

ANTIMICROBIAL RESISTANCE IN
NEISSERIA GONORRHOEAE IN
NEW ZEALAND
2017–2021 SURVEILLANCE REPORT

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Antimicrobial resistance in *Neisseria gonorrhoeae* in New Zealand 2017–2021 surveillance Report

Porirua, New Zealand

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INTRODUCTION

Gonorrhoea is one of the most common sexually transmitted infections (STI) globally, with 82.4 million new cases among adults aged 15–49 in 2020 (World Health Organization 2022). Untreated gonorrhoea can result in serious sequelae, including pelvic inflammatory disease, vertical transmission and increased HIV transmission (Moore 2016) (Tsevat 2017) (Greenberg 1979).

Antimicrobial resistance (AMR) in *Neisseria gonorrhoeae* (*N. gonorrhoeae*) is a growing public health threat globally. *N. gonorrhoeae* resistance to tetracyclines, macrolides, sulphonamides and quinolones has been documented (World Health Organization 2022) (M. S. Unemo 2019) (M. L. Unemo, WHO global antimicrobial resistance surveillance for *Neisseria Gonorrhoea* a retrospective observational study. 2021). Dual antibiotic therapy with ceftriaxone and azithromycin is the first line treatment for gonorrhoea recommended in many countries, including in New Zealand (NZ) (Society n.d.) (Australian Society for HIV n.d.) (Public Health Agency of Canada. 2022) (M. R. Unemo 2020). However, there are also a growing number of reports of resistance and treatment failures using this dual therapy (M. L. Unemo 2019) (Public Health England 2018) (Australian Government Department of Health 2018). However, in recent years, reduced susceptibility or resistance to ceftriaxone, the last option for first-line gonorrhoea monotherapy, has also emerged (M. L. Unemo, WHO global antimicrobial resistance surveillance for *Neisseria Gonorrhoea* a retrospective observational study. 2021) (M. L. Unemo 2019). Evidence of sustained transmission of high level azithromycin resistance and concern about effects of azithromycin on other pathogens and on the microbiome has led some jurisdictions, including the United Kingdom (UK) and United States (USA), to recommend single-agent ceftriaxone for uncomplicated gonorrhoea (Public Health England 2018) (Cyr 2020) (World Health Organization 2022).

HISTORY OF NEW ZEALAND AMR SURVEILLANCE

Antimicrobial susceptibility testing (AST) for *N. gonorrhoeae* has been conducted in New Zealand (NZ) intermittently since 1976. Following sporadic surveys, quarterly analysis was undertaken between 2005 and 2008 due to rising resistance to ciprofloxacin, the first line antibiotic at that time. Annual reporting by laboratories continued from 2009 to 2012, and from 2013, AST data was collected with STI laboratory surveillance data.

From 2013 to 2016, reporting of *N. gonorrhoeae* AMR focused on penicillin and ciprofloxacin resistance. Resistance to penicillin ranged from 4.5% in 2013 to 14.9% in 2016, with decreasing numbers of isolates available for AST (422 in 2013 to 168 in 2016). Resistance to ciprofloxacin ranged from 26.2% to 36.3%, also with decreasing numbers of isolates tested (1055 in 2013 to 831 in 2016). Penicillin and ciprofloxacin resistance results are currently of limited clinical utility, as penicillin is not used, and ciprofloxacin is now a third line agent for gonorrhoea treatment. Isolate numbers with reduced susceptibility to ceftriaxone were reported from 2014 to 2016 (1, 8, and 4 in 2014, 2015, and 2016 respectively), with total isolates tested not reported. Azithromycin resistance was included for the first time in the 2016 Annual STI surveillance report. No resistance was detected, however only 79 isolates from three District Health Boards were tested (The Institute of Environmental Science and Research Ltd. 2019).

In addition to routine surveillance data, periodic *N. gonorrhoeae* AMR surveys have been undertaken in 2014/15 and 2018/19 when laboratories were asked to send all *N. gonorrhoeae* isolates to ESR for analysis. With increased nucleic acid amplification (NAAT)-based testing since 2015, fewer isolates have been available for AST (The Institute of Environmental Science and Research Ltd 2021). The most recent AMR survey conducted by ESR in 2018/19 included 344 isolates provided by laboratories, with most isolates coming from the Auckland region. Two (0.6%) of the 344 isolates displayed reduced susceptibility to ceftriaxone and six (1.7%) were resistant to azithromycin (The Institute of Environmental Science and Research Ltd 2021). While a small number of isolates with reduced susceptibility to ceftriaxone have been identified, resistance to ceftriaxone has yet to be reported in NZ (The Institute of Environmental Science and Research Ltd. 2019).

METHODS

The collection, collation, and initial cleaning of laboratory data for gonorrhoea are described in the 2021 Annual Report dashboard methods. The result of this process are data stored in a SQL server database. These data include AST data for *N. gonorrhoeae* for ceftriaxone, azithromycin, penicillin, ciprofloxacin, and tetracyclines. The data are extracted from SQL into R.

AMR isolate numbers, testing methods and reporting practices vary between laboratories. Results received include minimum inhibitory concentration (MIC), zone diameter (ZD) and sensitive, intermediate/reduced susceptibility, resistant (SIR) data. Free-text data are entered by many laboratories, and multiple unique responses are received. These data are cleaned in R and interpretations confirmed with individual laboratories as required.

To analyse AST results from cultures, data were restricted to individuals with a National Health Index (NHI) or personal identifier (PID). Duplicate tests, defined as having the NHI or PID and occurring within the same month and year, were then excluded from the analysis. Next, MIC values were prioritised for AST reporting, and substituted with SIR or ZD values if missing. EUCAST breakpoints (Table 1) were used to interpret the MIC results reported here.

From 2018, laboratories began shifting azithromycin AST practices from MIC interpretations to European Committee on Antimicrobial Susceptibility Testing (EUCAST) epidemiological cut-off values (ECOFFs). Some laboratories have not reported ECOFFs to ESR, so the proportion of isolates which underwent azithromycin AST is likely to be an underestimate.

The MIC breakpoints used to interpret AST results in this report are based on EUCAST clinical breakpoint tables, last published in January 2022 (European Committee on Antimicrobial Susceptibility Testing 2022). For ceftriaxone, we used a combination of EUCAST (to determine resistance) and World Health Organization (WHO) guidelines to determine reduced susceptibility criteria. The MIC breakpoints used to interpret AST results are displayed in Table 1.

