

Ethnic disparities in community antibacterial dispensing in New Zealand, 2015

Naomi Whyler, Andrew Tomlin, Murray Tilyard, Mark Thomas

ABSTRACT

AIMS: There are significant ethnic disparities in the incidence of various infectious diseases in New Zealand. Antimicrobial stewardship interventions which ignore these disparities may have negative effects on the health of some ethnic groups. We aimed to determine the relationship between ethnicity and community antimicrobial dispensing in New Zealand, to inform the development of antimicrobial stewardship interventions in New Zealand.

METHODS: Demographic data on all patients registered with a general practice in New Zealand and on all community pharmacy antibacterial dispensings during 2015 were obtained from national healthcare databases. The rates of dispensing were measured as the number of dispensings per 1,000 population per day and as defined daily doses per 1,000 population per day.

RESULTS: The rate of community antibacterial dispensing for the total population surveyed was 3.01 dispensings per 1,000 population per day, and was 3.49 for Pacific, 3.23 for Māori, 3.02 for European, 2.70 for Middle Eastern, Latin American and African, and 2.35 for Asian people. In all ethnic groups the rate of community antibacterial dispensing increased with increasing socioeconomic deprivation. Seasonal variation in antibacterial dispensing ranged between 34% in Asian people and 24% in European people.

CONCLUSIONS: The ethnic disparities in the rates of antibacterial dispensing in New Zealand are consistent with, but less marked than, the ethnic disparities in the incidence of infectious diseases in New Zealand. Improved community-wide understanding of both the benefits and the harms of antibacterial medicines is necessary to support improved antibacterial use in New Zealand in the future.

The relentless spread of antibacterial resistance poses major threats for human health.^{1,2} The main influence on the speed with which antibacterial resistant bacteria spread within a nation is the level of antibacterial consumption within that nation.³ The total level of community antibacterial consumption is high in New Zealand when compared with many other nations.^{4,5} Community dispensing, mostly for prescriptions written by family doctors, comprises approximately 95% of antibacterial dispensing in New Zealand, a higher proportion than in most other nations.⁶ Many studies in other nations have suggested that approximately half of all antibiotic prescriptions dispensed in the community are not indicated, and provide nil or minimal benefit to the patient.^{7,8}

Antibacterials can, however, provide major benefits in the treatment of many infections. Strategies to reduce unnecessary antibacterial prescribing therefore need to be sufficiently nuanced so that antibacterials continue to be prescribed for those infections in which they provide significant benefits. In New Zealand, many of the infections for which antibacterials are beneficial are more common in Māori and Pacific people than people of other ethnicities. For example, over the five-year period 2004–2008, the age-standardised rate of admissions to hospital for an infectious disease was 2.35 times higher in Pacific people and 2.15 times higher in Māori than in all other ethnic groups.⁹ From 2012 to 2014 the rate of admission to hospital for a

first episode of acute rheumatic fever was 63 times higher in Pacific people and 27 times higher in Māori than in all other ethnic groups.¹⁰ One might therefore conclude that antibacterials should be dispensed more often to Māori and Pacific people than to people from other ethnic groups. However, some recent studies have suggested that antibacterials are less frequently dispensed to Māori when compared with most other ethnic groups. For example, Norris et al measured antibacterial dispensing in the Tairāwhiti region of New Zealand during 2011 and found that Māori, particularly those living rurally, were less likely to be dispensed an antibacterial than non-Māori.¹¹ More recently, Williamson et al measured antibacterial dispensing throughout New Zealand during 2014 and found that the highest rate of dispensing was to Pacific people with the lowest rates to Māori and Asian people.⁵

The aim of our present study was to measure the rates of community antibacterial dispensing for the major ethnic groups in New Zealand during 2015. We anticipated that this information would help to inform antibiotic stewardship programs in New Zealand.

Methods

Data for the study were obtained from two national healthcare databases managed by the New Zealand Ministry of Health. Information on all patients registered with a New Zealand general practice during the first quarter of 2015 was obtained from the Primary Health Organisation Enrolment Collection. This database records each patient's date of birth, gender, ethnicity, estimated level of socioeconomic deprivation and the general practice with which they are registered. Based on their self-reported ethnicity,¹² patients were assigned to one of six ethnic groups: Asian, European, Māori, MELAA (Middle Eastern, Latin American and African), Pacific and Other. The New Zealand Deprivation Index, which relates a person's place of residence to data contained in the New Zealand 2013 Census of Population and Dwellings, was used to determine the level of socio-economic deprivation for

each patient.¹³ Each patient was allocated to one of five deprivation quintiles (quintile 1 = the least deprived, quintile 5 = the most deprived).

