AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

AURA Antimicrobial Use and Resistance in Australia

October 2023

Analysis of 2015–2022 PBS and RPBS antimicrobial dispensing data

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Note regarding alternative descriptions

Due to the complexity of this document no alternative descriptions have been provided. If you need assistance with the structure of any graphs or charts, please email the Australian Commission on Safety and Quality in Health Care at AURA@safetyandquality.gov.au.

Contents

Key findings

In 2022, there were 21,848,005 antimicrobial prescriptions supplied under the Pharmaceutical Benefits Scheme (PBS) or Repatriation Pharmaceutical Benefits Scheme (RPBS) in Australia. While this represents a 9.6% increase from the number of prescriptions supplied in 2021 (*n* = 19,931,271), it is still well below the yearly number supplied prior to the COVID-19 pandemic.

When examined by volume of antimicrobial supplied, there was a slight increase in antimicrobial use. The defined daily dose (DDD) per 1,000 people per day was 16.8 in 2022, compared to 15.9 in 2021.

In 2022, 36.6% (*n* = 9,502,834) of the Australian population had at least one antimicrobial supplied under the PBS or RPBS, compared to 32.9% (*n* = 8,468,093) in 2021.

Among people who received antimicrobials, there was a small change in the number of prescriptions per person. In 2022, there were 2.30 antimicrobial prescriptions per person, compared to 2.35 in 2021.

The rate of antimicrobial prescriptions supplied per 1,000 people was 817 in 2022, compared to 744 in 2021.

People aged 65 years and over received the highest number of antimicrobial prescriptions (1–2 per person on average), and this was consistent across all states and territories.

At the level of specific classes of antimicrobials in 2022, tetracyclines had the highest volume of use (3.7 DDD per 1,000 people per day), followed by penicillins with extended spectrum (3.0 DDD per 1,000 people per day) and first-generation cephalosporins (2.5 DDD per 1,000 people per day).

Cefalexin, amoxicillin and amoxicillin–clavulanic acid were the most commonly prescribed individual antimicrobials in 2022. When assessed by age, amoxicillin use was higher in the 0–9 years age group compared to 2021.

For amoxicillin, amoxicillin–clavulanic acid, cefalexin, doxycycline and roxithromycin, the majority of original prescriptions were ordered with no repeats, which followed the PBS and RPBS policy change to reduce the permissible number of repeat prescriptions (generally from one to zero) on 1 April 2020.

Project background

The Australian Commission on Safety and Quality in Health Care (the Commission) contracted the Quality Use of Medicines and Pharmacy Research Centre (QUMPRC) of the University of South Australia to provide an annual report on community antimicrobial dispensing. This report complements a series of Antimicrobial Use and Resistance in Australia (AURA) Surveillance System reports developed by the Commission with funding provided by the Australian Government Department of Health and Aged Care (the Department), with further contributions from the states and territories by the collection and submission of their data.

Analysis of antimicrobial prescriptions supplied under the Australian Pharmaceutical Benefits Scheme (PBS) and Repatriation Pharmaceutical Benefits Scheme (RPBS) in 2022 was added to previous analyses for 2015–2021 for this report.

In 2020, there were two major events that may have affected antimicrobial use. The first was the change to repeat prescribing of selected antibiotics. In April 2020, there were PBS and RPBS policy changes for Australia's five most commonly dispensed antimicrobials (amoxicillin, amoxicillin–clavulanic acid, cefalexin, doxycycline and roxithromycin).[1] These changes reduced the number of repeat prescriptions permissible (typically from one to zero), with no change to the maximum quantity that could be dispensed for unrestricted antimicrobials. Larger quantities were only available under restricted or authorisation policies. These changes were intended to discourage prescription of repeats unless clinically necessary.

The second major event was the introduction of measures to curb the transmission of COVID-19, which included social distancing, working from home recommendations, telemedicine for all, travel restrictions and widespread free COVID-19 testing. Most of these measures first came into effect in the last week of March 2020 and continued in varying forms until late 2021 in most states and territories.

Data source

Services Australia provided a 13-year extract of antimicrobial prescriptions supplied under the PBS and RPBS. The extract included all antimicrobials listed on the PBS and RPBS that were dispensed between 1 January 2010 and 31 December 2022, including all prescriptions priced under the patient co-payment from July 2012 onwards (prescriptions which do not attract a reimbursement). The data did not contain details on any prescriptions provided as private supply.

The data included the following fields:

- Patient identifier (system-generated unique identifier)
- Patient date of birth (MMYYYY)
- Postcode in which the patient resided at the date of supply
- Postcode in which the prescriber's address was located at the date of supply
- PBS or RPBS item code
- Anatomical Therapeutic Chemical (ATC) classification code
- Drug name
- Product form and strength
- Quantity of PBS or RPBS item supplied
- Date of supply

- Type of prescription: original, repeat, authority
- Number of repeats ordered
- Number of previous supplies
- Regulator 49 indicator (previously Regulation 24, which indicates whether all repeats for a PBS or RPBS prescription were supplied at the same time as the original prescription)
- Specialty group of prescriber.

Methods

The antimicrobials included in the analyses presented in this report are shown in Table 1. These antimicrobials are referred to as 'all antimicrobials' in this report.

Table 1: Antimicrobials included in the analyses

ATC codes	Description
J01	Antibacterials for systemic use
A02BD	Combinations for eradication of *Helicobacter pylori*
A07AA09	Vancomycin (intestinal anti-infectives)
A07AA11	Rifaximin (intestinal anti-infective)
D06AX09	Mupirocin (cream/ointment, RPBS)
D06BA01	Sulfadiazine silver (cream)
S01AA01, S01AA11, S01AA12	Ophthalmological antibiotics: gentamicin, chloramphenicol, tobramycin
S01AE01, S01AE03	Ophthalmological fluoroquinolones: ofloxacin, ciprofloxacin
S02AA01, S02AA15	Otological anti-infectives: chloramphenicol, ciprofloxacin
S03AA	Framycetin (S01AA07 on WHO, but S03AA on pbs.gov.au)

The following analyses were undertaken:

1. Overall trends for all antimicrobials supplied over the years to 2022 defined as:
    - 1.1 Number of prescriptions dispensed per 1,000 people at national, state and territory and Statistical Area Level 3 (SA3) level (derived from postcode); 2015–2022
    - 1.2 Number of prescriptions dispensed per 1,000 people by class of antimicrobial; 2015–2022
    - 1.3 Defined daily dose (DDD) per 1,000 people per day at national and state and territory levels; 2017–2022
    - 1.4 DDD per 1,000 people per day by class of systemic antimicrobial (ATC code J01); 2017–2022

    The trends in antimicrobial use at the national and state and territory level are presented in graphical form. Results for the SA3 analysis are presented in tabular form as there are over 300 SA3 areas in Australia. Use within each year at the SA3 level is reported. The table also includes a spark-line for each SA3 to show the trend over the eight years

(2015–2022). The body of the report includes tables to show the top 10 SA3 areas with the greatest increase and top 10 SA3 areas with greatest decrease in antimicrobial use over the eight-year period (2015–2022).

Note: DDD of amoxicillin, which is set by the World Health Organization Collaborating Centre for Drug Statistics Methodology, was changed from 1 gram to 1.5 grams in 2019.[2] Previous AURA reports have used the 1 gram DDD. In this report, the 1.5 grams DDD has been used. This results in slight differences in annual volume of use across reports.[3–6]

2. Antimicrobial use by age in 2022

   The number of all antimicrobials dispensed per 1,000 people by patient age for patients' SA3 levels (derived from postcode) and patients' state and territory in 2022.

   The results at SA3 level are presented in tabular form for each SA3 area and age group. A graph for each age group is presented to show the top 10 SA3 and bottom 10 SA3 areas with highest and lowest numbers.

3. Top 10 antimicrobials supplied in 2022

   3.1.1 Most commonly supplied antimicrobials in 2022
   3.1.2 Original and repeat dispensing of the top 10 most commonly supplied antimicrobials; 2020–2022

   The number of original prescriptions dispensed with the maximum number of repeats as a proportion of all original prescriptions dispensed for the top 10 antimicrobials is ordered by prescriber's SA3, as well as by state and territory.

   The results at SA3 level are presented in tabular form for each SA3 and antimicrobial. A graph for each antimicrobial shows the top 10 SA3 and bottom 10 SA3 areas with highest and lowest numbers.

4. Rate per 1,000 people of all antimicrobials supplied in the winter season (June, July, August) by prescriber's SA3, as well as by state and territory; 2019–2022. The results are mapped to the Australian map to enable comparisons to analysis and reporting in the Commission's *Australian Atlas of Healthcare Variation*.[7]

Where age-standardised rates are reported, the reference population is the Australian population in mid-2013 for consistency with previous AURA reports. Where population data were reported, the mid-year (30 June) estimates for each calendar year as provided by the Australian Bureau of Statistics (ABS) were used.

Results

1. Overall trends in antimicrobial use in Australia

The fall in antimicrobial use that was observed in 2020 compared with previous years, most likely due to changes in healthcare practice and infection risk related to the COVID-19 pandemic, was maintained in 2021. The level of use rose in 2022 but has not returned to pre-2020 levels.

In 2021, there were 19,931,271 prescriptions supplied under the PBS and RPBS for all antimicrobials listed in Table 2. This was a 0.8% decrease from the number of prescriptions in 2020 (Table 2).

In 2022, there were 21,848,005 prescriptions supplied for all antimicrobials, which is a 9.6% increase compared to 2021.

In 2021, 32.9% (*n* = 8,468,093) of the Australian population had at least one antimicrobial dispensed under the PBS or RPBS, compared to 32.1% in 2020. This was an increase of 2.5%. On average, there were 2.35 antimicrobial prescriptions per person among people who received any antimicrobial in 2021.

In 2022, 36.6% (*n* = 9,502,834) of the Australian population had at least one antimicrobial dispensed under the PBS or RPBS, compared to 32.9% in 2021. This was an increase of 11.3%. On average, there were 2.30 antimicrobial prescriptions per person among people who received any antimicrobial in 2022.

Table 2: Number of PBS and RPBS prescriptions supplied for antimicrobials, 2015–2022

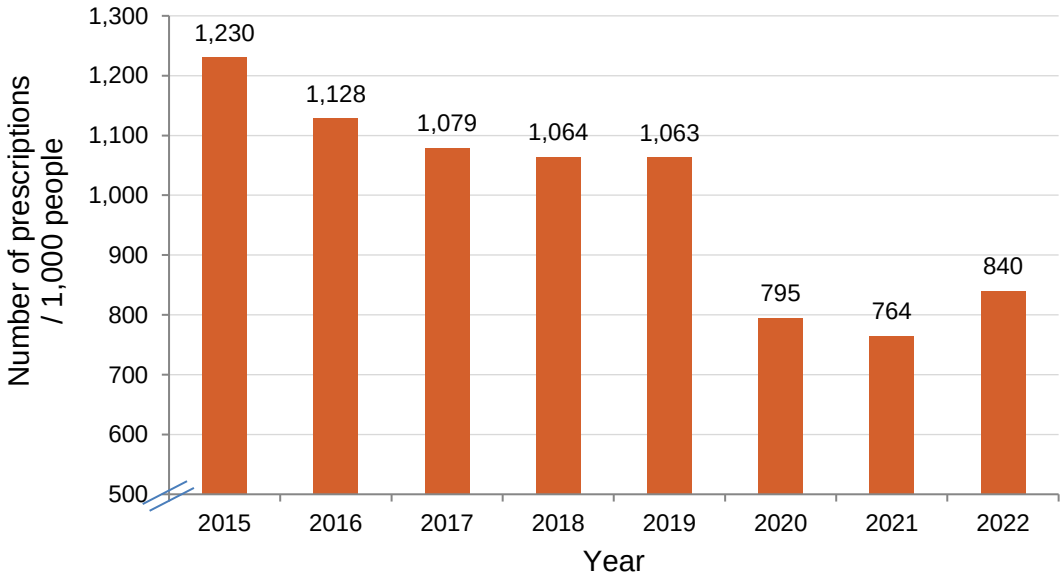
Year	All antimicrobials	Systemic antibacterials (J01)
2015	29,264,932	26,813,587
2016	27,324,648	26,926,933
2017	26,553,451	25,924,324
2018	26,229,366	25,427,786
2019	26,669,561	25,871,075
2020	20,095,926	19,425,518
2021	19,931,271	19,208,986
2022	21,848,005	21,059,515

PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme

1.1.1. Rate of antimicrobial prescriptions supplied per 1,000 people: national results, 2015–2022

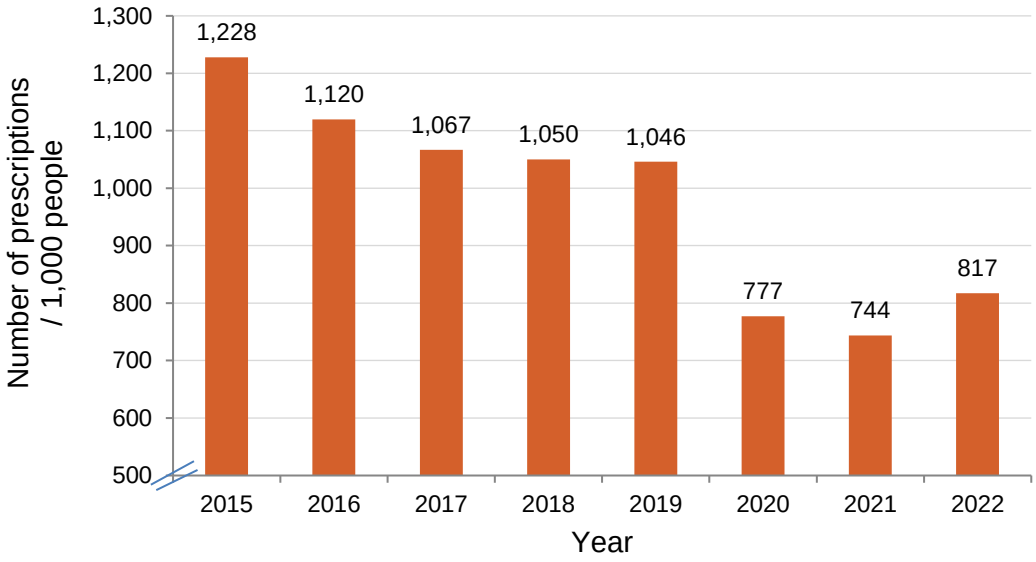
The rate of antimicrobial prescriptions supplied per 1,000 people in Australia was relatively stable between 2017–2019 but declined in 2020 and 2021 (Figure 1A and Figure 1B), most likely due to the COVID-19 pandemic and social distancing restrictions. However, the age-standardised rate increased to 817 prescriptions per 1,000 people in 2022 (Figure 1B).

Figure 1A: Crude rate per 1,000 people of all PBS and RPBS antimicrobial prescriptions supplied, 2015–2022



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme

Figure 1B: Age-standardised rate per 1,000 people of all PBS and RPBS antimicrobial prescriptions supplied, 2015–2022



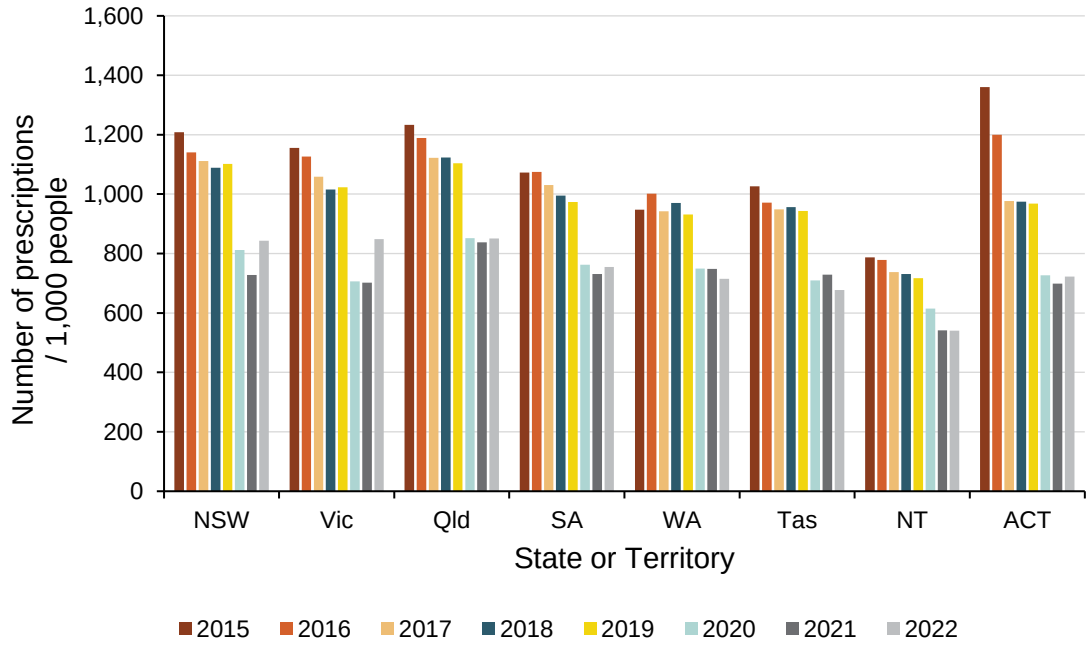
PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme
Note: Rates are age-standardised based on the age structure of the Australian national population in 2013 (for consistency with previous reports); national rates are based on the total number of prescriptions dispensed and people in Australia in the given year.

1.1.2. Rate of antimicrobial prescriptions supplied per 1,000 people: state and territory results, 2015–2022

The lower national rates of antimicrobial use in 2020 and 2021 were observed in all states and territories (Figure 2). In 2022, the rates did not change by much except in New South Wales (NSW) and Victoria compared to the previous two years. In 2022, antimicrobial use was highest in Queensland, NSW and Victoria, and lowest in the Northern Territory (NT) (Figure 2). This relationship was still evident after standardising for population differences (Figure 3). In 2022, antimicrobial use was highest in Queensland, NSW and Victoria, and lowest in the NT (Figure 3, age-standardised).

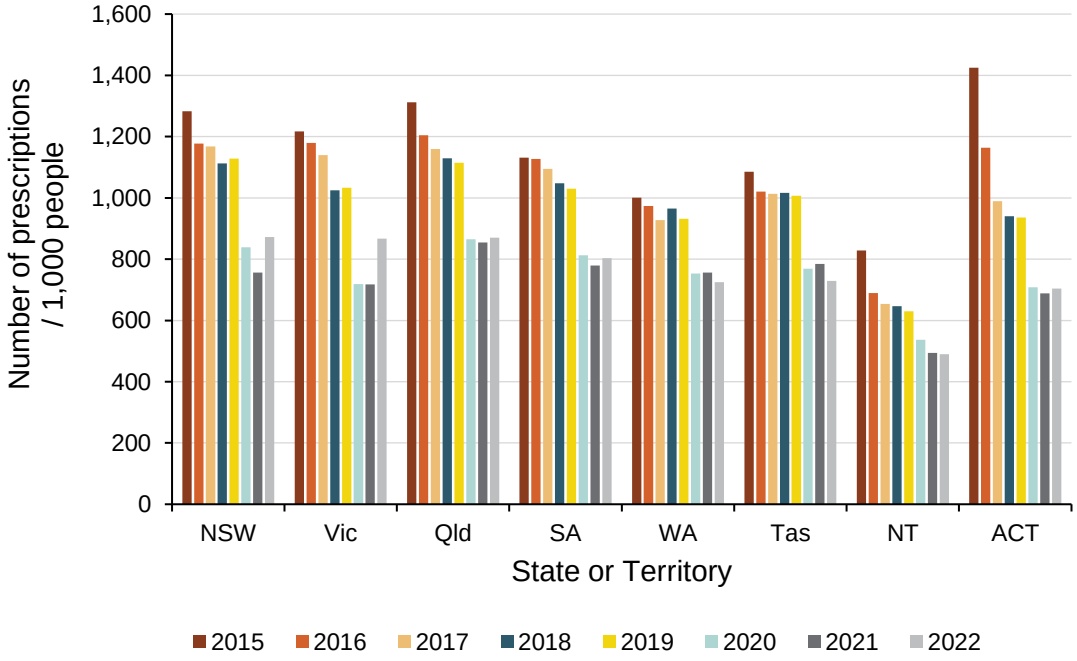
Data were not available at the patient level for supply of antimicrobials to Aboriginal and Torres Strait Islander health services, which may have contributed to some of the variation observed in states and territories with significant supply via Aboriginal and Torres Strait Islander health services.