Table 1: MIC breakpoints to interpret antimicrobial susceptibility testing results

Antimicrobial	MIC breakpoint for susceptibility (mg/L)	MIC breakpoint for reduced/intermediate ⁱ susceptibility (mg/L)	MIC breakpoint for resistance (mg/L)
Azithromycin	≤1.00*		>1.00*
Ceftriaxone	<0.06	≥0.06 to ≤0.125	>0.125
Ciprofloxacin	<0.03	≥0.03 to ≤0.06	>0.06
Penicillin	≤0.06	>0.06 to ≤1.00	>1.00
Tetracyclines	≤0.5	>0.5 to ≤1.00	>1.00

*Formal breakpoints for Azithromycin have not yet been determined; an epidemiological cut-off (ECOFF) is used with >1mg/L considered resistant.

ⁱ “Intermediate resistance” is used for penicillin while “reduced susceptibility” is used for ceftriaxone. These describe isolates which are not fully susceptible but also do not meet the definition for resistance.

RESULTS

CULTURE AND ANTIMICROBIAL SUSCEPTIBILITY TESTING

A detailed breakdown of gonorrhoea infection and culture numbers for 2021 is presented in Table 2. In 2021, 1,487 (23%) of the 6,458 reported gonococcal cases had a culture test. Of these, 1,223 were positive for gonorrhoea, and of these 1,187 (97%) underwent AST for ceftriaxone and 674 (55%) for azithromycin. An ESR survey on *N. gonorrhoeae* AMR surveillance data completed by 7/12 major diagnostic testing laboratories in NZ found that not all laboratories conduct susceptibility testing for Azithromycin (5/7 completed azithromycin AST), and results of AST may not be reported to ESR (1/5 labs testing for Azithromycin AST did not report to ESR). Given not all laboratories completed the survey, the number and proportion of laboratories that test and report azithromycin AST is currently unclear.

Te Waipounamu South Island was the region which reported the highest proportion of culture testing among positive cases (263/796, 33% of cases). Central North Island reported the lowest proportion of culture testing amongst positive cases (158/939, 17%). Te Manawa Taki reported the highest proportion of AST for azithromycin in 2021, testing 226/274 of isolates (83%).

Table 2: Total number of gonococcal infections, culture tests, positive culture results, ceftriaxone AST results and azithromycin AST results by region: 2021

Region	No. of infections ¹	No. of culture tests ²	No. of positive culture results ³	No. of Azithromycin AST results ⁴	No. of Ceftriaxone AST results ⁴
Central North Island	939	158 (17%)	114	1 (<1%) ⁵	104 (91%)
Northern North Island	3509	751 (21%)	597	342 (57%)	578 (97%)
Te Manawa Taki	1214	315 (26%)	274	226 (83%)	273 (99%)
Te Waipounamu South Island	796	263 (33%)	238	105 (44%)	232 (98%)
TOTAL	6458	1487 (23%)	1223	674 (55%)	1187 (97%)

¹ Infections exclude multiple positive results within a defined period of time.

² Deduplicated to exclude multiple positive results within the same episode. % of infections among individuals with a known NHI or PID (personal identifier) who had a culture test.

A 'period of testing' created for results with known NHI or PID and in the same year and month. Those with unknown NHI/PID removed.

All 'periods of testing' without a positive result removed.

All episodes/cases of gonorrhoea with a culture test taken in the same 'period of testing' included, with PCR only episodes removed.

Calculated number of gonorrhoea cases per region with a known NHI/PID where a culture test was taken (regardless of result)

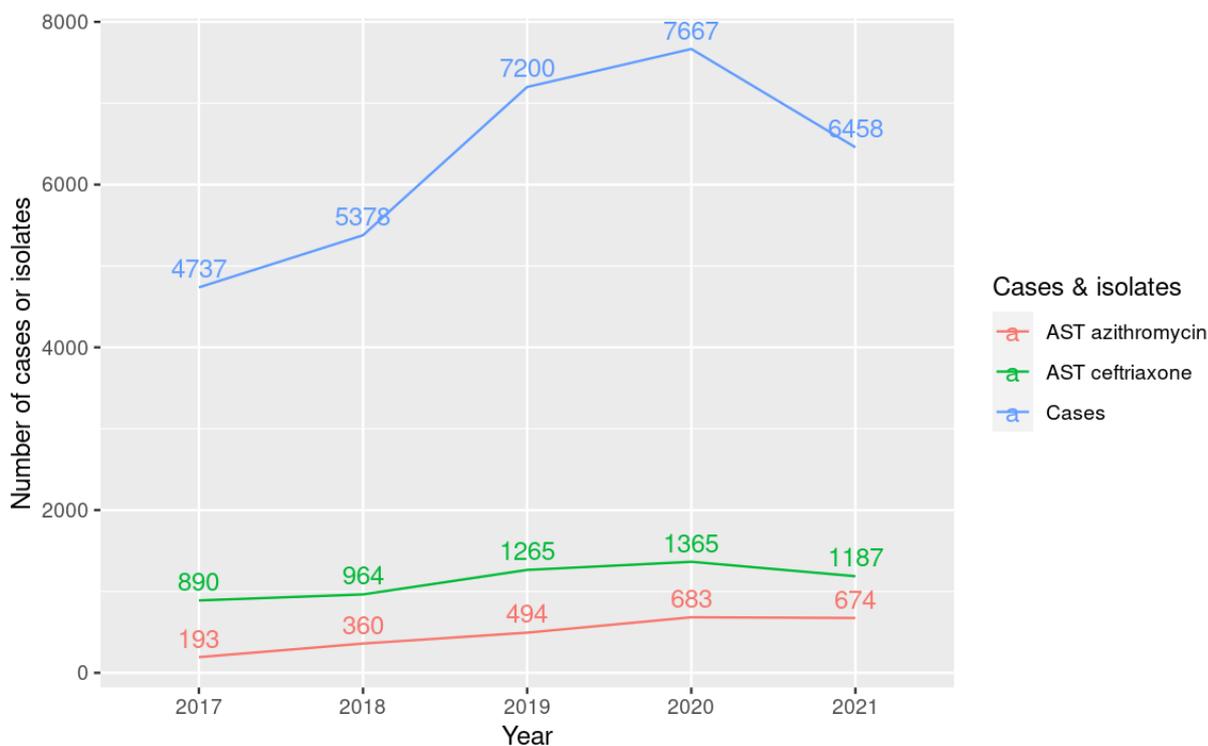
³ Of all the culture tests taken, these returned a positive result. A person with a gonococcal infection may return a negative culture test for several reasons, including: an extended transport time resulting in an unviable isolate; testing during the same infection but after treatment has started; and testing from a different anatomical site of the infection.