Data on all community antibacterial dispensings from 1 January 2015 to 31 December 2015 were obtained from the National Pharmaceutical Collection. Pharmaceuticals in this dataset are classified under the Anatomical Therapeutic Chemical (ATC) system.¹⁴ Data for each dispensing included the antibacterial agent, its formulation, daily dose and the quantity dispensed. Records from the two national datasets were linked for each patient using an encrypted form of their National Health Index (NHI) code.

Antibacterial dispensing was measured as the number of prescription items per 1,000 population per day, and as the number of defined daily doses (DDD) per 1,000 population per day.¹⁴ For prescriptions that resulted in repeat dispensings, measurements of prescription items per 1,000 population per day included only the initial dispensing, but measurements of DDDs per 1,000 population per day included the total amount dispensed inclusive of repeat dispensings.

We compared the total level of community antibacterial dispensing in New Zealand during 2015 with similar recent data from other developed nations.

We determined the effect of age and ethnicity on the rate of dispensing for each of the major antibacterial classes, and the effect of socio-economic deprivation on the rate of total antibacterial dispensing for each ethnic group. We also measured the seasonal variation in total antibacterial dispensing by calculating the percentage increase in antibacterial dispensing during the winter months (April–September) compared with antibacterial dispensing during the summer months (January–March plus October–December). (Seasonal variation = [dispensings (winter months)/dispensings (summer months)-1]X100.)

We used Poisson regression to test for a linear trend in antibacterial dispensing rates with increasing deprivation after adjusting for patient ethnicity.

Results

A total of 4,315,871 people were registered with New Zealand general practitioners during 2015. These patients comprised 93.9% of the total estimated New Zealand population of 4,596,700 at 30 June 2015.¹⁵ Patient ethnicity was recorded as: Asian (10.1%), European (65.2%), Māori (14.7%), Pacific (7.3%), MELAA (1.2%) and Other or unspecified (1.5%). Māori or Pacific ethnicity was strongly associated with high levels of socioeconomic deprivation. The proportion of patients within the most deprived quintile of the New Zealand population was 53% for Pacific people, 40% for Māori, 22% for MELAA, 15% for Asian, 14% for Other and 10% for European.

In total, 5,204,143 antibacterial courses were dispensed by community pharmacies, with 4,741,239 (91.1%) of these dispensed to 1,882,966 patients registered with a New Zealand general practice. The overall rate of community antibacterial dispensing for practice-registered patients was 4,741,239/4,315,871 (1.1 dispensings per person per year), with one or more antibacterial medicines dispensed to 43.6% (1,882,966/4,315,871) of all patients.

Antibacterial dispensing by ethnicity

The method used to measure antibacterial dispensing had a significant impact on comparisons between ethnic groups. When measured as the number of prescription items dispensed per 1,000 population per day, penicillins (1.72) comprised 57% of total antibacterial dispensing (3.01). Pacific

people had the highest rate of dispensing (3.49), followed by Māori (3.23), European (3.02), MELAA (2.70), Other (2.63) and Asian people (2.35) (Figure 1A) (Table 1). In contrast, when measured as DDDs per 1,000 population per day, the rate of dispensing of penicillins (15.99) and tetracyclines (13.17) were similar, comprising 46% and 38% respectively of total antibacterial dispensing (34.97). Europeans had the highest rate of dispensing (37.41), followed by Other (35.96), MELAA (33.76), Pacific (33.01), Māori (30.69) and Asian people (26.99) (Figure 1B).

Measurements of antibacterial dispensing in DDDs per 1,000 population per day are misleading when applied to children and significantly underestimate the number of children who have been dispensed an antibacterial medicine. As dispensing for children comprises a large proportion of total antibacterial dispensing, we used dispensings per 1,000 population per day for all further analyses.

Antibacterial dispensing by age and ethnicity

Total community antibacterial dispensing followed a ‘u-shaped’ distribution, regardless of ethnicity, with the highest rates of dispensing in people <5 years and >80 years of age (Figure 2A). The overall rate of dispensing in New Zealand during 2015 was broadly similar to that in Australia during 2014 (personal communication K Meleady, Australian Commission on Safety and Quality in Healthcare),¹⁶ and the US during 2011,¹⁷ but much greater than that in Sweden during 2014.¹⁸ The distributions

Figure 1: Amount of antibacterial medicines dispensed in the community in New Zealand, in relation to ethnicity, during 2015; (A) dispensings per 1,000 population per day, (B) defined daily doses (DDDs) per 1,000 population per day.