Figure 2: Crude rates of all PBS and RPBS antimicrobial prescriptions supplied per 1,000 people: states and territories, 2015–2022



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme
Note: Crude rates are based on the total number of prescriptions and people in the given state or territory. Prescriptions were allocated based on the SA3 of the patient's postcode.

Figure 3: Age-standardised rate of all PBS and RPBS antimicrobial prescriptions supplied per 1,000 people: states and territories, 2015–2022



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme
Note: Rates are age-standardised to the age structure of the Australian national population in 2013; rates are based on the total number of prescriptions and people in the given state or territory.

1.1.3. Rate of antimicrobial prescriptions supplied per 1,000 people: Statistical Area Level 3 results, 2015–2022

The results for antimicrobial use at the SA3 levels are presented in Appendix Table A1. The table lists each SA3 area on a separate line and presents a spark-line showing the trend over the eight years.

Table 3 shows the results for the top 10 SA3 areas with the greatest percentage increase in antimicrobial use in 2022 compared to 2021.

Table 4 shows the bottom 10 SA3 areas with the greatest percentage decrease in antimicrobial use in 2022 compared to 2021.

Table 3: Top 10 SA3 areas with greatest percentage increase in rate of all PBS and RPBS antimicrobial prescriptions supplied per 1,000 people; 2015–2022

			Rate of prescriptions supplied per 1,000 people								Percentage change						
SA3 code	**SA3 name**	**State or Territory**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2016–2015**	**2017–2016**	**2018–2017**	**2019–2018**	**2020–2019**	**2021–2020**	**2022–2021**
20604	Melbourne City	Vic	1152	967	913	555	552	378	375	530	-19.1	-5.9	-64.5	-0.5	-46	-0.8	29.2
11603	Mount Druitt	NSW	1601	1533	1477	665	726	548	561	749	-4.4	-3.8	-122.1	8.4	-32.5	2.3	25.1
20606	Stonnington - West	Vic	1083	1033	978	892	909	633	596	796	-4.8	-5.6	-9.6	1.9	-43.6	-6.2	25.1
20804	Stonnington - East	Vic	892	867	787	732	748	505	489	647	-2.9	-10.2	-7.5	2.1	-48.1	-3.3	24.4
12501	Auburn	NSW	1172	1049	1022	936	952	713	594	778	-11.7	-2.6	-9.2	1.7	-33.5	-20	23.7
20602	Darebin - South	Vic	1026	982	917	661	668	481	433	567	-4.5	-7.1	-38.7	1	-38.9	-11.1	23.6
20605	Port Phillip	Vic	1019	975	936	849	870	617	573	748	-4.5	-4.2	-10.2	2.4	-41	-7.7	23.4
21204	Dandenong	Vic	1132	1052	1004	925	955	679	604	788	-7.6	-4.8	-8.5	3.1	-40.6	-12.4	23.4
20607	Yarra	Vic	919	868	814	768	775	549	507	659	-5.9	-6.6	-6	0.9	-41.2	-8.3	23.1
20701	Boroondara	Vic	1043	1016	932	871	884	607	583	756	-2.7	-9	-7	1.5	-45.6	-4.1	22.9

PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme; SA3 = Statistical Area Level 3

Table 4: Bottom 10 SA3 areas with greatest percentage decrease in rate of all PBS and RPBS antimicrobial prescriptions supplied per 1,000 people, 2015–2022

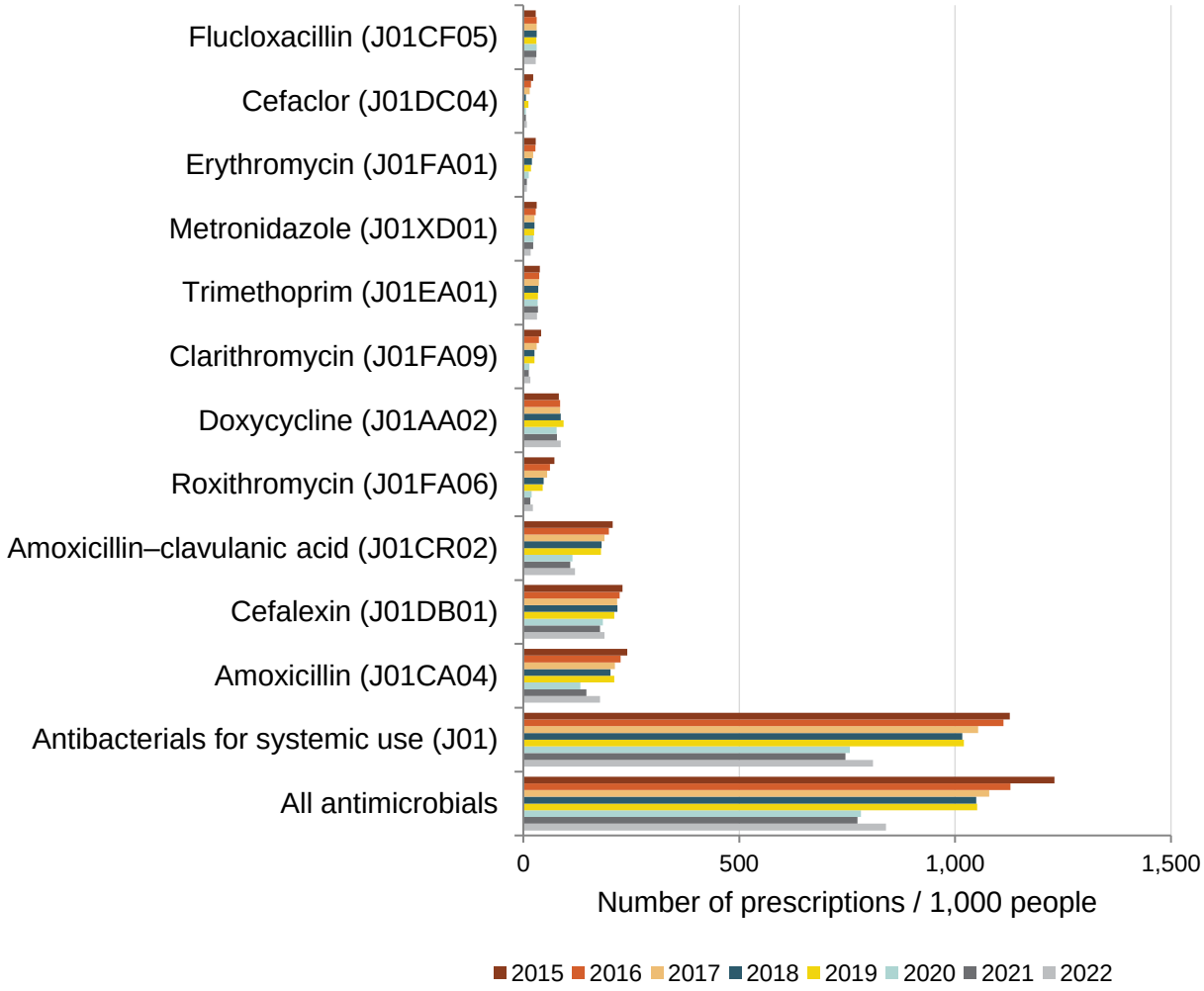
			Rate of prescriptions supplied per 1,000 people								Percentage change						
SA3 code	SA3 name	State or Territory	2015	2016	2017	2018	2019	2020	2021	2022	2016–2015	2017–2016	2018–2017	2019–2018	2020–2019	2021–2020	2022–2021
51001	Kimberley	WA	377	425	407	415	433	415	337	280	11.3	-4.4	1.9	4.2	-4.3	-23.1	-20.4
60303	South East Coast	Tas	886	890	884	867	809	619	669	569	0.4	-0.7	-2	-7.2	-30.7	7.5	-17.6
51104	Mid West	WA	1034	1096	1001	934	895	785	733	645	5.7	-9.5	-7.2	-4.4	-14	-7.1	-13.6
60301	Central Highlands (Tas.)	Tas	372	341	317	471	450	308	377	332	-9.1	-7.6	32.7	-4.7	-46.1	18.3	-13.6
60103	Hobart - North West	Tas	1252	1149	1146	1109	1084	812	777	688	-9	-0.3	-3.3	-2.3	-33.5	-4.5	-12.9
50102	Bunbury	WA	1154	1189	1115	917	876	707	734	653	2.9	-6.6	-21.6	-4.7	-23.9	3.7	-12.4
50901	Albany	WA	878	859	821	766	710	610	588	525	-2.2	-4.6	-7.2	-7.9	-16.4	-3.7	-12
51103	Goldfields	WA	1029	1069	984	913	858	700	641	576	3.7	-8.6	-7.8	-6.4	-22.6	-9.2	-11.3
31201	Bowen Basin - North	Qld	1049	1121	1100	1014	1022	856	797	722	6.4	-1.9	-8.5	0.8	-19.4	-7.4	-10.4
60203	North East	Tas	1086	978	976	933	958	761	795	725	-11	-0.2	-4.6	2.6	-25.9	4.3	-9.7

PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme; SA3 = Statistical Area Level 3

1.2. Number of antimicrobial prescriptions supplied per 1,000 people: results by type of antimicrobial, 2015–2022

Analysis of the number of antimicrobial prescriptions supplied per 1,000 people in the population shows a decrease in the number of prescriptions for all antimicrobials and for systemic antimicrobials in 2020 and 2021 compared to the period 2015–2019 (Figure 4). However, in 2022 there was an increase in the number of prescriptions for all antimicrobials and for systemic antimicrobials per 1,000 people compared to 2021. This increase is due to increased use of amoxicillin, cefalexin and amoxicillin–clavulanic acid (Figure 4).

Figure 4: Number of PBS and RPBS antimicrobial prescriptions supplied per 1,000 people, 2015–2022



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme

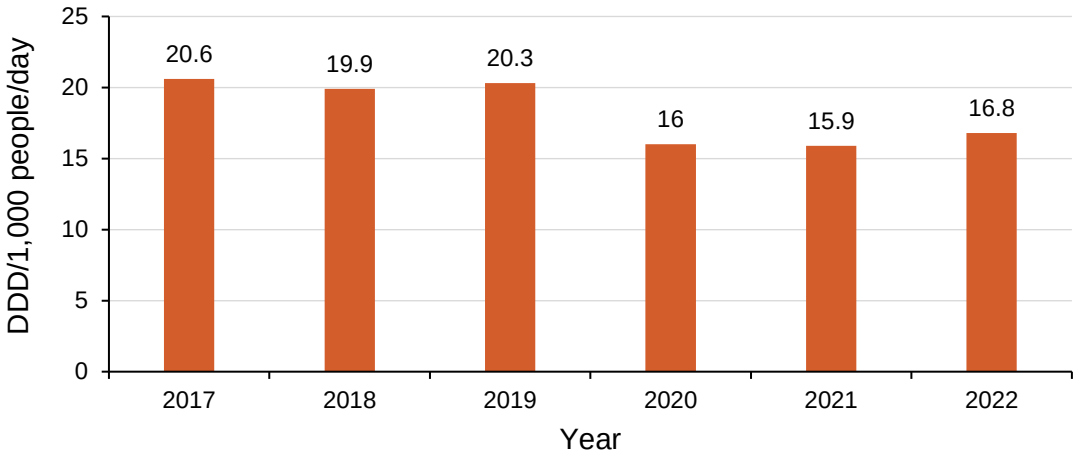
1.3.1. Rate of use of antimicrobials per 1,000 people by volume (DDD): national results, 2017–2022

When assessing antimicrobial use by volume, the volume of antimicrobials supplied in Australia increased slightly in 2022 compared to 2020 and 2021 (Figure 5).

The volume of all systemic antibacterials (J01) in 2022 was 16.8 DDD per 1,000 people per day.

Note: From non-systemic antimicrobials (not J01), only the combinations for eradication of *Helicobacter pylori* (A02BD) had a DDD, and the volume was 0.001 DDD per 1,000 people per day. Thus, the volume of systemic antimicrobials equals the volume of all antimicrobials as presented in Figure 5.

Figure 5: Quantity of all PBS and RPBS antimicrobial prescriptions supplied, expressed as DDD per 1,000 people per day, 2017–2022

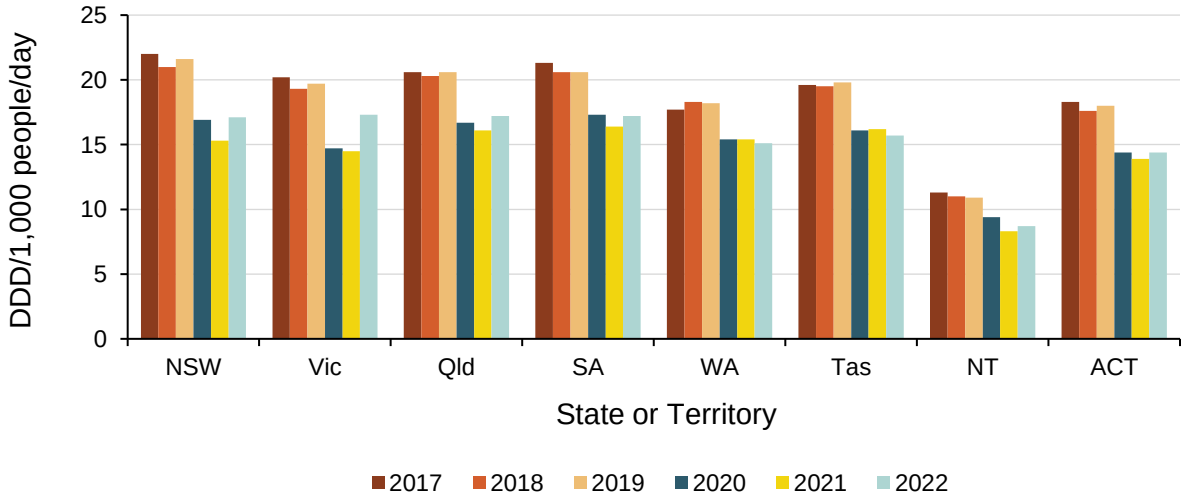


DDD = defined daily dose; PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme

1.3.2. Rate of use of antimicrobials per 1,000 people by volume (DDD): state and territory results, 2017–2022

When analysed at the state and territory level, the volume of use of antimicrobials increased in 2022 across most states and territories (except Tasmania and Victoria) compared to 2021.

Figure 6: Volume of all PBS and RPBS antimicrobial prescriptions supplied, expressed as DDD per 1,000 people per day: states and territories, 2017–2022

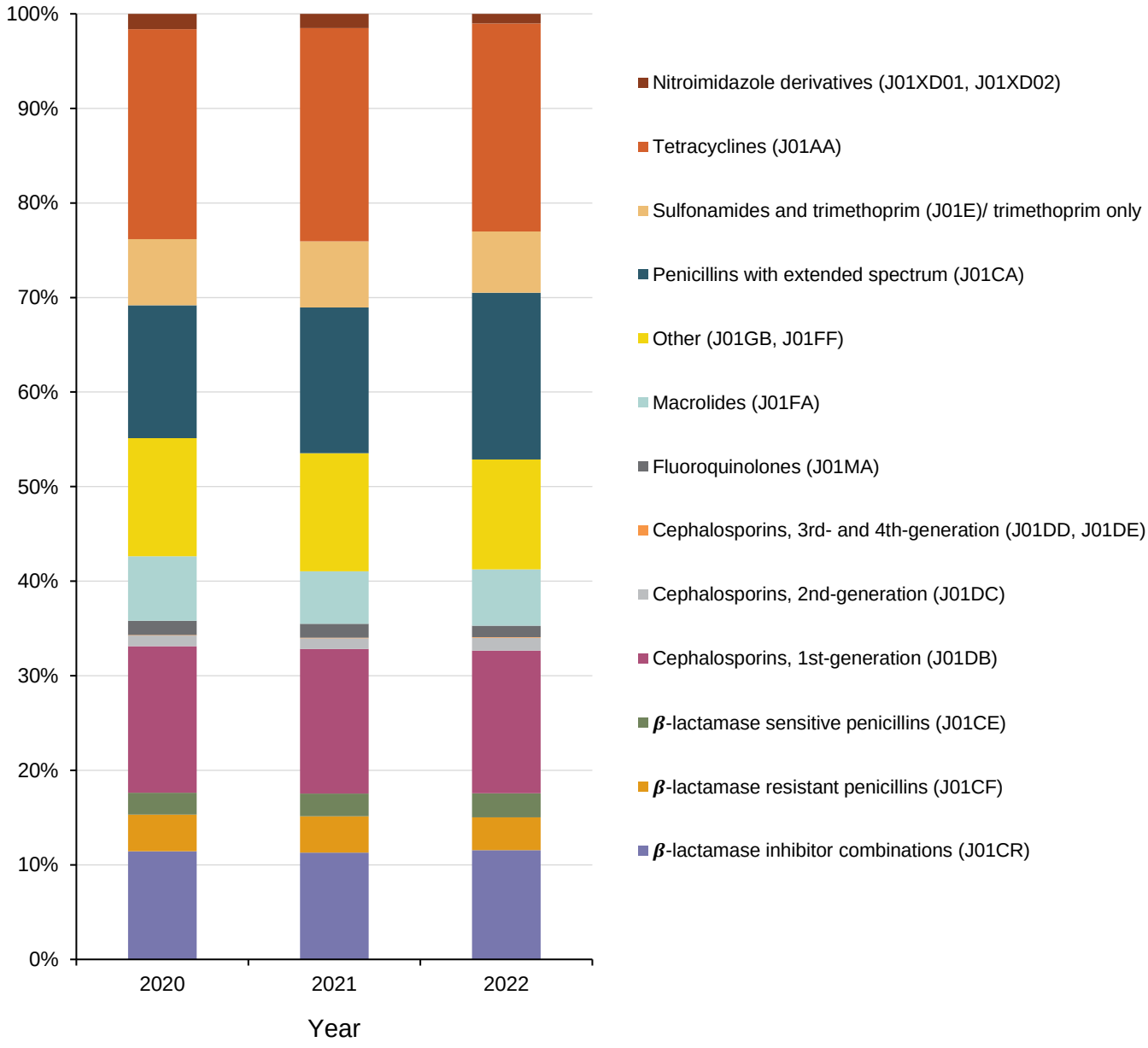


DDD = defined daily dose; PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme

1.4. Rate of use of antimicrobials per 1,000 people by volume (DDD): results by class of systemic antimicrobials (ATC code J01), 2017–2022

