Pacific COVID-19 Intelligence Gathering and Analysis Project: Evaluation of the August 2020 outbreak

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Purpose

This paper reports findings from the quantitative arm of the Pacific COVID-19 Intelligence Gathering and Analysis Project. It provides an overview of the methods used, the findings from the data analysis, and recommendations for improving data collection and reporting, particularly from a Pacific health equity perspective.

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Summary

Background The first major outbreak after the elimination of COVID-19 in Aotearoa New Zealand occurred in the Auckland region in August 2020, while the borders were still closed. While Pacific people make up approximately 15 percent of Auckland's population, more than two-thirds of COVID-19 cases during this outbreak were of Pacific ethnicity. We investigated the characteristics and outcomes of Pacific COVID-19 cases, the pattern of spread of the virus to Pacific contacts, and the effectiveness of contact tracing for Pacific people, compared with other ethnic groups.

Methods We extracted non-identifiable individual-level data relating to confirmed cases and contacts from the Episurv (National Surveillance database) and NCTS (National Contact Tracing Solution) databases for the period August 2020 to March 2021. We identified 194 locally acquired COVID-19 cases and excluded 15 cases that were recorded from February 2021 (as the Ministry of Health had changed the definition for case contacts from February 2021). We examined the demographic characteristics, presenting symptoms, comorbidities and outcomes (including hospitalisation and death), as well as the pattern of spread to contacts (number of contacts of cases, demographic characteristics of contacts, time to reach and isolation of contacts) for the remaining 179 locally acquired cases.

Findings Using prioritised ethnicity (an output approach that prioritises Māori ethnicity), Pacific made up 59% of cases (105 of 179), but 70% of cases (an additional 20 cases) when using total response ethnicity. Most of the Pacific cases were of Samoan ethnicity (76%). The median age of Pacific cases was 30-34 years, and the majority lived in the neighbourhoods classified as 'highly deprived' by the NZDep score. One third of all cases had underlying disease, and Pacific and Māori had high rates of cardiovascular disease and diabetes. Eleven per cent of all cases (22 cases) required hospitalisation, 4% (8 cases) were admitted to ICU and 2% (3 cases) died from COVID-19. Pacific (11 cases) and Māori (10 cases) comprised all but one of the cases admitted to hospital, all ICU admissions (2 Pacific, 6 Māori) and all cases who died from COVID-19 (1 Pacific, 2 Māori).

A total of 2,593 contacts were registered in NCTS and Pacific made up 46% of all contacts (using prioritised ethnicity, which was the only form of ethnicity output available). Twenty-five per cent of Pacific cases had no contacts registered in the database. Significant differences were found in the timeframes for reaching contacts of cases by ethnicity. This timeframe was highest for Māori (8.0 days) and Pacific (6.9 days) compared with European (4.2 days) and Other (4.0 days). The proportion of contacts reached within 4 days for Pacific contacts was 26% and significantly lower than for all other ethnicities. We were not able to examine the appropriateness of the response in relation to, for example, the composition of households and household characteristics, the use of interpreters and access to social supports, as these data were not available.

Conclusion Our findings confirm the greater health burden that Pacific and Māori face from COVID-19, and the intersection of risk associated with underlying health conditions and socioeconomic deprivation. We also highlight the problems with the quality of data and in particular the recording, analysis and reporting by ethnicity of case and contact data. Whilst improving equity for Māori and meeting our obligations under Te Tiriti o Waitangi should remain a key health system priority, the findings of this research support using total response, rather than prioritised ethnicity for health systems reporting. Total response ethnicity is also consistent with Statistics New Zealand guidelines.

The significant delay in the timeliness of care for Māori and Pacific is a striking finding that shows that even at this early stage of the pandemic in Aotearoa New Zealand, the public health response was inequitable for those at high risk. Furthermore, our findings highlight the need

for the use of indicators that reflect whānau realities and support monitoring of the appropriateness of health, social and cultural interventions so that public health responses to infectious disease outbreaks lead to equity for all population groups, particularly those known to be at high risk of experiencing inequitable care and outcomes.

Introduction

With over 580 million cases and almost 6.5 million deaths worldwide [1] to date, COVID-19 continues to pose a significant health threat to the world. New Zealand responded to several outbreaks of the virus successfully until December 2021, with the cornerstone of the response being widespread testing and rapid case management and contact tracing.

New Zealand experienced significant outbreaks of COVID-19 in March 2020 and August 2020, with vaccinations commencing in March 2021. The first case of the Omicron variant was detected in New Zealand on 16 December 2021 in managed isolation, but widespread community transmission was not recorded until late February 2022.

Before vaccinations were available, mitigation of the spread of SARS-CoV-2 largely depended on nonpharmaceutical interventions, such as physical distancing, hand hygiene, mask wearing, isolation and quarantine [2]. During the first wave, the NZ Government recognised that early contact tracing was key to containing the further spread of COVID-19 [3].

The Ministry of Health developed a comprehensive approach to contact tracing (NCTS) to ensure that the contact tracing system was fit for purpose. At the same time, the Ministry of Health commissioned a rapid Audit of Contact Tracing for COVID-19 [4]. The audit recommendations included that the Ministry of Health should develop a system to monitor the case-isolation and contact tracing process from end-to-end. Measuring performance indicators to drive improvement was considered an urgent priority. One of the targets identified was to quarantine 80% of contacts within 4 days of the onset of disease in a case.

Following (and preferentially, during) outbreaks, it is important to review the available data to assess the most affected population groups and ensure our systems are *effective and equitable*. As COVID-19 has emerged and continues to evolve as a health threat, timely analysis and interpretation of data are crucial in enabling us to improve our systems for managing current and future outbreaks of infectious diseases. The results also have implications for the wider health system, given the commitment to equity of health service access, quality and related outcomes for the reformed health system [5].

An analysis of New Zealand's first wave of COVID-19 in March 2020 showed that although Pacific people had a lower risk of contracting the virus than NZ Europeans, they were twice as likely to experience a severe outcome (hospitalisation). Pacific people during the first wave were also significantly more likely than other groups to have a locally acquired infection (rather than imported or import-related infection, as had been the case for Europeans) [6].

This finding, together with data from previous infectious disease outbreaks (e.g., H1N1 in 2009, mumps in 2017, measles in 2019), suggests that once COVID-19 is circulating in the community, Pacific communities are at very high risk of contracting the virus and subsequently experiencing adverse effects [7], [8], [9].

This phenomenon was demonstrated in New Zealand's second significant wave of COVID-19: the Auckland outbreak in August 2020. Although Pacific people make up approximately 15 per cent of Auckland's population, approximately two-thirds of COVID-19 cases during this outbreak were of Pacific ethnicity. It is therefore crucial, in order to protect the whole population, that our systems and public health services are rapidly responsive to the needs of Pacific people, families and communities.

Aim of the quantitative arm of the research

To examine and compare the characteristics of Pacific (and non-Pacific) COVID-19 cases and contacts, the public health response to case notification, and the impact of the COVID-19 outbreak on Pacific people and their families/households during the August 2020 outbreak.

Methods

Non-identifiable data relating to confirmed cases of COVID-19 were obtained from EpiSurv, and the National Contract Tracing Solution (NCTS) for the period between August 2020 and March 2021. This period included two major outbreaks of COVID-19 in New Zealand, the August 2020 outbreak and the February 2021 to March 2021 (Papatoetoe) outbreak.

These data were used to identify the dynamics of outbreaks within Pacific families and communities, with selected comparisons made against Māori, European and 'Other' ethnicities.

Data sources

EpiSurv is New Zealand's national reporting system for notifiable disease surveillance, managed by ESR on behalf of the Ministry of Health. The system collates notifiable disease information on a real-time basis from Public Health Services, collecting data such as case demographics, clinical features, risk factors and linkages between cases.

The EpiSurv dataset used for this analysis comprised all notified COVID-19 community cases between 7 August 2020 and 28 February 2021.

NCTS is a national data platform created by the Ministry of Health to augment regional Contact Training activity capacity and reliability and collect uniform information on COVID-19 contacts at a national level. The service, which became operational in August 2020, allows Public Health Units (PHUs) to delegate contact tracing to other PHUs and to the Ministry of Health's National Investigation and Tracing Centre.

The data platform to support NCTS holds data on contact tracing, border registration, border staff testing and managed isolation exemptions since August 2020. All contacts are linked to a case. The dataset used comprised all contacts interviewed between 11 August 2020 and 28 February 2021.

The EpiSurv and NCTS datasets were cleaned and analysed using SPSS.

The EpiSurv data allowed for multiple coding of ethnicity. However, NCTS data only reported one ethnic group per person, and data was already prioritised by Māori ethnicity (as per the Ministry of Health Ethnicity Data Protocols for the Health Sector); this meant that we could not identify contacts that were both Māori and Pacific.