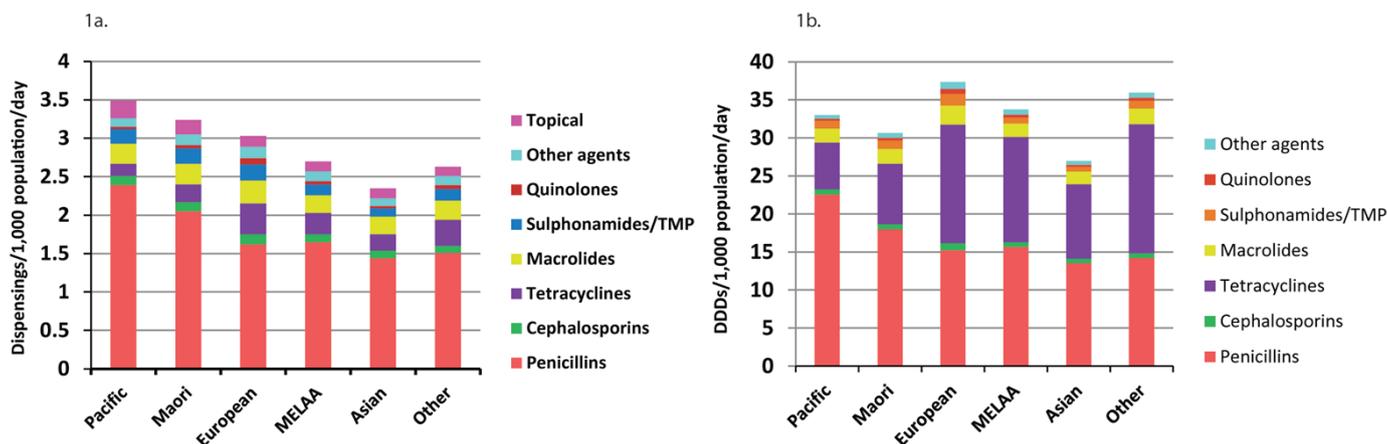


Table 1: Community antibacterial dispensing of medicines within each antibacterial class (dispensings per 1,000 population per day) for each ethnic group in New Zealand during 2015.

	Pacific	Māori	European	MELAA	Asian	Other	Not specified	Total
Penicillins	2.39	2.05	1.62	1.65	1.44	1.51	1.51	1.72
Cephalosporins	0.12	0.12	0.13	0.10	0.10	0.09	0.10	0.12
Tetracyclines	0.16	0.23	0.40	0.28	0.21	0.34	0.29	0.34
Macrolides ^a	0.26	0.27	0.30	0.23	0.23	0.25	0.24	0.28
Sulphonamides ^b	0.19	0.20	0.21	0.14	0.11	0.15	0.17	0.20
Quinolones	0.03	0.04	0.08	0.04	0.03	0.05	0.05	0.06
Other agents ^c	0.11	0.14	0.15	0.13	0.10	0.12	0.14	0.14
Topical agents ^d	0.23	0.19	0.14	0.13	0.13	0.12	0.11	0.15
Total (95% CI)	3.49 (3.48–3.50)	3.23 (3.23–3.24)	3.02 (3.02–3.03)	2.70 (2.68–2.72)	2.35 (2.34–2.36)	2.63 (2.61–2.66)	2.63 (2.58–2.67)	3.01 (3.01–3.01)

Abbreviations: MELAA, Middle Eastern, Latin American, African; CI, confidence intervals.

^a Includes lincosamides.

^b Includes trimethoprim (alone or in combination with sulphamethoxazole).

^c Includes nitroimidazoles, nitrofurantoin, vancomycin, fusidic acid and colistin.

^d Includes fusidic acid and mupirocin.

of total antibacterial dispensing by age for ethnic groups in New Zealand were approximately parallel (Figure 2B) with the rate of dispensing generally highest for Pacific people, and lowest for Asian people.

Similar ‘u-shaped’ distributions, with varying degrees of accentuation at the extremes of age, were seen for dispensing of penicillins (Figure 3A), cephalosporins (Figure 3B), macrolides and lincosamides (Figure 3D), and sulphonamides and trimethoprim (Figure 3E). However, the patterns of dispensing in relation to age differed for tetracyclines (Figure 3C), quinolones (Figure 3F), other antibacterials

(Figure 3G) and topical antibacterials (Figure 3H). There were high rates of dispensing of tetracyclines for European, MELAA and Asian people aged 15–19 years (Figure 3C) and of other antibacterials (predominantly nitroimidazoles and nitrofurantoin) for Māori, Pacific and European people aged 20–29 years (Figure 3G). Quinolone dispensing increased with age across all ethnic groups with the highest rates in European, Māori and MELAA people aged >80 years (Figure 3F). Rates of dispensing of topical antibacterials were highest for Pacific and Māori children <5 years of age (Figure 3H).