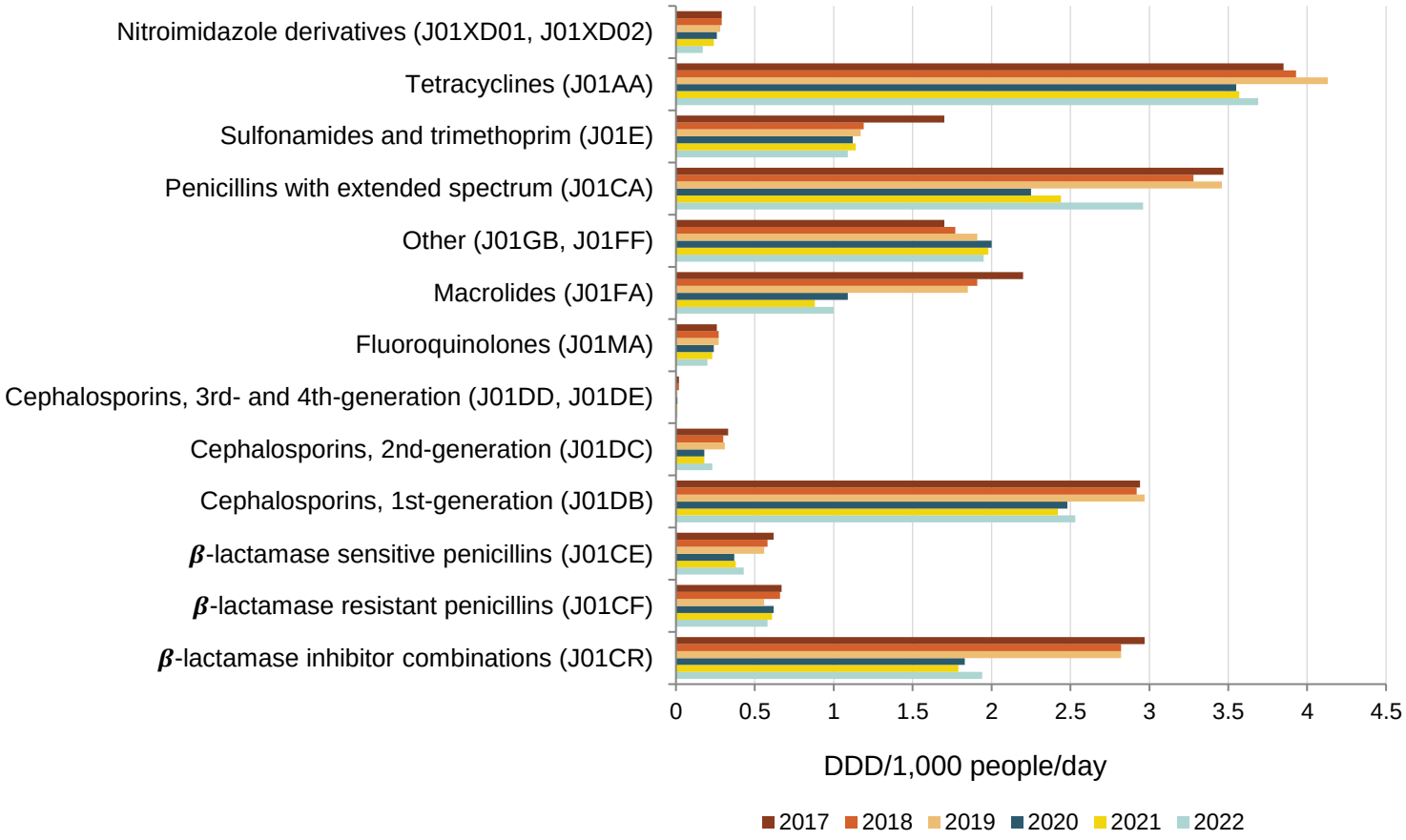
Figure 7A shows that tetracyclines had the highest volume of use in 2022 (3.7 DDD per 1,000 people per day), followed by penicillins with extended spectrum (3.0 DDD per 1,000 people per day) and first-generation cephalosporins (2.5 DDD per 1,000 people per day). Figure 7B compares the volume of use of systemic antibacterials across the years.

Figure 7A: DDD per 1,000 people per day by class of PBS and RPBS systemic antibacterial (J01) prescriptions supplied, presented as a 100% stacked bar chart, 2020–2022



DDD = defined daily dose; PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme

Figure 7B: DDD per 1,000 people per day by class of PBS and RPBS systemic antibacterial (J01) prescriptions supplied, 2017–2022

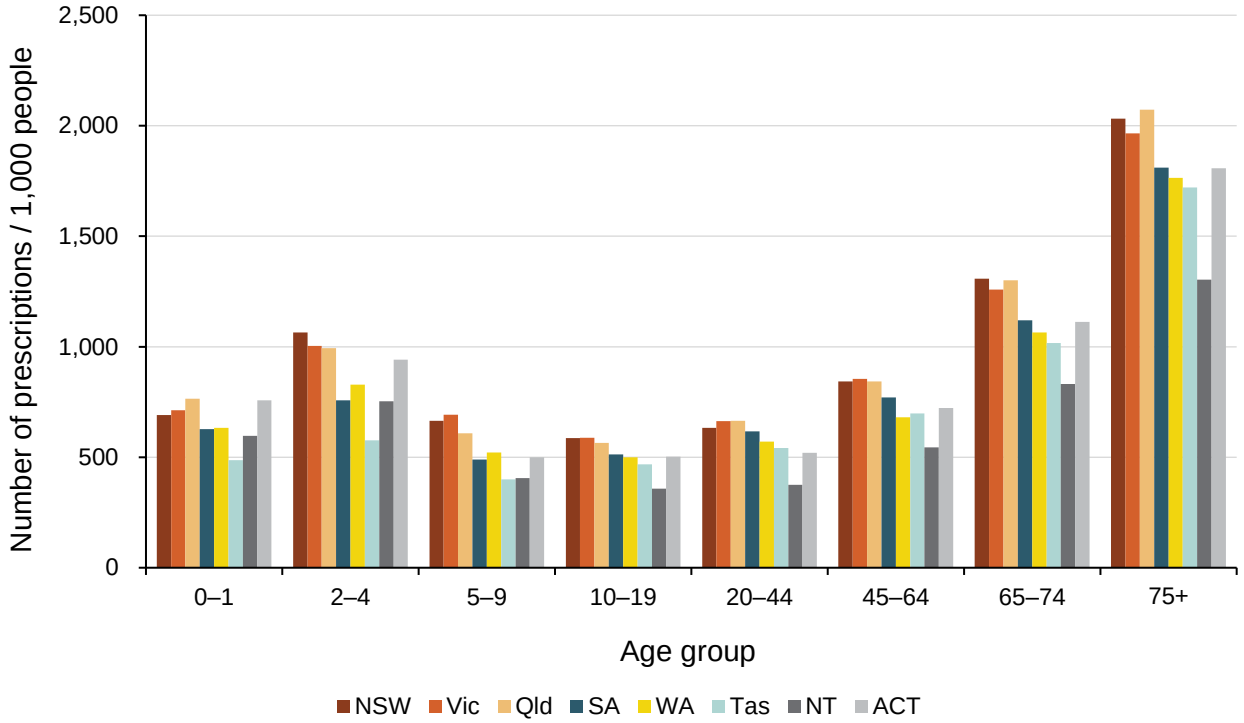


2. Antimicrobial use by age in 2022

2.1. Rate of antimicrobials supplied per 1,000 by patients' age: state and territory results, 2022

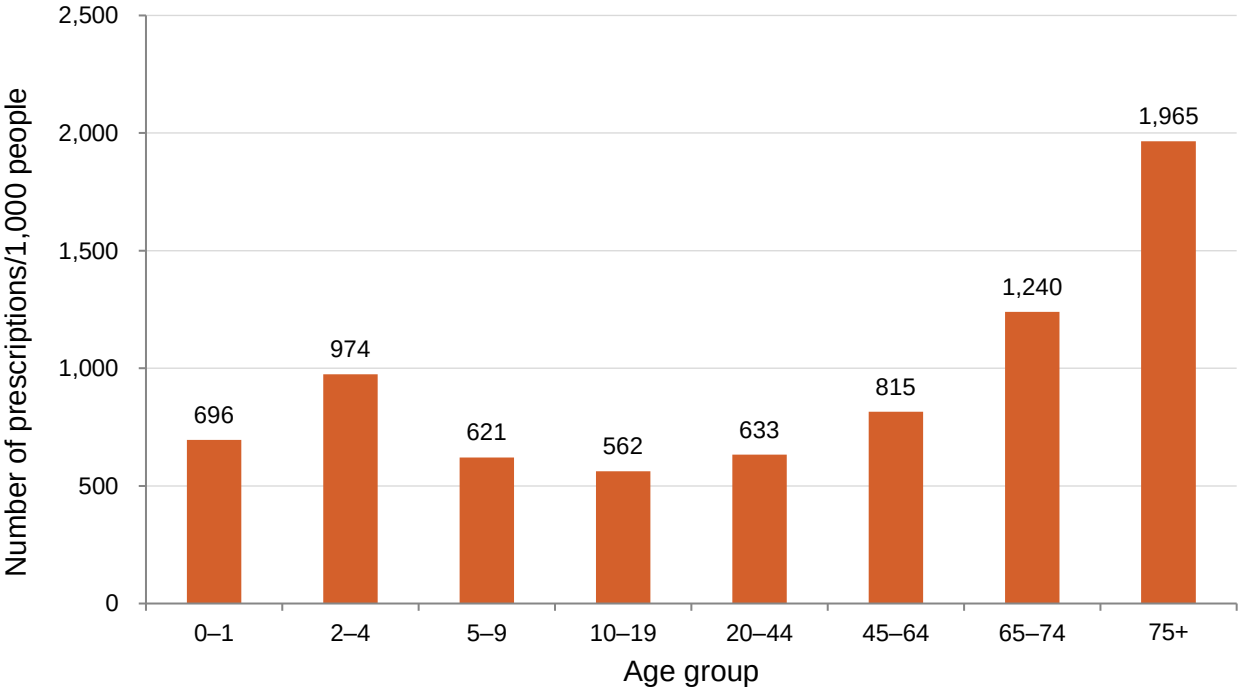
Analysis of antimicrobial use in 2022 by age group found that people who were aged 75 years and over received the highest number of antimicrobial prescriptions and that this was consistent across states and territories (Figure 8A). Figure 8B shows the use of antimicrobials by age group at national level.

Figure 8A: Number of all PBS and RPBS antimicrobial prescriptions supplied per 1,000 people, by patients' age: states and territories, 2022



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme
Note: Age-specific rates are based on the total number of prescriptions and number of people in a given age group in the state or territory in 2022.

Figure 8B: Number of all PBS and RPBS antimicrobial prescriptions supplied per 1,000 people by patient's age, 2022



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme

2.2. Rate of antimicrobials supplied per 1,000 by patients' age: Statistical Area Level 3 results, 2022

The results for all SA3 levels in 2022 are presented in Appendix Table A2. The table list each SA3 area and age group on a separate line. The rates are based on the total number of prescriptions supplied and number of people in a given age group in that SA3 area.

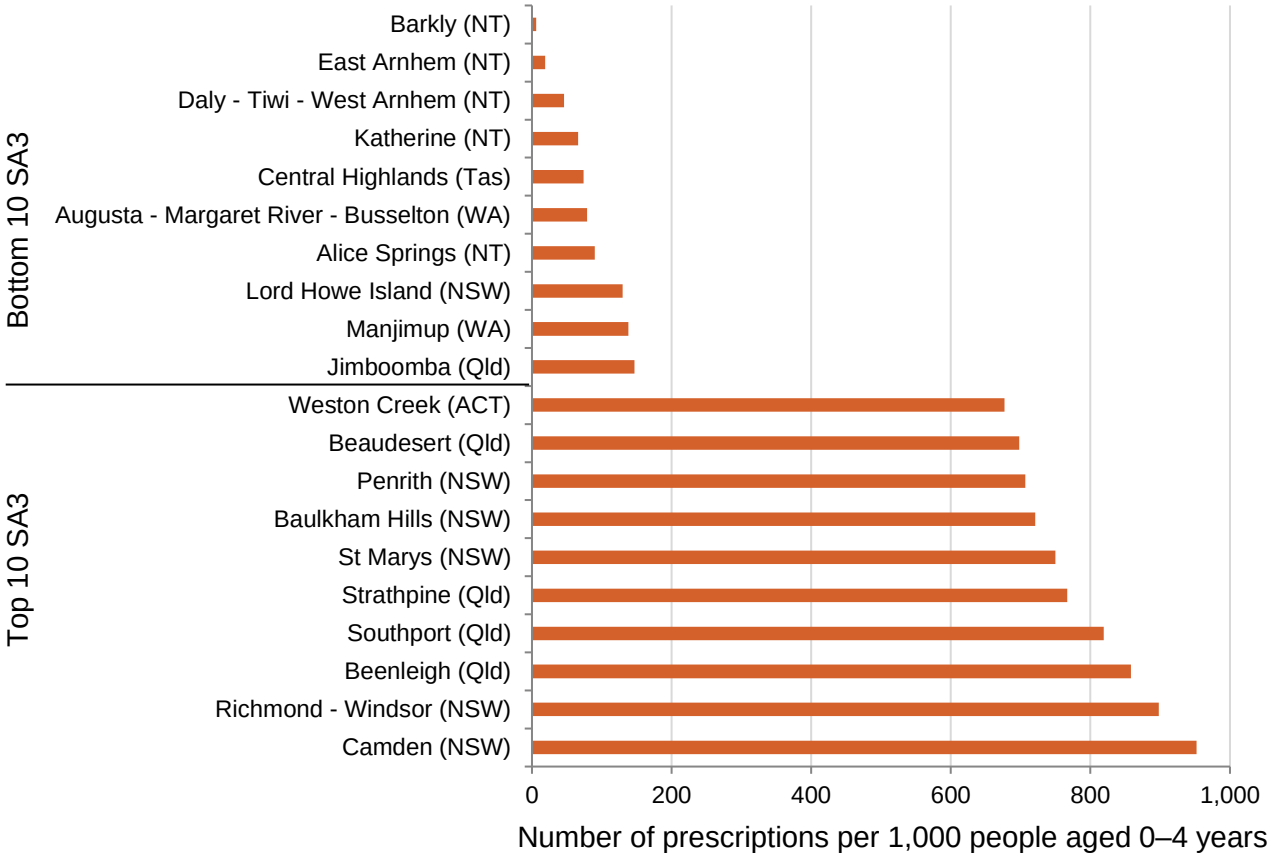
Figures 9–15 present a graph for each age group assessed, highlighting the top 10 SA3 and bottom 10 SA3 areas with highest and lowest rates of antimicrobial use in 2022.

The graphs show that the highest use of antimicrobials was in SA3 areas in NSW and Queensland: Richmond - Windsor (NSW), Camden (NSW), Beenleigh (Queensland) and Southport (Queensland) featured in the top 10 SA3 areas for most age groups in 2022.

SA3 areas in the NT had the lowest use, with the NT regions Barkly, East Arnhem and Katherine featured in the bottom 10 SA3 areas for almost all age groups. It should be noted, however, that antimicrobials supplied to Aboriginal and Torres Strait Islander health services are not included in these analyses, which may affect the NT results.

Figure 9: Top 10 and bottom 10 SA3 areas with highest and lowest rate of all PBS and RPBS antimicrobial prescriptions supplied per 1,000 people aged 0–4 years, 2022

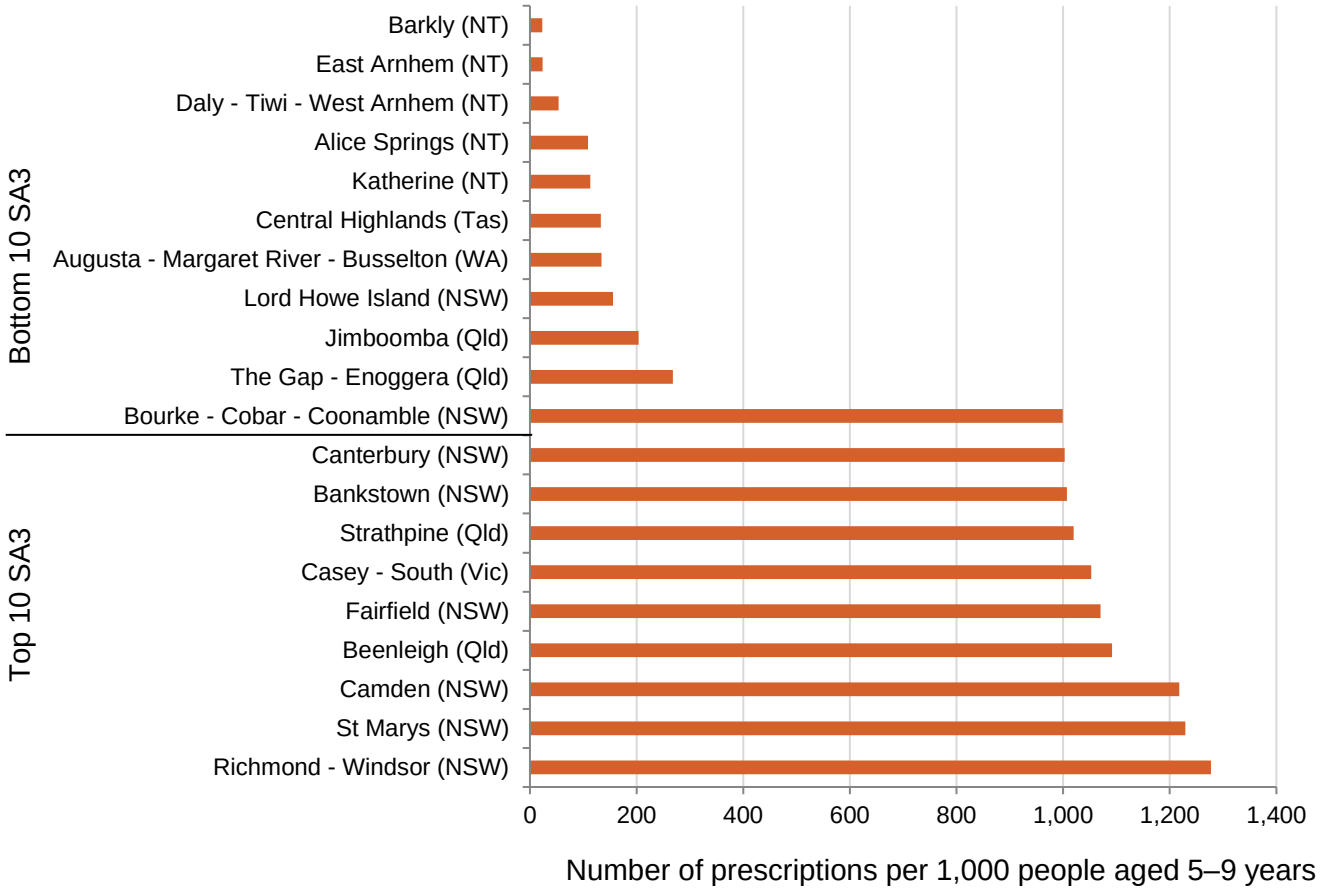
Age 0–4 years



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme; SA3 = Statistical Area Level 3

Figure 10: Top 10 and bottom 10 SA3 areas with highest and lowest number of all PBS and RPBS antimicrobial prescriptions supplied per 1,000 people aged 5–9 years, 2022