Exclusions

The EpiSurv dataset comprised 815 COVID-19 cases identified between 7 August 2020 and 28 February 2021. The 'source' of the cases was classified into four categories: 'imported case', 'import-related case', 'locally acquired, epidemiologically linked' and 'locally acquired case, unknown source'. This study involved analysis of locally acquired cases only (the 194 cases associated with the latter two categories), and therefore the 621 imported and import-related cases were excluded.

Of the 194 locally acquired cases, fifteen cases associated with the Papatoetoe outbreak in February 2021 were excluded from the analysis. The changes in the definition of case contacts that were made by the Ministry of Health during the Papatoetoe outbreak, meant that this dataset was not directly comparable to the earlier August 2020 outbreak. Consequently, this analysis focused on 179 locally acquired cases in the August 2020 outbreak.

Analysis

Case characteristics including age, gender, occupation, presenting symptoms, comorbidities and outcomes (including hospitalisation and death) by ethnicity were derived from EpiSurv data. However, household characteristics and patterns of transmission and their likely source could not be determined because this information was not provided.

Linked EpiSurv and NCTS data on cases and contact tracing were used to examine:

- The time between the date of onset of disease and report date of cases to the Public Health Unit (PHU) by ethnic group.
- The time between the report date of cases to the PHU and the date the case was first isolated by ethnic group.
- For cases that were already in quarantine before onset of disease: the time between date of quarantine and onset of disease by ethnic group.
- The demographic characteristics of the contacts.
- The number and ethnicity of contacts of cases by ethnicity of the case.
- The total duration cases spent in quarantine (if they were quarantined before they became a case) and isolation, by ethnicity.
- The 'exposure events' by which contacts were exposed to their cases, by ethnicity.
- The interval between date of onset of disease in the index case compared to the date of first contact with the contact by ethnicity of the case, and by ethnicity of the case and by ethnicity of contact.
- The time between the date of onset of disease in the index case compared to the date of isolation of the contact by ethnicity of the case.

An overview of our alignment with the analysis plan for this project is attached as Appendix one.

Ethics approval

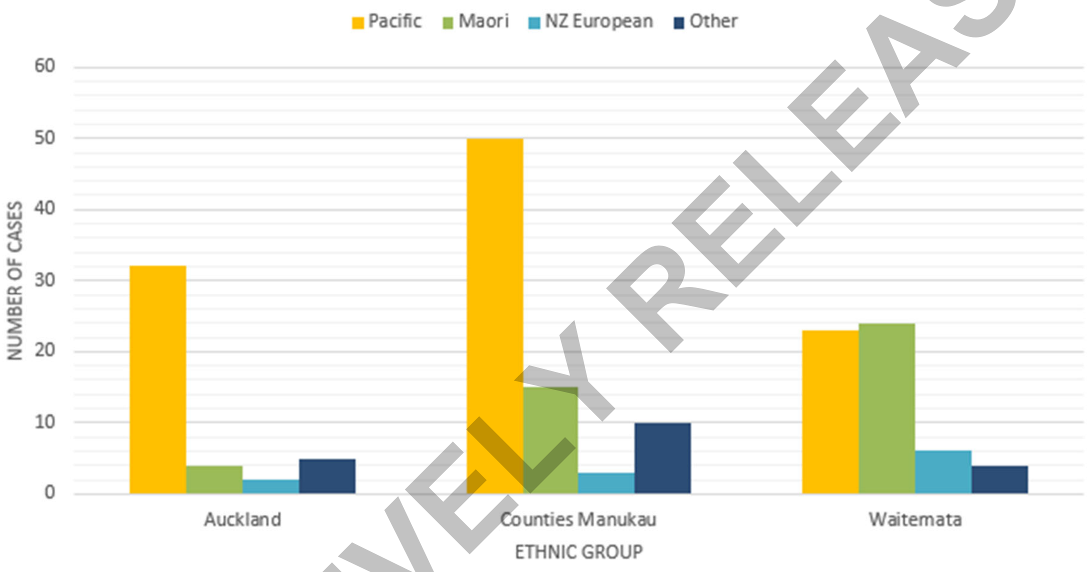
Ethics approval was granted by the University of Auckland Health Research Ethics Committee (AHREC): reference AH22351.

Results

Of the 179 locally acquired cases in the August 2020 outbreak, 140 (78 per cent) were whole genome sequenced and obtained a genome. The viruses causing the August 2020 outbreak were all classified as lineage C.12 [10] and belonged to a single cluster, indicating that the outbreak resulted from a single virus introduction. The root source of the outbreak was never identified.

Ethnic profile: Using the usual health protocols of prioritising Māori ethnicity, the ethnicity profile of the cases was as follows: Pacific (105 or 59 per cent), Māori (44 or 25 per cent), Other (19 or 11 per cent) and New Zealand European/Pakeha (11 or 6 per cent) (see Figure 1).

Figure 1: Number of outbreak cases within the three DHB areas by (Māori prioritised) ethnicity



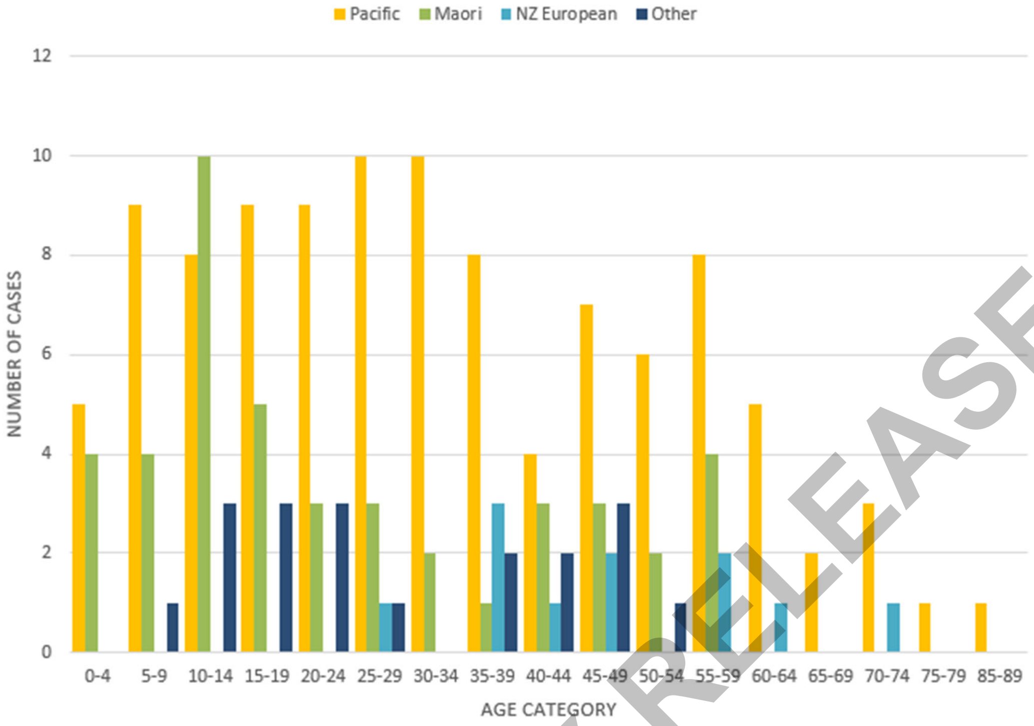
Note: Prioritised Māori ethnicity

Pacific cases that would have been missed through prioritisation of Māori: Of the 44 cases recorded as Māori, 20 (45 per cent) also identified as Pacific. Therefore, if a prioritisation process had not been applied to the ethnicity data, 125 (70 per cent) of cases were identified as Pacific.

The vast majority of the 125 Pacific cases, (101=76 per cent) were of Samoan ethnicity. Because of the small number of cases from non-Samoan Pacific ethnic groups, we could not perform further analyses by Pacific-specific ethnic groups.

Age profile: The age distribution of cases is presented in Figure 2. The key distinguishing characteristic by ethnicity was the median age category of cases: Pacific 30-34 years, Māori 15-19 years, New Zealand European 45-49 years and 'Other' 20-24 years. The group of 20 cases that identified as both Māori and Pacific (not shown separately in Figure 2) had the youngest median age 10-14 years.

Figure 2: Cases by age by ethnicity, Māori prioritised



Note: Prioritised Māori ethnicity

Gender profile: Women made up 53 per cent (94 cases) overall. Women made up half of all Pacific cases, with comparable rates for other ethnic groups except for NZ Europeans, but this group had only very few cases. The gender profile of cases is presented in Table 1.

