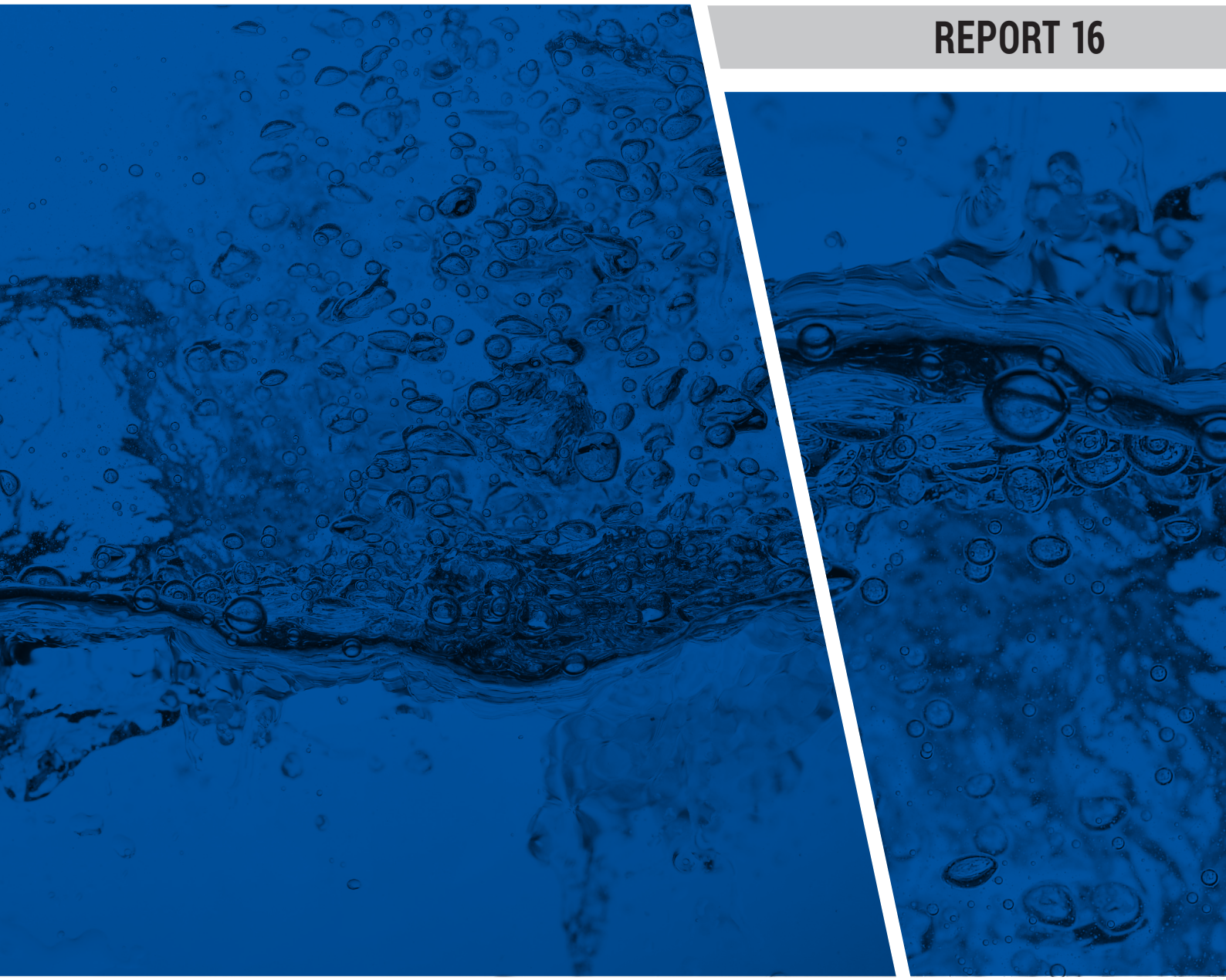
NATIONAL WASTEWATER DRUG MONITORING PROGRAM

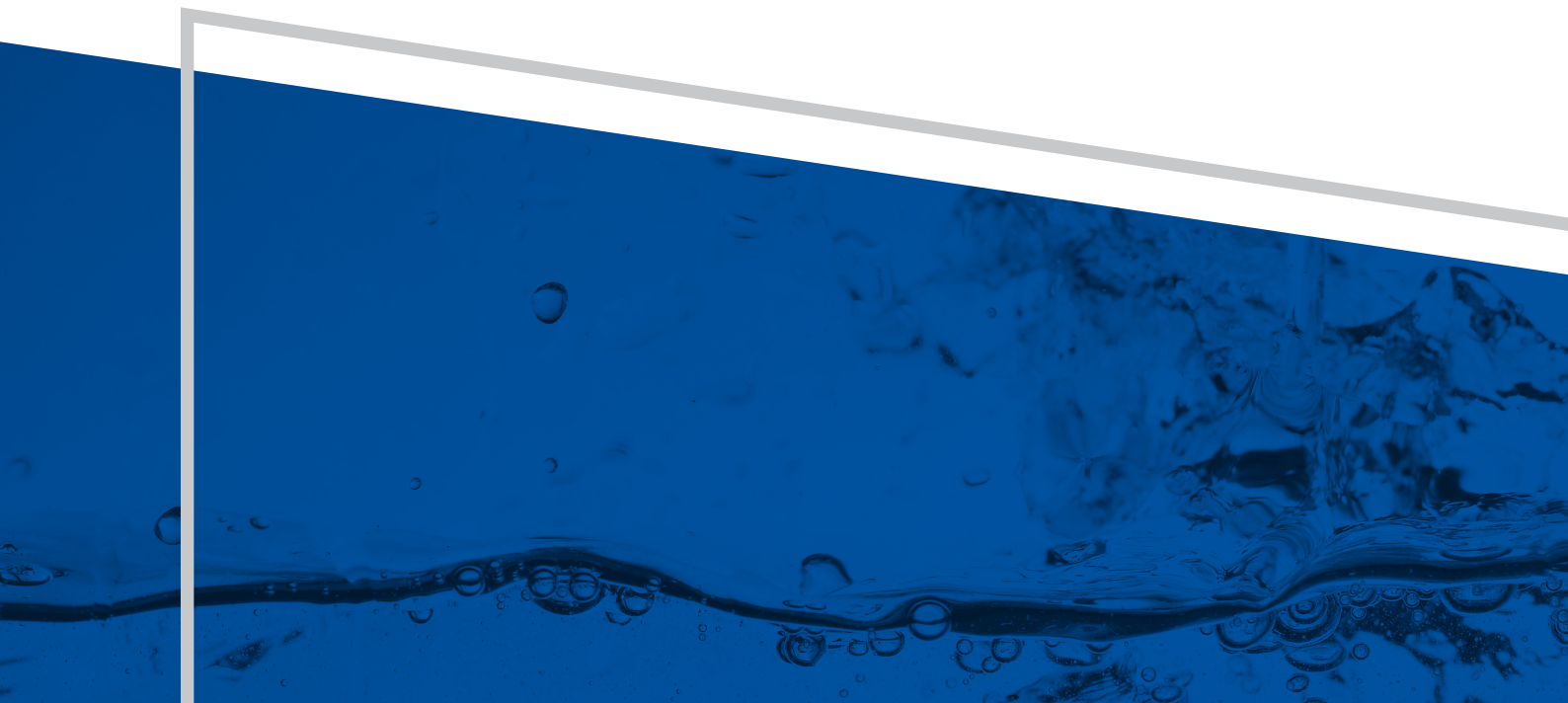
REPORT 16



AUSTRALIAN CRIMINAL INTELLIGENCE COMMISSION

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

University of South Australia



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CEO FOREWORD

The Australian Criminal Intelligence Commission (ACIC) is responsible for providing information and intelligence on criminal activity to support Government in creating a safer Australia. Much of the harm that Australians suffer at the hands of organised crime is due to illicit drugs. Serious and organised crime groups profit from the importation, manufacture, trafficking and sale of drugs that cause harm to the community.

The National Wastewater Drug Monitoring Program (the Program) is an Australian Government-funded initiative that continues to evolve. Wastewater analysis assists in understanding drug use within populations, providing a measure of one important aspect of national health—the demand for a range of drugs. Illicit drugs and licit drugs with abuse potential are inherently harmful. Reliable drug consumption data are a key indicator of the level of harm experienced by the community. This is because the level of community harm is directly related to the quantity of substances that are consumed. Understanding drug consumption at a population level supports effective allocation of resources to priority areas and assists to inform appropriate demand, supply and harm reduction strategies.

One of the advantages of the Program is the increasing volume of longitudinal data that has now been collected. This leaves the ACIC well placed to monitor short and longer-term market trends, key events such as COVID-19 and major law enforcement interventions, and to identify and monitor drug consumption in geographic locations that may be appropriate for focused responses.

The ACIC has developed partnerships to merge wastewater data with other drug data in locations of interest to develop a more detailed picture of high-risk markets, particularly in regional settings. Longitudinal data continues to demonstrate the unique characteristics of local drug markets.

TRENDS IDENTIFIED DURING THIS REPORTING PERIOD

Report 16 covered sampling in December 2021 and February 2022. In December 2021, 56 wastewater sites were monitored nationally. Based on 2016 Census data, these sites cover approximately 56 per cent of the Australian population. This reporting period again demonstrated varying trends in drug consumption, both nationally and within jurisdictions, and across drug types.

Between August and December 2021, consumption of methylamphetamine, cocaine, MDMA and MDA increased in both capital city and regional sites, while consumption of heroin and cannabis decreased. Consumption of alcohol and nicotine fluctuated within a relatively narrow range and was largely consistent with long-term trends. Consumption of oxycodone and fentanyl also fluctuated, but remains low and relatively stable, with regional consumption of fentanyl in December 2021 being the lowest level recorded by the Program.

We have seen over the life of the Program that consumption of most drugs (cocaine and heroin excepted) has generally been higher per capita in regional sites. This changed in the period covered by this report. In December 2021, per capita capital city consumption of methylamphetamine, cocaine and MDMA all exceeded regional consumption for the first time since April 2017.

THE IMPACT OF COVID-19 RESTRICTIONS ON DRUG MARKETS

Previous wastewater reports have demonstrated the impact of the COVID-19 restrictions on drug consumption across different drug markets. This report adds further detail to the picture, during a time when restrictions were being relaxed or removed in most jurisdictions. Between August and December 2021, the remnants of COVID-related restrictions did not impact drug markets uniformly, with differences continuing to be observed across drugs and between and within jurisdictions.

During the reporting period, the illicit stimulant markets showed early signs of increased consumption, but not yet to levels recorded previously by the Program or prior to COVID-19. However, it is also worth noting that a similar trend in methylamphetamine consumption occurred following August 2020, and preceded another sharp decrease in consumption in August 2021. These fluctuations demonstrate that market changes, chiefly caused by COVID-related movement restrictions, are not strictly linear, but are subject to different environmental influences. Future reports will show if a level of longer-term stability will return to the major illicit drug markets. The trend in consumption of the other illicit drugs monitored by the Program is one of fluctuation within a relatively narrow range (less than 10 doses per 1,000 people per day).

INTERNATIONAL DRUG COMPARISONS

Section 5 of the report provides updated 2021 data from the Sewage Core Group Europe (SCORE), which covered Europe, Asia and Oceania. All of the contributing countries (28, covering 129 cities) must sample and analyse wastewater in accordance with exacting and consistent criteria, so the results are directly comparable. The results for March/April 2021 confirm the strong preference in world terms by Australian illicit drug users for illicit stimulants (amphetamine, methylamphetamine, MDMA and cocaine), where we ranked first of 28 participating countries. The results also highlight the domination of our domestic stimulant market by methylamphetamine. Australia had the highest methylamphetamine consumption per capita compared to 24 other countries. Of the 26 countries reporting cocaine consumption and the 27 countries reporting MDMA consumption, Australia ranked 15th and 5th respectively. Of the 16 countries reporting cannabis consumption, Australia ranked 6th.

Wastewater analysis continues to provide unique and regular insight into drug consumption. Outputs from the Program improve our collective understanding of external factors that affect consumption and the resilience of the respective drug markets. Our longitudinal data assists in the identification of harmful drug consumption and adds granularity to analysis of priority markets so that tailored supply, demand and harm reduction efforts can be developed, implemented and monitored.

ACKNOWLEDGEMENTS

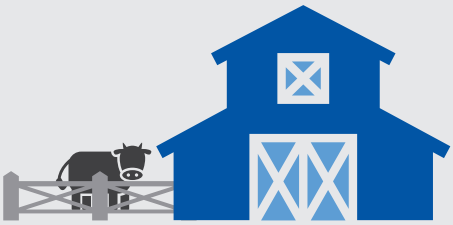
I would like to acknowledge the valuable support and expertise of the Universities of Queensland and South Australia, which undertook the data collection and analysis underpinning this report, and the ACIC officers who contributed to the project.

Michael Phelan APM
Chief Executive Officer
Australian Criminal Intelligence Commission

SNAPSHOT

The December 2021 collection covers around **56 per cent** of Australia's population—about **13 million Australians.**

Capital city **methylamphetamine, cocaine, MDMA, heroin** and **ketamine** average consumption exceeded regional consumption.



Regional **alcohol, nicotine, MDA, oxycodone**, **fentanyl** and **cannabis** average consumption exceeded capital city consumption.

In December 2021, capital city **meth, cocaine** and **MDMA** consumption all exceeded regional consumption for the first time since April 2017.

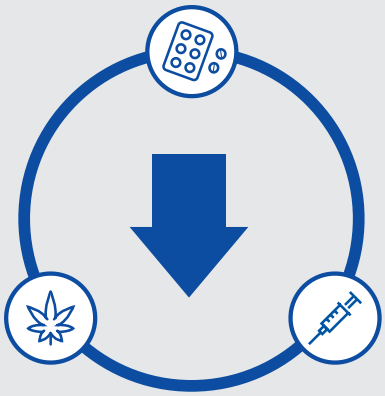
December 2021 and February 2022 highlights

Meth and **cocaine** consumption showed early signs of a recovery, but not to pre-COVID levels.

Record lows:

- **MDMA** capital city (February)
- **Fentanyl** regional (December)

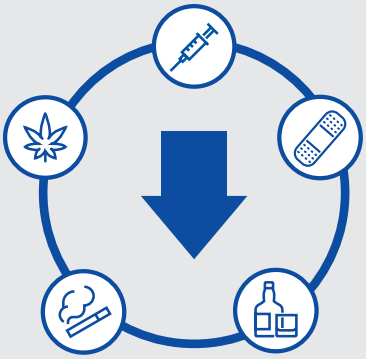
Between August and December 2021, the population-weighted average capital city consumption of:



heroin, oxycodone and cannabis **decreased**

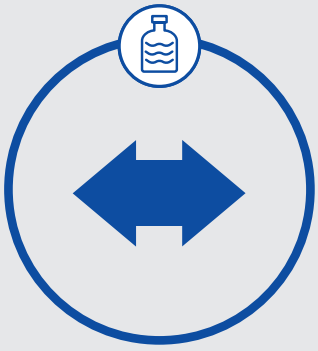
alcohol, nicotine, methylamphetamine, cocaine, MDMA, MDA, fentanyl and ketamine **increased**

Between August and December 2021, the population-weighted average regional consumption of:



alcohol, nicotine, heroin, fentanyl and cannabis **decreased**

methylamphetamine, cocaine, MDMA, MDA and oxycodone **increased**



ketamine remained **relatively stable**

INTERNATIONAL DRUG COMPARISONS

Methylamphetamine consumption in Australia ranked **first** of 25 SCORE countries

Cocaine consumption in Australia ranked **15th** of 26 SCORE countries

MDMA consumption in Australia ranked **5th** of 27 SCORE countries

Cannabis consumption in Australia ranked **6th** of 16 SCORE countries

INTRODUCTION

This is the 16th in a series of National Wastewater Drug Monitoring Program (the Program) reports to be publicly released by the Australian Criminal Intelligence Commission (ACIC) under budgetary arrangements that will see reports delivered until early 2024. The Program provides a measure of the consumption of key illicit drugs, as well as licit drugs including nicotine, alcohol and some pharmaceuticals. It provides valuable insight into trends and emerging issues in drug consumption across Australia and can identify new sources of risk.

The 16th report presents data on Australia's drug consumption for 12 substances and includes data for December 2021 (capital city and regional sites) and February 2022 (capital city sites). Longitudinal data captured by the Program increases our understanding of drug use nationally, in specific locations and over time. The period covered by this report saw the relaxation of COVID-19 restrictions in most but not all jurisdictions. Wastewater analysis provides us with unique insight into the implications of these changes for drug markets across Australia.

Findings presented in the wastewater reports provide law enforcement, policy, regulatory and health agencies with additional, objective data on the use of drugs. These data create opportunities to shape the response to the demand and supply sides of illicit drug markets, particularly in high-use areas, and inform harm reduction strategies. They permit priorities to be set and modified in a manner that is consistent with constantly evolving drug markets and broader world circumstances.

IMPLEMENTATION

The ACIC has contracted The University of Queensland, and through it the University of South Australia, to deliver the Program. Relationships have been built between the universities and the operators of wastewater facilities across Australia to permit the collection and analysis of samples.

In this report, wastewater analysis from the Program measured the presence[1] of the following substances:

- methylamphetamine
- amphetamine
- cocaine
- 3,4-methylenedioxymethylamphetamine (MDMA)
- 3,4-methylenedioxyamphetamine (MDA)
- heroin
- cannabis
- oxycodone
- fentanyl
- nicotine
- alcohol
- ketamine.

1 The contract recognises that threshold levels are substance dependent and will vary accordingly. Refer to the research findings for further information on detection levels, and whether it was possible to measure all substances.

The ACIC continues to review the appropriateness of monitored substances with its partners, stakeholders and the universities.

Both contracted universities monitor wastewater across Australia, covering all state and territory capital cities and a range of regional cities and towns. In December 2021, 56 wastewater treatment plants participated nationally (see Figure 1).[2] Sites were selected to permit the ACIC to provide data on major population areas, sites of actual or potential concern from a drug use perspective and sites where the treatment plant operators have established relationships with the 2 universities.

Figure 1: The breakdown of sites by jurisdiction for December 2021.

Participation from all states and territories is vital to informing our understanding of the national picture of drug use and demand. In the event that one or more states and territories decide(s) not to participate in the national program in the future, the ACIC, in consultation with the universities, will identify replacement sites from participating states and territories to ensure that the largest possible segment of the national population is sampled. Accordingly, the location of sites within and between states and territories may change over the life of the Program, although the intention is to ensure as much continuity as possible in relation to site participation.

2 Sampling also occurred in February 2022 in capital city sites, with 19 participating wastewater sites nationally, covering approximately 47 per cent of the Australian population.

REPORTING

Program reports are completed 3 times a year and made public. In accordance with current wastewater analysis conventions, the terms of the contract, and to protect the integrity of the Program, the exact locations of wastewater treatment plants sampled are not publicly released by the ACIC. Stakeholders in law enforcement, health and other relevant policy agencies are provided with classified information identifying actual sampling locations to inform appropriate responses.

Reported results reflect per capita use in all locations and, with the exception of MDA, cannabis and ketamine (for which reliable dose figures are not available), are expressed in terms of both the number of doses and the weight or volume consumed per capita of the respective substances, to facilitate comparison between substances.

EXPLOITATION OF PROGRAM DATA

The Program is based on a well-established and internationally recognised methodology. The ACIC considers that Program data provide an important basis for the development of empirically informed government and private sector policy and decision making. The reports provide regular, timely, unambiguous and detailed measures of the level of demand for the listed substances in the Australian population, complementing other drug datasets published in Australia. Report 16 of the Program measures the drug use of approximately 56 per cent of the Australian population.[3]

Wastewater data are also particularly useful for identifying differences in levels of drug consumption in capital city and regional areas of Australia. The data reinforce the different dynamics that apply to both capital city and regional markets and illustrate drug preference variations that exist both within and between states and territories. Understanding these preferences is important in the development and delivery of national responses and in tailoring responses to suit the specific needs of individual jurisdictions. Wastewater analysis also permits the ACIC to gain insight into the priorities of serious and organised crime groups that supply illicit drug markets. Regular and near-real-time wastewater reporting enables the ACIC and partners to detect and respond to increasing drug threats in a timely way. The number and diversity of regional sites that participate in the Program permit confident assessments to be made of drug trends outside of the capital cities and facilitates local responses to the different circumstances that apply in each location. This is important because it allows wastewater data to complement a number of other drug data sources in Australia that have very limited regional coverage, or are confined to capital cities. It also permits the ACIC and our partners to speak with greater confidence about local drug threats. Wastewater data are used with other available data sources to develop a comprehensive and accurate understanding of drug markets nationally and in each state and territory.

The triangulated data shows that domestic drug markets are complex and vary between jurisdictions, with external influences affecting markets in different ways at different time periods. Other Program data illustrated that consumption of the respective drugs also varied considerably at different sites within jurisdictions. Given that a relatively small proportion of the Australian population consumes illicit drugs, it is very important that datasets that purport to measure drug consumption cover a significant proportion of the population on a regular and ongoing basis and a variety of local drug markets. It is also important that Australian drug datasets are constantly interpreted in a complementary manner.

3 The December 2021 population estimate is based on the Australian Bureau of Statistics 2016 Census data and catchment data supplied by the operators of the wastewater facilities and service providers.

The ACIC engages with academic institutions, industry and public sector agencies to identify further data applications. Opportunities identified include informing responses in high risk areas; measuring drug use in specific local areas; estimating the size of discrete illicit markets; and exploring options for monitoring the effectiveness of existing demand, supply and harm reduction initiatives. Advantages of the Program include that the data are collected on an ongoing basis, are reported regularly, and the Program is sufficiently flexible to allow for focusing collection activity in different geographic locations and at more regular intervals in response to identified need.

IMPACT OF COVID-19 AND RELATED RESTRICTIONS ON DRUG CONSUMPTION

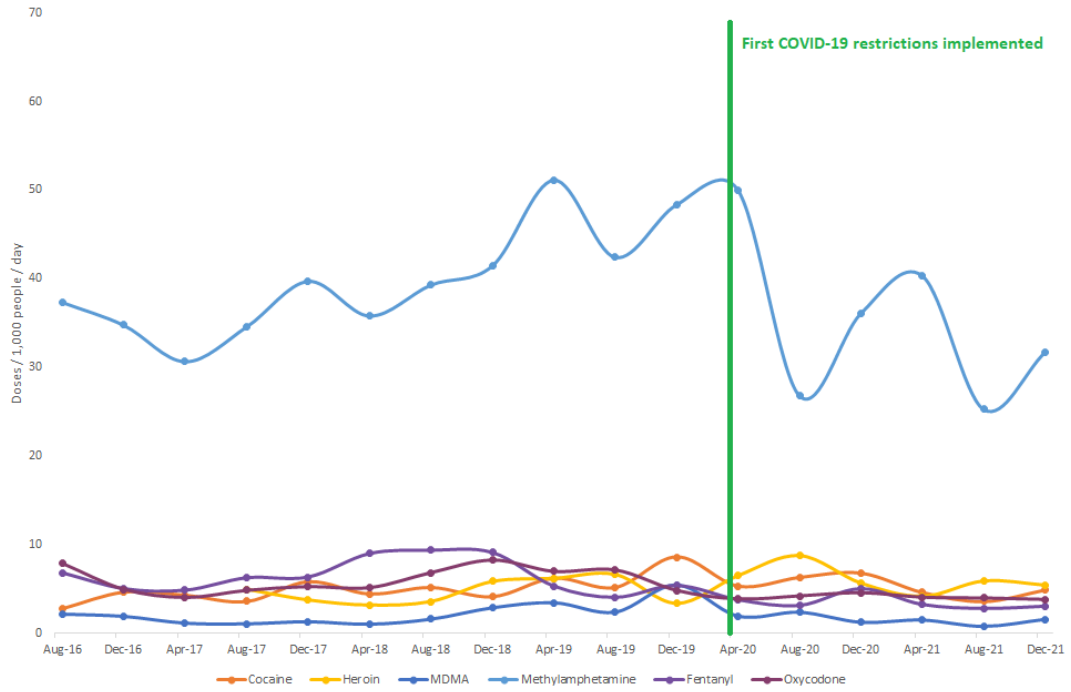
From March 2020 there were COVID-related border, travel and association restrictions in all jurisdictions to varying extents and for varying periods of time. Some of these restrictions were broad-based approaches, introduced throughout the states and territories, while others applied to specific regions or cities/towns within a jurisdiction for various time periods. By December 2021, and more particularly February 2022, many of these restrictions had been relaxed or removed in most jurisdictions.

The previous 2 wastewater reports have demonstrated the impact of the COVID-19 restrictions on drug markets. This report adds further detail to the picture. Between August and December 2021:

- Consumption of the illicit stimulants methylamphetamine, cocaine, MDMA and MDA increased in both capital city and regional sites.
- Consumption of heroin and cannabis decreased in both capital city and regional sites.
- Consumption of alcohol and nicotine fluctuated within a relatively narrow range and was largely consistent with long-term trends.
- Consumption of oxycodone and fentanyl fluctuated, but remained low and relatively stable, with regional consumption of fentanyl in December 2021 being the lowest level recorded by the Program.

The most recent data continues to point to drug markets that vary by commodity and jurisdiction. Organised crime groups continue to find ways to supply the major illicit drug markets, generating significant illicit revenue, but they continue to face challenges, not least from law enforcement agencies. Program data also continues to demonstrate the resilience of Australia's illicit drug markets. The illicit stimulant markets are showing early signs of increased consumption, but not yet to levels recorded previously by the Program or prior to COVID-19. However, it is also worth noting that a similar trend in methylamphetamine consumption occurred following August 2020, and preceded another sharp decrease in consumption in August 2021 (see Figure 2). Future reports will show if a level of longer-term stability will return to the major illicit drug markets, and methylamphetamine in particular. These fluctuations demonstrate that market changes, chiefly caused by COVID-related movement restrictions, are not strictly linear, but are subject to different environmental influences.

Figure 2: National average drug consumption of methylamphetamine, cocaine, MDMA, heroin, oxycodone and fentanyl.



CAPITAL CITY V REGIONAL COMPARISON

Over the life of the Program, consumption of most drugs has generally been higher per capita in regional sites. The exception is cocaine and heroin, where consumption is generally higher in the cities—these 2 drug types are distinguished from the other illicit drug markets because they are exclusively imported (that is, there is no domestic production). Of note, in the period covered by this report, capital city consumption of the major illicit stimulants methylamphetamine, cocaine and MDMA exceeded regional consumption for the first time since April 2017.

INTERNATIONAL COMPARISON

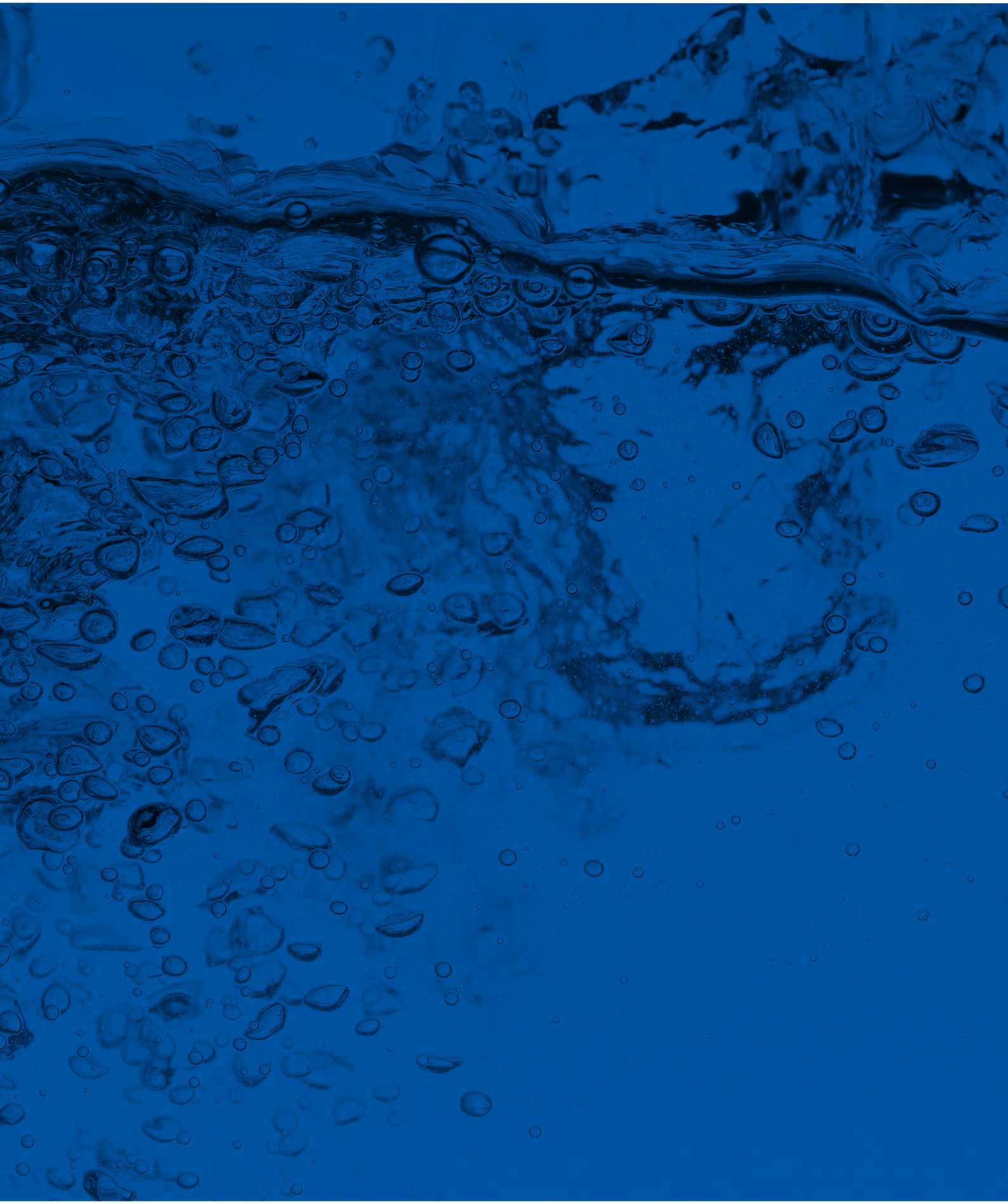
One of the advantages of wastewater analysis is that the process has been standardised by a European network of laboratories called SCORE.[4] The SCORE network permits comparison between analytical results obtained in 2021 from 129 cities in 28 countries in Europe, Oceania and Asia. These results confirm the considerable per capita consumption of illicit stimulants in Australia, even in world terms, and that our illicit stimulant consumption is dominated by methylamphetamine.

RESULTS FROM THE COLLECTION

Wastewater data are an important part of the suite of datasets available to increase our understanding of drug consumption, demand and supply in Australia. Making data from the Program publicly available assists to enrich understanding and informs the national conversation on drug trends and related demand. This 16th report of the Program builds on national drug consumption data contained in the preceding reports to identify temporal trends in drug use across states, territories and the nation. It provides data on capital city and regional drug use and, where possible, comparisons with previous levels of use in sites across Australia and internationally. This, and future reports, continue to build and shape understanding on trends and changes in patterns of use, creating an increasingly detailed picture of drug consumption in Australia.

4 SCORE is the Sewage Core Group Europe.

Whatever the future trajectory of drug consumption, a multi-dimensional approach that targets supply, demand and harm reduction is critical to addressing drug use in Australia. Drug consumption estimates derived from wastewater data, when used in combination with other data—such as seizure, arrest, price, purity, health and availability data—provide insight into drug markets, including their resilience and points of vulnerability, and the potential for coordinated supply, demand and harm reduction strategies to reduce harm to the Australian community.



RESEARCH FINDINGS

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LIST OF ABBREVIATIONS

ABS	Australian Bureau of Statistics
ACIC	Australian Criminal Intelligence Commission
ACT	Australian Capital Territory
DASSA	Drug and Alcohol Services South Australia
LC-MS/MS	Liquid chromatography tandem mass spectrometry
LOD	Limit of detection
LOQ	Limit of quantification
MDA	3,4-methylenedioxyamphetamine
MDMA	3,4-methylenedioxymethylamphetamine
NSW	New South Wales
NT	Northern Territory
NWDMP	National Wastewater Drug Monitoring Program
Qld	Queensland
SA	South Australia
SPE	Solid phase extraction
Tas	Tasmania
THC	Tetrahydrocannabinol
THC-COOH	11-nor-9-carboxy-tetrahydrocannabinol
Vic	Victoria
WA	Western Australia
WWTP	Wastewater treatment plant

TERMINOLOGY

Methylamphetamine is also commonly known as methamphetamine. In this report, consistent with the preferences of the Australian Criminal Intelligence Commission, methylamphetamine is used.

MDMA is commonly known as ecstasy.

Alcohol consumption in this report refers to ethanol consumption, but the more general term 'alcohol' is used throughout.

Nicotine consumption has replaced tobacco consumption in this report as the target metabolites may also be derived from nicotine replacement products such as gums and patches.

THC and THC-COOH: Tetrahydrocannabinol is the main psychoactive compound in cannabis and is referred to as THC throughout this report. Cannabis consumption levels have been calculated from the THC metabolite, 11-nor-9-carboxy-tetrahydrocannabinol (THC-COOH).

1: EXECUTIVE SUMMARY

The Australian Criminal Intelligence Commission (ACIC)'s National Wastewater Drug Monitoring Program (NWDMP or the Program) reports on selected substances of concern in most populated regions of Australia since August 2016. The current version of the NWDMP focuses on 12 licit and illicit drugs—nicotine, alcohol, methylamphetamine, amphetamine, cocaine, MDMA, MDA, oxycodone, fentanyl, heroin, cannabis and ketamine. Estimates of drug consumption in a population are determined from measured concentrations of drug metabolites (excreted into the sewer system after consumption) in wastewater samples. The results are used to monitor trends in drug consumption over the life of the Program. Wastewater treatment plants (WWTPs) located across capital cities and regional Australia and covering all states and territories have been invited to participate in the Program. Each site has been allocated a unique code. Site names are not included in this report to maintain treatment plant confidentiality. Site codes stay assigned to each WWTP throughout the course of the Program.

