SURVEILLANCE REPORT: ANTIBIOTIC CONSUMPTION IN NEW ZEALAND, 2006 – 2014

PREPARED FOR: Ministry of Health

CLIENT REPORT No: FW15031

PREPARED BY: Institute of Environmental Science and Research Limited

PUBLISHED: May 2016

This report is available at www.surv.esr.cri.nz

First published: 10 May 2016

Recommended citation:
Williamson DA, Roos RF, Verrall A.
Antibiotic consumption in New Zealand, 2006–2014.
The Institute of Environmental Science and Research Ltd. Porirua, New Zealand. 2016.

ISSN: 2463-2813

Client Report FW15031

ACKNOWLEDGEMENTS

This report was prepared by Dr Deborah Williamson, Dr Rebekah Roos, and Dr Ayesha Verrall.

Thanks to the following people for their contributions to this report:

Jason Arnold (PHARMAC) for providing data and helpful advice, Dr Mehnaz Adnan (Health Intelligence Team, ESR) for peer review of the SAS analysis and Maritza Marull for formatting the report.

Associate Professor Mark Thomas, Dr Alesha Smith, Greg Williams and Helen Heffernan for peer review.

This report was prepared as part of a Ministry of Health contract for scientific services.

DISCLAIMER

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SUMMARY

- One of the key drivers of antimicrobial resistance is the use and misuse of antibiotics, and high levels of community antibiotic consumption correlates with high frequencies of bacterial resistance in some settings.
- As such, knowledge of the patterns of antibiotic consumption within a population provides valuable information on when, where, and to whom antibiotics are prescribed. Such knowledge is critical in informing possible public health interventions to reduce inappropriate antibiotic use.
- Accordingly, the aims of this study were to: (i) to determine national patterns of antibiotic consumption, including assessment of seasonal variation in prescribing, and (ii) explore potential associations between antibiotic consumption and patient characteristics, such as age, sex and ethnicity.
- Data on all subsidised antibiotic dispensing in New Zealand between 1st January 2006 and 31st December 2014 were obtained from the National Pharmaceutical Collection. This study includes information on 'antibacterials for systemic use (ATC group J01)', subsequently referred to as 'antibiotics'. In keeping with the World Health Organization Collaborating Centre (WHOCC) for Drug Statistics methodology, antibiotic dispensing was expressed as the number of defined daily doses (DDDs) per 1000 population per day (DID).
- Total antibiotic consumption in New Zealand increased by 49% from 17.3 DID in 2006, to 25.8 DID in 2014 (Table 4). Antibiotic consumption peaked in 2012 and 2013 at 25.9 DID.
- The increase in antibiotic consumption occurred across all regions, in all ages, and amongst all ethnic groups.
- The use of extended-spectrum penicillins (ie amoxicillin), which almost doubled in the study period, made a major contribution to the overall increase. In 2014 extended-spectrum penicillins represented approximately one-quarter of all antibiotic use in New Zealand. In general, penicillin consumption was highest in young children, in the upper North Island and in Pacific peoples.
- Consumption of quinolones increased early in the study period and then declined from 2011 onwards.
- Total antibiotic consumption in New Zealand in 2013 was higher than 22 of 29 European countries participating in antibiotic consumption surveillance in 2013.
- This report provides valuable baseline information on patterns of antibiotic consumption in New Zealand, and serves as an ongoing platform on which to gauge the effects of potential future community-based antimicrobial stewardship efforts.
- Future work should focus on identifying the appropriateness of antibiotic prescribing, particularly for penicillin prescribing, and on both reducing unwarranted antibiotic use and improving antibiotic selection when therapy is indicated.

1. INTRODUCTION

Antimicrobial resistance (AMR) is one of the greatest public health threats of the modern age [1]. As the prevalence of antimicrobial resistance rises, treatment of common infectious diseases such as respiratory infections and urinary tract infections becomes increasingly challenging. Advances made in complex medical procedures, such as organ transplantation, neonatology and intensive care, are also threatened. Compounding this threat is the scarcity of new antimicrobial compounds in the research and development pipeline [2].

One of the key factors responsible for the emergence and spread of AMR is the use and overuse of antimicrobials [3]. As such, knowledge of the consumption of antimicrobials within a population provides valuable insights into how, when and where antimicrobials are being used [4]. Other benefits of monitoring antimicrobial consumption include the provision of information to:

- guide the development of treatment guidelines and national formularies
- evaluate the impact of educational and regulatory interventions
- provide a platform to assess the cost-effectiveness of antimicrobial prescribing
- benchmark comparisons of antimicrobial usage at a local, regional, national or international level
- assess the public health consequences of antimicrobial use (and misuse).

In 2001, the World Health Organization (WHO) Global Strategy for Containment of Antimicrobial Resistance identified two fundamental priorities in efforts to combat AMR [5]: (1) a national commitment to AMR containment as a public health priority; and (2) effective surveillance of AMR and antimicrobial usage to support the development, implementation and evaluation of AMR containment efforts. More recently, in 2015, the WHO Regional Committee for the Western Pacific produced the Action Agenda for Antimicrobial Resistance in the Western Pacific Region [6]. The report identified a number of regional knowledge gaps, including a lack of national policies on antimicrobial use in half of responding member countries [6]. As such, one of the priority actions identified in the report was to 'improve surveillance of AMR and monitoring of antimicrobial use'. The report suggested a number of mechanisms for achieving this aim:

- *develop and implement harmonized standards and methodologies for improved monitoring of AMR and antimicrobial use in human and emerging pathogens, in alignment with globally agreed approaches, and guidance of regional coordinating mechanisms*
- *incorporate the use of reliable evidence to inform policy and action through coherent national systems and regional networks and collect, analyse, share and disseminate data generated from monitoring of AMR and antimicrobial use through these networks*
- *develop and strengthen national surveillance systems including laboratory capacity to monitor trends of AMR and antimicrobial use, supported by regional surveillance networks.*

Unlike surveillance of AMR, there is no standardised surveillance system for monitoring antimicrobial consumption in New Zealand, and to date, information on antimicrobial usage in New Zealand has been sporadic. Several previous studies have assessed different aspects of antimicrobial usage in New Zealand [7-10], although few have systematically described the comparative and longitudinal trends of antimicrobial usage across sociodemographic strata such as age, sex and ethnicity. Such information is particularly relevant in New Zealand, where the incidence of many infectious diseases has marked sociodemographic inequalities.

Accordingly, the aims of this first annual report on antimicrobial consumption in New Zealand are to:

- provide an overview of antimicrobial consumption in the New Zealand community
- provide information on comparative antimicrobial usage stratified by patient characteristics such as age, sex, ethnicity and District Health Board (DHB) domicile
- provide information on geographic differences in antimicrobial consumption across New Zealand
- assess the feasibility of using previously described quality indicators of antimicrobial usage, in order to facilitate comparison with other geographic settings
- establish an effective and sustainable surveillance system for monitoring antimicrobial consumption in New Zealand.

2. METHODS

2.1 DATA SOURCES

2.1.1 National Pharmaceutical Collection

Information on antimicrobial dispensing between 1 January 2006 and 31 December 2014 was obtained from the National Pharmaceutical Collection, a data warehouse jointly owned by the New Zealand Ministry of Health and PHARMAC (the national Pharmaceutical Management Agency). This warehouse contains information on subsidised dispensings (cf. prescriptions) of medications, including antimicrobials that have been processed by the Sector Services General Transaction Processing System (GTPS). The Pharmaceutical Collection only contains information about antimicrobials that have been dispensed in the community, that is, it does not contain information on antimicrobials dispensed in private or public hospitals. Through an encrypted National Health Index number, dispensing records are linked to basic demographic information about each patient, including age, sex, ethnicity and DHB domicile.

2.1.2 Statistics New Zealand

Denominator data from Statistics New Zealand was used to calculate rates of antibiotic consumption. Further details are provided in the Analytical Methods section below.

2.2 ANALYTICAL METHODS

In this report, community antibiotic consumption was defined as the amount of systemic antibiotics for which a reimbursement claim was made to PHARMAC. This includes claims from primary care and discharge prescriptions (ie. prescriptions written in hospitals, but dispensed in the community) but excludes consumption in hospitals.

Antimicrobial claims were categorised according to the anatomical therapeutic chemical (ATC) classification. For the purposes of this project, information on ‘antibacterials for systemic use (ATC group J01)’ were included (subsequently referred to as ‘antibiotics’). This category excludes topical antibiotics, antimycobacterials, antifungals and antivirals. Data on dispensing of topical antimicrobials, antifungals and antivirals were not included in this report. Only first- and second-generation cephalosporin consumption were considered in this report, as third- and fourth-generation cephalosporins are not used in a community setting in New Zealand. For clarity, the term ‘antibiotic consumption’ is used throughout the report.

Consistent with the ATC system and recent methodology described by the European Centre for Disease Prevention and Control (ECDC) [11], the following J01 classifications (‘Level 3 classification’ also known as ‘pharmacological subgroups’) were used:

Table 1. Level 3 classification by ATC code and antibiotic class

ATC code	Antibiotic class	Route of administration
J01A	Tetracyclines	Oral
J01C	Penicillins	Oral
J01D	Cephalosporins and other β-lactams	Oral
J01E	Sulfonamides and trimethoprim	Oral
J01F	Macrolides and lincosamides	Oral
J01M	Quinolones	Oral
J01X	Urinary antiseptics	Oral

Similarly, based on ATC and ECDC methodology [11], the following subclasses of antibiotics ('Level 4 classification' also known as 'chemical subgroups') were assessed (Table 2). The European Surveillance of Antimicrobial Consumption (ESAC) classification is also listed in Table 2, where applicable.

Table 2. Level 4 classification by ATC code, antibiotic subclass and ESAC classification

ATC group	Subclass	ESAC classification
J01A: Tetracyclines	J01AA02: Doxycycline J01AA07: Tetracycline J01AA08: Minocycline	
J01C: Penicillins	J01CA: Penicillins with extended-spectrum • J01CA04: amoxicillin J01CE: β-lactamase-sensitive penicillins • J01CE02: phenoxymethylpenicillin (penicillin V) J01CF: β-lactamase resistant penicillins • J01CF01: dicloxacillin • J01CF05: flucloxacillin J01CR Combinations of penicillins, including β-lactamase inhibitors • J01CR02: amoxicillin and enzyme inhibitor	Broad-spectrum Narrow-spectrum Broad-spectrum
J01D: Cephalosporins and other β-lactams	J01DB: First-generation cephalosporins • J01DB01: cephalexin J01DC Second-generation cephalosporins • J01DC04: cefaclor	Narrow-spectrum Broad-spectrum
J01E: Sulfonamides and trimethoprim	J01EA: Trimethoprim and derivatives • J01EA01: trimethoprim J01EE Combinations of sulfonamides and trimethoprim, incl. derivatives • J01EE01: sulfamethoxazole and trimethoprim	
J01F: Macrolides and lincosamides	J01FA: Macrolides • J01FA01: erythromycin • J01FA06: roxithromycin • J01FA09: clarithromycin • J01FA10: azithromycin J01FF Lincosamides • J01FF01: clindamycin	 Short-acting (narrow-spectrum) Intermediate-acting (broad-spectrum) Intermediate-acting (broad-spectrum) Long-acting (broad-spectrum)
J01M: Quinolones	JO1MA: Fluoroquinolones • JO1MA02: ciprofloxacin • J01MA06: norfloxacin • J01MA14: moxifloxacin	 Second-generation First-generation Third-generation
J01X: Urinary antiseptics	• J01XE01: nitrofurantoin	

In keeping with the World Health Organization Collaborating Centre (WHOCC) for Drug Statistics methodology, antibiotic dispensing was expressed as the number of defined daily doses (DDDs) per 1000 population per day, also known as DID. Pharmaceutical claims data includes the drug formulation and the number of units dispensed for each record, which allows calculation of the total amount dispensed. By dividing amounts dispensed by the agreed average adult maintenance dose per day, the number of DDDs dispensed are obtained. This allows the aggregation of antibiotic

consumption within and across classes of antibiotics, which would not be possible if amounts alone were compared. DDDs were calculated based on the 2013 update from the WHOCC (www.whocc.no/atc_ddd_index). Importantly, DDDs are not applicable to paediatric populations (defined as children under 15 years of age in this report) or to topical antibiotics. Therefore, for comparisons across age groups, the dispensing rate was calculated as the number of packages dispensed per 100 population per year, also known as PID. However, in order to allow comparison with other reports that have used DID across all age groups [8, 11], we present consumption of systemic antibiotics predominantly by DID.

Pharmaceutical claims data is linked to demographic data (including age, sex and ethnicity) of the patient through an encrypted unique identifier, the National Health Index (NHI) number. We excluded records that were not linked to an encrypted NHI number. Additional exclusions from the analysis related to the order type: only individual prescriptions were included, whereas practitioner's supply orders and bulk supply orders were excluded.

2.2.1 Statistical analysis

Rates of antibiotic consumption by age group, sex, and district health board (DHB) were calculated using mid-year population estimates from Statistics New Zealand. Denominator data used to calculate rates for ethnic groups are based on the proportion of people in each ethnic group from the 2013 census 'usually resident population' applied to the mid-year population estimates. Ethnicity was prioritised in the following order: Māori, Pacific peoples, Asian, Middle Eastern/Latin American/African (MELAA) and European or Other (including New Zealander) ethnic groups.

Linear regression was performed on annual totals (DID) to assess the statistical significance of trends over time.

The calculation of DID and disaggregation by year, age, sex, prioritised ethnicity and DHB was carried out using SAS Enterprise Guide 4.3. Linear regression and confidence intervals were calculated by STATA, version 13.

2.3 QUALITY INDICATORS

The European Surveillance of Antimicrobial Consumption (ESAC, http://ecdc.europa.eu/ en/ activities/surveillance/ESAC-Net/Pages/index.aspx) project previously described a set of 12 quality indicators that could be used to assess outpatient antibiotic use [12]. These quality indicators were developed by consensus through a series of workshops, and were ranked according to their relevance in the following areas:

- reducing antimicrobial resistance
- patient health benefit
- cost effectiveness
- information for public health policy makers.

The suggested indicators are presented in Table 3 below.

Table 3. ESAC Quality Indicators

Indicator	Description	Measure
J01	**Consumption of antibacterials for systemic use (J01)**	**DDD per 1000 population per day**
J01C	**Consumption of penicillins (J01C)**	**DDD per 1000 population per day**
J01D	**Consumption of cephalosporins (J01D)**	**DDD per 1000 population per day**
J01F	**Consumption of macrolides and lincosamides (J01F)**	**DDD per 1000 population per day**
J01M	**Consumption of quinolones (J01M)**	**DDD per 1000 population per day**
J01CE_%	Consumption of β-lactamase sensitive penicillins (J01CE)	Percentage of total consumption
J01CR_%	**Consumption of combinations of penicillins, including β-lactamase inhibitors (J01CR)**	**Percentage of total consumption**
J01DD+DE_%	Consumption of third- and fourth-generation cephalosporins (J01DD and J0DE)	Percentage of total consumption
J01MA_%	**Consumption of fluoroquinolones (J01MA)**	**Percentage of total consumption**
J01_B/N	**Ratio of the consumption of broad-spectrum* to the consumption of narrow-spectrum^ penicillins, cephalosporins and macrolides**	**Ratio**
J01_SV	**Seasonal variation of the total antibiotic consumption (J01) in a 12-month period starting in July and ending the following June.**	**Percentage: [DDD (winter quarters)/ DDD (summer quarters)]**
J01M_SV	Seasonal variation of quinolone consumption (J01M) in a 12-month period starting in July and ending the following June.	Percentage: [DDD (winter quarters)/ DDD (summer quarters)]

* (J01(CR+DC+(F-FA01))).
^ (J01(CE+DB+FA01)).

In order to establish a baseline for these quality measures in New Zealand and facilitate comparison with other countries, we included nine of these quality indicators in this report (highlighted in Table 3). We did not include the indicator assessing β-lactamase-sensitive penicillins (penicillin V, J01CE_%) as these accounted for <1% of total antibiotic consumption. In addition, we did not include information on consumption of third- and fourth-generation cephalosporins (J01DD+DE_%) as these are not used in the New Zealand community. Finally, we did not include information on seasonal variation in quinolone consumption (J01M_SV), as this was influenced by schedule changes to norfloxacin in New Zealand.

3. RESULTS

3.1 TOTAL ANTIBIOTIC CONSUMPTION

The dataset comprised approximately 36 million records. Just over one percent of records were excluded because they were not linked to an NHI (403,164 or 1.12%). The percentage without an NHI decreased across the study period (from 1.7% in 2006 to 0.85% in 2014).

Total antibiotic consumption in New Zealand increased significantly by 50% from 17.3 in 2006 to 25.9 DID in 2012 and remained stable from 2012 to 2014 (Figure 1). The average annual increase from 2006 to 2014 was 1.06 DID per year (95% confidence interval 0.74 – 1.38) (P <0.001). Overall, penicillins (J01C) were the most heavily consumed group of antibiotics (13.1 DID in 2014), followed by tetracyclines (J01A, 6.5 DID in 2014)) and then macrolides (J01F, 2.9 DID in 2014) (Figure 1 and Table 4).

Statistically significant increases in consumption were detected for all level 3 groups, with the exception of quinolones (J01M) for which consumption peaked in 2009 and 2010 at 0.8 DID, and then reduced significantly to 0.6 DID in 2014 (Table 4). Between 2006 and 2014, consumption of penicillins (J01C) increased by 4.2 DID, accounting for almost half the increase in total antibiotic consumption, followed by tetracycline (J01A) consumption, which increased by 2.6 DID.

Overall, the most heavily consumed individual antibiotics were doxycycline (6.4 DID in 2014) and amoxicillin (6.4 DID in 2014), which together accounted for 49.3% of all consumption in 2014, followed by amoxicillin-clavulanate (4.6 DID in 2014), and flucloxacillin (1.7 DID in 2014) (Table 5).

Figure 1. Antibiotic consumption for systemic use (ATC group J01), 2006–2014, expressed as DDD per 1000 population per day

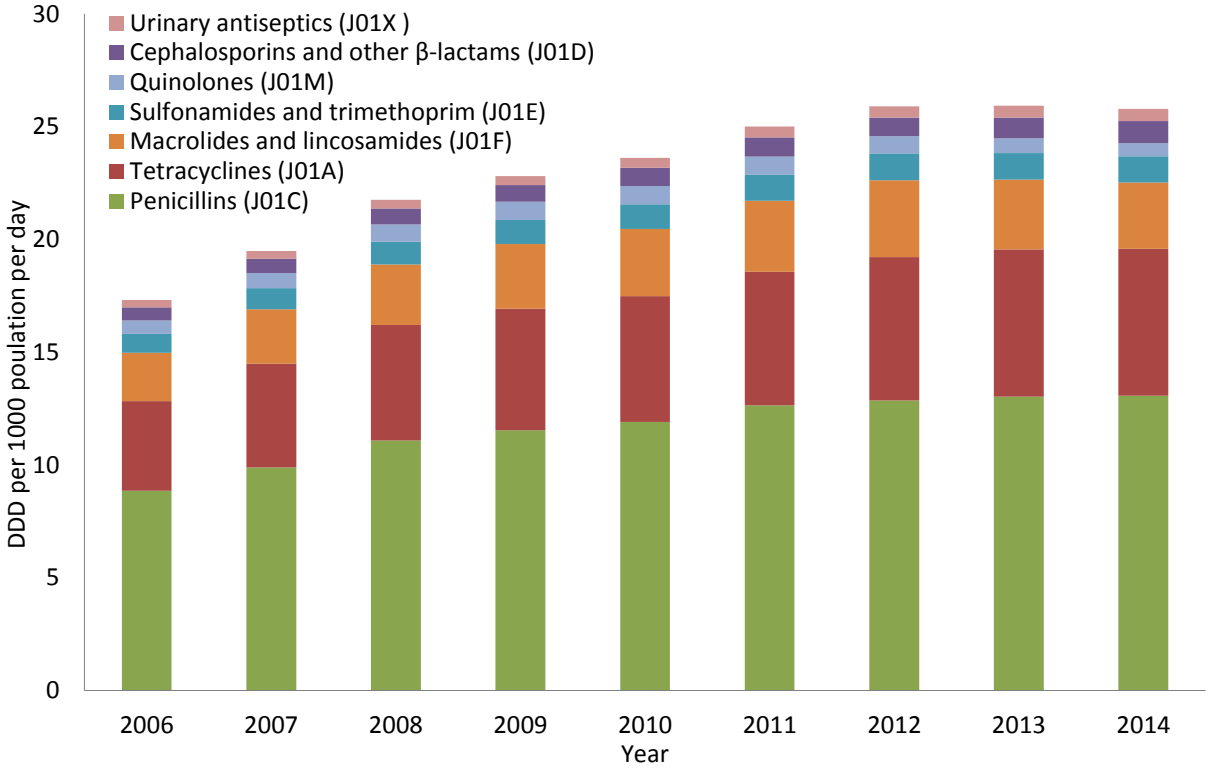


Table 4. Antibiotic consumption for systemic use by ATC level 3 group in New Zealand, 2006–2014, expressed as DDD per 1000 population per day

ATC level 3 group	2006	2007	2008	2009	2010	2011	2012	2013	2014	Average annual increase (95% confidence interval)	P value
Tetracyclines (J01A)	3.97	4.60	5.13	5.39	5.59	5.92	6.37	6.52	6.53	0.32 (0.25 - 0.38)	<0.001
Penicillins (J01C)	8.86	9.89	11.08	11.54	11.90	12.64	12.85	13.03	13.06	0.51 (0.36 - 0.67)	0.001
Cephalosporins and other β-lactams (J01D)	0.58	0.63	0.71	0.74	0.82	0.86	0.82	0.93	0.99	0.05 (0.04 - 0.06)	<0.001
Sulfonamides and trimethoprim (J01E)	0.84	0.94	1.01	1.06	1.10	1.16	1.19	1.18	1.17	0.04 (0.03 - 0.05)	<0.001
Macrolides and lincosamides (J01F)	2.14	2.40	2.68	2.87	2.97	3.15	3.40	3.10	2.93	0.12 (0.04 - 0.19)	0.007
Quinolones (J01M)	0.59	0.67	0.77	0.81	0.81	0.79	0.78	0.65	0.58	0.00 (-0.03 - 0.03)	0.879
Urinary antiseptics (J01X)	0.31	0.33	0.36	0.38	0.42	0.47	0.51	0.52	0.54	0.03 (0.03 - 0.03)	<0.001
Total (J01)	**17.29**	**19.47**	**21.73**	**22.79**	**23.61**	**24.99**	**25.89**	**25.91**	**25.77**	**1.06 (0.74 - 1.38)**	**<0.001**

Table 5. Ten most heavily consumed antibiotics in the New Zealand community, 2014, expressed as DDD per 1000 population per day

Antibiotic name	DDD per 1000 population per day	Proportion of all DDD in 2014 (%)
Doxycycline	6.36	24.7
Amoxicillin	6.35	24.6
Amoxicillin-clavulanate	4.61	17.9
Flucloxacillin	1.73	6.7
Roxithromycin	1.40	5.4
Erythromycin	1.36	5.3
Trimethoprim	0.65	2.5
Trimethoprim-sulfamethoxazole	0.52	2.0
Nitrofurantoin	0.52	2.0
Ciprofloxacin	0.46	1.8

3.2 DEMOGRAPHIC ASSOCIATIONS WITH ANTIBIOTIC CONSUMPTION

3.2.1 Age

Antibiotic consumption increased significantly over the study period across all age groups (selected years are shown in Figure 2 and all years are shown in Table 6). Antibiotic consumption was consistently high among young adults aged 15–19 years and older adults (aged ≥ 60 years).

Figure 2. Antibiotic consumption for systemic use (ATC group J01) by year and age group, 2006-2014, expressed as DDD per 1000 population per day

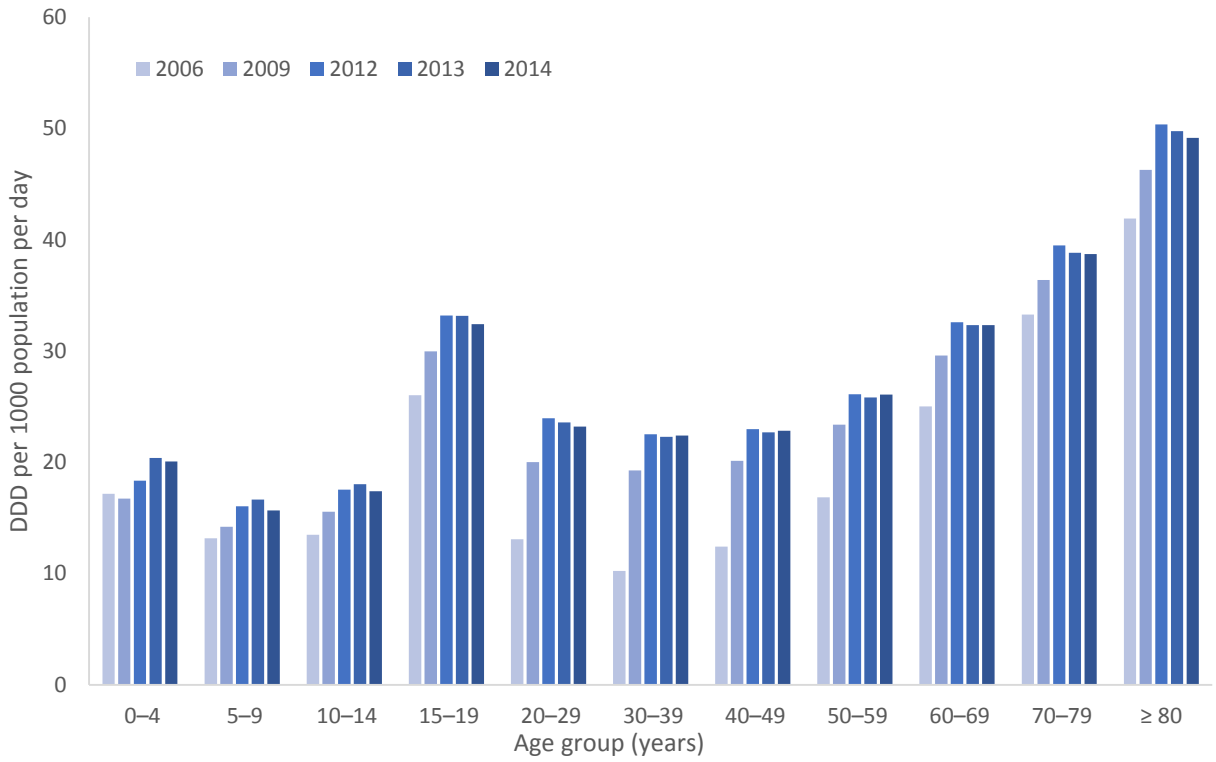


Table 6. Antibiotic consumption for systemic use (ATC group J01) by year and age group, 2006-2014, expressed as DDD per 1000 population per day

Age group (years)	2006	2007	2008	2009	2010	2011	2012	2013	2014
0–4	17.17	16.97	17.15	16.73	17.32	17.92	18.36	20.41	20.08
5–9	13.16	13.54	14.11	14.22	14.93	16.26	16.04	16.65	15.68
10–14	13.50	13.89	15.42	15.57	16.28	17.24	17.55	18.04	17.40
15–19	26.04	26.71	28.24	29.99	30.84	32.12	33.19	33.17	32.40
20–29	13.09	15.25	18.12	20.02	21.26	22.91	23.97	23.60	23.20
30–39	10.25	13.71	17.75	19.26	20.17	21.82	22.53	22.28	22.41
40–49	12.43	15.87	18.77	20.12	20.71	22.03	22.98	22.68	22.84
50–59	16.87	20.90	22.34	23.40	23.99	25.04	26.13	25.83	26.08
60–69	25.04	27.25	29.16	29.59	30.15	31.52	32.58	32.32	32.33
70–79	33.28	33.80	35.99	36.38	37.03	38.44	39.49	38.82	38.72
≥ 80	41.92	42.50	45.15	46.28	47.15	49.09	50.36	49.76	49.14
Total	**17.29**	**19.47**	**21.73**	**22.79**	**23.61**	**24.99**	**25.89**	**25.91**	**25.77**

When measured in PID, antibiotic consumption was highest at the extremes of age (Figure 3, Table 7). Adults aged ≥80 years had the highest rate of consumption followed by children under five years.