Table 1: Gender profile of cases by prioritised ethnicity

	Female	Male	Total	Female (%)	Male (%)
Pacific Peoples	55	50	105	52%	48%
European	7	4	11	64%	36%
Māori	22	22	44	50%	50%
Other	10	9	19	53%	47%
Total	94	85	179	53%	48%

Note: Prioritised Māori ethnicity

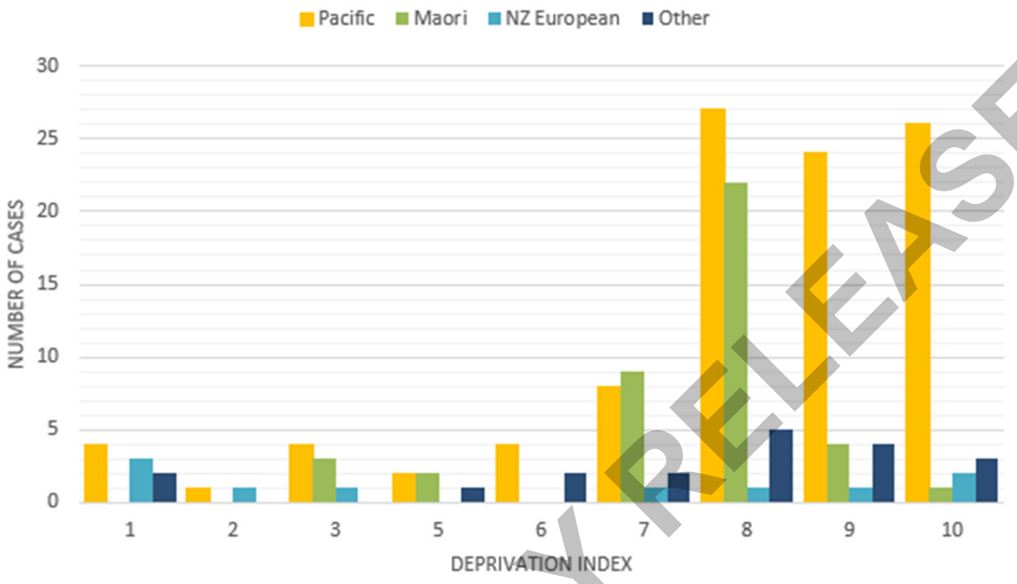
Deprivation index: Pacific cases were disproportionately from areas of higher deprivation, with 71 per cent of cases from deciles 8-10 on the New Zealand Deprivation Index, with a median deprivation decile of 8.5 and mean value of 8.0.

The comparable shares for other ethnicities were as follows: Māori (66 per cent/median of 8.0/mean of 7.4), European (40 per cent/median of 5.0/mean of 5.2) and 'Other' of 69 per cent/median of 8.0/mean of 7.3).

Among the cases in the Auckland August 2020 cluster, there were only eleven cases of NZ Europeans people who were resident in areas of least deprivation. Therefore, comparisons between ethnic groups in relation to deprivation cannot be made in this outbreak.

The distribution of cases by ethnicity by New Zealand Deprivation Index level is presented in Figure 3.

Figure 3: New Zealand Deprivation Index (NZDep2013) by ethnicity



Note: Prioritised Māori ethnicity

Comorbidities and other conditions: Around one in three (31 per cent) cases had a comorbidity or other underlying condition. The proportion of cases with comorbidities or other conditions by ethnicity was as follows: Pacific (37 cases or 35 per cent), Māori (14 cases or 32 per cent), Other (2 cases or 11 per cent) and NZ European (2 cases or 18 per cent). Note that Māori and Pacific cases had a much higher rate of comorbidities than Europeans, despite having a younger age profile.

Among all cases, the most common comorbidities or other underlying conditions were cardiovascular disease (21 cases or 12 per cent) followed by diabetes (17 cases or 10 per cent).

The sixteen Pacific people with cardiovascular disease made up 15 per cent of all Pacific cases. The comparable figures for diabetes were 12 cases (11 per cent). Nine Pacific cases (7 per cent) had both cardiovascular disease and diabetes.

The distribution of comorbidities and other underlying conditions by type and ethnicity are presented in Table 2.

Table 2: Comorbidities or other underlying conditions by ethnicity

	Pacific (105)	Māori (44)	NZ European (11)	Other (19)	Total (179)
Any underlying disease	37 (35%)	14 (32%)	s 9(2)(a) [redacted]	[redacted]	55 (31%)
Cardiovascular disease	16 (15%)	s 9(2)(a) [redacted]	[redacted]	[redacted]	21 (12%)
Diabetes	12 (11%)	s 9(2)(a) [redacted]	[redacted]	[redacted]	17 (10%)
Chronic Lung Disease	s 9(2)(a) [redacted]	[redacted]	[redacted]	[redacted]	6
Neurologic Disease	s 9(2)(a) [redacted]	[redacted]	[redacted]	[redacted]	1
Malignancy	s 9(2)(a) [redacted]	[redacted]	[redacted]	[redacted]	1
Renal Failure	s 9(2)(a) [redacted]	[redacted]	[redacted]	[redacted]	2
Liver Disease	0	0	0	0	0
Immune Deficiency	0	0	0	0	0
Pregnancy	s 9(2)(a) [redacted]	[redacted]	[redacted]	[redacted]	3
Postpartum	0	0	0	0	0
Other Underlying Disease	21	12	s 9(2)(a) [redacted]	[redacted]	36

Note: Prioritised ethnicity was used to output ethnicity data for this table

Occupational profile: Available data on the occupational profile of cases was limited to whether an individual was a health care worker or not. Eight of the cases were healthcare workers. s 9(2)(a) [redacted]

Explanatory note: **The majority ethnicity of the eight healthcare workers were Pacific cases.**

Case identification: Of the 179 cases, 166 (93 per cent) were identified through contact tracing. One case was of a NZ European MIQ staff member discovered by regular screening who had been infected in the community. Twelve cases were discovered because they sought healthcare (seven Pacific, two Māori and three from 'Other' ethnicities).

Patterns of isolation: Of the 179 cases, 157 isolated in a facility, 21 at home and one in a 'other' setting. Home isolation was completed by nine (or 9 per cent) Pacific cases, seven (16 per cent) Māori cases, three (or 27 per cent) NZ Europeans and two (or eleven per cent) from the 'Other' ethnicities.

Symptoms: Of all 179 cases, 143 (80 per cent) were symptomatic when they were reported. Another 18 developed symptoms later, leaving 18 cases asymptomatic.

Information on the distribution of symptoms by type among the 161 cases that had or developed symptoms is presented in Table 3.

Table 3: Symptoms by type by ethnicity

Symptom	Pacific	Māori	NZ Euro	Other	Total
Cough	78 (74%)	28 (64%)	7 (64%)	10 (53%)	123 (69%)
Headache	72 (69%)	29 (66%)	9 (82%)	10 (53%)	121 (68%)
Coryza	60 (58%)	21 (48%)	9 (82%)	13 (69%)	103 (58%)
Weakness	59 (57%)	18 (41%)	10 (91%)	12 63%)	99 (55%)
Fever	59 (57%)	25 (57%)	2 (18%)	8 (42%)	94 (53%)
Anosmia	48 (46%)	23 (52%)	7 (64%)	7 (37%)	85 (48%)
Muscle Pain	51 (49%)	17 (39%)	7 (64%)	7 (37%)	82 (46%)
Sore throat	37 (35%)	19 (43%)	3 (27%)	11 (58%)	70 (39%)
Other symptoms*	28 (27%)	17 (39%)	6 (55%)	9 (47%)	60* (34%)
Shortness of breath	33 (31%)	15 (34%)	5 (46%)	4 (21%)	57 (32%)
Diarrhoea	32 (31%)	11 (25%)	3 (27%)	4 (21%)	50 (28%)
Joint pain	31 (30%)	9 (21%)	3 (27%)	4 (21%)	47 (26%)
Nausea /Vomiting	27 (26%)	8 (18%)	4 (36%)	3 (16%)	42 (24%)
Abdominal pain	22 (21%)	5 (11%)	4 (36%)	1 (5%)	32 (18%)
Irritable/confused	19 (18%)	7 (16%)	2 (18%)	2 (11%)	30 (17%)
Chest pain	11 (11%)	8 (18%)	3 (27%)	4 (21%)	26 (15%)
Abnormalities LungXray	7 (7%)	6 (14%)	0	0	13 (7%)
Other signs	4 (4%)	2 (5%)	0	0	6 (3%)
Abnormalities LungAuscultation	0	2 (5%)	0	0	2 (1%)
Dyspnea	0	2 (5%)	0	0	2 (1%)
Pharyngitis	0	1 (2%)	0	0	1 (1%)
Seizure	0	0	0	0	0
Conjunctivitis	0	0	0	0	0
Coma	0	0	0	0	0

Note: Prioritised ethnicity was used to output ethnicity data for this table

* "Other symptoms are listed as 'free text' and include descriptions such as 'blocked nose', 'loss of taste', 'nasal congestion' and 'sore eyes'

Health service utilisation and outcomes: All except one of the 179 cases were reported in the greater Auckland area; 78 (44 per cent) in Counties Manukau, 57 (32 per cent) in Waitematā, and 43 (24 per cent) in Auckland. The remaining case was reported in the Waikato District Health Board region.

Of the 179 cases:

- Twenty-two were hospitalised. Hospitalisation was required for 11 (11 per cent) of Pacific cases, ten (23 per cent) Māori and one (nine per cent) of Europeans
- Eight cases were treated in ICU: This more intensive treatment was required for two (two per cent) Pacific and six (14 per cent) Māori cases, and
- Three people died, of whom two were Māori, and one was Pacific.