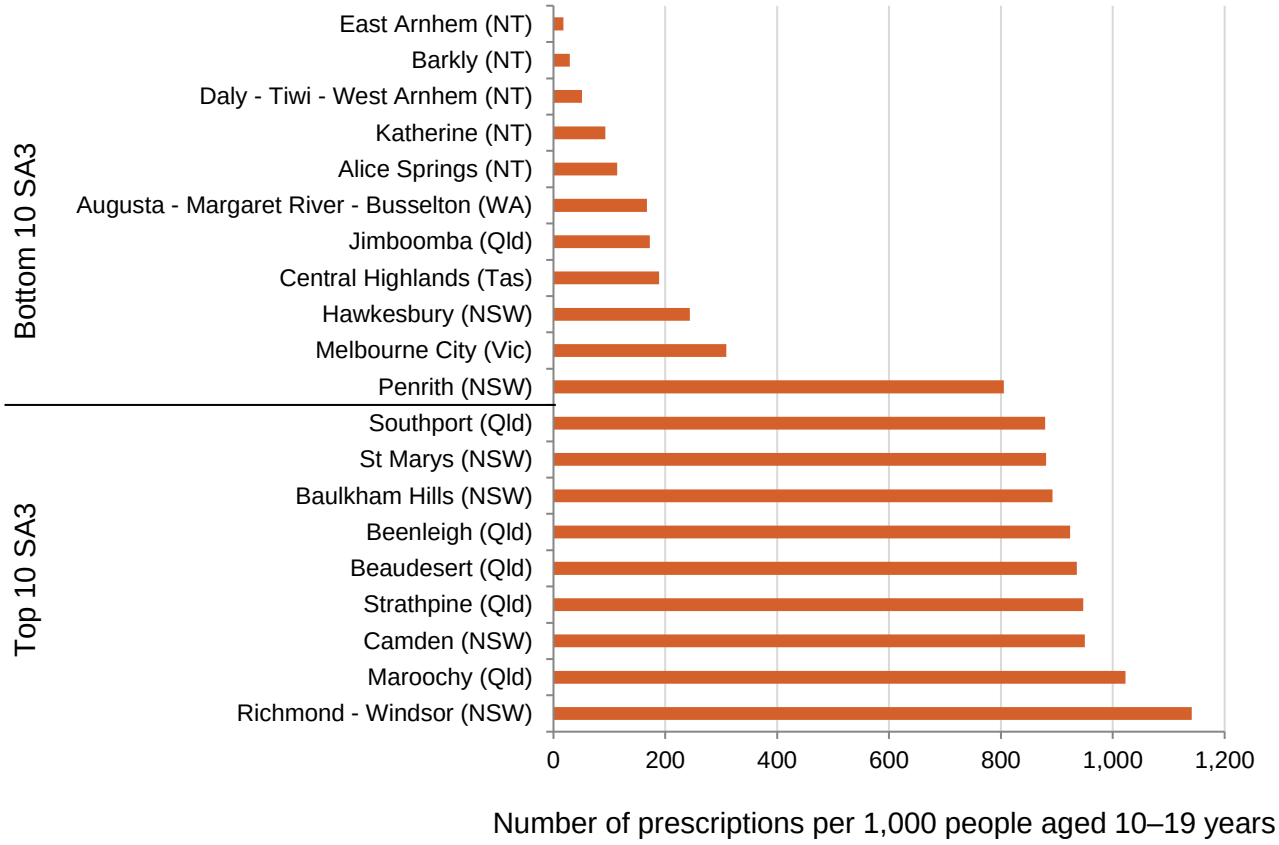
Age 5–9 years



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme;
SA3 = Statistical Area Level 3

Figure 11: Top 10 and bottom 10 SA3 areas with highest and lowest number of all PBS and RPBS antimicrobial prescriptions supplied per 1,000 people aged 10–19 years, 2022

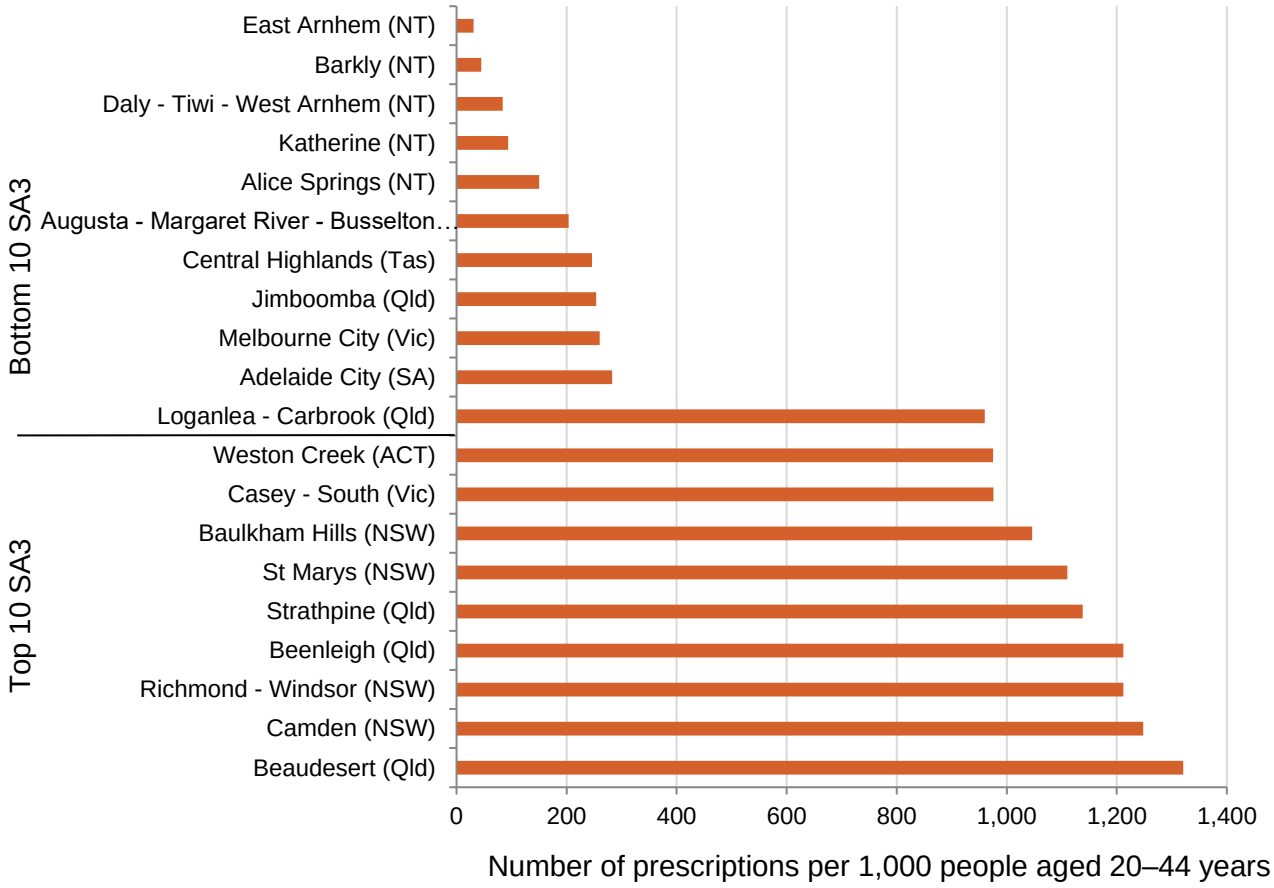
Age 10–19 years



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme;
SA3 = Statistical Area Level 3

Figure 12: Top 10 and bottom 10 SA3 areas with highest and lowest number of all PBS and RPBS antimicrobial prescriptions supplied per 1,000 people aged 20–44 years, 2022

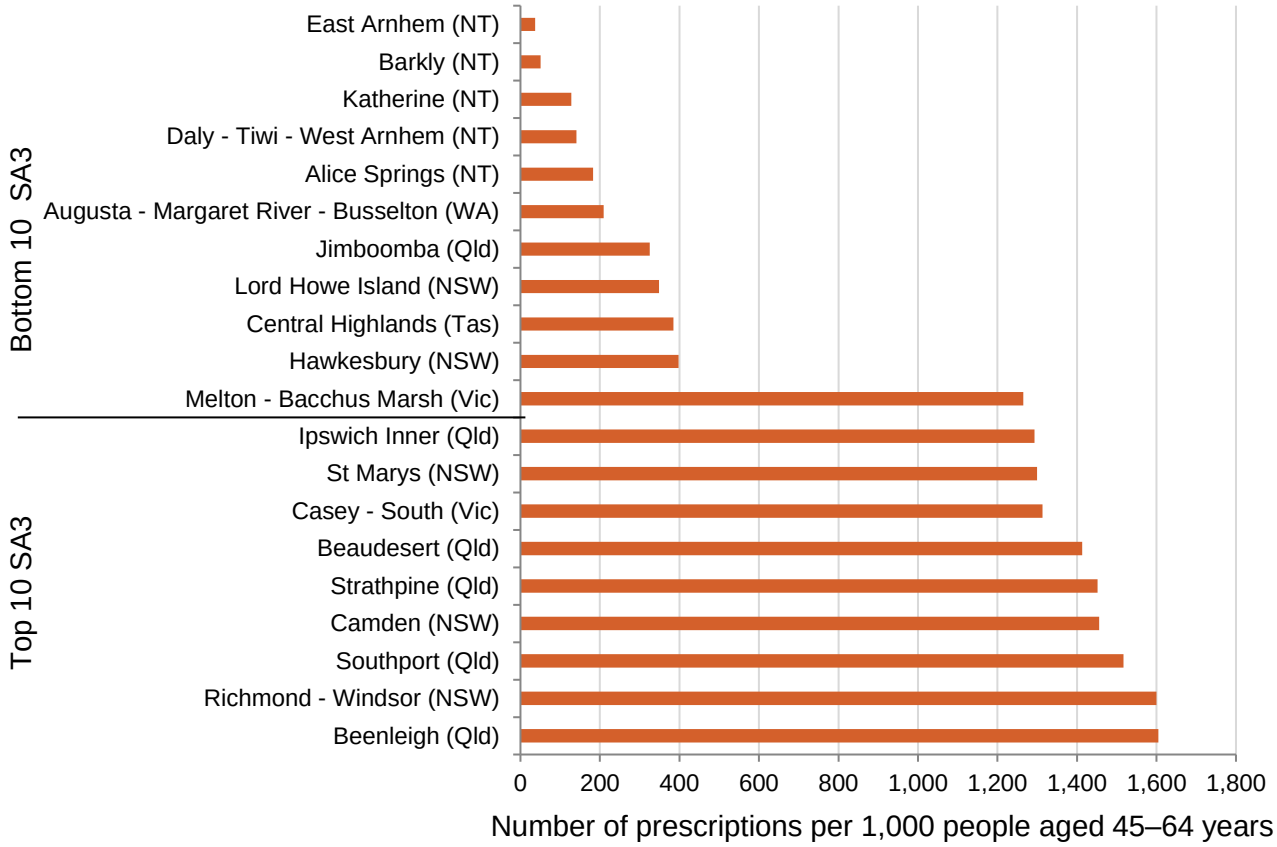
Age 20–44 years



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme;
SA3 = Statistical Area Level 3

Figure 13: Top 10 and bottom 10 SA3 areas with highest and lowest number of all PBS and RPBS antimicrobial prescriptions supplied per 1,000 people aged 45–64 years, 2022

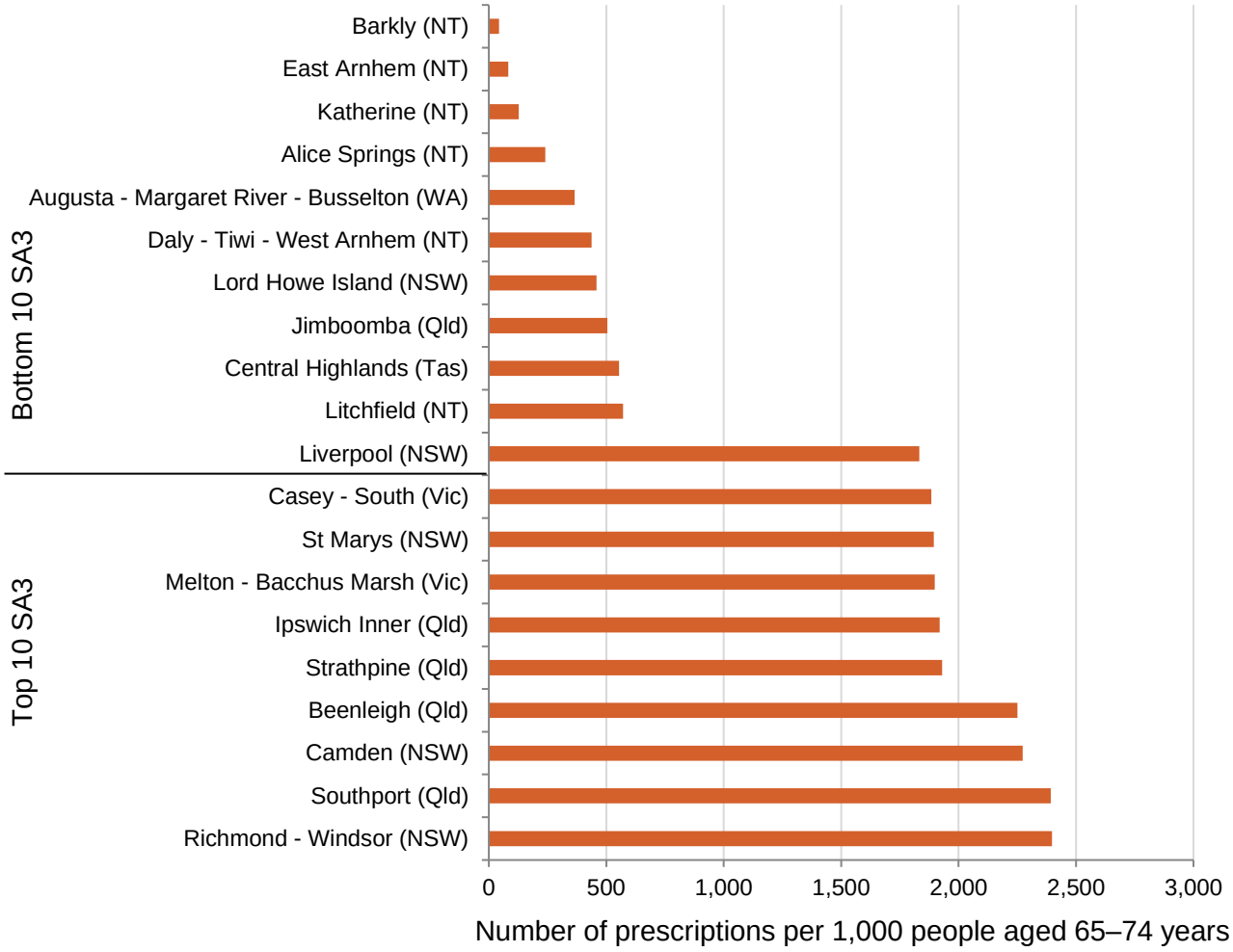
Age 45–64 years



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme;
SA3 = Statistical Area Level 3

Figure 14: Top 10 and bottom 10 SA3 areas with highest and lowest number of all PBS and RPBS antimicrobial prescriptions supplied per 1,000 people aged 65–74 years, 2022

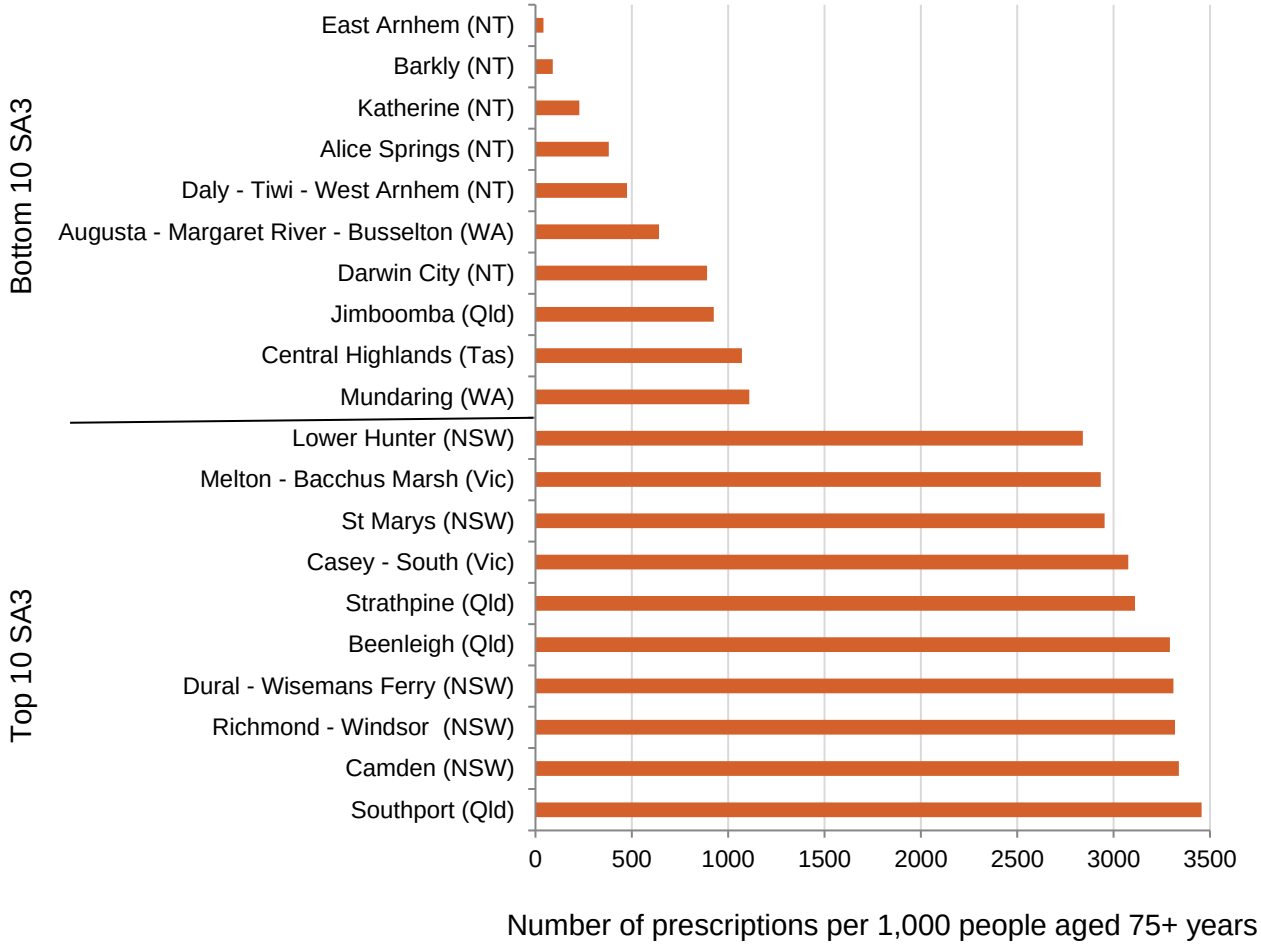
Age 65–74 years



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme;
SA3 = Statistical Area Level 3

Figure 15: Top 10 and bottom 10 SA3 areas with highest and lowest number of all PBS and RPBS antimicrobial prescriptions supplied per 1,000 people aged 75+ years, 2022

Age 75+ years



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme;
SA3 = Statistical Area Level 3

3. Top 10 antimicrobials in 2022

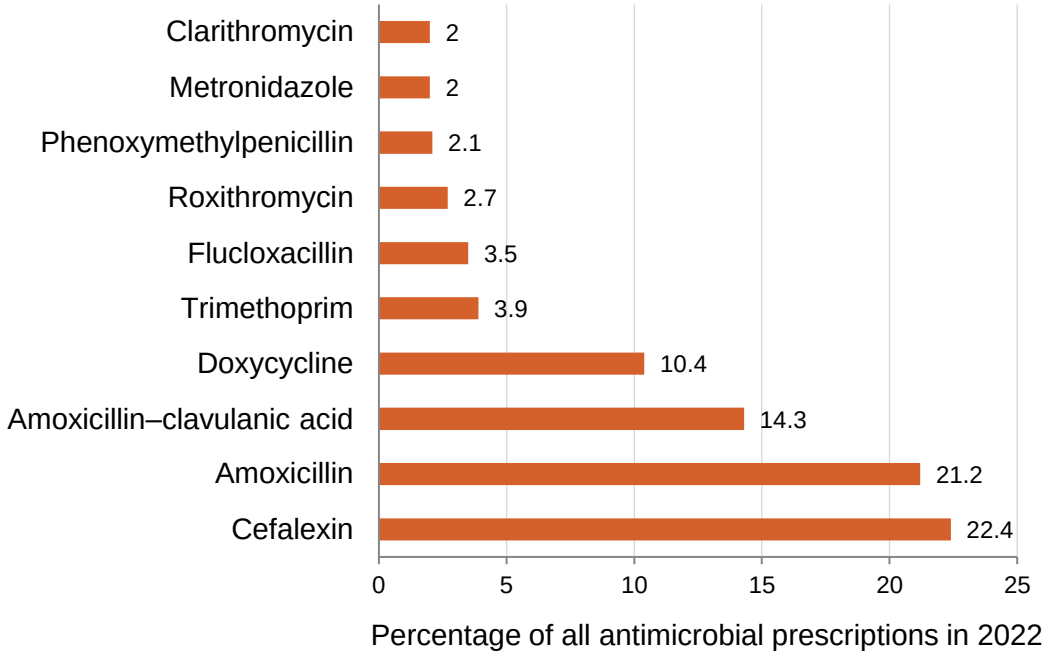
3.1. Most commonly supplied antimicrobials, 2015–2022

There were 21,848,005 prescriptions supplied under the PBS and RPBS for all antimicrobials in 2022. Of these prescriptions, 88% were issued by general practitioners (GPs), 8% by specialists, 4% by dental practitioners, and less than 1% by allied health professionals.