For Report 16, wastewater samples were collected for up to 7 consecutive days during weeks in December 2021 and February 2022. The December 2021 collection involved regional and capital city sites, while February 2022 only covered capital city sites. A total of 56 sites participated in the Program for December 2021, consisting of 20 capital city WWTPs and a further 36 regional WWTPs, covering a population of 13 million Australians. Data from this report equates to coverage of approximately 56 per cent of Australia's population for December 2021 and 47 per cent for February 2022 (capital city sites only).

A total of 7,503 individual daily samples have been collected and analysed since the beginning of the Program, with new results from 511 additional samples added in this report, bringing the total number to 8,014. The collected samples provide comprehensive Australia-wide baseline data against which subsequent results can be compared to ascertain both spatial and temporal trends. The snapshot of the scale of drug use over a week in December 2021 was compared with historical data included in previous reports. The December 2021 dataset was used for the spatial comparison as it was more comprehensive, including both capital city and regional sites. The temporal comparison includes the latest capital city collection data for February 2022.

The spatial trends in the current reporting period and longer-term temporal trends have likely been impacted by the COVID-19 pandemic. State and territory specific border and social restrictions generally but not uniformly eased since the previous reporting period and between the current sampling months. The results outlined in this report need to be understood in this context.

After normalising the amount of drug measured in wastewater for population size and average dose consumed, alcohol and nicotine remained the highest consumed drugs in all states and territories in December 2021. The average consumption of nicotine was substantially higher in regional areas (approximately 2,100 equivalent cigarettes/day/1,000 people) compared to capital cities (approximately 1,600 equivalent cigarettes/day/1,000 people). Consumption was quite variable between sites. On a national level, the Northern Territory continues to have the highest per capita nicotine consumption.

Alcohol consumption in regional areas (approximately 1,300 standard drinks/day/1,000 people) was higher than in the capital cities (approximately 1,150 standard drinks/day/1,000 people) in December 2021. The Northern Territory and Tasmania had the highest capital city use of alcohol in December 2021. While there have been short-term fluctuations, overall alcohol consumption has been relatively steady since the start of the Program. Regional Tasmania is the only jurisdiction showing a long-term declining trend in alcohol consumption. The Northern Territory had a temporary decrease in alcohol consumption following the implementation of a minimum unit price on alcohol content from October 2018 (O'Brien 2021), however consumption appears to have increased since then towards pre-intervention levels.

Methylamphetamine consumption was on average higher in the capital cities than regional Australia in December 2021 at about 33 and 30 doses per day, per 1,000 people, respectively. Nevertheless, regional sites in New South Wales, Queensland, South Australia and Victoria reported some of the highest consumption levels in December 2021. The Northern Territory and Tasmania were amongst the lowest consumers of the drug. Methylamphetamine consumption declined in many parts of the country in August 2021 to the lowest levels recorded by the Program, before a gradual recovery.

Cocaine consumption in Australia in December 2021 was highest in the capital city of New South Wales and a capital city site in Tasmania and Victoria. Average consumption of the drug in regional areas (approximately 3 doses/day/1,000 people) in Australia was at much lower levels than in the capital cities (approximately 6 doses/day/1,000 people). A trough in cocaine consumption was evident in mid-2021 in many jurisdictions, after which use increased, but to lower levels than the same time last year.

MDMA consumption remains relatively low, with capital city average consumption in December 2021 at fewer than 2 doses per day per 1,000 people and slightly above 2 in regional areas. The current collection period showed wide variation in consumption across the country. Sites with the highest consumption in December 2021 were in New South Wales and Queensland. There has been a decline in the temporal trend in MDMA consumption across almost all jurisdictions, with historical low levels being reported in multiple parts of the country. This was most obvious in February 2022 in the Northern Territory capital city site, where MDMA had previously been consistently amongst the highest in the nation and is now among the lowest. MDA, being a stimulant in its own right as well as a metabolite of MDMA, was excreted at relatively low levels. A few sites in New South Wales, as well as a site in the Northern Territory and Western Australia had well above average levels of the drug. MDA excretion has also been declining, with no measurable amounts being found at some sites.

Oxycodone and fentanyl are prescription pharmaceutical opioids with abuse potential. Both oxycodone and fentanyl consumption was considerably higher in regional parts of the country in December 2021 compared to capital city consumption. In the case of oxycodone, the difference was almost double. Sites in Tasmania and regional South Australia had the highest consumption of oxycodone in December 2021, while high consumption levels of fentanyl were reported at sites in multiple states. When considered in the context of temporal data, oxycodone consumption remains largely steady at historically low levels. Similarly, the average consumption of fentanyl has been mostly unchanged since June 2021, also at the lowest levels since the start of the Program.

Heroin consumption in December 2021 was highest in the Australian Capital Territory and parts of New South Wales, Queensland and Victoria. Average consumption of the drug was much lower in regional areas (slightly more than 2 doses/day/1,000 people) compared to the capital cities (approximately 6.5 doses/day/1,000 people). The trends in heroin consumption are quite variable and generally do not appear to follow common patterns between jurisdictions. Capital city Tasmania and Western Australia are 2 jurisdictions where declining consumption trends have been a feature over several years.

Regional cannabis consumption was on average higher than in the capital cities in December 2021. Sites in New South Wales, the Northern Territory, South Australia and Tasmania all reported well above average cannabis consumption in December 2021. Nationally, cannabis consumption has been trending downwards since August 2021. Of note is the recent upward surge in the regional Northern Territory site.

Ketamine is a pharmaceutical compound of growing concern due to its abuse potential. Capital city excretion levels were almost double the regional averages in December 2021. In Victoria, 7 sites reported ketamine excretion levels higher than the national average, with a capital city site in New South Wales and a regional site in Queensland also reporting high ketamine excretion levels. Considering that ketamine has only been included since Report 13, fewer temporal data points are available for the drug. Early indications are that ketamine use is low and clear trends are not yet apparent.

2: INTRODUCTION

2.1 PREAMBLE

Wastewater analysis is a technique for monitoring the population-scale consumption of substances. The University of Queensland and the University of South Australia were commissioned to provide drug consumption data to the ACIC, for an initial 3 year period from 2016 to 2019, including 9 public reports. The universities have been re-commissioned to provide data for a further 4 years, including 12 public reports. Wastewater treatment sites have been assessed, bimonthly in the case of capital city sites and every 4 months for regional sites. The aim has been to acquire data on the population-scale use of substances that cause potential harm, either through addiction, health risks, or criminal and anti-social behaviour. The intention is to build on the baseline data of substance use across Australia to establish trends. This latest NWDMP report compares consumption data from previous reports with results obtained from all sites in December 2021 and capital cities in February 2022. The report presents patterns of substance use across Australia, showing differences in levels between capital cities and regional centres, within and between states and territories, and nationally.

Compounds of concern include nicotine from nicotine intake (cigarettes, gum, patches, e-cigarettes, etc.), ethanol from alcohol consumption, pharmaceuticals with abuse potential such as ketamine, oxycodone and fentanyl, illicit substances such as methylamphetamine, MDMA, MDA, cocaine, cannabis and heroin.

Amphetamine and MDA were not included in the initial reports. Amphetamine is a by-product of methylamphetamine pyrolysis and is also one of its metabolites. It is also a prescribed drug but can be used as an illicit substance. However, levels of amphetamine generally correspond with the expected values from the excretion of methylamphetamine. Similarly, MDA is a metabolite of MDMA but can also be used as an illicit drug. Since the proportion of MDA derived from MDMA is known it has been included in the NWDMP since Report 3. The amount of MDA was calculated by subtracting 1.65 mg of MDA for every 100 mg of MDMA consumed (Pizarro et al. 2002; Khan & Nicell 2011) and is expressed in units of mg excreted per day per 1,000 people. Cannabis was measured by its urinary metabolite, THC-COOH. Cannabis results are expressed only as mg consumed per day per 1,000 people and will also be expressed as dose per day per 1,000 people when better estimates of a typical dose become available. Ketamine is measured via its metabolite, norketamine. Ketamine results are reported as the amount (mg) of drug excreted per day per 1,000 people due to the absence of clear information in the scientific literature around suitable factors to estimate consumption of the substance in wastewater.

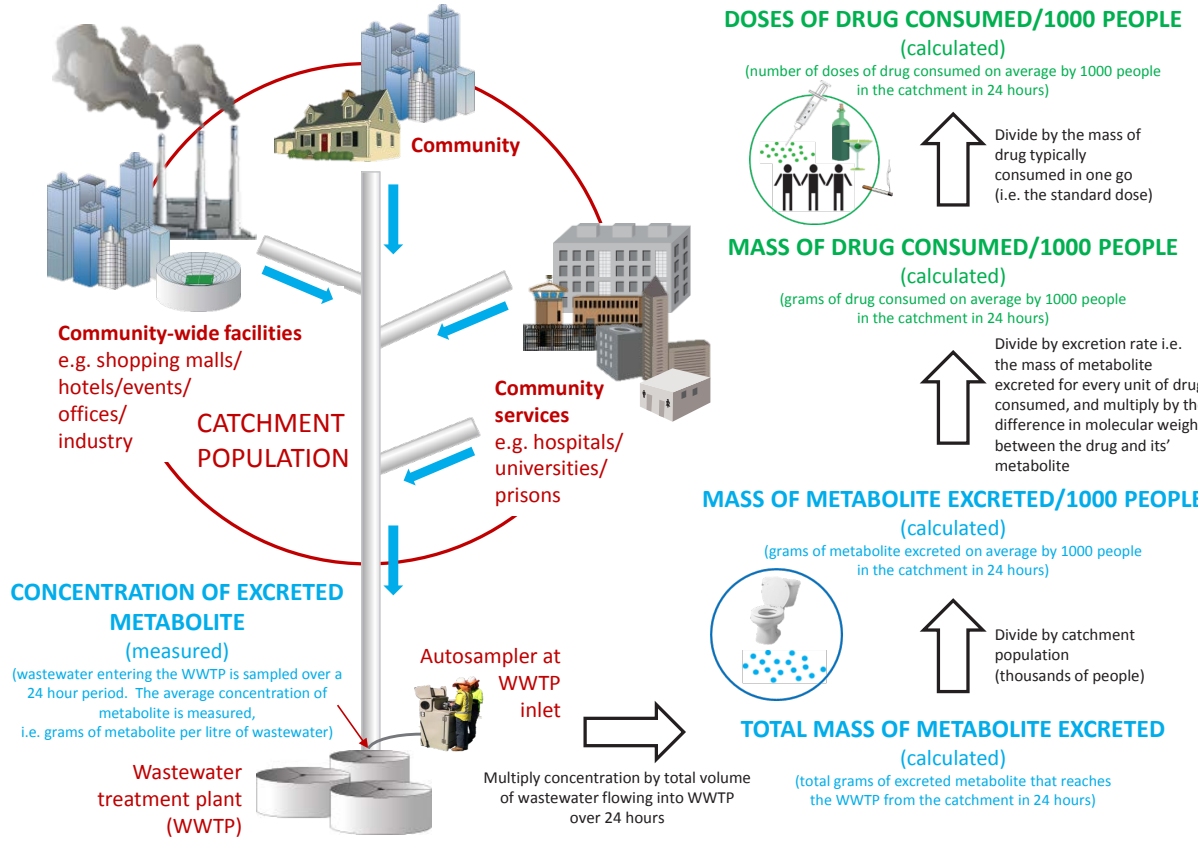
3: METHODS

The method underlying wastewater-based monitoring of drug use in a given population is based on the principle that any given compound that is consumed (irrespective of whether it is swallowed, inhaled/smoked or injected) will subsequently be excreted. This may be either in the chemical form it was consumed and/or in a chemically modified form that is referred to as a metabolite. Once the excreted compound or metabolite is flushed, it will enter the sewer system, assuming the toilet forms part of a wastewater catchment.

The drugs and their metabolites of interest were listed in the first NWDMP report (available at www.acic.gov.au), as well as an in-depth description of the methodologies involved.[5] Collectively, waste products in the sewer system arrive at a WWTP where wastewater samples are collected over a defined sampling period. Measuring the amount of a target compound in the wastewater stream allows for a back-calculation factor to be applied to determine the amount of drug that was used over the collection period (Figure 3). The method is non-invasive and is done on a population-scale level, so individuals are not targeted, and privacy is respected.

5 Information in relation to heroin appears in Report 3.

Figure 3: Schematic of the population catchment area and methodology employed to convert measured concentration of substances in wastewater to mass loads or doses consumed per day per normalised population.



To obtain an estimate of drug use, representative samples are collected over a given period (typically 24 hours) using autosamplers that collect time or flow proportional samples. Wastewater treatment plant operators aid with collecting the samples from the influent autosampler (where the wastewater enters the treatment plants). Details of the calculation methods are given in Report 1. Apart from a few sites in regional Western Australia, operators have been collecting a second daily influent sample with sodium metabisulphite (0.5% m/v) as preservative from August 2018 to allow for the detection of the cannabis metabolite.

Collected wastewater samples were analysed at the University of South Australia and The University of Queensland laboratories. The steps routinely performed in these laboratories are based on filtration of the samples followed by an enrichment/concentration step where the concentrated sample is injected, or (for chemicals with sufficiently high concentrations) direct injection of samples into the analytical instruments. The instrumental analysis consists of chromatographic separation and subsequent compound specific detection. A summary of the extraction and analytical methods is given in Report 1. An updated excretion table including THC-COOH and dose can be found in Appendix 1. Methods to extract and analyse the cannabis metabolite are outlined in Tscharke et al. (2016). Concentrations of drug metabolites were determined in the wastewater using liquid chromatography-tandem mass spectrometric (LC-MS/MS) analytical methods. Drug consumption estimates for each catchment population were calculated from these measured concentrations using flow volumes and estimates of the catchment population size by evaluating census data vs. catchment maps, together with excretion and dose data obtained from the scientific literature.

3.1 PARTICIPATING WASTEWATER TREATMENT PLANTS (WWTPs)

Fifty-six WWTPs across Australia participated in the NWDMP for the December 2021 collection period (Figure 4). Of these, 20 sites were located in capital cities and a further 36 in regional areas, covering a wide range of catchment population sizes. Sites were selected in consultation with the ACIC. The number of participating sites for this report and a complete list of participating sites, number of samples and relative catchment sizes are listed in Table 1 and Appendix 2. To maintain the confidentiality of the participating sites, all sites were allocated a unique code to de-identify their results for the course of the Program. Only site codes are presented in the results.

Figure 4: Participating WWTPs in December 2021 showing the number of capital city and regional plants by state and territory. The colours in this figure are matched with others in the remainder of the report to identify results relating to individual states and territories.

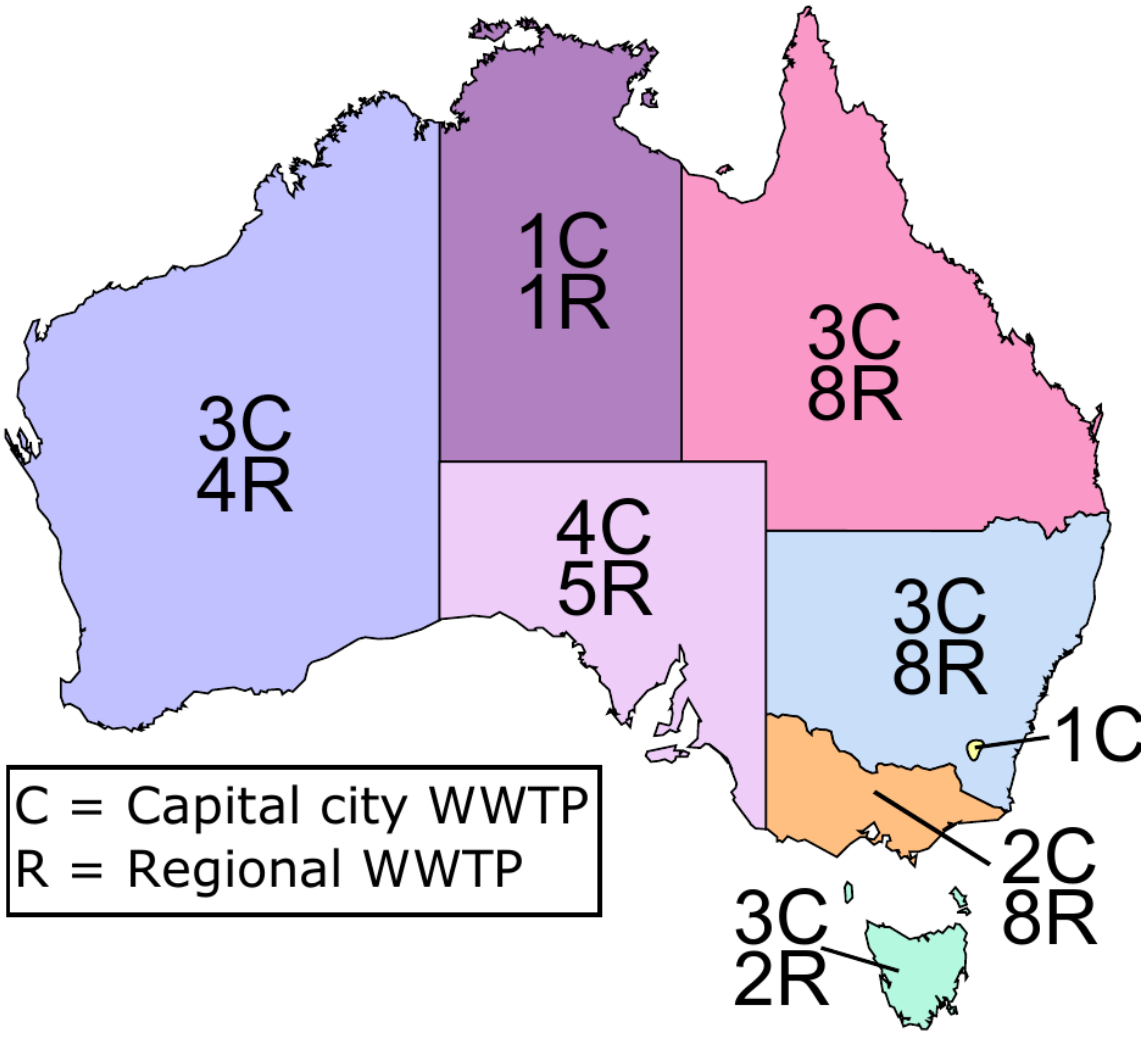


Table 1: Number of participating WWTPs for the periods covered in this report. One collection period aims to collect data from both capital city (C) and regional (R) sites, while the other collection period aims to collect data from capital city sites only.

State/territory	Dec 2021 Capital	Dec 2021 Regional	Feb 2022 Capital
ACT	1	0	1
NSW	3	8	3
NT	1	1	1
Qld	3	8	2
SA	4	5	4
Tas	3	2	3
Vic	2	8	2
WA	3	4	3
Sites	**20**	**36**	**19**
Population (millions) C & R	**11.2**	**1.8**	**11.0**
% of Australian population	**47.9**	**7.6**	**46.9**
Total population (millions)		**13.0**	**11.0**
% of Australian population		**55.5**	**46.9**

Estimates have been rounded to the nearest 0.1 million. Census 2016 population used (23,401,892) for population percentage estimates.

3.2 SAMPLE COLLECTION AND PREPARATION

Daily composite samples were collected by treatment plant staff on 7 consecutive days, or where 7 days was not feasible, across as many consecutive days as possible. Regional sites in South Australia have only been providing weekend samples since April 2018, which should be considered when interpreting historical results for the period when the number of sampling days was 5—see Appendix 3, Report 6. In addition, weekend samples in many of the Tasmanian sites were not available. Small revisions may be made to historical data when more accurate data become available, for example, when updated flow measurements supplied by wastewater treatment authorities or population estimates become available. Samples were stored at 4°C or were frozen prior to transport to South Australia or Queensland. Further details of the sampling protocol and relevant quality controls are included in Irvine et al. (2011), Lai et al. (2011), Lai et al. (2015), Tscharke et al. (2016) and Bade et al. (2019). All other descriptions of calculations, extractions and analytical methods are outlined in Report 1 (available at www.acic.gov.au). Methods to detect and analyse THC-COOH are outlined in Tscharke et al. (2016).

3.3 PRESENTATION OF DATA AND INTERPRETATION OF GRAPHS

Reported averages: All averages for state/territory or Australia-wide drug consumption data are presented throughout this report as population weighted averages. The number of people in the catchment population is used as the weighting for the respective drug consumption data for that population. For example, to calculate the population weighted average of capital city methylamphetamine consumption, the methylamphetamine consumption data for each WWTP was multiplied by the respective population number, all data were then summed and divided by the total population across all capital city sites. Reported average values are therefore not skewed towards usage data from small, non-representative populations.

Per capita consumption: The per capita consumption estimates presented in this report are calculated using the total estimated catchment population (which includes children). For example, per capita alcohol consumption has previously been reported by the Australian Bureau of Statistics (ABS) based on population numbers for people aged 15 and over. The consumption values presented in the current report will be under-estimated compared to those determined for an adult-only population. For consistency, data from other studies included in this report were recalculated where necessary using the estimated total population.

Graphical presentation of data: An overview of how the data is presented in the graphs for the individual sites is given in Figure 5. This includes information on interpreting the consumption data presented on the vertical axes in all graphs in this report. In some graphs, the values plotted in the graph can be read as either mass of drug consumed (left axis) or doses of drug consumed (right axis). For the specific case of MDA, the amount of MDA excreted following MDA consumption is not known, and therefore this drug can only be expressed as how much drug was excreted into the sewer network, e.g., the mg excreted per 1,000 people per day. This is also the case with ketamine. For cannabis, the approximate dosage is not well defined, and results are expressed as mg consumed per 1,000 people per day.

Bubble charts are included to represent the relative extent of consumption in capital cities and regional areas for each jurisdiction. See Figure 6 for a description of how to interpret the bubble charts.

Instrumental method limits of detection and limits of quantification: Since the wastewater samples contain very low quantities of particular drugs, the limit of detection (LOD) was determined analytically as the lowest concentration of that drug that could be determined in the sample (using the methods described in Report 1). A drug may be present at a concentration below the LOD, however trace quantities may be present at undetectable levels. The limit of quantification (LOQ)[6] is a concentration (higher than the LOD), above which we have high confidence that the concentration measured on the analytical instrument is accurate. Above the LOD but below the LOQ there may be some uncertainty as to the actual concentration. To be conservative (a drug may be present but there is uncertainty as to its concentration) and in line with current practice, for back calculations to estimate per capita consumption, a concentration below the LOD was included as a value of LOD/√2. A concentration above the LOD but below LOQ is included at the midpoint between the LOD and LOQ (i.e. (LOD + LOQ)/2). The frequency of detection of each analyte of interest is included in Appendix 3.

6 LOQ is the lowest level that can be accurately measured.

Weekly pattern of drug use: The pattern of drug use over the sampling week for the sites in this report cannot be elucidated from the data included in the current report. This is because the starting day of the collection week did not always correspond for every plant. We present the maximum, minimum and average (for individual sites as illustrated in Figure 5) and only population-weighted average values for all other graphs. Consistent patterns of drug use in Australia from previous wastewater-based epidemiology studies indicate that some substances such as cocaine, MDMA and alcohol have high variation in weekly consumption rates, with higher consumption on weekends. Other drugs such as methylamphetamine, oxycodone and fentanyl tend to have lower daily variation, suggesting that their consumption is consistent throughout the week (Lai et al. 2015, Tscharke et al. 2016).

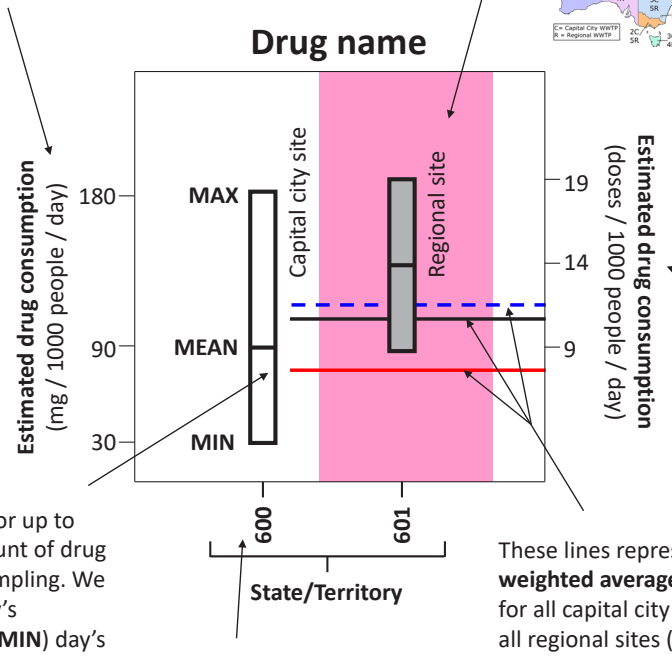
Figure 5: Explanation of the graphical representation of data for individual sites and bubble maps. General concepts relevant to all graphs in the report are also outlined (unique site codes, explanation of vertical axes, colour coding).

The **left hand axis** shows the estimated total mass consumed (in milligrams, mg) of a drug which is calculated by measuring the concentration of the drug's metabolite in a 24 hour wastewater composite sample, multiplying by the flow volume in the 24 hours, dividing by the population size and applying an excretion factor for the metabolite (see Equation 1, Report 1 for details).

To convert the mass consumed (left axis) to the estimated doses consumed (right axis), we divide the estimated mass consumed by the standard dose amount. Dose amount and excretion factors are given in Appendix 1 of Report 4. In this example, at Site 600, the minimum consumption was 30 mg in one day, the maximum was 180 mg and average was 90 mg per day over the sampling period (for every 1,000 people).

We collect wastewater data for up to 7 days and estimate the amount of drug consumed for each day of sampling. We plot the maximum (**MAX**) day's consumption, the minimum (**MIN**) day's consumption and the average (**MEAN**) across the 7 days. If the box is long, there is a large difference in consumption patterns over the week; for example, if drugs are used excessively at weekends but not often during the week. Alternatively, a short box suggests a similar drug usage every day of the week. See also main text.

Colours help identify the State or Territory that the data relates to (colours are consistent between Figures).



The **right hand axis** shows the estimated number of doses of a drug consumed by 1,000 people in the catchment in a 24 hour period; e.g., one dose would be 1 cigarette, 1 standard drink or 1 injected amount of drug. In this example, at Site 601, the minimum consumption was 9 doses in one day, the maximum was 19 and average was 14 per day over the sampling period (for every 1,000 people).

Unique number allocated to each WWTP to maintain confidentiality. WWTP names will not be disclosed publicly.

These lines represent the **population weighted averages** for drug consumption for all capital city sites (blue dotted line), all regional sites (red line) and for all sites combined (black line). The method to calculate weighted population averages is given in the main text. In this example, the average consumption for regional Site 601 (horizontal bar within red checked box) is above both the average for regional sites and all sites nationally. In contrast, the average consumption for capital city Site 600 is below the national average.

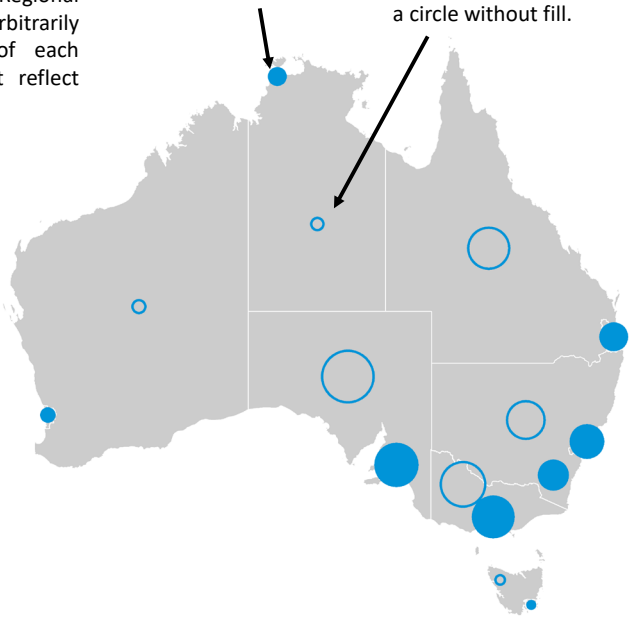
Figure 6: Explanation of the graphical representation of data for individual sites and bubble maps. General concepts relevant to all graphs in the report are also outlined (unique site codes, explanation of vertical axes, colour coding).

Bubbles:
Capital city site averages are drawn over the capital city of a jurisdiction and the regional site averages are drawn in the middle of the State or Territory. Regional bubbles are drawn arbitrarily close to the centre of each jurisdiction and do not reflect location of sites.

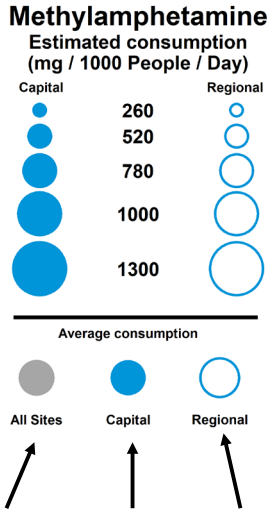
This type of plot gives a rough overview of drug consumption per jurisdiction. The other temporal and spatial comparison graphs give greater resolution to compare between locations and over time, and should be used for analysis.

Capital city average:
Population-weighted average of all capital sites tested per jurisdiction. Capital sites are indicated by a filled circle.

Regional city average:
Population-weighted average of all regional sites tested per jurisdiction. Regional sites are indicated by a circle without fill.



Legend:
The population-weighted average drug consumption for each jurisdiction is represented as a scaled circle. Representative consumption estimates are shown at the right of the bubble plot. Each bubble is scaled individually based on the consumption level.



Aggregated data:
The population-weighted average drug consumption is also shown as a point of comparison for all sites, all capital, and regional sites that were tested within the timepoint. This incorporates sites from **all jurisdictions** for the timepoint under investigation. These are also represented with sizes representing the scale of use categories used for the jurisdictional averages.

4: RESULTS

Estimated drug consumption data are presented in several different ways in the following sections to allow comparisons of drug use at the individual site level for December 2021 (section 4.1), temporal trends for states and territories for the past 2 years (section 4.2) and within each state and territory (section 4.3). December 2021 data were used for section 4.1, which compares the individual sites, as it included the latest set of results for the full suite of sites included in the Program.
We recommend exercising caution when comparing results between sites, as some plants provided samples for fewer days than others and the collection week, and the days of the month, did not correspond in all instances. A list of the detection frequency for each drug can be found in Appendix 3.
This report retained the current population estimates introduced in Report 4 by integrating the specific wastewater catchment areas against the high-resolution population data released from the 2016 Census. The uncertainties in individual population estimates have less impact when data are averaged, for example when broader comparisons at the state/territory or international level are undertaken. The uncertainties in population numbers may be particularly evident in smaller regional communities or sites where short-term population changes occur due to employment opportunities, tourism or festival events.

4.1 INDIVIDUAL SITE COMPARISON OF DRUG USE IN DECEMBER 2021

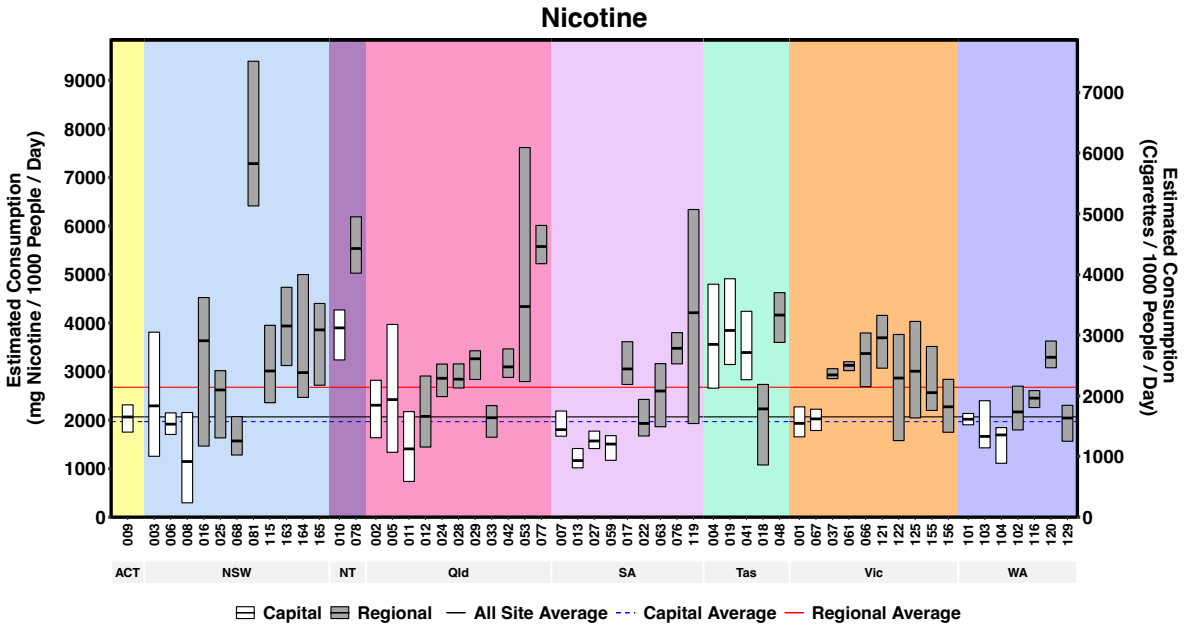
4.1.1 NICOTINE AND ALCOHOL

Nicotine is the main psychoactive substance present in tobacco products. Two nicotine metabolites, cotinine and hydroxycotinine, were used to represent the consumption of tobacco. The estimate is expressed as nicotine in this report as the method cannot distinguish between nicotine intake from tobacco, electronic cigarettes and nicotine replacement therapies such as patches and gums. The December 2021 results show that nicotine consumption varied widely between sites across the country (Figure 7). Average consumption in regional Australia was higher than in the capital cities (red horizontal and dotted blue lines, respectively). The Northern Territory and Tasmania had the highest capital city nicotine consumption in December 2021. Some regional sites in several states and territories had well above average nicotine consumption, particularly New South Wales, the Northern Territory and Queensland. Nicotine consumption showed large fluctuations between different sites and over the sampling week, with no obvious patterns evident across the country.