A detailed summary of disease outcome data is presented in Table 4.

Table 4: Outcome of disease

	Total (n=179)	Hospitalised (n=22)	ICU (n=8)	Died (n=3)	OR hospitalisation	aOR hospitalisation	p-value aOR
Sex							
Male	85	14 (17%)	6 (7%)	3	**2.1 (0.8-5.3)**	2.2 (0.7-7.4)	
Female	94	8 (9%)	2 (2%)	0	**ref**	ref	0.190
Age category							
0-24	76	1 (1%)	1 (1%)	0	**ref**	**ref**	0.031
25-39	41	5 (12.2%)	1 (2%)	0	**10.42 (1.2-92.5)**	**13.0 (1.2-146.2)**	
40-59	48	12 (25%)	5 (10%)	2	**25.0 (3.1-199.8)**	**27.0 (2.7-274.0)**	
60-89	14	4 (29%)	1 (7%)	1	**3.0-295.8)**	**39.1 (2.7-568.2)**	
Ethnic group							
Pacific	105	11 (11%)	2 (2%)	1	**ref**	**ref**	0.041
Māori	44	10 (23%)	6 (14%)	2	**2.5 (1.0-6.4)**	**8.0 (1.9-33.8)**	
NZ European	11	1 (9%)	0				
Other	19	0	0				
Diabetes							
Yes	17	10 (59%)	s 9(2)(a)	s 9(2)(a)	17.9 (5.8-55.3)		
No	162	12 (7%)			ref		
CVD							
Yes	21	11 (52%)	s 9(2)(a)	s 9(2)(a)	14.7 (5.1-42.1)		
No	158	11 (7%)			ref		
Underlying Dis							
Yes	55	19 (35%)	7 (13%)	s 9(2)(a)	**21.3 (6.0-76.0)**	**17.0 (3.9-73.7)**	
No	124	s 9(2)(a)			**ref**	**ref**	< 0.001

Only one European and no other ethnicity cases were hospitalised. Multivariable analysis indicated that the risk of hospitalisation was increased in older people and those with underlying disease. Compared to Pacific people, Māori were more likely to be hospitalised.

Onset of disease, report date, quarantine, and isolation: All 179 cases had been isolated, and 79/179 cases were recorded as quarantined before isolation. For 17/79 cases however, the registered onset of disease date was before the quarantine date. These cases must have been misclassified as the definition of quarantine is the separation of healthy people who may have been exposed, compared with isolation, defined as the separation of people who are contagious. The remaining 62 cases were truly quarantined before the onset of disease. The ethnicity of the 62 cases who were quarantined (and the proportion of their respective ethnic group that they represent for all cases) was Pacific 40/105 (38 per cent), Māori 11/44 (25 per cent), NZ European 6/11 (55 per cent), and 'Other' ethnicity 5/19 (26 per cent). This reflects the number of close contacts who went on to become cases, after which they were isolated.

The mean interval between onset of disease and report date to PHU was 3.52 days (n=143, range 1-17 days); the mean interval between report date to PHU and isolation was 0.4 days (n=179, range 1-14 days); the mean interval between quarantine date and onset of disease was 4 days (n=62, range 0-21 days) and the mean duration people spent in quarantine/isolation was 16 days (n=179, range 0-50).

Figure 4 to Figure 7 provide results for these different time intervals in days by ethnicity. No statistically significant differences between ethnicities were found in the intervals studied.

Figure 4: Number of days between the onset of disease and report date to PHU, by ethnicity (n=143)

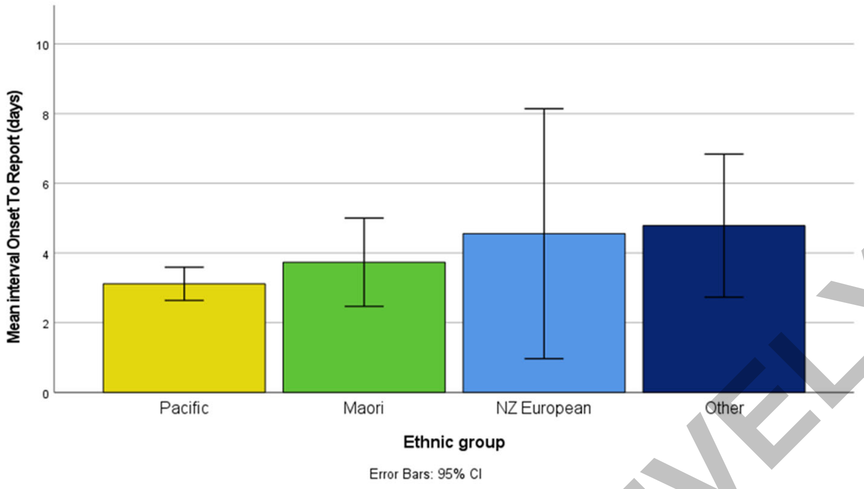


Figure 5: Number of days between report date to PHU and isolation (n = 179)

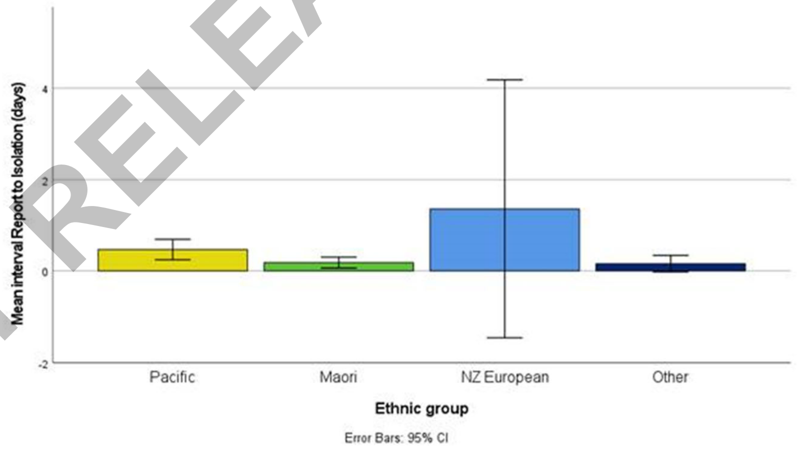


Figure 6: Number of days in quarantine until onset of disease, by ethnicity (n=62).

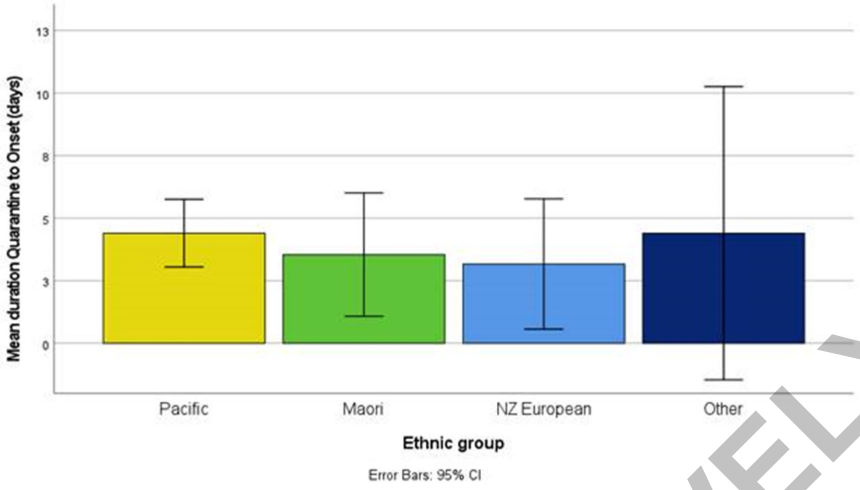
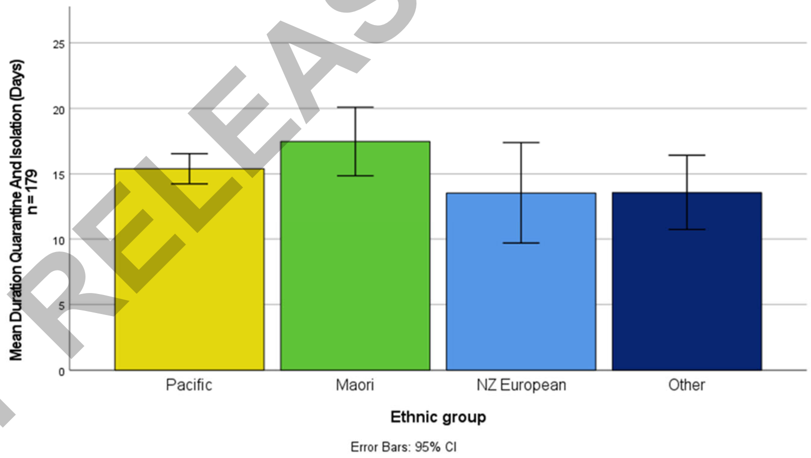


