTS experts.*

Secondary attack rates by vaccination status overall, and by contact event risk

Data stratified by vaccination status are shown for information only. A full analysis of vaccine effectiveness is to follow, which will account for setting and for vaccination status of both index cases and their contacts (not performed in this analysis).

However, in this initial analysis, vaccination status did appear to have an impact on SARs, but this might vary by setting. If an index case was fully vaccinated 14 or more days before causing their (first) exposure event, the SAR was 1.4% (95% CI 1.0–1.8%) compared with 2.7% (95% CI 2.6–2.9%) in those not fully vaccinated. In fully vaccinated contacts, the SAR reduced to 0.9% (95% CI 0.7–1.1%) from 3.1% (95% CI 2.9-3.3%) (see Table 3). These Vaccine-related SARs were not stratified by vaccine status in the contacts and in the index cases, respectively.

Among the 41 secondary cases arising from a fully vaccinated index case, 32 of these were in non-vaccinated contacts, and nine were in fully vaccinated contacts. All nine secondary infections from a fully vaccinated index to fully vaccinated contact arose in household settings.

Table 3: Secondary cases, contacts, and secondary attack rates for COVID-19 Delta infection by vaccination status, August–October 2021

	Secondary cases, n	Contacts, N	SAR %	(95% CI)
Total for index vaccination				
Fully vaccinated	41	3023	1.4	(1.0–1.8)
Not fully vaccinated	1010	37060	2.7	(2.6–2.9)
Among close and close plus contacts				
Fully vaccinated	2	2398	0.1	(0.0–0.3)
Not fully vaccinated	147	31766	0.5	(0.4–0.5)
Among household contacts				
Fully vaccinated	39	125	31.2	(22.2–42.7)
Not fully vaccinated	863	1847	46.7	(43.7–49.9)
Total for contact vaccination				
Fully vaccinated	84	9290	0.9	(0.7–1.1)

Not fully vaccinated	967	30793	3.1	(2.9–3.3)
Among close and close plus contacts				
Fully vaccinated	13	7491	0.2	(0.1–0.3)
Not fully vaccinated	136	26673	0.5	(0.4–0.6)
Among household contacts				
Fully vaccinated	71	355	20.0	(15.6–25.2)
Not fully vaccinated	831	1617	51.4	(48.0–55.0)

Extracted from the NCTS and EpiSurv databases, and the COVID-19 vaccination register on 11am 11/10/21

Secondary attack rates and relative risks by demographic and vaccination factors among contacts with high-risk exposures types and/or settings

Among those contact types and settings with >5% SAR (household, close plus and private gatherings), the overall SAR was 34.4% (95% CI 32.3–36.6%). SARs and crude relative risks were examined by demographic factors (gender, age group, ethnicity, and deprivation for both the index cases and contacts), and vaccination in index cases and contacts. Elevated risk (SAR>40%) was seen by age group (index cases aged 40–59 and contacts aged 0–19 years), ethnicity (Pacifica index cases and contacts), and among unvaccinated contacts; all of which were statistically significant when independently examining the relative risks (see Appendix Table 4).

However, when considering all demographic and vaccination factors that were statistically significant ($p<0.05$; gender of contact, age group of index and of contact, ethnicity of contact and vaccination status of contacts) simultaneously, and adjusting for contact risk type, the patterns of risk were modified. There was no longer any effect of index cases ethnicity, and it was not included in the adjusted estimates, the relative risk for contacts of Pacifica ethnicity (compared with others) decreased from 1.81 to 1.48, whereas the increased risk associated with increasing age of index cases became more apparent. The reduction in risk of 62% for those fully vaccinated was similar to the unadjusted estimate. A sensitivity analysis of this model limited to household interactions only was undertaken given the SARs for household suggest a very different levels or risk, however, no substantial differences were detected.

The differences between the independently examined risks and the risk when considered simultaneously likely reflect complex interactions between ethnicity, age and intensity of contact. The differences between the independently examined risks and the risk when considered simultaneously likely reflect complex interactions between ethnicity, age and intensity of contact.