Alcohol consumption was measured using a specific metabolite of ethanol, ethyl sulphate. In December 2021, average alcohol consumption was higher in regional areas than in the capital cities (Figure 8). The Northern Territory and Tasmania had the highest average capital city consumption of alcohol in December 2021. New South Wales, the Northern Territory and Queensland were generally the highest regional consumers of alcohol. Sites in South Australia and Western Australia generally had average or below average alcohol consumption compared to the national regional and capital city averages. Very large variations were observed in many parts of the country over the course of the sampling week, particularly at Site 101, mostly coinciding with weekend days. Regional sites in Tasmania only provided weekday samples.

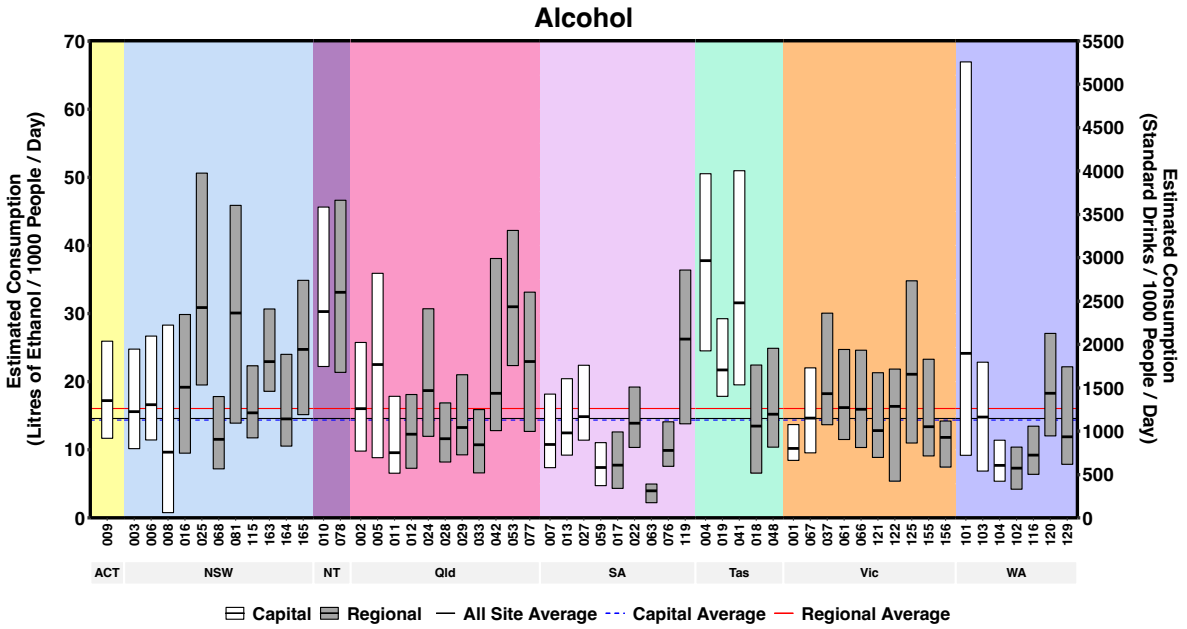
The relative consumption levels can be represented by showing the relative scale of use of nicotine (Figure 9) and alcohol (Figure 10) as capital city or regional ‘bubbles’ for each state and territory. The above average consumption of nicotine and alcohol in the Northern Territory is evident from the size of the bubbles in that region. These findings need to be understood in the knowledge that there is only one capital city site and one regional site included for this jurisdiction (however approximately 25 per cent of the population of the Northern Territory is covered by those 2 sites).

Figure 7: Estimated nicotine consumption for December 2021 in mass of nicotine consumed per day (left axis) and number of cigarettes per day (right axis) per thousand people. The number of collection days varied from 5-7.



- Regional average higher
- Variable consumption

Figure 8: Estimated alcohol consumption for December 2021 in volume consumed per day (left axis) and standard drinks per day (right axis) per thousand people. The number of collection days varied from 5-7.



- Regional average higher
- Wide weekly spread a common feature

Figure 9: Estimated average nicotine consumption per jurisdiction for December 2021 in number of cigarettes per day per thousand people. The number of collection days varied from 5-7.

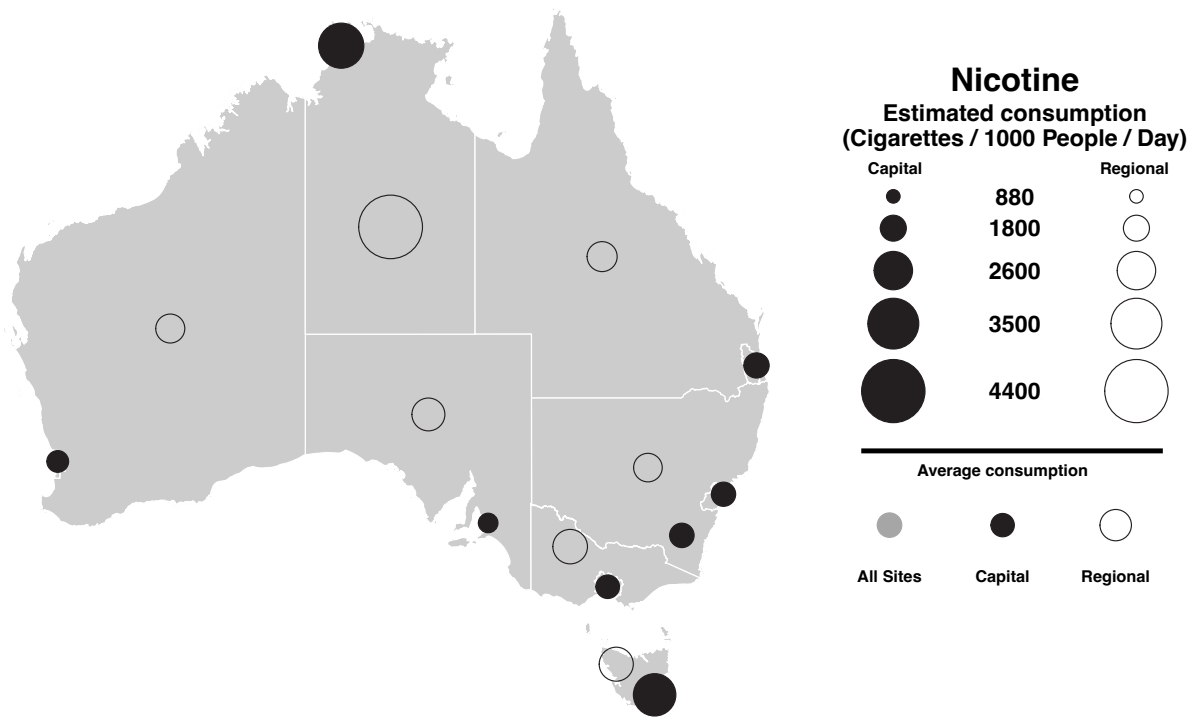
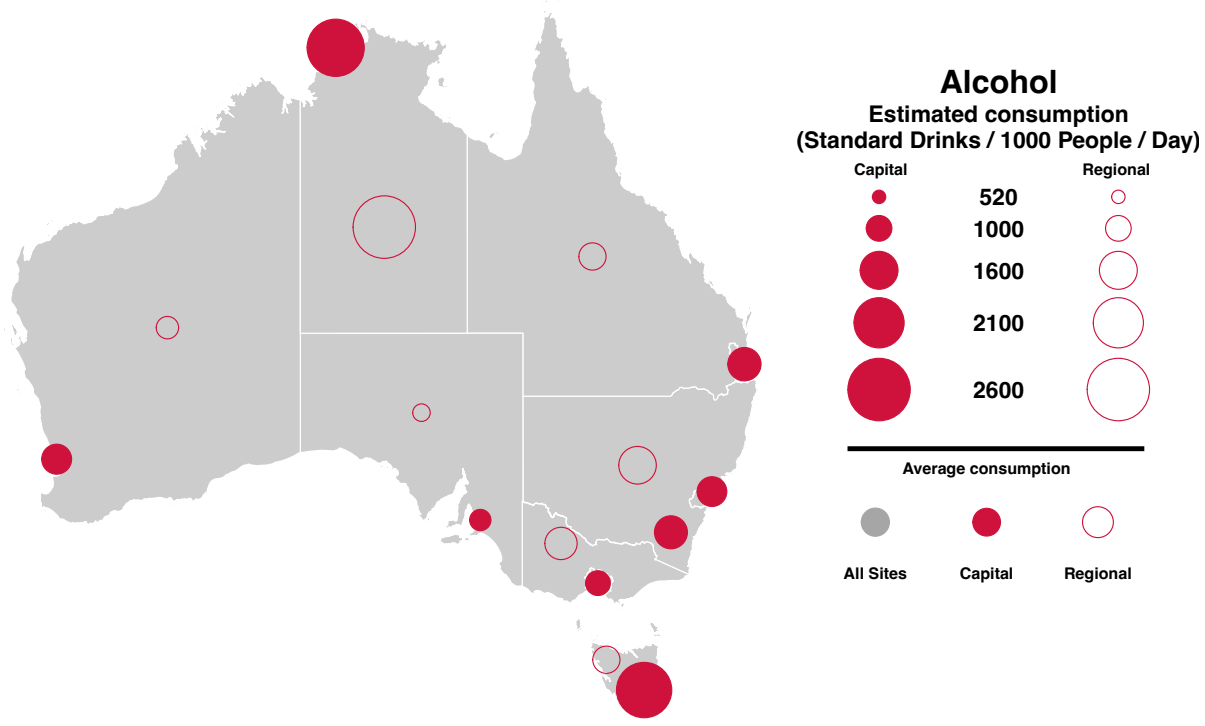


Figure 10: Estimated average alcohol consumption per jurisdiction for December 2021 in number of standard drinks per day per thousand people. The number of collection days varied from 5-7.



4.1.2 STIMULANTS

The relative estimated consumption levels across the participating sites for 4 stimulants—methylamphetamine, cocaine, MDMA and MDA—are described in more detail below.

4.1.2.1 METHYLAMPHETAMINE

Methylamphetamine consumption levels varied considerably across sites (Figure 11). Average methylamphetamine consumption in regional areas was lower than in the capital cities in December 2021. This result has occurred only 3 times previously over the course of the Program. South Australia and Western Australia typically had some of the highest average capital city methylamphetamine consumption levels in December 2021, while sites in New South Wales, Queensland, South Australia and Victoria reported high regional consumption, well above the national average. The 2 territories and Tasmania had consumption levels well below the national averages in December 2021.

4.1.2.2 AMPHETAMINE

The measured concentration of amphetamine in the December 2021 samples mostly fell within a range which is consistent with the reported excretion rates following methylamphetamine consumption (Gracia-Lor et al. 2016). The results were largely in agreement with our previous findings (see Appendix 4 of Report 1). Although the levels of amphetamine in wastewater samples can be largely attributed to the metabolism of methylamphetamine, the drug is prescribed for some behavioural disorders and the method cannot differentiate between medical and illicit use.

4.1.2.3 COCAINE

Benzoylecgonine, the specific metabolite of cocaine, was used to estimate the consumption of the stimulant. Per capita capital city cocaine consumption was around twice that of regional areas in December 2021 (Figure 12). Overall, New South Wales had the highest capital city consumption levels in the nation, with high capital city consumption also reported in one site in Tasmania. Several regional sites in New South Wales ranked highest in the country. Cocaine consumption was generally low in most other regional sites across Australia.

4.1.2.4 MDMA (3,4-METHYLENEDIOXYMETHYLAMPHETAMINE)

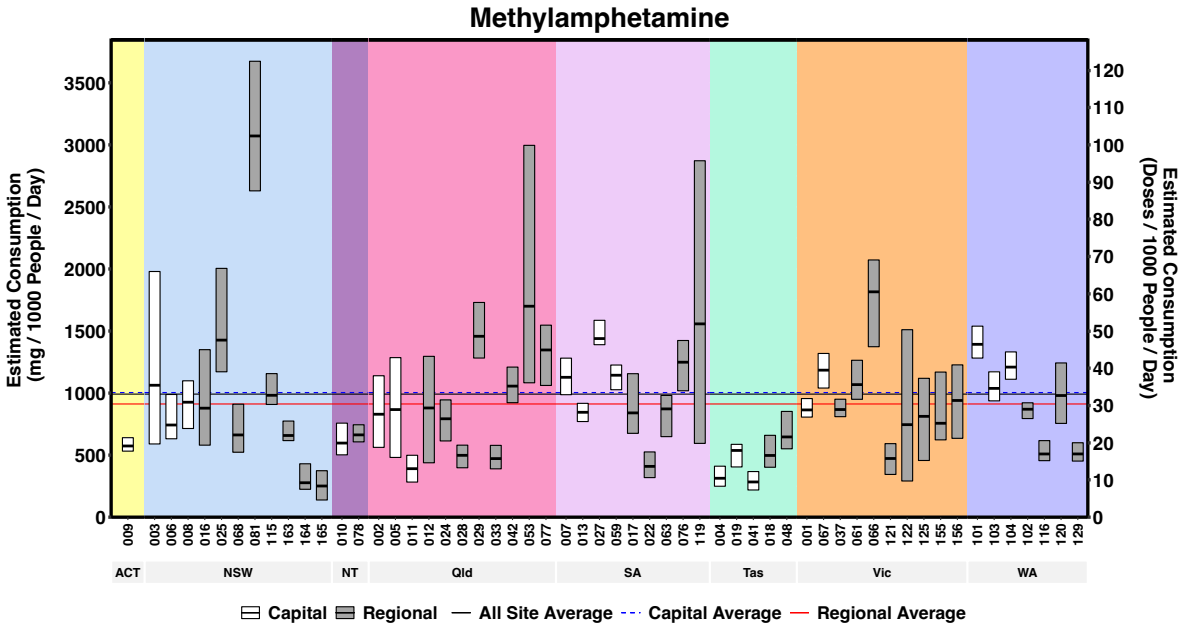
The average consumption of MDMA remains lower than the previous 2 stimulants when expressed as doses per day per 1,000 people (Figure 13). Apart from a few exceptions, consumption of the drug was relatively low and consistent across the country. New South Wales and Queensland each had a capital city site with MDMA levels well above national averages. The regional national average was marginally below the capital city and all site averages in December 2021.

4.1.2.5 MDA (3,4-METHYLENEDIOXYAMPHETAMINE)

MDA is both a drug in its own right and a metabolite of MDMA. Since the proportion of MDA eliminated after MDMA consumption is known, the proportion of MDA attributable to MDMA metabolism was subtracted from the total measured amount of MDA for each site. Results for MDA were expressed as mg excreted per 1,000 people per day (daily mass load) and not as consumption due to the lack of metabolic information of MDA elimination following MDA consumption. Excretion levels of the drug were mostly low across Australia (Figure 14). The national capital city average was slightly lower than the national regional average in December 2021. Four sites had consumption levels substantially above the rest of the country and national averages. These were a capital city and a regional site in New South Wales, a regional site in the Northern Territory and a regional site in Western Australia.

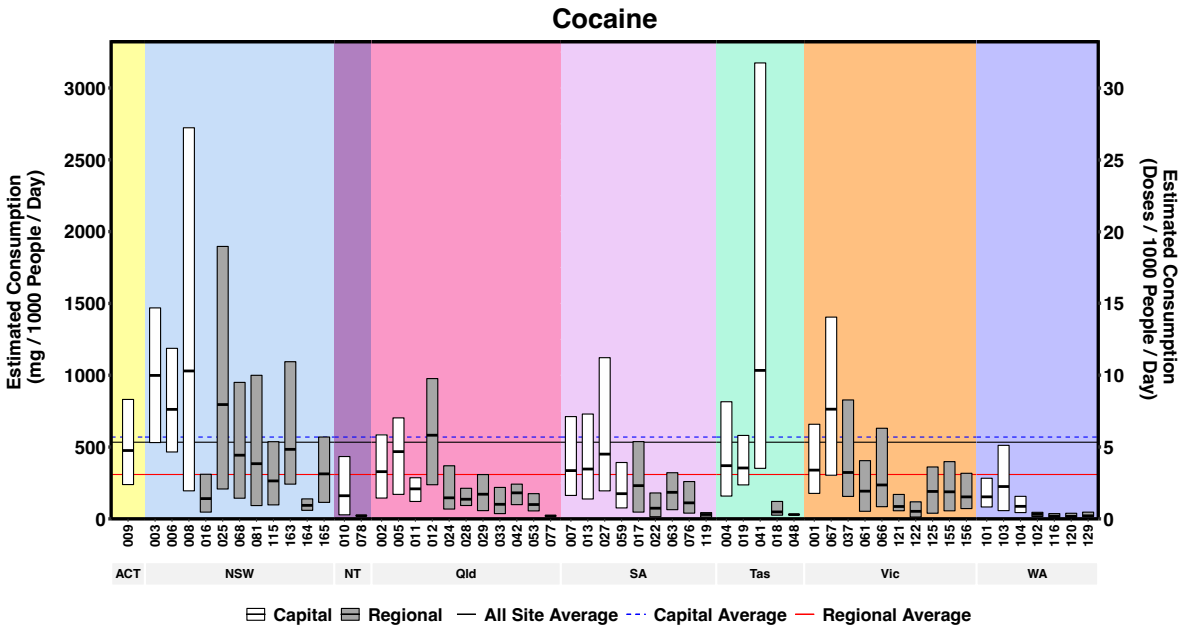
The scale of use of each stimulant is expressed as a bubble graph to compare regional and capital city use of methylamphetamine (Figure 15), cocaine (Figure 16), MDMA (Figure 17) and MDA (Figure 18) across the country. Higher consumption of cocaine on the south-eastern seaboard remains apparent.

Figure 11: Estimated methylamphetamine consumption for December 2021 in mass consumed per day (left axis) and doses per day (right axis) per thousand people. The number of collection days varied from 5-7.



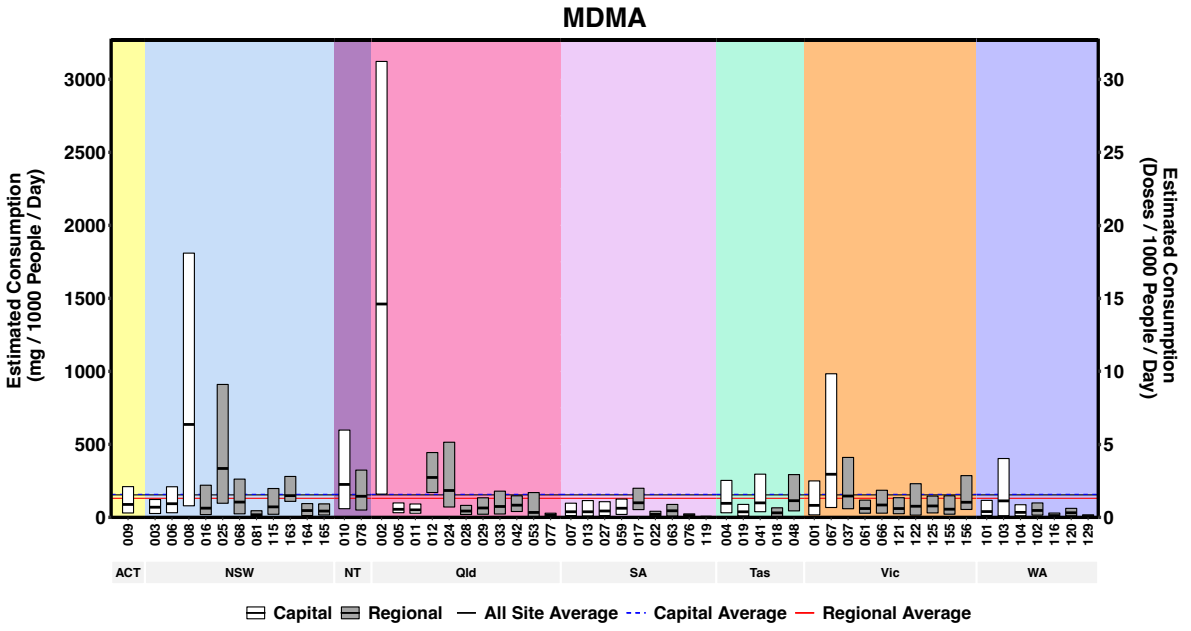
- **Higher capital city consumption**
- **High variability across the nation**

Figure 12: Estimated cocaine consumption for December 2021 in mass consumed per day (left axis) and doses per day (right axis) per thousand people. The number of collection days varied from 5-7.



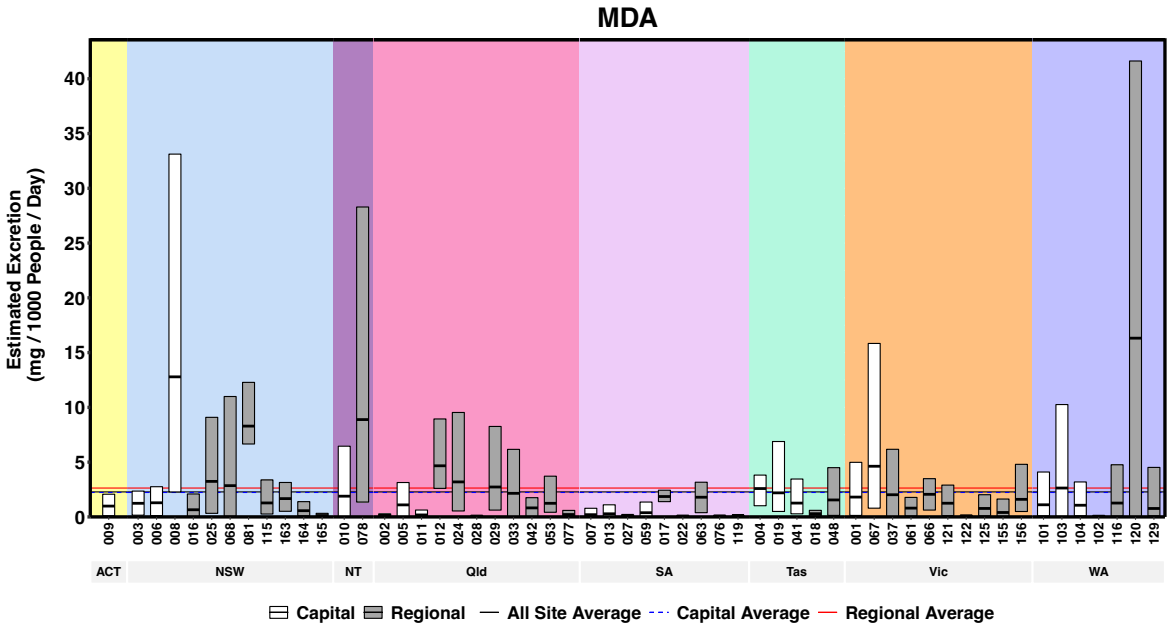
- Higher capital city consumption
- High overall consumption in New South Wales

Figure 13: Estimated MDMA consumption for December 2021 in mass consumed per day (left axis) and doses per day (right axis) per thousand people. The number of collection days varied from 5-7.



- Lower regional consumption
- Mostly low consumption nationally

Figure 14: Estimated MDA excretion for December 2021 in mass excreted per day per thousand people. The number of collection days varied from 5-7.



- Higher regional consumption
- Relatively low consumption

Figure 15: Estimated average methylamphetamine consumption per jurisdiction for December 2021 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

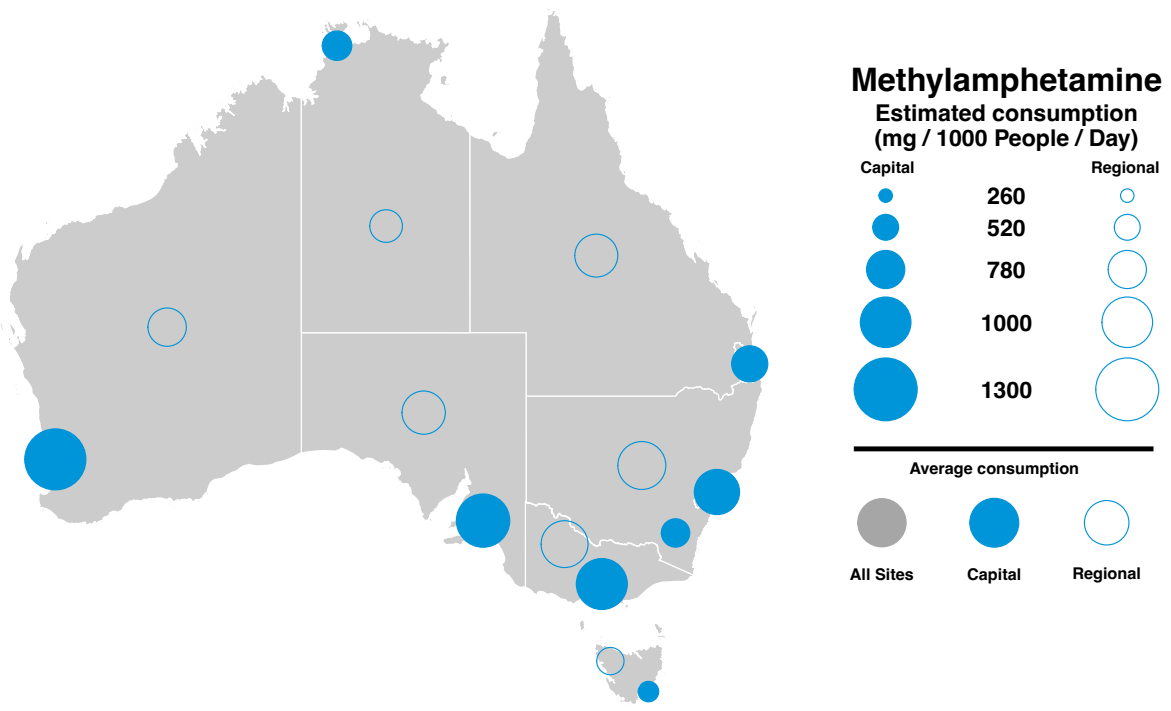


Figure 16: Estimated average cocaine consumption per jurisdiction for December 2021 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

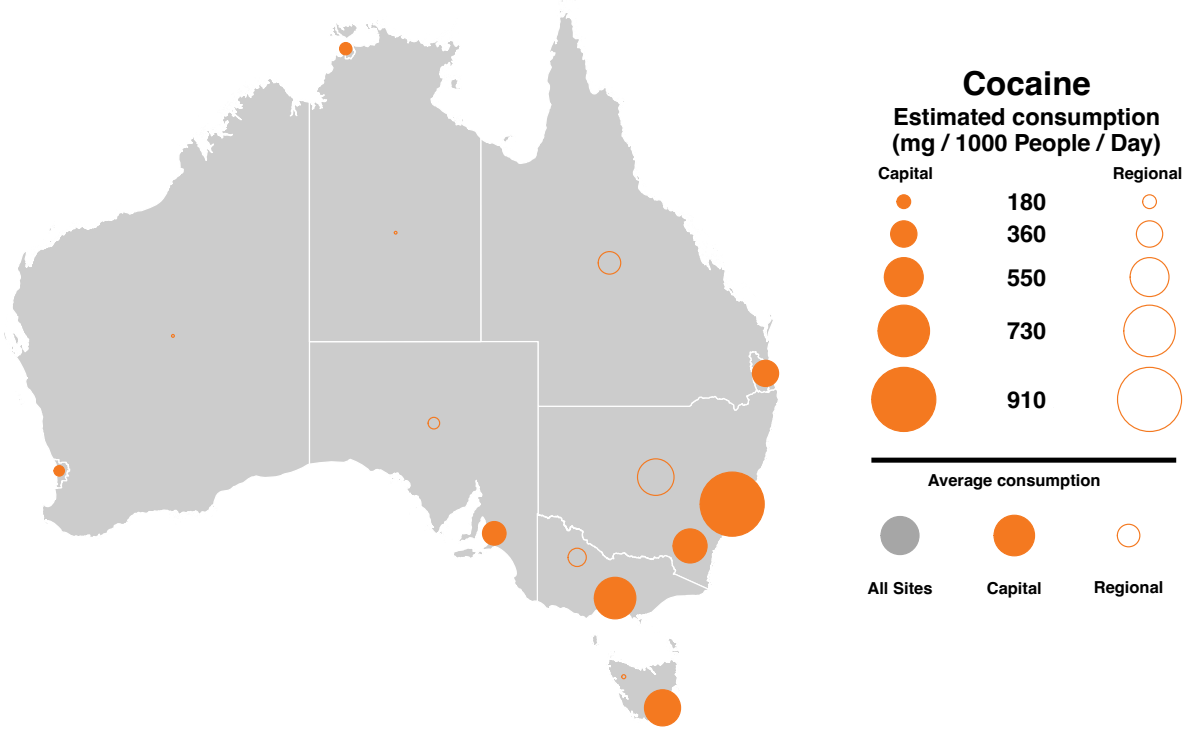


Figure 17: Estimated average MDMA consumption per jurisdiction for December 2021 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

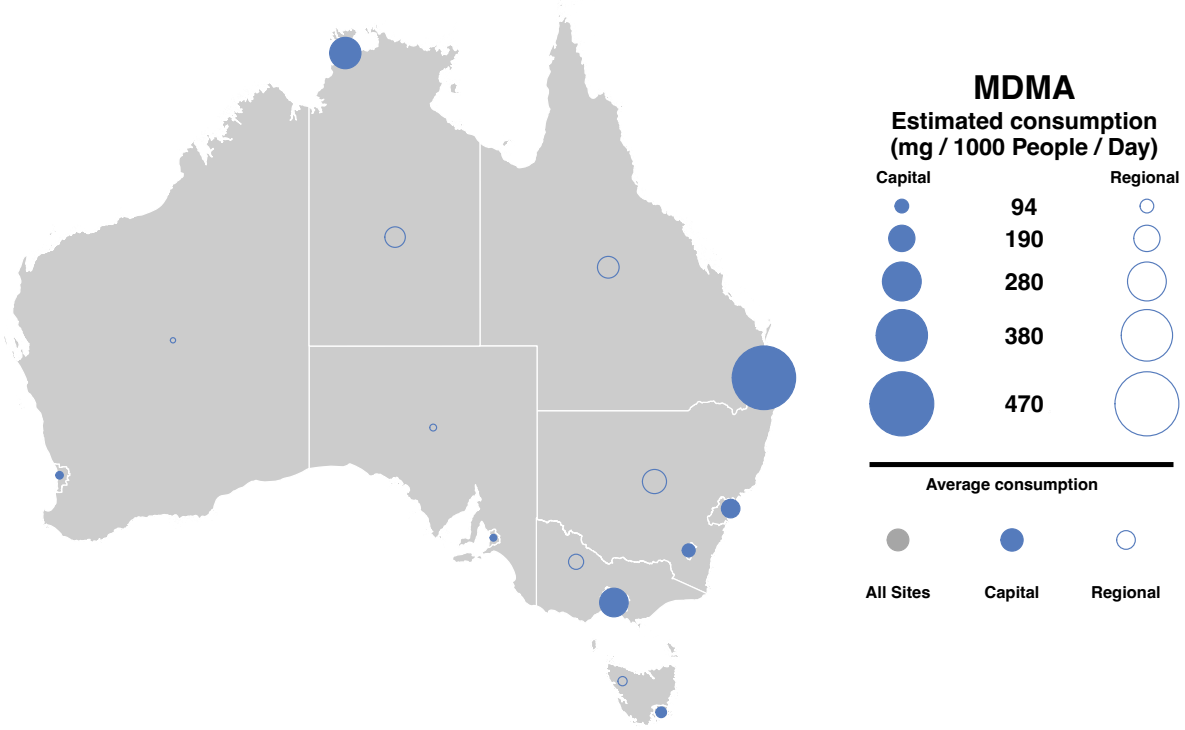
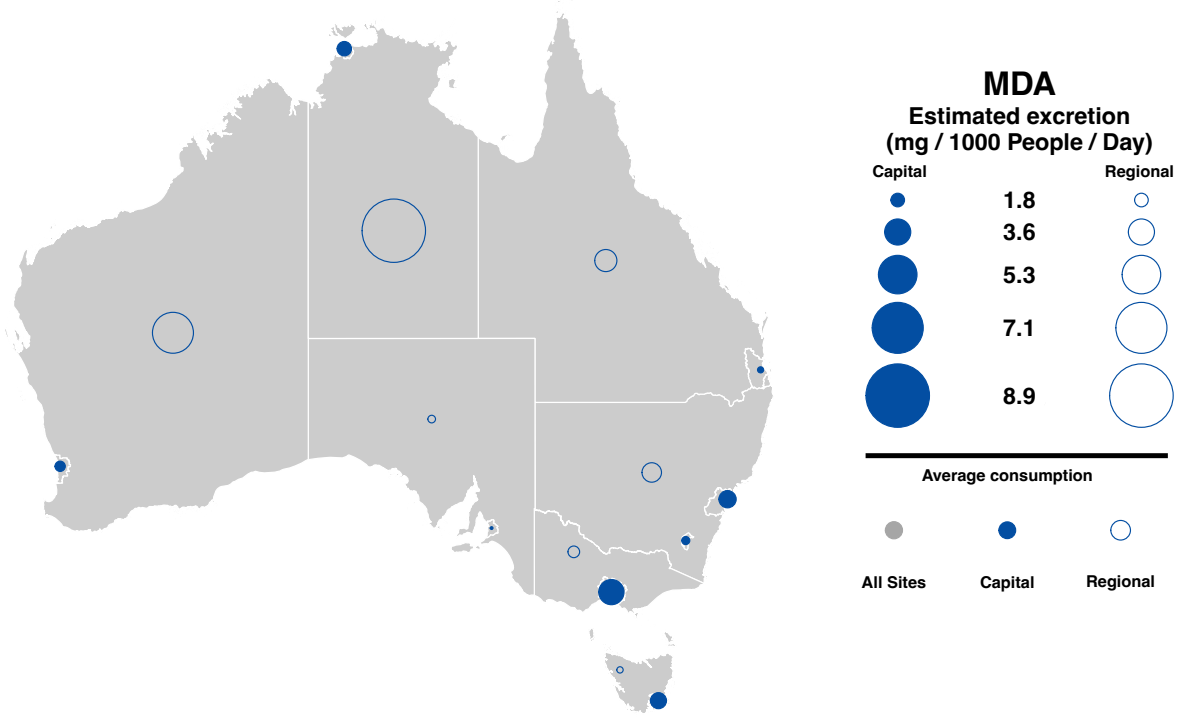


Figure 18: Estimated average MDA excretion per jurisdiction for December 2021 in mg excreted per day per thousand people. The number of collection days varied from 5-7.