Figure 3. Antibiotic consumption for systemic use (ATC group J01) by age group, 2014, expressed as packages per 100 population per year

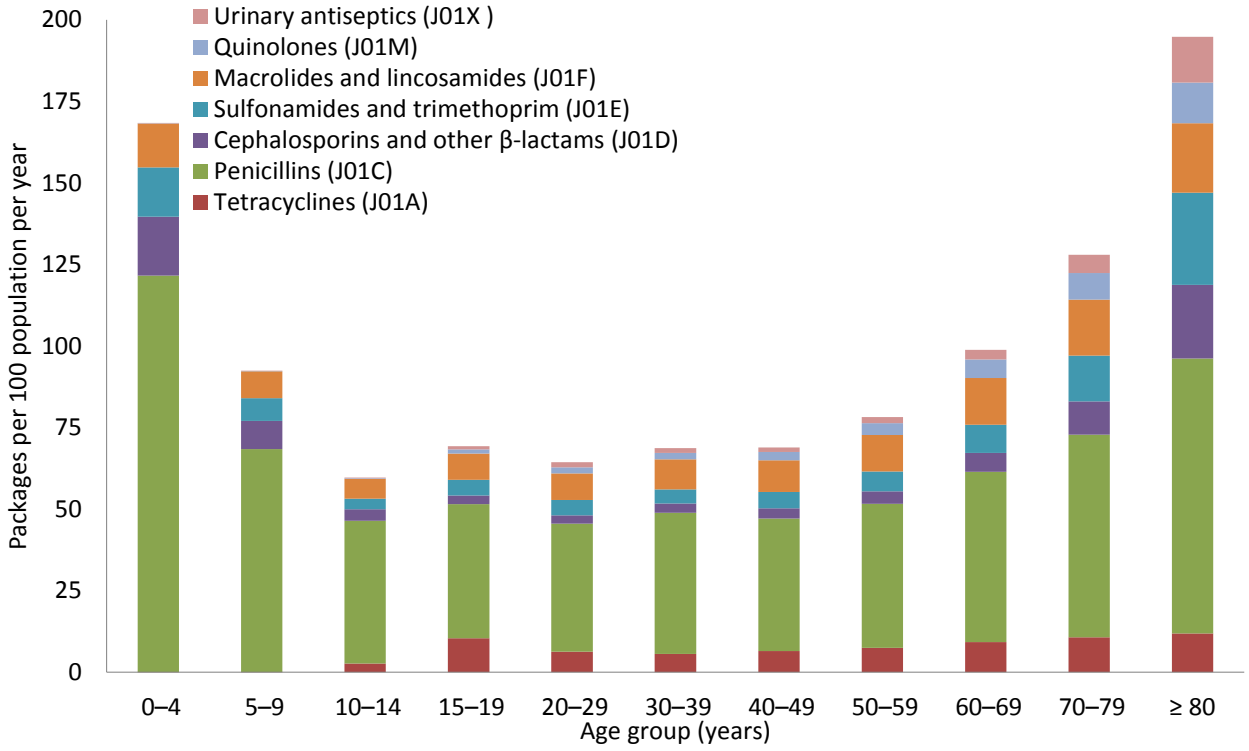
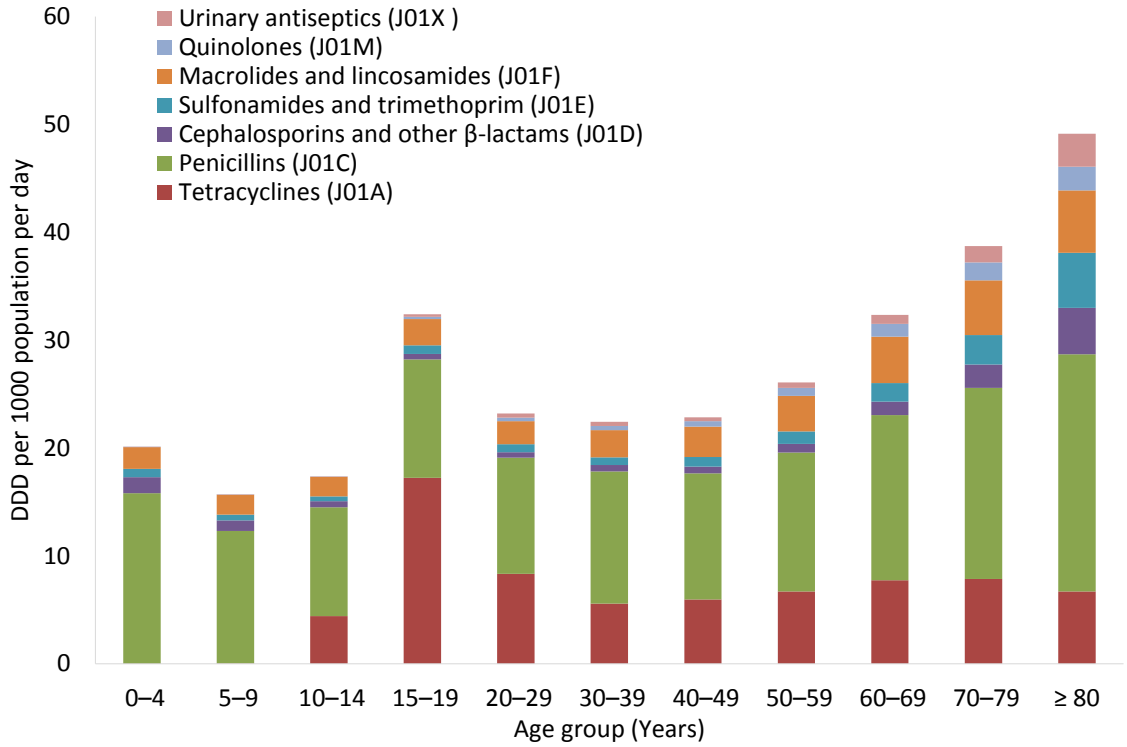


Table 7. Antibiotic consumption for systemic use in packages by age group and ATC level 3 group, 2014, expressed as packages per 100 population per year

ATC level 3 group	Age group (years)											
	0–4	5–9	10–14	15–19	20–29	30–39	40–49	50–59	60–69	70–79	≥80	All
Tetracyclines (J01A)	0.00	0.02	2.64	10.42	6.34	5.58	6.50	7.51	9.27	10.76	11.87	6.37
Penicillins (J01C)	121.60	68.45	43.81	41.17	39.20	43.29	40.64	44.09	52.18	62.12	84.29	52.94
Cephalosporins and other β-lactams (J01D)	18.10	8.58	3.53	2.59	2.58	2.91	3.08	3.83	5.80	10.18	22.59	5.89
Sulfonamides and trimethoprim (J01E)	15.07	7.01	3.23	4.87	4.72	4.33	5.04	6.14	8.64	14.03	28.31	7.49
Macrolides and lincosamides (J01F)	13.48	8.23	6.07	8.01	8.08	9.16	9.75	11.14	14.32	17.18	21.24	10.75
Quinolones (J01M)	0.03	0.08	0.24	1.23	1.91	1.97	2.54	3.68	5.70	8.13	12.44	2.97
Urinary antiseptics (J01X)	0.11	0.11	0.14	1.02	1.57	1.44	1.31	1.79	2.84	5.48	13.95	2.02
Total (J01)	**168.40**	**92.48**	**59.65**	**69.30**	**64.42**	**68.68**	**68.87**	**78.19**	**98.75**	**127.88**	**194.68**	**88.43**

In general, antibiotic consumption (measured by DID) increased with age, except for tetracyclines (J01A) which had the highest consumption in the 15–19 years age group (17.2 DID) and declined in older age groups (Figure 4, Table 8). Three age groups had an average annual consumption of more than one antibiotic dispensing per year (under five years, 70–79 years and ≥80 years age groups).

Figure 4. Antibiotic consumption for systemic use (ATC group J01) by age group, 2014, expressed as DDD per 1000 population per day*



*DDDs presented for children aged under 15 years should be interpreted with caution (see analytical methods).

Table 8. Antibiotic consumption for systemic use by age group and ATC level 3 group, 2014, expressed as DDD per 1000 population per day

ATC level 3 group	Age group (years)											
	0–4	5–9	10–14	15–19	20–29	30–39	40–49	50–59	60–69	70–79	≥80	All
Tetracyclines (J01A)	0.00	0.02	4.42	17.24	8.33	5.56	5.94	6.71	7.72	7.86	6.71	6.53
Penicillins (J01C)	15.81	12.30	10.09	10.98	10.77	12.27	11.70	12.87	15.31	17.73	21.96	13.06
Cephalosporins and other β-lactams (J01D)	1.48	0.97	0.55	0.49	0.51	0.58	0.65	0.81	1.25	2.15	4.31	0.99
Sulfonamides and trimethoprim (J01E)	0.77	0.55	0.46	0.80	0.75	0.72	0.89	1.16	1.74	2.74	5.10	1.17
Macrolides and lincosamides (J01F)	2.00	1.82	1.79	2.44	2.13	2.54	2.80	3.28	4.31	5.07	5.79	2.93
Quinolones (J01M)	0.00	0.02	0.05	0.21	0.33	0.38	0.51	0.76	1.18	1.65	2.19	0.58
Urinary antiseptics (J01X)	0.01	0.02	0.03	0.24	0.40	0.37	0.36	0.50	0.82	1.52	3.07	0.52
Total (J01)	**20.08**	**15.68**	**17.40**	**32.40**	**23.20**	**22.41**	**22.84**	**26.08**	**32.33**	**38.72**	**49.14**	**25.77**

3.2.2 Sex

Overall, females consumed more antibiotics than males (28.6 DID and 22.8 DID respectively in 2014, Figure 5). This difference in consumption was observed to varying extents across all classes, and was greatest for sulphonamides and trimethoprim (J01E) as well as urinary antiseptics (J01X), (Table 9). In 2006, females consumed 52% more quinolones (J01M) than males, although consumption for this pharmacological group actually equalised by 2014 (Table 36 in the Appendix).

Figure 5. Antibiotic consumption for systemic use (ATC group J01) by sex, 2006 to 2014, expressed as DDD per 1000 population per day

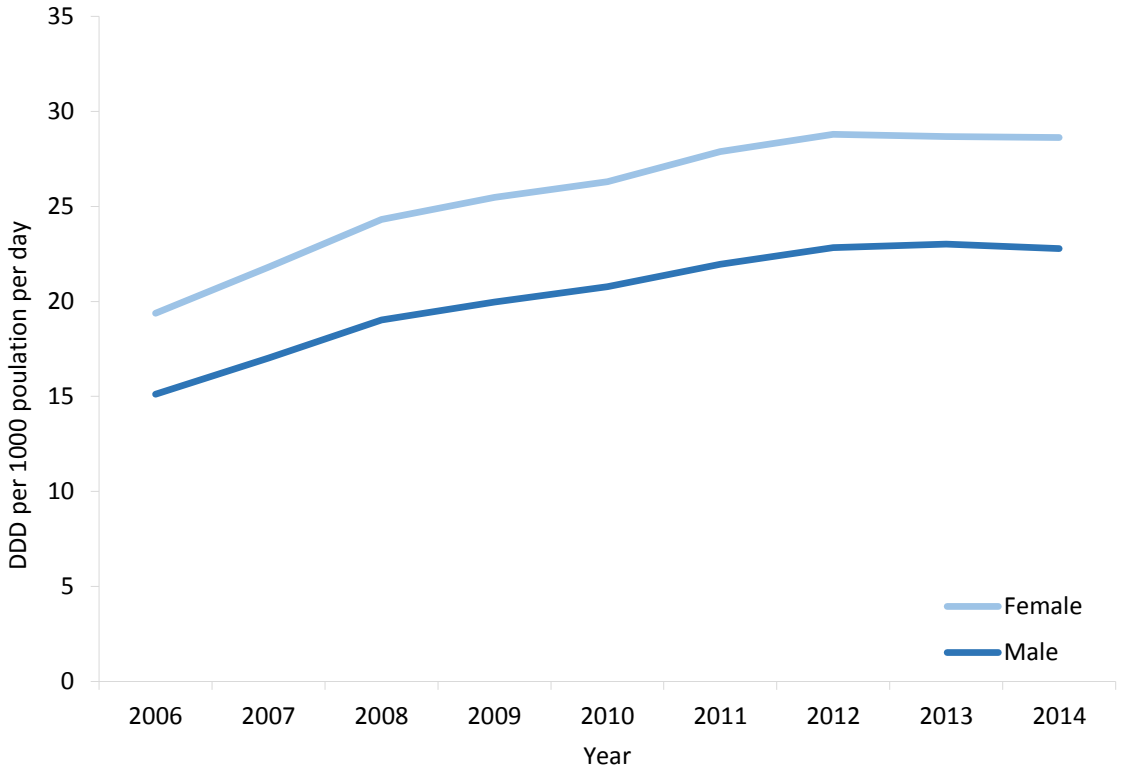


Table 9. Antibiotic consumption for systemic use by sex and ATC group level 3, 2014, expressed as DDD per 1000 population per day

ATC level 3 group	Female	Male	Total
Tetracyclines (J01A)	7.08	5.94	6.53
Penicillins (J01C)	13.82	12.27	13.06
Cephalosporins and other β-lactams (J01D)	1.29	0.67	0.99
Sulfonamides and trimethoprim (J01E)	1.59	0.73	1.17
Macrolides and lincosamides (J01F)	3.40	2.44	2.93
Quinolones (J01M)	0.58	0.58	0.58
Urinary antiseptics (J01X)	0.88	0.15	0.52
Total (J01)	**28.63**	**22.79**	**25.77**

3.2.3 Ethnicity

Pacific peoples had the highest rate of total antibiotic consumption, followed by the European or Other and MELAA ethnic groups (Figure 6). Māori consumed 13% less antibiotics than the European or Other ethnic group in 2006, a gap that increased to 18% in 2014. Antibiotic consumption amongst the Asian ethnic group was lowest, but increased rapidly over the study period from 8.2 to 17.9 DID, a 119% increase. The high rate of consumption in Pacific peoples was driven largely by penicillins (J01C), which accounted for 71.7% of all consumption in this group. The European or Other ethnic group had the highest consumption rate for all pharmacological groups, except penicillins (J01C) and tetracyclines (J01A), which were highest in Pacific peoples and MELAA ethnic groups, respectively (Table 10). Ethnic differences were largely stable over time except for quinolones (J01M) for which reduction in use was greatest in the European or Other ethnic group (Table 37 in the Appendix).

Figure 6. Antibiotic consumption for systemic use (ATC group J01) by ethnicity, 2006–2014, expressed as DDD per 1000 population per day

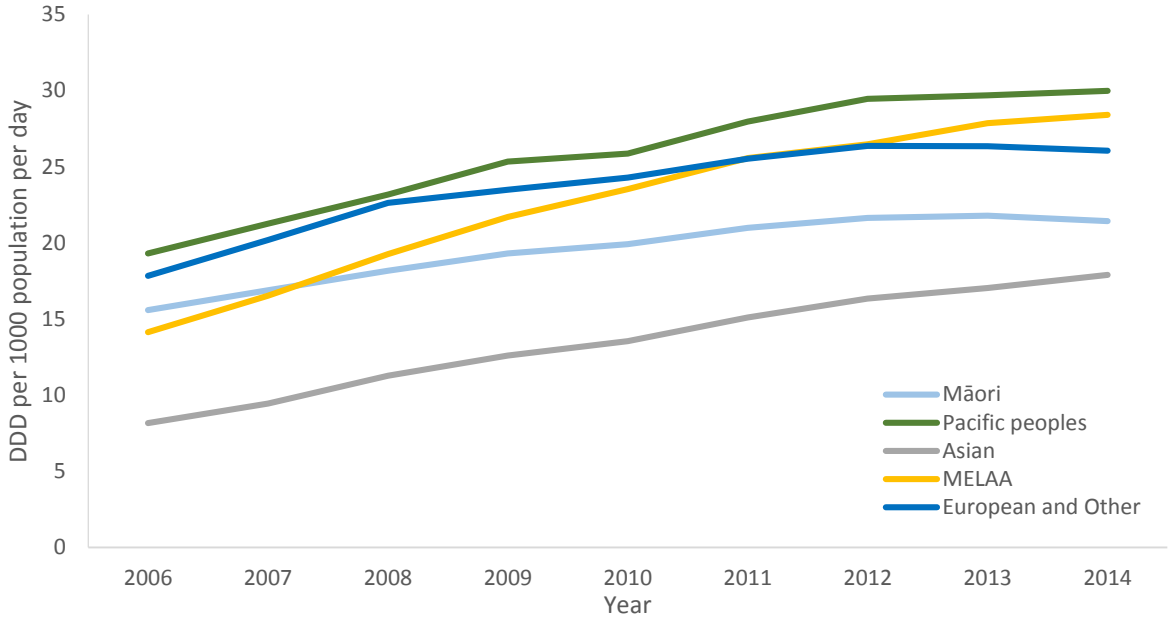


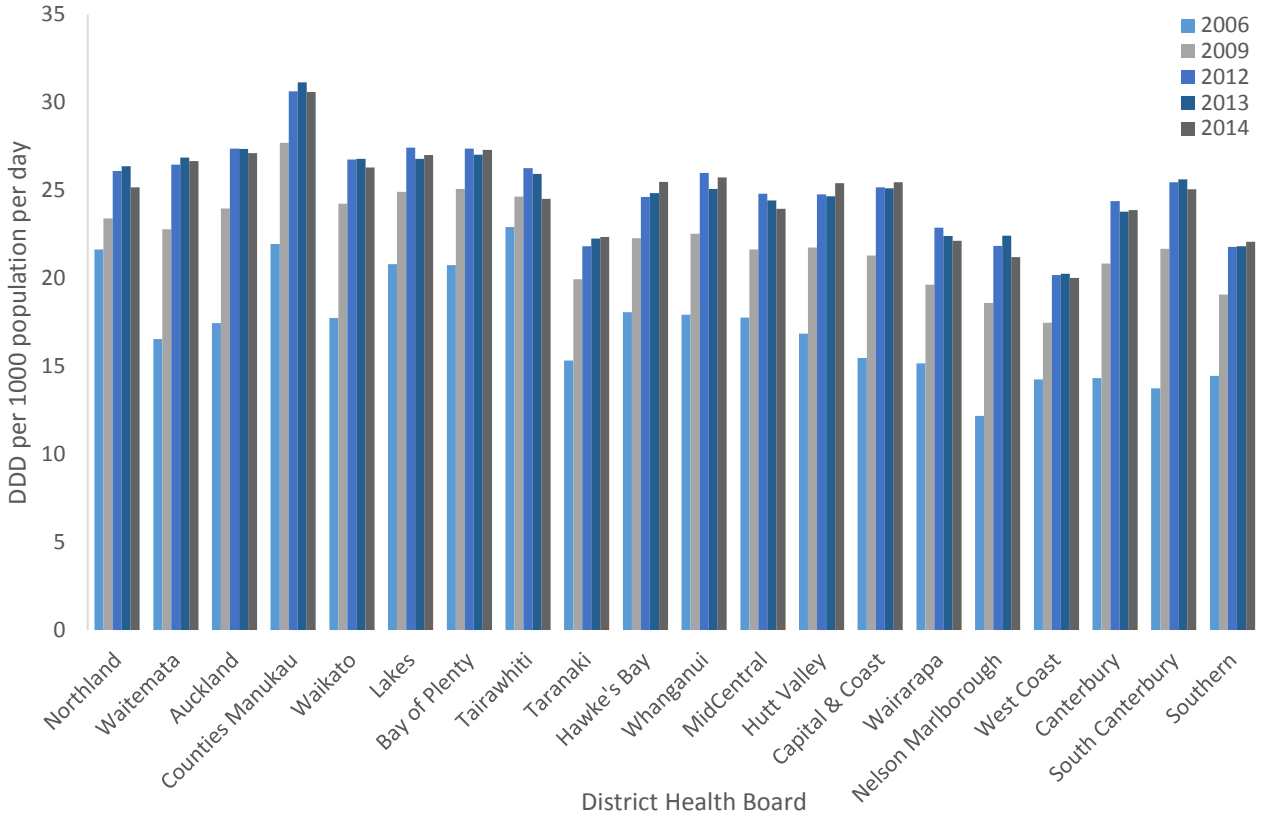
Table 10. Antibiotic consumption for systemic use by ethnic group and ATC group level 3, 2014, expressed as DDD per 1000 population per day

ATC level 3 group	Māori	Pacific peoples	Asian	MELAA	European or Other	Total
Tetracyclines (J01A)	3.25	3.26	4.16	7.78	7.39	6.53
Penicillins (J01C)	13.44	21.50	10.27	15.44	11.89	13.06
Cephalosporins and other β-lactams (J01D)	0.80	0.98	0.64	0.83	1.05	0.99
Sulfonamides and trimethoprim (J01E)	0.89	0.98	0.49	0.80	1.32	1.17
Macrolides and lincosamides (J01F)	2.36	2.66	1.82	2.67	3.09	2.93
Quinolones (J01M)	0.32	0.30	0.27	0.47	0.68	0.58
Urinary antiseptics (J01X)	0.34	0.30	0.23	0.40	0.61	0.52
Total (J01)	**21.40**	**29.99**	**17.87**	**28.38**	**26.03**	**25.77**

3.2.4 District Health Board

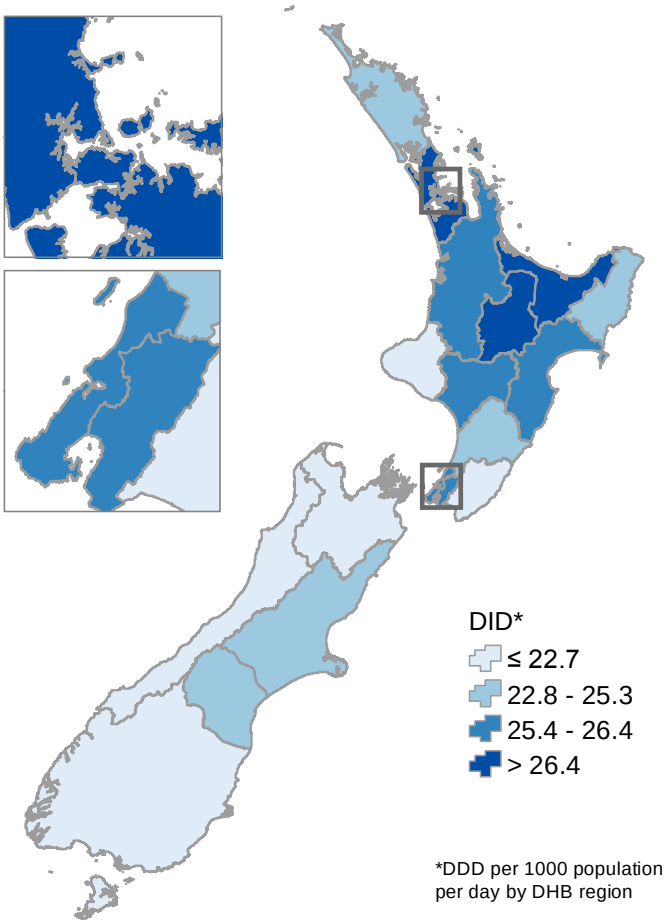
In all DHBs, there was a significant increase in antibiotic consumption between 2006 and 2014 (selected years are shown in Figure 7). However, in most DHBs, there was a small decrease in antibiotic consumption between 2013 and 2014 (Figure 7 and Table 21 in the Appendix).

Figure 7. Antibiotic consumption for systemic use (ATC group J01) by year and District Health Board, 2006–2014, expressed as DDD per 1000 population per day



There was considerable geographic variation in total antibiotic consumption across the country, with dispensing rates highest in the upper North Island in 2014 compared to the rest of the country (Figure 8 and Table 21 in the Appendix). In 2014, the highest rate of consumption was in Counties Manukau DHB (30.6 DID) and the lowest rate was in West Coast DHB (20.3 DID).

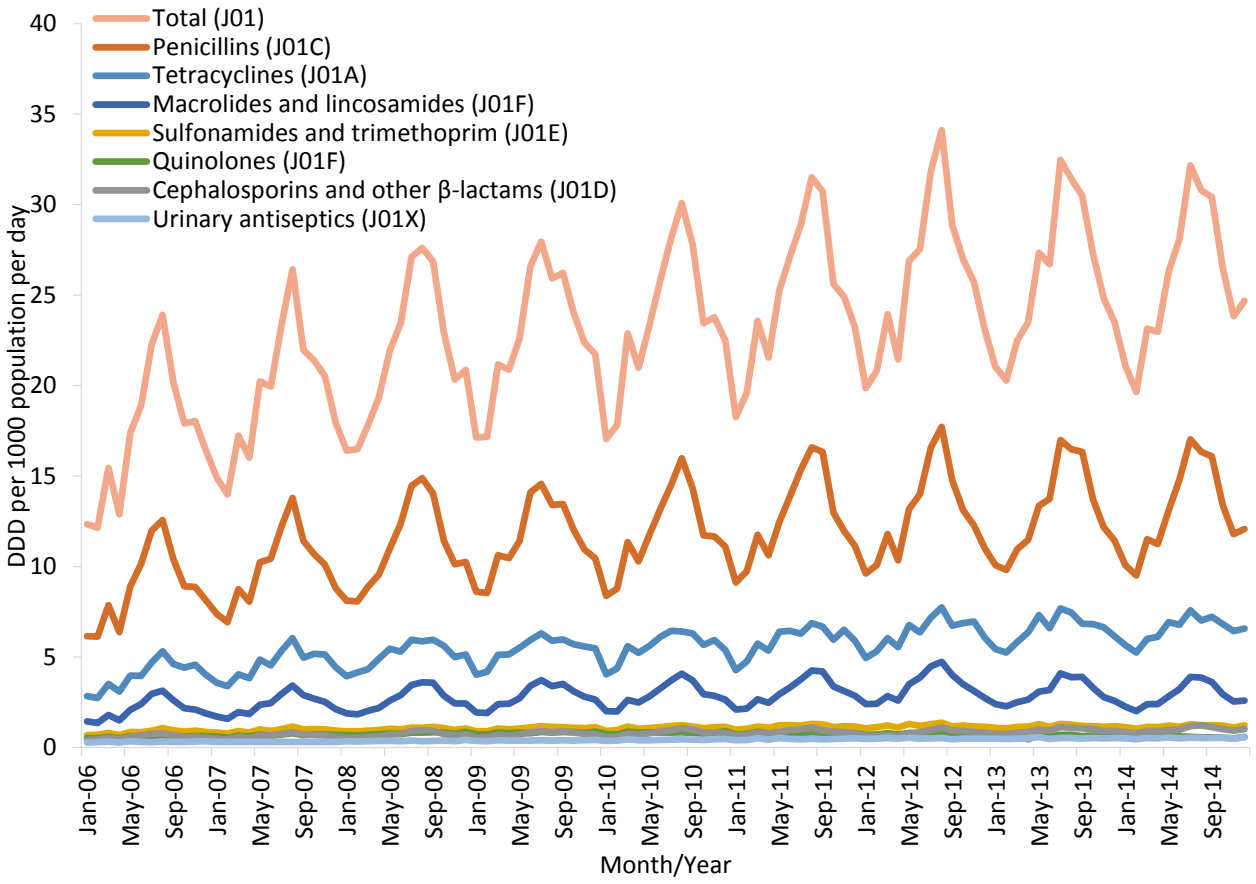
Figure 8. Antibiotic consumption for systemic use (ATC group J01) by District Health Board, 2014, expressed as DDD per 1000 population per day



3.2.5 Seasonality

There was marked seasonal variation in antibiotic consumption, with consumption consistently higher in the winter quarter (June to August), compared to the summer quarter (December to February) (Figure 9). In 2014, total consumption (J01) was 40.9% greater (interquartile range 34.7% – 43.9%) in the winter quarter compared to the summer quarter. This seasonal variation was largely driven by variation in consumption of penicillins, and to a lesser extent, macrolides and tetracyclines.