⁴ Includes all positive culture results received with completed Antimicrobial Susceptibility Testing (AST) data in order of preference from minimum inhibitory concentration (MIC) to SIR results (Susceptible; increased exposure/Intermediate/reduced susceptibility, Resistant) to disk diffusion results. % of AST results from no. of positive culture results.

⁵ Numbers of azithromycin AST results reported from the Central North Island were low compared to other regions between 2019 and 2021. This may be due to differences in reporting rather than testing practices.

Numbers of gonorrhoea cases and isolates undergoing azithromycin and ceftriaxone AST from 2017 to 2021 are shown in Figure 1. Overall, gonorrhoea cases reported per year increased by 62% from 2017 to 2020 and decreased in 2021 by nearly 16%. Between 2018–2020, 22% – 24% of all reported cases consistently underwent a culture test. This was a decrease from 2017 when 1,485/4,737 cases (31%) underwent culture. This decrease is likely related to an increase in molecular methods for diagnostic testing.

Figure 1: Number of gonorrhoea cases reported and isolates subsequently undergoing antimicrobial susceptibility testing for azithromycin and ceftriaxone in NZ: 2017–2021



The percentage of cases undergoing ceftriaxone AST ranged between 17.5% – 18.9% (1265/7200 in 2019 and 980/4737 in 2017) and increased for azithromycin from 4.0% in 2017 (193/4737) to 10.4% in 2021 (674/6458). It is not clear whether this increase is due to increased testing or increased reporting.

Azithromycin & Ceftriaxone Resistance

Figure 2: Proportion of *Neisseria gonorrhoeae* isolates with resistance (or reduced susceptibility) to ceftriaxone and azithromycin in NZ: 2017–2021

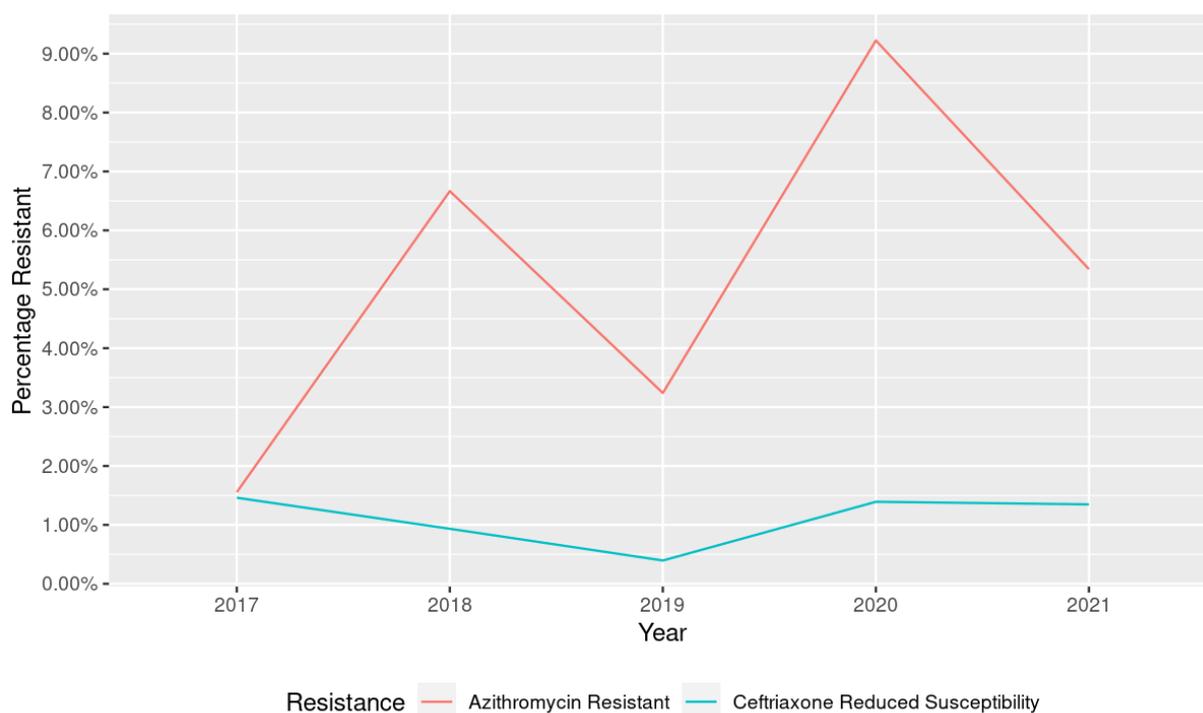


Table 3: Resistance to ceftriaxone and azithromycin for *Neisseria gonorrhoeae* in New Zealand: 2017–2021

	2017	2018	2019	2020	2021
Ceftriaxone Reduced Susceptibility	1.5% 13/890	0.9% 9/964	0.4% 5/1265	1.4% 19/1365	1.3% 16/1187
Azithromycin Resistant	1.6% 3/193	6.7% 24/360	3.2% 16/494	9.2% 63/683	5.3% 36/674

Figure 2 and Table 3 show the proportion of deduplicated gonorrhoea isolates (rather than gonorrhoea cases) with resistance to azithromycin and reduced susceptibility to ceftriaxone. No isolates have been reported as resistant to ceftriaxone. The percentage of isolates with reduced susceptibility to ceftriaxone remains low, fluctuating between 0.4% and 1.5% between 2017 and 2021 (Table 4).

Resistance to azithromycin has also fluctuated, but overall has increased from 1.6% in 2017 to a peak of 9.2% in 2020, before declining to 5.3% in 2021 (Table 5).