Figure 2: Amount of antibacterial medicines dispensed in the community (dispensings per 1,000 population per day) in relation to age; (A) in New Zealand during 2015, Sweden during 2014,¹⁷ the US during 2011,¹⁶ and Australia during 2015 [personal communication K Meleady, Australian Commission on Safety and Quality in Healthcare], (B) by ethnicity, in New Zealand during 2015.

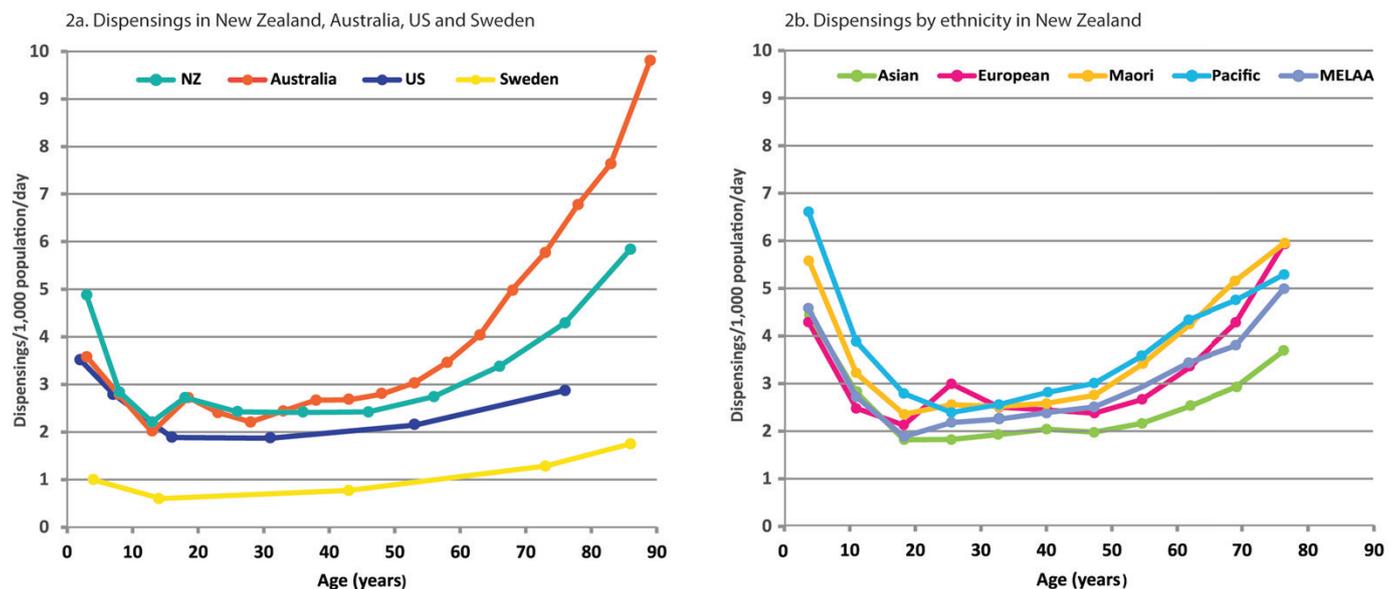


Figure 3: Amount of antibacterial medicines dispensed in the community (dispensings per 1,000 population per day) in relation to age and ethnicity, in New Zealand during 2015; (A) penicillins, (B) cephalosporins, (C) tetracyclines, (D) macrolides and lincosamides, (E) sulphonamides and trimethoprim, (F) quinolones, (G) other antibacterials and (H) topical antibacterials.