4.1.3 OPIOIDS

Two prescription opioids were measured, as well as heroin, an illicit drug. Oxycodone and fentanyl are legally prescribed pharmaceuticals with abuse potential. Although wastewater analysis cannot be used to differentiate between prescribed use for therapeutic purposes and use for non-medical purposes, the relative scale of use of these substances remains of interest as they have the potential for misuse.

4.1.3.1 PHARMACEUTICAL OPIOIDS

The metabolism and excretion profiles of oxycodone and fentanyl are well established. The main metabolite of each compound was measured to estimate drug consumption.

Oxycodone consumption across Australia in December 2021 was variable. A feature of the national use of oxycodone was the substantially higher average regional consumption compared with capital city consumption (Figure 19). Capital city sites in Tasmania had above average oxycodone consumption in December 2021 and were the highest in the country, while regional sites in New South Wales, South Australia and Victoria had the highest regional consumption in the nation. Western Australia had relatively low overall consumption levels compared to the national averages.

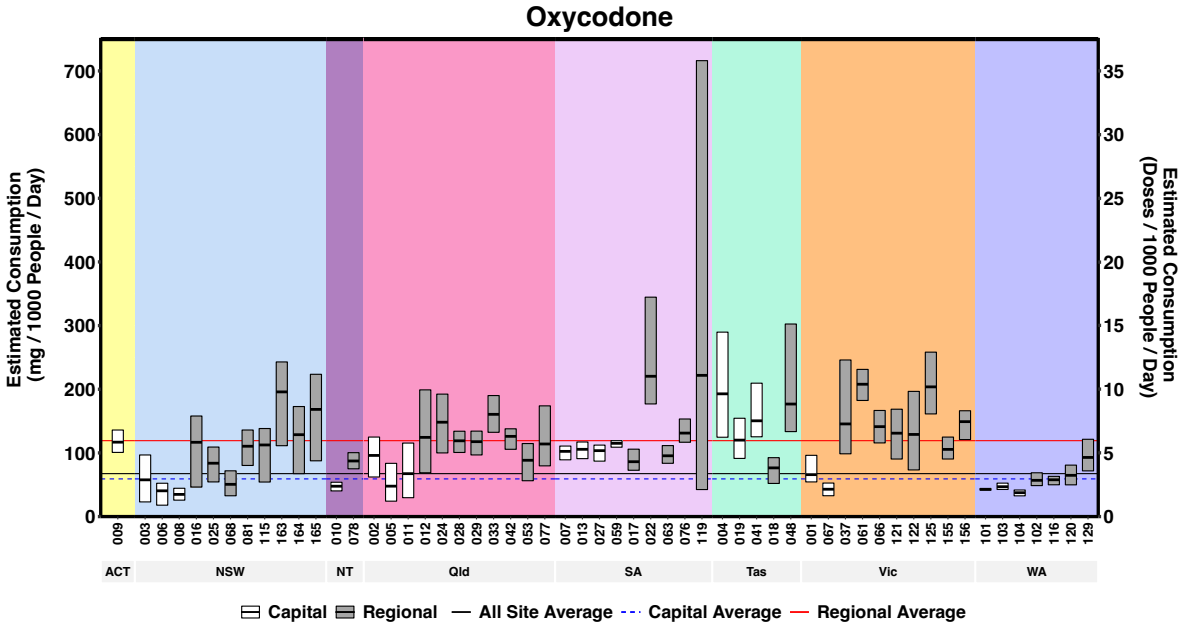
Fentanyl use was also characterised by higher average regional consumption, albeit not as distinct as oxycodone (Figure 20). A few regional sites spread across the country had particularly high consumption levels, with a relatively large spread across the sampling period. Specific days at some sites recorded consumption levels below the quantification limits of the method.

The relative scale of oxycodone and fentanyl use was apparent when results were aggregated by jurisdiction and capital or regional area and presented in bubble graph form. Generally higher oxycodone consumption rates in regional areas and in capital city Tasmania were apparent (Figure 21). With the exception of Tasmania, average fentanyl consumption was relatively low in most capital cities compared to regional areas (Figure 22).

4.1.3.2 HEROIN

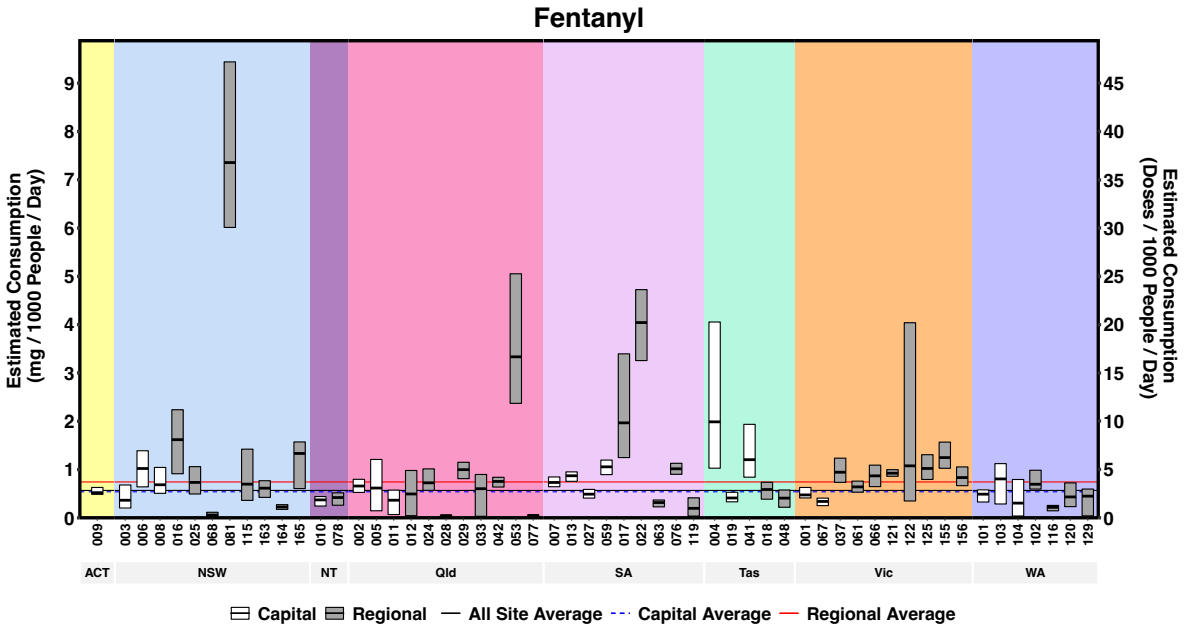
Heroin is metabolised in the body and excreted in low amounts as the unique metabolite, 6-monoacetylmorphine (6-MAM). Since the compound is characteristic of heroin metabolism, it can be used to distinguish heroin from other opioids such as morphine and codeine. Heroin consumption in the capital cities was generally much higher than regional areas, the average being almost 3 times higher in December 2021 (Figure 23). Capital city sites in the Australian Capital Territory, New South Wales, Queensland and Victoria had the highest consumption levels in December 2021, well above the average and most other sites. Some regional sites in New South Wales and Victoria also had consumption levels well above the regional average. Consumption of the drug tended to be low in many other parts of the country, with regional Queensland, South Australia and Western Australia having daily levels at or below the limits of quantification in most places. The elevated heroin consumption in capital city Victoria is clearly evident from the bubble graph (Figure 24).

Figure 19: Estimated oxycodone consumption for December 2021 in mass consumed per day (left axis) and doses per day (right axis) per thousand people. The number of collection days varied from 5-7.



- **Higher regional consumption**

Figure 20: Estimated fentanyl consumption for December 2021 in mass consumed per day (left axis) and doses per day (right axis) per thousand people. The number of collection days varied from 5-7.



- Higher regional consumption
- Highest consumption in regional New South Wales

Figure 21: Estimated average oxycodone consumption per jurisdiction for December 2021 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

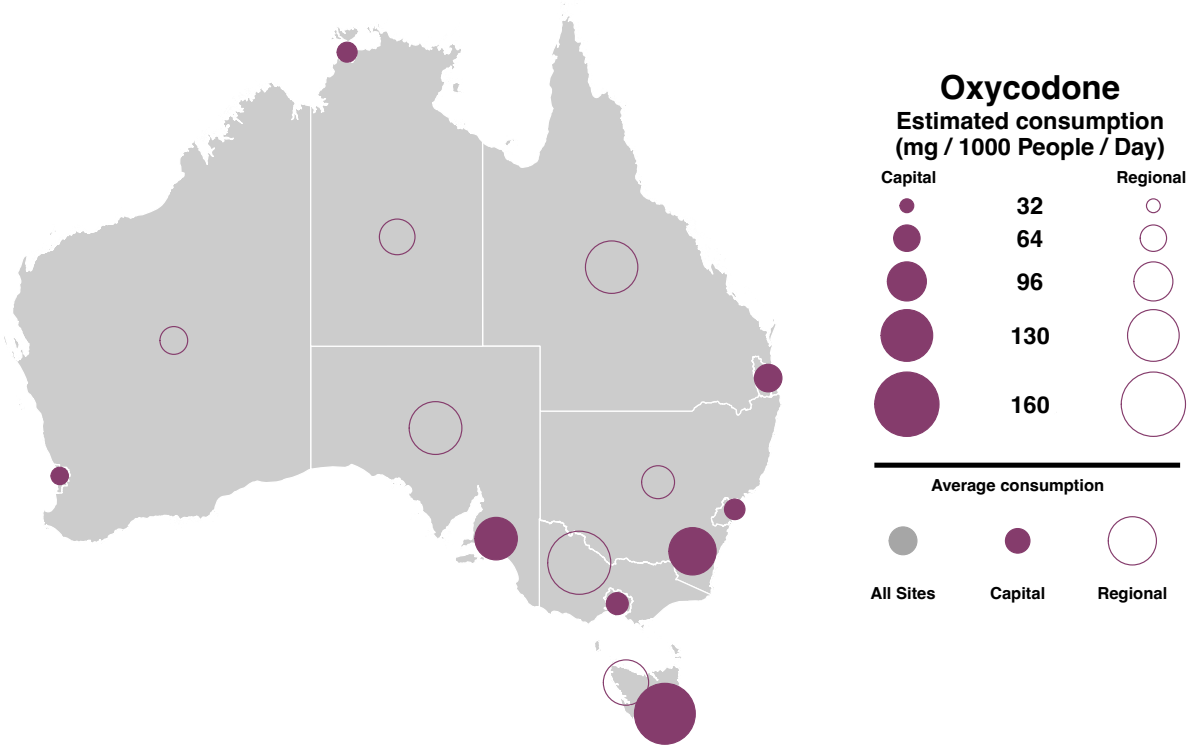


Figure 22: Estimated average fentanyl consumption per jurisdiction for December 2021 in mg consumed per day per thousand people. The number of collection days varied from 5-7.

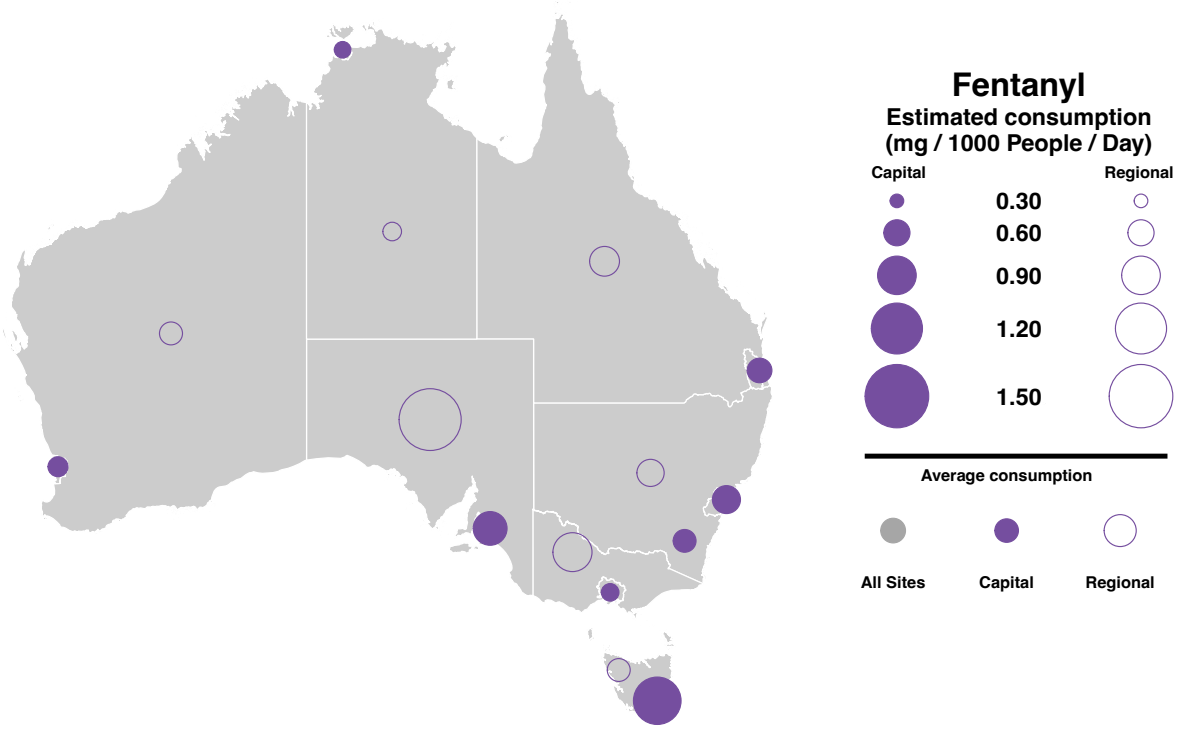
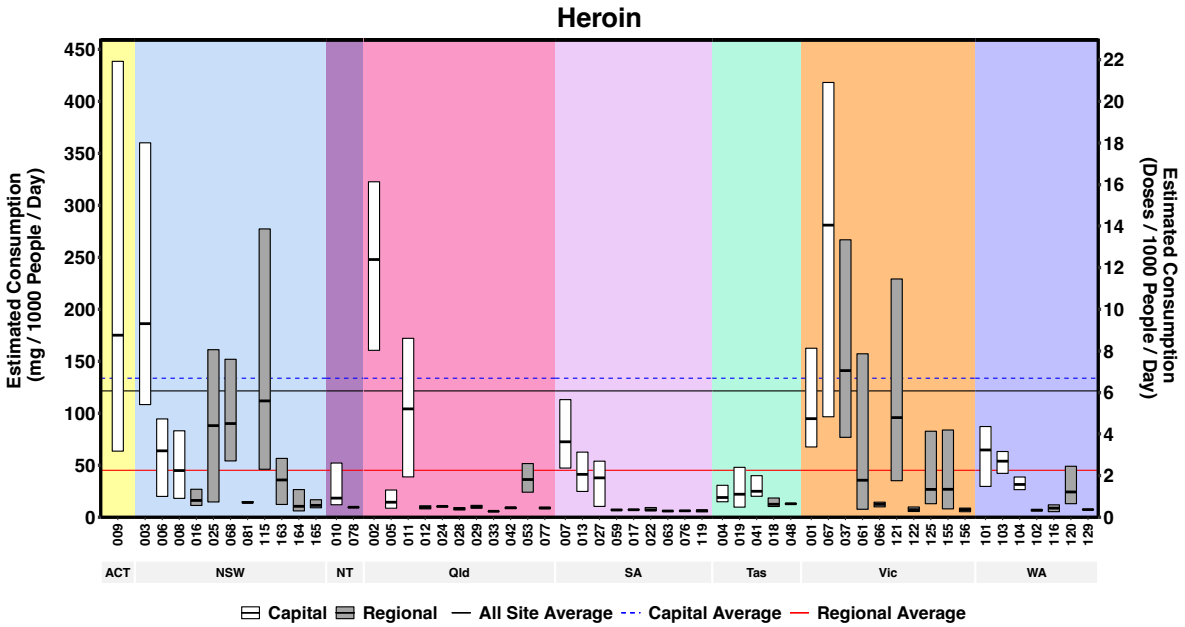
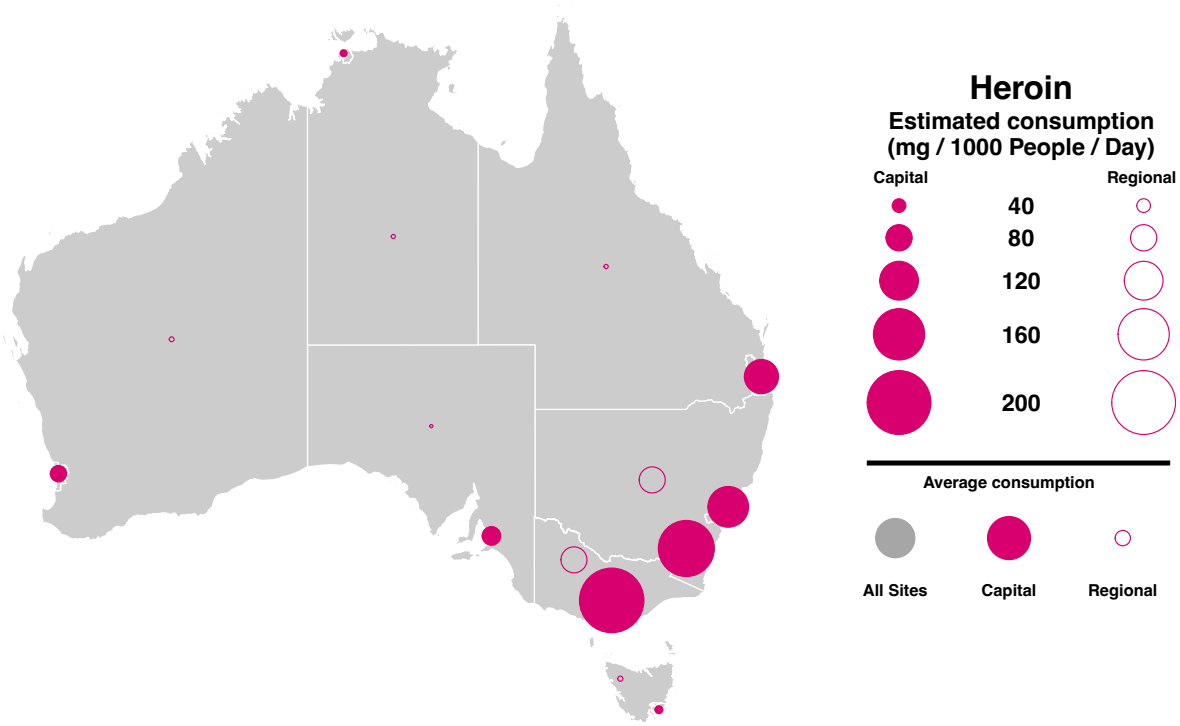


Figure 23: Estimated heroin consumption for December 2021 in mass consumed per day (left axis) and doses per day (right axis) per thousand people. The number of collection days varied from 5-7.



- Lower regional consumption, often not quantifiable
- Highest consumption generally in Victoria

Figure 24: Estimated average heroin consumption per jurisdiction for December 2021 in mg consumed per day per thousand people. The number of collection days varied from 5-7.



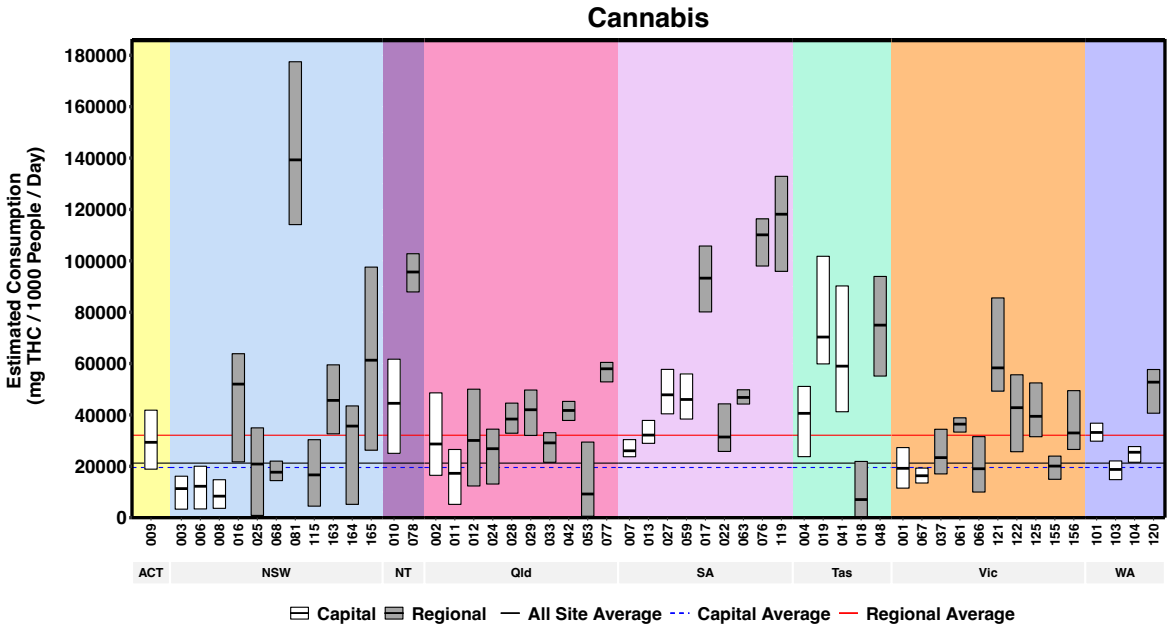
4.1.4 CANNABIS

Tetrahydrocannabinol (THC) is the main psychoactive compound found in cannabis. The compound is metabolised and largely cleared through the intestine. A small proportion (0.6 per cent) is excreted through the kidneys as 11-nor-9-carboxy-tetrahydrocannabinol (THC-COOH). The latter is known to adsorb to various surfaces, including sewer infrastructure. Therefore, in terms of wastewater analysis, the sewer design and collection method may play a part in the reportable levels of the target metabolite used for the purposes of the NWDMP. Upon collection, samples need to be preserved to avoid degradation of THC-COOH, without using acidification (McCall et al. 2016). This is one reason why cannabis consumption is not reported on a regular basis in other countries where wastewater analysis is routinely conducted. Acidification is a common preservation technique. For the NWDMP, separate samples are collected each day and preserved specifically for THC-COOH analysis, except for some sites in regional Western Australia.

Cannabis consumption was expressed as the daily mass load (mg) of consumed active ingredient (THC) consumed per 1,000 people. An average dose was not defined as for most other drugs in the report. The dose of cannabis depends on several factors, such as the part of the plant, the strain, or whether an extract was used. This will be included in graphical representations of the data when an appropriate dose becomes available.

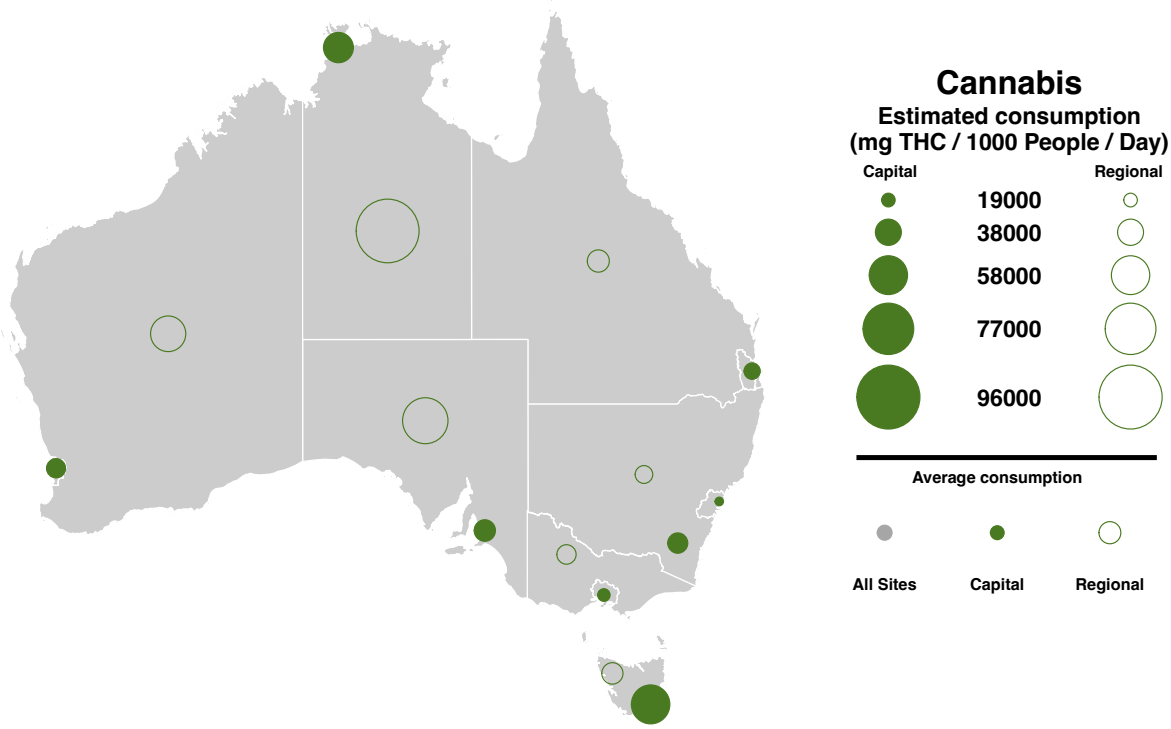
Large spatial differences were evident across Australia in December 2021 (Figure 25). Average regional consumption exceeded capital city consumption. The highest consumption was mostly observed in regional sites in New South Wales, the Northern Territory and South Australia. Tasmania had the highest consumption of the capital cities. In contrast, capital city New South Wales had very low cannabis consumption levels. The bubble plot and jurisdictional differences of cannabis use across Australia show the generally higher consumption in regional areas (Figure 26).

Figure 25: Estimated cannabis consumption for December 2021 in mass consumed per day (left axis). The number of collection days varied from 5-7.



- Higher regional consumption
- Variable consumption across the country

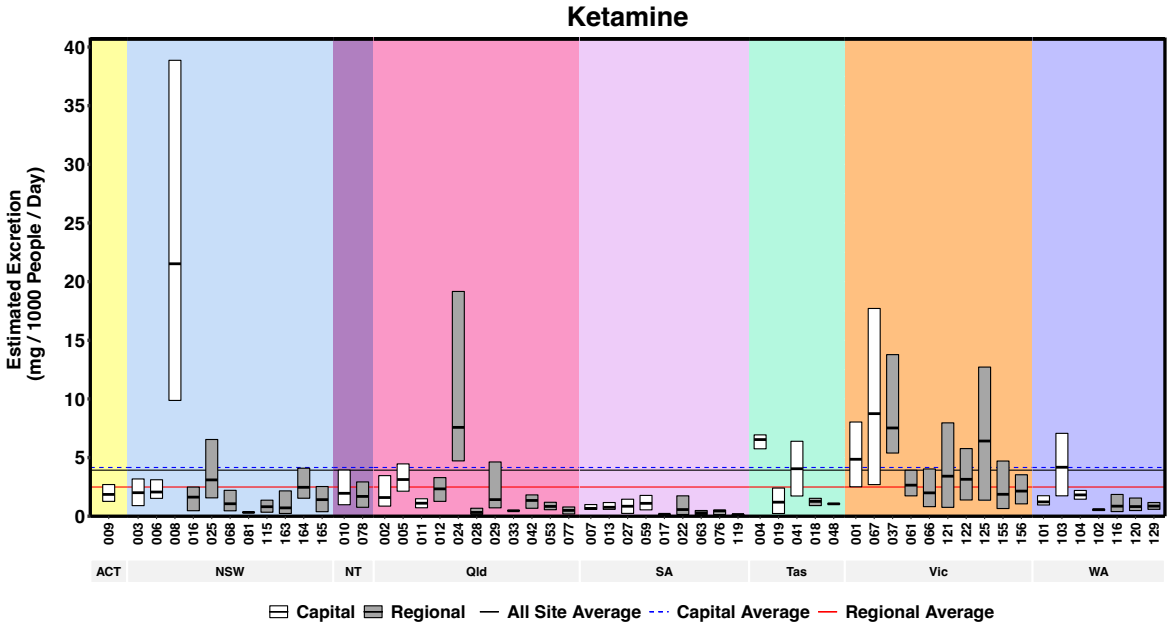
Figure 26: Estimated average cannabis consumption per jurisdiction for December 2021 in mg consumed per day per thousand people. The number of collection days varied from 5-7.



4.1.5 KETAMINE

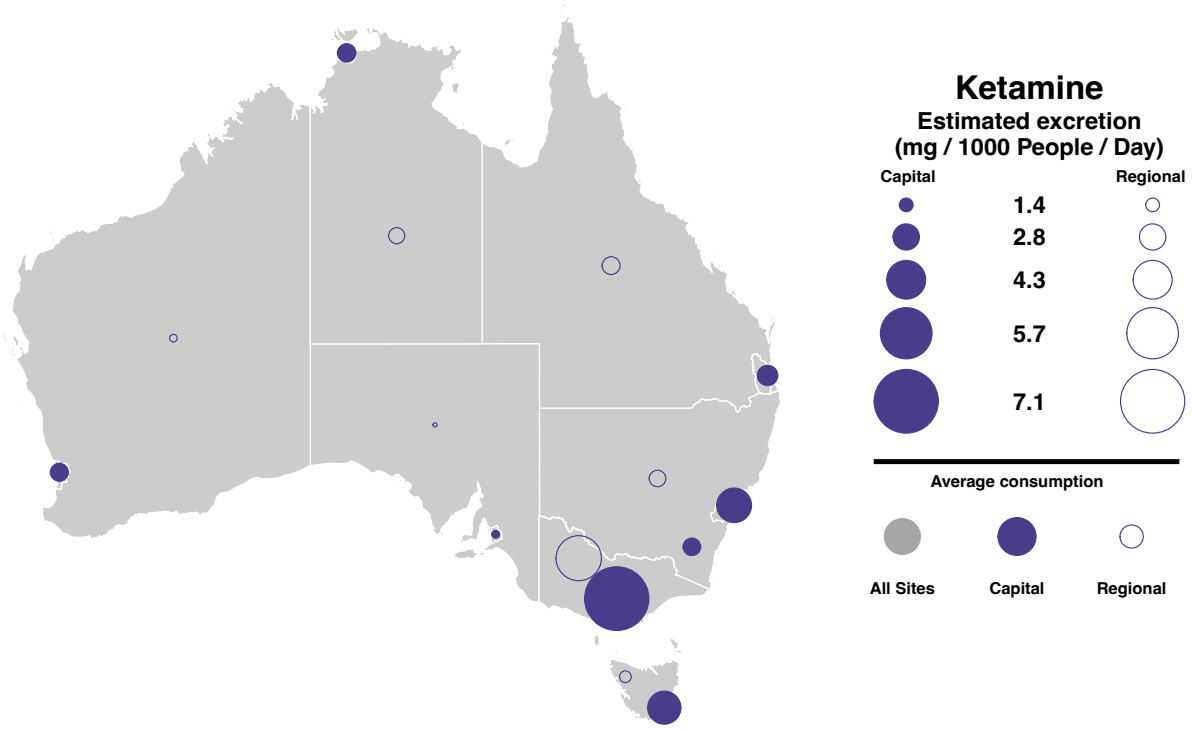
Ketamine, measured as its metabolite, norketamine, is used medically for the management of acute pain often associated with surgery or trauma. It has veterinary applications as well, although this may have less relevance in terms of wastewater monitoring due to the separation of stormwater and agricultural run-off and the sewer network in most Australian catchments. Due to its sedative and hallucinogenic effects, the drug has been associated with illicit substance abuse and is listed as a new psychoactive substance by the United Nations Office on Drugs and Crime (UNODC). The reported proportions of ketamine and its metabolites in wastewater leave some doubt as to an appropriate factor to convert excreted amounts to consumed amounts. Therefore, measured levels are shown as excreted daily mass loads, similar to the case of the stimulant, MDA. The regional average was lower than the capital cities, partly because values fell below the method detection limits on certain days at various sites (Figure 27). A site in New South Wales and Queensland had comparatively high excretion levels, while Victoria had above average consumption at a number of sites across the state. A bubble plot shows the relative scale of ketamine excretion across Australia, with Victoria having the highest consumption in December 2021 (Figure 28).

Figure 27: Estimated ketamine excretion for December 2021 in mass excreted per day (left axis) per thousand people. The number of collection days varied from 5-7.



- Lower regional excretion
- High excretion in specific catchments

Figure 28: Estimated average ketamine excretion per jurisdiction for December 2021 in mg excreted per day per thousand people. The number of collection days varied from 5-7.



4.2 TEMPORAL CHANGES IN DRUG CONSUMPTION ESTIMATES BY JURISDICTION

The per capita consumption of each drug outlined in the following figures compares data acquired in this report to previous collection periods on a state or territory basis. The data relating to capital cities in this section have been updated to include both the December 2021 and February 2022 collections, while regional areas were updated for December 2021. This needs to be considered when comparing results between sections 4.1 and 4.2. Ketamine was included in the Program for the first time in Report 13 and so has fewer data points than the other substances.

Although every effort has been made to assess the same sites for each period, the individual sites and the number of sites used to generate the population-weighted averages may have changed between periods. Comparing between time points should be done with caution. This would be most evident for the regional averages, which had more variation in participation between each period (see Appendix 2 and Appendix 3, Report 6 and Appendix 2 in this report). The current report presents the last 2 years of data. Prior data dating back to 2016 for each substance of interest is available on the ACIC website by jurisdiction.

Note: the horizontal red, blue and black lines on each temporal graph which represent the averages are the cumulative average across all sampling time points and all analysed samples.

4.2.1 NICOTINE AND ALCOHOL

Trends in nicotine consumption tend to be state-specific (Figure 29). Short-term changes since the previous reporting period (August and October 2021) varied across jurisdictions. Average regional per capita nicotine consumption is well above capital city consumption levels, with the Northern Territory having the highest per capita consumption in the country.