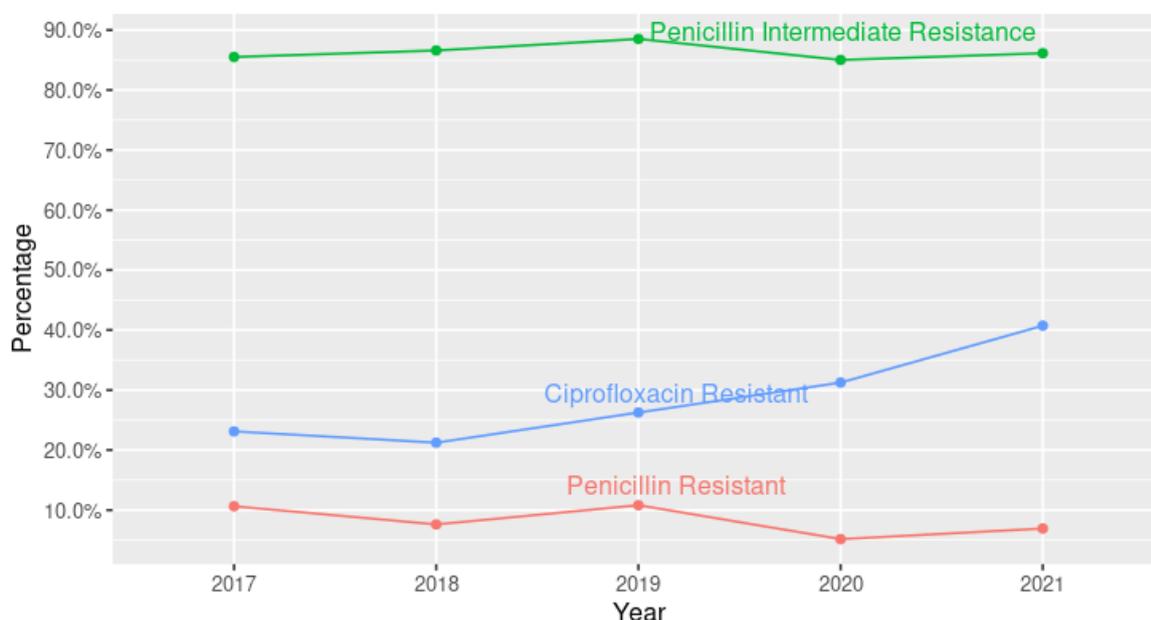
In 2017 and 2018 azithromycin resistance rates were similar between isolates from males and females. In 2019 however, resistance amongst isolates from males (4.0%) was nearly four times that of isolates from females (0.9%). This trend has continued into 2021, with the percentage of resistant isolates among males more than twice that of females. By age, azithromycin resistance was highest amongst isolated from those aged 15–24 in 2018 and amongst isolates from those aged 20–24 years and 30+ years in 2019. In 2020, resistance increased with age; 6.9% of isolates from those aged 20–24 years were resistant compared to 14% of isolates from those aged 40+. This was similar in 2021 with isolates amongst those aged 40+ reporting the highest rates of resistance (7.2%). By ethnicity, resistance to azithromycin was highest amongst isolates from those of European/other

ethnicity for most reporting years except 2018 when the highest resistance was reported among isolates from those of Māori and Asian ethnicities.

The highest percentage and number of azithromycin resistant isolates were reported in the Northern region for every year except 2017 and 2020 when Te Waipounamu reported 27% (34/125) of their isolates as resistant. Central North Island have reported few antimicrobial resistance results over this period. Changes to azithromycin AST practices occurred in some laboratories between 2018–2021, including in testing methods (changes in MIC gradient strip brands) and azithromycin interpretation (from MIC to EUCAST ECOFFs). These changes may have impacted AST results for azithromycin reported here.

Penicillin & Ciprofloxacin Resistance

Figure 3: Proportion of *Neisseria gonorrhoeae* isolates with resistance (or intermediate resistance) to penicillin and ciprofloxacin in NZ: 2017–2021



Over the 2017–2021 period resistance to penicillin has fluctuated but overall has decreased slightly from nearly 10.6% in 2017 to 6.9% in 2021. Intermediate resistance to penicillin has also remained steady but very high (>85%) for all reporting years (Table 7).

By sex, intermediate resistance to penicillin ranged from 82–90% among isolates from males and from 84–88% among isolates from females between 2017–2021. By age, intermediate resistance fluctuated, and there were no noticeable differences by ethnicity. Little AST for penicillin is undertaken in the Central and Northern North Island. Penicillin AST methods differ across laboratories, with some using disc diffusion and others MIC gradient strip testing, with different brands of strip tests. These differences in methods may yield different results across laboratories.

Ciprofloxacin resistance has increased steadily from 21% in 2018, to just over 40% in 2021 [Table 6]. By sex, resistance to ciprofloxacin was similar from 2017–2019 but has diverged slightly since. In 2020 resistance was 28% among isolates from females and 32% among isolates from males and in 2021, 20% of isolates were resistant among females and 45% among males. Resistance was similar across age groups from 2017–2019, slightly increased with age in 2020, and in 2021, resistance continued to increase with age from 20% of isolates in those aged 15–19 to 53% of isolates in those aged 40+. By ethnicity, isolates from those of Asian ethnicity had the highest rates of resistance each year, except for 2020, when those of European/other ethnicity reported the highest rates. Intermediate resistance to ciprofloxacin was under 1% throughout the reporting period and is not shown on this graph.

Tetracycline Resistance

AST results have only been received from one region (Te Waipounamu) from 2017–2021 [Table 8]. Resistance has increased during the reporting period from 24% of isolates in 2017 to 43% in 2021 in this region. The number of isolates tested has remained consistent, around 120 isolates since 2018. By sex, resistance is slightly higher amongst isolates from males across all years since 2018. Given the low number of isolates tested, overall comparisons by age and ethnicity have not been presented.

DISCUSSION AND LIMITATIONS

To date there have been no reported gonococcal isolates that are resistant to ceftriaxone in NZ, and levels of reduced susceptibility remain low (1.3% in 2021). Since 2017, the proportion of isolates with reduced susceptibility has been higher among females compared to males; in 2021 3.4% of samples from females had reduced susceptibility compared to 0.9% of male samples. Higher levels of reduced susceptibility have been reported in Te Manawa Taki compared to other regions, with up to 3.9% reduced susceptibility in 2020 (3.3% in 2021). The proportion of gonorrhoea cases undergoing susceptibility testing has been stable during the reporting period, and almost all isolates which are cultured undergo AST for ceftriaxone.