Figure 9. Seasonality of antibiotic consumption for systemic use (ATC group J01), by month, 2006-2014, expressed as DDD per 1000 population per day



3.3 TETRACYCLINES (J01A)

In New Zealand, the most commonly used tetracycline was doxycycline, accounting for 97.4% of all tetracycline consumption in 2014 (Figure 10 and Table 11). Tetracycline hydrochloride consumption was negligible, accounting for 0.03% of all antibiotic consumption within the J01A group in 2014.

Figure 10. Consumption of tetracyclines for systemic use (ATC group J01A), 2006–2014, expressed as DDD per 1000 population per day

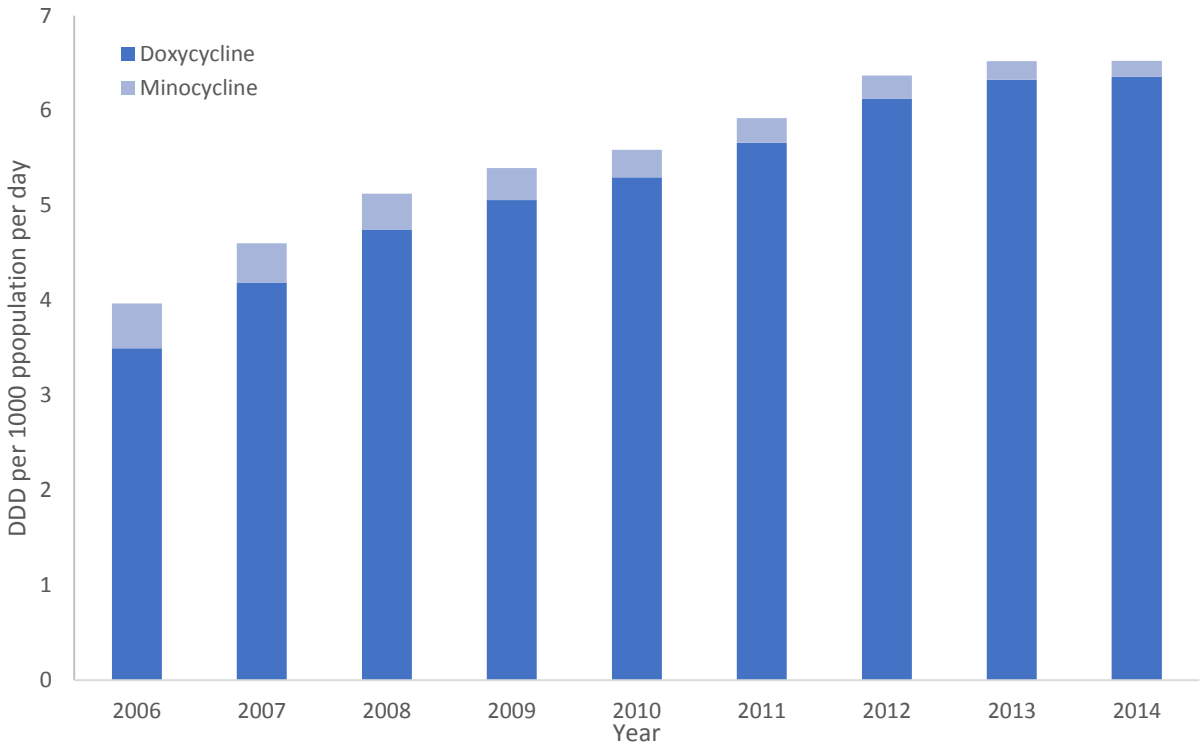
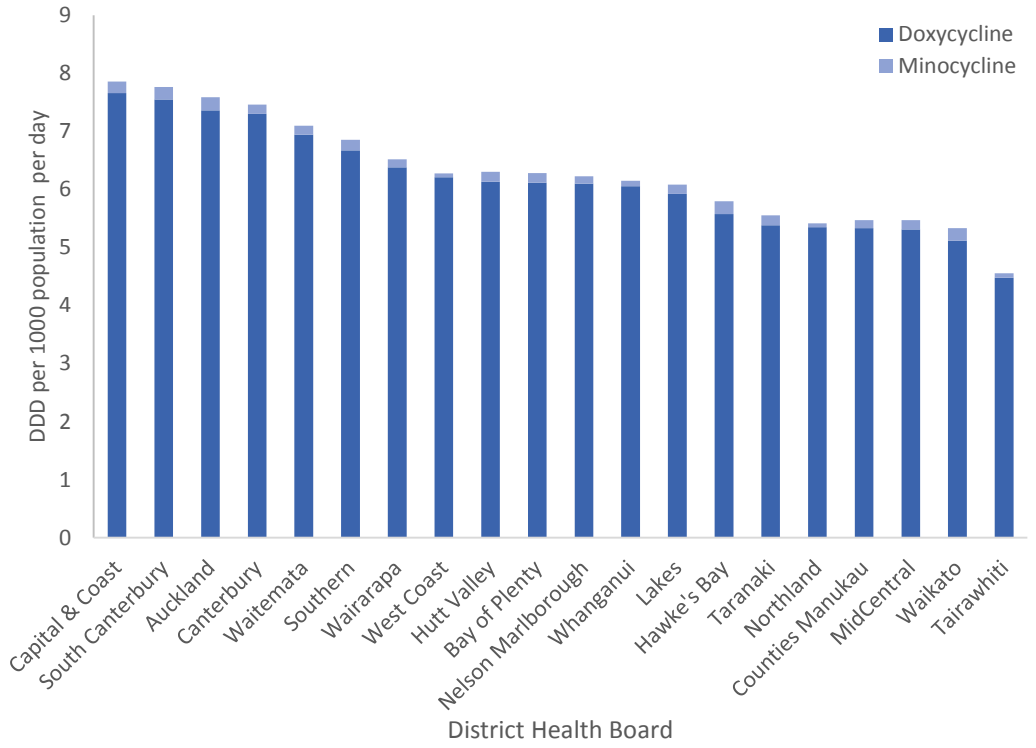


Table 11. Consumption of tetracyclines for systemic use (ATC group J01A) by ATC level 4 group, 2006–2014, expressed as DDD per 1000 population per day

ATC Level 4 Group	2006	2007	2008	2009	2010	2011	2012	2013	2014
Doxycycline	3.50	4.19	4.75	5.06	5.30	5.66	6.13	6.33	6.36
Minocycline	0.47	0.42	0.38	0.34	0.29	0.26	0.24	0.20	0.17
Total (J01A)	**3.97**	**4.60**	**5.13**	**5.39**	**5.59**	**5.92**	**6.37**	**6.52**	**6.53**

There were differences in tetracycline (J01A) consumption by DHB, with the highest rate of consumption in Capital & Coast DHB (7.86 DID), and the lowest rate in Tairawhiti DHB (4.56 DID) (Figure 11 and Table 22 in the Appendix).

Figure 11. Consumption of tetracyclines for systemic use (ATC group J01A) by ATC level 4 group and District Health Board, 2014, expressed as DDD per 1000 population per day



There were also differences in consumption according to age, sex and ethnicity, with the highest rates of consumption in the 15–19 year age category, in females and in the MELAA and European or Other ethnic groups (Figure 12, 13 and 14 and Table 29 in the Appendix).

Figure 12. Consumption of tetracyclines for systemic use (ATC group J01A) by ATC level 4 group and age group, 2014, expressed as DDD per 1000 population per day

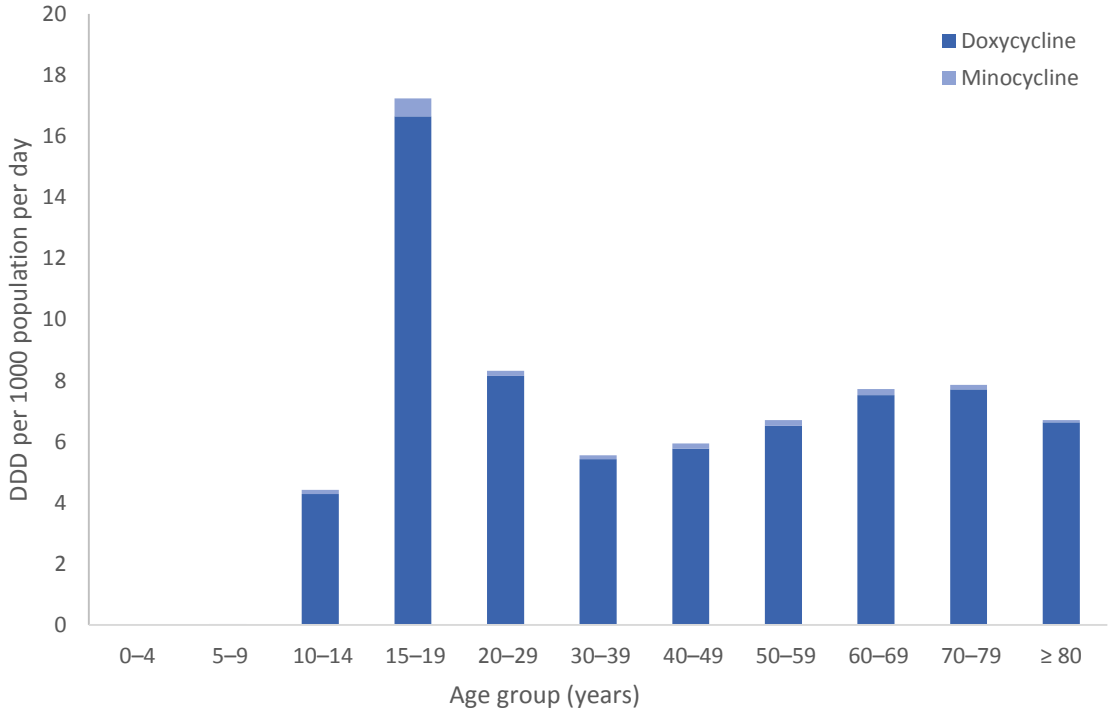


Figure 13. Consumption of tetracyclines for systemic use (ATC group J01A) by ATC level 4 group and sex, 2014, expressed as DDD per 1000 population per day

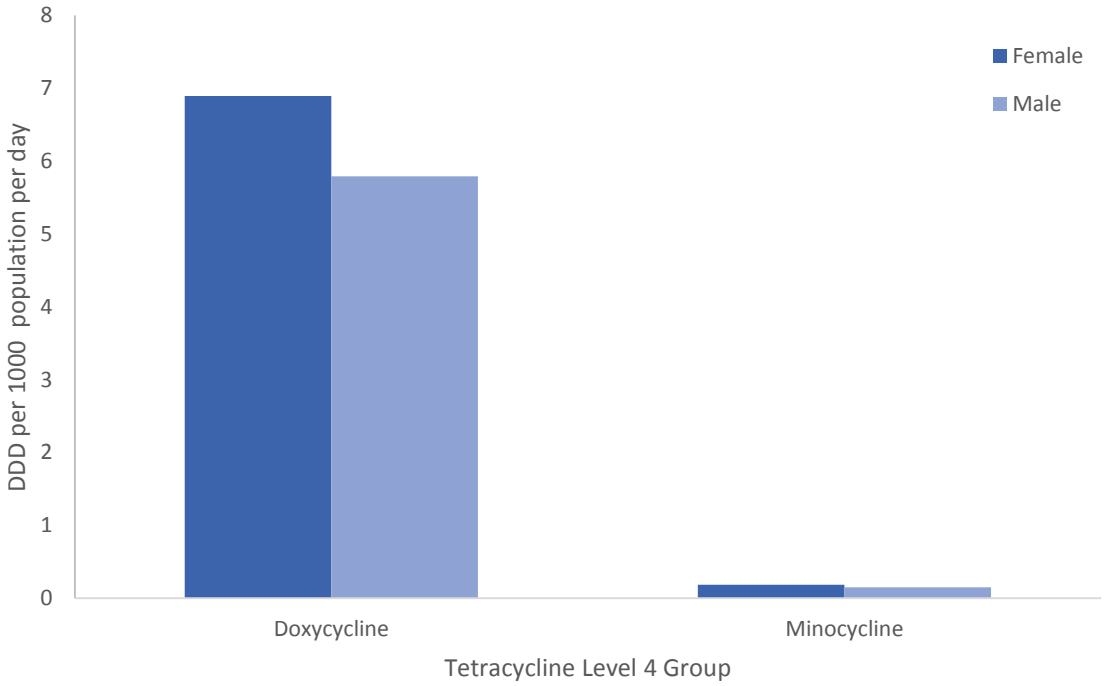
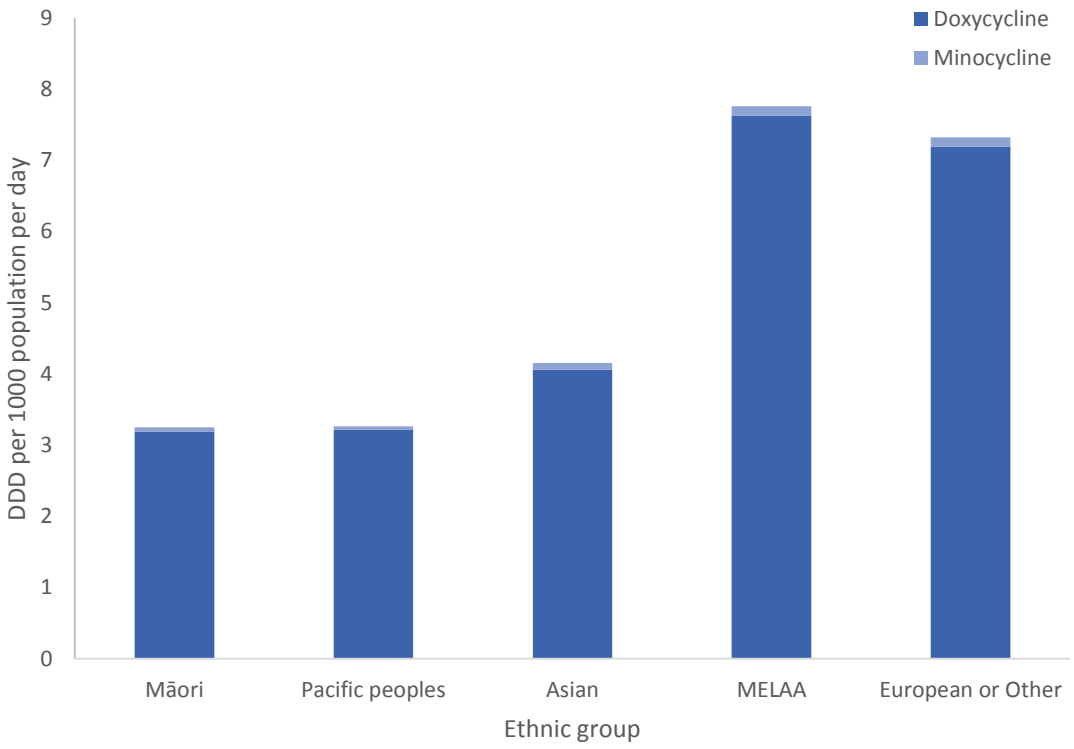


Figure 14. Consumption of tetracyclines for systemic use (ATC group J01A) by ATC level 4 group and ethnic group, 2014, expressed as DDD per 1000 population per day



3.4 PENICILLINS (J01C)

Penicillin (J01C) consumption increased by 50% between 2006 and 2014, largely driven by a doubling of amoxicillin consumption, the only drug in the extended-spectrum penicillins (J01CA) category (Figure 15 and Table 12).

Figure 15. Consumption of penicillins (ATC group J01C) by ATC level 4 group, 2006–2014, expressed as DDD per 1000 population per day

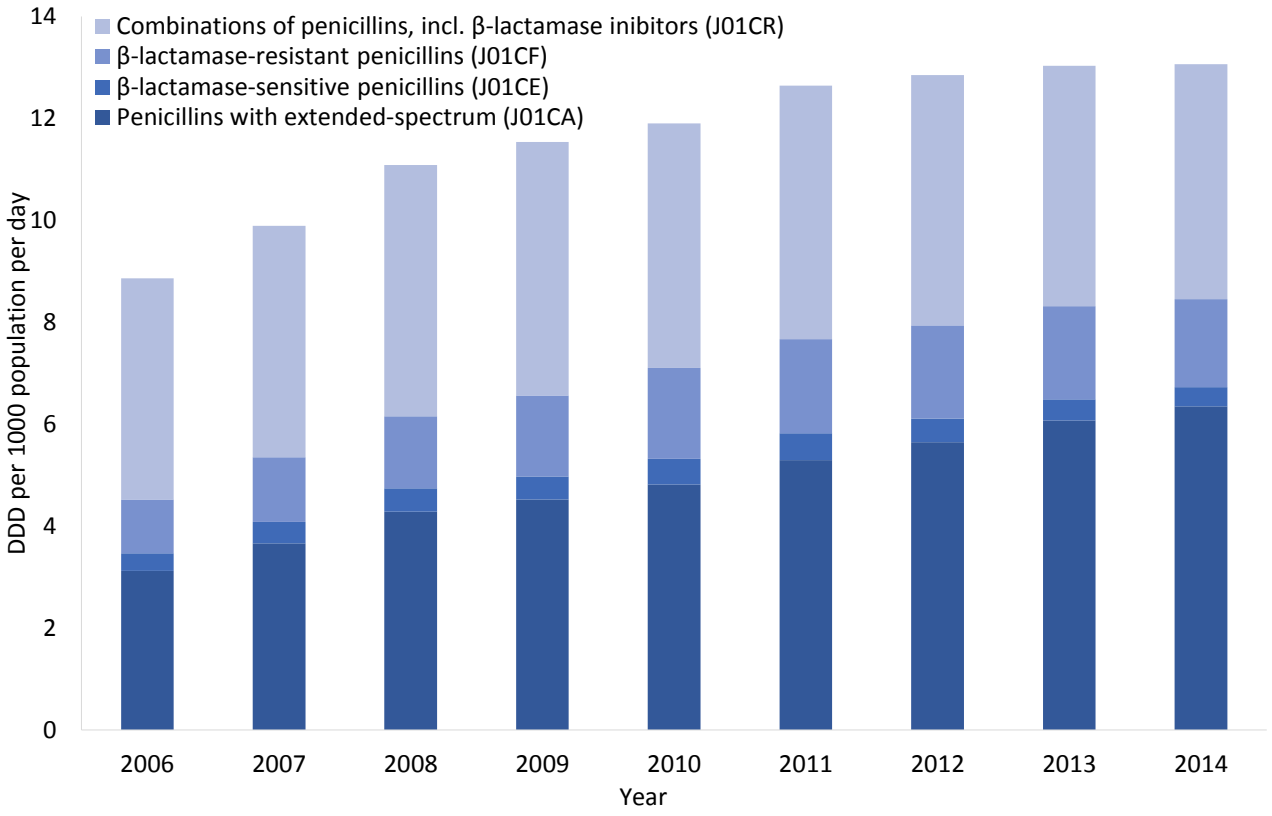
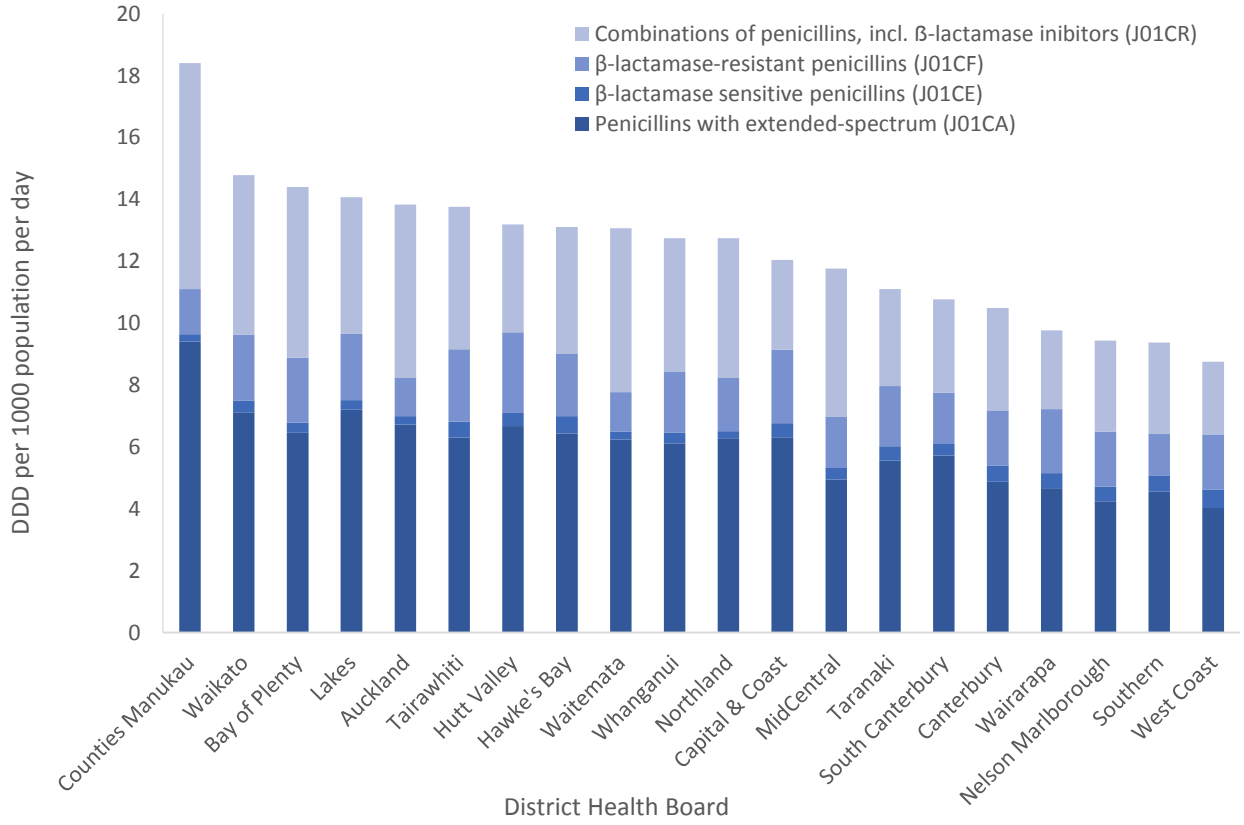


Table 12. Consumption of penicillins (ATC group J01C) by ATC level 4 group, 2006–2014, expressed as DDD per 1000 population per day

ATC level 4 group	2006	2007	2008	2009	2010	2011	2012	2013	2014
Penicillins with extended-spectrum (J01CA)	3.12	3.66	4.28	4.52	4.81	5.29	5.65	6.07	6.35
β-lactamase-sensitive penicillins (J01CE)	0.35	0.42	0.46	0.45	0.51	0.53	0.46	0.42	0.37
β-lactamase-resistant penicillins (J01CF)	1.05	1.27	1.42	1.59	1.78	1.84	1.82	1.82	1.73
Combinations of penicillins, incl. β-lactamase inhibitors (J01CR)	4.34	4.54	4.93	4.98	4.80	4.98	4.92	4.72	4.61
Total (J01C)	**8.86**	**9.89**	**11.08**	**11.54**	**11.90**	**12.64**	**12.85**	**13.03**	**13.06**

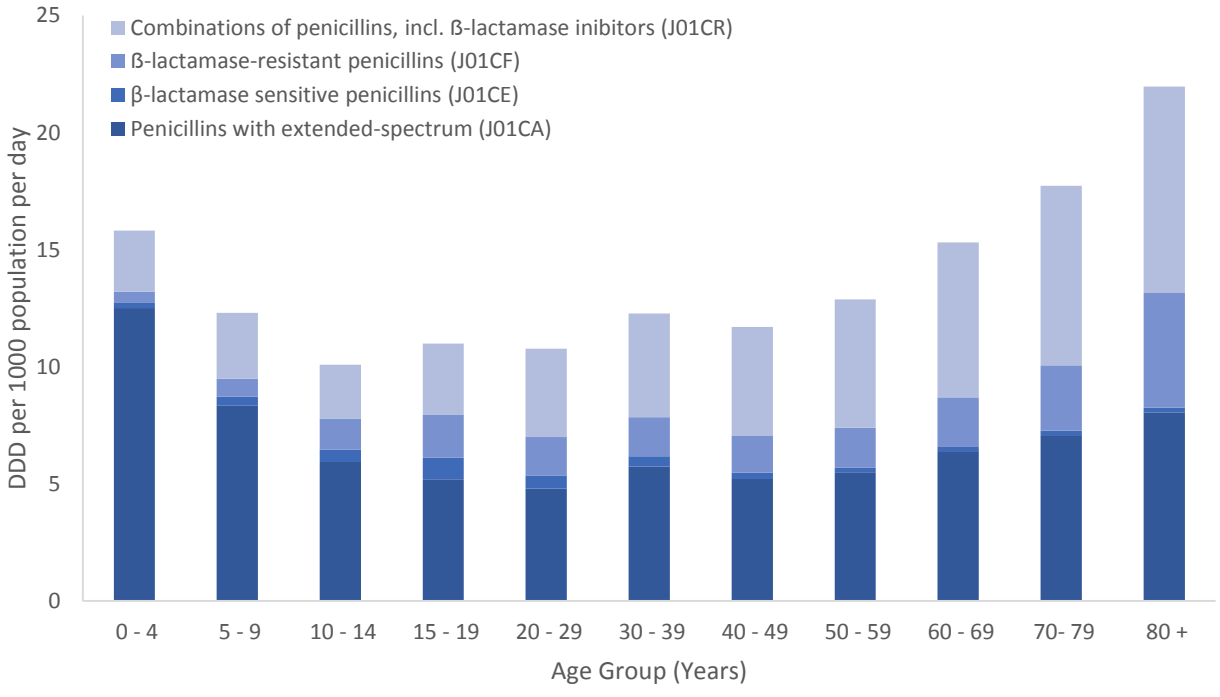
There were considerable differences in penicillin (J01C) consumption by DHB, with the highest rate of consumption in Counties Manukau DHB (18.4 DID) and the lowest rate in West Coast DHB (8.8 DID) (Figure 16 and Table 23 in the Appendix).