The time between date of prescription and date of supply in 2022 was examined. This revealed that 70% were dispensed on the same day that they were prescribed, and a further 9% were dispensed on the subsequent day.

Figure 16 presents the top 10 antimicrobials supplied in 2022. These accounted for 85% of all antimicrobials supplied in the year. Cefalexin, amoxicillin and amoxicillin–clavulanic acid were the most commonly prescribed antimicrobials in 2022.

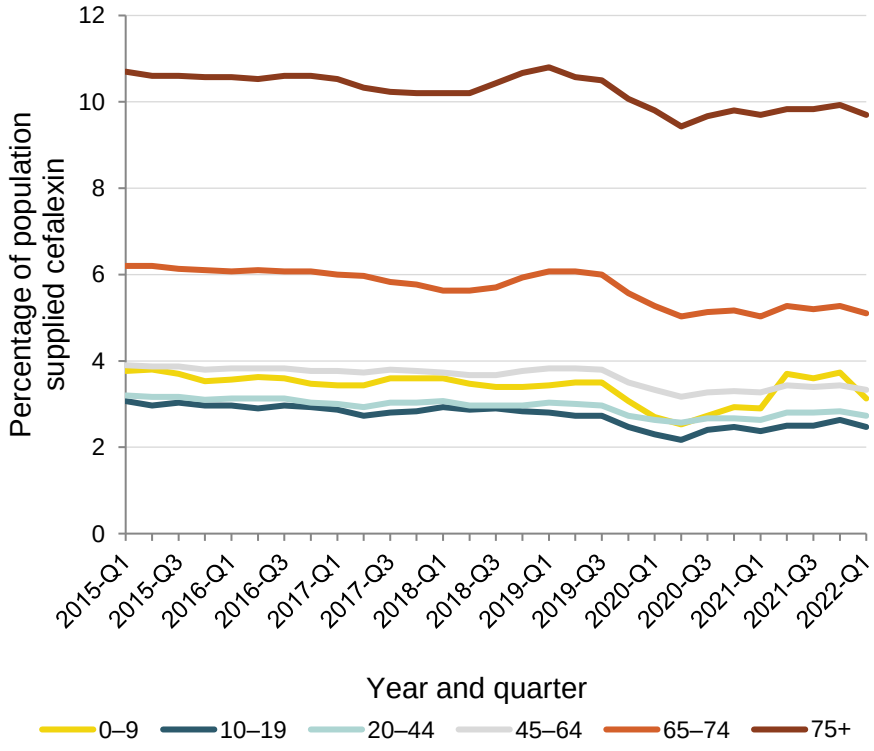
Figure 16: Top 10 PBS and RPBS antimicrobial prescriptions supplied, 2022



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme

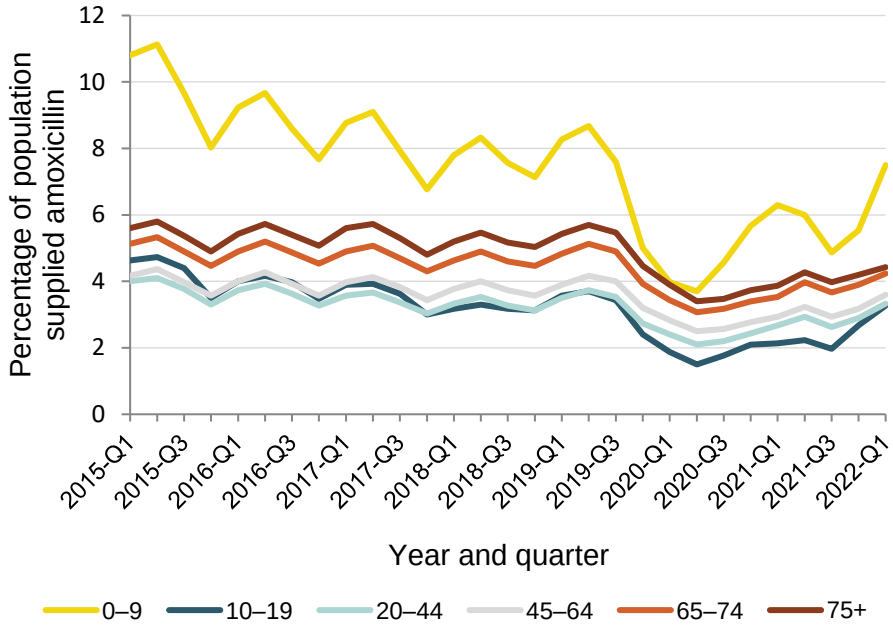
Figures 17–19 present the use of the three top antimicrobials, cefalexin, amoxicillin and amoxicillin–clavulanic acid, by age groups, 2015 Quarter 1 to 2022 Quarter 1 (3-point moving average). Figures 17–19 show that the use of all three antibiotics was rising in the 0–9 years age group over 2020–2022.

Figure 17: Proportion of population supplied with cefalexin under the PBS or RPBS, by age groups, 2015 Quarter 1 to 2022 Quarter 1 (3-point moving average)



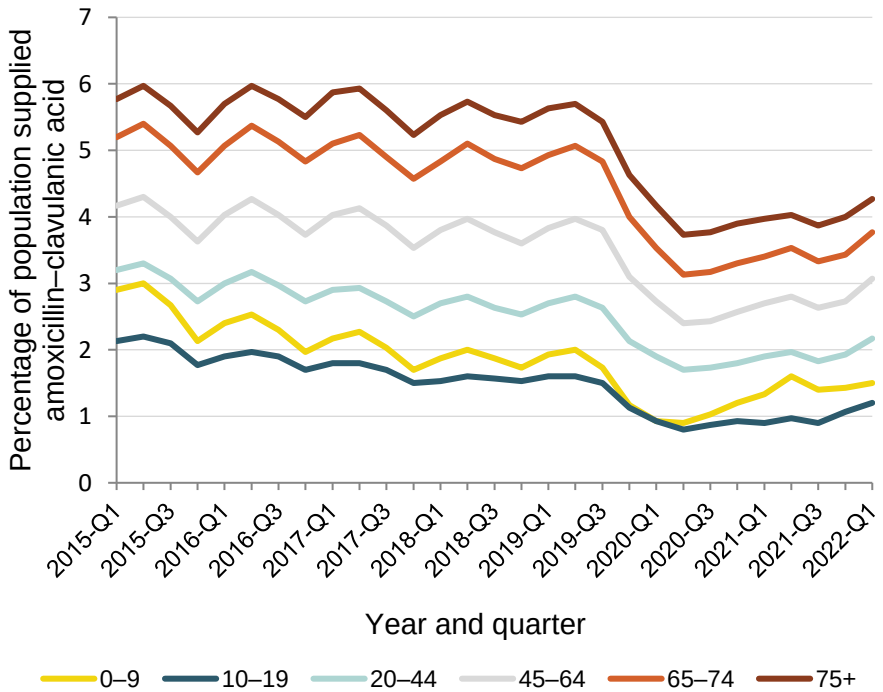
PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme

Figure 18: Proportion of population supplied with amoxicillin under the PBS or RPBS, by age groups, 2015 Quarter 1 to 2022 Quarter 1 (3-point moving average)



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme

Figure 19: Proportion of population supplied with amoxicillin–clavulanic acid under the PBS or RPBS, by age groups, 2015 Quarter 1 to 2022 Quarter 1 (3-point moving average)



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme

3.2.1. Percentage of original antimicrobial prescriptions with maximum repeats for the most commonly used antimicrobials, 2020–2022

Original prescriptions accounted for 87% of all prescriptions supplied in 2022 (15,998,664/18,490,079) for the top 10 antimicrobials supplied in the year. For each item, the maximum repeats allowed was determined using the PBS and RPBS Schedules. For items which have no repeats allowed, the number of repeats was assumed to be zero. In April 2020, there were PBS and RPBS policy changes for Australia's five most commonly dispensed antimicrobials (amoxicillin, amoxicillin–clavulanic acid, cefalexin, doxycycline and roxithromycin). These changes reduced the number of repeat prescriptions permissible (typically from one to zero) with no change to the maximum quantity that could be dispensed for unrestricted antimicrobials. New item numbers for larger quantities became available under streamlined authority prescriptions.

Table 5 presents the distribution of original prescriptions in 2022. It shows that the majority of original prescriptions for amoxicillin, amoxicillin–clavulanic acid, cefalexin, roxithromycin and phenoxymethylpenicillin were ordered with no repeats, consistent with the PBS listing (column 6 in Table 5).

Table 5: Distribution of original prescriptions for the most commonly supplied PBS and RPBS antimicrobials, 2022

	PBS and RPBS items with repeats allowed (percentage)			**PBS and RPBS items with no repeats allowed (percentage)**	
Antimicrobial	Original prescriptions ordered with maximum repeats allowed	Original prescriptions ordered with more repeats than maximum repeats allowed	Original prescriptions ordered with less repeats than maximum repeats allowed	Original prescriptions ordered with no repeats, when no repeats are allowed	Original prescriptions ordered with some repeats, when no repeats allowed
Doxycyline	45.6	0.1	35.1	19.2	0.1
Amoxicillin	7.6	0	20.9	71.2	0.3
Flucloxacillin	0.8	0.1	1.3	94.8	3
Amoxicillin–clavulanic acid	3.9	0	5.8	90	0.3
Cefalexin	5.3	0	8.7	85.7	0.2
Trimethoprim	23.6	0.2	74.4	1.8	0.1
Clarithromycin	40.9	1.1	52.7	5.3	0
Roxithromycin*	0	0	0	99.5	0.5
Phenoxymethyl-penicillin	6.9	0	14.3	78.6	0.2
Metronidazole	22	0.1	72.2	5.6	0.1

PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme
* No repeats are allowed for roxithromycin after April 2020
Notes:
1. Analysis is based on date of supply.
2. For all other antimicrobials presented in Table 5: from the original prescriptions ordered with some repeats when no repeats are allowed (last column), 95%–100% were authority prescriptions.

Table 6 presents the proportion of prescriptions supplied for which the time between supply of the original prescription and the first repeat was less than 10 days. The table shows that results do not differ too much between 2021 and 2022 (after the PBS and RPBS policy changes to reduce the number of repeat prescriptions permissible [typically from one to zero] in 2020).

Table 6: Proportion of repeats dispensed within 10 days from original prescription, for the most commonly supplied PBS and RPBS antimicrobials for which repeats were ordered, 2021–2022

	2021	**2022**
Antimicrobial	Percentage (and number) of prescriptions with repeats where the first repeat was supplied within 10 days from the original prescription	Percentage (and number) of prescriptions with repeats where the first repeat was supplied within 10 days from the original prescription
Cefalexin	36.5% (*n* = 33,495)	37.6% (*n* = 37,447)
Amoxicillin	50.4% (*n* = 39,902)	52.8% (*n* = 46,809)
Amoxicillin–clavulanic acid	60% (*n* = 25,934)	59.9% (*n* = 28,631)
Doxycycline	24.1% (*n* = 66,969)	26.8% (*n* = 76,934)
Roxithromycin*	6.4% (*n* = 144)	5.9% (*n* = 123)
Trimethoprim	39.3% (*n* = 30,485)	37.9% (*n* = 27,600)
Trimethoprim–sulfamethoxazole	26.3% (*n* = 20,228)	25.5% (*n* = 18,592)
Clarithromycin	49.5% (*n* = 28,456)	49.4% (*n* = 31,705)
Metronidazole	40.3% (*n* = 12,381)	41.8% (*n* = 7,879)
Flucloxacillin	47.9% (*n* = 5370)	47.2% (*n* = 5,055)
Phenoxymethylpenicillin	27.3% (*n* = 1,709)	34.3% (*n* = 2,264)

PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme
* No repeats are allowed for roxithromycin after April 2020
Note: Less than 10 days was chosen for analysis as most pack sizes provide treatment for 5 to 10 days. Repeat prescriptions dispensed after 10 days may indicate an interruption of the original duration of treatment.

Table 6A presents the proportion of prescriptions supplied for which the time between supply of the original prescription and the first repeat was less than 1, 6 and 12 months, respectively.

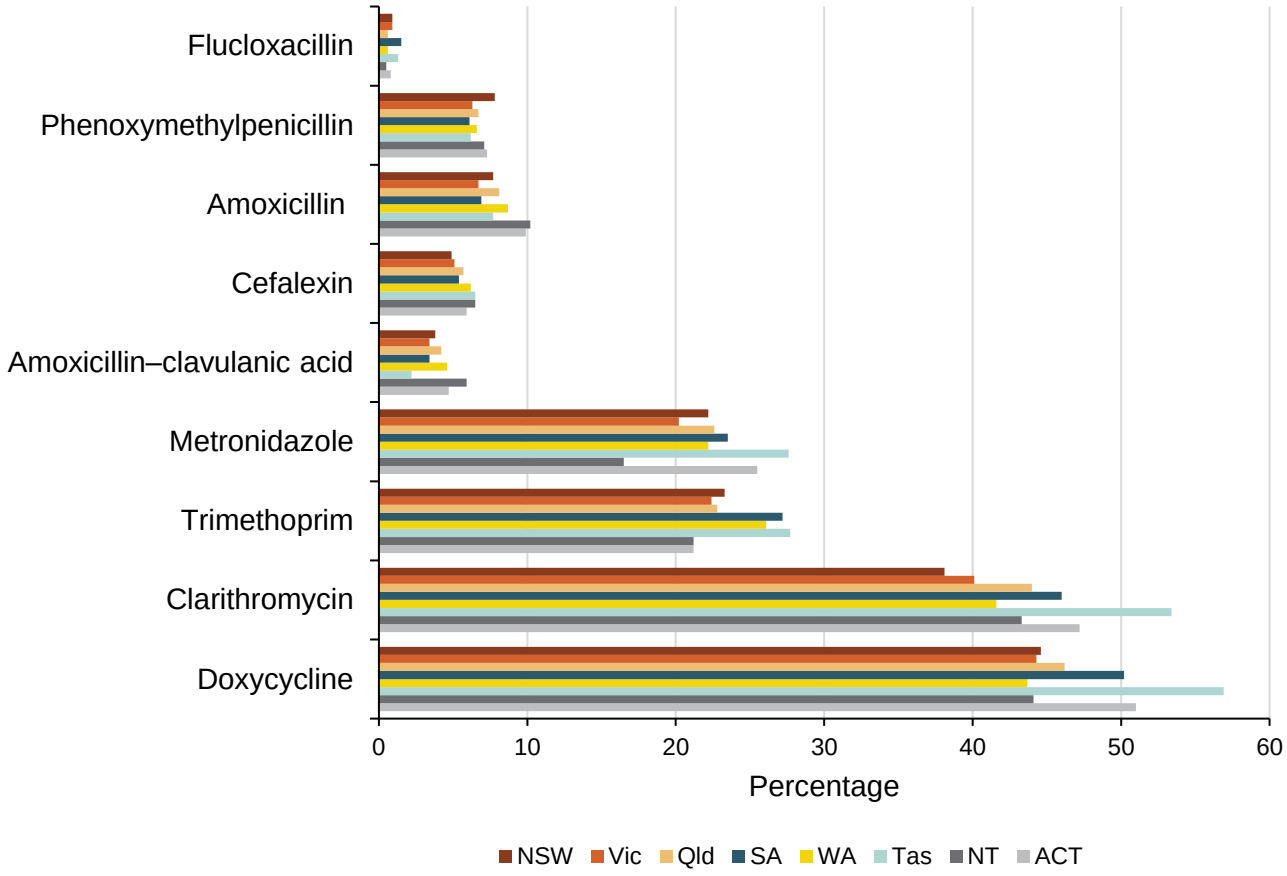
Table 6A: Proportion of repeats supplied within 1, 6 and 12 months from original prescription, for PBS and RPBS antimicrobials most commonly ordered with repeats, 2020–2022

	2020–2022	**2020–2022**	**2020–2022**
Antimicrobial	Percentage of prescriptions with repeats where the first repeat was within 1 month from the original prescription	Percentage of prescriptions with repeats where the first repeat was within 6 months from the original prescription	Percentage of prescriptions with repeats where the first repeat was within 12 months from the original prescription
Cefalexin	65.6	93.5	98.2
Amoxicillin	67.1	91.3	97.2
Amoxicillin–clavulanic acid	75.7	93.9	98.5
Doxycycline	62.9	93.5	97.8
Roxithromycin*	79.6	96.9	99.8
Trimethoprim	59.8	88.7	97.1
Trimethoprim–sulfamethoxazole	50.8	94.1	98.5
Clarithromycin	70.5	92.1	97.2
Metronidazole	62.1	89.1	97.4
Flucloxacillin	77.4	96.3	98.9
Phenoxymethylpenicillin	60.9	94.3	98.5

PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme
* Repeats were allowed for roxithromycin before April 2020

3.2.2. Percentage of original antimicrobial prescriptions with maximum number of repeats ordered as a proportion of all original antimicrobial prescriptions for the most commonly used antimicrobials: state and territory results, 2022

Figure 20: Percentage of original prescriptions with maximum repeats ordered (when repeats are allowed) as a proportion of all original PBS and RPBS prescriptions of the most commonly supplied antimicrobials: states and territories, 2022



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme
Notes:
1. State or territory has been allocated based on the location of the prescriber's postcode.
2. No repeats are allowed for roxithromycin after April 2020, thus the rates are zero and are not included in the graphs.