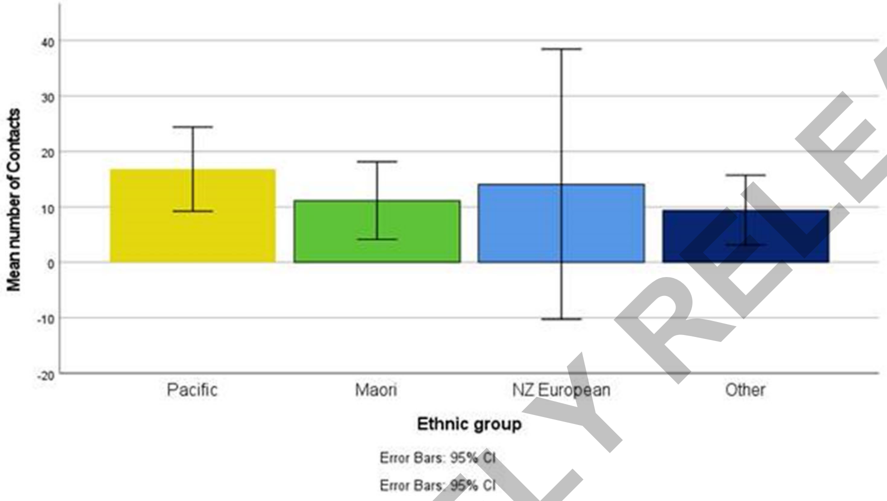
Figure 7: Number of days in quarantine and isolation combined, by ethnicity (n=179)



Contacts: The 179 cases had a total of 2,593 contacts registered in NCTS. Of the 179 cases, 51 had no contacts registered on NCTS: 26/105 (25 per cent) Pacific cases had no contacts registered, 20/44 (45 per cent) Māori, 2/11 (18 per cent) NZ European and 3/19 (16 per cent) 'Other' ethnicities.

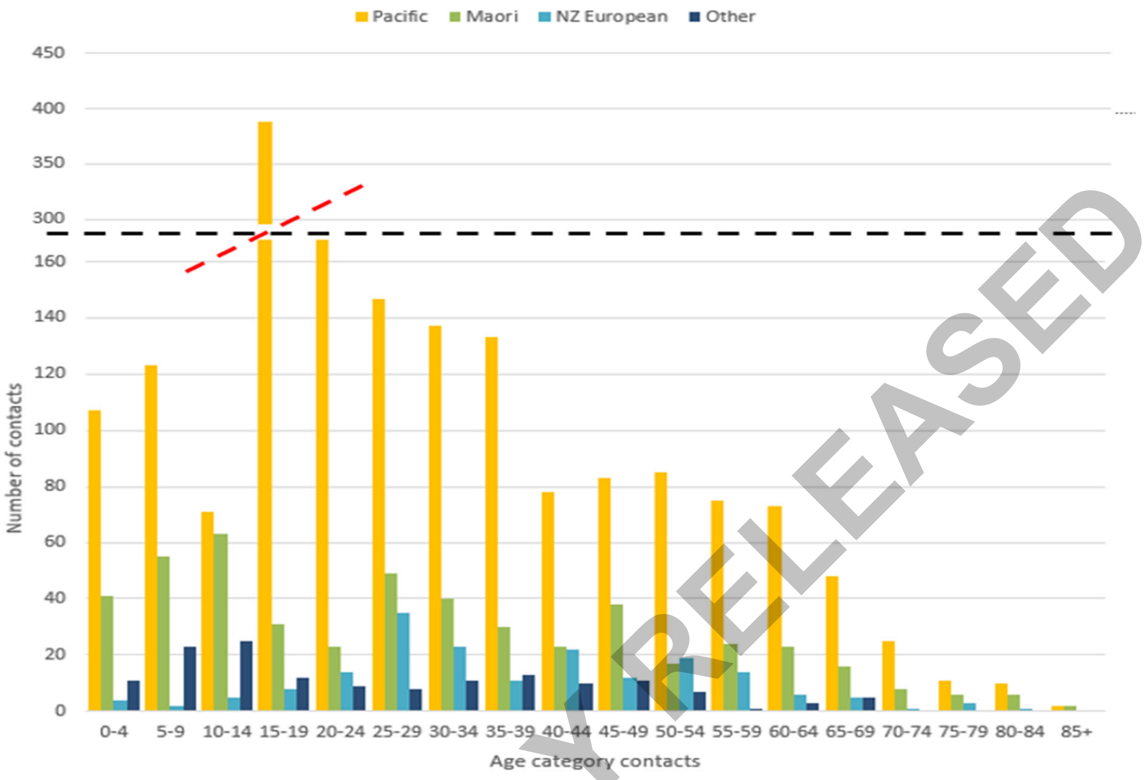
The mean number of contacts of all 179 cases, registered in NCTS, was 14.5 (n=179, range 0-242), and the number by ethnicity is presented in Figure 8. Again, 95% confidence intervals show that differences between ethnic groups did not reach statistical significance. Still, there was a trend for Pacific cases to have a higher mean number of contacts (approximately 17) than NZ European (approximately 14) and Māori (approximately 10).

Figure 8: Mean number and 95% confidence intervals of contacts by ethnicity



The age distribution of contacts is presented as Figure 9. These results indicate that the age distribution of Pacific contacts is much younger than Pacific cases – a pattern that is not present among Māori cases and contacts.

Figure 9: Age of the contacts by ethnicity



Analysis of the mean age group of contacts and cases by ethnicity is presented in *Figure 10* and *Figure 11*.

Figure 10: Mean age group of the cases, by ethnicity (n=179)

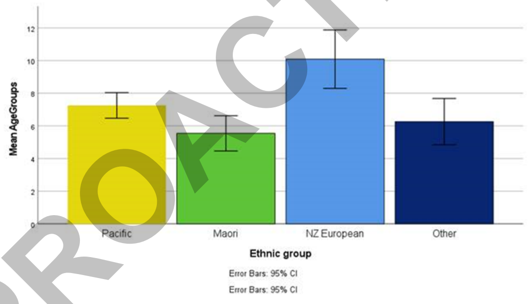
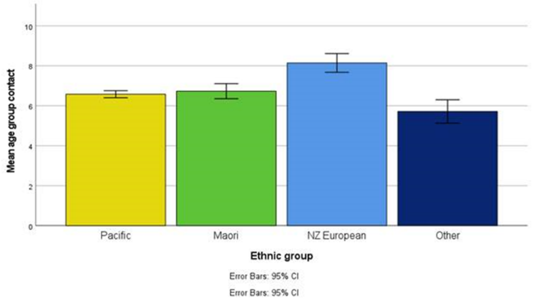


Figure 11: Mean age group of contacts, by ethnicity (n=2,593)



Exposure events: An 'exposure event' is registered for each contact. Of all contacts, the majority (28 per cent) were exposed by 'Other', not specified exposure events, followed by 'Work' (20 per cent), 'School or University' (19 per cent) and 'Household' (17 per cent).

More than half (51 per cent) of the Pacific contacts were exposed at School/University or Work, whereas most Māori contacts (69 per cent) were exposed by 'Household' or 'Other' contact. A large number of student exposure in Pacific contacts is probably explained by the younger age structure of these contacts. However, a large proportion of Pacific (12 per cent) and Māori (19 per cent) were exposed in a healthcare facility (see Table 5 and Table 6).

Notably, a large proportion of the 'Other' exposure events for Pacific people were in a church setting. Unfortunately, 'church' was not an option as an exposure event in NTCS, despite at least five churches being caught up in the August 2020 outbreak, as reported in the media.

Table 5: Exposure events registered on NCTS by ethnicity of the contact

		Ethnicity of contact				
		Pacific	Māori	NZ Euro	Other	
Exposure Event	Contact location	3 (0.2%)	0	67 (36%)	0	70 (3%)
	Healthcare facility	211 (12%)	92 (19%)	1 (1%)	1 (1%)	305 (12%)
	Household	255 (15%)	112 (23%)	21 (11%)	48 (32%)	436 (17%)
	Other	371 (21%)	227 (46%)	38 (21%)	92 (62%)	728 (28%)
	Other Transport	1 (0.1%)	0	0	0	1 (0%)
	Public Transport	26 (2%)	0	0	0	26 (1%)
	School or University	444 (25%)	58 (12%)	0	0	502 (19%)
	Work	453 (26%)	6 (1%)	58 (31%)	8 (5%)	525 (20%)
	Total	1764 (100%)	495 (100%)	185 (100%)	149 (100%)	

Table 6: Ethnicity of the contacts by ethnicity of the case

		Ethnicity contact				Total
		Pacific	Māori	NZ Euro	Other	By ethnicity case
Ethnicity case	Pacific 79 (62%)	1021 **(58%)**	151 (9%)	254 (14%)	338 (19%)	1764 (68%)
	Māori 24 (19%)	148 (30%)	190 **(38%)**	109 (22%)	48 (10%)	495 (19%)
	NZ Euro 9 (7%)	9 (5%)	17 (9%)	110 **(60%)**	49 (27%)	185 (7%)
	Other 16 (13%)	3 (2%)	2 (1%)	28 (19%)	116 **(78%)**	149 (6%)
Total	By ethnicity contact (100%)	1181 (46%)	360 (14%)	501 (19%)	551 (21%)	2593 (100%)

Cases and contacts tended to have the same ethnicity, with Māori cases having the most diverse ethnic contacts.