Figure 16. Consumption of penicillins (ATC group J01C) by ATC level 4 group and District Health Board, 2014, expressed as DDD per 1000 population per day



The highest rate of penicillin consumption was in the ≥80 year age group, and this group also had the highest consumption of penicillins plus β-lactamase inhibitors (ie. amoxicillin-clavulanate). However, the highest consumption of extended-spectrum penicillins (ie. amoxicillin) was in the under five years and 5–9 years age group (Figure 17 and Table 30 in the Appendix).

Figure 17. Consumption of penicillins (ATC group J01C) by ATC level 4 group and age group, 2014, expressed as DDD per 1000 population per day



Consumption of penicillins did not differ by sex, except for extended-spectrum penicillin consumption (J01CA), which was higher in females (Figure 18). Consumption was highest in Pacific peoples (21.5 DID) (Figure 19).

Figure 18. Consumption of penicillins (ATC group J01C) by ATC level 4 group and sex, 2014, expressed as DDD per 1000 population per day

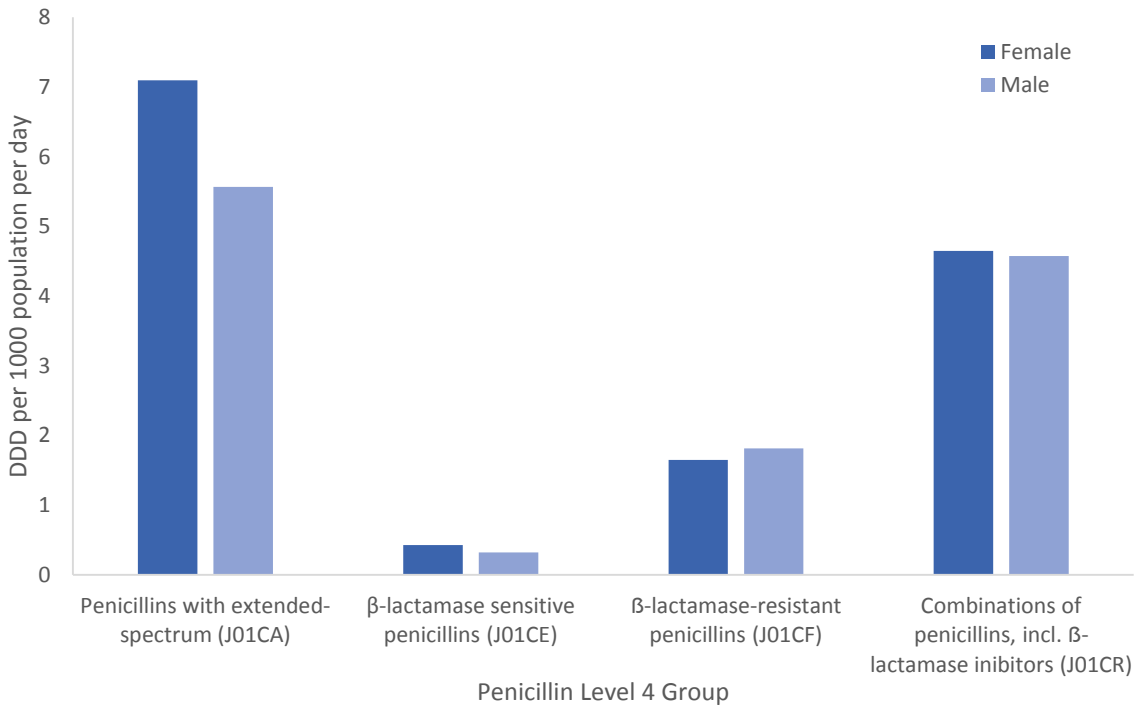
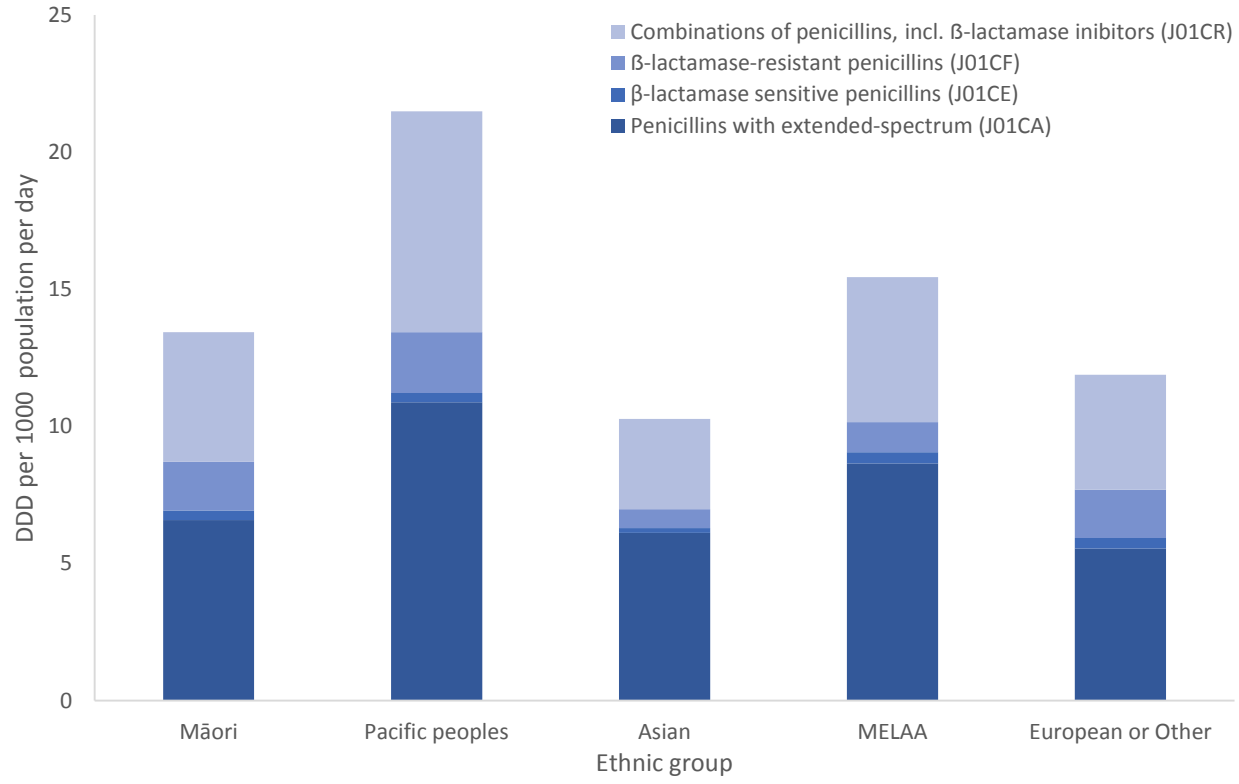


Figure 19. Consumption of penicillins (ATC group J01C) by ATC level 4 group and ethnic group, 2014, expressed as DDD per 1000 population per day



3.5 CEPHALOSPORINS AND OTHER BETA-LACTAMS (J01D)

Cephalosporins and other β-lactams (J01D) made a small but increasing contribution to overall antibiotic consumption. Increases were initially within the second-generation cephalosporins (cefaclor), but use of this group stabilized in 2010 concurrent with increased use of first-generation cephalosporins (cefalexin) (Figure 20 and Table 13).

Figure 20. Consumption of cephalosporins for systemic use (ATC group J01D) by ATC level 4 group, 2006–2014, expressed as DDD per 1000 population per day

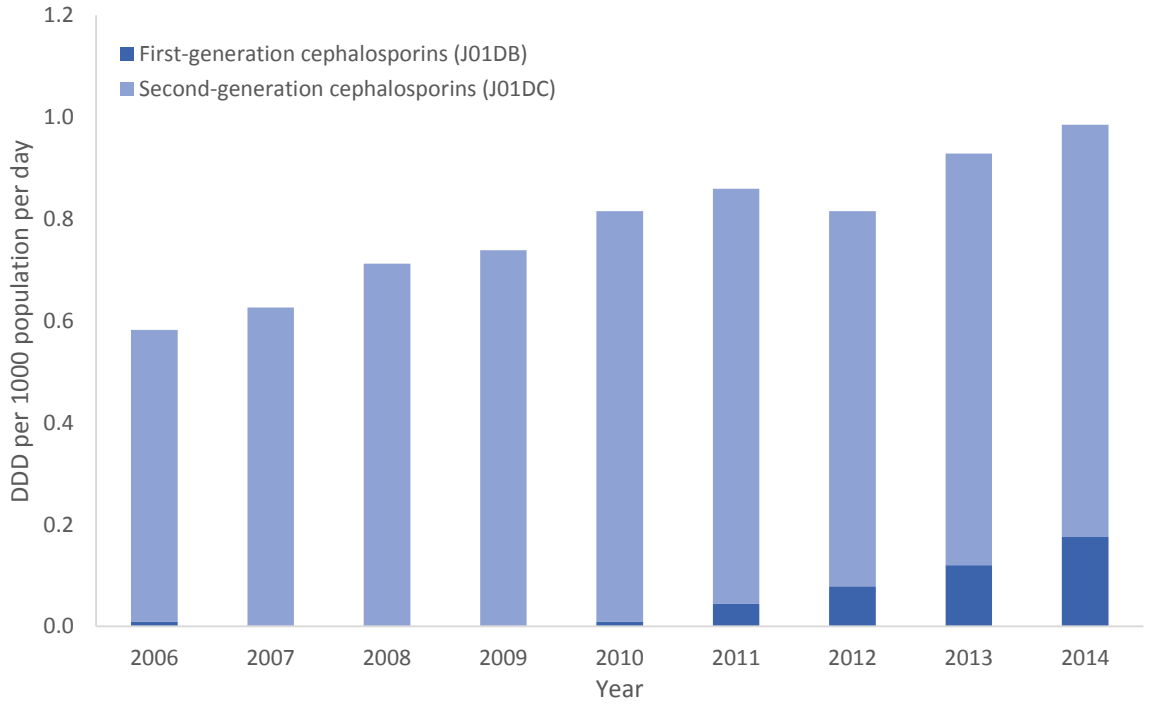
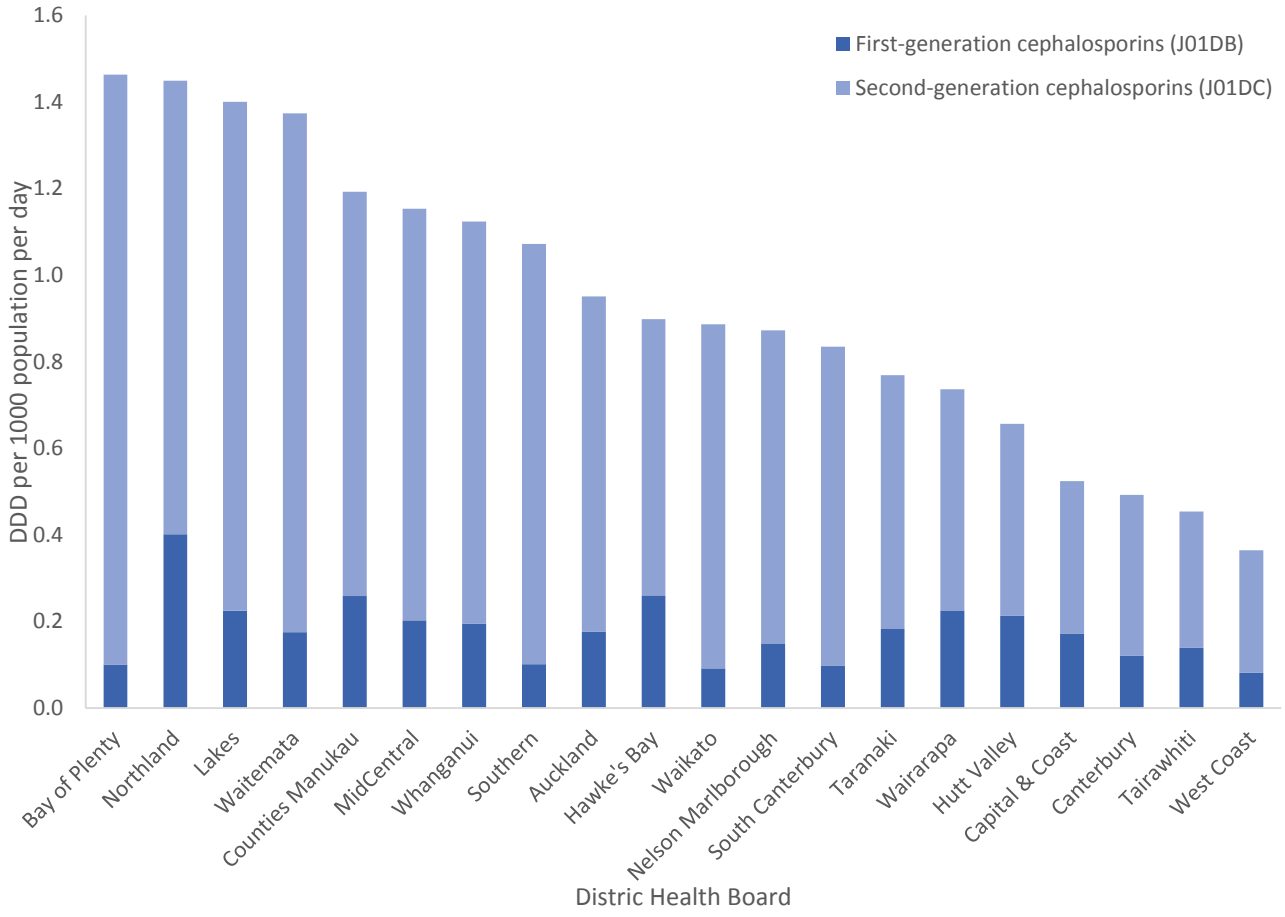


Table 13. Consumption of cephalosporins for systemic use (ATC group J01D) by ATC level 4 group, 2006–2014, expressed as DDD per 1000 population per day

ATC level 4 group	2006	2007	2008	2009	2010	2011	2012	2013	2014
First-generation cephalosporins (J01DB)	0.01	<0.01	<0.01	<0.00	0.01	0.04	0.08	0.12	0.18
Second-generation cephalosporins (J01DC)	0.57	0.62	0.71	0.74	0.81	0.82	0.74	0.81	0.81
Total	**0.58**	**0.62**	**0.71**	**0.74**	**0.82**	**0.86**	**0.82**	**0.83**	**0.99**

The highest rate of cephalosporin consumption was in Bay of Plenty DHB (1.5 DID), while the lowest rate was in West Coast DHB (0.4 DID) (Figure 21 and Table 24 in the Appendix).

Figure 21. Consumption of cephalosporins (ATC group J01D) by ATC level 4 group and District Health Board, 2014, expressed as DDD per 1000 population per day



The highest consumption of cephalosporins in 2014 was among adults aged ≥80 years (Figure 22 and Table 31 in the Appendix), with consumption almost eight times higher than the average consumption in younger adult age groups (15–49 years).

There were also notable differences in cephalosporin consumption by sex and ethnicity. Consumption of second-generation cephalosporins (cefaclor) was significantly higher in females, (Figure 23), and was highest in the European or Other ethnic group, and lowest in the Asian ethnic group (Figure 24).

Figure 22. Consumption of cephalosporins (ATC group J01D) by ATC level 4 group and age group, 2014, expressed as DDD per 1000 population per day

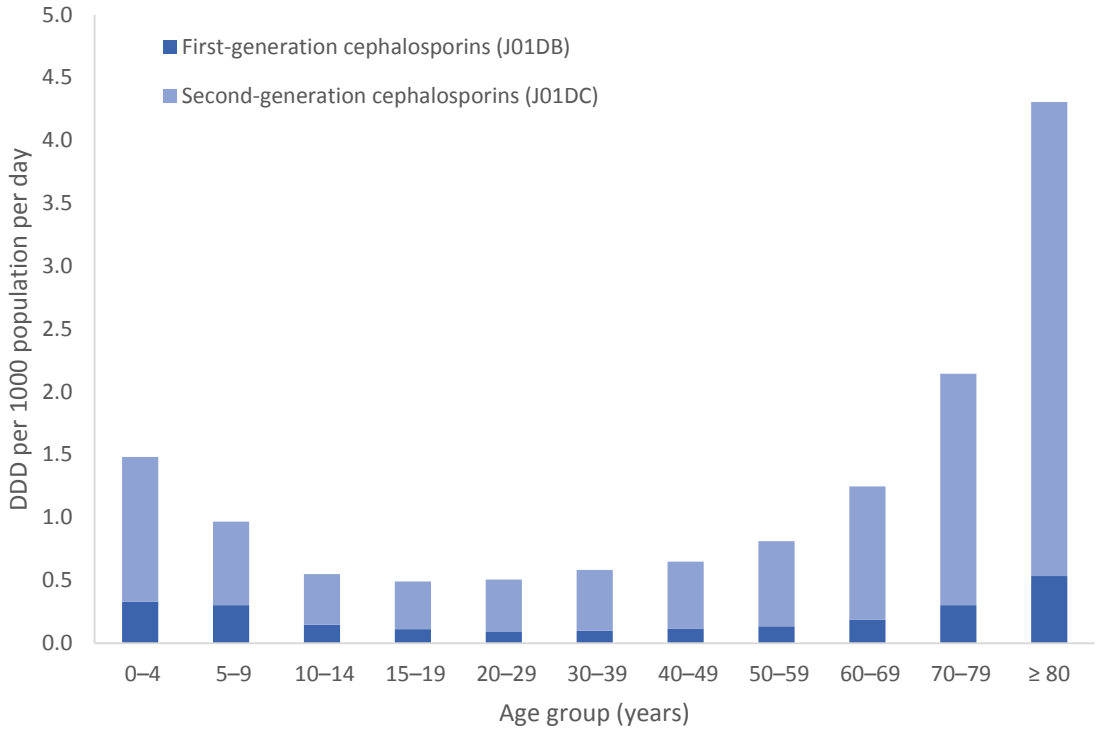


Figure 23. Consumption of cephalosporins (ATC group J01D) by ATC level 4 group and sex, 2014, expressed as DDD per 1000 population per day

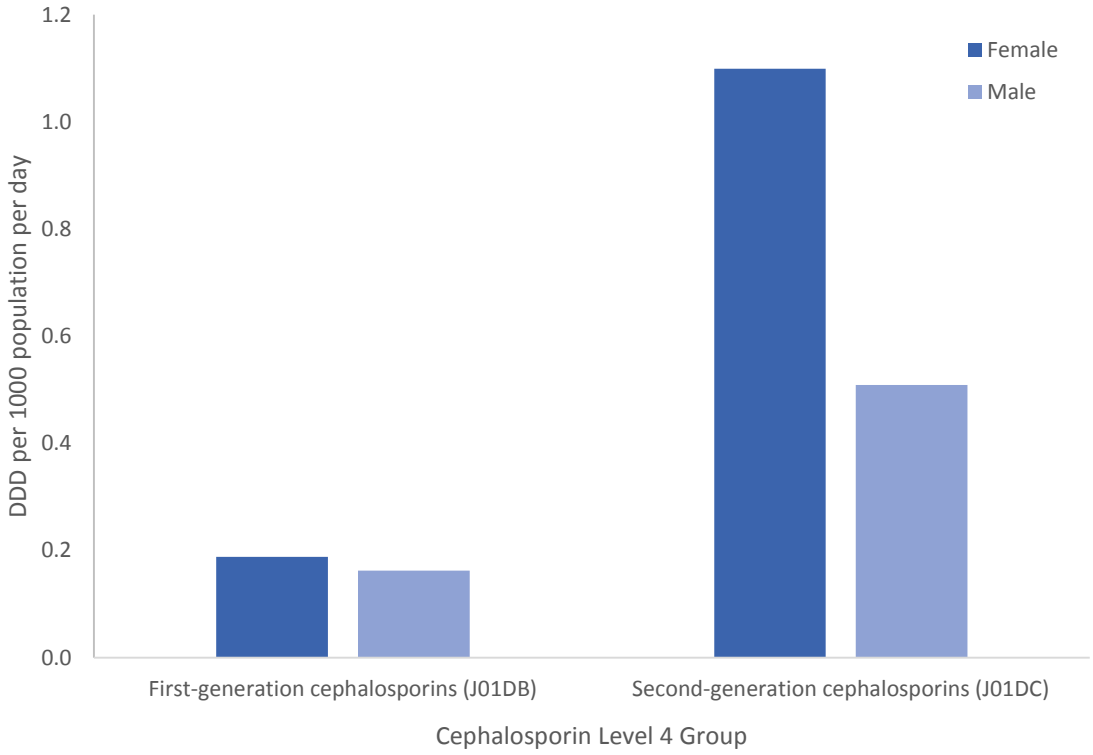
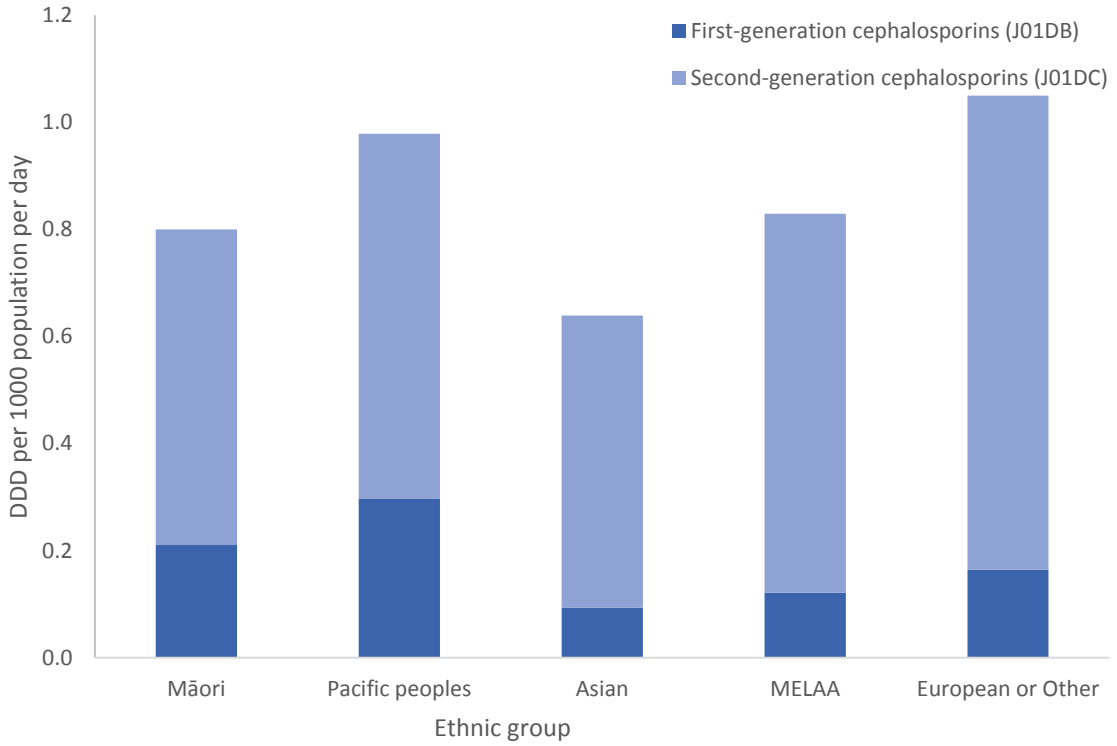


Figure 24. Consumption of cephalosporins (ATC group J01D) by level 4 group and ethnic group, 2014, expressed as DDD per 1000 population per day



3.6 SULFONAMIDES AND TRIMETHOPRIM (J01E)

Consumption of trimethoprim (J01EA) and trimethoprim-sulfamethoxazole (co-trimoxazole, J01EE) increased significantly between 2006 and 2014, from 0.84 DID in 2006 to 1.17 DID in 2014, although it decreased slightly between 2012 and 2014 (Figure 25 and Table 14). Proportionally, consumption of trimethoprim increased within the J01E group, from 49% in 2006, to 55% in 2014. Consumption of sulfonamides (J01EC) was negligible and accounted for less than 0.05% of all antibiotic consumption within the J01 group in 2014.