Overall, alcohol consumption does not appear to have changed substantially over the past 12 months. No consistent or uniform patterns in alcohol consumption are evident across the country (Figure 30). Average per capita regional alcohol consumption exceeds capital city consumption, however the difference in alcohol consumption in regional areas compared to capital city consumption was less pronounced than for nicotine. The Northern Territory and capital city Tasmania continue to have the highest overall consumption of alcohol, while South Australia and Western Australia have the lowest alcohol consumption in the country. Noticeably lower consumption is observed in regional South Australia.

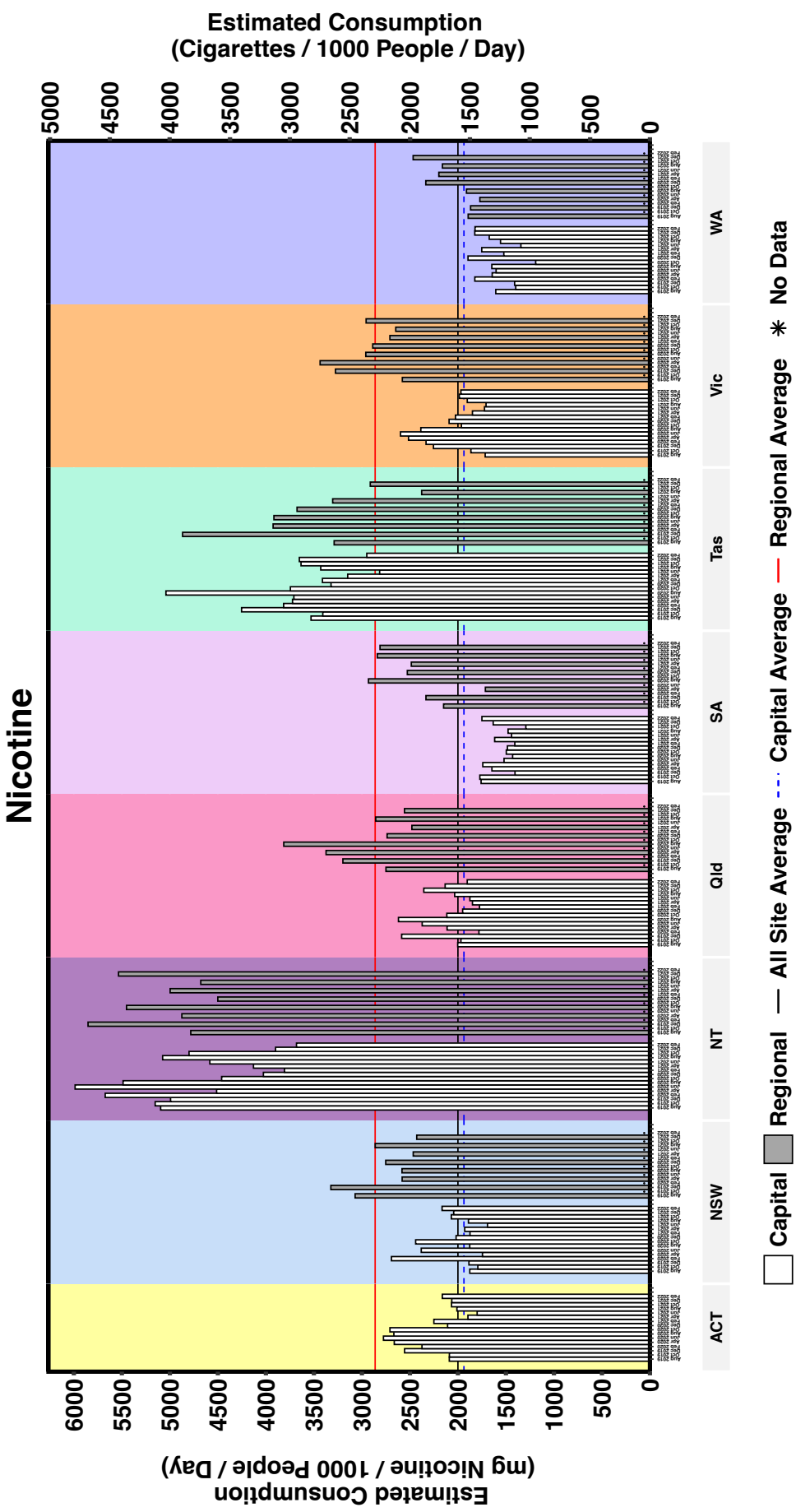


Figure 29: Estimated average consumption of nicotine by state/territory, August 2019 to February 2022, where 1 cigarette provides 1.25 mg of nicotine.

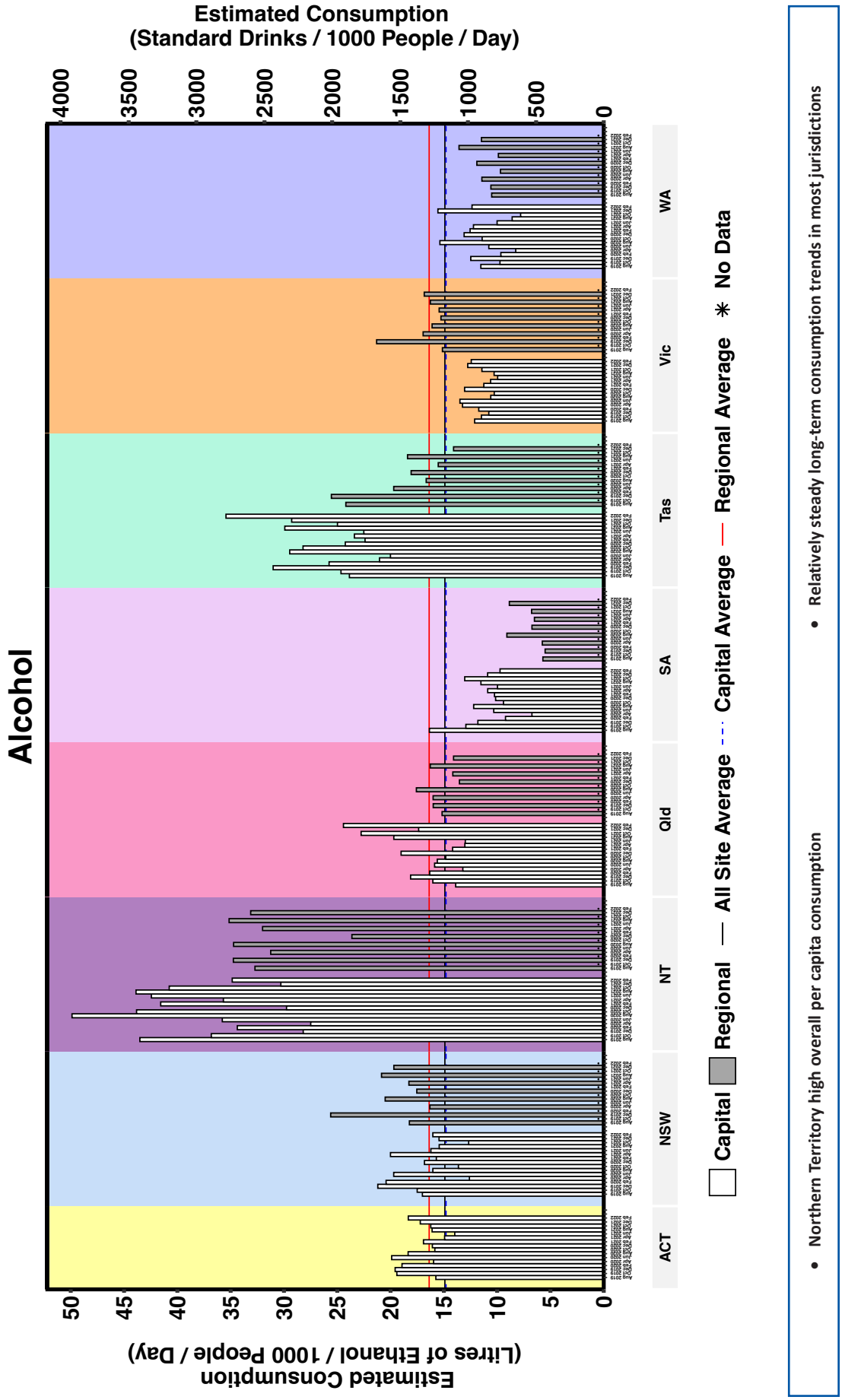


Figure 30: Estimated average consumption of alcohol by state/territory, August 2019 to February 2022. A standard drink is 10.0 g or 12.6 mL.

4.2.2 STIMULANTS

Methylamphetamine consumption was highly affected by COVID-19 related restrictions and a slump in use was evident in mid-2020 in most parts of the country. Since then, consumption of the drug has recovered to differing degrees across the country (Figure 31). In the Australian Capital Territory, the Northern Territory and Tasmania, methylamphetamine consumption has remained at the lower end of the scale. Long-term average per capita regional methylamphetamine consumption is higher than capital city consumption. Following considerable fluctuations in consumption, Western Australia had the highest average capital city consumption nationally in December 2021. New South Wales had the highest regional consumption, and in February 2022, New South Wales had the highest capital city consumption nationally.

Several sites have data available from before the start of the NWDMP showing long-term changes in use of methylamphetamine (Figures 32 and 33). Consumption of the substance has increased many-fold since the start of wastewater monitoring studies from 2009. Methylamphetamine consumption levels at the 2 regional sites in Queensland in December 2021 were almost back to where they were in 2014 (Site 12) and 2015 (Site 33), while in South Australia, consumption levels in the 4 capital city sites in February 2022 were below 2014 levels. Monitoring in Victoria and Western Australia does not go quite as far back. Methylamphetamine consumption levels in the 3 capital city sites in Western Australia in February 2022 were less than half the October 2016 levels. In contrast, the 2 capital city sites in Victoria appear to have been less impacted, with less evident variations over time.

Cocaine consumption had been steadily increasing in almost all capital cities and many regional parts of Australia for the years leading up to the start of COVID-19 restrictions (Figure 34). At that point, consumption declined across the country. Average capital city cocaine consumption is well above regional consumption levels. New South Wales remains the jurisdiction with the highest average per capita cocaine consumption nationally. Cocaine consumption remains low in Western Australia and the Northern Territory.

MDMA consumption across Australia has been declining over the past 2 years and is currently at the lowest levels since the Program commenced in August 2016 (Figure 35). Long-term trends in MDMA consumption over the life of the Program show that MDMA consumption was increasing from August 2016, before peaking in late 2019. Long-term average per capita regional MDMA consumption exceeds capital city consumption. The Northern Territory and Tasmania capital cities have historically been the 2 locations where MDMA consumption tended to be the highest in the nation. This has changed in the current reporting period, with consumption now more evenly spread over several jurisdictions.

MDA use, corrected for the proportion derived from MDMA (Khan & Nicell 2011), has declined in recent years (Figure 36). There have been sporadic spikes in MDA excretion, most notably in regional Queensland, but generally the overall trend in consumption across most jurisdictions is decreasing. Average per capita regional MDA excretion is around double capital city excretion levels. Victoria had the highest average capital city MDA excretion in December 2021, with the Northern Territory having the highest regional consumption nationally.

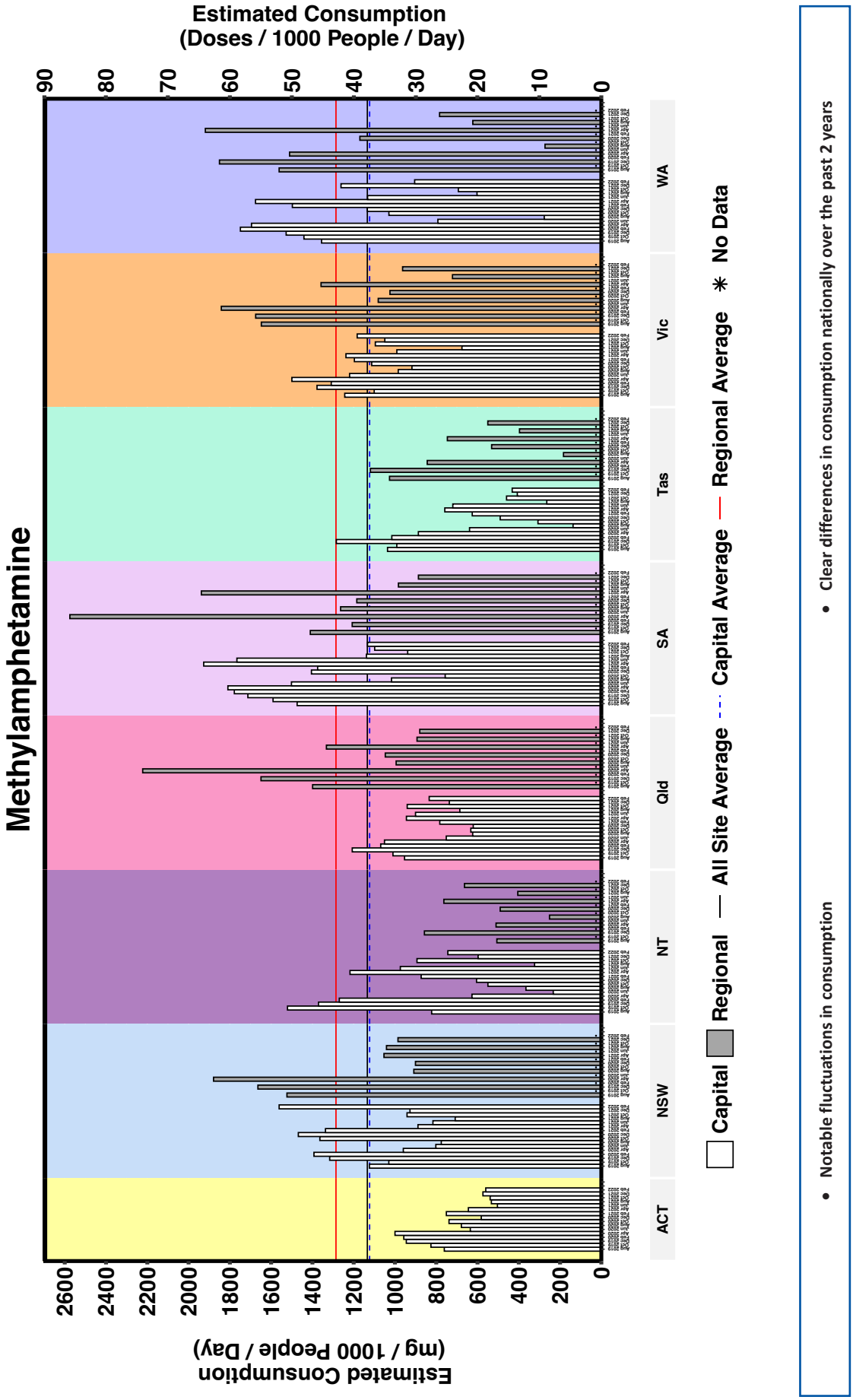


Figure 31: Estimated average consumption of methylamphetamine by state/territory, August 2019 to February 2022.

Figure 32: Change in methylamphetamine consumption for sites in Queensland and South Australia with historical data.

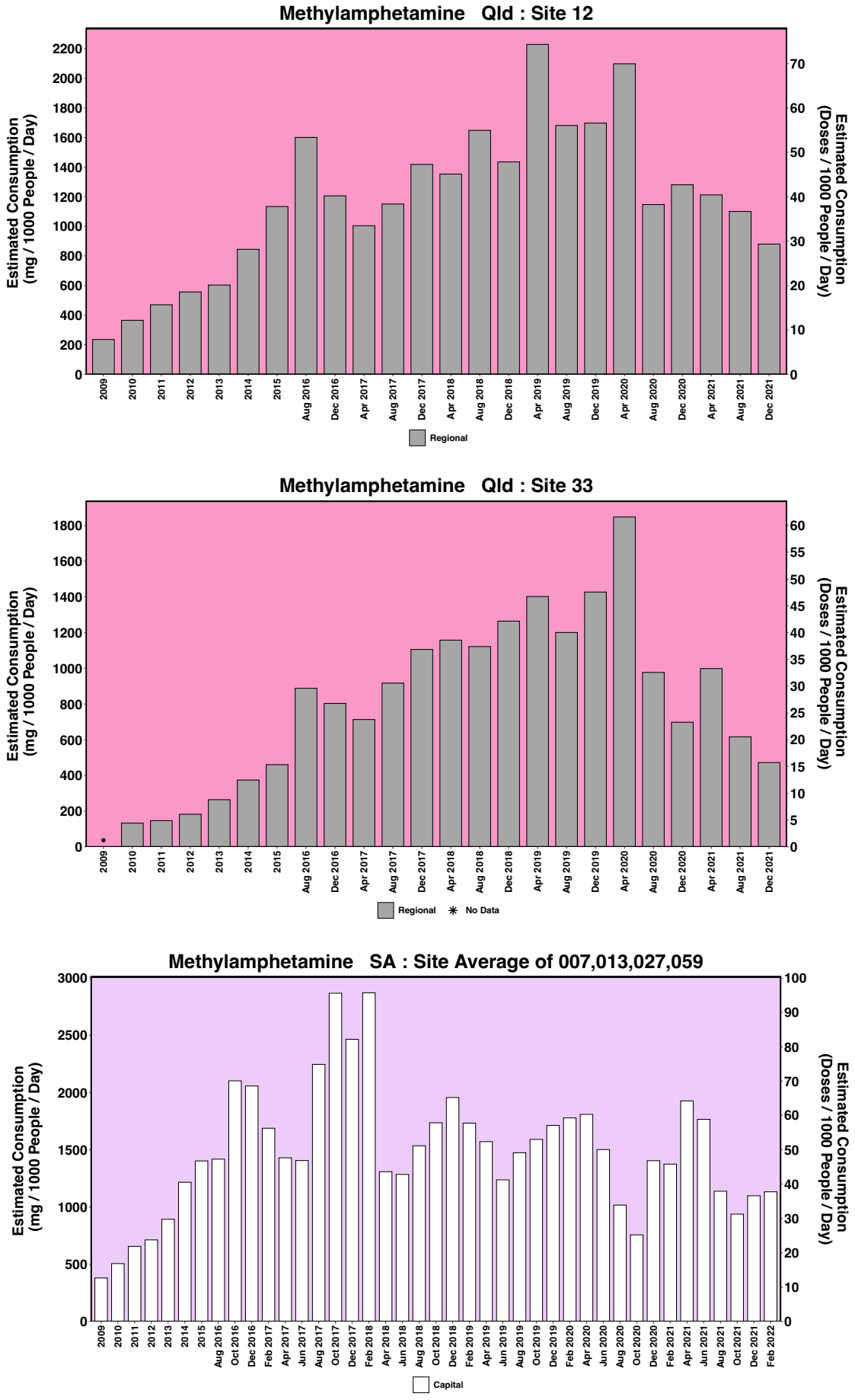
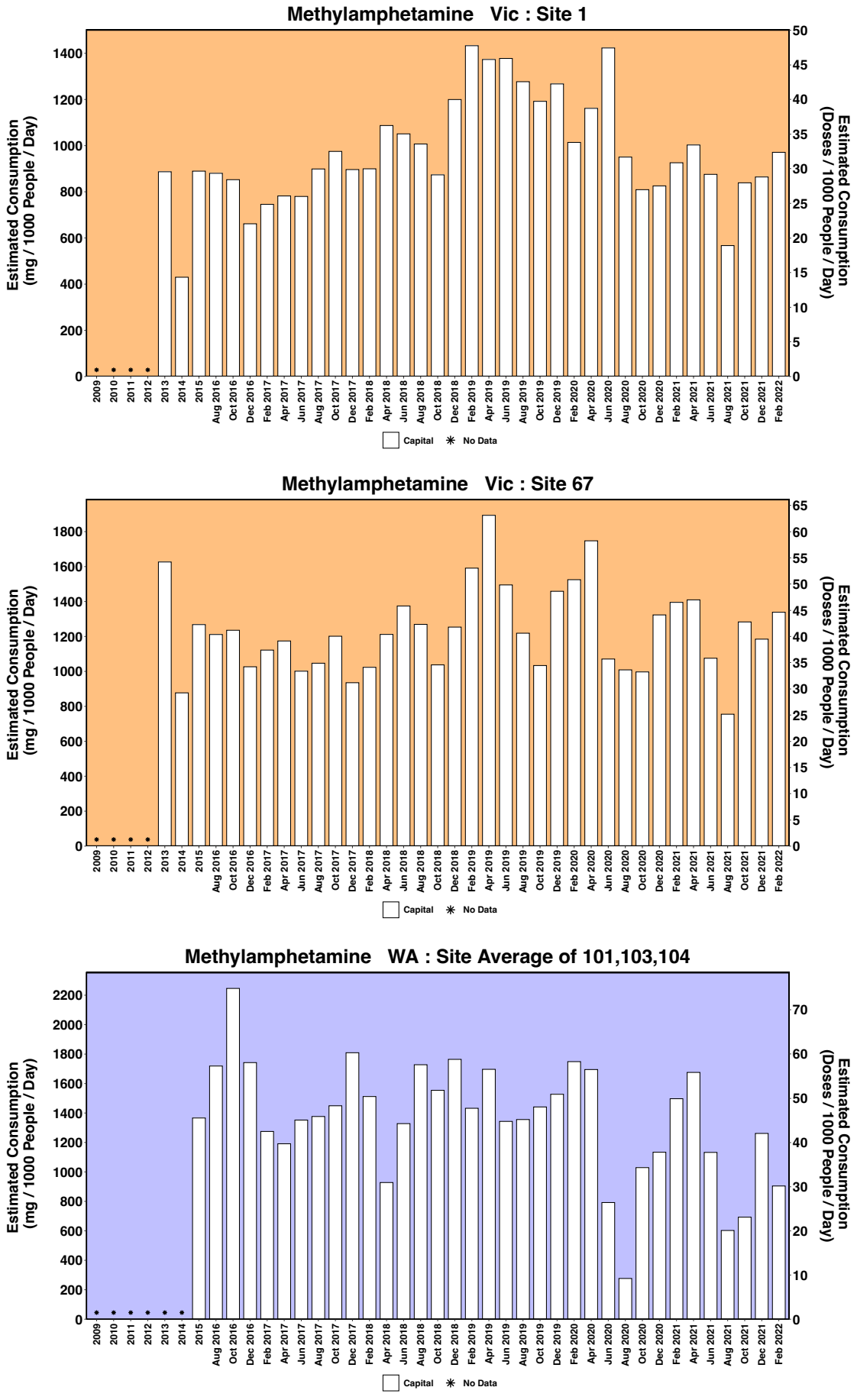


Figure 33: Change in methylamphetamine consumption for sites in Victoria and Western Australia with historical data. Both Victorian sites were the average of one week per year in 2013, 2014 and 2015.



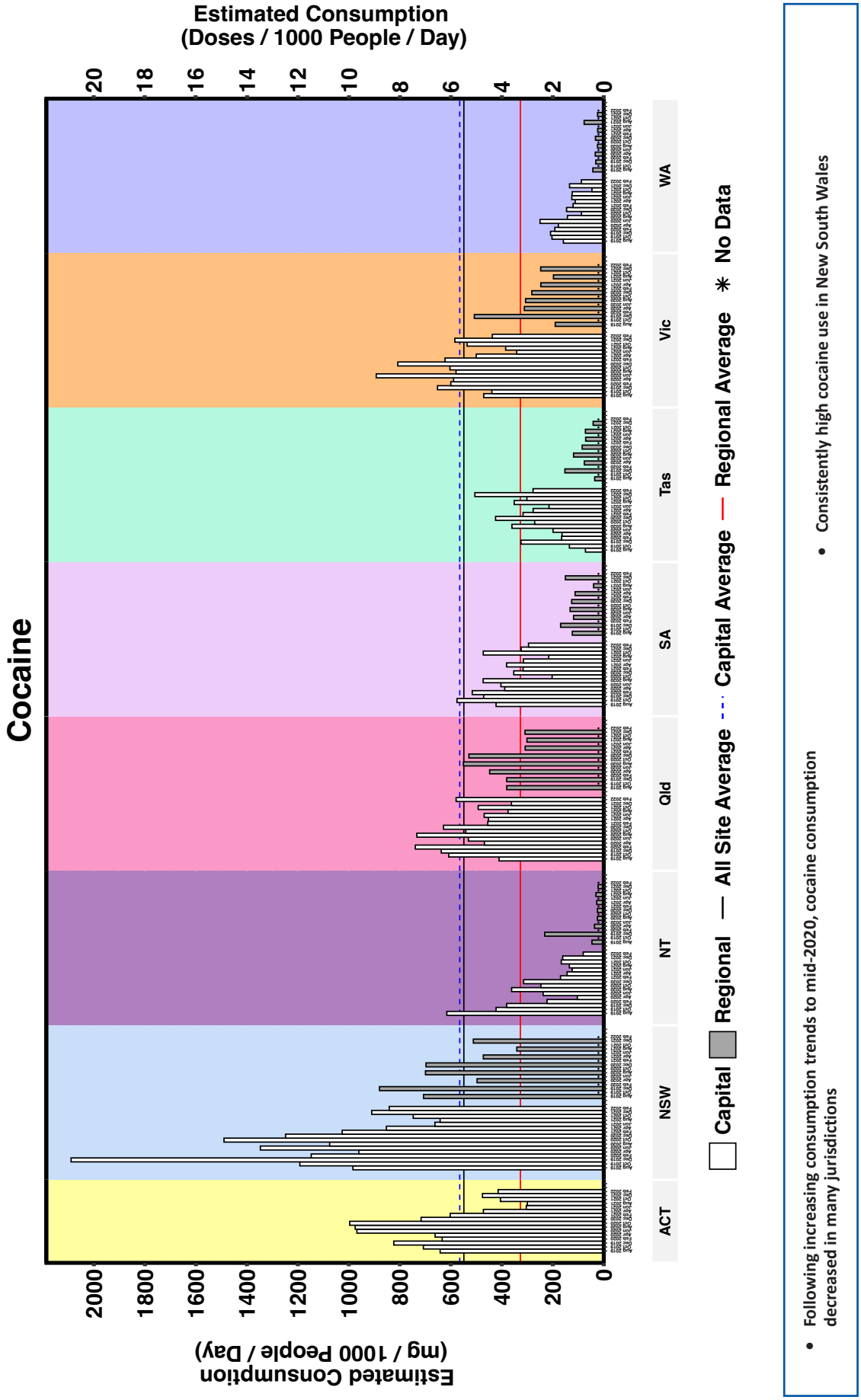


Figure 34: Estimated average consumption of cocaine by state/territory, August 2019 to February 2022.

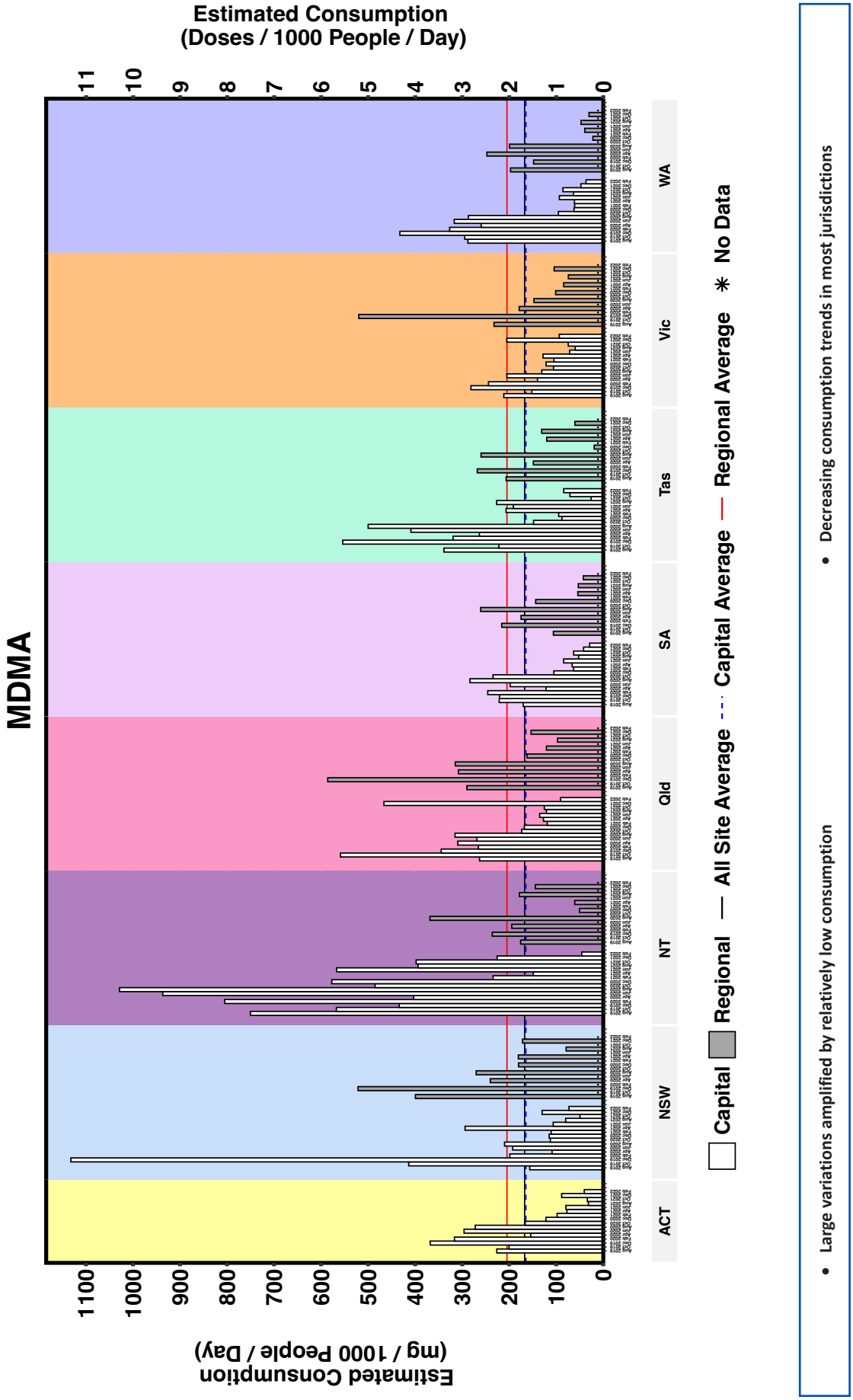


Figure 35: Estimated average consumption of MDMA by state/territory, August 2019 to February 2022.

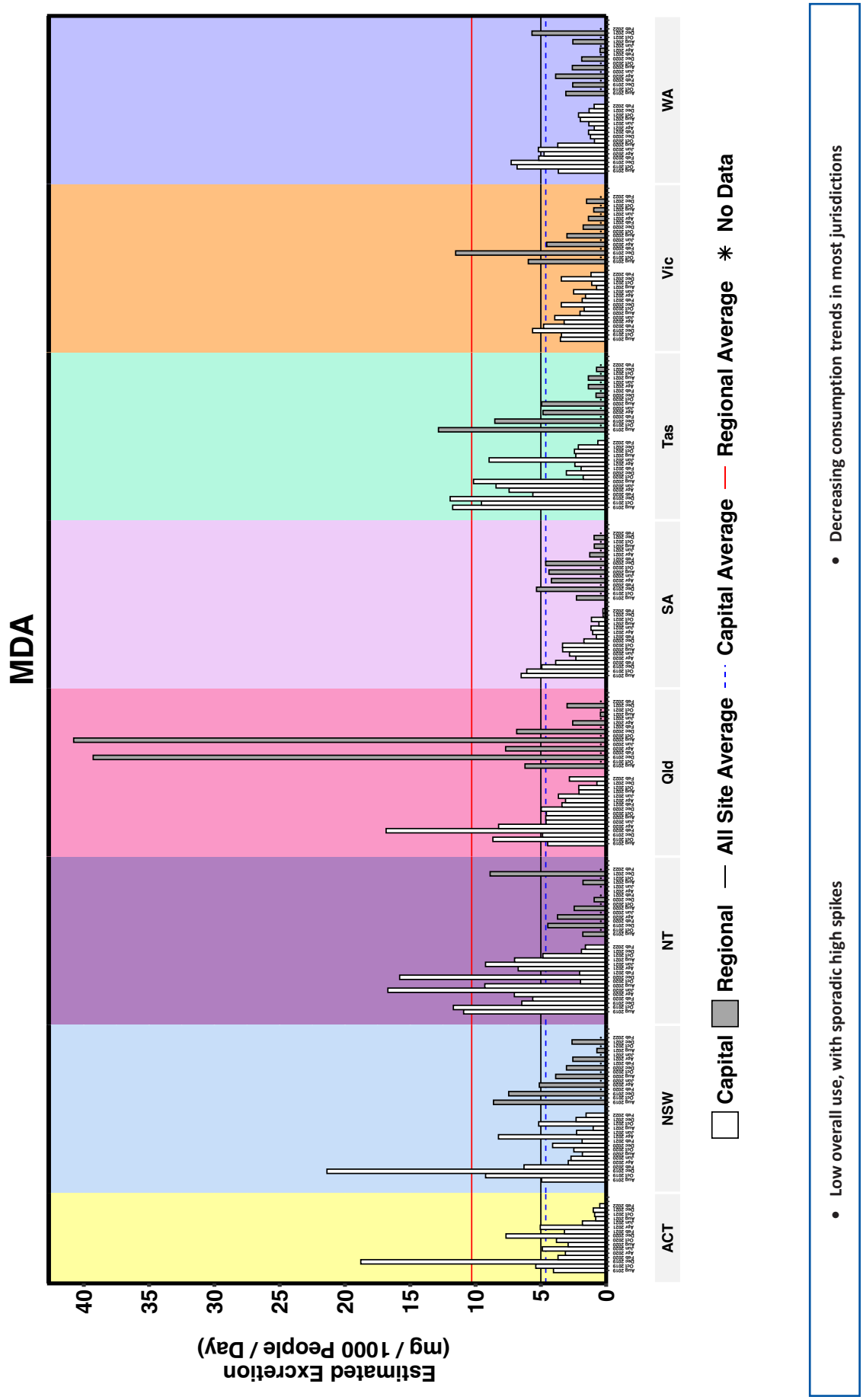


Figure 36: Estimated average excretion of MDA by state/territory, August 2019 to February 2022.

4.2.3 OPIOIDS

Oxycodone consumption over the past 2 years has been characterised by a period of general decreases (Figure 37). Findings from the current reporting period are largely consistent with the recent levelling off in oxycodone consumption. Average per capita regional oxycodone consumption is nearly double capital city levels. Capital city Tasmania, the Australian Capital Territory and regional Queensland and Victoria tend to be among the highest consumers of oxycodone nationally.