The proportion of contacts by ethnicity was Pacific 46 per cent (Pacific cases 59 per cent), Māori 14 per cent (Māori cases 25 per cent), NZ European 19 per cent (NZ European cases 11 per cent) and 'Other' 21 per cent ('Other' cases 6 per cent) (see Table 6).

Table 7: Ethnicity of contact by DHB of the index

		DHB of the index case			
		Auckland	Counties	Waitematā	Total
Ethnicity contact	Pacific	**407 (83%)**	**882 (79%)**	475 (48%)	1764 (68%)
	Māori	36 (7%)	146 (13%)	**313 (32%)**	495 (19%)
	NZ European	4 (1%)	38 (3%)	**143 (15%)**	185 (7%)
	Other	44 (9%)	55 (5%)	50 (5%)	149 (6%)
	Total	491 (100%)	1121 (100%)	981 (100%)	2593 (100%)

The ethnicity of the contacts, based on the DHB of the linked cases, was not evenly distributed between DHBs. For example, for Auckland and Counties Manukau DHBs, the vast majority of the contacts were of Pacific ethnicity, whereas in Waitematā, relatively more contacts were of Māori and European ethnicity.

Contact tracing timeframes: The mean time between reporting date of the case and the first contact with the contact was highest for Māori cases (8.13 days), followed by Pacific cases (6.66 days), NZ European (4.62) and 'Other' (4.10) (see *Figure 12*).

Statistical analysis (Kruskal-Wallis test) found significant differences in timeframes of contact tracing between all ethnic groups except for NZ Europeans and 'Other' ethnicity.

A similar trend was seen when analysed by ethnicity of the contacts: 8.04 days for Māori and 6.91 days for Pacific contacts (see *Figure 13*).

Figure 12: Mean number of days between onset of disease of case and first contact with the contacts, by ethnicity of the cases (n=2355)

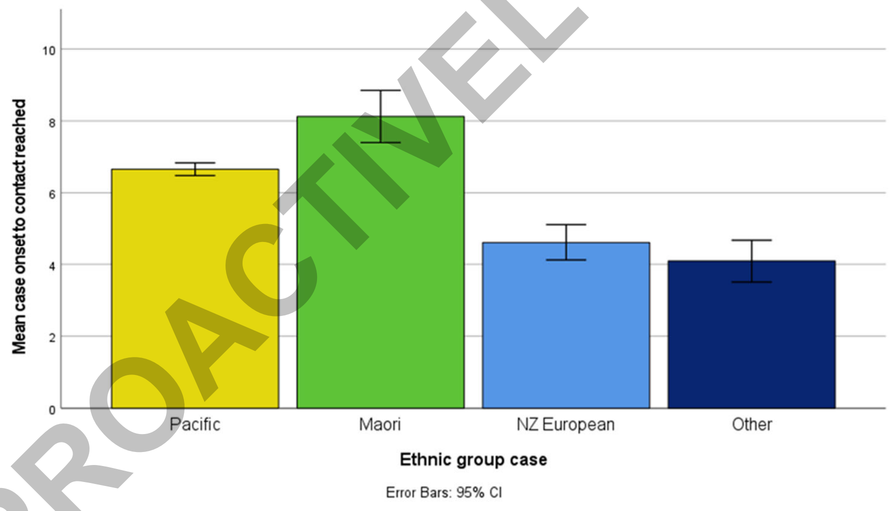
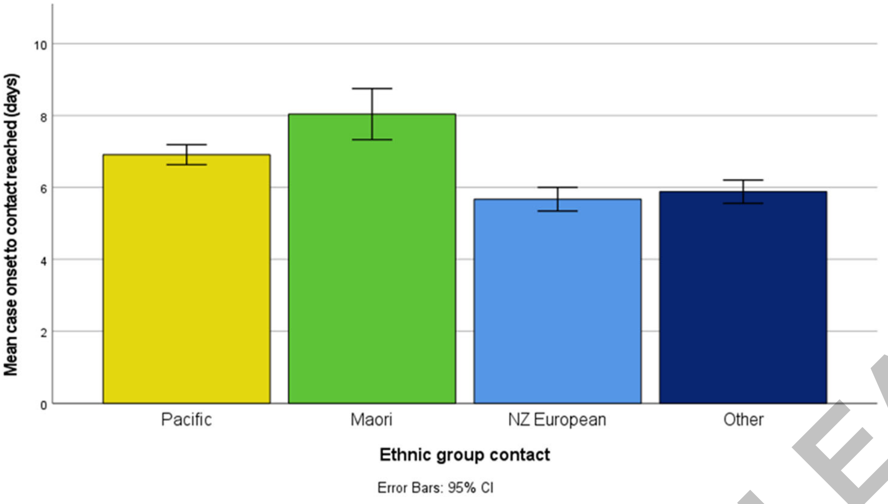


Figure 13: Mean number of days between onset of disease of case and first contact with the contacts, by ethnicity of the contacts (n=2355)



The overall proportion of contacts reached within 4 days after onset of disease of the case was 37% (see Table 8). For Pacific people, this proportion was 26%, which is significantly lower than for all other ethnicities.

Table 8: proportion of contact reached within 4 days of onset of disease of the case, by ethnicity

	Contacts reached <4 days n/N (%) 860/2355 (37%)	**OR (95% CI)**	**p-value**
Pacific	421 (26%)	ref	
Māori	216 (51%)	2.97 (2.38-3.70)	<0.001
NZ European	112 (61%)	4.40 (3.21-6.04)	<0.001
Other	111(82%)	12.57 (8.03-19.67	<0.001

Discussion

Inequities in COVID-19 infection rates and in the public health response

During the first COVID-19 outbreak in NZ (March to May 2020), Pacific people had a slightly lower risk of contracting the virus than New Zealand Europeans. This risk profile was likely because the most prominent transmission source during the first wave was international travel while the borders were still open, and there were no imported cases from the Pacific islands. Pacific people were however significantly more likely to have a *locally acquired* infection and were twice as likely to be hospitalised. The majority of cases were imported, younger adults of European ethnicity and of higher socioeconomic status [5].

During the second wave of COVID-19 in Auckland in August 2020, the borders were closed. The majority of the 179 locally acquired cases in this wave were Pacific people (105 = 59 per cent), Māori (44=13 per cent) of whom 20 (11 per cent) were both Māori and Pacific. Only 11 cases (6 per cent) were of NZ European ethnicity. All reported cases were in the metro Auckland area and the majority lived in the most deprived neighbourhoods. These same Pacific communities in South Auckland were also most affected by New Zealand's largest measles epidemic in more than two decades that occurred in 2019 [11]. While a definite root source of this COVID-19 outbreak was not determined; it is likely that a border worker was the initial case in this outbreak. Pacific people make up a high proportion of border workers and these workers are more likely to live in densely populated areas, with overcrowded housing that increases the risk of virus spread. It was therefore predictable that an outbreak dominated by Pacific people would occur.

The high outbreak potential in the Pacific population, mainly in South Auckland, was confirmed in this COVID-19 outbreak with closed borders: the vast majority of cases (59%) were Pacific, even when using analyses with prioritisation by Māori ethnicity; Pacific cases had the highest mean number of contacts per case (although this finding did not reach statistical significance), and of all contacts of cases in this outbreak, almost half were Pacific.

Evaluation of the first COVID-19 outbreak (March 2020) found that severe outcomes of disease (hospitalisation) were associated with 'older age', 'having at least one underlying condition', and 'Pacific' or 'Asian' ethnicity relative to 'European of other' ethnicity. In this second wave, we also found an association between severe outcome (hospitalisation), older age, and 'having at least one underlying disease'. Comparisons with the ethnic majority group (NZ European) however were limited because of the underrepresentation of this group, with only 11 cases in this outbreak.

Nevertheless, we did find that Māori and Pacific cases were twice as likely to have underlying diseases compared with Europeans, and all but one of the 22 hospitalised cases, all 8 cases in ICU and all 3 deaths of cases were of Māori or Pacific ethnicity.

In March 2021, New Zealand commenced vaccination of border workers, and on 15 Apr 2021 a comprehensive vaccination rollout plan was released [12]. Until the vaccine was available, non-pharmaceutical interventions, such as isolation of cases and quarantine of contacts, were the most important means of defence.