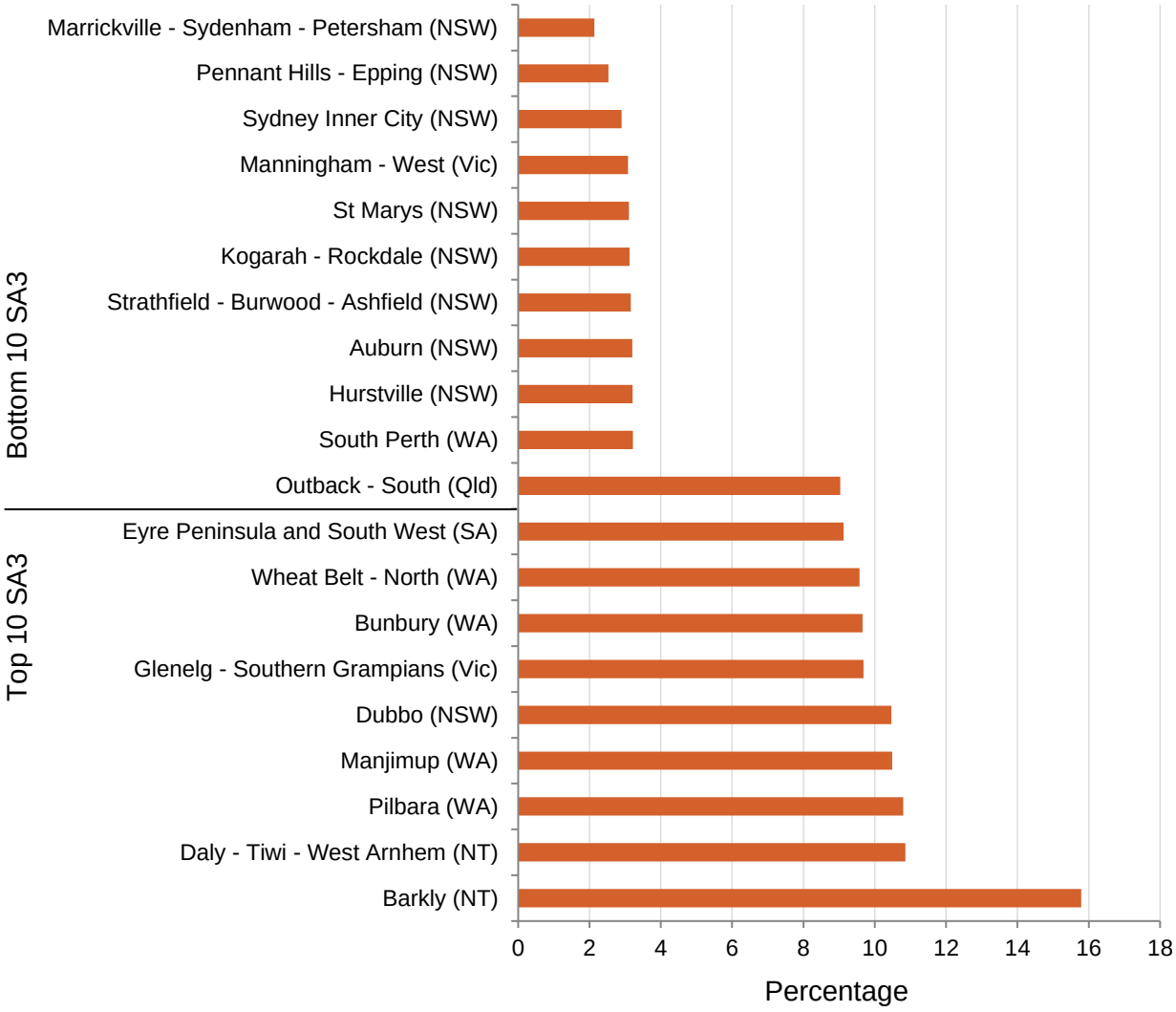
3.2.3 Percentage of original antimicrobial prescriptions with maximum number of repeats ordered as a proportion of all original antimicrobial prescriptions for the most commonly used antimicrobials: Statistical Area Level 3 results, 2022

The results at SA3 level are presented in Appendix Table A3, where each statistical area and the relevant antimicrobials are reported on a separate line within the area.

Graphs for the most commonly used antimicrobials showing the top 10 SA3 and bottom 10 SA3 areas with highest and lowest numbers for repeat ordering in 2022 are presented in Figures 21–29.

Figure 21: Percentage of PBS and RPBS cefalexin prescriptions with maximum number of repeats ordered as a proportion of all original cefalexin prescriptions supplied, by prescriber's SA3, 2022

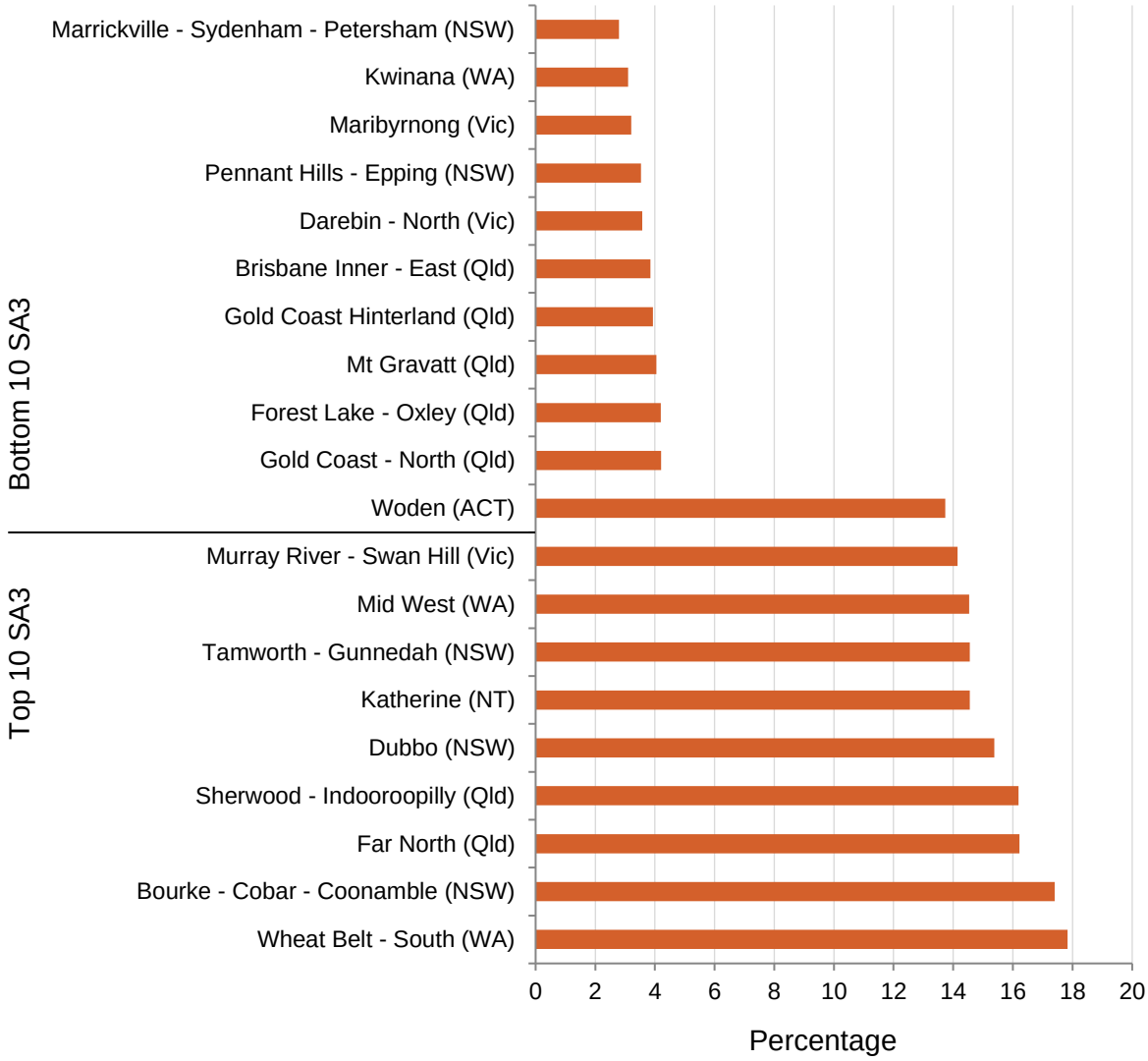
Cefalexin



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme; SA3 = Statistical Area Level 3

Figure 22: Percentage of PBS and RPBS amoxicillin prescriptions with maximum number of repeats ordered as a proportion of all original amoxicillin prescriptions supplied, by prescriber's SA3, 2022

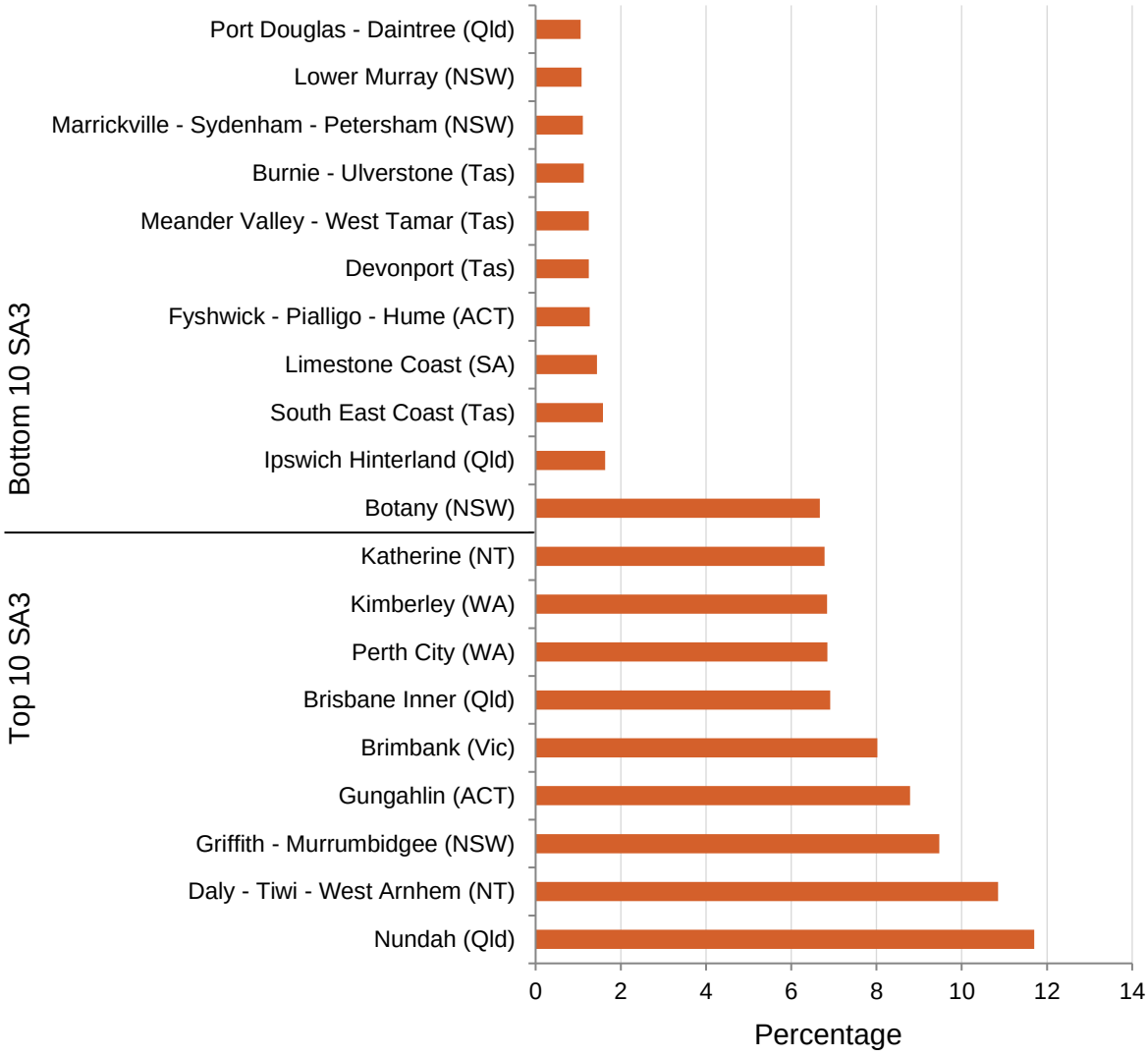
Amoxicillin



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme;
SA3 = Statistical Area Level 3

Figure 23: Percentage of PBS and RPBS amoxicillin–clavulanic acid prescriptions with maximum number of repeats ordered as a proportion of all original amoxicillin–clavulanic acid prescriptions supplied, by prescriber's SA3, 2022

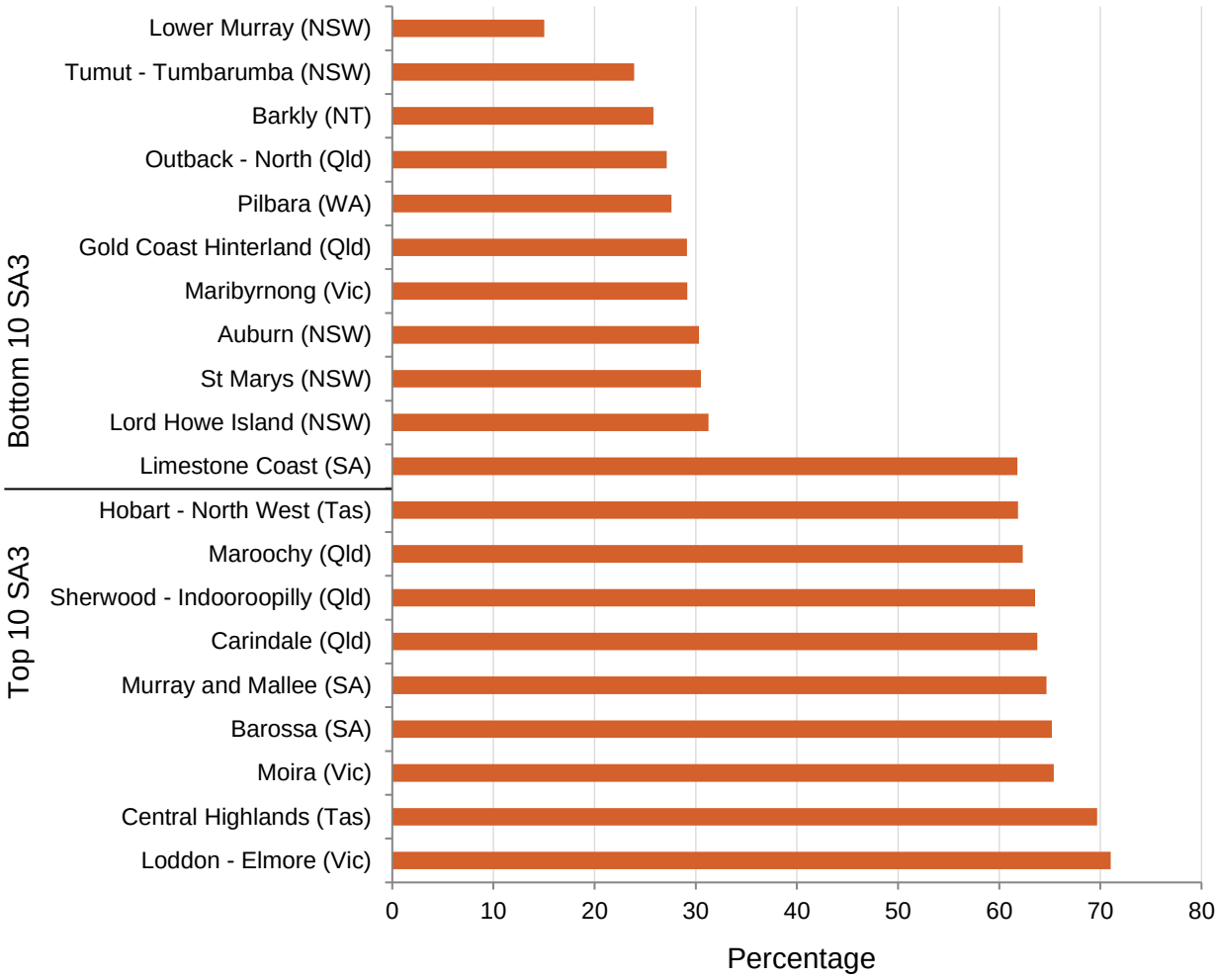
Amoxicillin–clavulanic acid



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme;
SA3 = Statistical Area Level 3

Figure 24: Percentage of PBS and RPBS doxycycline prescriptions with maximum number of repeats ordered as a proportion of all original doxycycline prescriptions supplied, by prescriber's SA3, 2022

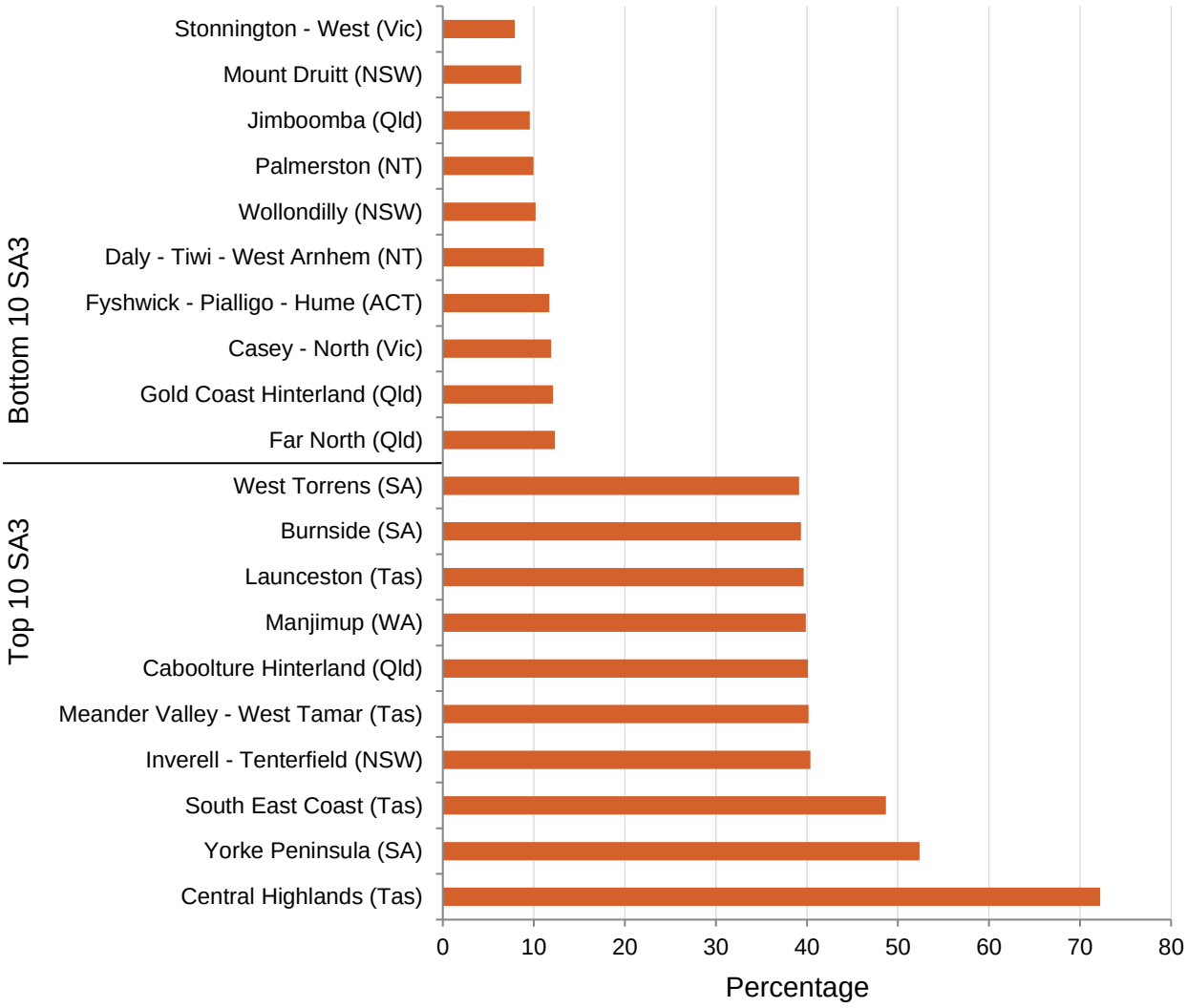
Doxycycline



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme;
SA3 = Statistical Area Level 3

Figure 25: Percentage of PBS and RPBS trimethoprim prescriptions with maximum number of repeats ordered as a proportion of all original trimethoprim prescriptions supplied, by prescriber's SA3, 2022