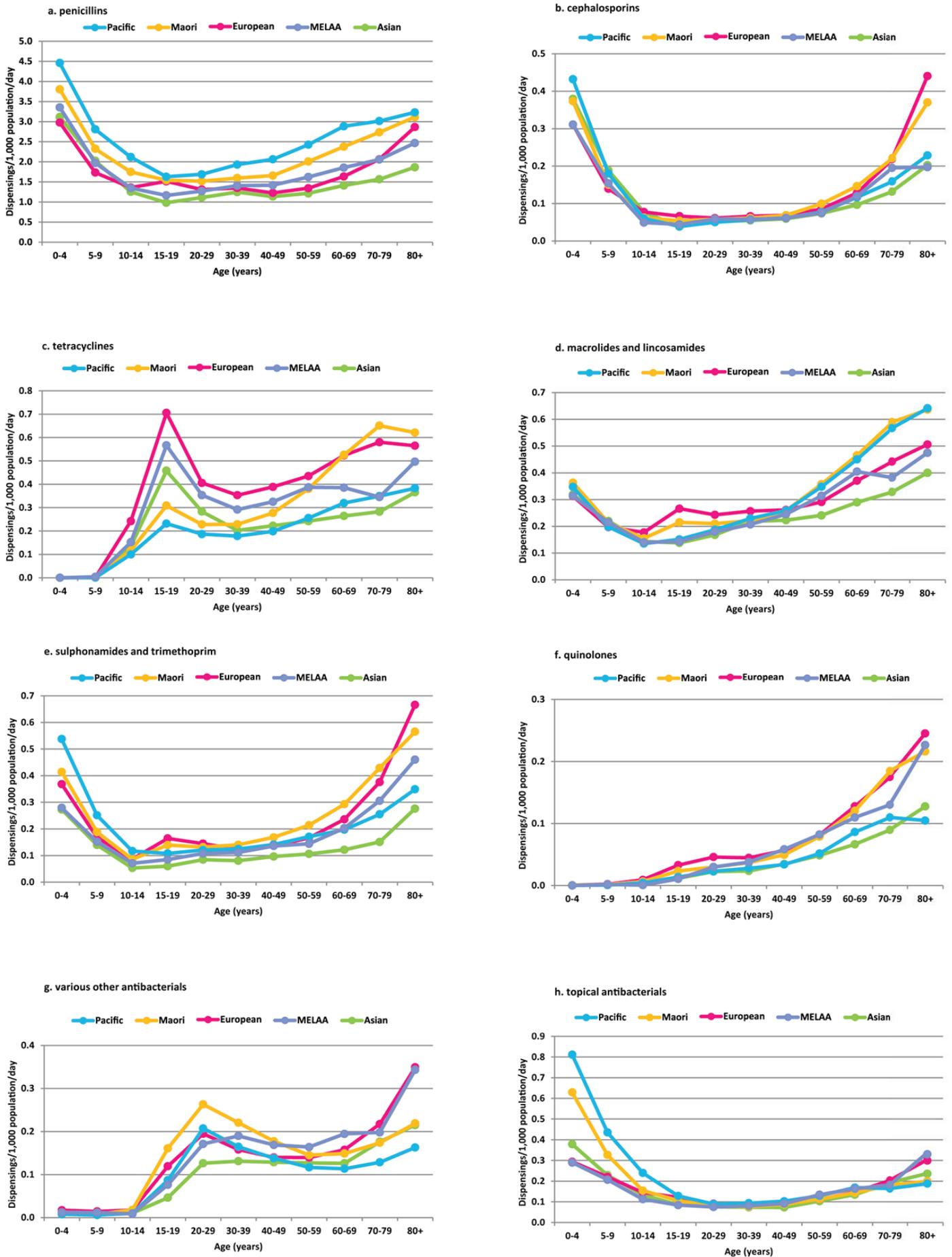
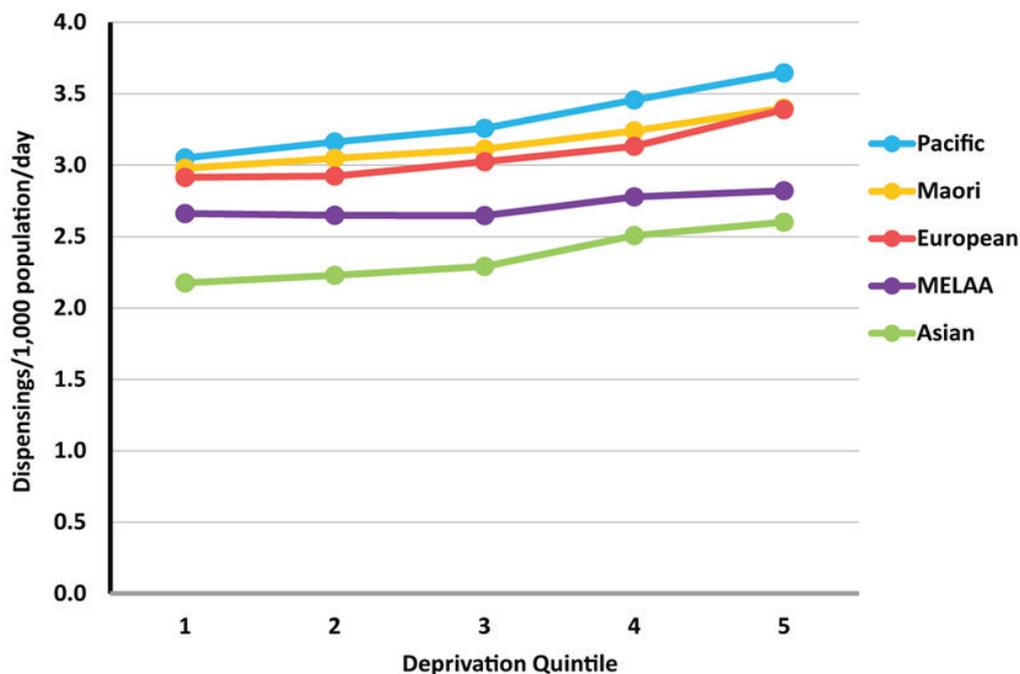


Figure 4: Amount of antibacterial medicines dispensed in the community (dispensings per 1,000 population per day) in relation to ethnicity and level of socioeconomic deprivation, in New Zealand during 2015.