Figure 25. Consumption of sulphonamides and trimethoprim for systemic use (ATC group J01E), 2006–2014, expressed as DDD per 1000 population per day

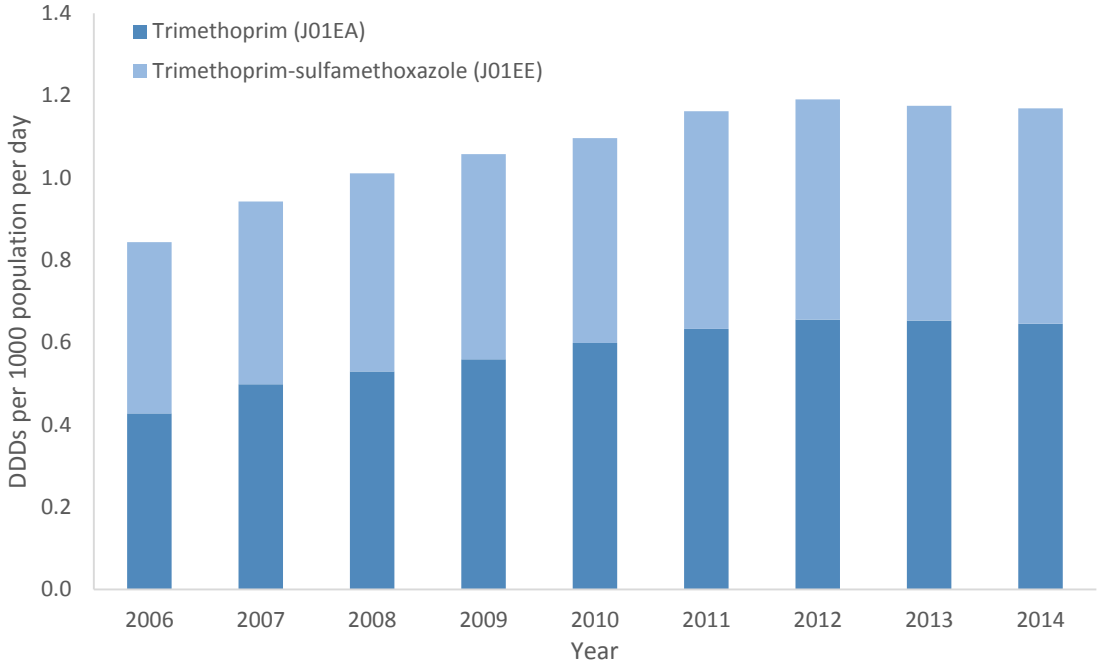
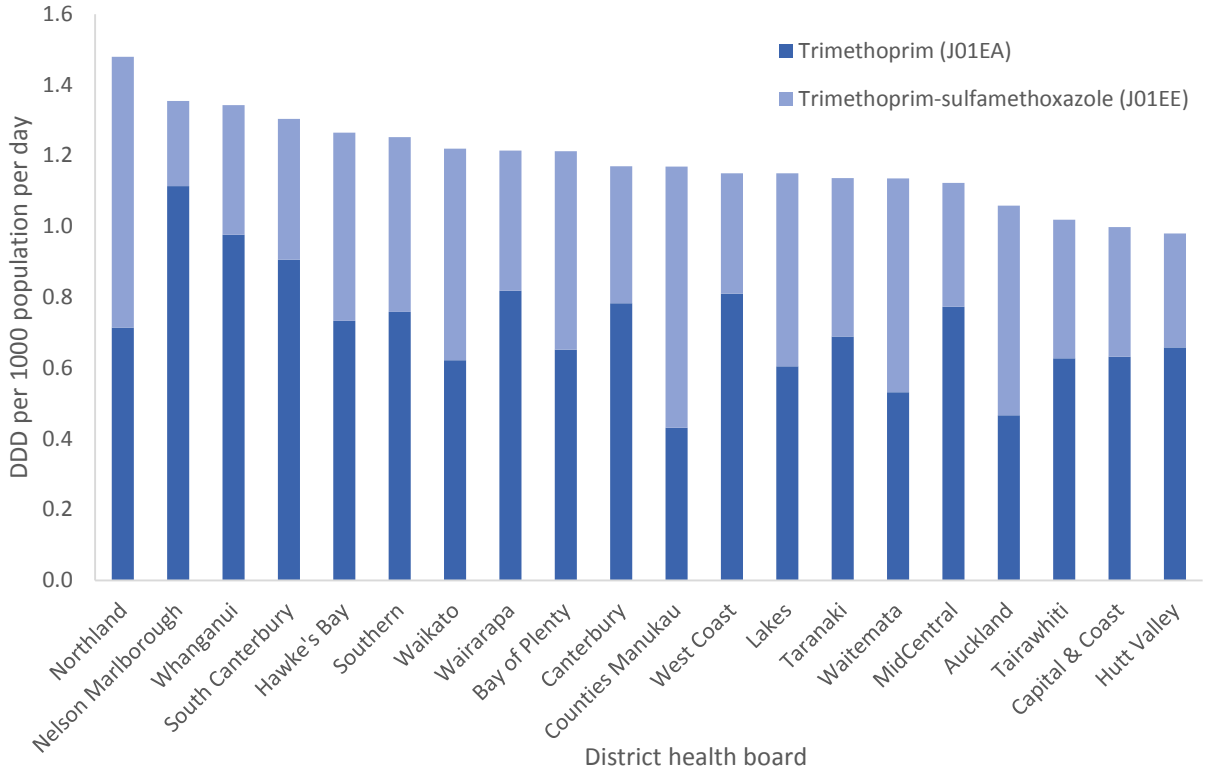


Table 14. Consumption of sulfonamides and trimethoprim for systemic use (ATC group J01E), 2006–2014, expressed as DDD per 1000 population per day

ATC Level 4 Group	2006	2007	2008	2009	2010	2011	2012	2013	2014
Trimethoprim (J01EA)	0.43	0.50	0.53	0.56	0.60	0.63	0.66	0.65	0.65
Trimethoprim-sulfamethoxazole (J01EE)	0.42	0.44	0.48	0.50	0.50	0.53	0.54	0.52	0.52
Sulfonamides (J01EC)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<0.01	<0.01
Total	**0.84**	**0.94**	**1.01**	**1.06**	**1.10**	**1.16**	**1.19**	**1.18**	**1.17**

Overall, consumption of sulphonamides and trimethoprim (J01E) was highest in Northland DHB (1.5 DID) and lowest in Tairawhiti, Hutt Valley and Capital & Coast DHBs (1.0 DID) (Figure 26 and Table 25 in the Appendix). However, there were considerable differences between DHBs in the relative proportions of trimethoprim (J01EA) versus trimethoprim-sulfamethoxazole (J01EE) consumed. For example, trimethoprim (J01EA) consumption accounted for 82% of J01E consumption in Nelson Marlborough DHB, but only 36% of J01E consumption in Counties Manukau DHB (Figure 26).

Figure 26. Consumption of sulphonamides and trimethoprim for systemic use (ATC group J01E), by ATC level 4 group and District Health Board, 2014, expressed as DDD per 1000 population per day



Similar to other classes of antibiotics, consumption of sulphonamides and trimethoprim (J01E) increased with age (Figure 27 and Table 32 in the Appendix). The relative proportion of trimethoprim use increased with age, accounting for 75% of consumption for ≥ 80 year olds within the J01E group in 2014. Consumption of sulfonamides and trimethoprim was higher in females; this was most marked for trimethoprim (Figure 28). There were also differences in consumption by ethnicity, with consumption highest in the European or Other ethnic group, and lowest in the Asian ethnic group (Figure 29).

Figure 27. Consumption of trimethoprim for systemic use (ATC group J01E), by ATC level 4 group and age group, 2014, expressed as DDD per 1000 population per day

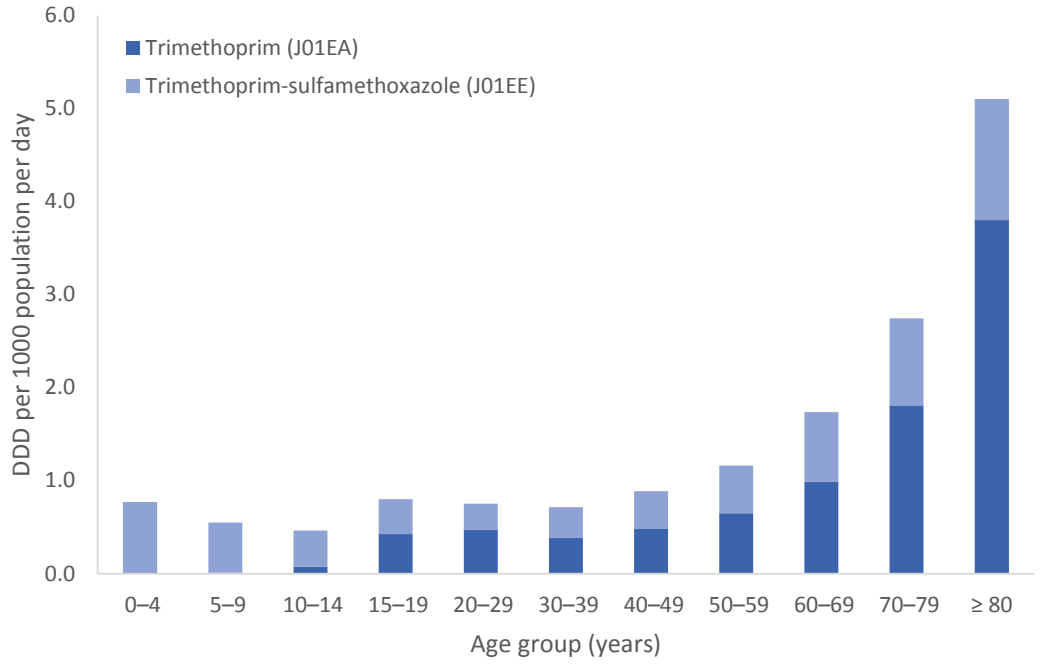


Figure 28. Consumption of sulfonamides and trimethoprim for systemic use (ATC group J01E), by ATC level 4 group and sex, 2014, expressed as DDD per 1000 population per day

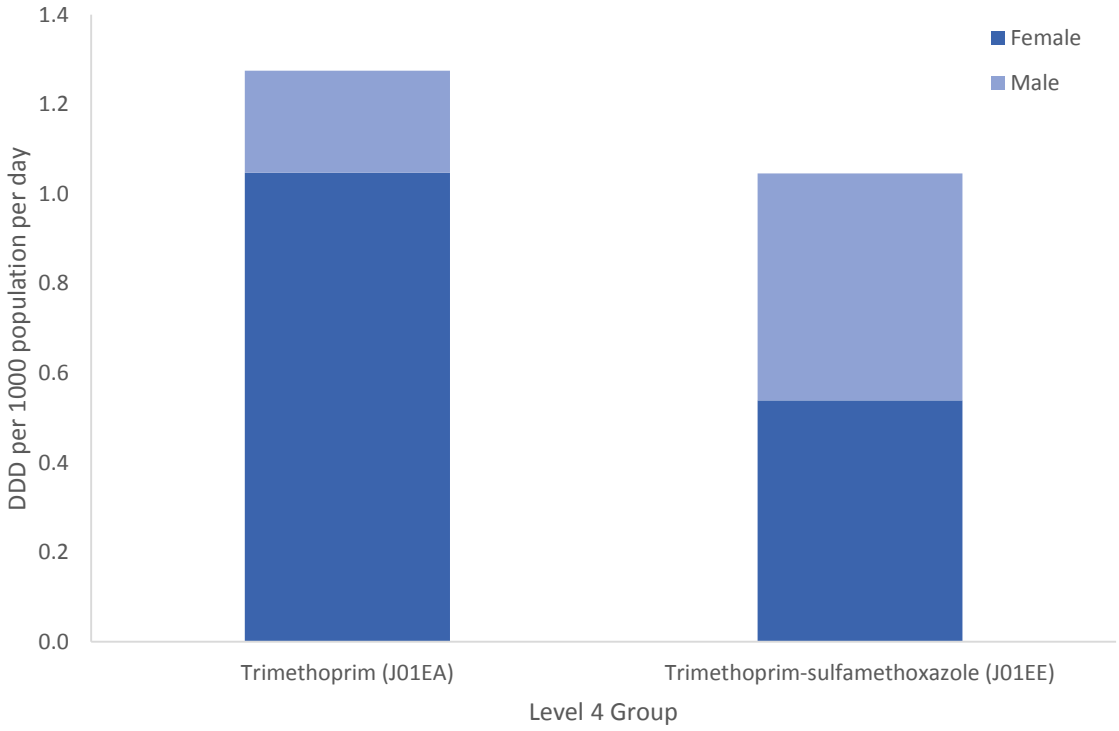
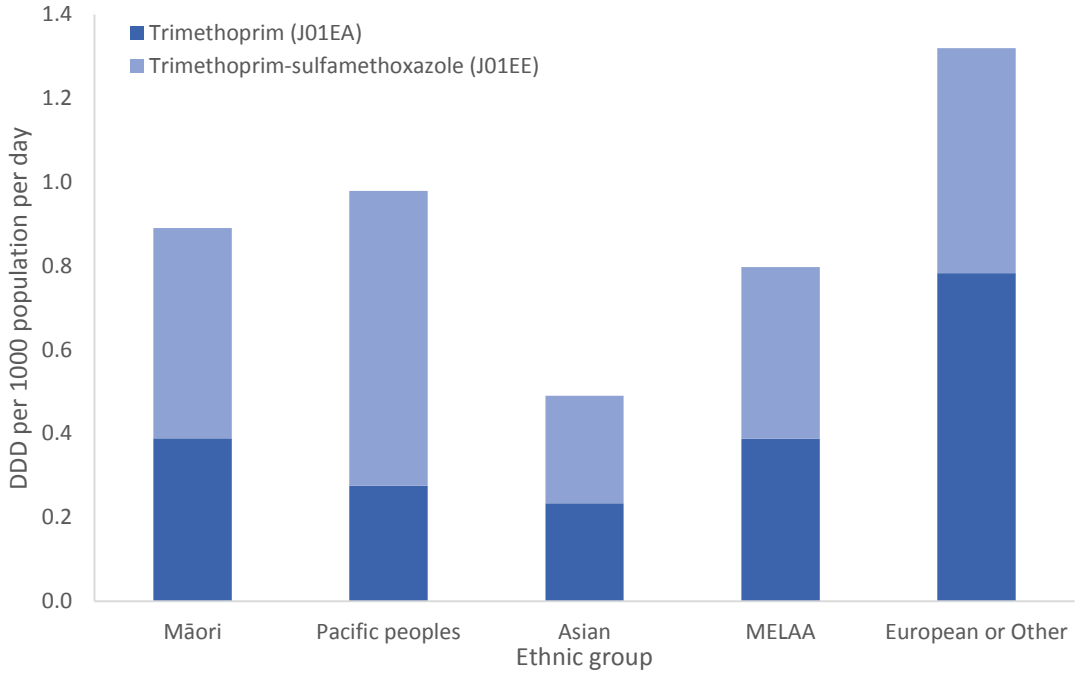


Figure 29. Consumption of sulfonamides and trimethoprim for systemic use (ATC group J01E), by ATC level 4 group and ethnic group, 2014, expressed as DDD per 1000 population per day



3.7 MACROLIDES AND LINCOSAMIDES (J01F)

Consumption of intermediate-acting macrolides (roxithromycin) increased significantly during the study period to match that of short-acting macrolides (predominantly erythromycin) (Figure 30 and Table 15). The use of long-acting macrolides (azithromycin) increased from 2006 to 2014, although their overall contribution was low (0.1 DID in 2014). Consumption of lincosamides (clindamycin, J01FF) was negligible, accounting for only 1.7% of the J01F group.

Figure 30. Consumption of macrolides for systemic use (ATC group J01F) by level 4 group, 2006–2014, expressed as DDD per 1000 population per day

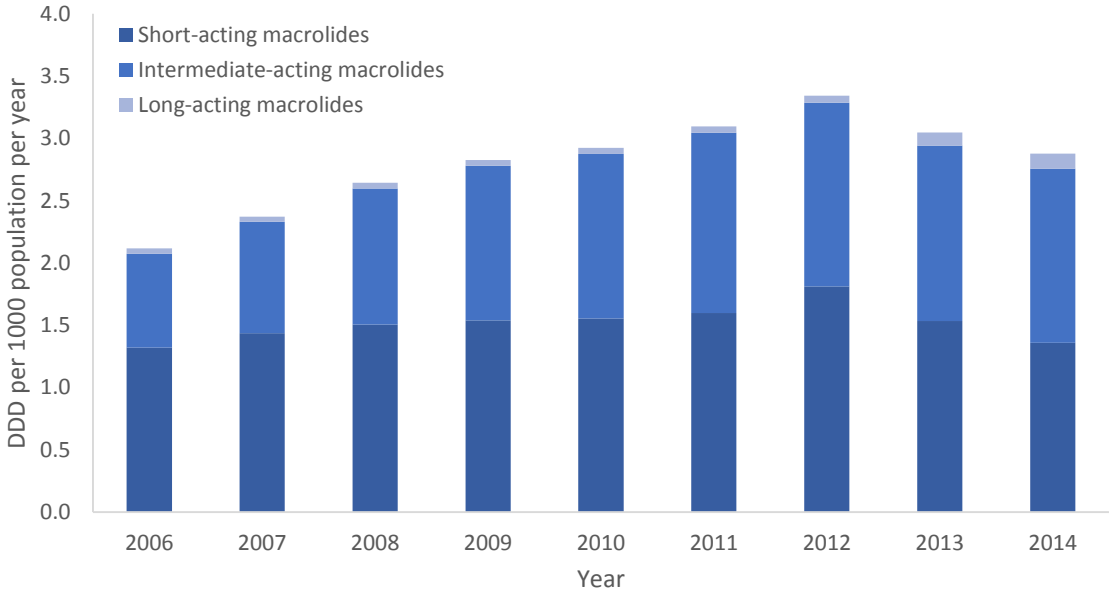
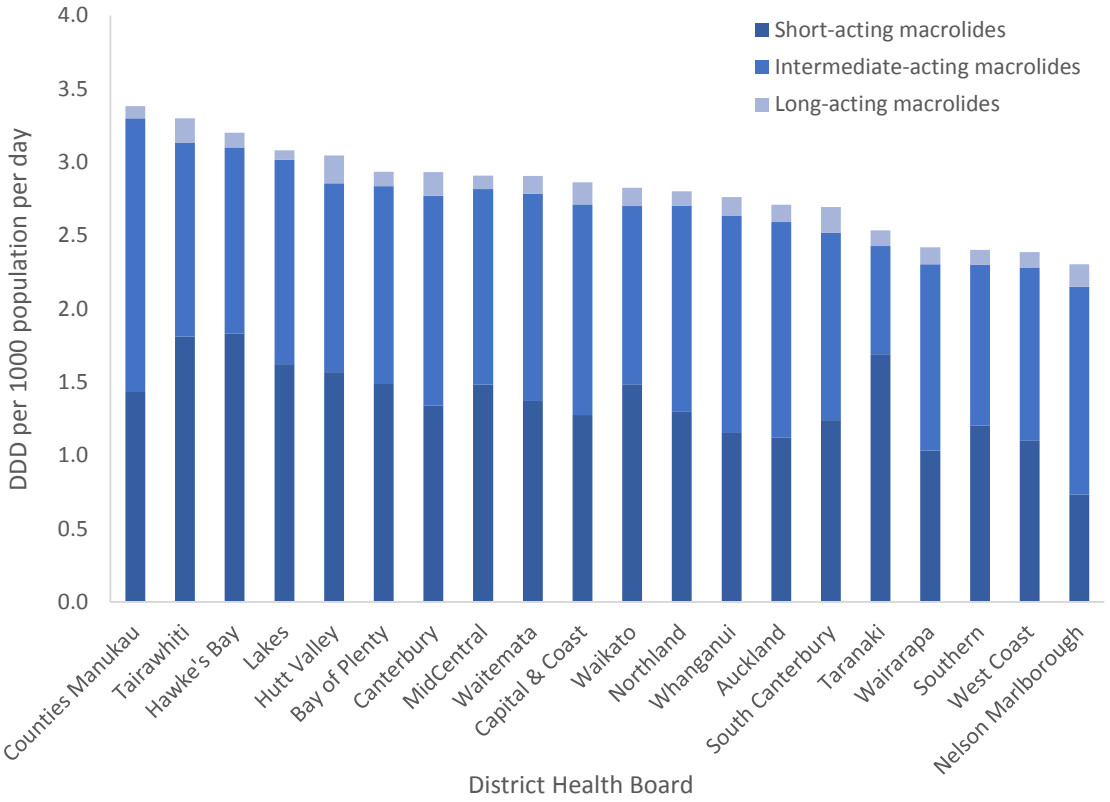


Table 15. Consumption of macrolides and lincosamides (ATC group J01F) by level 4 group, 2006–2014, expressed as DDD per 1000 population per day

ESAC classification	2006	2007	2008	2009	2010	2011	2012	2013	2014
Short-acting macrolides	1.32	1.43	1.51	1.54	1.55	1.60	1.81	1.53	1.36
Intermediate-acting macrolides	0.75	0.89	1.09	1.24	1.32	1.45	1.47	1.41	1.40
Long-acting macrolides	0.04	0.04	0.04	0.05	0.05	0.05	0.06	0.11	0.12
Lincosamides	0.03	0.03	0.04	0.04	0.05	0.05	0.05	0.06	0.05
Total	**2.14**	**2.40**	**2.68**	**2.87**	**2.97**	**3.15**	**3.40**	**3.10**	**2.93**

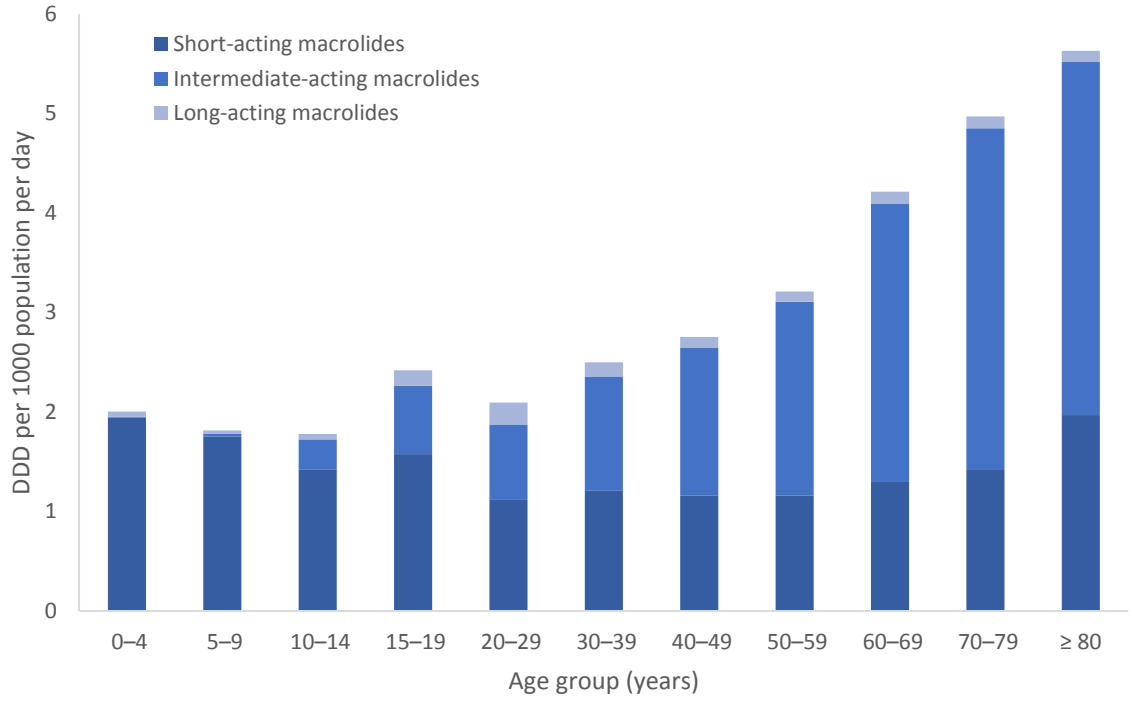
There was relatively limited variation in macrolide use across DHBs (Figure 31 and Table 26 in the Appendix), with the highest rates of macrolide consumption in Counties Manukau DHB (3.4 DID in 2014) and the lowest rates in Nelson Marlborough DHB (2.3 DID in 2014).

Figure 31. Consumption of macrolides (ATC group J01F) by level 4 group and District Health Board, 2014, expressed as DDD per 1000 population per day



Macrolide consumption in children was almost exclusively due to short-acting macrolides. The highest consumption of macrolides was in adults aged over 80 years. There was also an age-related increase in the proportion of macrolide consumption attributable to intermediate-acting macrolides. For example, in 2014, in the ≥80 year age group, 63% of macrolides consumed were intermediate-acting macrolides (Figure 32 and Table 33 in the Appendix).

Figure 32. Consumption of macrolides (ATC group J01F) by level 4 group and age group, 2014, expressed as DDD per 1000 population per day



There were also differences in macrolide consumption according to sex and ethnicity. Consumption of macrolides was highest among females (Figure 33) and people in the European or Other and MELAA ethnic groups (Figure 34).

Figure 33. Consumption of macrolides (ATC group J01F) by level 4 group and sex, 2014, expressed as DDD per 1000 population per day

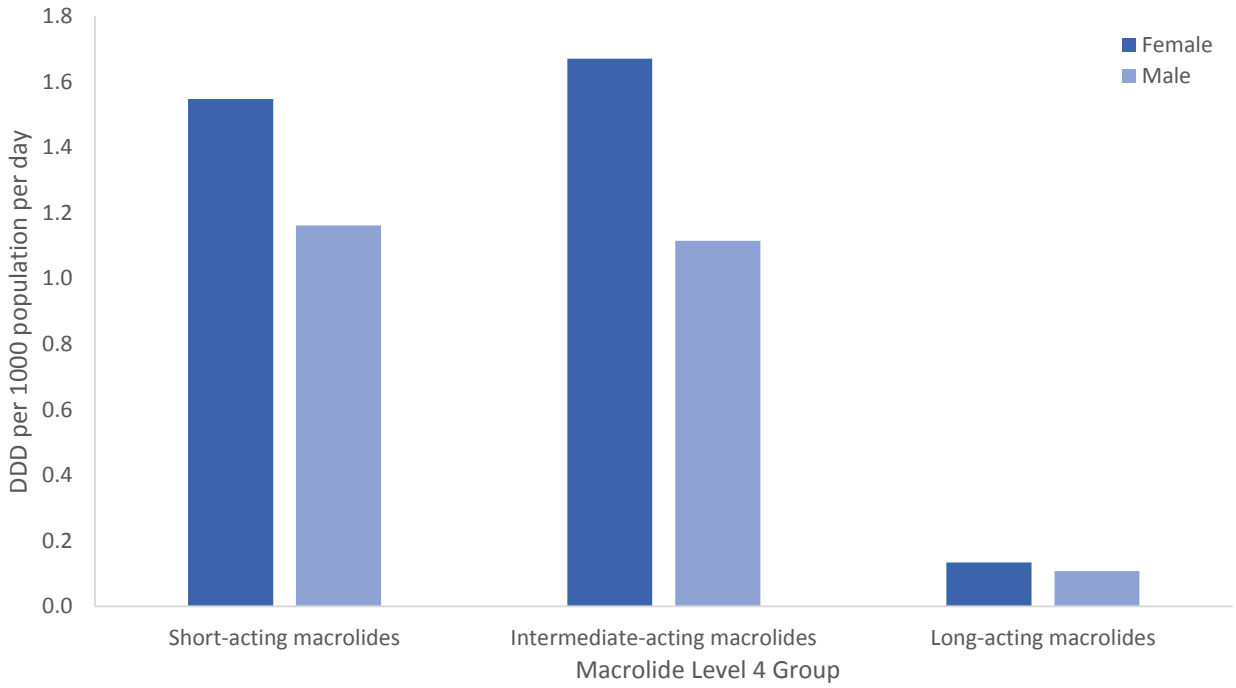
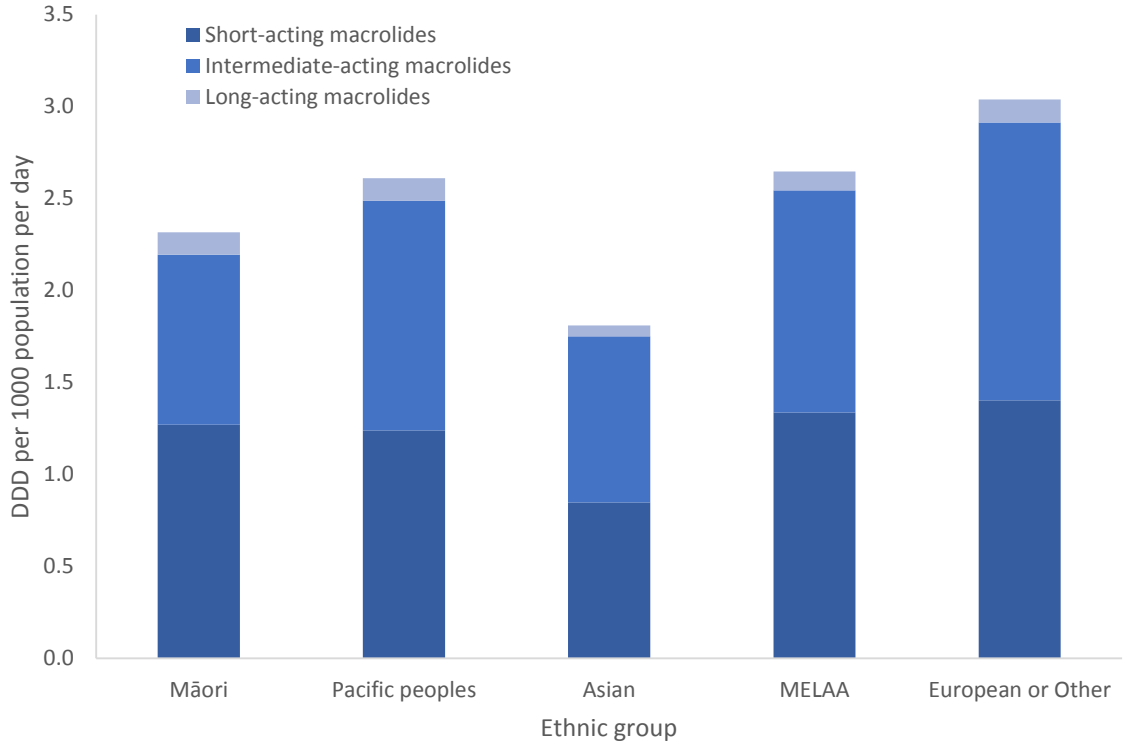


Figure 34. Consumption of macrolides (ATC group J01F) by level 4 group and ethnic group, 2014, expressed as DDD per 1000 population per day



3.8 QUINOLONES (J01M)

Quinolones were the only class of antibiotics whose consumption did not increase from 2006 to 2014 (Figure 35). Overall, there was a significant reduction in first-generation quinolone consumption (norfloxacin) between 2006 and 2014 (Table 16). Second-generation quinolone (ciprofloxacin) consumption increased until 2012 and peaked at 0.55 DID, followed by a decrease to 0.46 DID. Third-generation quinolones (moxifloxacin) made a negligible contribution to community quinolone consumption. Interestingly, rates of quinolone consumption were lowest in those DHBs that had high rates of consumption of β-lactam antibiotics (Figure 36 and Table 27 in the Appendix).