A full analysis of vaccine effectiveness has not yet been performed. It should also be noted that vaccination was uncommon in this cohort rendering estimates with wide confidence intervals, and that there are many residual confounders that cannot be accounted for.

Caveats and Limitations for interpreting findings

These data will not match NCTS reports. Unlinked cases that caused exposure events are included, and these data were limited to exposure events that occurred 14 or more days ago. SARs are measured among susceptible contacts, so there is an argument for excluding vaccinated contacts, though with the low vaccination rates in the NCTS cohort, it is unlikely that this would have made a significant difference to any findings. While 8% of all contacts were not reached, only four were close plus or household contacts. Over 70% of contacts not reached were close or casual plus contacts aged less than 40 years old. As only a small

fraction of contacts had no NHI recorded (less than 1% for close plus and household), the resulting missing information on vaccination status and demographics should have little impact on findings.

However, vaccination-related findings should be interpreted with caution. There were few fully vaccinated index cases and contacts on which to base analyses, and interactions were complex. The intensity of exposure and individual factors such as age and co-morbidities will impact on vaccination effectiveness.

There is also likely to be misclassification of NCTS sourced data or missing data given the pressured response-driven collection and recording of information in the NCTS. The most significant identified issues were:

- Just over half of data on settings had not been categorised from the exposure event notes, this was categorised by the COVID-19 Science and Insights Group and has not been quality controlled.
- Contacts in this cohort were managed under a specific exposure. This was determined by a hierarchy that took the highest risk contact classification or the latest exposure if there are more than one event at the same classification. This selected exposure was used to define all contact risk type, setting and time since vaccination in contacts. For contacts with more than one exposure event, the exposure event associated with the most risk or that lead to a secondary case, where applicable, may not have been correctly identified.
- There was no information to confirm transmission from an index to secondary case; the evidence used is based on dates, locations, and intensity of exposure, therefore, it is likely some secondary cases are unlinked cases.
- There was insufficient information about dwellings, for example numbers of occupants, size of the dwelling and ventilation, to further examine the risk in household settings.
- It was not possible to re-check the index infection occurred before contact exposure event.

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Appendix

Table 4: Secondary attack rates and relative risk of secondary COVID-19 Delta infection among index cases with household or close-plus contacts, August–October 2021

	Secondary cases, n	Contacts, N	SAR, %	(95% CI)	Crude RR (95% CI)		Adjusted RR* (95% CI)	
Total	**985**	**2,867**	**34.4**	**(32.2–36.6%)**				
Demographics								
Gender of index case								
Male	443	1339	33.1	(30.1–36.3)	Reference			
Female	542	1492	36.3	(33.3–39.5)	1.10	(0.99–1.22)	–	
Gender of contacts								
Male	485	1459	33.2	(30.3–36.3)	Reference			
Female	500	1368	36.5	(33.4–39.9)	1.10	(0.99–1.22)	1.12	(1.03–1.23)
Age group of index case								
0–19	223	663	33.6	(29.4–38.4)	Reference			
20–39	387	1239	31.2	(28.2–34.5)	0.93	(0.81–1.06)	0.96	(0.85–1.09)
40–59	278	668	41.6	(36.9–46.8)	1.23	(1.07–1.42)	1.34	(1.19–1.52)
60+	63	197	32.0	(24.6–40.9)	0.95	(0.75–1.19)	1.24	(1.02–1.50)
Age group of contacts								
0–19	465	1050	44.3	(40.4–48.5)	Reference			
20–39	297	1011	29.4	(26.1–32.9)	0.66	(0.59–0.75)	0.87	(0.78–0.97)
40–59	177	564	31.4	(26.9–36.4)	0.71	(0.62–0.81)	0.98	(0.85–1.11)
60+	46	206	22.3	(16.3–29.8)	0.50	(0.39–0.66)	0.88	(0.69–1.13)
Ethnicity of index case								
Māori	207	739	28.0	(24.3–32.1)	1.26	(1.00–1.59)	–	
Pacific	634	1496	42.4	(39.1–45.8)	1.91	(1.55–2.35)	–	
Asian	65	272	23.9	(18.4–30.5)	1.08	(0.81–1.44)	–	