In all age groups the rate of dispensing of penicillins was higher in Māori and in Pacific people than in other ethnic groups. The rate of dispensing of penicillins to those most at risk of rheumatic fever—Pacific and Māori people aged 5–20 years—was 45% (95% CI, 44–46%) higher in Pacific people (2.22 dispensings per 1,000 population per day), and 24% (95% CI, 23–25%) higher in Māori (1.90 dispensings per 1,000 population per day), than in people of the same age in other ethnic groups (1.53 dispensings per 1,000 population per day).

Antibacterial dispensing by ethnicity and level of socio-economic deprivation

The impact of socio-economic deprivation on rates of antibacterial dispensing was relatively consistent in all ethnic groups (Figure 4). There was a 3.6% increase in dispensing rate per unit increase in deprivation quintile across all patients after adjusting for ethnic group ($P < 0.001$). This linear trend with increasing deprivation was also found within each ethnic group ($P < 0.001$). The overall rate of dispensing was 18% (95% CI, 18–19%) higher for all people in quintile 5 (3.37 dispensings per 1,000 population per day) than it was for all people in quintile 1 (2.85 dispensings per 1,000 population per

day). The overall rate of dispensing was 48% (95% CI, 48–49%) higher in Pacific people (3.49 dispensings per 1,000 population per day) than in Asian people (2.35 dispensings per 1,000 population per day).

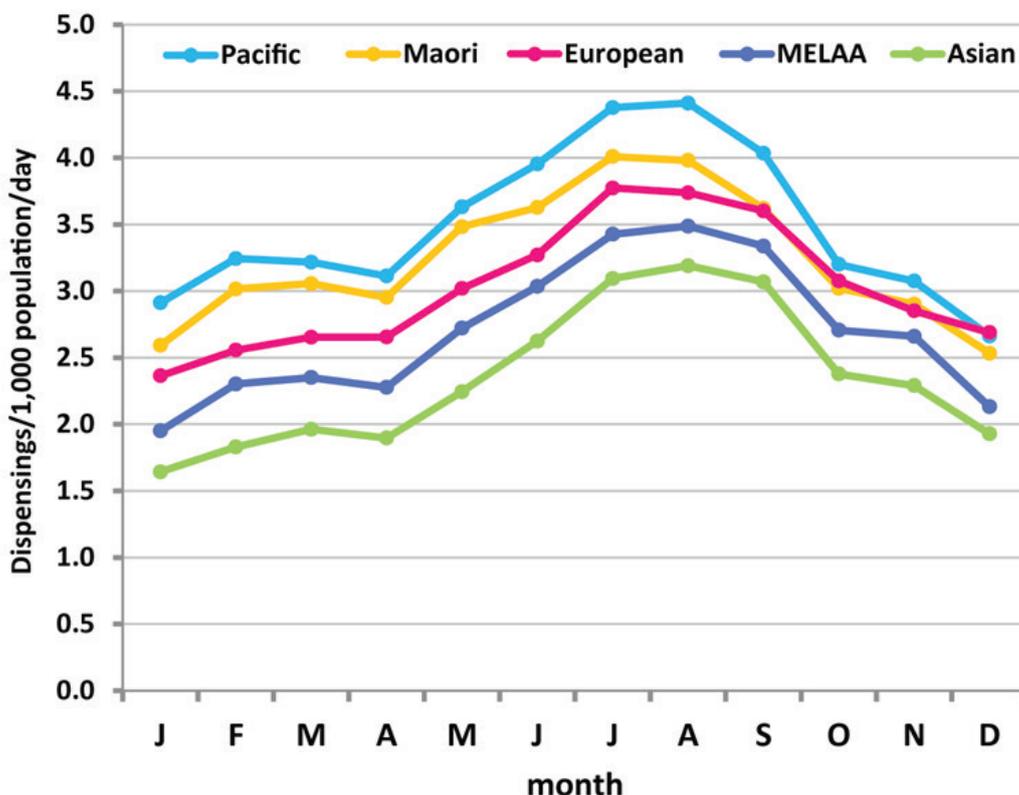
Antibacterial dispensing by ethnicity and season

The seasonal variation in the rate of antibacterial dispensing for the total New Zealand population was 26% (95% CI, 26–27%) (Figure 5). The seasonal variation in the rate of dispensing was 29% (95% CI, 29–30%) in Pacific people, 28% (95% CI, 27–28%) in Māori, 25% (95% CI, 24–25%) in European, 31% (95% CI, 28–33%) in MELAA and 35% (95% CI, 34–36%) in Asian people.