We reviewed for the August 2020 outbreak, some of the contact tracing performance indicators used by the Ministry of Health. For the 179 cases, we found a mean interval between onset of disease and report to PHU of 3.52 days, a mean interval of 0.4 days between reporting cases to PHU and isolation and a mean duration of isolation of 16 days. The interval between onset of disease and reporting can be influenced by several factors: patients often do not get tested on the first day of disease, laboratory testing can be delayed and there can be a delay in reporting to PHU. The available data did not allow more detailed analyses. The mean interval between reporting and isolation however was only 0.4 days, which means that the isolation of cases was rapid after reporting to the PHU. We analysed these indicators by ethnicity and did not find any significant differences, however the numbers were small, especially for the NZ European group.

We also analysed the interval between the onset of disease of the case, and the date that the contacts were first reached by ethnicity. We found significant differences: contact tracing of Māori cases took on average more than 8 days, and this was significantly longer than for Pacific cases (almost 7 days), which was significantly longer than for NZ European and 'Other" ethnic groups (between 4 and 5 days).

The proportion of contacts reached within 4 days of onset of disease was only 37%, well below the 80% target indicator set by the Ministry of Health. The proportion of Pacific people reached within 4 days of onset of disease (26%) was significantly lower than for all other ethnic groups (Māori 51%, NZ European 61% and Other 82%). Slower contact tracing means that contacts are quarantined later after exposure, increasing the risk that the virus will spread in the community.

This delay in contact tracing for Pacific people is concerning, as it adds to all other risk factors for infectious diseases in Pacific people that are well documented. A 2019 report on Pacific health for the Health and Disability Review found that compared with all other ethnic groups, Pacific people are more likely to live in neighbourhoods of 'high deprivation', have the lowest median incomes, higher unemployment rates, the lowest rate of home ownership and the highest rates of household crowding [13].

The need to strengthen the public health response to infectious diseases, specifically for Pacific people in South Auckland, was reported in a review of the largest measles outbreak in decades in New Zealand in 2019 [14]. This review also found large ethnic and economic inequities in the disease burden: Pacific and Māori populations had the highest rates of measles in all age groups, the highest rates of hospitalisations, and two-thirds of these cases were living in NZDep 2013 areas 9 or 10. The report found that the measles outbreak started in other areas of metropolitan Auckland, and then spread to Pacific communities in South Auckland, that became the epicentre of the outbreak. The outbreak management had moved from phase 1 (stamp it out) through phase 2 (manage it) to phase 3 (outbreak and epidemic management), and contact tracing had stopped, before it had reached the most vulnerable Pacific communities in South Auckland, because the Public Health Unit had reportedly exhausted its resources [14].

In this relatively small COVID-19 outbreak with only 179 cases (105 Pacific and 44 Māori), that occurred only a few months following the end of the 2019 measles outbreak, the health system was still not able to deliver contact tracing in an equitable way.

Preparedness, data collection and data quality

Contact Tracing Systems

A large pandemic has been expected and predicted for decades. Most countries had developed pandemic preparedness plans, but no country was well prepared for the unprecedented COVID-19 pandemic. New Zealand was also underprepared.

The surveillance of notifiable infectious diseases in New Zealand has been standardised in EpiSurv - the official national surveillance database - for over two decades. An important omission in the public health system however, that immediately became clear with the COVID-19 Response, was the lack of a national contact tracing database. Contact tracing was managed at a local and regional level by Public Health Units. Although Public Health Physicians had been aware of this national omission since the SARS-CoV-1 outbreak in 2002, a national contact tracing database had not been established in 2020.

Surveillance is "the *ongoing*, *systematic* collection, analysis, and interpretation of health-related data that is essential for planning, implementation, and evaluation of public health practice." [15]. Effective surveillance involves the study of trends, that requires data to be collected and registered consistently over time. Consistent quality and completeness of data is important to monitor equity. The 'National Contact Tracing Solution', a cloud-based software platform for collecting and storing all information about cases and contacts, was developed under pressure, after the first wave of COVID-19 in New Zealand – the Ministry of Health's Director of Public Health has described this as "building the plane as you fly it..." [16]. The NCTS platform was operationalised very quickly, and this has had implications for the consistency and quality of data [17].

Surveillance data is usually collected by well-trained public health staff. For large-scale contact tracing that was established as part of the NCTS, a large workforce had to be trained urgently, who then entered the data into a new contact tracing system. It is unsurprising that data quality issues have emerged. One example of the problem is the frequent mix-up in the use of the terms 'quarantine' (separating healthy people who may have been exposed) and 'isolation' (separating patients who are contagious). Unfamiliarity with these terms may have been the reason why we found 17 people in the NCTS misclassified in 'quarantine' but the start date of their illness is registered as prior to entering quarantine.

Ethnicity Data and Protocols

To improve the quality and consistency of ethnicity data, the Ministry of Health published 'HISO 10001:2017 *Ethnicity Data Protocols for the Health and Disability Sector'* in 2017 [18]. Consistency of ethnicity data in all systems that collect data is of utmost importance to monitor equity in health outcome and public health response. The Ministry of Health HISO 10001:2017.

The Ministry of Health Ethnicity Data Protocols state that ethnicity data should be collected in a standard manner following the StatsNZ standardised Census ethnicity question [19], and that ethnicity data should be collected at least every three years [18] For consistency of surveillance data, and to comply with MoH protocols, every time a patient is reported with a notifiable disease, the patient is asked for their ethnicity and these details are updated in the EpiSurv database. In NCTS, however, these data protocols were not followed and contacts were not asked about their ethnicity. The ethnicity registered for contacts in the NHI databases was copied in to the NCTS database, even if more than three years had passed since the ethnicity data had been collected. This practice contributed to discrepancies in ethnicity data between the Episurv and NCTS databases [20].

Prioritisation of ethnicity data by Māori is common practice in the health and disability system, though not a requirement by the ethnicity protocols [21]. With an increasing proportion of the NZ population identifying as both Māori and Pacific, reporting data by prioritised ethnicity increasingly underestimates the impact on Pacific peoples and their possible specific needs. In Census 2018, for example, 28 per cent of the children under 15 who identified as Pacific also identified as Māori, and this percentage is steadily growing.

The effect of prioritisation was clearly seen in our research, where a further 20 Pacific cases (who had been classified only as Māori) were identified when prioritised Māori ethnicity was not used. Using total response ethnicity increased the overall proportion of Pacific cases from 59 percent to 70 per cent. Statistics New Zealand does not recommend prioritisation of ethnicity when reporting data [18, 22].

The group that identified as Māori, as well as Pacific, had a younger median age than other ethnic groups. This characteristic makes it likely that the prioritisation of ethnicity causes bias in the analyses. This bias increases as the population becomes more ethnically diverse and mixed.

Consistency and coordination of data changes

The August 2020 outbreak represents an opportunity to comprehensively examine the case management and contact tracing response to COVID-19. Following this outbreak, many changes were made to policy and NCTS data collection (often very rapid changes), particularly during the Auckland August 2021 and Omicron 2021/2022 outbreaks. The frequent changes made to the different variables used in the operational NCTS database were often not coordinated with the EpiSurv surveillance database. Inconsistency of data collection during an outbreak makes it impossible to identify and understand key trends. These changes and inconsistencies in data collection eventually led to the discontinuation of the use of EpiSurv surveillance data for reporting cases through the ESR reporting dashboards, that had to be taken offline just before the major omicron outbreak started. (https://nzcoviddashboard.esr.cri.nz/)

The loss of this key reference point is a concern because EpiSurv is a *surveillance* system that has consistency of data collection and standard data quality checks. The NCTS which was designed as an *operational* system does not meet these data requirements for a surveillance system. Official reports of COVID-19 cases now use EpiSurv and NCTS data, without specifying which data comes from the surveillance system and which data is added from the operational system, with its many inconsistencies, leaving the quality of surveillance unknown. https://www.health.govt.nz/covid-19-novel-coronavirus/covid-19-data-and-statistics/covid-19-current-cases￼.

Limitations

Several limitations should be noted when interpreting the results presented in this report.

Completeness and consistency of data collection

Surveillance data for all notifiable diseases is collected in a national uniform and consistent way, based on notification criteria described in the MoH Communicable Diseases manual, using standardised questionnaires developed by Public Health Physicians in MoH, ESR and Public Health Units: the case report forms (CRF). Early in the outbreak, a CRF for COVID-19 was developed, however the CRF was not used by the NCTS, that was separately developed by MoH for contact tracing purposes.

Comparing equity between groups

Because the August 2020 outbreak comprised mostly Pacific and Māori cases living in highly deprived areas, and the majority ethnic group (European New Zealanders) was underrepresented, we could only make limited comparisons between cases belonging to different ethnic groups.

Although we found clear inequities in the public health response between different ethnicities in the Auckland region, we could not evaluate if the COVID-19 response was equitable and consistent between different PHU/DHB regions.

Prioritisation of ethnicity data

We used data that was prioritised for Māori ethnicity for pragmatic reasons relating to data consistency when linking databases. We recognise our obligations as citizens of Aotearoa New

Zealand to the principles of Te Tiriti o Waitangi and the potential for all research to contribute to improving Māori health outcomes.