The trend relating to fentanyl consumption has been downward over the past few years, even though some sporadic increases have been evident in parts of the country (Figure 38). Average per capita regional fentanyl consumption is notably higher than capital city consumption. Tasmania had the highest average capital city fentanyl consumption in December 2021, with South Australia having the highest regional consumption nationally.

In contrast to the pharmaceutical opioids, heroin is mostly consumed in the capital cities (Figure 39). Heroin consumption appeared to peak in mid-2020. Victoria had the highest average capital city heroin consumption in December 2021, with New South Wales having the highest regional consumption nationally. Heroin consumption has been measured in 4 capital city sites in South Australia since 2013 (Figure 40). A gradual, long-term decrease in heroin consumption was evident from 2013 to early 2019, followed by a rapid increase towards the end of that year. However, since the start of the pandemic in Australia, heroin consumption has fluctuated in these sites.

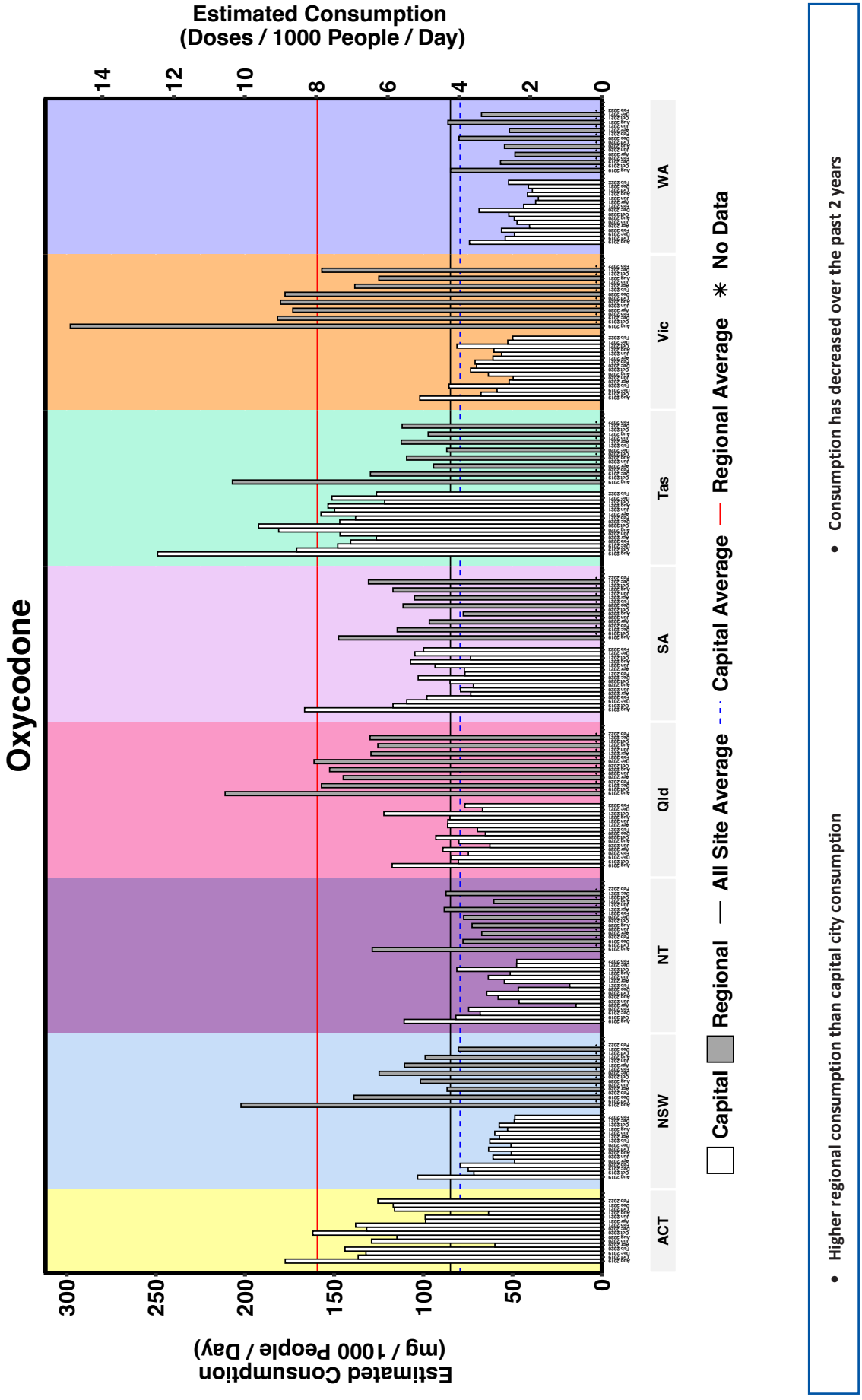


Figure 37: Estimated average consumption of oxycodone by state/territory, August 2019 to February 2022.

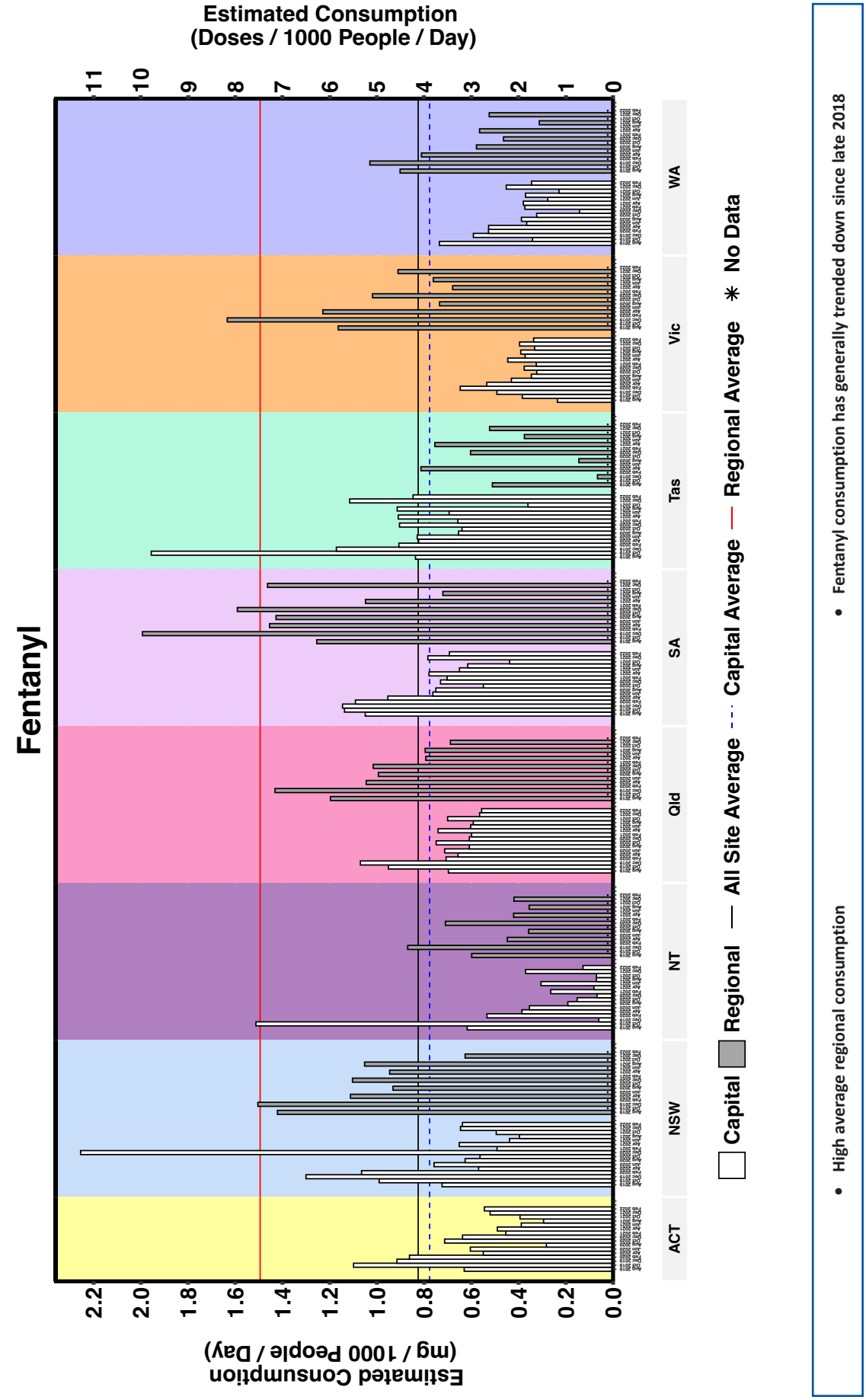


Figure 38: Estimated average consumption of fentanyl by state/territory, August 2019 to February 2022.

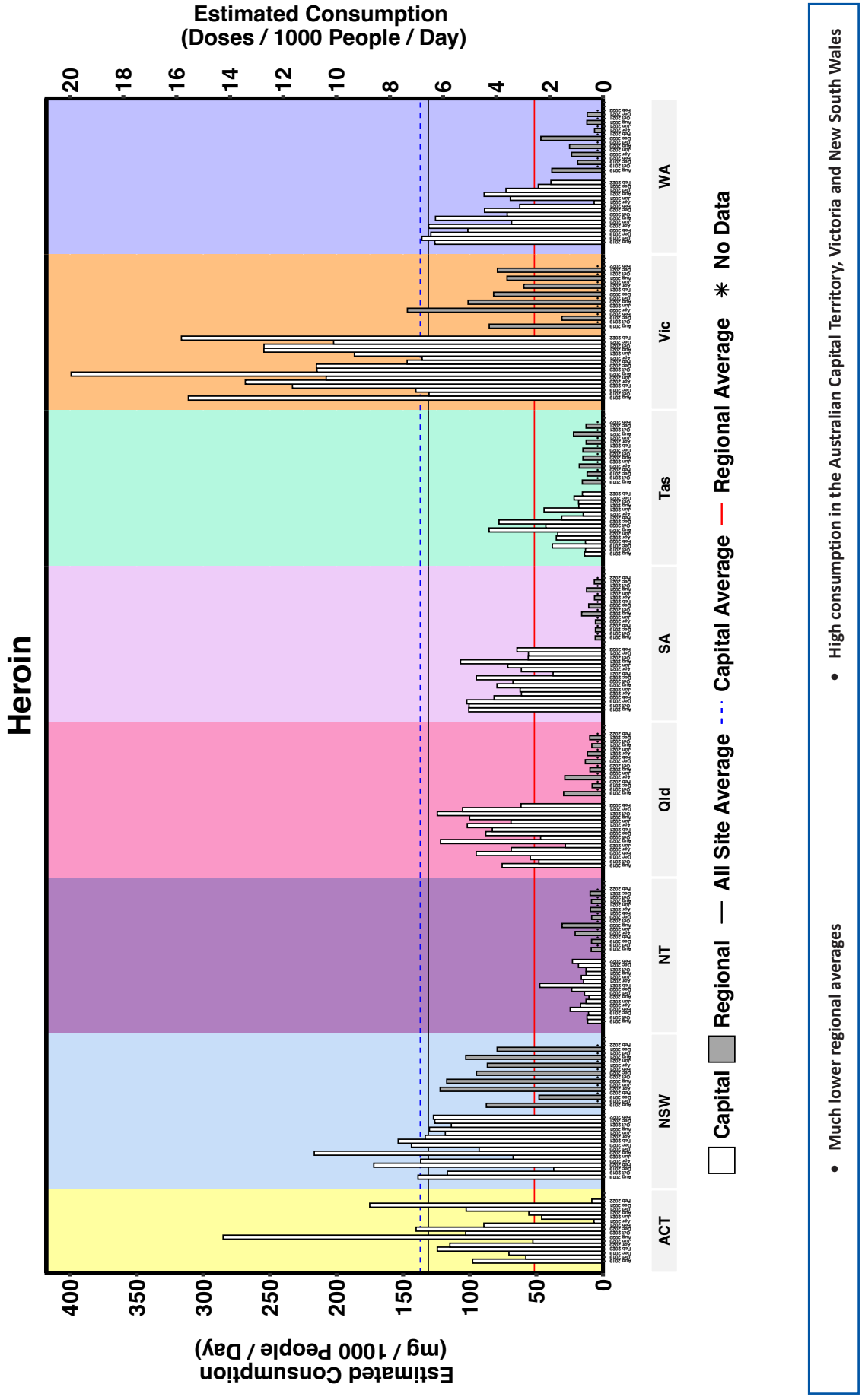
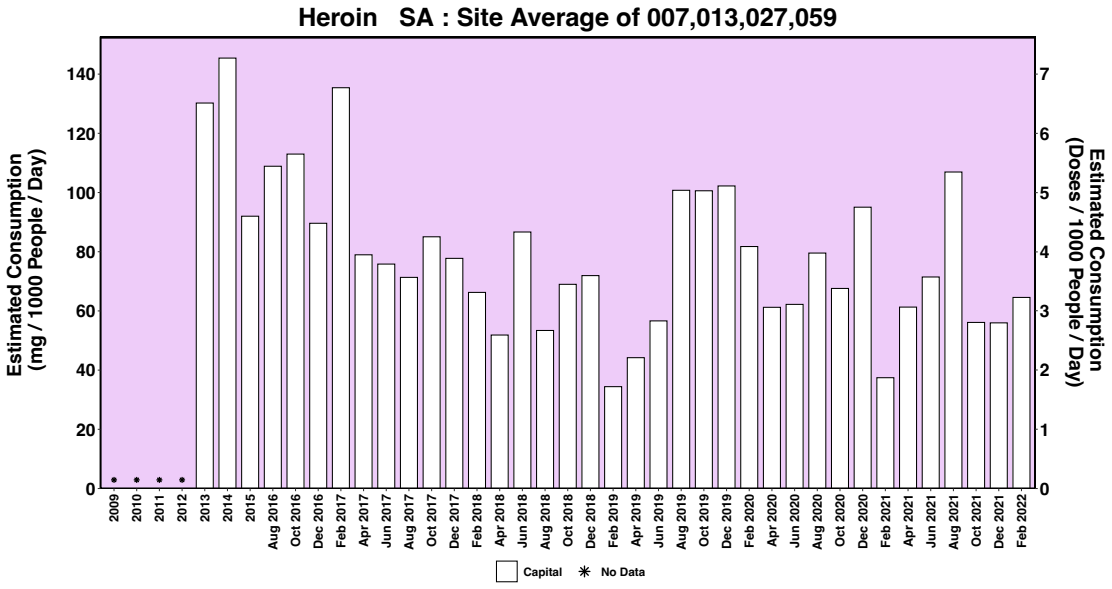


Figure 39: Estimated average consumption of heroin by state/territory, August 2019 to February 2022.

Figure 40: Change in heroin consumption for sites in South Australia with historical data.



4.2.4 CANNABIS

Cannabis was first included in the NWDMP in August 2018. Trends over the past 2 years show that cannabis consumption has been steadily increasing almost everywhere (Figure 41). This is especially evident in regional Northern Territory and Western Australia, both of which had record high consumption levels in December 2021. Average per capita regional cannabis consumption is substantially higher than capital city consumption. Tasmania had the highest average capital city cannabis consumption in December 2021, with the Northern Territory having the highest regional consumption nationally.

Cannabis consumption has been measured in 4 capital city sites in South Australia since 2011. An overall increasing trend in consumption was observed until early 2019, followed by a short-term decline to February 2020, before increasing again (Figure 42).

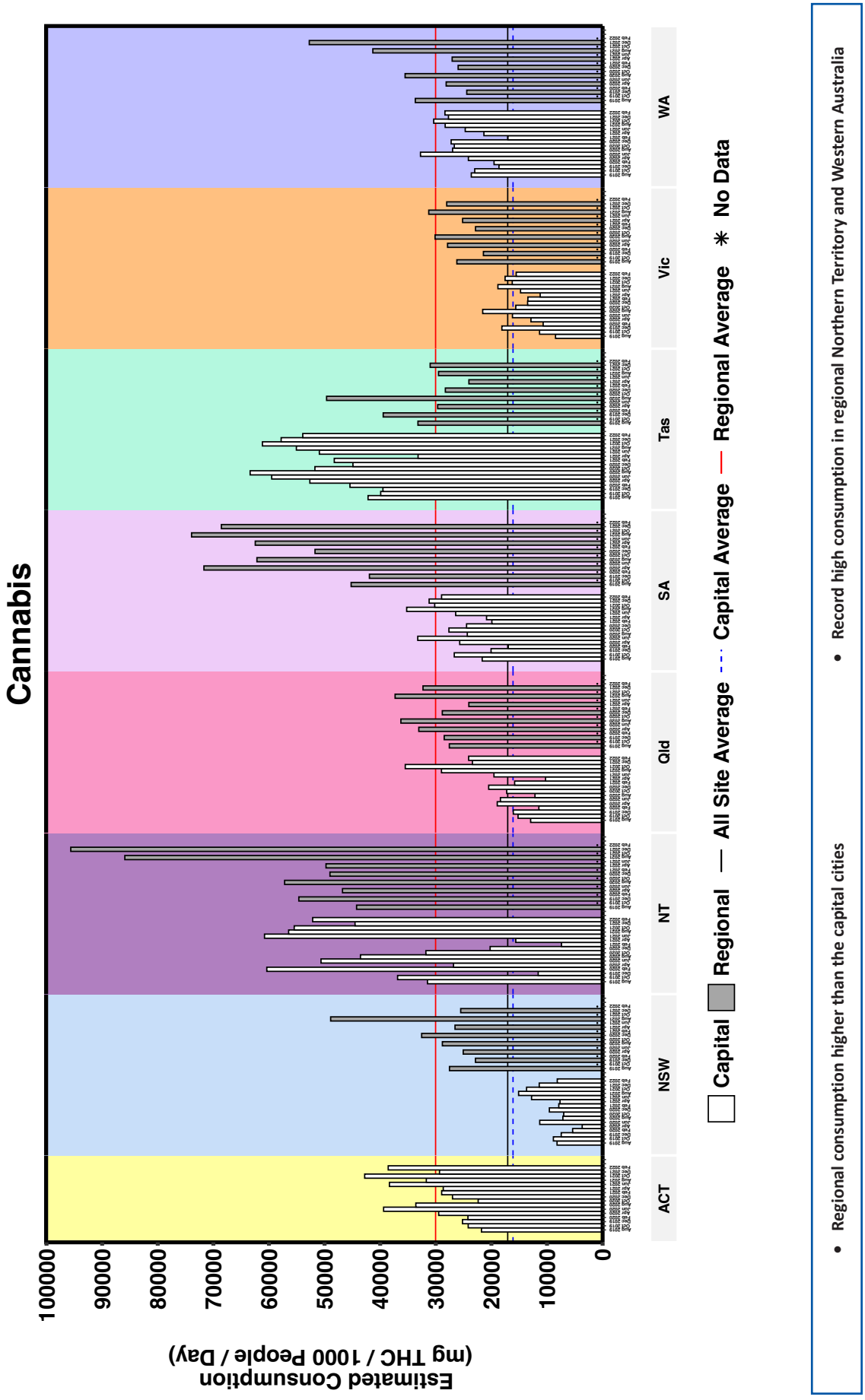
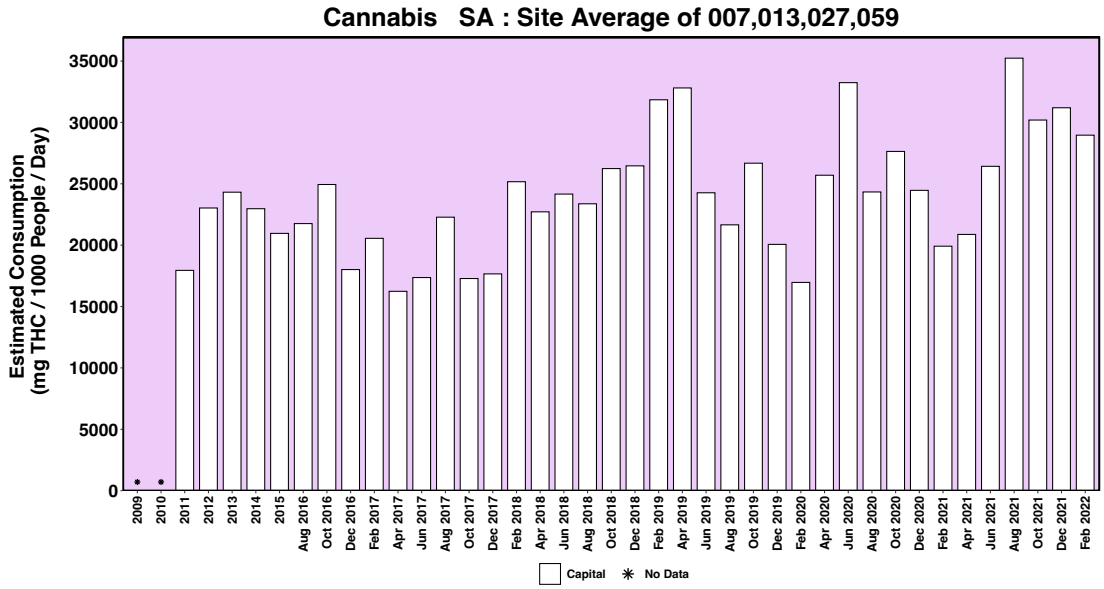


Figure 41: Estimated average consumption of cannabis by state/territory, August 2019 to February 2022.

Figure 42: Change in cannabis consumption for sites in South Australia with historical data. Cannabis is detected via the THC metabolite, THC-COOH.



4.2.5 KETAMINE

Ketamine has been part of the Program since December 2020. Average per capita capital city ketamine excretion is higher than regional excretion levels. Victoria had the highest average capital city and regional ketamine excretion levels nationally in December 2021 (Figure 43). South Australia has had the lowest ketamine excretion levels over the past year, with the Northern Territory capital city site having the largest variability in excretion levels between collection periods.

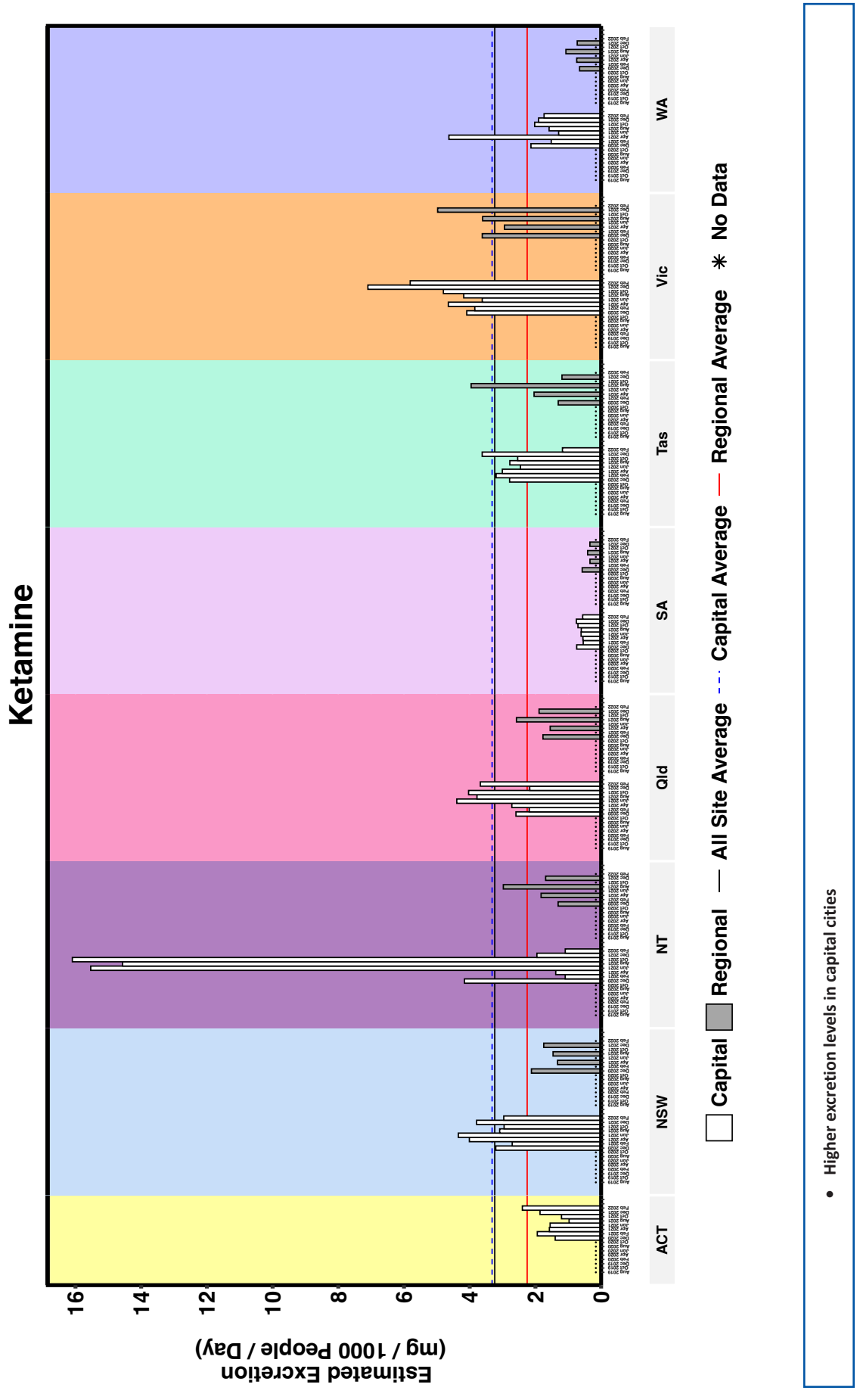


Figure 43: Estimated average excretion of ketamine by state/territory, August 2019 to February 2022.

4.3 NATIONAL CAPITAL CITY AND REGIONAL AVERAGES

In order to show the national trends for the individual substances, all capital city and regional sites were combined for each substance (Figure 44 to Figure 49). Fewer sites were sampled in October 2016 and this is highlighted as such in the respective figures.

In terms of legal substances with abuse potential, nicotine consumption has remained relatively unchanged from the start of the Program, with only small fluctuations evident. Results from this reporting period show marginal changes in capital city and regional nicotine consumption. In the case of the capital cities, nicotine use has shown an upward trend since mid-2021. Alcohol consumption also appears relatively steady over time, with some short-term peaks and troughs. One of these troughs in 2020 coincided with restrictions implemented in response to COVID-19 (Figure 44).

Overall methylamphetamine consumption in regional Australia increased more than in the capital cities from early 2017 to the start of the pandemic in early 2020 (Figure 45). From that point, methylamphetamine consumption decreased substantially to August 2020. Consumption in the capital cities made a gradual recovery over the 6 months to early 2021, back to near pre-pandemic levels. While regional consumption also increased, the recovery was less pronounced. However, methylamphetamine consumption again decreased by August 2021 to the lowest levels recorded by the Program. Since then, consumption has again started to increase. The higher use of methylamphetamine in regional Australia that was evident from 2017 to April 2020 has diminished, with no clear distinction between regional and capital city consumption of late.

MDMA consumption rates declined over the first year of the Program, followed by a gradual increase to the end of 2019 (Figure 45). MDMA consumption reached a peak in both capital city and regional areas in December 2019, but has since declined, with capital city consumption in February 2022 the lowest level recorded by the Program.

Long-term trends in cocaine consumption clearly show the discrepancy between capital city and regional consumption (Figure 46). Capital city cocaine consumption consistently exceeds regional consumption by some margin in Australia. The pattern for MDA tends to be reversed in favour of regional consumption, although this observation has been less evident since late 2020. In general, trends in MDA use have been declining since 2016, with the lowest MDA excretion levels in both capital city and regional areas recorded by the Program in August 2021.

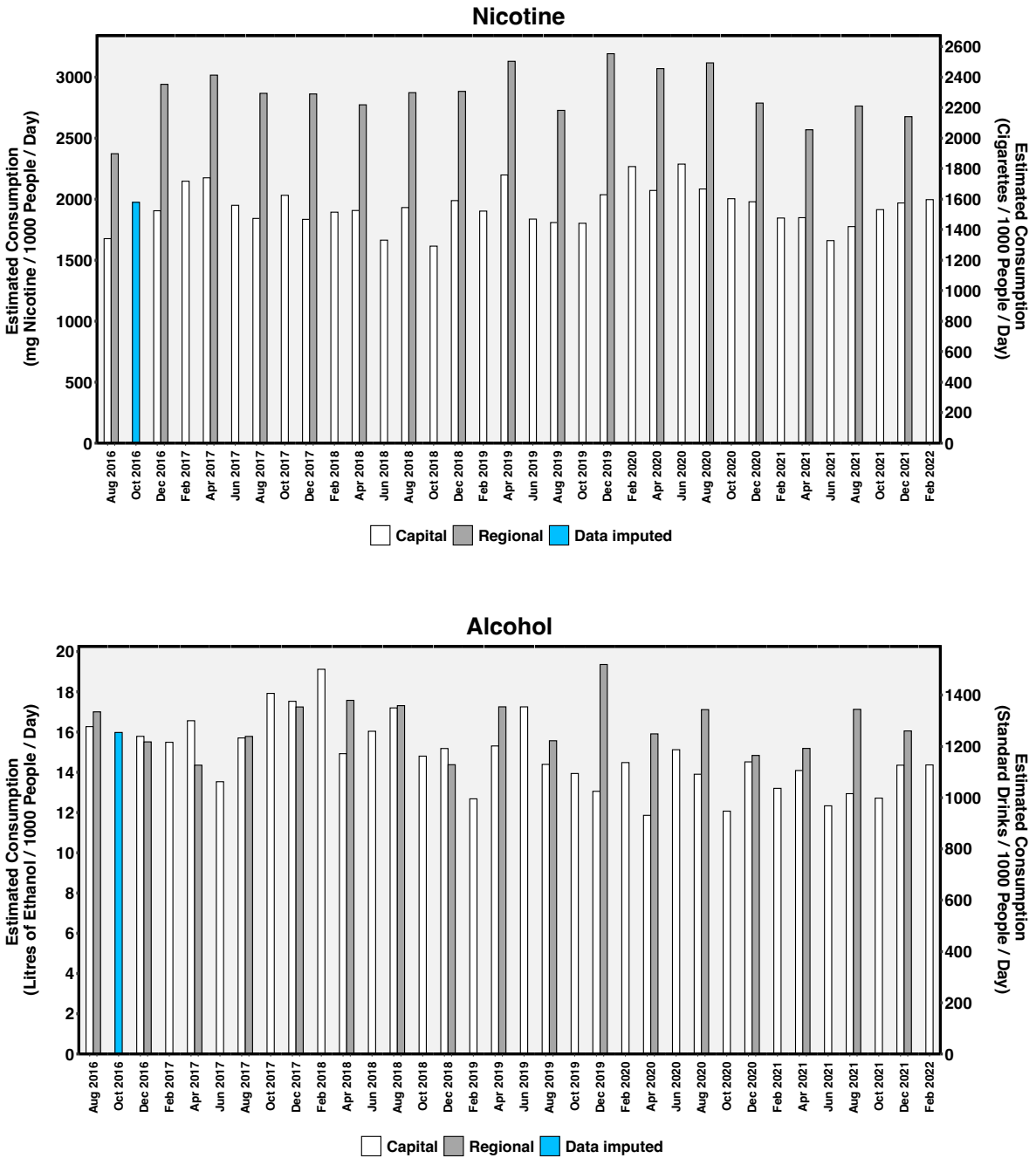
Very large differences between capital city and regional consumption have been evident for the 2 pharmaceutical opioids, fentanyl and oxycodone, for almost all sampling periods (Figure 47). For the most part. capital city populations have consumed both drugs at substantially lower levels compared to regional areas, although the gap in fentanyl consumption closed over the course of 2020 and 2021. Oxycodone consumption increased steadily after early 2017 to a peak in December 2018 and has since decreased. The decrease in regional consumption was more apparent than capital city consumption. Fentanyl consumption has followed a similar trend, with consumption of both substances decreasing over the life of the Program.

The remaining substances, heroin, ketamine and cannabis had mixed patterns in the national context (Figure 48 and Figure 49, respectively). Heroin trends have been quite variable, partly attributable to relatively low consumption. Since April 2020, regional heroin consumption has declined, while capital city consumption has fluctuated.

Capital city ketamine excretion is higher than regional excretion, with ketamine consumption fluctuating since it was introduced to the Program in December 2020.