Figure 35. Consumption of quinolones for systemic use (ATC group J01M) by ATC level 4 group, 2006–2014, expressed as DDD per 1000 population per day

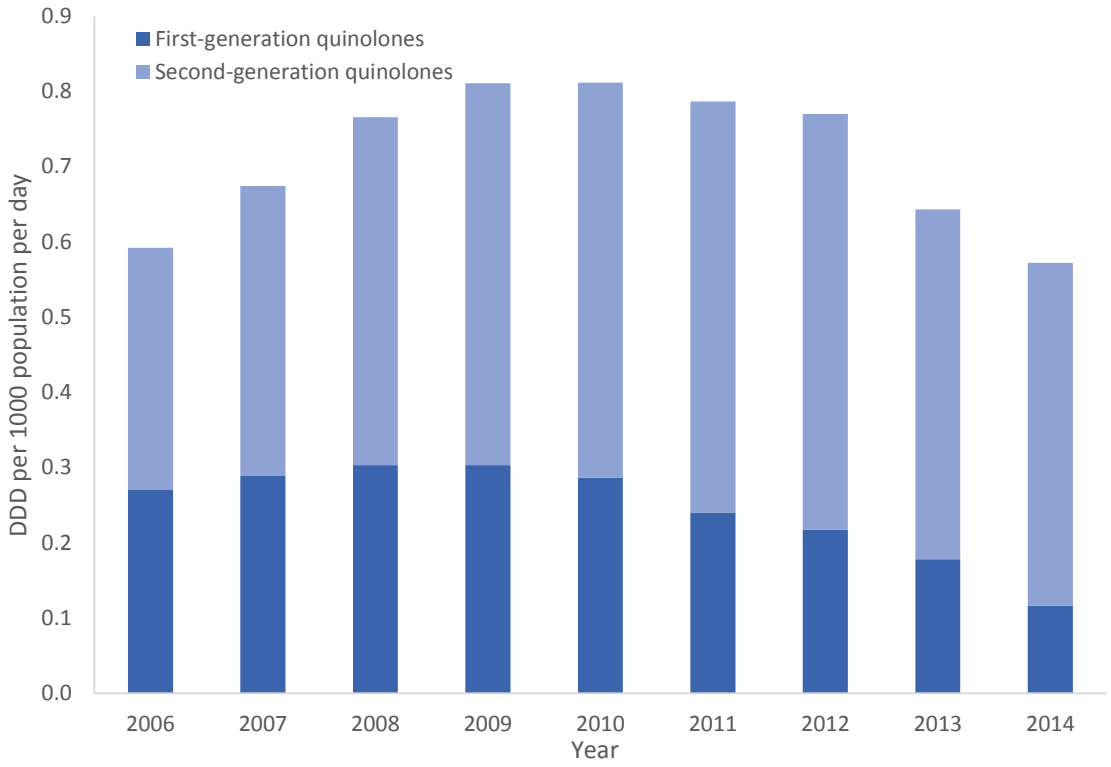
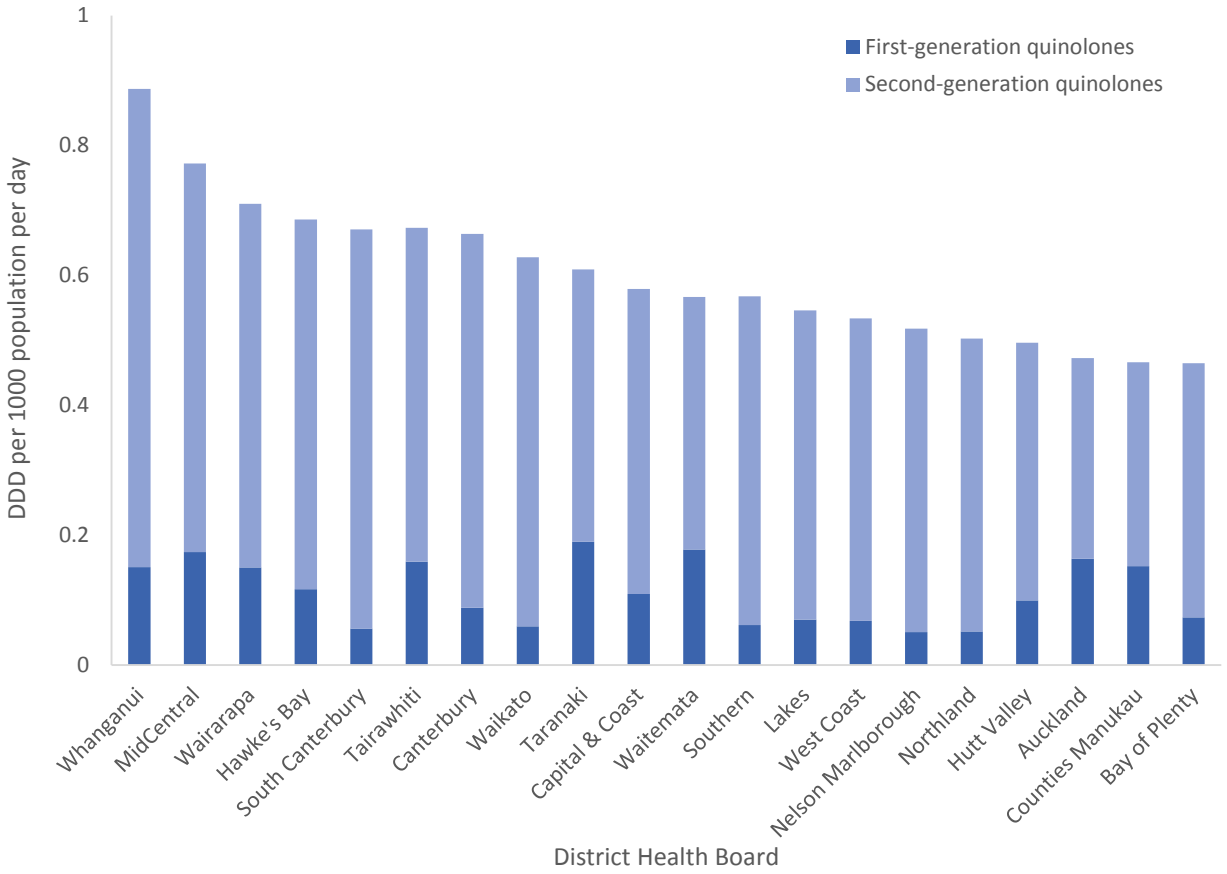


Table 16. Consumption of quinolones (ATC group J01M), by ATC level 4 group, 2006–2014, expressed as DDD per 1000 population per day

ESAC classification	2006	2007	2008	2009	2010	2011	2012	2013	2014
First-generation quinolones	0.27	0.29	0.30	0.30	0.29	0.24	0.22	0.18	0.12
Second-generation quinolones	0.32	0.39	0.46	0.51	0.52	0.55	0.55	0.46	0.46
Third-generation quinolones	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
Total	**0.59**	**0.67**	**0.77**	**0.81**	**0.81**	**0.79**	**0.78**	**0.65**	**0.58**

Figure 36. Consumption of quinolones (ATC group J01M) by ATC level 4 group and District Health Board, 2014, expressed as DDD per 1000 population per day



As expected, quinolone consumption increased with age (Figure 37 and Table 34 in the Appendix). First-generation quinolone consumption was significantly higher in females, likely reflecting use in urinary tract infections, and second-generation quinolone consumption was significantly higher in males (Figure 38). There were marked differences in consumption by ethnicity, with consumption highest in the European or Other ethnic group. This was largely driven by differences in second-generation quinolone consumption (Figure 39).

Figure 37. Consumption of quinolones (ATC group J01M) by ATC level 4 group and age group, 2014, expressed as DDD per 1000 population per day

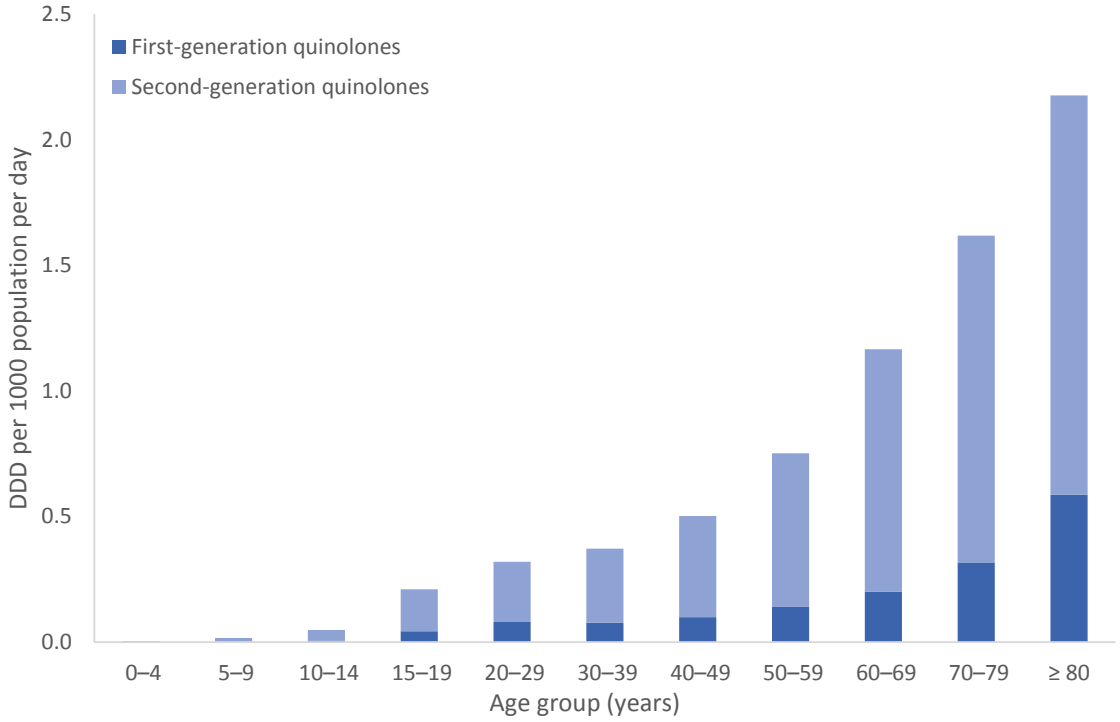


Figure 38. Consumption of quinolones (ATC group J01M) by ATC level 4 group and sex, 2014, expressed as DDD per 1000 population per day

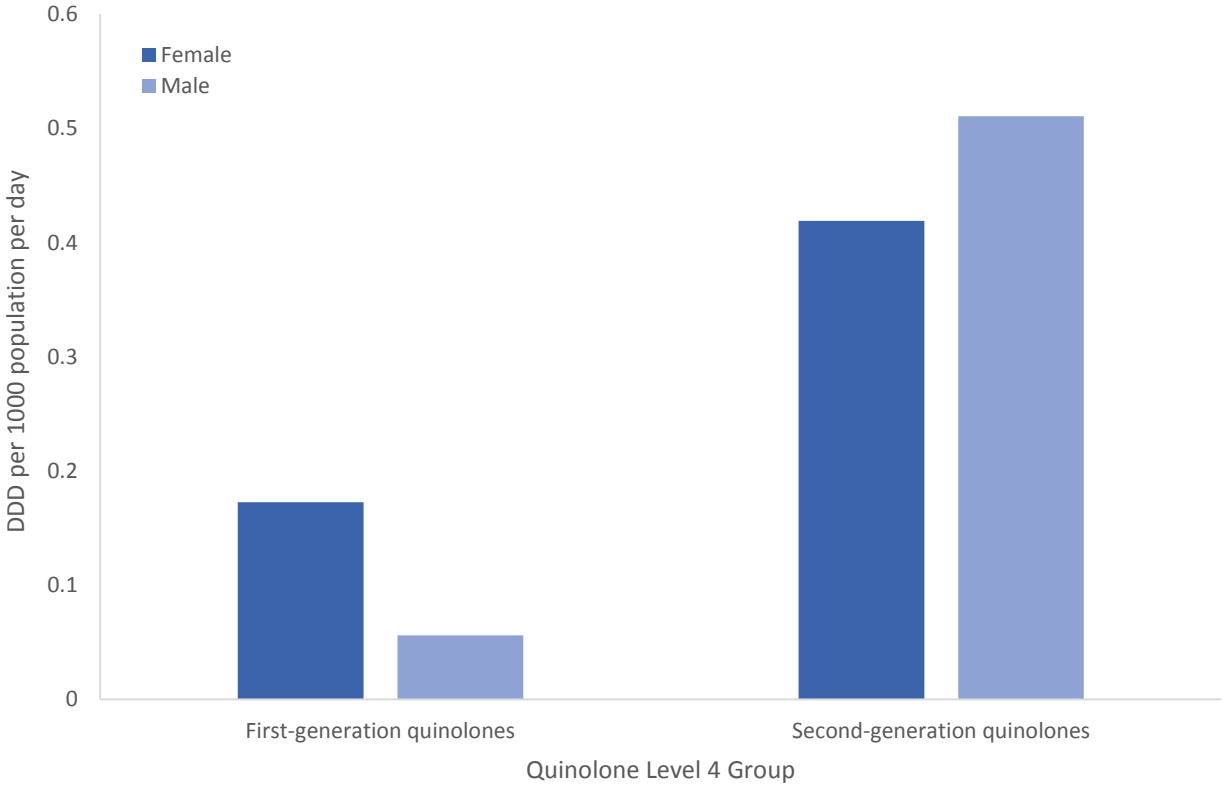
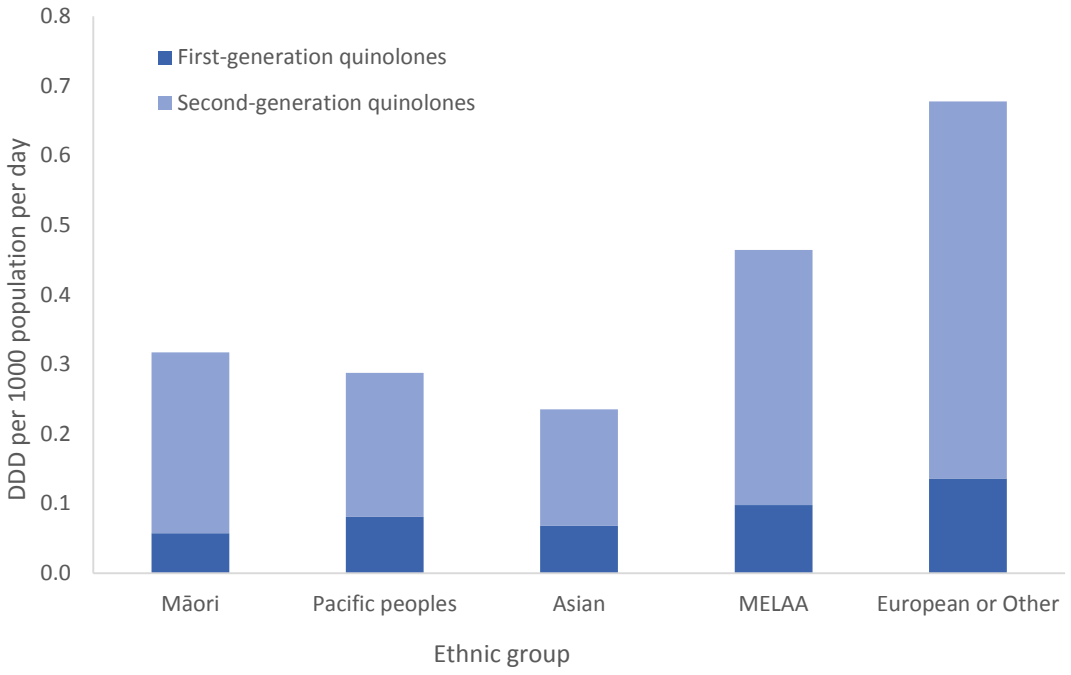


Figure 39. Consumption of quinolones (ATC group J01M) by ATC level 4 group and ethnic group, 2014, expressed as DDD per 1000 population per day



3.9 URINARY ANTISEPTICS (J01X)

Consumption of urinary antiseptics (nitrofurantoin) increased significantly between 2006 and 2014 (Figure 40 and Table 17). Similar to quinolone consumption, consumption was lowest in those DHBs that had high rates of β-lactam consumption (Figure 41). Rates of consumption were highest in adults aged over 80 years, in females and in the European or Other ethnic group (Figure 42-44 and Table 35 in the Appendix).

Figure 40. Consumption of urinary antiseptics (ATC group J01X), 2006–2014, expressed as DDD per 1000 population per day

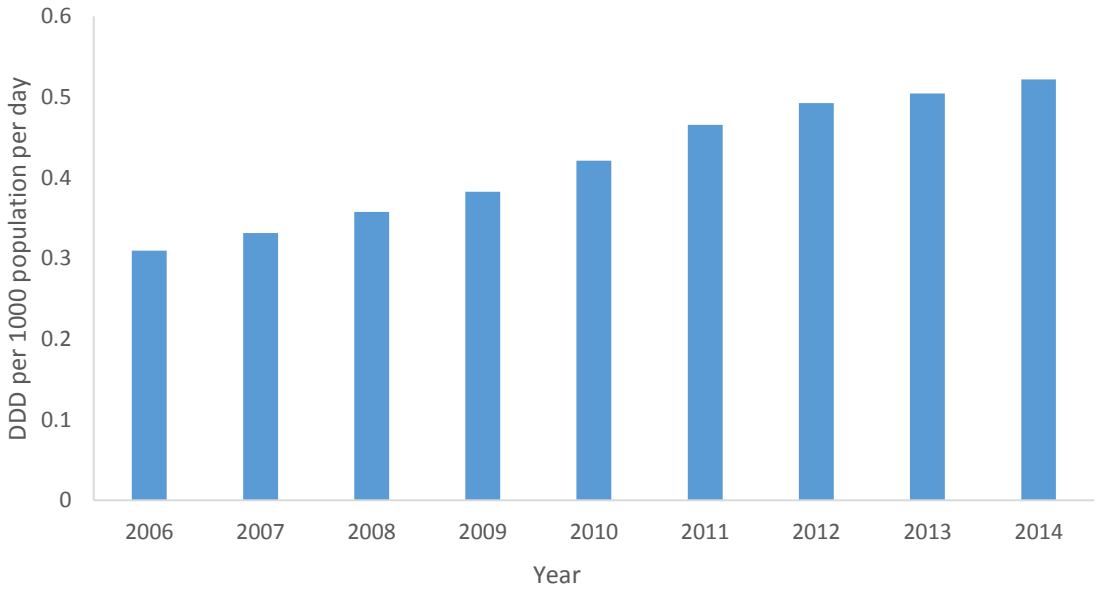


Table 17. Consumption of urinary antiseptics (ATC group J01X), 2006–2014

Subclass	2006	2007	2008	2009	2010	2011	2012	2013	2014
J01X Nitrofurantoin	0.31	0.33	0.36	0.38	0.42	0.47	0.49	0.50	0.52

Figure 41. Consumption of urinary antiseptics (ATC group J01X) by District Health Board, 2014, expressed as DDD per 1000 population per day

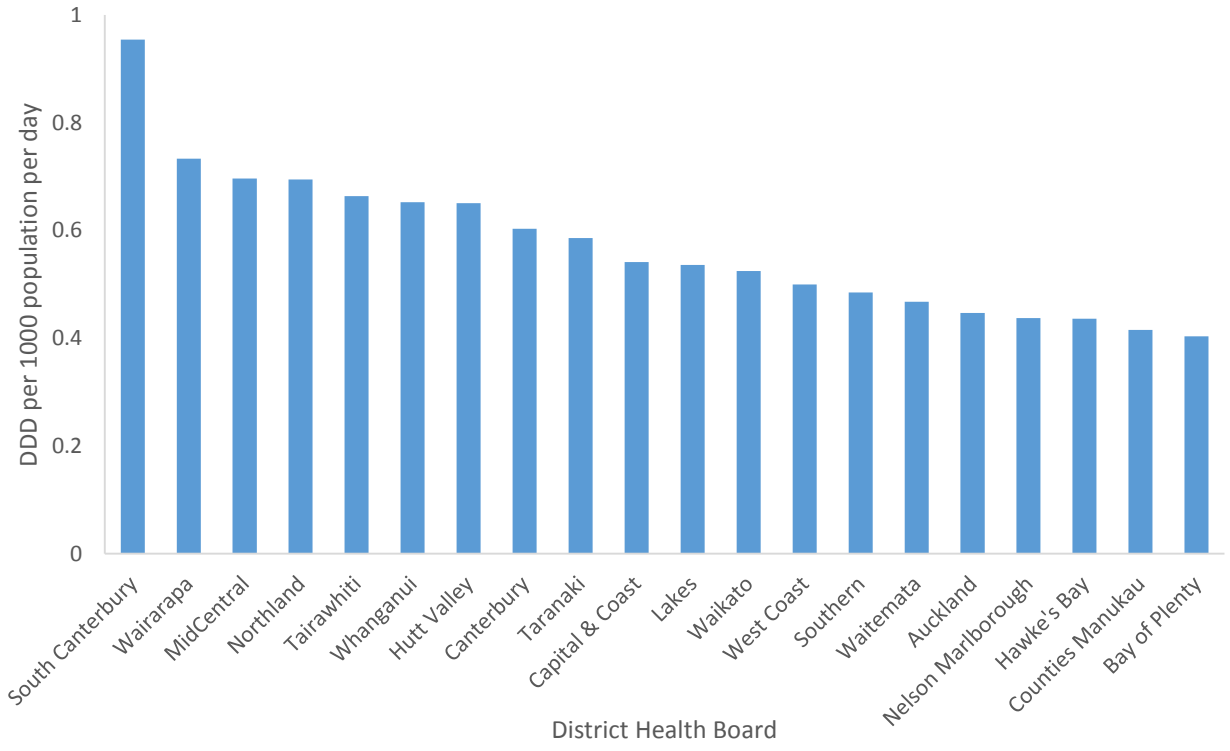


Figure 42. Consumption of urinary antiseptics (ATC group J01X) by age group, 2014, expressed as DDD per 1000 population per day

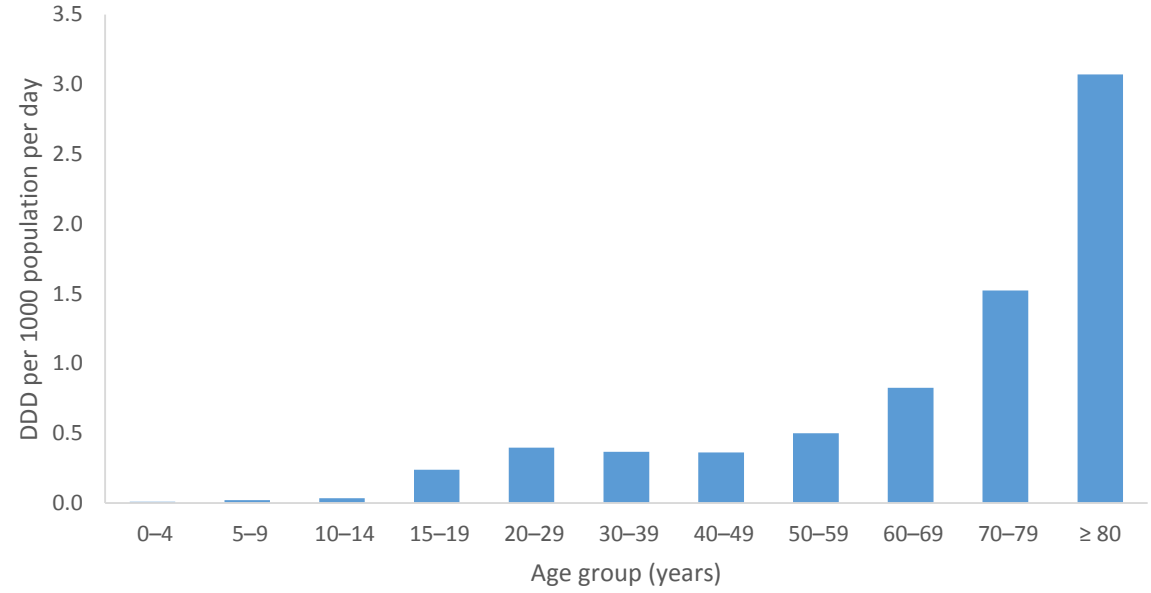


Figure 43. Consumption of urinary antiseptics (ATC group J01X) by sex, 2006–2014, expressed as DDD per 1000 population per day