Azithromycin resistance (>1mg/L) has increased over time. No isolates with high-level resistance to azithromycin (>256mg/L) have been reported in New Zealand to date, and the MIC of resistant isolates were all <8.0mg/L, except for one isolate in 2020 with MIC of 16.0mg/L. The reason for the differences in resistance rates between the 2018/19 ESR survey (1.7% resistance) and surveillance data (6.7% 2018, 3.2% 2019) is not clear, but may reflect sampling practices. The 2018/19 survey intended to collect consecutive isolates while this report includes isolates collected for routine clinical practice.

These data highlight the continued importance of bacterial culture to monitor AMR, in addition to molecular testing for diagnosis. The proportion of gonococcal infections with an isolate available for AST has consistently been 17–18% over the past four years. This is slightly lower than that reported in Australia (23%) (Lahra 2022). Comparison with UK and US AMR surveillance is difficult due to different sentinel systems in use. (Public Health England 2021) (Centers for Disease Control and Prevention 2022).

NZ gonorrhoea AMR data are not systematically sampled and are influenced by swabbing practices. Cultures are primarily taken in sexual health services, with sampling bias potentially affecting generalisability of resistance profiles. An improved understanding of the demographics of those swabbed, including through the integration of clinical and laboratory data, may provide insight.

There were numerous data quality challenges, including a lack of standardisation of results, transcription errors resulting from the manual data entry process, and random errors. Efforts were made to confirm results with all laboratories, particularly resistant results, however some random errors may persist. Further, the small number of isolates tested, and differential reporting practices across laboratories limited the identification of spatial patterns in resistance. Finally, inconsistencies in AMR methods between laboratories, and changes in AST practices that occurred between 2017–2021 may have influenced the results presented in this report. These include differences in testing methodologies, materials, and interpretation standards used for each antibiotic across many labs.

In the future AMR gonorrhoea data will be included with the STI annual report/dashboard. There is work underway to enhance AMR data collection and this will also enable more timely reporting.

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APPENDIX

Ceftriaxone gonococcal AST results by region, ethnicity, and sex

Table 4: Number & proportion (%) of gonococcal isolates with reduced susceptibility to ceftriaxone, New Zealand, 2017–2021 by sex, age, ethnicity and region

Variable	2017		2018		2019		2020		2021	
	N	RS * N = 13 (1.5%) ¹	N	RS * N = 9 (0.9%) ¹	N	RS * N = 5 (0.4%) ¹	N	RS * N = 19 (1.4%) ¹	N	RS * N = 16 (1.3%) ¹
Sex	890		964		1,265		1,365		1,187	
Female	215	6 (2.8%)	241	5 (2.1%)	354	2 (0.6%)	322	10 (3.1%)	203	7 (3.4%)
Male	675	7 (1.0%)	723	4 (0.6%)	911	3 (0.3%)	1043	9 (0.9%)	984	9 (0.9%)
Age group	886		949		1,226		1,344		1,186	
0–14	7	0 (0.0%)	9	1 (11%)	16	0 (0%)	10	0 (0%)	7	0 (0%)
15–19	122	1 (0.8%)	120	1 (0.8%)	118	0 (0%)	105	2 (1.9%)	99	0 (0%)
20–24	239	4 (1.7%)	217	2 (0.9%)	283	1 (0.4%)	294	4 (1.4%)	226	4 (1.8%)
25–29	195	3 (1.5%)	218	3 (0.9%)	296	1 (0.3%)	321	6 (1.9%)	274	3 (1.1%)
30–39	179	4 (2.2%)	232	3 (0.9%)	333	1 (0.3%)	374	1 (0.3%)	362	5 (1.4%)
40+	144	1 (0.7%)	153	1 (0.7%)	180	2 (1.1%)	240	4 (1.7%)	218	4 (1.8%)
Unknown	4	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Ethnicity	890		964		1,265		1,365		1,187	
Asian	64	0 (0%)	57	2 (3.5%)	99	0 (0%)	113	1 (0.9%)	122	1 (0.8%)
European/Other	338	2 (0.6%)	380	1 (0.3%)	505	3 (0.6%)	495	3 (0.6%)	450	4 (0.9%)
Māori	172	7 (4.1%)	240	3 (1.2%)	304	1 (0.3%)	331	6 (1.8%)	305	6 (2.0%)
Pacific	141	0 (0%)	116	2 (1.7%)	169	0 (0%)	186	0 (0%)	168	1 (0.6%)
Unknown	175	4 (2.3%)	171	1 (0.6%)	188	1 (0.5%)	240	9 (3.8%)	142	4 (2.8%)
Region	890		964		1,265		1,365		1,187	
Central North Island	130	1 (0.8%)	143	0 (0%)	133	0 (0%)	148	3 (2.0%)	104	1 (1.0%)
Northern North Island	448	7 (1.6%)	401	5 (1.2%)	588	3 (0.5%)	630	4 (0.6%)	578	6 (1.0%)
Te Manawa Taki	118	4 (3.4%)	152	4 (2.6%)	233	1 (0.4%)	306	12 (3.9%)	273	9 (3.3%)
Te Waipounamu South Island	194	1 (0.5%)	268	0 (0%)	311	1 (0.3%)	281	0 (0%)	232	0 (0%)

¹n (%)

* RS = Reduced susceptibility to ceftriaxone

Azithromycin gonococcal AST results by region, ethnicity and sex

Table 5: Number & proportion (%) of gonococcal isolates with resistance to azithromycin, New Zealand, 2017–2021 by sex, age, ethnicity, and region