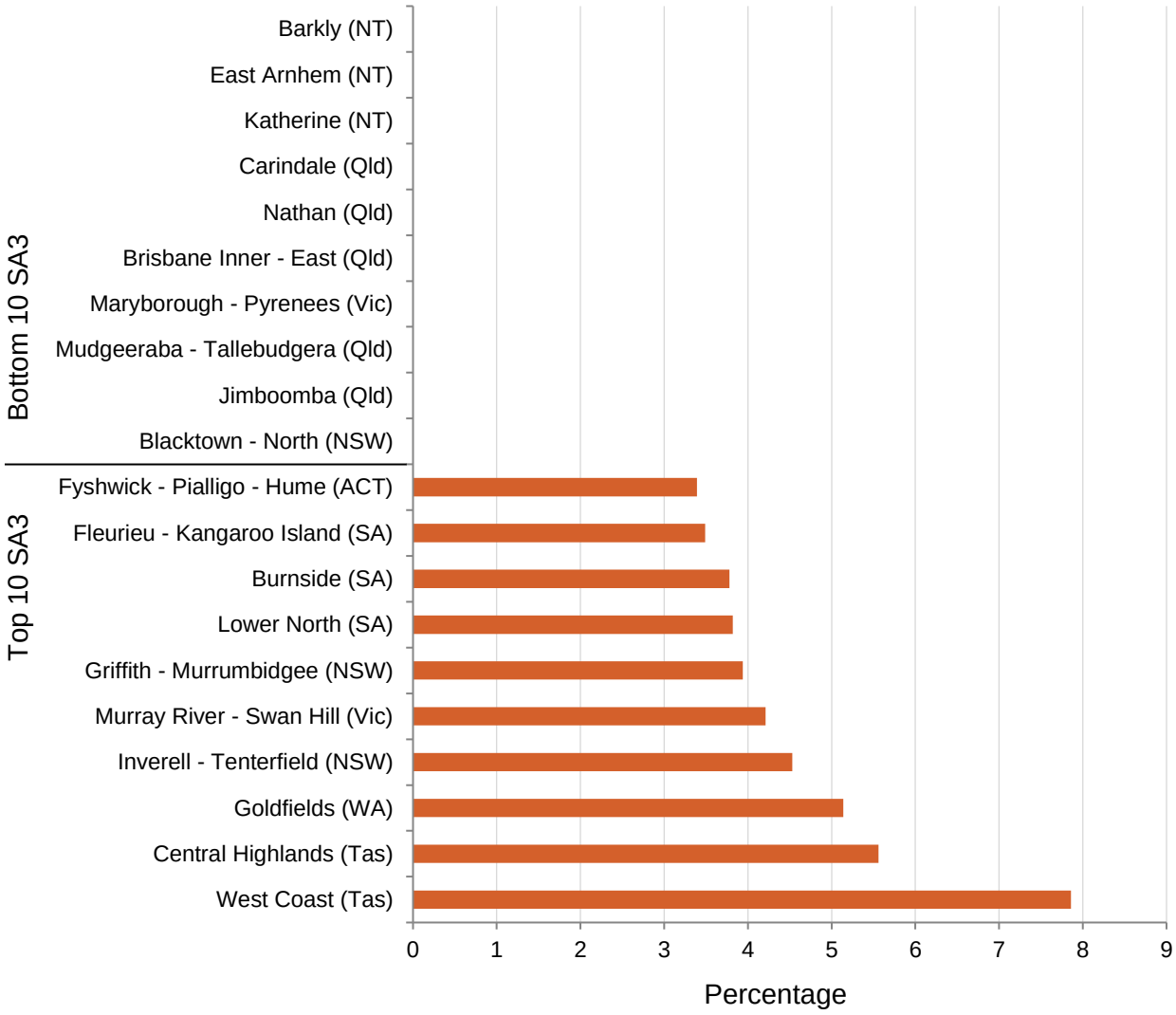
Trimethoprim



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme;
SA3 = Statistical Area Level 3

Figure 26: Percentage of PBS and RPBS flucloxacillin prescriptions with maximum number of repeats ordered as a proportion of all original flucloxacillin prescriptions supplied, by prescriber's SA3, 2022

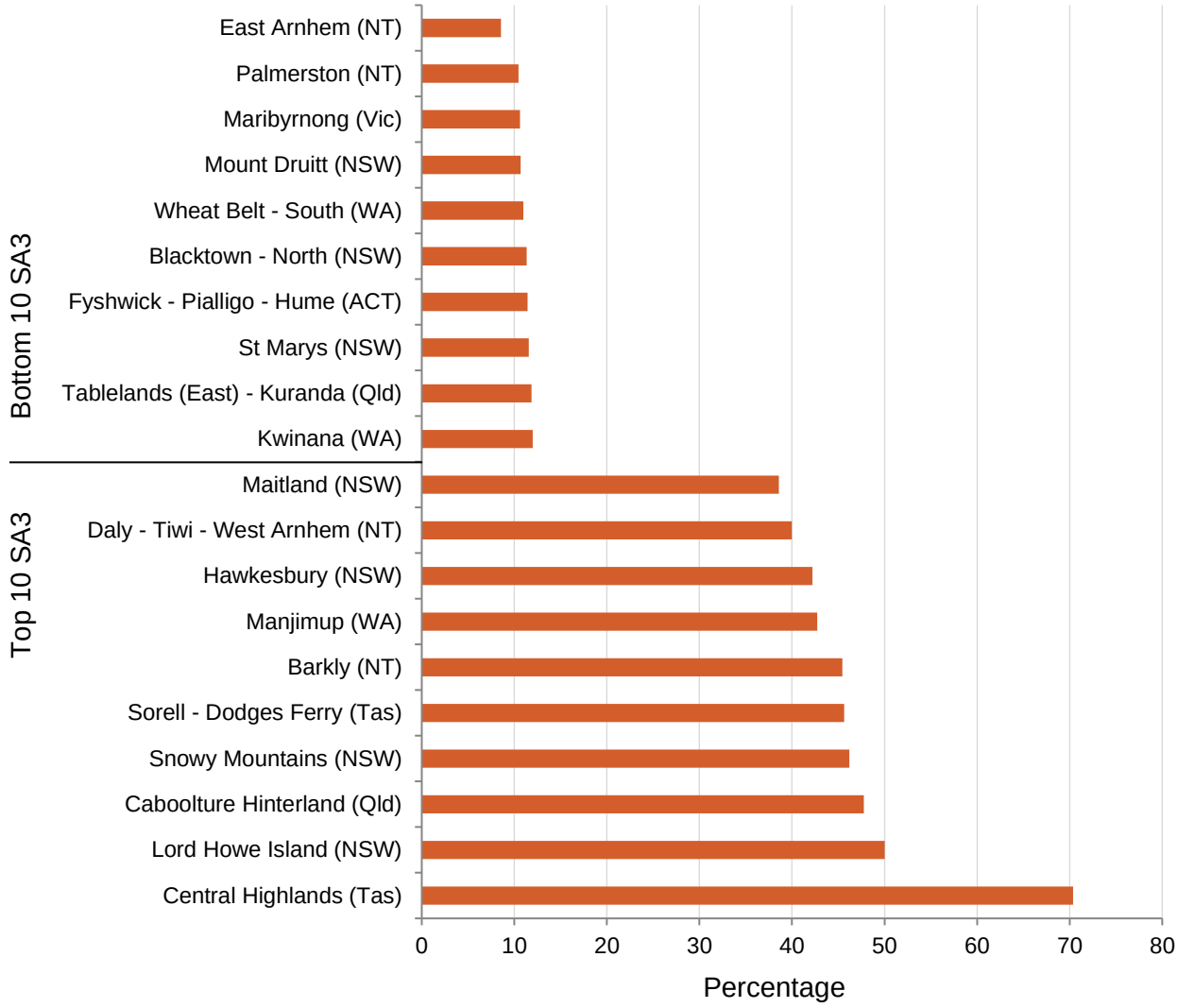
Flucloxacillin



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme;
SA3 = Statistical Area Level 3
Note: No flucloxacillin prescriptions were supplied with the maximum number of repeats for the bottom 10 SA3s.

Figure 27: Percentage of PBS and RPBS metronidazole prescriptions with maximum number of repeats ordered as a proportion of all original metronidazole prescriptions supplied, by prescriber's SA3, 2022

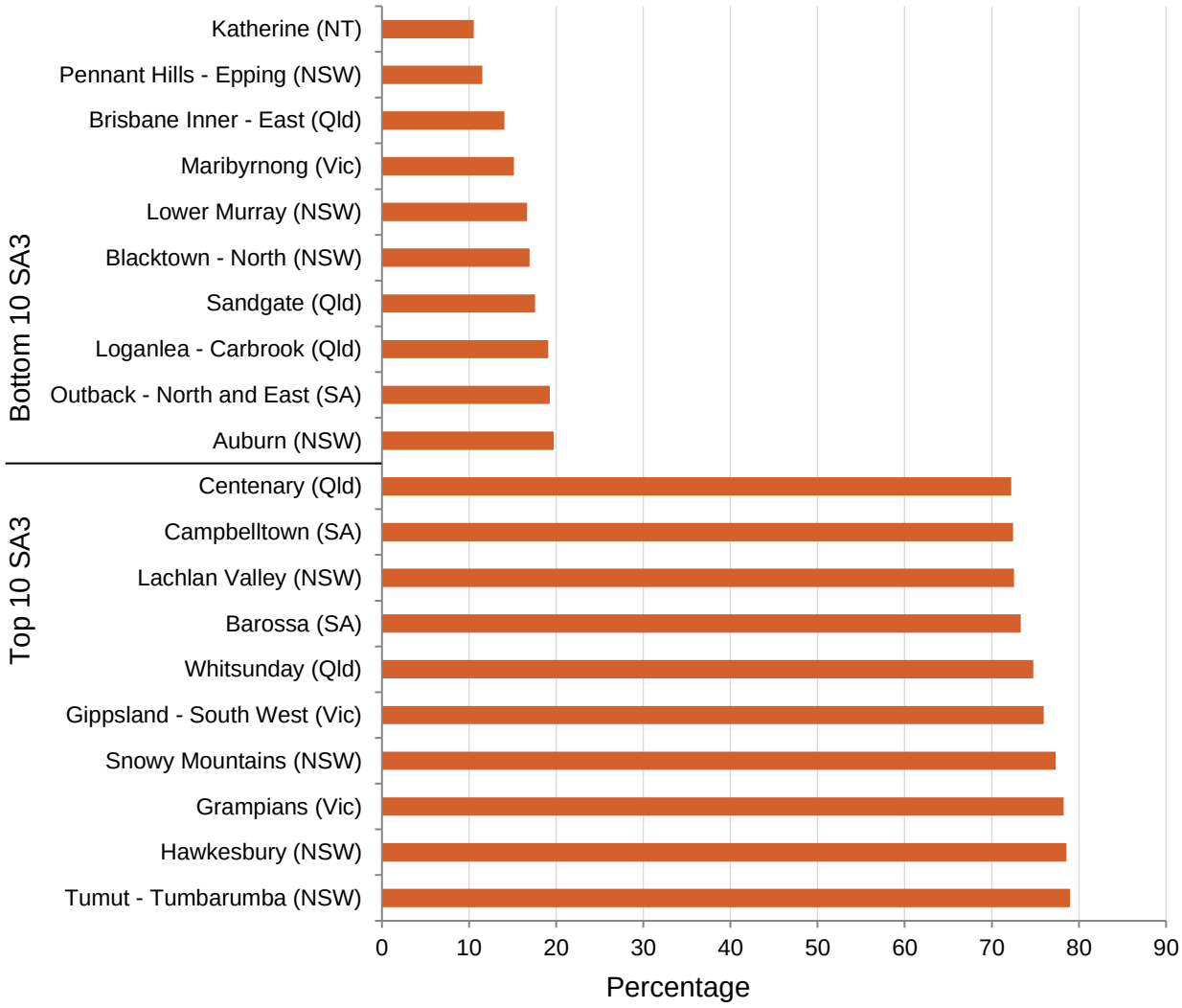
Metronidazole



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme;
SA3 = Statistical Area Level 3

Figure 28: Percentage of PBS and RPBS clarithromycin prescriptions with maximum number of repeats ordered as a proportion of all original clarithromycin prescriptions supplied, by prescriber's SA3, 2022

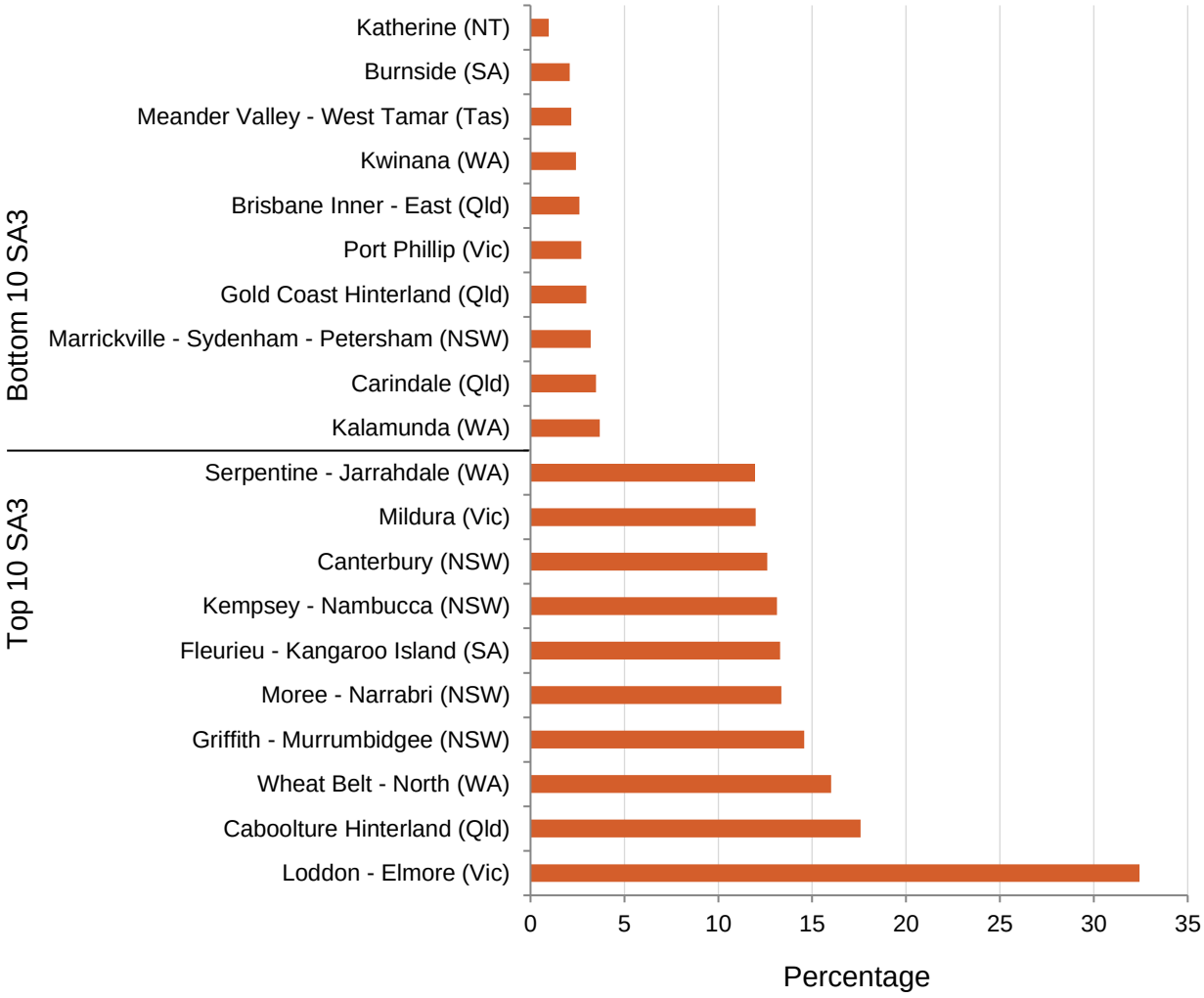
Clarithromycin



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme;
SA3 = Statistical Area Level 3

Figure 29: Percentage of PBS and RPBS phenoxymethylpenicillin prescriptions with maximum number of repeats ordered as a proportion of all original phenoxymethylpenicillin prescriptions supplied, by prescriber's SA3, 2022

Phenoxymethylpenicillin



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme;
SA3 = Statistical Area Level 3

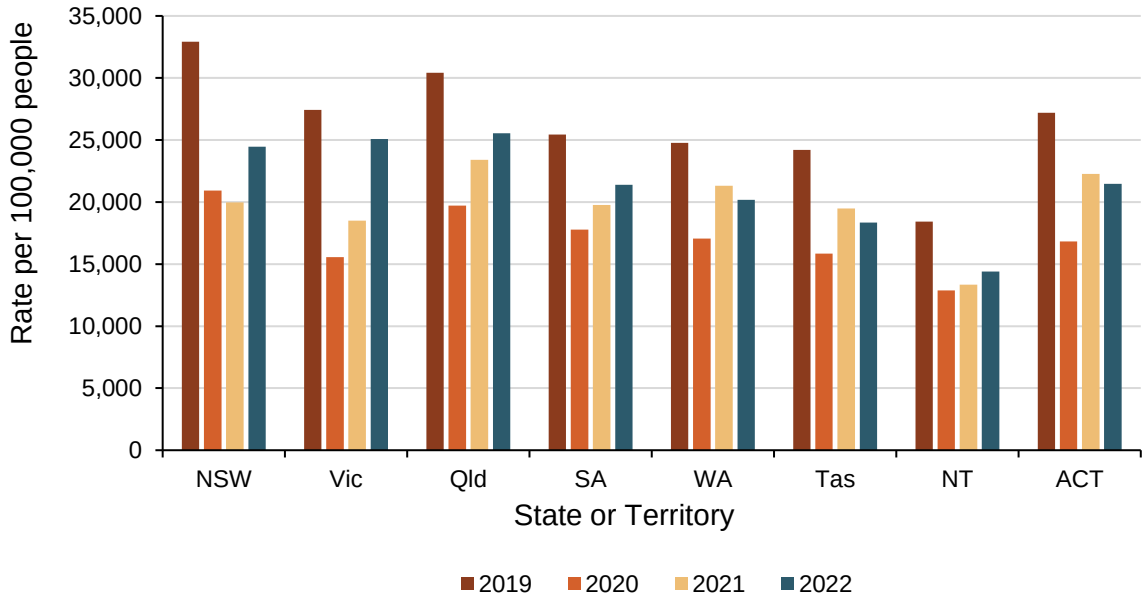
4. Rate of antimicrobials supplied in the winter season of 2022

4.1. Rate of antimicrobials supplied in the winter season by prescriber's state or territory, 2019–2022

The age-standardised rate of antimicrobials supplied in the winter of 2022 was higher in NSW, Queensland, Victoria, the NT and South Australia (SA) when compared to 2021. In 2022, the rate ranged from around 14,400 prescriptions per 100,000 people in the NT to 25,500 in Queensland (Figure 30). It should be noted that influenza returned to Australia in 2022, having been at very low levels in 2020 and 2021. Influenza rates increased in May 2022 and peaked in June 2022.[8]

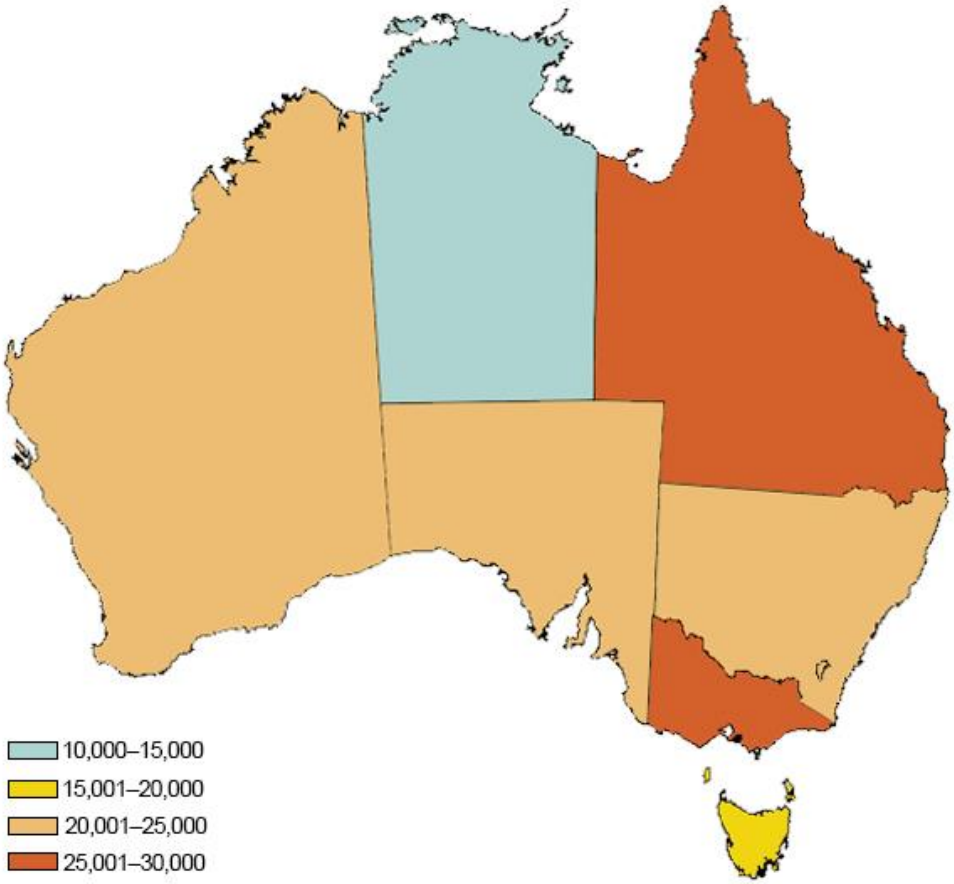
The age-standardised rates for 2022 are mapped to Australian states and territories in Figure 31.