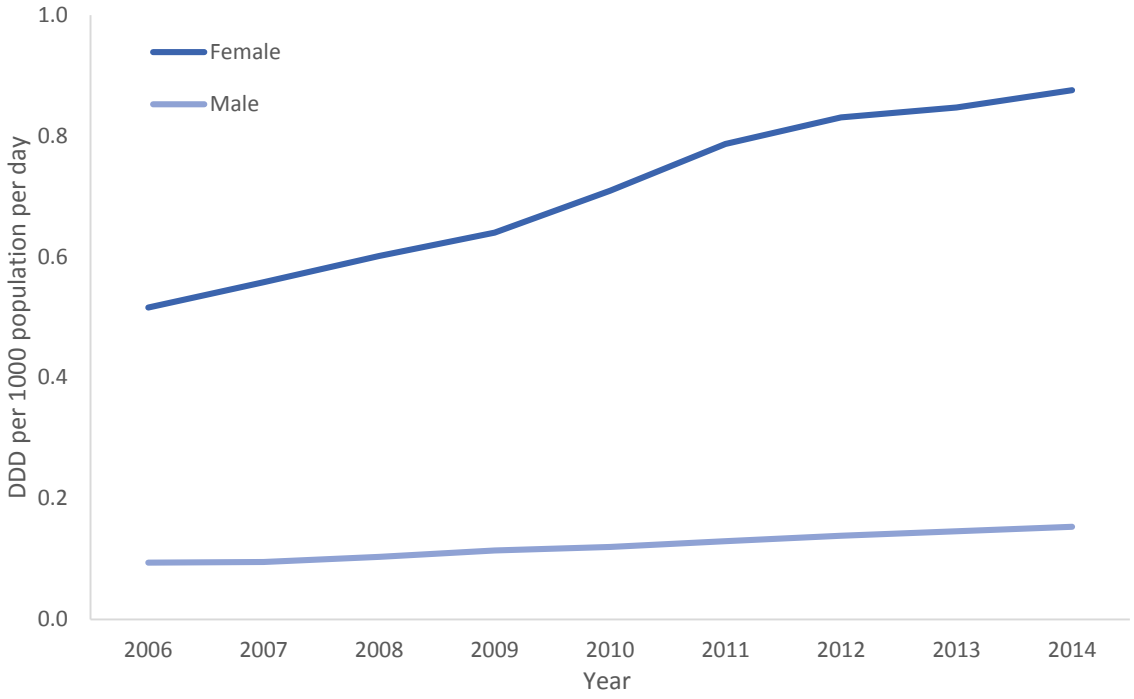
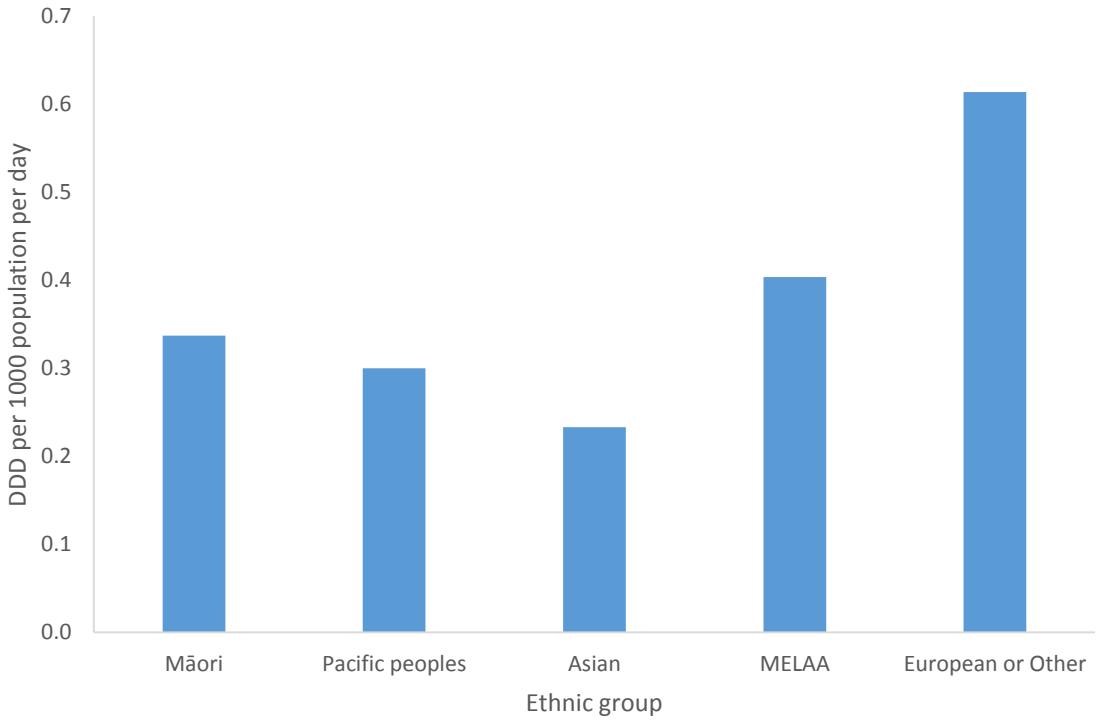


Figure 44. Consumption of urinary antiseptics (ATC group J01X) by ethnic group, 2014, expressed as DDD per 1000 population per day



3.10 QUALITY INDICATORS

Based on data from the European Surveillance of Antimicrobial Consumption (ESAC) project, a set of nine quality indicators were incorporated into this report, which were designed to be used for improved quantitation of antibiotic consumption in primary care, and to assess relevant changes in national antibiotic prescribing patterns. Previous work has suggested that efforts directed to improving these indicator values may impact on reducing antimicrobial resistance, improving cost-effectiveness of antimicrobial use, and providing information for public health policy makers [12]. Data are presented in Table 18, and in keeping with the ESAC report, the minimum value (p0), 25th percentile (p25), median (p50), 75th percentile (p75) and maximum value (p100) are displayed at the bottom of the table. For all indicators, low values reflect better performance against the indicator, with the best performance being within the first quartile (p0–p25).

The first five indicators (J01, J01C, J01D, J01F and J01M) describe overall consumption, and also consumption by major subgroup. Overall, the five DHBs that were in the highest quartile (p75-p100) for total antibiotic consumption (J01), were also more often in the highest quartile for other quality indicators. A notable exception was that DHBs with the highest overall antibiotic consumption had some of the lowest rates of consumption of quinolones (JO1M).

The next two indicators (J01CR_% and J01MA_%) describe the percentage of the total consumption of antibiotics according to various sub-groups: combinations of penicillins including β-lactamase inhibitors (J01CR, represented by amoxicillin-clavulanate), and fluoroquinolones (J01MA). Six DHBs were in the highest quartile for relative consumption of β-lactam combinations; these DHBs were not represented amongst the DHBs with the highest relative consumption of quinolones (apart from MidCentral DHB).

The next category (J01_B/N) describes the ratio of the consumption of broad-spectrum penicillins, cephalosporins and macrolides to the consumption of narrow-spectrum penicillins, cephalosporins and macrolides. This ratio ranged from 1.97 in Taranaki DHB, to 5.32 in Counties Manukau DHB.

The final indicator describes seasonal variation in total antibiotic use (J01), and is calculated based on antibiotic consumption in the winter quarter (June 2014 to August 2014) compared with the summer quarter (December 2013 to February 2014). Seasonal variation ranged from 24.4% in West Coast DHB, to 53.2% in Counties Manukau DHB.

Table 18. ESAC Quality Indicators

DHB	Consumption (DDD per 1000 persons per day) in 2014					Relative consumption (% of J01)		Broad/narrow	Seasonal variation
	J01	J01C Penicillins	J01D Cephalosporins and other β-lactams	J01F Macrolides and lincosamides	J01M Quinolones	J01CR_%	J01MA_%	J01_B/N*	S01_SV#
Northland	25.2	12.8	**1.4**	2.9	0.5	17.9	2.0	3.7	41.2
Waitemata	**26.7**	13.1	**1.4**	2.9	0.6	**19.9**	2.1	**4.5**	**47.6**
Auckland	**27.1**	**13.8**	1.0	2.7	0.5	**20.6**	1.8	**5.1**	**44.4**
Counties Manukau	**30.6**	**18.4**	**1.2**	**3.4**	0.5	**23.9**	1.6	**5.3**	**53.2**
Waikato	26.3	**14.8**	0.9	2.9	0.6	**19.6**	2.4	3.8	**49.5**
Lakes	**27.0**	**14.1**	**1.4**	**3.2**	0.6	16.4	2.0	3.3	40.6
Bay of Plenty	**27.3**	**14.4**	**1.5**	3.0	0.5	**20.2**	1.8	**4.4**	**48.3**
Tairawhiti	24.5	13.8	0.5	**3.4**	**0.7**	18.8	**2.7**	2.6	36.7
Taranaki	22.3	11.1	0.8	2.6	0.6	14.0	**2.7**	2.0	42.9
Hawke's Bay	25.5	13.1	0.9	**3.3**	**0.7**	16.0	**3.5**	2.3	37.7
Whanganui	25.7	12.8	1.1	2.8	**0.9**	16.8	**3.2**	**4.1**	38.1
MidCentral	24.0	11.8	1.2	2.9	**0.8**	**20.0**	**3.0**	3.5	41.9
Hutt Valley	25.4	13.2	0.7	**3.1**	0.5	13.7	2.0	2.5	43.0
Capital & Coast	25.5	12.0	0.5	2.9	0.6	11.4	2.3	2.6	34.5
Wairarapa	22.1	9.8	0.7	2.4	**0.7**	11.5	**3.2**	2.6	27.6
Nelson Marlborough	21.2	9.4	0.9	2.3	0.5	13.9	2.5	3.9	30.4
West Coast	20.0	8.8	0.4	2.4	0.5	11.7	**2.7**	2.2	24.4
Canterbury	23.9	10.5	0.5	3.0	**0.7**	13.9	**2.8**	2.7	35.1
South Canterbury	25.1	10.8	0.8	2.7	**0.7**	12.1	**2.7**	3.0	43.7
Southern	22.1	9.4	1.1	2.5	0.6	13.3	**2.6**	2.8	32.0
New Zealand	**25.8**	**13.1**	**1.0**	**2.9**	**0.6**	**17.9**	**2.2**	**3.7**	**42.7**

Quartile	J01	J01C	J01D	J01F	J01M	J01CR_%	J01MA_%	J01_B/N	S01_SV
p0	20.0	8.8	0.4	2.3	0.48	11.4	1.6	2.0	24.4
p25	22.7	10.6	0.7	2.6	0.51	13.4	2.0	2.6	34.7
p50	25.3	12.8	0.9	2.9	0.58	16.2	2.5	3.2	40.9
p75	26.4	13.8	1.2	3.1	0.67	19.7	2.7	3.9	43.9
p100	30.6	18.4	1.5	3.4	0.89	23.9	3.5	5.3	53.2

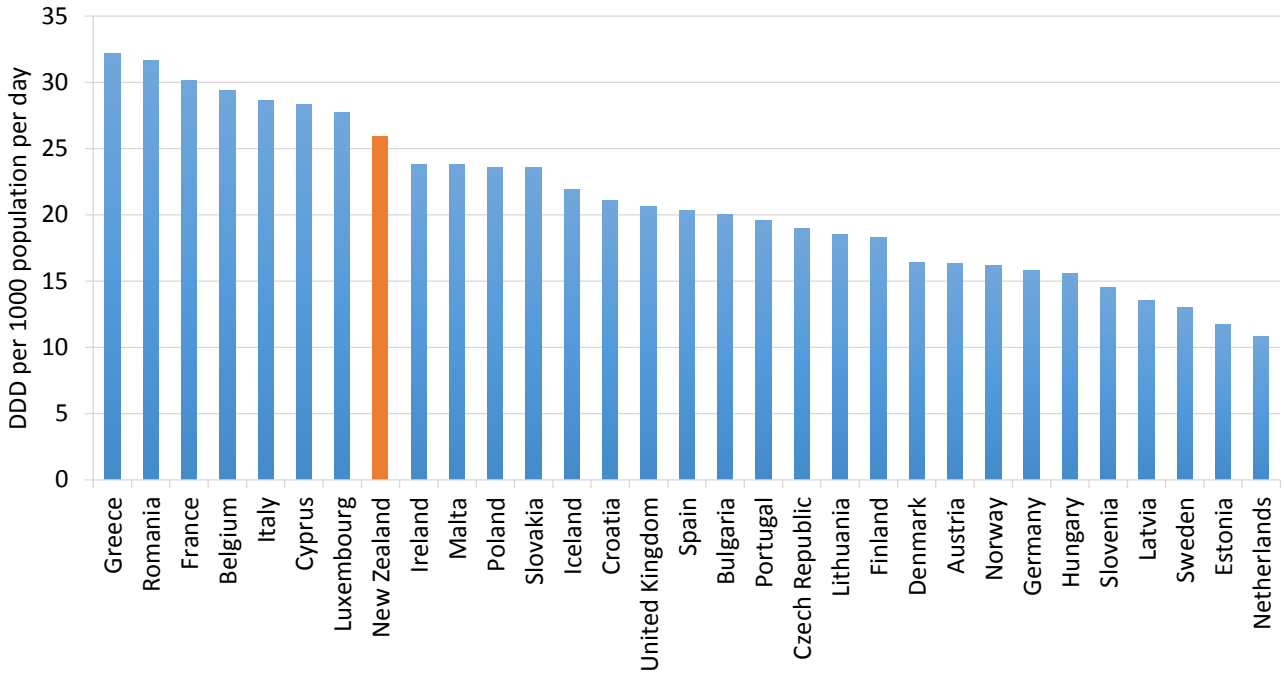
First (lowest) band (p0-p25)
Second (middle) band (p25-p75)
Third (highest) band (p75-p100)

*(JO1(CR+DC+(F-FA01)))/(J01(CE+DB+FA01))

Ratio Winter: Summer Quarters 2013/14

When total antibiotic consumption in the New Zealand community was compared to antibiotic consumption data from the European Centre for Disease Prevention and Control (ECDC), New Zealand's total antibiotic consumption in 2013 was higher than 22 out of 29 European countries surveyed by the ECDC that year (Figure 45).

Figure 45. Antibiotic consumption of 29 European countries and New Zealand, 2013, expressed as DDD per 1000 population per day



(Source: ECDC [22])

4. KEY FINDINGS

This report is the first to systematically assess the trends and demographics of antibiotic consumption in New Zealand and highlights some notable issues relating to the use of antibiotics in New Zealand.

4.1 TRENDS IN ANTIBIOTIC CONSUMPTION

Antibiotic use increased by 49% between 2006 and 2014, and this increase occurred across all DHBs, in all ages, and amongst all ethnic groups. However, between 2012 and 2014 there was a slight decrease in antibiotic consumption, which occurred across the majority of DHBs. Overall consumption of antibiotics varied considerably across the country, and showed a distinct north-south gradient, with the highest consumption generally in the upper North Island.

The increase in overall antibiotic consumption was generally driven by an increase in consumption of penicillins, particularly extended spectrum penicillins (ie. amoxicillin), which almost doubled in consumption between 2006 and 2014, and currently represents approximately one-quarter of all antibiotic use in New Zealand. Importantly, as an extended-spectrum penicillin, amoxicillin has potential to facilitate resistance in a wide range of bacteria, including some gram-negative Enterobacteriaceae such as *Escherichia coli* [13]. There is considerable potential for overuse of amoxicillin, as its indications are for conditions whose clinical features overlap with those of viral illness, such as respiratory tract infections, exacerbations of chronic obstructive pulmonary disease and pharyngitis.

Notably, consumption of quinolones increased early in the study period and then declined from 2011 onwards. Quinolones could be considered a priority class for reducing inappropriate consumption, as quinolone resistance can severely limit treatment options for serious bacterial infections, such as complex urinary tract infections, and some gastrointestinal infections. Multiple factors may have contributed to the observed decline in quinolone consumption, which began with a reduction in norfloxacin dispensing from 2010 onwards. These factors may include educational measures directed towards primary care practitioners around the appropriate use of quinolones (particularly the use of norfloxacin as a second-line agent in the treatment of uncomplicated community UTI), and efforts by community microbiology laboratories to only release antimicrobial susceptibility data on appropriate empiric antibiotic therapy. In addition, a specific recommendation on ciprofloxacin prescribing was introduced in May 2013 for four indications (microbiologically confirmed and clinically significant *Pseudomonas* spp. infection, prostatitis, pyelonephritis, or gonorrhoea). This recommendation may also have contributed to the reduction in quinolone prescribing. Of note, quinolone consumption was generally highest in those DHBs that had the lowest consumption of β-lactam antibiotics. It is not possible to determine from these data the appropriateness of quinolone consumption in these regions, but the wide regional discrepancies in quinolone consumption warrant further investigation.

Importantly, there were changes in the co-payment and funding system for antibiotics over the study period that may have partly impacted on antibiotic consumption trends (Greg Williams, PHARMAC, personal communication). From July 2004, the co-payment for a patient without a community services card reduced from $15 (adult) / $10 (child) to $3. A possible consequence of this change was that a number of prescriptions that would not have previously been funded by the Crown were funded, and therefore captured in the National Pharmaceutical Collection. Implementation of $3 maximum co-payments for enrolled Primary Health Organisation (PHO) patients was rolled out over 5 years by age

in the following order: >65 years (July 2004), 18-24 years (July 2005), 45–64 years (July 2006), 25-44 years (July 2007), all remaining groups (September 2008). This funding change may partly explain the increase in antibiotic consumption observed between 2006 and 2008. Co-payments have subsequently been raised to $5 from 1 January 2014, although the potential impact of this change on antibiotic consumption is not yet clear. In addition, from 2010, there was also an increase in the use of first-generation cephalosporins (ie. cephalexin), specifically in paediatric populations. The 250 mg cephalexin capsule was delisted in March 2007 and cephalexin liquid was delisted in September 2006. In December 2009, PHARMAC relisted the oral liquid and the capsules were relisted in September 2010. This is likely to have directly contributed to the increase in cephalexin usage observed from 2010 onwards.

4.2 ANTIBIOTIC CONSUMPTION AND PATIENT CHARACTERISTICS

There were some important differences in antibiotic use according to patient factors such as age, sex and ethnicity. For example, penicillin consumption was generally highest in young children and the elderly, in the upper North Island and in Pacific peoples. The reasons for these demographic differences in penicillin consumption are unclear, but may include factors such as differential disease rates (eg, the incidence of respiratory tract infections in New Zealand is highest at the extremes of age and in Pacific Peoples [14, 15]), practitioner prescribing thresholds, and treatment guidelines for common conditions such as streptococcal pharyngitis [16].

In adults, consumption of all antibiotic classes was highest in adults aged over 80 years, with the exception of tetracyclines (specifically doxycycline), which had a notable peak in consumption in the 15–19 year age group. This is likely to reflect prolonged courses of doxycycline in the treatment of acne [17], and to a lesser extent, in the treatment of sexually transmitted infections [18].

In general, antibiotic consumption was higher in females than males, in keeping with other studies assessing antibiotic use in the community [19, 20]. The reasons for this are uncertain, but may include higher rates of urinary tract infections in females, differential utilisation of primary care services, or a greater proportion of elderly females than males in the population. This current study cannot assess whether sex-related differences in antibiotic consumption reflects over-use of antibiotics in females, or under-use in males, although it is interesting to note that measures to control quinolone consumption eliminated the observed differences between the sexes. It is therefore possible that antibiotic overuse may at least partially explain the observed differences between the sexes.

We also observed differences in antibiotic consumption according to ethnicity. In general, antibiotic use was lowest in Asian and Māori ethnic groups compared to the European or Other, MELAA and Pacific peoples ethnic groups. For Māori, this is at distinct odds with their high burden of infectious diseases [21], and warrants further exploration. One previous study has specifically assessed antibiotic use and ethnicity in New Zealand, and, similar to our findings, observed lower rates of antibiotic consumption in Māori compared to non-Māori [9]. These authors hypothesised that some of these differences in antibiotic use may be related to barriers to healthcare access, including the cost of primary care and prescriptions, and cultural differences in knowledge or understanding of infectious diseases and antibiotics.

Total antibiotic consumption was highest in Pacific peoples, and this was largely driven by penicillins (J01C), where the consumption in Pacific peoples was almost twice as high as in the Asian and European or Other ethnic groups. Pacific peoples are known to have some of the highest rates of infectious diseases in New Zealand, particularly common infections such as respiratory tract infections and skin infections, and it is entirely possible that much of the antibiotic consumption in this group is appropriate to the high disease burden [21]. However, given the high rates of antibiotic use in this group, future work should attempt to better understand the specific indications for antibiotic prescribing.

4.3 ANTIBIOTIC CONSUMPTION IN NEW ZEALAND COMPARED TO OTHER SETTINGS

In this report, we used internationally agreed quality indicators to facilitate comparison of antibiotic consumption in New Zealand with other countries [12]. Relative to 29 European countries participating in ESAC in 2013, total antibiotic consumption in New Zealand in 2013 (25.9 DID) was higher than 22 of these countries [22]. In addition, the median seasonal variation in total antibiotic consumption in New Zealand was 41%, second only to Hungary (47%) and Luxembourg (41%) [22]. Moreover, recent work from Australia assessing use of antibiotics supplied through the Pharmaceutical Benefits Scheme (PBS) and Repatriation Pharmaceutical Benefits Scheme (RPBS) observed a DID of 22.8 in 2013 [23]. Taken together, these findings suggest that antibiotic consumption in New Zealand is comparatively high by international standards, and it is possible that a large number of antibiotics may be prescribed for seasonal conditions in which antibiotic treatment has no clear benefit (eg, viral upper respiratory tract infection).

4.4 STRENGTHS AND LIMITATIONS

There were a number of limitations with this study. In particular, dispensing data do not provide any information on the indications for, or appropriateness of antibiotic usage. Such information is important when comparing antibiotic consumption across demographic groups that may have a differential incidence of infections (eg, urinary tract infections in females; skin infections in children). Moreover, dispensing data are unable to account for patient-level factors, particularly adherence to therapy. In addition, the dataset used in this study does not include practitioner's supply orders (PSO) or bulk supply orders. This may, in part, explain some of the differences in antibiotic consumption observed across ethnic groups. For example, the sore throat management component of the rheumatic fever prevention programme uses the PSO scheme for access to antibiotics. Given that this programme predominantly targets Māori and Pacific children, it is likely that antibiotic consumption in these groups is higher than the levels observed in this study.

There were also some notable strengths to this work. In particular, our dataset provides high-level coverage of the population of interest, and New Zealand's use of a universal health number across the health sector supports highly effective data linkage, including use of linked sociodemographic data. This allowed us to assess the trends and demographics of antibiotic consumption across the entire nation.

4.5 CONCLUSIONS

In summary, this report provides valuable baseline information on patterns of antibiotic consumption in New Zealand, and serves as an ongoing platform on which to gauge the effects of potential future community-based antimicrobial stewardship efforts. Notable findings include: (i) a marked increase in antibiotic consumption over the study period; (ii) ethnic and geographic differences in antibiotic consumption, particularly in relation to penicillins; and (iii) relatively high rates of consumption in New Zealand compared to similar developed countries. Future work should focus on identifying the appropriateness of antibiotic prescribing, particularly for seasonal penicillin prescribing, and on both reducing unwarranted antibiotic use and improving antibiotic selection when therapy is indicated, in order to reduce and mitigate antimicrobial resistance in New Zealand.

5. RECOMMENDATIONS

- Ongoing surveillance of antibiotic consumption should be performed in order to measure the effects of future antibiotic stewardship efforts, incorporating the quality indicators suggested in this report.
- Targeted quantitative and qualitative research is performed in order to better understand the indications and appropriateness of antibiotic prescribing, focusing on priority antibiotics and populations identified in this report. This would include seasonal prescribing of extended-spectrum penicillins in children and the elderly, the use of doxycycline in adolescents and young adults, and an exploration of possible reasons for ethnic discrepancies in antibiotic consumption, including the contribution of PSO and bulk supply orders.
- Work is undertaken to understand the factors that contributed to success in reducing community quinolone consumption, in order to better inform efforts to reduce consumption of other antibiotics.
- The findings of this study are communicated appropriately to relevant stakeholders, including infectious diseases physicians, clinical microbiologists, general practitioners and community pharmacists.

APPENDIX

Table 19. Antibiotic consumption for systemic use by sex and ATC group level 3, 2014, expressed as packages per 100 population per year

ATC level 3 group	Female	Male	Total
Tetracyclines (J01A)	7.16	5.54	6.37
Penicillins (J01C)	55.29	50.49	52.94
Cephalosporins and other β-lactams (J01D)	7.43	4.29	5.89
Sulfonamides and trimethoprim (J01E)	10.56	4.28	7.49
Macrolides and lincosamides (J01F)	12.41	9.03	10.75
Quinolones (J01M)	3.46	2.46	2.97
Urinary antiseptics (J01X)	3.46	0.53	2.02
Total (J01)	**99.81**	**76.67**	**88.48**

Table 20. Antibiotic consumption for systemic use by ethnic group and ATC group level 3, 2014, expressed as packages per 100 population per year

ATC level 3 group	Māori	Pacific peoples	Asian	MELAA	European or Other	Total
Tetracyclines (J01A)	3.73	3.33	3.39	5.93	7.26	6.37
Penicillins (J01C)	58.57	87.16	41.77	62.06	47.54	52.94
Cephalosporins and other β-lactams (J01D)	5.79	7.15	4.36	5.46	6.80	5.89
Sulfonamides and trimethoprim (J01E)	7.02	8.35	3.73	6.01	7.89	7.49
Macrolides and lincosamides (J01F)	9.49	10.72	7.23	10.54	11.02	10.75
Quinolones (J01M)	1.64	1.66	1.41	2.38	3.47	2.97
Urinary antiseptics (J01X)	1.33	1.21	0.87	1.45	2.38	2.02
Total (J01)	**87.64**	**119.59**	**62.78**	**93.86**	**86.41**	**88.48**

Table 21. Antibiotic consumption for systemic use (ATC group J01) by DHB, 2006 to 2014, expressed as DDDs per 1000 population per day

District Health Board	2006	2007	2008	2009	2010	2011	2012	2013	2014
Northland	21.65	22.14	24.04	23.40	23.97	25.64	26.11	26.38	25.17
Waitemata	16.55	18.81	21.69	22.79	24.10	25.80	26.46	26.87	26.67
Auckland	17.45	19.77	22.54	23.96	25.02	26.75	27.37	27.37	27.13
Counties Manukau	21.96	23.50	25.82	27.71	28.40	29.86	30.63	31.14	30.60
Waikato	17.75	20.16	22.56	24.25	24.94	25.67	26.75	26.79	26.30
Lakes	20.80	22.63	23.77	24.93	25.30	26.87	27.43	26.79	27.00
Bay of Plenty	20.75	22.29	24.47	25.08	26.21	27.19	27.37	27.03	27.31
Tairawhiti	22.92	21.87	22.27	24.64	25.66	27.19	26.27	25.94	24.52
Taranaki	15.32	16.88	18.87	19.95	20.19	21.03	21.82	22.26	22.34
Hawke's Bay	18.08	20.03	22.10	22.28	22.78	24.44	24.63	24.85	25.49
Whanganui	17.92	20.45	21.67	22.53	23.23	24.05	25.99	25.09	25.73
MidCentral	17.76	20.24	21.85	21.65	22.77	24.10	24.82	24.42	23.95
Hutt Valley	16.85	19.46	21.02	21.74	22.27	24.15	24.78	24.66	25.41
Capital & Coast	15.48	18.02	20.34	21.29	22.11	23.86	25.18	25.12	25.47
Wairarapa	15.16	17.80	19.81	19.64	21.37	22.82	22.88	22.41	22.14
Nelson Marlborough	12.17	14.85	17.01	18.61	19.19	20.86	21.84	22.43	21.21
West Coast	14.25	15.57	16.56	17.47	17.84	19.36	20.19	20.27	20.03
Canterbury	14.33	17.28	20.02	20.85	21.64	22.41	24.38	23.79	23.88
South Canterbury	13.75	17.11	20.37	21.69	23.13	24.45	25.47	25.62	25.06
Southern	14.46	16.73	18.14	19.07	19.34	20.79	21.79	21.83	22.09
Total	**17.31**	**19.49**	**21.75**	**22.80**	**23.62**	**25.01**	**25.90**	**25.93**	**25.79**

Table 22. Consumption of tetracyclines (ATC group J01A) by ATC level 4 group, and District Health Board, 2014, expressed as DDD per 1000 population per day

District Health Board	Doxycycline	Minocycline	Total (J01A)
Northland	5.35	0.07	5.42
Waitemata	6.94	0.15	7.10
Auckland	7.36	0.23	7.59
Counties Manukau	5.34	0.13	5.47
Waikato	5.12	0.22	5.33
Lakes	5.92	0.16	6.08
Bay of Plenty	6.12	0.17	6.28
Tairawhiti	4.48	0.08	4.56
Taranaki	5.38	0.17	5.55
Hawke's Bay	5.58	0.22	5.80
Whanganui	6.05	0.10	6.15
MidCentral	5.31	0.16	5.47
Hutt Valley	6.13	0.17	6.31
Capital & Coast	7.66	0.20	7.86
Wairarapa	6.38	0.13	6.52
Nelson Marlborough	6.10	0.13	6.23
West Coast	6.21	0.06	6.27
Canterbury	7.30	0.16	7.46
South Canterbury	7.55	0.21	7.76
Southern	6.68	0.18	6.86
Total	**6.36**	**0.17**	**6.53**