However, the use of the standard method of ethnicity reporting in the Health and Disability sector, i.e., prioritised ethnicity, results in increasing under-estimates (often significantly so) of the impact of disease on Pacific peoples. We recommend that this approach to reporting should be reviewed. We note that Statistics New Zealand does not recommend the use of prioritised ethnicity but rather recommends the use of total response or, where appropriate, sole/combination ethnicity.

Contact tracing

For the 179 cases locally acquired cases in this outbreak, a total of 2,593 contacts were registered in NCTS. Fifty-one of these cases, including 26 (25%) of Pacific cases, had no contacts registered at all. It is highly unlikely that so many Pacific cases had no contacts, and this finding is likely the result of the design and data quality of NCTS, that was set up as an operational database, rather than specifically for surveillance purposes. A possible reason for this lack of registered contacts could be that within families - or other groups with multiple linked cases outside that group, it is not always clear to which case exactly the contact is linked. Therefore, it is possible that contacts were arbitrarily linked to a single case in a cluster, leaving the other cases with zero contacts.

Data on household characteristics (such as number of household members, multi-generational households) and preferred language is routinely collected for other notifiable diseases, but these data were missing in the datasets we received, presumably because this information was not collected for COVID-19. It was also not possible with the available data to evaluate how COVID was spread within households. Household contact information is particularly important for Māori and Pacific ethnic groups, who often live with large extended families and are most vulnerable to the impacts of infectious diseases. Lack of this data makes it impossible to learn and plan for future outbreaks.

Differing characteristics between people contacted and those not reached

Contacts who were identified but not reached for whatever reason (which is common) are not registered in NCTS. It is possible that the number and characteristics of people who could not be contacted, especially if there are differences in proportion between ethnicities, would have influenced the results obtained inequitably between ethnicities, if they had been registered and included.

Conclusions

The majority of the COVID-19 cases and contacts in the August 2020 outbreak were Pacific, followed by Māori. One-third of all cases had one or more comorbidities or other underlying conditions. Pacific and Māori cases had the highest rates of underlying conditions, and also the highest rates of hospitalisation. All cases that required ICU treatment, and the cases who died, were Pacific or Māori. Factors independently related to hospitalisation during the August 2020 outbreak included underlying conditions, Māori ethnicity (compared to Pacific ethnicity) and older age.

Pacific cases lived in areas of highest deprivation, followed by Māori; most outbreak cases were from a non-European ethnic group, making comparison with the majority ethnic group, European New Zealanders, not possible.

Pacific contacts made up 59 per cent of all contacts in the data, but 25 per cent of Pacific cases had no contacts registered. Pacific contacts tended, on average, to be younger than Pacific cases, and most Pacific contacts were exposed in education or workplace settings.

The average time between the reporting of a case and first contact with a contact was 6.66 days for Pacific cases. This interval was significantly longer than that for NZ European and 'other' ethnicities, but significantly shorter for Māori. The proportion of contacts reached within 4 days of onset of disease was significantly lower for Pacific than for all other ethnicities.

In this first COVID-19 outbreak after the New Zealand borders closed, Pacific people were most affected in many ways: the incidence in Pacific people was highest, the number of exposed contacts who were Pacific was highest and the proportion of Pacific contacts that was reached within 4 days was lowest of all ethnicities.

Recommendations

Recommendation 1: Ethnicity data

a) Evaluate whether the Ministry of Health's Ethnicity data protocol is fit for use in pandemics and epidemics throughout the (health) system. If implementation of these protocols is not feasible, alternative methods of ethnicity data collection should be developed. This is not only important for COVID-19, but for all notifiable disease

b) Report health data by ethnicity using the total response method. This approach to reporting will not lose any data on Māori health, but provide more insight into the health of Pacific communities

Recommendation 2: Timely reporting of equity data

Implement timely reporting by ethnicity of all system performance indicators published by the Ministry of Health [23]. Ensure that trends that show inequities in the response are acted on immediately.

Recommendation 3: The quality and completeness of data

Review the overall quality, consistency and completeness of COVID-19 surveillance data in EpiSurv and operational data in NCTS and make recommendations about how to improve and coordinate future surveillance to ensure monitoring of outcomes.

Make a clear distinction between surveillance data in EpiSurv and operational data in NCTS. Ensure that surveillance data that is collected is and remains fit for purpose (consistent, complete and regular quality checks to improve data quality) so that it will remain possible to study trends over time when required.

Any further delays in implementation of quality ethnicity data collection, analysis and reporting will increasingly contribute to negative health outcomes, specifically for Pacific people.

There may be value in convening a working group to review the quality of ethnicity data for the COVID response and the implementation of the Ethnicity Data Protocols in infectious disease control in general. A review group should include strong Māori and Pacific expertise and ensure that any approaches are considered through the lens of the principles of Te Tiriti o Waitangi, as well as acknowledging the perspectives of Pacific communities.

Recommendation 4: Record all changes in collection of data, also during outbreaks.

All changes made to surveillance systems need to be carefully recorded and reported so that researchers and others using the data can understand the quality of the data and how these changes influence the surveillance results, including in terms of reporting responsiveness to equity.

Recommendation 5: Equity starts with culturally appropriate data collection.

Māori and Pacific health professionals should be included in current and future revisions of the CD manual, CRF forms and NCTS data collection.

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Appendix one: Progress in relation to the analysis plan

Analysis plan component	Status
Characteristics of cases	
1. Compare the characteristics (see below) of all Pacific COVID-19 cases in New Zealand with cases from other ethnic groups (Māori, Asian, European, Other): a. Age, sex, NZDep quintile, DHB b. Comorbidities (diabetes, cardiovascular disease, asthma/COPD, renal disease) and other conditions (e.g., pregnancy) c. Occupation (healthcare worker, airport worker, managed isolation facility worker, etc.)	a. and b. Completed. c. The available data only provided information on whether cases were healthcare workers, limiting the type of analysis that was possible.
2. Compare the household characteristics (see below) of all Pacific COVID-19 cases in New Zealand with cases from other ethnic groups (Māori, Asian, European, Other): a. Number of household members b. Number of adults c. Number of children d. Number of generations living in the household e. Number of bedrooms (if available) f. Ratio of household members to bedrooms g. Number of cases per household h. Proportion of household members affected	Not progressed. EpiSurv data did not include data on household characteristics. NCTS data included some elements, but these were not able to be linked in a way that would allow the identification of household (and non-household) cases.
3. Compare the number of close contacts (household and non-household) of Pacific and non-Pacific cases	Completed
4. Describe and compare the characteristics (age, sex, ethnicity) of close contacts of Pacific and non-Pacific cases	Completed

Transmission	
5. Compare the mode of transmission among Pacific and non-Pacific COVID-19 cases in the first and (2 Feb-1 May 2020) second waves (11 Aug-24 September 2020) involving community transmission in New Zealand a. Imported cases (cases with a reported history of international travel within 14 days of onset) b. Import-related cases (cases that have a reported link [close contact or epidemiological link] to an imported/overseas acquired case) c. Locally acquired cases, epidemiologically linked (cases that have no reported history of international travel within 14 days of onset and no recorded epidemiological link to a source case). Of the locally acquired cases, to differentiate mode of transmission: (household, workplace, school, church, other) d. Locally acquired cases, unknown source (cases that have no reported history of international travel within 14 days of onset and no recorded epidemiological link to a source case).	Not progressed. The data sample we received did not include 'first wave' cases.
6. Calculate the average number of secondary cases arising from each Pacific case	Not progressed The available data did not allow linking of cases in the manner envisaged in the analysis plan.
7. Compare the outcomes of Pacific and non-Pacific COVID-19 cases by age: a. Hospitalisation b. ICU admission c. Death	Completed
Public health system response	
8. Describe the languages spoken by cases/contacts and the number and proportion of cases and contacts that were provided language support/interpreters during initial contact and subsequent follow-up.	Not progressed The available data did not include information on languages spoken or provision of interpretation services.
9. Describe the locations of isolation for Pacific and non-Pacific COVID-19 cases a. Isolation/quarantine facility b. Home c. Other	Completed

10. Describe the locations of quarantine for Pacific and non-Pacific COVID -19 cases a. Isolation/quarantine facility b. Home c. Other	Completed
11. Describe the social, welfare and clinical supports provided to Pacific COVID-19 cases and contacts during isolation and quarantine	Not progressed The available data does not include information on supports provided to cases and contacts
12. Examine the timeliness of the public health response for COVID-19 cases by ethnicity (comparing first and second waves): a. Time between symptom onset and testing b. Time between testing and test result c. Time between testing and first contact with the public health unit d. Time between case scoping and effective isolation (for the second wave, this will be the time the case was transferred to an isolation facility or the time the exemption was granted and security put in place at their home/elsewhere)	Not progressed. The available data includes information on the second wave only.
Impact of isolation and quarantine on cases and contacts	
13. Examine the duration of isolation for Pacific and non-Pacific cases	Completed
14. Examine the duration of quarantine for Pacific and non-Pacific close contacts	Completed