Variable	2017		2018		2019		2020		2021	
	N	Resistant, N = 3 (1.5%) ¹	N	Resistant, N = 24(6.7%) ¹	N	Resistant, N = 16(3.2%) ¹	N	Resistant, N = 63(9.2%) ¹	N	Resistant, N = 36(5.3%) ¹
Sex	193		360		494		683		674	
Female	53	1 (1.9%)	74	5 (6.8%)	117	1 (0.9%)	133	6 (4.5%)	114	3 (2.6%)
Male	140	2 (1.4%)	286	19 (6.6%)	377	15 (4.0%)	550	57 (10.0%)	560	33 (5.9%)
Age group	193		358		493		683		674	
0–14	2	0 (0.0%)	2	0 (0.0%)	7	0 (0.0%)	1	0 (0.0%)	3	0 (0%)
15–19	31	1 (3.2%)	35	3 (8.6%)	44	0 (0.0%)	44	2 (4.5%)	47	3 (6.4%)
20–24	54	0 (0.0%)	73	7 (9.6%)	144	5 (5.0%)	144	10 (6.9%)	111	6 (5.4%)
25–29	38	0 (0.0%)	82	4 (4.9%)	171	2 (1.6%)	171	14 (8.2%)	162	5 (3.1%)
30–39	35	1 (2.9%)	94	5 (5.3%)	201	6 (4.3%)	201	20 (10.0%)	213	12 (5.6%)
40+	33	1 (3.0%)	72	5 (6.9%)	122	3 (3.8%)	122	17 (14%)	138	10 (7.2%)
Unknown	0	0 (0%)	0	0 (0.0%)	0	0 (0.0%)	0	0 (0.0%)	0	0 (0.0%)
Ethnicity	193		360		494		683		674	
Asian	3	0 (0.0%)	23	2 (8.7%)	34	0 (0.0%)	60	3 (5.0%)	74	3 (4.1%)
European/Other	57	2 (3.5%)	137	11 (8.0%)	198	9 (4.5%)	219	33 (15.0%)	248	17 (6.9%)
Māori	19	1 (5.3%)	65	6 (9.2%)	95	3 (3.2%)	151	13 (8.6%)	171	8 (4.7%)
Pacific	8	0 (0.0%)	18	0 (0.0%)	56	0 (0.0%)	77	3 (3.9%)	79	2 (2.5%)
Unknown	106	0 (0.0%)	117	5 (4.3%)	111	4 (3.6%)	176	11 (6.2%)	102	6 (5.9%)
Region	193		360		494		683		674	
Central North Island	15	2 (13%)	10	3 (30.0%)	1	0 (0.0%)	1	1 (100.0%)	1	0 (0.0%)
Northern North Island	0	0 (.0%)	99	9 (9.1%)	231	10 (4.3%)	328	17 (5.2%)	342	24 (7.0%)
Te Manawa Taki	95	1 (1.1%)	130	6 (4.6%)	141	3 (2.1%)	228	11 (4.8%)	226	7 (3.1%)
Te Waipounamu South Island	83	0 (0.0%)	121	6 (5.0%)	121	3 (2.5%)	126	34 (27.0%)	105	5 (4.8%)

¹n (%)

Ciprofloxacin gonococcal AST results by region, ethnicity and sex

Table 6: Number & proportion (%) of gonococcal isolates with resistance to ciprofloxacin, New Zealand, 2017–2021 by sex, age, ethnicity, and region

Variable	2017		2018		2019		2020		2021	
	N	Resistant, N = 235 (23.1%) ¹	N	Resistant, N = 210 (21.2%) ¹	N	Resistant, N = 333 (26.3%) ¹	N	Resistant, N = 420 (31.3%) ¹	N	Resistant, N = 481 (40.7%) ¹
Sex	1,017		989		1,268		1,344		1,181	
Female	223	57 (26%)	242	49 (20%)	356	86 (24%)	305	85 (28%)	197	39 (20%)
Male	792	177 (22%)	742	159 (21%)	907	243 (27%)	1033	335 (32%)	979	440 (45%)
Unknown	2	1 (50%)	5	2 (40%)	5	4 (80%)	6	0 (0%)	5	2 (40%)
Age group	1,017		989		1,268		1,344		1,181	
0–14	8	1 (12%)	9	2 (22%)	15	4 (27%)	12	2 (17%)	6	0 (0%)
15–19	123	31 (25%)	122	25 (20%)	118	20 (17%)	99	22 (22%)	97	19 (20%)
20–24	266	63 (24%)	229	55 (24%)	277	73 (26%)	291	64 (22%)	228	69 (30%)
25–29	228	43 (19%)	217	54 (25%)	297	66 (22%)	318	100 (31%)	274	118 (43%)
30–39	212	52 (25%)	240	47 (20%)	328	96 (29%)	361	146 (40%)	362	163 (45%)
40+	175	44 (25%)	175	25 (16%)	192	57 (30%)	239	80 (33%)	212	112 (53%)
Unknown	5	1(20%)	17	2(12%)	41	17(41%)	24	6(25%)	2	0(0%)
Ethnicity	1,017		989		1,268		1,344		1,181	
Asian	77	25 (32%)	61	20 (33%)	98	33 (34%)	122	38 (34%)	120	71 (59%)
European/Other	412	90 (22%)	393	77 (20%)	511	170 (33%)	482	201 (42%)	447	215 (48%)
Māori	184	47 (26%)	245	47 (19%)	308	59 (19%)	322	88 (27%)	304	90 (30%)
Pacific	170	42 (25%)	117	30 (26%)	166	17 (10%)	183	25 (14%)	167	55 (33%)
Unknown	174	31 (18%)	173	36 (21%)	185	54 (29%)	245	68 (28%)	143	50 (35%)
Region	1,017		989		1,268		1,344		1,181	
Central North Island	125	23 (18%)	143	17 (12%)	132	19 (14%)	151	33 (22%)	103	45 (44%)
Northern North Island	587	155 (26%)	423	134 (32%)	590	117 (20%)	626	187 (30%)	576	284 (49%)
Te Manawa Taki	111	11 (9.9%)	152	24 (16%)	227	79 (35%)	300	78 (26%)	271	77 (28%)
Te Waipounamu South Island	194	46 (24%)	271	35 (13%)	319	118 (37%)	267	122 (46%)	231	75 (32%)

¹n (%)

Penicillin gonococcal AST results by region, ethnicity and sex¹

Table 7: Number & proportion (%) of gonococcal isolates by susceptibility to penicillin, New Zealand, 2017–2021 by sex, age, ethnicity, and region