Table 23. Consumption of penicillins (ATC group J01C) by ATC level 4 group, and District Health Board, 2014, expressed as DDD per 1000 population per day

District Health Board	Penicillins with extended-spectrum (J01CA)	β-lactamase-sensitive penicillins (J01CE)	β-lactamase-resistant penicillins (J01CF)	Combinations of penicillins, incl. β-lactamase inhibitors (J01CR)	Total (J01C)
Northland	6.29	0.22	1.74	4.51	12.75
Waitemata	6.24	0.26	1.27	5.30	13.08
Auckland	6.73	0.26	1.25	5.58	13.83
Counties Manukau	9.41	0.23	1.46	7.31	18.42
Waikato	7.12	0.39	2.12	5.17	14.79
Lakes	7.21	0.31	2.15	4.42	14.08
Bay of Plenty	6.47	0.33	2.10	5.52	14.41
Tairawhiti	6.31	0.52	2.34	4.60	13.77
Taranaki	5.56	0.47	1.94	3.13	11.10
Hawke's Bay	6.44	0.56	2.03	4.08	13.11
Whanganui	6.11	0.35	1.96	4.33	12.75
MidCentral	4.95	0.37	1.67	4.78	11.77
Hutt Valley	6.68	0.43	2.61	3.48	13.20
Capital & Coast	6.32	0.46	2.37	2.90	12.04
Wairarapa	4.67	0.49	2.07	2.55	9.78
Nelson Marlborough	4.25	0.47	1.77	2.95	9.44
West Coast	4.03	0.60	1.78	2.35	8.76
Canterbury	4.88	0.52	1.78	3.31	10.50
South Canterbury	5.72	0.38	1.65	3.02	10.78
Southern	4.57	0.52	1.36	2.94	9.38
Total	**6.35**	**0.37**	**1.73**	**4.61**	**13.06**

Table 24. Consumption of cephalosporins and other β-lactams (ATC group J01D) by ATC level 4 group, and District Health Board, 2014, expressed as DDD per 1000 population per day

District Health Board	First-generation cephalosporins (J01DB)	Second-generation cephalosporins (J01DC)	Total (J01D)
Northland	0.40	1.05	1.45
Waitemata	0.18	1.20	1.37
Auckland	0.18	0.77	0.95
Counties Manukau	0.26	0.93	1.19
Waikato	0.09	0.79	0.89
Lakes	0.22	1.18	1.40
Bay of Plenty	0.10	1.36	1.46
Tairawhiti	0.14	0.31	0.45
Taranaki	0.18	0.59	0.77
Hawke's Bay	0.26	0.64	0.90
Whanganui	0.20	0.93	1.12
MidCentral	0.20	0.95	1.15
Hutt Valley	0.21	0.44	0.66
Capital & Coast	0.17	0.35	0.52
Wairarapa	0.23	0.51	0.74
Nelson Marlborough	0.15	0.72	0.87
West Coast	0.08	0.28	0.36
Canterbury	0.12	0.37	0.49
South Canterbury	0.10	0.74	0.83
Southern	0.10	0.97	1.07
Total	**0.18**	**0.81**	**0.99**

Table 25. Consumption of sulfonamides and trimethoprim (ATC group J01E) by ATC level 4 group, and District Health Board, 2014, expressed as DDD per 1000 population per day

District Health Board	Trimethoprim (J01EA)	Trimethoprim-sulfamethoxazole (J01EE)	Total (J01E)
Northland	0.71	0.76	1.48
Waitemata	0.53	0.60	1.14
Auckland	0.47	0.59	1.06
Counties Manukau	0.43	0.74	1.17
Waikato	0.62	0.60	1.22
Lakes	0.61	0.55	1.15
Bay of Plenty	0.65	0.56	1.21
Tairawhiti	0.63	0.39	1.02
Taranaki	0.69	0.45	1.14
Hawke's Bay	0.73	0.53	1.27
Whanganui	0.98	0.37	1.34
MidCentral	0.77	0.35	1.12
Hutt Valley	0.66	0.32	0.98
Capital & Coast	0.63	0.37	1.00
Wairarapa	0.82	0.40	1.21
Nelson Marlborough	1.11	0.24	1.35
West Coast	0.81	0.34	1.15
Canterbury	0.78	0.39	1.17
South Canterbury	0.91	0.40	1.30
Southern	0.76	0.49	1.25
Total	**0.65**	**0.52**	**1.17**

Table 26. Consumption of macrolides and lincosamides (ATC group J01F) by ATC level 4 group, and District Health Board, 2014, expressed as DDD per 1000 population per day

District Health Board	Short-acting macrolides	Intermediate-acting macrolides	Long acting-macrolides	Lincosamides (J01FF)	Total (J01F)
Northland	1.30	1.41	0.10	0.07	2.87
Waitemata	1.37	1.41	0.12	0.03	2.94
Auckland	1.12	1.47	0.12	0.04	2.75
Counties Manukau	1.43	1.87	0.08	0.06	3.44
Waikato	1.48	1.22	0.12	0.07	2.89
Lakes	1.62	1.39	0.06	0.10	3.18
Bay of Plenty	1.49	1.35	0.10	0.10	3.04
Tairawhiti	1.81	1.32	0.17	0.06	3.36
Taranaki	1.69	0.74	0.11	0.04	2.58
Hawke's Bay	1.83	1.27	0.10	0.08	3.28
Whanganui	1.15	1.48	0.13	0.04	2.81
MidCentral	1.48	1.33	0.09	0.04	2.95
Hutt Valley	1.57	1.29	0.19	0.04	3.09
Capital & Coast	1.27	1.44	0.15	0.03	2.89
Wairarapa	1.03	1.27	0.11	0.03	2.45
Nelson Marlborough	0.73	1.42	0.15	0.03	2.34
West Coast	1.10	1.18	0.11	0.06	2.45
Canterbury	1.34	1.43	0.16	0.04	2.97
South Canterbury	1.24	1.28	0.17	0.02	2.72
Southern	1.20	1.10	0.10	0.05	2.45
Total	**1.36**	**1.40**	**0.12**	**0.05**	**2.93**

Table 27. Consumption of quinolones (ATC group J01M) by ATC level 4 group, and District Health Board, 2014, expressed as DDD per 1000 population per day

District Health Board	First-generation quinolones	Second-generation quinolones	Total (JO1M)
Northland	0.05	0.45	0.50
Waitemata	0.18	0.39	0.57
Auckland	0.16	0.31	0.47
Counties Manukau	0.15	0.31	0.47
Waikato	0.06	0.57	0.63
Lakes	0.07	0.48	0.55
Bay of Plenty	0.07	0.39	0.46
Tairawhiti	0.16	0.51	0.67
Taranaki	0.19	0.42	0.61
Hawke's Bay	0.12	0.57	0.69
Whanganui	0.15	0.74	0.89
MidCentral	0.17	0.60	0.77
Hutt Valley	0.10	0.40	0.50
Capital & Coast	0.11	0.47	0.58
Wairarapa	0.15	0.56	0.71
Nelson Marlborough	0.05	0.47	0.52
West Coast	0.07	0.47	0.53
Canterbury	0.09	0.58	0.66
South Canterbury	0.06	0.61	0.67
Southern	0.06	0.51	0.57
Total	**0.12**	**0.46**	0.57

Table 28. Consumption of urinary antiseptics (ATC group J01X) by ATC level 4 group, and District Health Board, 2014, expressed as DDD per 1000 population per day

District Health Board	Total J01X
Northland	0.69
Waitemata	0.47
Auckland	0.45
Counties Manukau	0.42
Waikato	0.52
Lakes	0.54
Bay of Plenty	0.40
Tairawhiti	0.66
Taranaki	0.59
Hawke's Bay	0.44
Whanganui	0.65
MidCentral	0.70
Hutt Valley	0.65
Capital & Coast	0.54
Wairarapa	0.73
Nelson Marlborough	0.44
West Coast	0.50
Canterbury	0.60
South Canterbury	0.95
Southern	0.48
Total	**0.52**

Table 29. Consumption of tetracyclines (ATC group J01A), by age group, 2014, expressed as DDD per 1000 population per day

Age Group	2006	2007	2008	2009	2010	2011	2012	2013	2014
0–4	0.04	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
5–9	0.05	0.03	0.02	0.02	0.03	0.03	0.03	0.02	0.02
10–14	3.05	3.16	3.37	3.50	3.72	3.89	4.24	4.51	4.42
15–19	12.69	12.84	13.23	14.18	14.75	15.63	16.85	17.69	17.24
20–29	4.39	5.10	6.08	6.65	7.08	7.74	8.44	8.53	8.33
30–39	2.12	3.11	4.22	4.57	4.72	5.02	5.38	5.58	5.56
40–49	2.85	3.92	4.68	4.93	5.05	5.30	5.73	5.81	5.94
50–59	3.98	5.35	5.56	5.67	5.81	6.02	6.49	6.54	6.71
60–69	5.69	6.35	6.77	6.83	6.88	7.27	7.57	7.71	7.72
70–79	6.48	6.41	6.57	6.59	6.83	7.24	7.78	7.73	7.86
≥ 80	5.73	5.58	5.78	6.01	6.01	6.23	6.47	6.62	6.71
Total	**3.97**	**4.60**	**5.13**	**5.39**	**5.59**	**5.92**	**6.37**	**6.52**	**6.53**

Table 30. Consumption of penicillins (ATC group J01C) by age group, 2014, expressed as DDD per 1000 population per day

Age Group	2006	2007	2008	2009	2010	2011	2012	2013	2014
0–4	12.73	12.73	12.73	12.73	12.73	12.73	12.73	12.73	12.73
5–9	9.98	9.98	9.98	9.98	9.98	9.98	9.98	9.98	9.98
10–14	7.81	8.15	9.17	9.10	9.47	10.09	9.93	10.43	10.09
15–19	9.41	9.82	10.68	11.15	11.36	11.72	11.49	10.99	10.98
20–29	6.12	7.21	8.58	9.50	10.09	10.78	10.98	10.78	10.77
30–39	5.77	7.53	9.62	10.44	10.96	11.92	12.04	11.97	12.27
40–49	6.55	8.15	9.60	10.30	10.52	11.26	11.55	11.51	11.70
50–59	8.39	10.11	10.95	11.48	11.69	12.29	12.69	12.64	12.87
60–69	11.85	12.77	13.58	13.71	13.92	14.62	15.12	15.07	15.31
70–79	15.22	15.32	16.46	16.55	16.79	17.44	17.76	17.64	17.73
≥ 80	18.75	19.08	20.17	20.52	20.53	21.69	22.53	22.06	21.96
Total	**8.86**	**9.89**	**11.08**	**11.53**	**11.90**	**12.64**	**12.85**	**13.03**	**13.06**

Table 31. Consumption of cephalosporins and other β-lactams (ATC group J01D) by age group, 2014, expressed as DDD per 1000 population per day

Age Group	2006	2007	2008	2009	2010	2011	2012	2013	2014
0–4	1.27	1.22	1.25	1.20	1.30	1.31	1.23	1.32	1.48
5–9	0.64	0.67	0.69	0.69	0.77	0.84	0.77	0.87	0.97
10–14	0.38	0.38	0.45	0.44	0.48	0.50	0.44	0.52	0.55
15–19	0.37	0.38	0.44	0.44	0.46	0.49	0.43	0.47	0.49
20–29	0.26	0.30	0.36	0.40	0.45	0.48	0.44	0.48	0.51
30–39	0.31	0.35	0.42	0.44	0.51	0.54	0.50	0.55	0.58
40–49	0.33	0.38	0.46	0.49	0.54	0.57	0.53	0.60	0.65
50–59	0.47	0.53	0.59	0.64	0.72	0.72	0.68	0.77	0.81
60–69	0.79	0.85	0.96	0.99	1.06	1.10	1.06	1.22	1.25
70–79	1.38	1.44	1.63	1.67	1.80	1.80	1.76	2.02	2.15
≥ 80	2.22	2.49	2.81	2.94	3.27	3.59	3.57	4.22	4.31
Total	**0.58**	**0.63**	**0.71**	**0.74**	**0.82**	**0.86**	**0.82**	**0.93**	**0.99**

Table 32. Consumption of sulfonamides and trimethoprim (ATC group J01E) by age group, 2014, expressed as DDD per 1000 population per day

Age Group	2006	2007	2008	2009	2010	2011	2012	2013	2014
0–4	1.03	0.97	0.96	0.90	0.86	0.84	0.81	0.76	0.77
5–9	0.59	0.59	0.62	0.63	0.64	0.65	0.63	0.57	0.55
10–14	0.42	0.42	0.46	0.48	0.50	0.53	0.51	0.48	0.46
15–19	0.62	0.64	0.70	0.73	0.77	0.86	0.86	0.84	0.80
20–29	0.40	0.47	0.55	0.62	0.66	0.72	0.76	0.76	0.75
30–39	0.34	0.46	0.58	0.62	0.64	0.70	0.74	0.73	0.72
40–49	0.49	0.63	0.72	0.77	0.82	0.88	0.91	0.91	0.89
50–59	0.76	0.95	0.95	1.03	1.06	1.14	1.15	1.17	1.16
60–69	1.35	1.48	1.52	1.55	1.60	1.69	1.75	1.72	1.74
70–79	2.42	2.57	2.64	2.70	2.72	2.75	2.81	2.73	2.74
≥ 80	4.69	4.81	4.94	5.04	5.19	5.32	5.31	5.19	5.10
Total	**0.84**	**0.94**	**1.01**	**1.06**	**1.10**	**1.16**	**1.19**	**1.18**	**1.17**

Table 33. Consumption of macrolides and lincosamides (ATC group J01F) by age group, 2014, expressed as DDD per 1000 population per day

Age Group	2006	2007	2008	2009	2010	2011	2012	2013	2014
0–4	2.07	2.25	1.98	2.04	2.15	2.23	2.67	2.26	2.00
5–9	1.84	1.79	1.79	1.91	1.97	2.20	2.48	2.05	1.82
10–14	1.72	1.67	1.83	1.94	1.99	2.11	2.32	2.01	1.79
15–19	2.49	2.55	2.69	2.93	2.95	2.88	3.02	2.70	2.44
20–29	1.42	1.60	1.90	2.12	2.20	2.37	2.51	2.28	2.13
30–39	1.25	1.70	2.19	2.42	2.55	2.81	3.04	2.70	2.54
40–49	1.61	2.03	2.41	2.68	2.78	2.98	3.22	2.94	2.80
50–59	2.26	2.74	2.98	3.18	3.29	3.42	3.65	3.38	3.28
60–69	3.46	3.71	4.06	4.18	4.32	4.50	4.73	4.49	4.31
70–79	4.44	4.59	4.98	5.11	5.16	5.40	5.68	5.36	5.07
≥ 80	4.88	5.02	5.53	5.57	5.74	5.94	6.29	6.04	5.79
Total	**2.14**	**2.40**	**2.68**	**2.87**	**2.97**	**3.14**	**3.39**	**3.10**	**2.93**

Table 34. Consumption of quinolones (ATC group J01M) by age group, 2014, expressed as DDD per 1000 population per day

Age Group	2006	2007	2008	2009	2010	2011	2012	2013	2014
0–4	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00
5–9	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
10–14	0.08	0.08	0.10	0.08	0.09	0.08	0.07	0.06	0.05
15–19	0.32	0.32	0.35	0.38	0.37	0.33	0.32	0.26	0.21
20–29	0.31	0.36	0.42	0.48	0.49	0.49	0.48	0.38	0.33
30–39	0.30	0.38	0.50	0.54	0.54	0.53	0.51	0.42	0.38
40–49	0.43	0.55	0.67	0.72	0.73	0.73	0.70	0.58	0.51
50–59	0.72	0.91	0.98	1.05	1.05	1.03	1.01	0.85	0.76
60–69	1.34	1.50	1.64	1.66	1.67	1.57	1.55	1.31	1.18
70–79	2.16	2.29	2.47	2.50	2.38	2.31	2.21	1.84	1.65
≥ 80	3.15	3.01	3.34	3.42	3.35	3.19	3.03	2.51	2.19
Total	**0.59**	**0.67**	**0.77**	**0.81**	**0.81**	**0.79**	**0.78**	**0.65**	**0.58**

Table 35. Consumption of urinary antiseptics (ATC group J01X) by age group, 2014, expressed as DDD per 1000 population per day

Age Group	2006	2007	2008	2009	2010	2011	2012	2013	2014
0–4	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5–9	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
10–14	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03
15–19	0.14	0.15	0.16	0.17	0.18	0.21	0.22	0.23	0.24
20–29	0.18	0.21	0.23	0.26	0.29	0.33	0.36	0.38	0.40
30–39	0.16	0.18	0.21	0.23	0.25	0.30	0.33	0.33	0.37
40–49	0.17	0.20	0.23	0.24	0.27	0.31	0.33	0.34	0.36
50–59	0.28	0.31	0.33	0.33	0.37	0.41	0.46	0.48	0.50
60–69	0.55	0.59	0.63	0.66	0.71	0.76	0.79	0.81	0.82
70–79	1.18	1.18	1.23	1.26	1.35	1.49	1.49	1.51	1.52
≥ 80	2.51	2.51	2.59	2.80	3.06	3.13	3.16	3.11	3.07
Total	**0.31**	**0.33**	**0.36**	**0.38**	**0.42**	**0.47**	**0.49**	**0.50**	**0.52**

Table 36. Antibiotic consumption by sex and ATC level 3 group, 2006 to 2014, expressed as DDD per 1000 population per day

Tetracyclines (J01A)	Year	Female	Male	Total
	2006	4.32	3.60	3.97
	2007	4.97	4.22	4.60
	2008	5.55	4.68	5.13
	2009	5.83	4.94	5.39
	2010	6.02	5.13	5.59
	2011	6.41	5.41	5.92
	2012	6.87	5.84	6.37
	2013	7.02	6.00	6.52
	2014	7.08	5.94	6.53

Penicillins (J01C)	Year	Female	Male	Total
	2006	9.45	8.24	8.86
	2007	10.57	9.18	9.89
	2008	11.83	10.31	11.08
	2009	12.29	10.75	11.53
	2010	12.61	11.16	11.90
	2011	13.41	11.84	12.64
	2012	13.62	12.04	12.85
	2013	13.74	12.28	13.03
	2014	13.82	12.27	13.06

Cephalosporins and other β-lactams (J01D)	Year	Female	Male	Total
	2006	0.75	0.40	0.58
	2007	0.82	0.43	0.63
	2008	0.93	0.48	0.71
	2009	0.98	0.49	0.74
	2010	1.07	0.54	0.82
	2011	1.14	0.57	0.86
	2012	1.07	0.55	0.82
	2013	1.22	0.63	0.93
	2014	1.29	0.67	0.99

Sulfonamides and trimethoprim (J01E)	Year	Female	Male	Total
	2006	1.14	0.54	0.84
	2007	1.29	0.58	0.94
	2008	1.37	0.63	1.01
	2009	1.44	0.66	1.06
	2010	1.51	0.67	1.10
	2011	1.59	0.71	1.16
	2012	1.63	0.73	1.19
	2013	1.59	0.74	1.18
	2014	1.59	0.73	1.17

Table 36 (cont.) Antibiotic consumption by sex and ATC level 3 group, 2006 to 2014, expressed as DDD per 1000 population per day

Macrolides and lincosamides` (J01F)	Year	Female	Male	Total
	2006	2.50	1.76	2.14
	2007	2.80	1.98	2.40
	2008	3.13	2.20	2.68
	2009	3.35	2.36	2.87
	2010	3.45	2.47	2.97
	2011	3.66	2.61	3.14
	2012	3.93	2.84	3.39
	2013	3.56	2.62	3.10
	2014	3.40	2.44	2.93

Quinolones (J01M)	Year	Female	Male	Total
	2006	0.71	0.47	0.59
	2007	0.80	0.54	0.67
	2008	0.90	0.63	0.77
	2009	0.95	0.66	0.81
	2010	0.94	0.68	0.81
	2011	0.89	0.69	0.79
	2012	0.85	0.70	0.78
	2013	0.69	0.60	0.65
	2014	0.58	0.58	0.58

Urinary antiseptics (J01X)	Year	Female	Male	Total
	2006	0.52	0.09	0.31
	2007	0.56	0.09	0.33
	2008	0.60	0.10	0.36
	2009	0.64	0.11	0.38
	2010	0.71	0.12	0.42
	2011	0.79	0.13	0.47
	2012	0.83	0.14	0.49
	2013	0.85	0.15	0.50
	2014	0.88	0.15	0.52

Total (J01)	Year	Female	Male	Total
	2006	19.40	15.13	17.31
	2007	21.82	17.04	19.49
	2008	24.33	19.05	21.75
	2009	25.49	19.99	22.80
	2010	26.31	20.80	23.62
	2011	27.90	21.97	25.00
	2012	28.82	22.85	25.90
	2013	28.69	23.03	25.93
	2014	28.64	22.81	25.78

Table 37. Antibiotic consumption by ethnic group and ATC level 3 group, 2006 to 2014, expressed as DDD per 1000 population per day

Tetracyclines (J01A)	Year	Māori	Pacific people	Asian	MELAA	European or Other	Total
	2006	2.14	1.86	1.75	3.56	4.57	3.97
	2007	2.30	2.09	2.09	4.42	5.31	4.60
	2008	2.48	2.34	2.48	4.90	5.91	5.13
	2009	2.61	2.52	2.84	5.49	6.19	5.39
	2010	2.68	2.66	3.07	6.12	6.38	5.59
	2011	2.85	2.85	3.39	6.46	6.73	5.92
	2012	3.13	3.18	3.83	6.78	7.21	6.37
	2013	3.30	3.18	4.01	7.42	7.40	6.52
	2014	3.25	3.26	4.16	7.78	7.39	6.53

Penicillins (J01C)	Year	Māori	Pacific people	Asian	MELAA	European or Other	Total
	2006	10.00	13.87	4.62	7.94	8.24	8.86
	2007	10.88	15.23	5.29	8.95	9.26	9.89
	2008	11.70	16.67	6.38	10.71	10.45	11.08
	2009	12.35	18.27	7.09	11.86	10.71	11.53
	2010	12.67	18.48	7.63	12.85	11.05	11.90
	2011	13.32	20.01	8.57	14.09	11.65	12.63
	2012	13.41	20.73	9.10	14.28	11.80	12.85
	2013	13.64	21.12	9.64	15.21	11.94	13.03
	2014	13.44	21.50	10.27	15.44	11.89	13.06

Cephalosporins and other β-lactams (J01D)	Year	Māori	Pacific people	Asian	MELAA	European or Other	Total
	2006	0.45	0.47	0.34	0.40	0.64	0.58
	2007	0.47	0.50	0.36	0.44	0.69	0.63
	2008	0.53	0.53	0.41	0.55	0.79	0.71
	2009	0.57	0.57	0.45	0.66	0.81	0.74
	2010	0.64	0.67	0.50	0.73	0.89	0.82
	2011	0.67	0.72	0.53	0.77	0.93	0.86
	2012	0.65	0.73	0.51	0.70	0.88	0.82
	2013	0.73	0.86	0.58	0.79	1.00	0.93
	2014	0.80	0.98	0.64	0.83	1.05	0.99

Sulfonamides and trimethoprim (J01E)	Year	Māori	Pacific people	Asian	MELAA	European or Other	Total
	2006	0.62	0.69	0.25	0.45	0.97	0.84
	2007	0.66	0.76	0.29	0.57	1.09	0.94
	2008	0.70	0.80	0.34	0.57	1.18	1.01
	2009	0.75	0.82	0.36	0.67	1.23	1.06
	2010	0.80	0.84	0.37	0.70	1.27	1.10
	2011	0.88	0.91	0.41	0.73	1.33	1.16
	2012	0.91	1.01	0.46	0.85	1.35	1.19
	2013	0.91	1.00	0.48	0.81	1.32	1.18
	2014	0.89	0.98	0.49	0.80	1.32	1.17

Table 37 (cont.) Antibiotic consumption by ethnic group and ATC level 3 group, 2006 to 2014, expressed as DDD per 1000 population per day

Macrolides and lincosamides (J01F)	Year	Māori	Pacific people	Asian	MELAA	European or Other	Total
	2006	1.83	1.94	0.96	1.33	2.30	2.14
	2007	1.97	2.17	1.11	1.66	2.59	2.40
	2008	2.09	2.25	1.33	1.90	2.91	2.68
	2009	2.30	2.54	1.48	2.33	3.08	2.87
	2010	2.38	2.57	1.54	2.37	3.20	2.97
	2011	2.52	2.80	1.72	2.62	3.35	3.14
	2012	2.77	3.11	1.91	2.90	3.60	3.39
	2013	2.51	2.88	1.84	2.78	3.29	3.10
	2014	2.36	2.66	1.82	2.67	3.09	2.93

Quinolones (J01M)	Year	Māori	Pacific people	Asian	MELAA	European or Other	Total
	2006	0.36	0.30	0.17	0.26	0.71	0.59
	2007	0.40	0.33	0.21	0.33	0.81	0.67
	2008	0.44	0.38	0.25	0.43	0.92	0.77
	2009	0.48	0.41	0.28	0.47	0.97	0.81
	2010	0.48	0.42	0.29	0.50	0.97	0.81
	2011	0.47	0.40	0.32	0.57	0.94	0.79
	2012	0.44	0.41	0.34	0.62	0.91	0.78
	2013	0.35	0.35	0.28	0.51	0.77	0.65
	2014	0.32	0.30	0.27	0.47	0.68	0.58

Urinary antiseptics (J01X)	Year	Māori	Pacific people	Asian	MELAA	European or Other	Total
	2006	0.18	0.16	0.07	0.16	0.38	0.31
	2007	0.20	0.17	0.08	0.13	0.41	0.33
	2008	0.20	0.19	0.09	0.19	0.44	0.36
	2009	0.22	0.20	0.11	0.23	0.47	0.38
	2010	0.25	0.23	0.13	0.26	0.52	0.42
	2011	0.27	0.26	0.16	0.33	0.56	0.46
	2012	0.30	0.28	0.19	0.33	0.59	0.49
	2013	0.33	0.28	0.20	0.35	0.60	0.50
	2014	0.34	0.30	0.23	0.40	0.61	0.52

Total (J01)	Year	Māori	Pacific people	Asian	MELAA	European or Other	Total
	2006	15.58	19.29	8.16	14.13	17.83	17.31
	2007	16.89	21.25	9.44	16.52	20.19	19.48
	2008	18.16	23.17	11.27	19.25	22.62	21.75
	2009	19.30	25.34	12.60	21.71	23.47	22.81
	2010	19.91	25.86	13.54	23.53	24.29	23.62
	2011	20.99	27.97	15.10	25.56	25.52	24.97
	2012	21.62	29.46	16.33	26.46	26.36	25.90
	2013	21.78	29.69	17.03	27.86	26.35	25.92
	2014	21.41	29.98	17.88	28.39	26.05	25.79

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