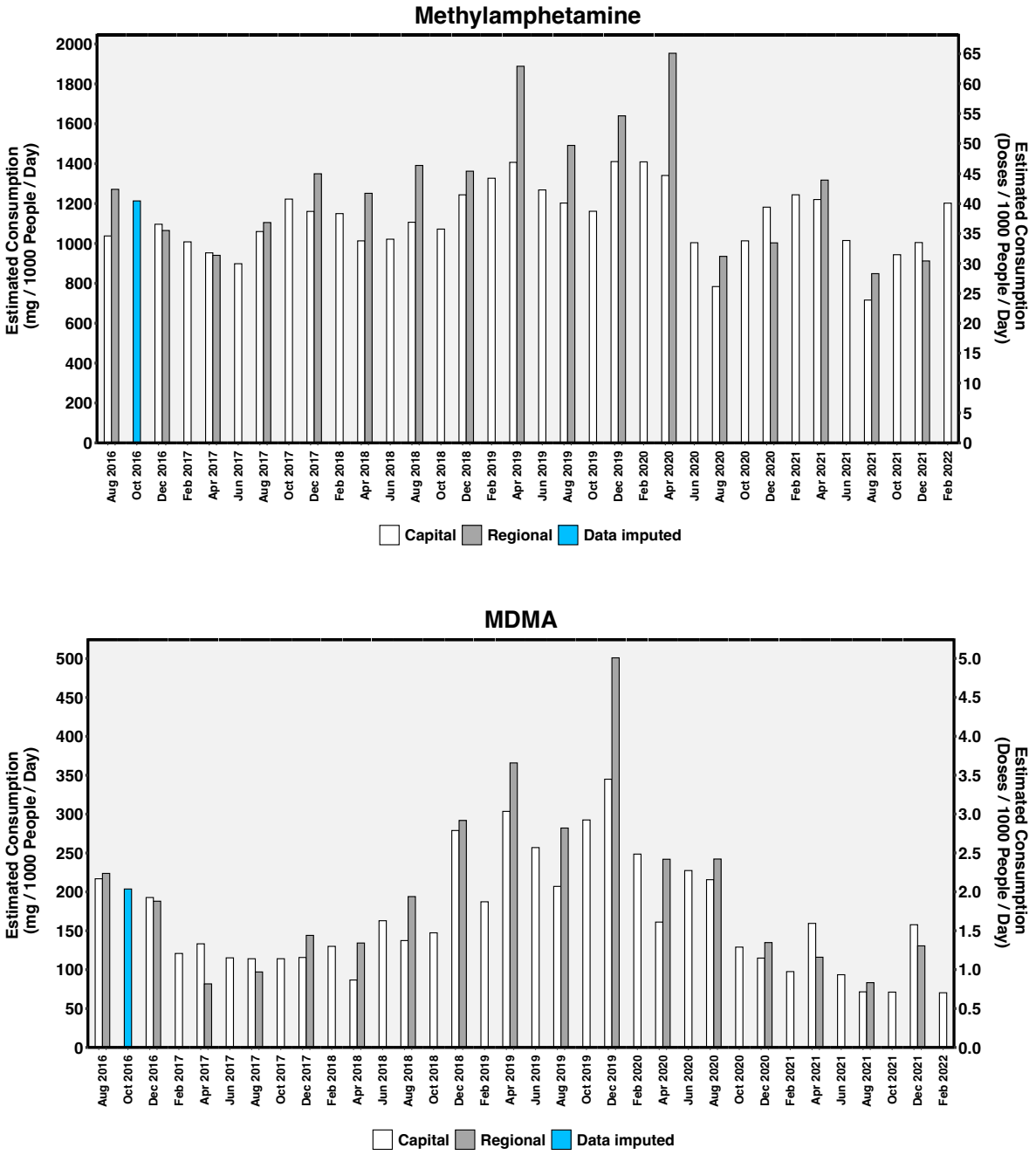
Capital city cannabis consumption was relatively steady over the first year, after which time consumption fluctuated (Figure 49). In August 2021, capital city and regional cannabis consumption reached record high levels, but has since declined.

Figure 44: The population-weighted average of all sites for nicotine and alcohol.



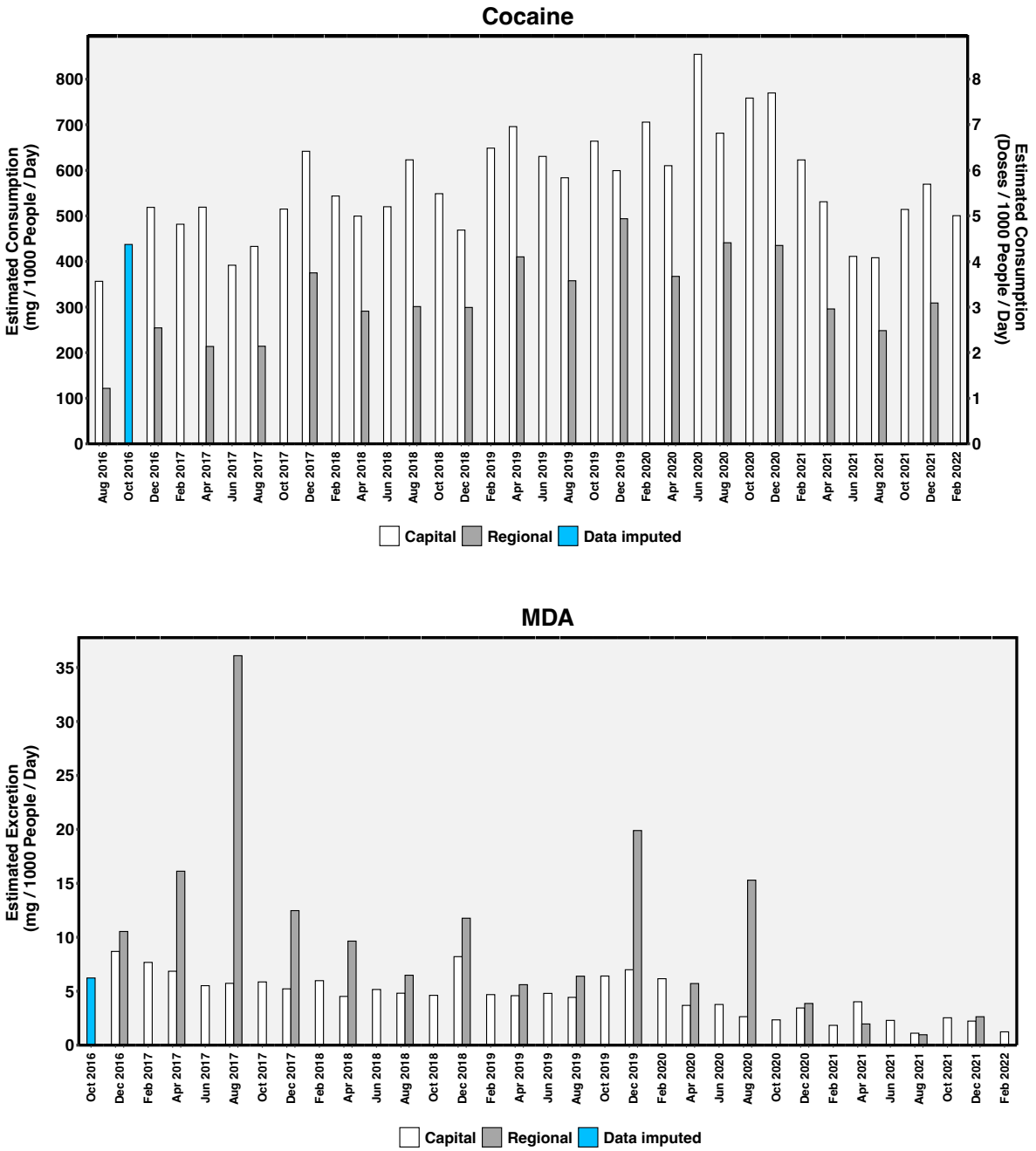
Regional areas are only sampled every second collection period. As Queensland and New South Wales capital city sites were not sampled in October 2016, their average consumption in August and December 2016 was used to provide the overall October estimate.

Figure 45: The population-weighted average of all sites for methylamphetamine and MDMA.



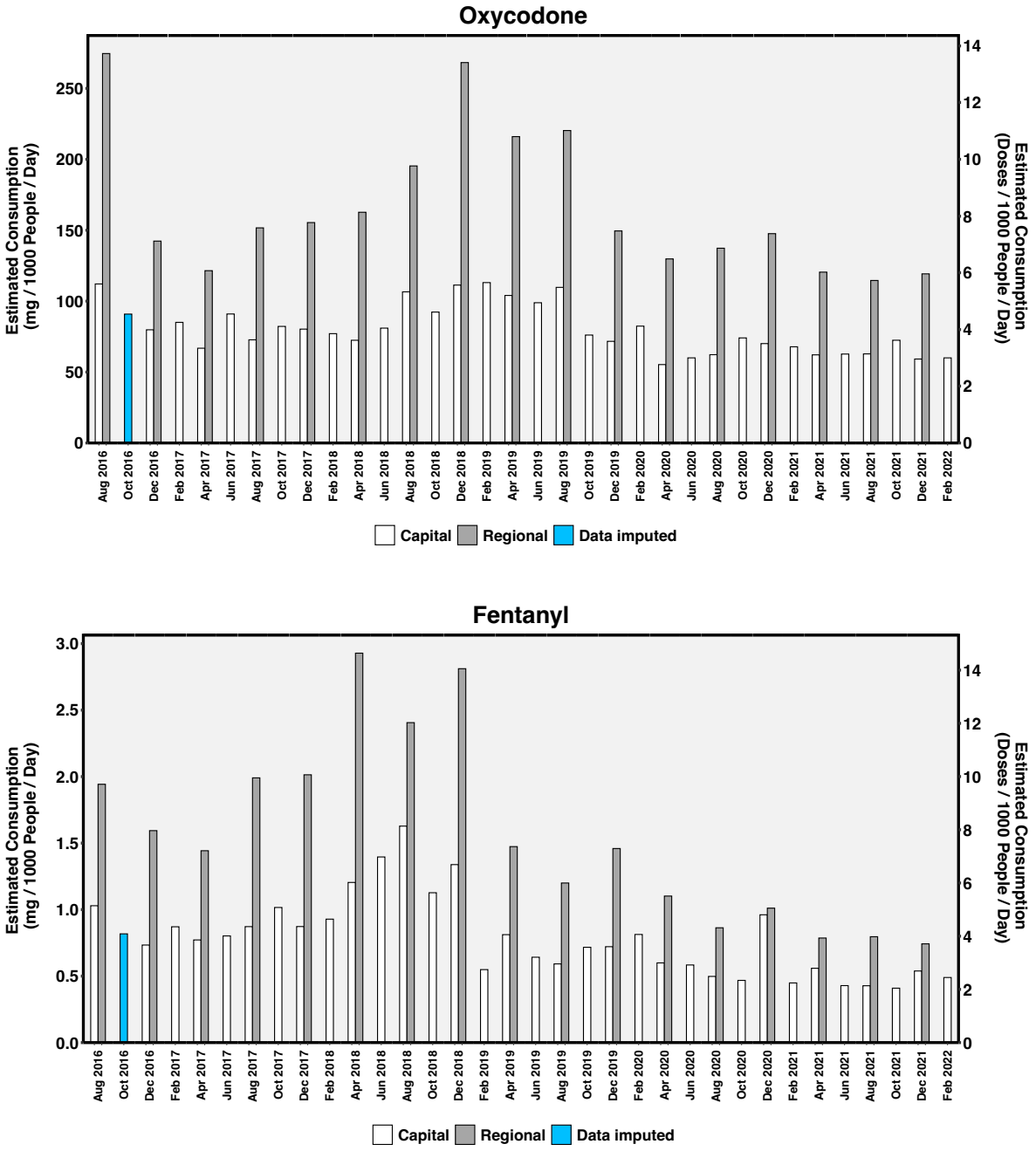
Regional areas are only sampled every second collection period. As Queensland and New South Wales capital city sites were not sampled in October 2016, their average consumption in August and December 2016 was used to provide the overall October estimate.

Figure 46: The population-weighted average of all sites for cocaine and MDA.



Regional areas are only sampled every second collection period. As Queensland and New South Wales capital city sites were not sampled in October 2016, their average consumption in August and December 2016 was used to provide the overall October estimate.

Figure 47: The population-weighted average of all sites for oxycodone and fentanyl.



Regional areas are only sampled every second collection period. As Queensland and New South Wales capital city sites were not sampled in October 2016, their average consumption in August and December 2016 was used to provide the overall October estimate.

Figure 48: The population-weighted average of all sites for heroin and ketamine.

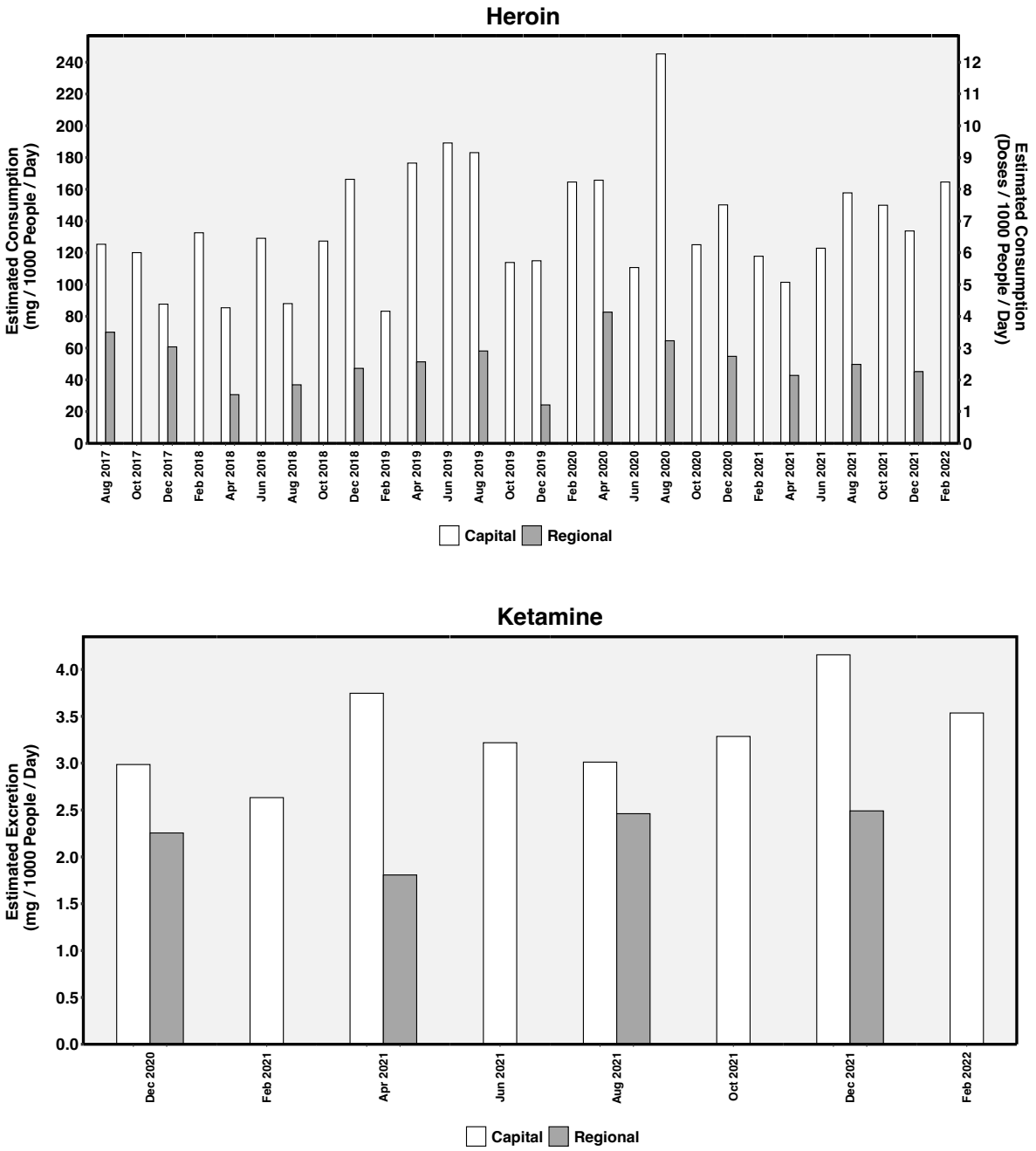
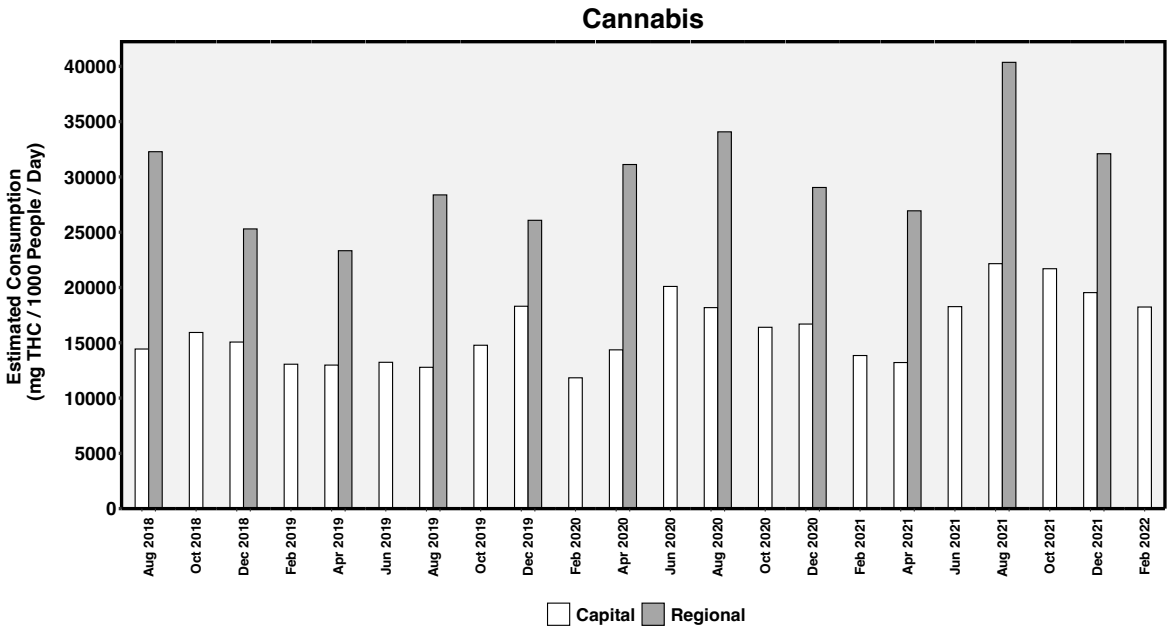


Figure 49: The population-weighted average of all sites for cannabis.



4.4 DRUG PROFILE FOR EACH STATE AND TERRITORY

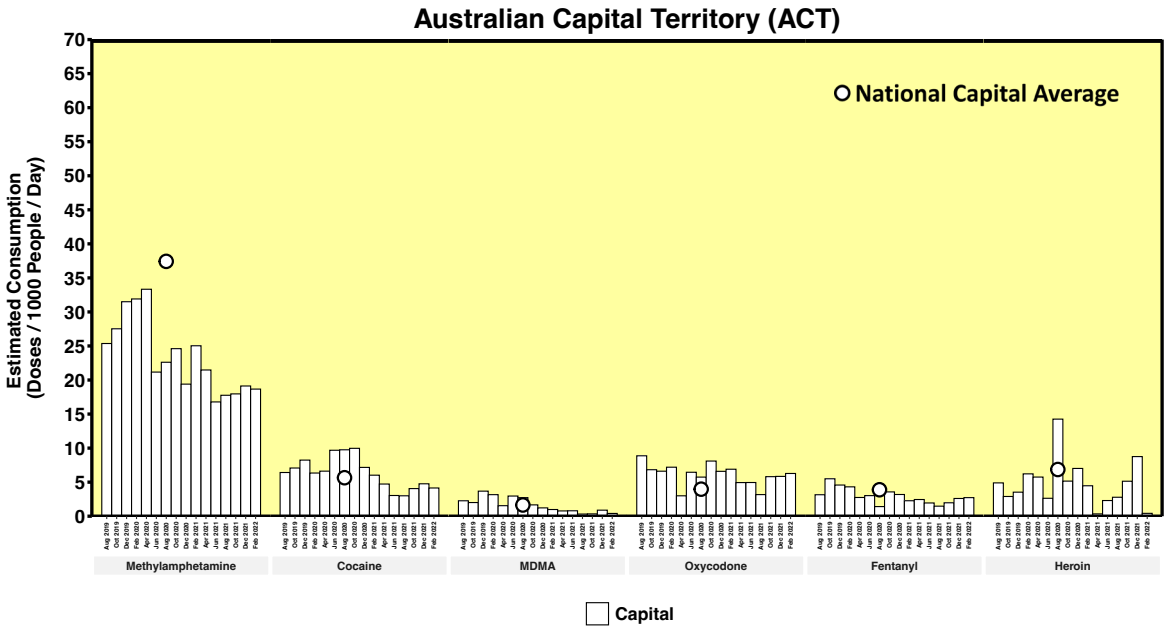
To compare the scale of use of different types of drugs within the same region (for example, within a state or territory), drug consumption was reported as the number of doses consumed and plotted on the same figure. Cannabis has been omitted from this section in this and previous reports since the definition of a typical dose of cannabis is not well defined. This will be included in comparisons when an appropriate dose for cannabis becomes available. In the absence of clear pharmacokinetic excretion data for MDA and ketamine, these compounds were also excluded.

When the amount of drug measured in wastewater was normalised for population size and average dose consumed (excretion factors listed in Appendix 1), alcohol and nicotine remained consistently the highest consumed drugs in all states and territories. For example, in December 2021 the national average consumption of nicotine and alcohol per 1,000 people, per day, was approximately 1,700 cigarettes (Figure 5) and 1,200 standard drinks (Figure 6), whereas for methylamphetamine the national average consumption was approximately 33 doses per 1,000 people per day (Figure 9).

Aside from nicotine and alcohol, of the illicit stimulants with available dose information, methylamphetamine remained the most consumed (Figure 50 to Figure 53). This was the case across all regions of Australia, with the scale of methylamphetamine consumption consistently high for both capital cities and regional areas. There have however been some changes in methylamphetamine consumption, as illustrated in the case of New South Wales, where early in the Program regional consumption far exceeded capital city use (Figure 50). More recently, the relative scales of use have converged. In February 2022, capital city consumption exceeded regional consumption in New South Wales, with capital city consumption increasing to the highest level reported in New South Wales over the life of the Program.

In terms of the profiles of other drugs monitored by the NWDMP (cocaine, MDMA, oxycodone and fentanyl), national patterns were less consistent. The proportional increase in cocaine consumption in most jurisdictions up to the latter part of 2020 was evident, but levels have declined for the most part since then. In most states, a decline in and stabilisation of pharmaceutical opioid consumption is apparent.

Figure 50: Profile of average drug consumption by state or territory, August 2019 to February 2022 for capital city sites and to December 2021 for regional sites. Consumption is shown as the number of doses, per 1,000 people, per day to allow comparison of drugs of different types within the same region (state or territory). The circles represent the cumulative national average of all time points for respective drugs.



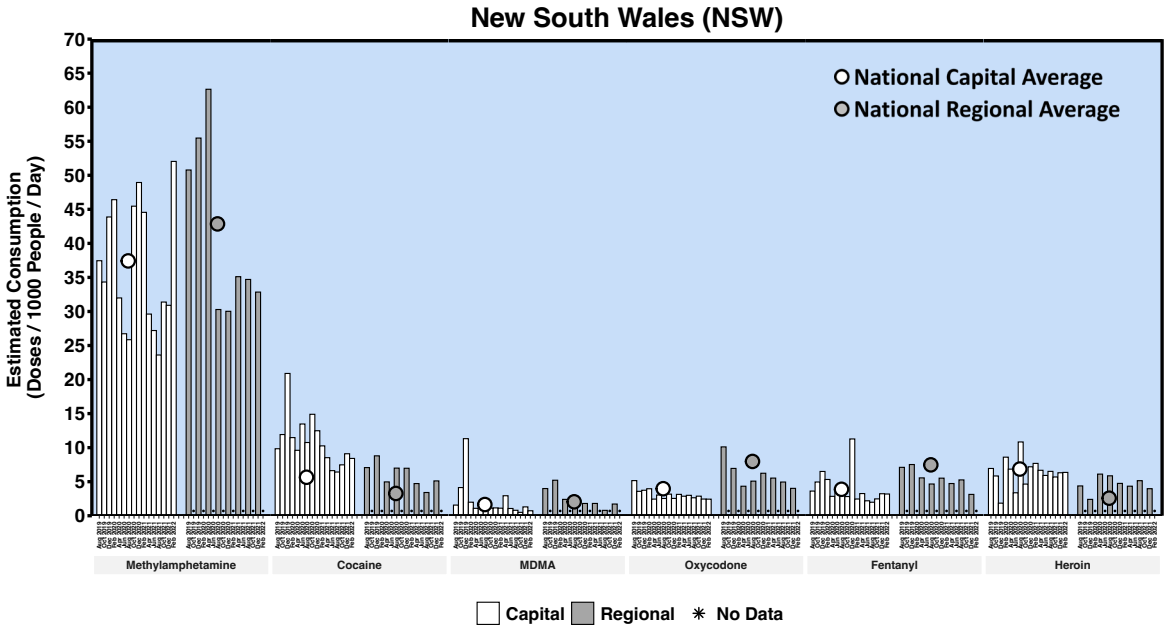


Figure 51: Profile of average drug consumption by state or territory, August 2019 to February 2022 for capital city sites and to December 2021 for regional sites.

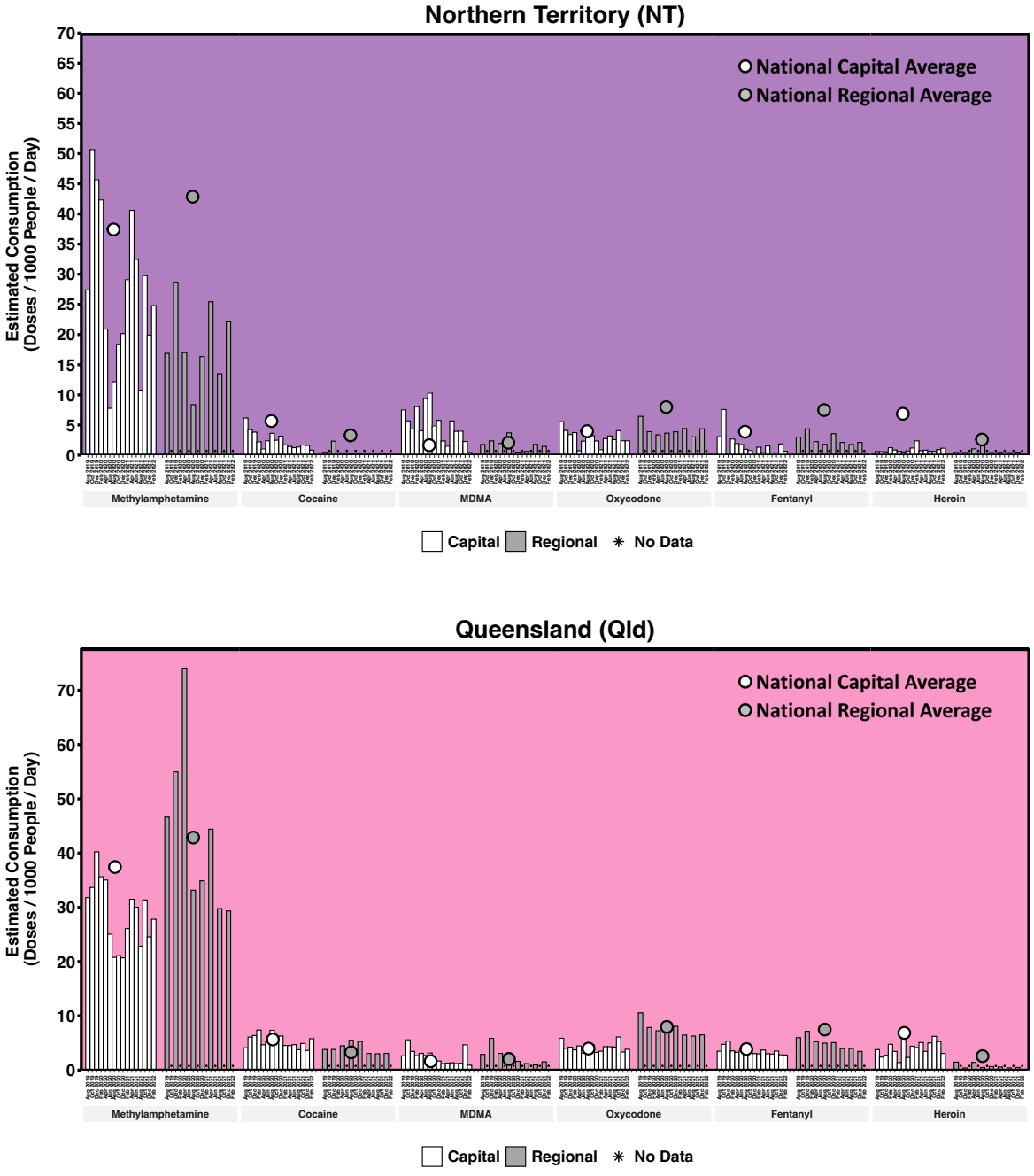
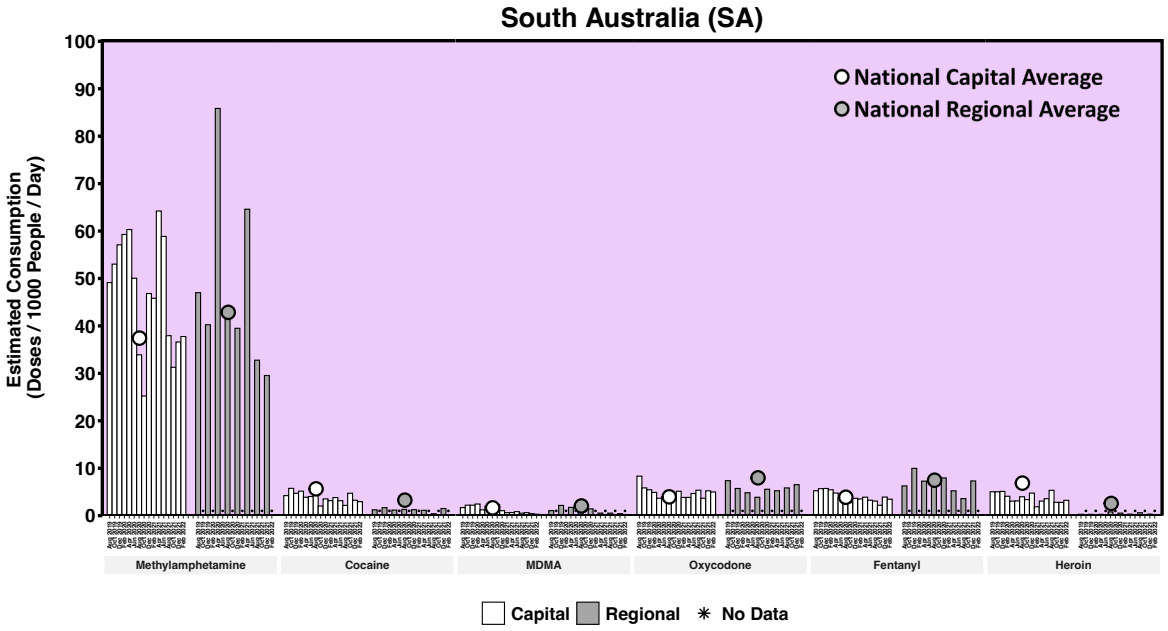


Figure 52: Profile of average drug consumption by state or territory, August 2019 to February 2022 for capital city sites and to December 2021 for regional sites. Note: the y axis for South Australia is higher than the other jurisdictions.



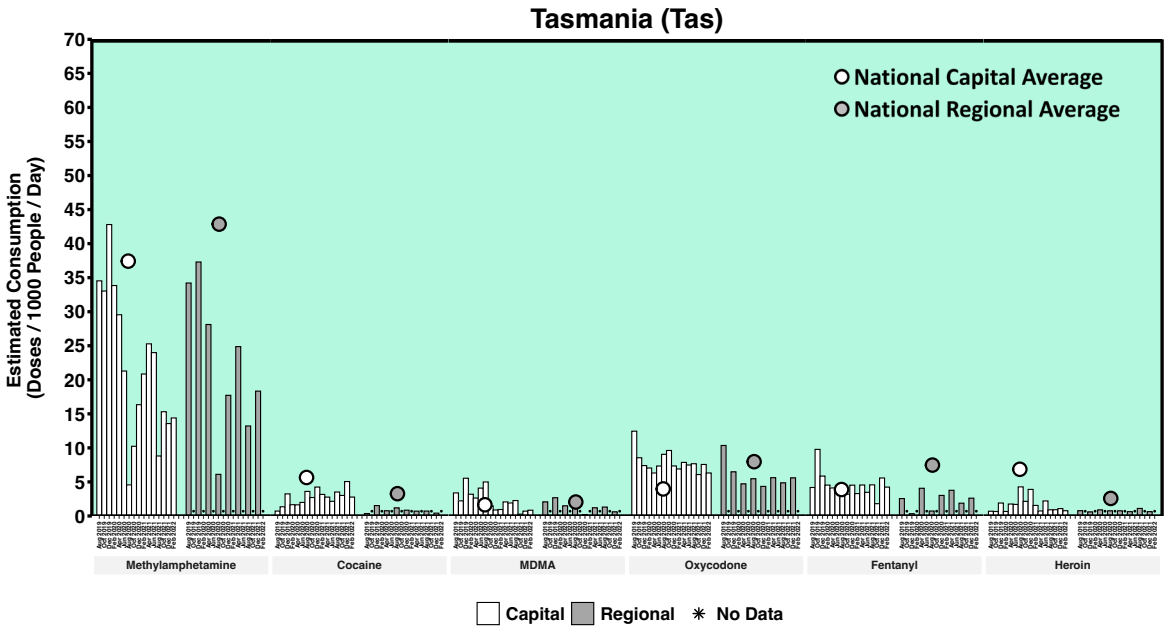
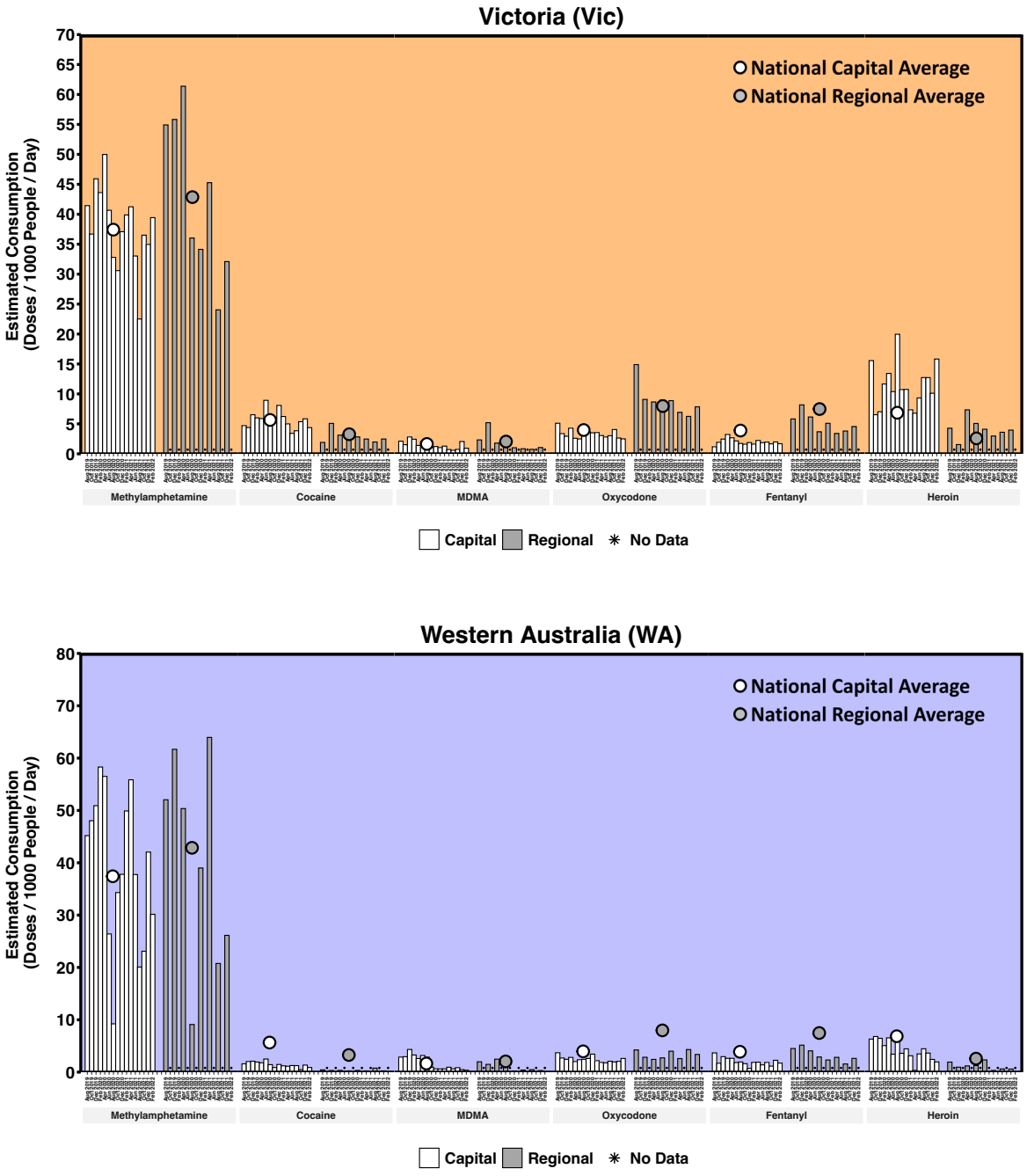


Figure 53: Profile of average drug consumption by state or territory, August 2019 to February 2022 for capital city sites and to December 2021 for regional sites. Note: the y axis for Western Australia is higher than the other jurisdictions.