Discussion

We found that the rate of total community antibacterial dispensing in New Zealand during 2015 (3.01 dispensings per 1,000 population per day) was 3.3 times higher than in Sweden during 2014 (0.90),¹⁸ 2.1 times higher than in Denmark during 2015 (1.45),¹⁹ 1.7 times higher than in Canada during 2011 (1.79)²⁰ and 1.3 times higher than in the US during 2010–2011 (2.31),¹⁷ but 14% lower than in Australia during 2014 (3.50).¹⁶ These findings emphasise the pressing needs, to strengthen public health

Figure 5: Amount of antibacterial medicines dispensed in the community (dispensings per 1,000 population per day) in relation to ethnicity and season, in New Zealand during 2015.



programs, incorporating both pharmaceutical and non-pharmaceutical approaches, that will reduce the incidence of infectious diseases in New Zealand, and also to more effectively deliver community antimicrobial stewardship in New Zealand.

Overall rates of community antibacterial dispensing were higher in Pacific and Māori people than in people of other ethnicities. A previous study found lower rates of antibacterial dispensing in Māori, when compared with non-Māori, in a geographically isolated region of New Zealand during 2005–2006,¹¹ and a national study found that the rates of dispensing in Māori, during 2008 to 2014, were less than in Pacific, European and MELAA people, but more than in Asian people.⁵ Other recent studies found antibacterial dispensing rates in Māori and Pacific people in New Zealand to be greater than in other ethnic groups.^{21,22} Ethnic disparities in community antibacterial dispensing have also been demonstrated in the US where community antibacterial dispensing rates during 2011 were found to be higher in counties with a greater proportion of black residents.¹⁷ We also found antibacterial dispensing rates to be higher in people living

in more socio-economically deprived areas, supporting the findings of two previous New Zealand studies that also found higher rates of antibacterial dispensing in communities with higher levels of socio-economic deprivation.^{22,23} A large US study also found that community antibacterial dispensing rates were highest in counties with the lowest per capita income.¹⁷

Higher rates of antibacterial consumption by Pacific and Māori people may result in higher prevalence of antibiotic resistance in the bacteria that commonly cause infectious diseases in Pacific and Māori people. A study of *Staphylococcus aureus* infections in 16,249 patients admitted to Auckland City Hospital between 2001 and 2011 found the proportion of infections caused by non-multidrug resistant methicillin resistant *S. aureus* (nmMRSA) to be 2.41 times higher in Pacific people and 1.48 times higher in Māori people than in people of other ethnicities.²⁴ High rates of dispensing of topical fusidic acid for Pacific and Māori children under five years of age (Figure 3H) may have contributed to the high proportion of *S. aureus* infections in Pacific and Māori people that were caused by nmMRSA.²⁵

Other somewhat unexpected effects of antimicrobial consumption are widely reported. Frequent antibiotic treatment in early childhood is strongly associated with childhood obesity,²⁶ possibly as the consequence of inhibiting the growth of intestinal bacteria that help to maintain the normal thickness and function of the mucin on the intestinal surface.²⁷ The rate of antibacterial dispensing in children less than five years old was 52% (95% CI, 51–53%) higher in Pacific children (6.60 dispensings per 1,000 population per day), and 29% (95% CI, 28–30%) higher in Māori children (5.60 dispensings per 1,000 population per day), than in children of all other ethnicities (4.33 dispensings per 1,000 population per day). The higher rates of antibacterial dispensing for Pacific and Māori children may have contributed to obesity rates approximately four times higher in Pacific children and 1.6 times higher in Māori children than in children of all other ethnicities in New Zealand.²⁸

Higher rates of antibacterial dispensing for Pacific and Māori people are to be expected in the light of their higher incidence of infectious diseases. From 2004 to 2008, rates of admission to hospital for infectious diseases were 2.35 times greater in Pacific and 2.15 times greater in Māori people than in people of other ethnicities.⁹ Even greater ethnic disparities were found in the rates of hospital admission for staphylococcal skin and soft tissue infections during 2000–2011, which were five times greater in Pacific and three times greater in Māori people than in Europeans,²⁹ and for rates of notification of invasive pneumococcal disease in 2015, which were 4.3 times greater in Pacific and 3.8 times greater in Māori people than in people of other ethnicities.³⁰ However, the overall rate of community antibacterial dispensing in New Zealand during 2015 was only 19% higher in Pacific people, and 11% higher in Māori than in people of all other ethnicities. These findings suggest that antibacterial prescribing may be appropriate more often for Māori and Pacific people than for people from other ethnic groups, and there may be more opportunities to reduce inappropriate prescribing when treating people from other ethnic groups.