Variable	2017				2018				2019				2020				2021			
	N	Resistant, N = 22(10.6%) ¹	Intermediate, N = 177(85.5%) ¹	Susceptible, N = 8(3.86%) ¹	N	Resistant, N = 21(7.6%) ¹	Intermediate, N = 239(86.5%) ¹	Susceptible, N = 16(5.8%) ¹	N	Resistant, N = 32(10.8%) ¹	Intermediate, N = 262(88.5%) ¹	Susceptible, N = 2(0.7%) ¹	N	Resistant, N = 21(5.2%) ¹	Intermediate, N = 346(85.0%) ¹	Susceptible, N = 40(9.8%) ¹	N	Resistant, N = 21(6.9%) ¹	Intermediate, N = 261(86.1%) ¹	Susceptible, N = 21(6.9%) ¹
Sex	207				276				296				407				303			
Female	59	5 (9%)	52 (88%)	2 (3%)	67	8 (12%)	56 (84%)	3 (5%)	80	6 (7.5%)	72 (90%)	2 (3%)	101	5 (5%)	83 (82%)	13 (13%)	50	1 (2%)	44 (88%)	5 (10%)
Male	147	17 (12%)	124 (84%)	6 (4.%)	208	13 (6%)	182 (88%)	13 (6%)	215	26 (12%)	189 (88%)	0 (0%)	305	16 (5%)	262 (86%)	27 (9%)	252	20 (8%)	216 (86%)	16 (6%)
Unknown	1	0 (0%)	1 (100%)	0 (0%)	1	0 (0%)	1 (100%)	0 (0%)	1	0 (0%)	1 (100%)	0 (0%)	1	0 (0%)	1 (100%)	0 (0%)	1	0 (0%)	1 (100%)	0 (0%)
Age group	207				276				296				407				303			
0–14	1	0 (0%)	1 (100%)	0 (0%)	1	1 (100%)	0 (0%)	0 (0%)	4	0 (0%)	4 (100%)	0 (0%)	4	0 (0%)	3 (75%)	1 (25%)	1	0 (0%)	1 (100%)	0 (0%)
15–19	34	5 (15%)	28 (82%)	1 (3%)	26	5 (19%)	20 (77%)	1 (4%)	14	0 (0%)	14 (100%)	0 (0%)	23	2 (9%)	18 (78%)	3 (13%)	16	0 (0%)	15 (94%)	1 (6%)
20–24	55	7 (13%)	45 (82%)	3 (6%)	65	4 (6%)	56 (86%)	5 (8%)	54	5 (9.3%)	49 (91%)	0 (0%)	86	3 (4%)	70 (81%)	13 (15%)	49	3 (6%)	45 (92%)	1 (2%)
25–29	42	1 (2%)	38 (90%)	3 (7%)	56	2 (4%)	52 (93%)	2 (4%)	64	8 (12%)	56 (88%)	0 (0%)	78	7 (9%)	65 (83%)	6 (8%)	64	5 (8%)	53 (83%)	6 (9%)
30–39	34	1 (3%)	32 (94%)	1 (3%)	70	7 (10%)	58 (83%)	5 (7%)	73	10 (14%)	62 (85%)	1 (1%)	122	5 (4%)	108 (89%)	9 (7%)	98	10 (10%)	79 (81%)	9 (9%)
40+	36	8 (22%)	28 (78%)	0 (0%)	44	0 (0%)	41 (93%)	3 (7%)	62	8 (13%)	53 (85%)	1 (2%)	73	3 (4%)	63 (86%)	7 (10%)	74	3 (4%)	67 (91%)	4 (5%)
Unknown	5	0(0%)	5(100%)	0(0%)	14	2(14%)	12(86%)	0(0.0%)	25	1(4%)	24(96%)	0(0%)	21	1(5%)	19(90%)	1(5%)	1	0(0.0%)	1(100%)	0(0%)
Ethnicity	207				276				296				407				303			
Asian	4	2 (50%)	1 (25%)	1 (25%)	6	0 (0%)	6 (100%)	0 (0%)	14	4 (29%)	10 (71%)	0 (0%)	11	1 (9%)	9 (82%)	1 (9%)	12	3 (25%)	8 (67%)	1 (8%)
European/ Other	63	11 (17%)	49 (78%)	3 (5%)	101	3 (3%)	94 (93%)	4 (4%)	117	12 (10%)	104 (89%)	1 (1%)	133	5 (4%)	114 (86%)	14 (11%)	113	10 (89%)	99 (88%)	4 (4%)
Māori	23	1 (4%)	21 (91%)	1 (4%)	50	7 (14%)	41 (82%)	2 (4%)	50	4 (8.0%)	45 (90%)	1 (2%)	91	4 (4%)	79 (87%)	8 (9%)	86	5 (6%)	73 (86%)	7 (8%)
Pacific	4	1 (25%)	2 (50%)	1 (25%)	7	1 (14%)	6 (86%)	0 (0%)	2	1 (50%)	1 (50%)	0 (0%)	18	3 (17%)	15 (83%)	0 (0%)	15	1 (7%)	11 (73%)	3 (20%)
Unknown	113	7 (6%)	104 (92%)	2 (2%)	112	10 (9%)	92 (82%)	10 (9%)	113	11 (9.7%)	102 (90%)	0 (0%)	154	8 (5%)	129 (84%)	17 (11%)	77	2 (3%)	70 (90%)	6 (8%)
Region	207				276				296				407				303			
Central North Island	7	1 (14%)	2 (29%)	4 (57%)	6	0 (0%)	6 (100%)	0 (0%)	65	2 (67%)	1 (33%)	0 (0%)	65	4 (6%)	48 (74%)	13 (20%)	14	0 (0%)	9 (64%)	5 (36%)
Northern North Island	17	1 (6%)	14 (82%)	2 (12%)	13	1 (8%)	12 (92%)	0 (0%)	15	0 (0%)	16 (100%)	0 (0%)	15	2 (13%)	11 (73%)	2 (13%)	18	0 (0%)	12 (67%)	6 (33%)
Te Manawa Taki	80	2 (3%)	77 (96%)	1 (1%)	102	7 (7%)	81 (79%)	14 (14%)	165	8 (7%)	114 (93%)	1 (1%)	165	7 (4%)	138 (84%)	20 (12%)	147	4 (2.7%)	133 (90%)	10 (7%)
Te Waipounamu South Island	103	18 (17%)	84 (82%)	1 (1%)	155	13 (8%)	140 (90%)	2 (1%)	162	22 (14%)	131 (85%)	1 (1%)	162	8 (5%)	149 (92%)	5 (3.1%)	124	17 (14%)	107 (86%)	0 (0%)