Figure 30: Age-standardised rate of all PBS and RPBS antimicrobial prescriptions supplied per 100,000 people in winter (June–August), by prescriber's state or territory, 2019–2022



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme
Note: Victoria was in lockdowns associated with the COVID-19 pandemic in winter 2020, while NSW, the Australian Capital Territory (ACT) and Victoria were in lockdowns associated with the COVID-19 pandemic in winter 2021.

Figure 31: Rate of all PBS and RPBS antimicrobial prescriptions supplied per 100,000 people in the winter of 2022 (June–August), mapped to Australian states and territories

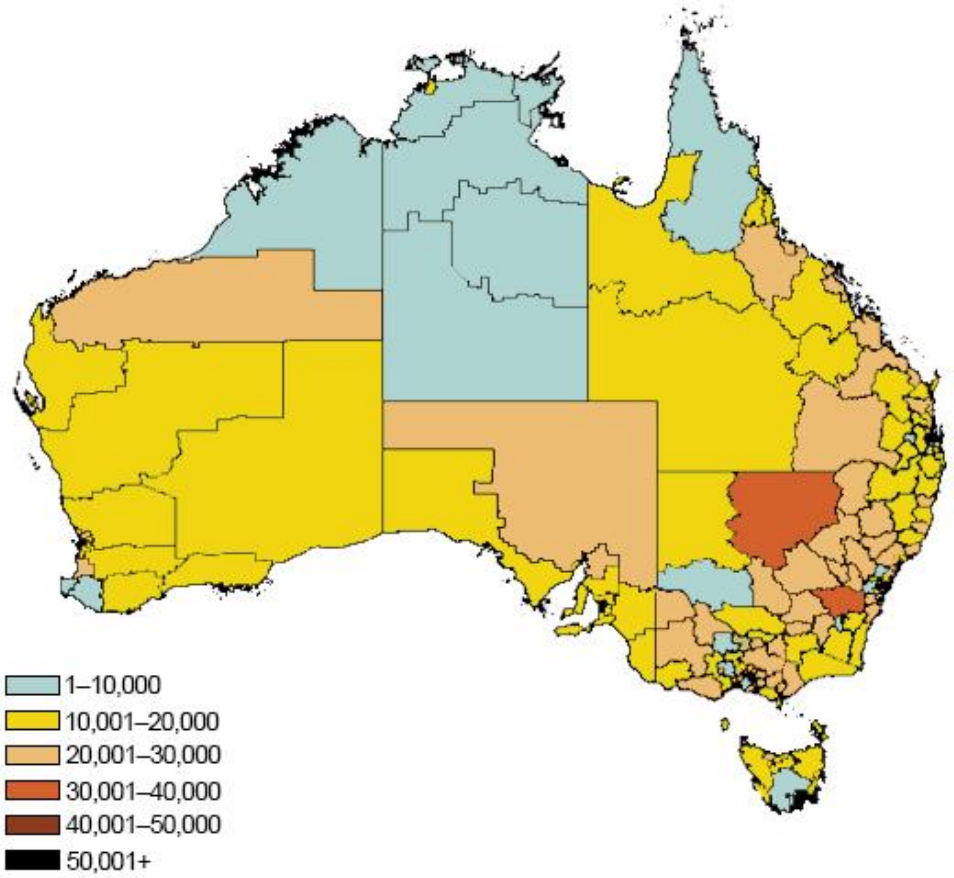


PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme

4.2. Number of all antimicrobials supplied per 100,000 people in the winter season of 2022, by prescriber's state or territory

The results at SA3 level are presented in Appendix Table A4, with each SA3 area on a separate line. The rate is age-standardised to the Australian population in 2013. The rates in 2022 are also mapped to Australia's SA3 map (Figure 32).

Figure 32: Number of all PBS and RPBS antimicrobial prescriptions supplied per 100,000 people in the winter of 2022, mapped to Australian SA3 areas



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme; SA3 = Statistical Area Level 3

Antimicrobial shortages

In December 2022, the Therapeutic Goods Administration (TGA) highlighted a number of antimicrobials that were in short supply due to manufacturing issues or increased demand.[9] The alert included 19 different antimicrobial active ingredients; amoxicillin, amoxicillin–clavulanic acid, azithromycin, cefaclor, cefalexin, cefotaxime, clindamycin, doxycycline, erythromycin, flucloxacillin, metronidazole, moxifloxacin, nitrofurantoin, phenoxymethylpenicillin, procaine benzylpenicillin, rifampicin, sulfamethoxazole–trimethoprim, and trimethoprim. The shortages are expected to extend across 2023, with associated influences on antibiotic use.

Drivers of this shortage include increased global demand, with global antimicrobial consumption having risen almost 50% over the last 20 years, mostly driven by a rise in use in low- and middle-income countries.[10] However, average use in low- and middle-income countries is still lower than in high-income countries.

A production shortfall is also contributing[11], which is also possibly related to COVID-19 and lockdowns and illness rates in both China and India. The antimicrobial supply chain is significantly reliant on China and India, particularly for the synthesis of the active ingredient. A Wellcome Trust report analysed supply chain issues for a representative list of 40 antibiotics, finding that the

majority of manufacturing sites are in India and China.[11] Using amoxicillin as the example, the report showed that the precursor ingredient for amoxicillin, 6-aminopenicillanic acid (6-APA), is manufactured at seven sites in the world, five of which are in China, with the other two in Mexico and Europe.[11] There are 17 sites that manufacture amoxicillin from 6-APA, with eight in China, three in India and the remaining six in Europe.[11] The density of sites in China and India highlights the vulnerability of the supply chain during periods of instability such as the global COVID-19 pandemic.

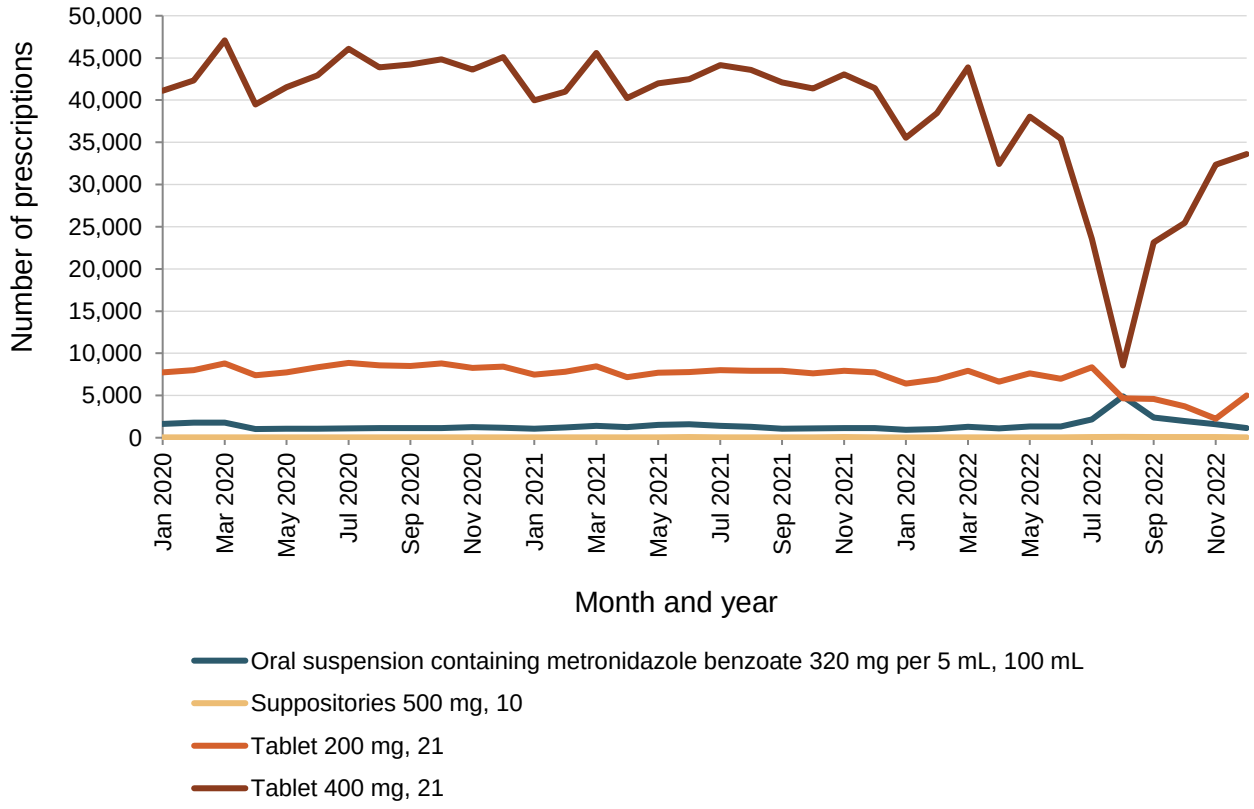
Finally, local drivers may also have contributed to shortages. For example, there have been increased rates of infectious disease since the lifting of the COVID-19 restrictions. In 2022, there were 330,000 notifications of respiratory diseases in Australia, compared to 5,000 in 2021.[12]

Aggregated data were obtained from PBS and RPBS statistics to examine early signs of the impact of the shortages. Figure 33 shows that the shortage of metronidazole could be observed during August 2022, with levels now returning to previous levels.

Amoxicillin mixtures have also been in short supply, and Figure 34 shows that there has been a therapeutic shift to cefalexin in response.

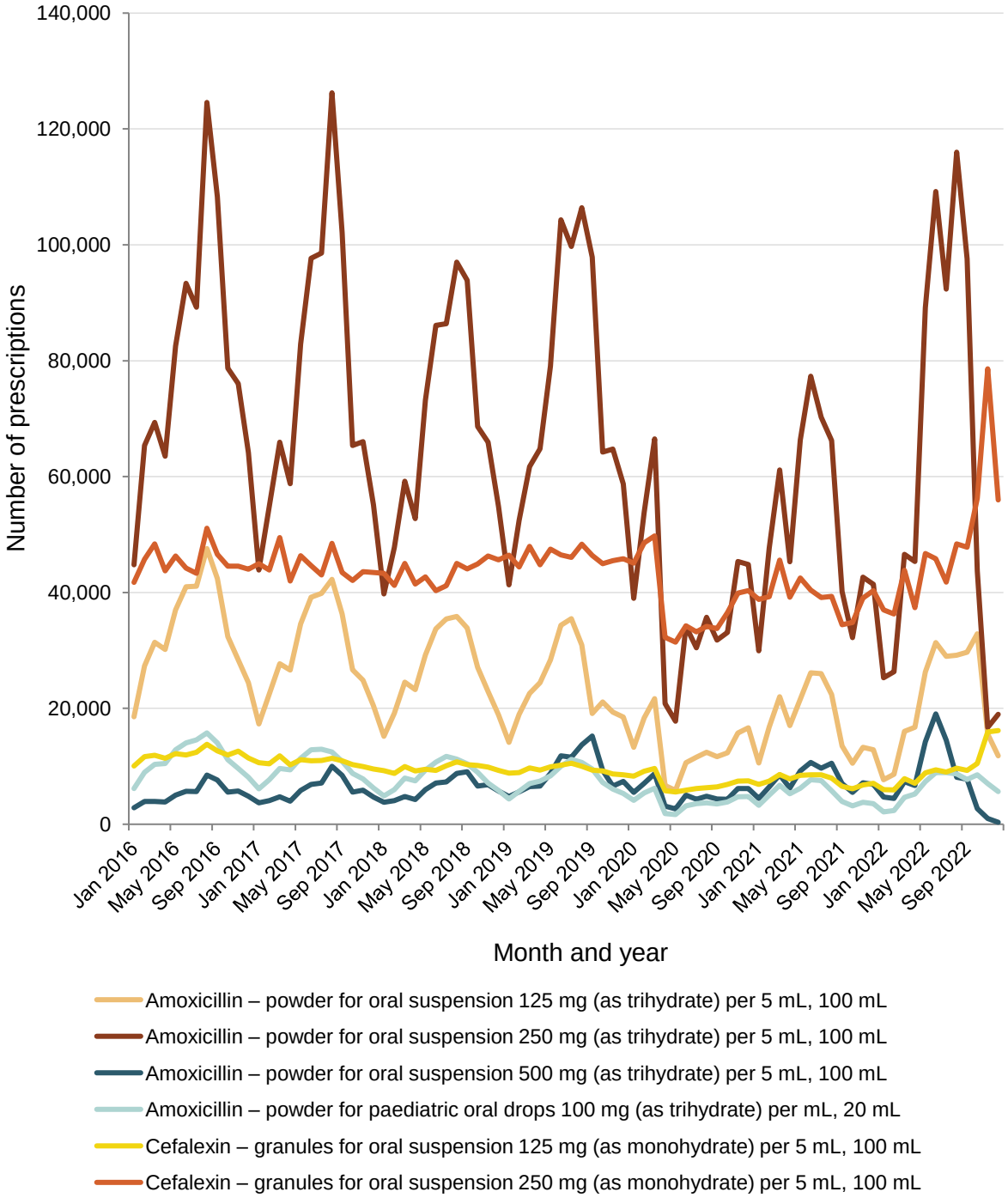
Analyses to further examine the impact of antimicrobial shortages across 2023 will be required.

Figure 33: Number of PBS and RPBS metronidazole prescriptions supplied by formulation, 2020–2022



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme

Figure 34: Number of PBS and RPBS amoxicillin and cefalexin suspension prescriptions supplied, 2016–2022



PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme

Discussion

There was a 9.6% increase in overall PBS and RPBS antimicrobial use in 2022 compared to 2021, with a slight increase observed when examining use by volume (16.8 DDD per 1,000 people per day in 2022 versus 15.9 DDD per 1,000 people per day in 2021). There was a small change in the number of prescriptions supplied per person among people who received antimicrobials in the calendar year: 2.30 prescriptions per person in 2022 compared to 2.35 in 2021.

In 2022, 36.6% (*n* = 9,502,834) of the Australian population had at least one PBS or RPBS antimicrobial prescription supplied, compared to 32.9% (*n* = 8,468,093) in 2021. In 2022, the rate of antimicrobial prescriptions supplied per 1,000 people in Australia was 817 – an increase from 744 in 2021.

Even though antimicrobial use in Australia seems to be increasing in 2022 compared to 2021, it is still lower than it was prior to COVID-19:

- The rate of antimicrobial prescriptions supplied per 1,000 people in Australia was 817 in 2022 compared to 1,046 in 2019
- DDD per 1,000 people per day was 16.8 in 2022 compared to 20.3 in 2019
- Proportion of the Australian population supplied with at least one PBS or RPBS antimicrobial prescription was 36.6% in 2022 compared to 40% in 2019.

The ongoing impact of reducing the number of repeats supplied and improved infection prevention and control as a result of the COVID-19 pandemic appears to have led to sustained reductions in antimicrobial use in 2022.

Appendix

Antimicrobials supplied under the PBS and RPBS by SA3 are included in the Appendix. These data can be used by health services, Public Health Networks, general practitioners and other clinicians to review antimicrobial use in their local area and compare to other areas.

The Appendix is provided as a separate file:

- Table A1: Rate of all antimicrobial prescriptions supplied under the PBS and RPBS per 1,000 people, age-standardised: SA3 results, 2015–2022
- Table A2: Rate of all antimicrobials supplied under the PBS and RPBS per 1,000 people by patient's age (years): SA3 results, 2022
- Table A3: Percentage of original antimicrobial prescriptions with maximum number of repeats ordered as a proportion of all original antimicrobial prescriptions supplied under the PBS and RPBS for the most commonly used antimicrobials by prescriber's SA3, 2022
- Table A4: Number of all PBS and RPBS antimicrobial prescriptions supplied per 100,000 people in the winter season (Jun, Jul, Aug) by prescriber's SA3, 2022.

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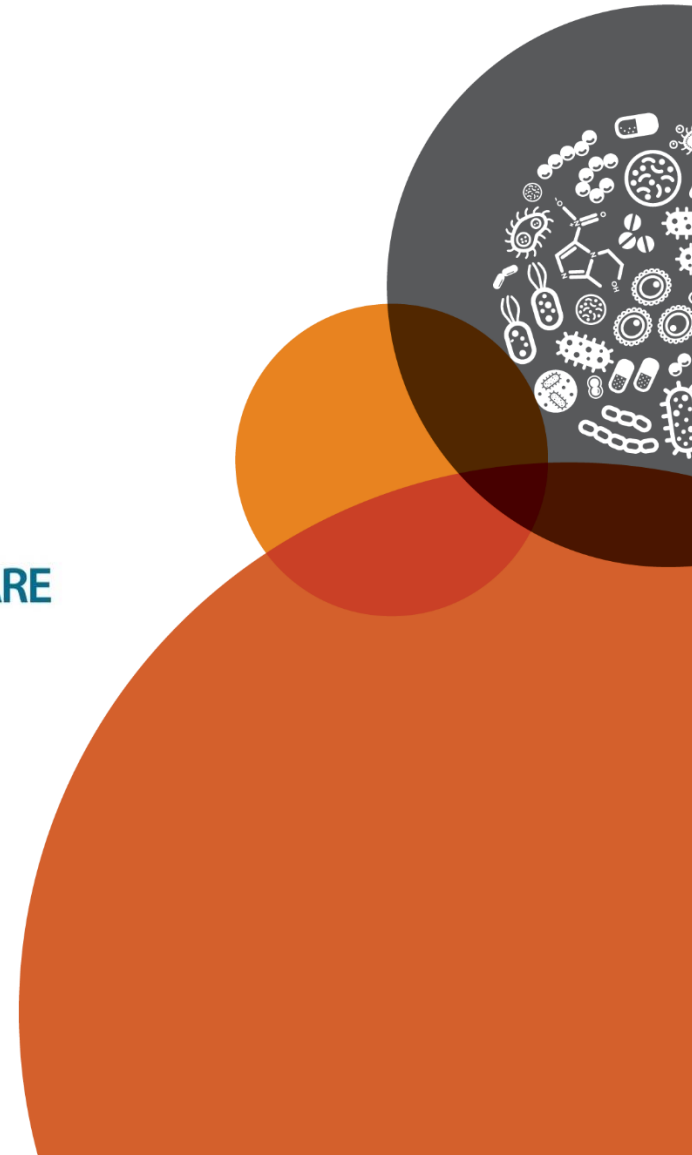

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