The management of patients with pharyngitis due to *Streptococcus pyogenes* poses a particular problem with regard to antimicrobial stewardship in New Zealand. Between 2000 and 2014, 2,108 patients were admitted to hospital for first episodes of acute rheumatic fever in New Zealand: 1,068 (51%) were Māori, 821 (39%) were Pacific people, and 219 (10%) were people of Other ethnicity, with the overwhelming majority of patients aged 5–20 years.¹⁰ The incidence of hospitalisation for a first episode of acute rheumatic fever during 2012–2014 was 63 times greater in Pacific people, and 27 times greater in Māori, than in people of other ethnicities.¹⁰ However, we found that the rate of dispensing of penicillins for patients 5–20 years of age was only 45% higher in Pacific people, and 24% higher in Māori, than in people of all other ethnicities. It seems likely that a large proportion of the penicillins dispensed to patients of other ethnicities aged 5–20 years was inappropriately prescribed for people either with pharyngitis but minimal risk of rheumatic fever,³¹ or with self-limiting respiratory tract infections for which antibacterial therapy is almost never indicated.³²

In previous studies seasonal variation in antibacterial dispensing has been used as a surrogate measure of prescribing quality. Recent studies have found the seasonal variation in community antibacterial dispensing to be 12% in Denmark, 14% in the UK, 36% in Germany and 39% in Italy during 2015,³³ and 25% in the US between 2006 and 2010.³⁴ We found that the seasonal variation in antibacterial dispensing ranged from 25% in European people to 35% in Asian people, suggesting that, based on this indicator, the quality of antibacterial prescribing is relatively consistent across ethnic groups in New Zealand. However, the relatively high levels of seasonal variation in antibacterial dispensing in all ethnic groups in New Zealand, when compared with the overall levels in Denmark and the UK, do suggest that there is considerable scope to reduce prescribing in New Zealand for patients with winter coughs and colds.

The strengths of this study include the inclusion of data for more than 90% of all community antibacterial dispensings, the high rate of self-reported ethnicity in

the general practice patient records, and the ability to include other demographic factors including age and socio-economic deprivation in our analyses. Limitations of the study include the inability to include antibacterials dispensed directly by doctors from supplies provided to them on practitioner supply orders, or to include antibacterials dispensed by nurses within school-based public health programmes including the sore throat management programme. Such dispensing is more likely to have occurred for socio-economically deprived patients, of whom a very large proportion would have been of Māori or Pacific ethnicity.

In conclusion, we found the overall rate of community antibacterial dispensing in New Zealand to be high, with the highest rates in Pacific and Māori people. The higher rates of dispensing in Pacific and Māori people reflect their higher incidence of various infectious diseases. Programmes

intended to reduce community antibacterial dispensing in New Zealand need to be sufficiently nuanced so that they do not lead to reduced rates of antibacterial treatment for infections that require treatment. Our study suggests that the risk of this occurring will be greatest in Pacific and Māori people. Unfortunately, higher rates of antibacterial consumption by Pacific and Māori people will inevitably result in correspondingly higher rates of adverse consequences, including higher prevalence of antibacterial resistance and of the metabolic consequences that are caused by alterations in the gut microbiome. Further research is required to better understand the factors that lead to ethnic differences in the levels of antibacterial dispensing in New Zealand. Reducing inappropriate antibacterial consumption is at least as important for Pacific and Māori people as it is for other population groups.

Competing interests:

Nil.

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Author information:

Naomi Whyler, Adult Infectious Diseases Department, Auckland City Hospital, Auckland;
Andrew Tomlin, Best Practice Advocacy Centre, Dunedin;

Murray Tilyard, Best Practice Advocacy Centre, Dunedin; Mark Thomas, Adult Infectious Diseases Department, Auckland City Hospital, Auckland; Department of Molecular Medicine and Pathology, University of Auckland, Auckland.

Corresponding author:

Associate Professor Mark Thomas, Department of Molecular Medicine and Pathology,
University of Auckland, Park Rd, Grafton, Private Bag 92019, Auckland 1142.
mg.thomas@auckland.ac.nz

URL:

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