¹n (%)

Tetracycline gonococcal AST results by sex, age, ethnicity and region

Table 8: Number & proportion (%) of gonococcal isolates by susceptibility to tetracycline, New Zealand, 2017–2021 by sex, age, ethnicity, and region

Variable	2017			2018			2019			2020			2021							
	N	Resistant, N = 20 (23.5%) ¹	Intermediate N = 27 (31.8%) ¹	Susceptible, N = 38 (44.7%) ¹	N	Resistant, N = 20 (16.3%) ¹	Intermediate , N = 28 (22.8%) ¹	Susceptible, N = 75 (61.0%) ¹	N	Resistant N = 39 (30.2%) ¹	Intermediate N = 52 (40.3%) ¹	Susceptible, N = 38 (29.5%) ¹	N	Resistant N = 49 (37.4%) ¹	Intermediate , N = 63 (48.1%) ¹	Susceptible N = 19 (14.5%) ¹	N	Resistant, N = 48 (43.6%) ¹	Intermediate N = 54 (49.1%) ¹	Susceptible, N = 8 (7.0%) ¹
Sex	85				123				129				131				110			
Female		6 (29%)	4 (19%)	11 (52%)		4 (14%)	4 (14%)	21 (72%)		7 (25%)	6 (21%)	15 (54%)		8 (31%)	16 (62%)	2 (7.7%)		4 (31%)	9 (69%)	0 (0%)
Male		14 (22%)	23 (36%)	27 (42%)		16 (17%)	24 (26%)	54 (57%)		32 (32%)	46 (46%)	23 (23%)		41 (39%)	47 (45%)	17 (16%)		44 (45%)	45 (46%)	8 (8.2%)
Age group	85				123				129				131				110			
0–14		0 (0%)	0 (0%)	1 (100%)		0 (0%)	0 (0%)	0 (0%)		0 (0%)	0 (0%)	2 (100%)		0 (0%)	0 (0%)	0 (0%)		0 (0%)	0 (0%)	0 (0%)
15–19		5 (33%)	2 (13%)	8 (53%)		3 (25%)	4 (33%)	5 (42%)		1 (50%)	1 (50%)	0 (0%)		3 (60%)	2 (40%)	0 (0%)		1 (25%)	3 (75%)	0 (0%)
20–24		4 (15%)	10 (38%)	12 (46%)		6 (22%)	6 (22%)	15 (56%)		8 (33%)	8 (33%)	8 (33%)		9 (39%)	9 (39%)	5 (22%)		7 (44%)	7 (44%)	2 (12%)
25–29		4 (25%)	6 (38%)	6 (38%)		2 (7.1%)	10 (36%)	16 (57%)		10 (28%)	14 (39%)	12 (33%)		10 (37%)	14 (52%)	3 (11%)		7 (47%)	7 (47%)	1 (6.7%)
30–39		2 (18%)	3 (27%)	6 (55%)		8 (26%)	3 (9.7%)	20 (65%)		15 (37%)	16 (39%)	10 (24%)		17 (37%)	22 (48%)	7 (15%)		16 (41%)	20 (51%)	3 (7.7%)
40+		5 (31%)	6 (38%)	5 (31%)		1 (4.0%)	5 (20%)	19 (76%)		5 (21%)	13 (54%)	6 (25%)		10 (33%)	16 (53%)	4 (13%)		17 (47%)	17 (47%)	2 (5.6%)
Ethnicity	85				123				129				131				110			
Asian		1 (33%)	0 (0%)	2 (67%)		0 (0%)	0 (0%)	6 (100%)		3 (38%)	3 (38%)	2 (25%)		3 (38%)	5 (62%)	0 (0%)		6 (75%)	2 (25%)	0 (0%)
European/ Other		10 (21%)	16 (34%)	21 (45%)		10 (16%)	15 (24%)	37 (60%)		22 (28%)	39 (49%)	19 (24%)		29 (40%)	33 (46%)	10 (14%)		26 (38%)	39 (57%)	3 (4.4%)
Māori		0 (0%)	5 (50%)	5 (50%)		3 (14%)	3 (14%)	15 (71%)		5 (24%)	3 (14%)	13 (62%)		11 (35%)	14 (45%)	6 (19%)		13 (52%)	10 (40%)	2 (8.0%)
Pacific		1 (50%)	0 (0%)	1 (50%)		1 (17%)	3 (50%)	2 (33%)		1 (100%)	0 (0%)	0 (0%)		3 (43%)	2 (29%)	2 (29%)		2 (33%)	1 (17%)	3 (50%)
Unknown		8 (35%)	6 (26%)	9 (39%)		6 (21%)	7 (25%)	15 (54%)		8 (42%)	7 (37%)	4 (21%)		3 (23%)	9 (69%)	1 (7.7%)		1 (33%)	2 (67%)	0 (0%)
Region	85				123				129				131				110			
Central North Island		0 (0%)	0 (0%)	1 (100%)		0 (0%)	0 (0%)	0 (0%)		0 (0%)	0 (0%)	0 (0%)		0 (0%)	0 (0%)	0 (0%)		0 (0%)	0 (0%)	0 (0%)
Northern North Island		1 (100%)	0 (0%)	0 (0%)		0 (0%)	1 (100%)	0 (0%)		0 (0%)	0 (0%)	0 (0%)		0 (0%)	0 (0%)	0 (0%)		0 (0%)	0 (0%)	0 (0%)
Te Manawa Taki		0 (0%)	0 (0%)	0 (0%)		0 (0%)	0 (0%)	0 (0%)		0 (0%)	0 (0%)	0 (0%)		0 (0%)	0 (0%)	0 (0%)		0 (0%)	0 (0%)	0 (0%)
Te Waipounamu South Island		19 (23%)	27 (33%)	37 (45%)		20 (16%)	27 (22%)	75 (61%)		39 (30%)	52 (40%)	38 (29%)		49 (37%)	63 (48%)	19 (15%)		48 (44%)	54 (49%)	8 (7.3%)

¹n (%)



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