5: COMPARISONS WITH INTERNATIONAL DATA

5.1: BACKGROUND

Wastewater-based epidemiology has been standardised by a European network of laboratories focussed on quality sampling and analysis called the Sewage Core Group Europe (SCORE). The SCORE network facilitates an annual inter-laboratory testing program among laboratories that research and measure illicit drugs in wastewater across the globe. SCORE is partially funded by the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA). As part of this routine laboratory benchmarking, participating laboratories which pass analytical criteria are invited to submit 7 days of analysed wastewater data, thus ensuring the quality of the analysis for reported data. The research teams at The University of Queensland and University of South Australia have participated in and passed this testing regime for more than 5 years. As the methods are standardised and tested internationally, this allows for the comparison of data between countries.

European data from this inter-laboratory testing regime were obtained from the SCORE network, as reported on the EMCDDA website and estimated from the SCORE results for non-European sites. The most recent available data were from March and April 2021 from participating laboratories, specifically from Australia (43 cities), and 81 cities in 25 countries across Europe, 4 cities in New Zealand and one city in South Korea. Cities in the United States of America and South Africa were not represented in the 2021 collection. SCORE reports results for the participating cities and countries as the amount of drug excreted in mg per day per 1,000 people, whereas the NWDMP converts these measures to consumption (either as mg consumed/day/1,000 people or doses consumed/day/1,000 people). To compare the same units, the SCORE data were converted to the NWDMP consumption estimates by applying the same excretion factors and doses used in the NWDMP. The data for each site was aggregated by population-weighting each site to formulate the country average, using the same methodology as the NWDMP.

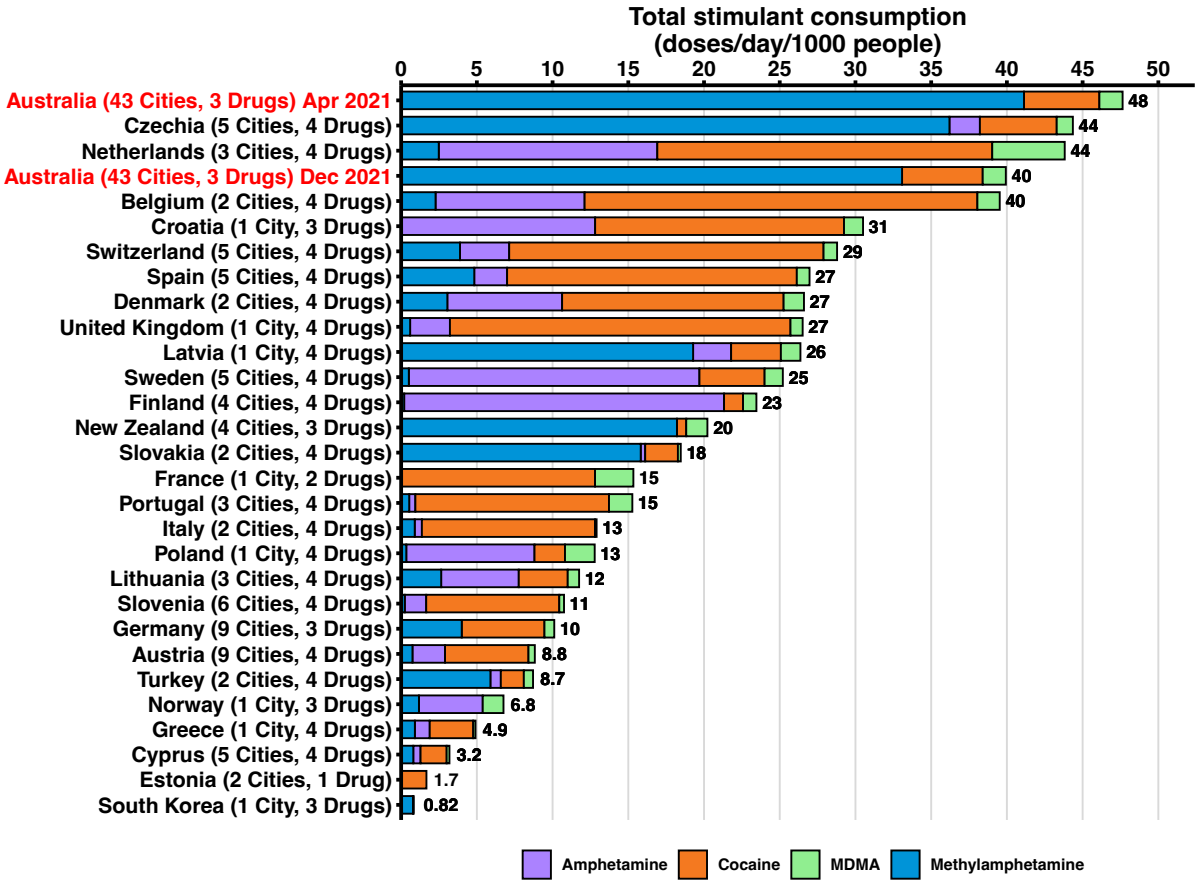
A comparison between the per capita consumption of stimulants was made between data from Australia (from the NWDMP) to data from the SCORE study. These comparisons may help to evaluate the relative scale of use across several countries. However, it should be noted that such comparisons need to be understood in the context of preferences and availability of drugs which may be very different between countries. For example, throughout many parts of Europe, amphetamine is more commonly consumed than methylamphetamine, which is the opposite to Australia. In Australia, the amphetamine detected in wastewater is almost wholly accounted for by the metabolism of methylamphetamine to amphetamine. It may also be the case that the availability, price, trafficking networks or drug preferences may be different between Australia and elsewhere, which may drive differences observed in the ratio of cocaine, amphetamine, MDMA and methylamphetamine consumption. Additionally, the latest SCORE data may only relate to only a single site or city per country and may not be representative of drug use across the entire country.

5.2: RESULTS

Due to the large difference in preference and availability between the popular stimulant drugs mentioned above, total stimulant use was combined and compared between locations. In Figure 54, cocaine, MDMA, methylamphetamine and amphetamine consumption was expressed as the number of doses/day/1,000 people and summed to evaluate the total use of these 4 common stimulants. In the case of amphetamine, all data were adjusted for the expected percentage of the drug which is derived from methylamphetamine metabolism. For the Australian data, amphetamine was not included as generally the majority of amphetamine in wastewater is expected to be due to methylamphetamine metabolism. In some countries, including Australia, amphetamine (in the form of dextroamphetamine or dexamfetamine) can also be prescribed for the treatment of ADHD, which cannot be separated using the methodology which has been used to acquire these drug concentrations. It should also be noted that not all sites measured or detected all drugs, which may also limit the comparisons between some locations. Two Australian datasets were used. The April 2021 data was included as it represented roughly the same sampling period as the other participating countries and will be used to inform comparisons with other countries. The December 2021 dataset was also included to provide a current perspective.

Australia ranked highest in terms of combined stimulant use when the April 2021 dataset (48 doses/day/1,000) was compared to the SCORE dataset (Figure 54). It is apparent that the Australian and Czechia rankings are a consequence of a high proportion of methylamphetamine use, whereas the Netherlands and Belgium were proportionally higher in cocaine and/or amphetamine use. For the Australian data, total stimulant use was higher in April 2021 than in December 2021, but the proportion of each stimulant was similar.

Figure 54: The total amount of stimulants consumed (as the population-weighted average doses, per 1,000 people, per day) for each country in the SCORE dataset. Note the data labels are rounded to 2 significant figures.

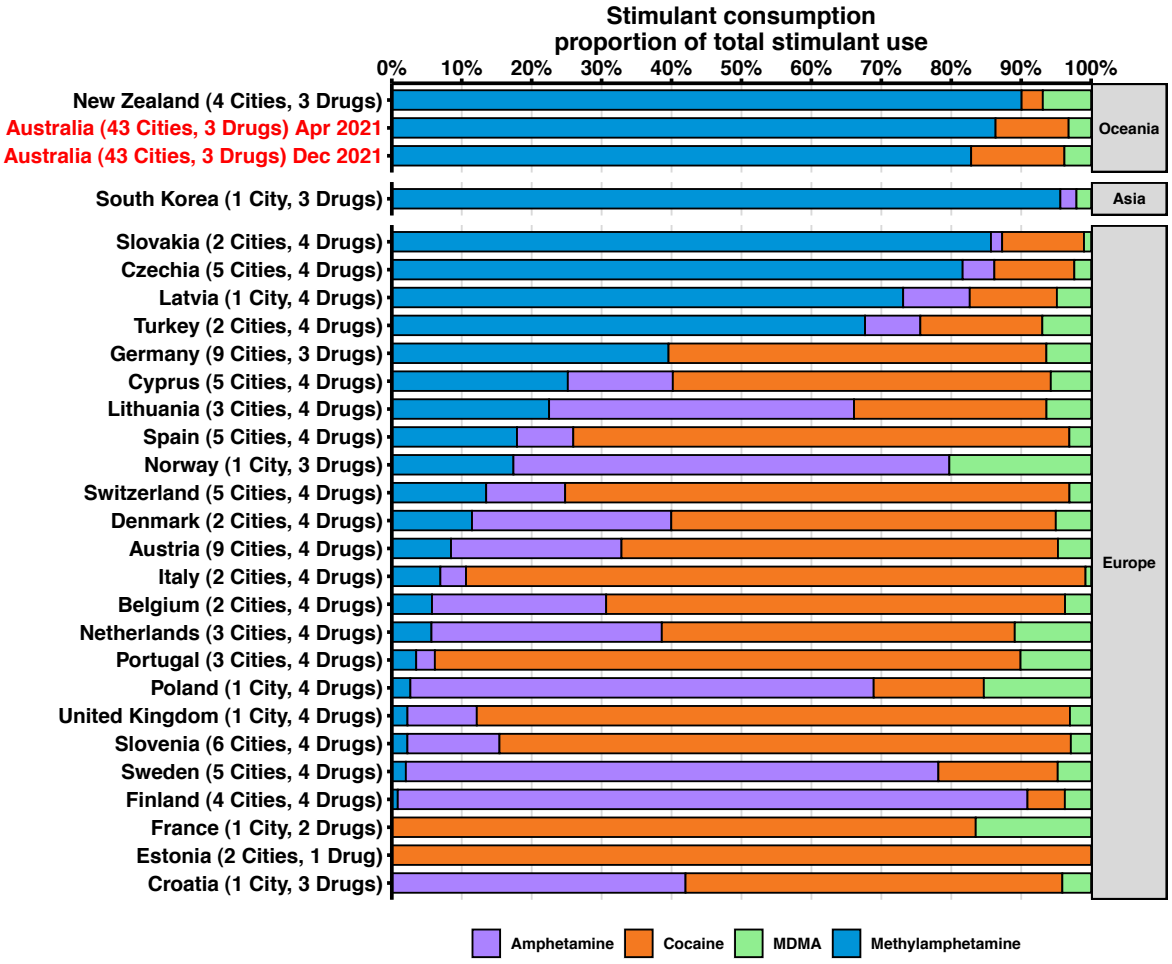


Note: the international estimates are based on data of a few sites per country only and therefore may not represent the national per capita consumption for a given drug in a given country. All SCORE European data were from March 2021. Australian data is from April and December 2021.

The contribution of each of the 4 stimulants to the total number of doses can be visualised a different way to reveal the proportion of each of the stimulant use within each country. Figure 55 shows the same data as Figure 54, but with each drug scaled as a percentage of the total consumed within each country. This representation of the data (scaled to the same value of 100 per cent) reveals the contribution of each drug to the total use, or drug profile, which can be compared between locations.

The profile of stimulant use in Australia is heavily influenced by methylamphetamine consumption, which accounts for more than 80 per cent of total illicit stimulants consumed. This is similar in some Western European countries like Slovakia and Czechia at around 80 per cent, New Zealand (>80 per cent) and South Korea (>95 per cent). Of the European sites, those in Lithuania, Norway, Poland, Sweden and Finland were amphetamine dominant, while Slovakia, Czechia, Latvia and Turkey were methylamphetamine dominant. Cocaine tended to be dominant elsewhere (e.g. Estonia, France, the United Kingdom (UK) and Portugal).

Figure 55: National population weighted average consumption for cities reported in the SCORE dataset for methylamphetamine, MDMA, cocaine and amphetamine, represented as the proportion of the total stimulant consumption in each country. Note that some countries did not analyse for or detect some substances.



The high methylamphetamine consumption estimates in Australia were evident when comparing the drug individually with sites in the SCORE study (Figure 56). Methylamphetamine levels in Australia in April 2021 were the highest compared to all other countries participating in the study. It is important to note that some countries with reasonably high methylamphetamine use according to police actions or research papers, such as in Asia and parts of the Americas, are not represented here. Amphetamine data is shown for the other countries in Figure 57.

Figure 56: National population weighted average consumption of methylamphetamine in the SCORE dataset.

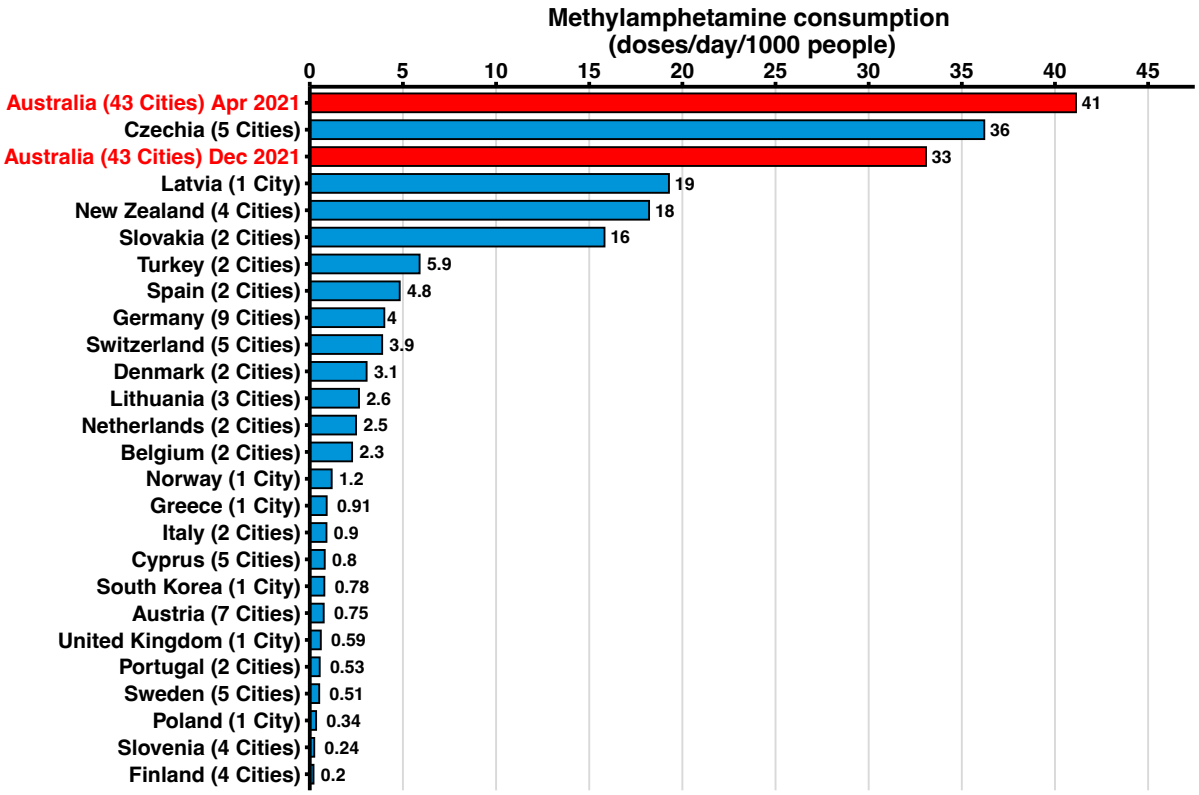
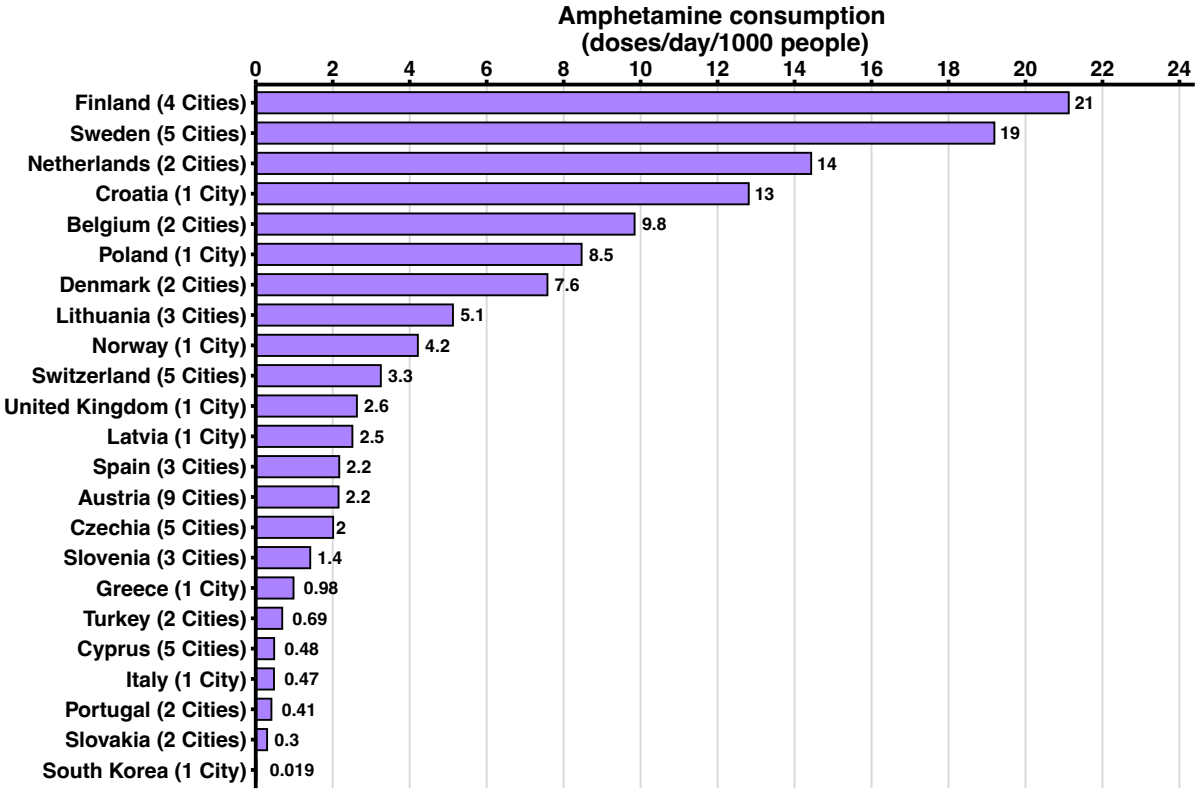


Figure 57: National population weighted average consumption of amphetamine in the SCORE dataset.



Note: the international estimates are based on data of a few sites per country only and therefore may not represent the national per capita consumption for a given drug in a given country. All SCORE data were from March 2021. Australian data is from April and December 2021.

Compared to drug usage patterns in the SCORE dataset, Australian cocaine consumption was towards the lower end (5-5.3 doses/day/1,000 people; Figure 58). The highest consumption was observed in Belgium, the UK and the Netherlands (22-26 doses/day/1,000 people). Australian MDMA consumption ranked towards the higher end of the SCORE sites (1.5 doses/ day/1,000 people; Figure 59), yet was still less than a third of the consumption levels observed in the Netherlands (4.8 doses/day/1,000 people), and similar to consumption levels reported in New Zealand (1.4 doses/day/1,000 people).

Figure 58: National population weighted average consumption of cocaine in the SCORE dataset.

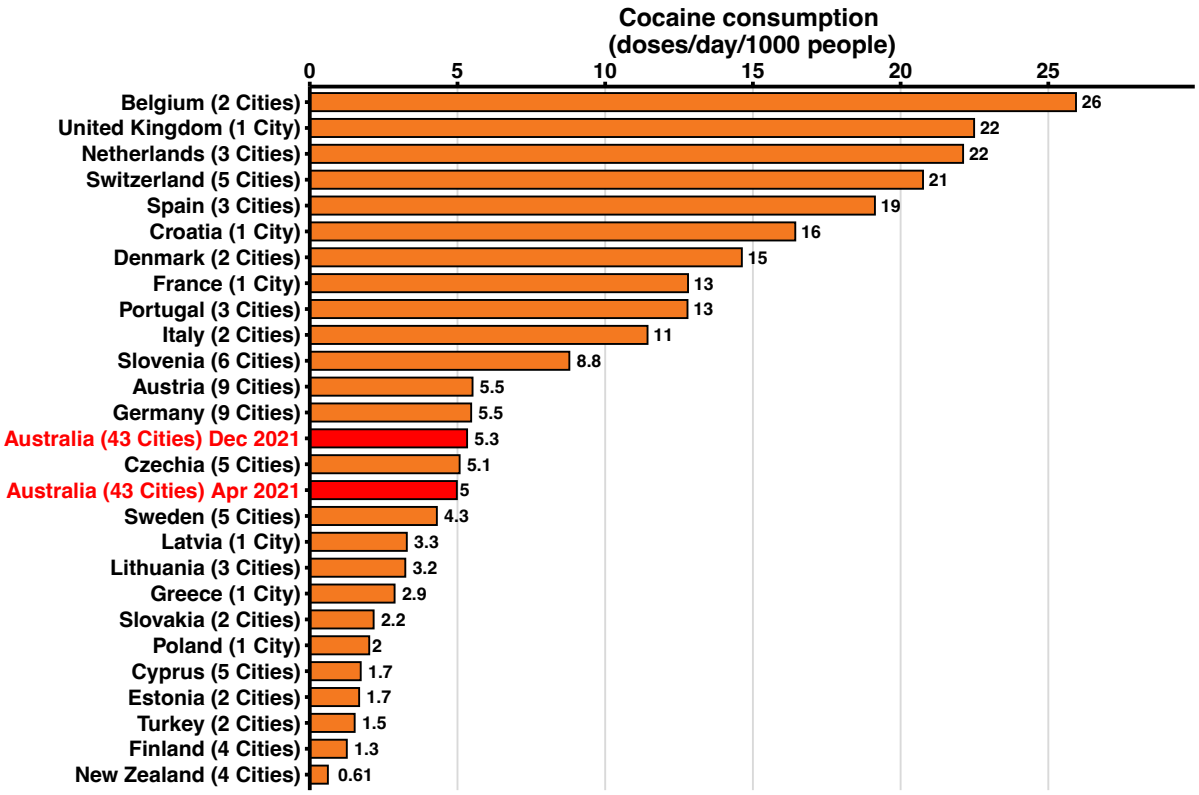
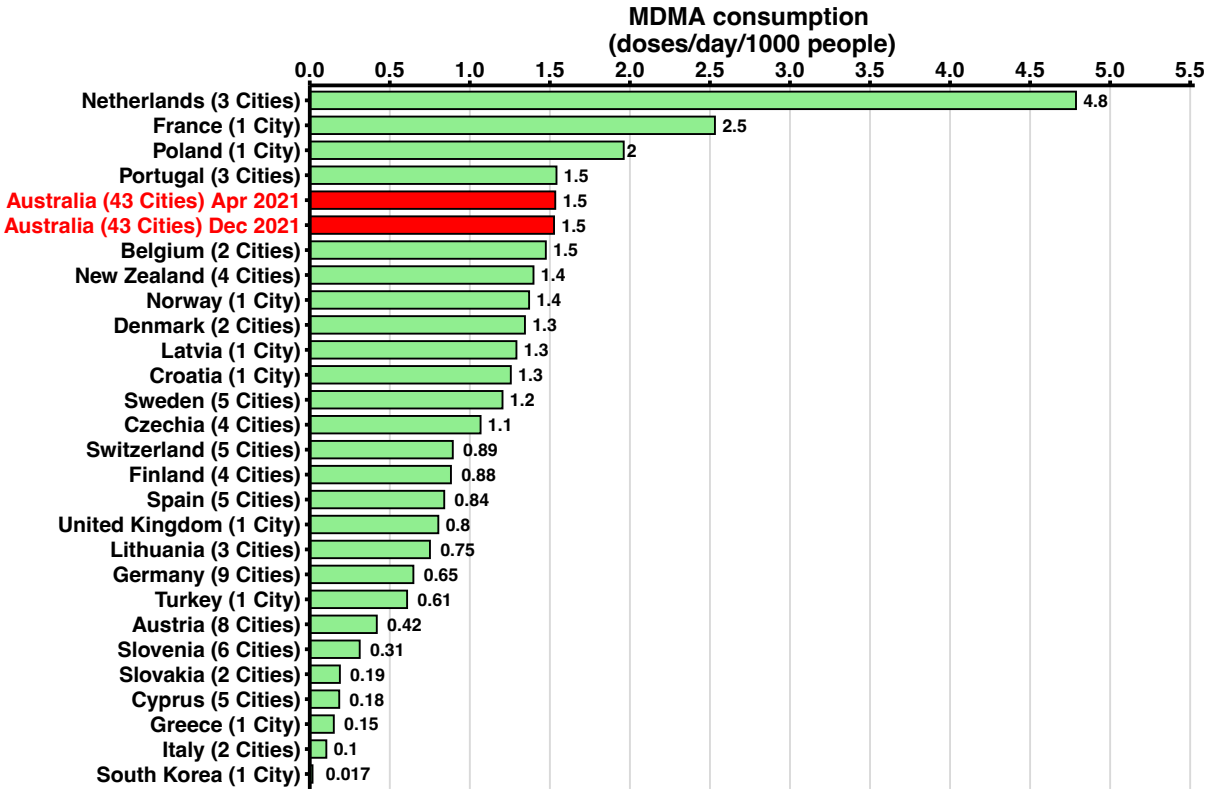


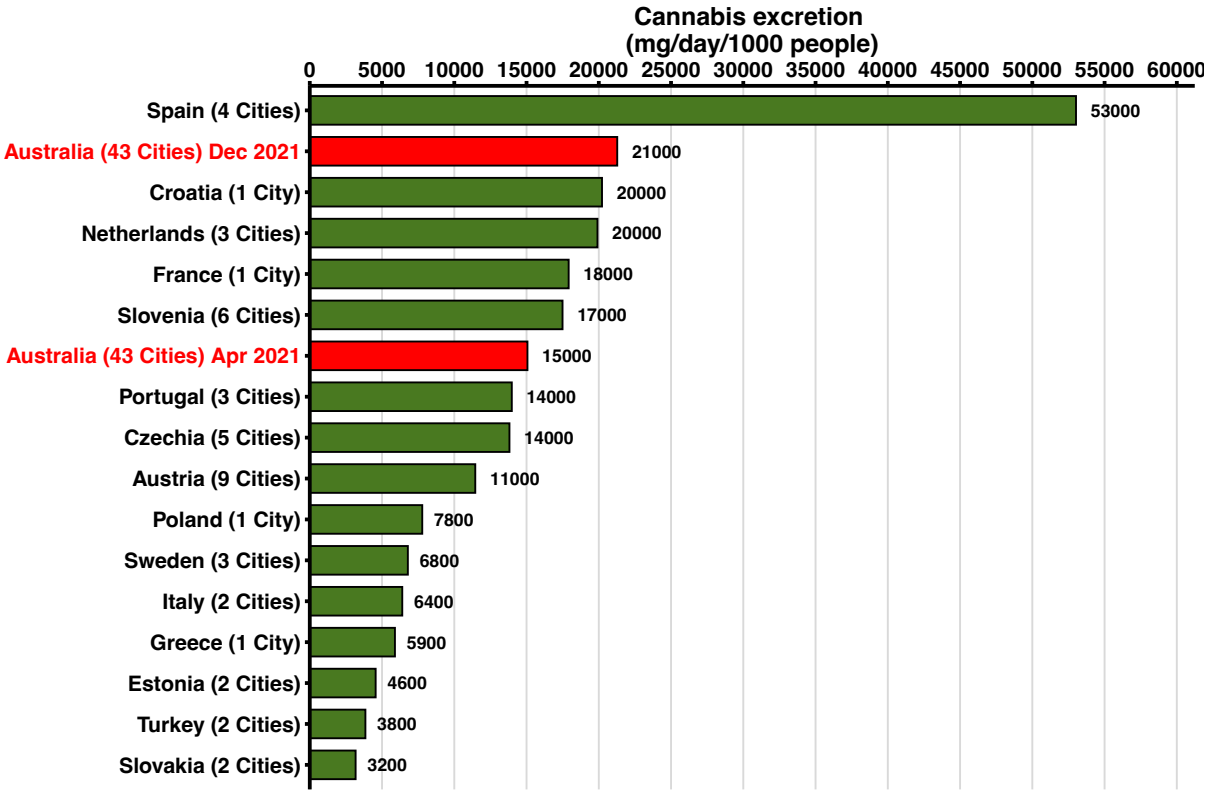
Figure 59: National population weighted average consumption of MDMA in the SCORE dataset.



Note: the international estimates are based on data of a few sites per country only and therefore may not represent the national per capita consumption for a given drug in a given country. All SCORE data were from March 2021. Australian data is from April and December 2021.

Australian data was compared with cannabis excretion assessed in 15 countries across Europe as part of the 2021 SCORE inter-lab sampling campaign (Figure 60). Spain had the highest consumption (53,000 mg THC excreted/day/1,000 people), followed by Croatia and the Netherlands (both 20,000 mg THC excreted/day/1,000 people). Based on April 2021 data, Australia ranked sixth, excreting 15,000 mg THC /day/1,000 people. Turkey and Slovakia were among the countries reporting the lowest consumption (3,200 and 3,800 mg THC excreted/day/1,000 people).

Figure 60: National population weighted average consumption of cannabis in the SCORE dataset.



Note: the international estimates are based on data of a few sites per country only and therefore may not represent the national per capita consumption for a given drug in a given country. All SCORE data were from March 2021. Australian data is from April and December 2021.

6: ACKNOWLEDGEMENTS

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The symbols/images used in Figure 3 in the report were provided courtesy of the Integration and Application Network, University of Maryland, Center for Environmental Science (ian.umces.edu/symbols/).

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8: APPENDICES

APPENDIX 1: DRUG-SPECIFIC PARAMETERS FOR ANALYTICAL REPORTING AND USAGE CALCULATIONS

Analyte levels of detection, levels of reporting, highest detection, excretion factors and standard doses from the literature.

Analyte/metabolite	Drug	Limit of detection (LOD) [ng/L]	Limit of quantification (LOQ) [ng/L]	Excretion factor	Standard dose pure drug (mg)
Amphetamine	Amphetamine	12	16	0.394[a]	30[b]
Cocaine	Cocaine	17	50	0.075[b]	100[b]
Cotinine	Nicotine	33	100	0.3[c]	1.25[c]
Norfentanyl	Fentanyl	0.1	0.1	0.3[d]	0.2[d]
MDA*	MDA	1	4	n.a.	n.a.[#]
MDMA	MDMA	1.5	2	0.225[b]	100[b]
Mephedrone	Mephedrone	0.4	0.8	n.a.	n.a.
Methylamphetamine	Methylamphetamine	33	100	0.39[g]	30[b]
Methylone	Methylone	0.01	0.1	n.a.	n.a.
Hydroxycotinine	Nicotine	17	50	0.44[c]	1.25[c]
Noroxycodone	Oxycodone	0.1	1	0.22[f]	20[d]
Ethyl Sulphate	Alcohol (ethanol)	167	500	0.00012[e]	10[ge]
Benzoylecgonine	Cocaine	33	100	0.35[g]	100[b]
6-Monoacetylmorphine	Heroin	0.5	1.0	0.013[h]	20[i]
THC-COOH	THC (cannabis)	30	180	0.006[b]	n.a.
Norketamine	Ketamine	1	2	n.a.^	n.a.

n.a. = data not available; a = (Khan and Nicell 2012); b = (Zuccato et al. 2008); c = (Castiglioni et al. 2015); d = (Rossi 2016); e = (Ryu et al. 2016); f = (Lalovic et al. 2006); g = (Lai et al. 2011); h = (Boerner et al. 1975); i = (Sullivan et al. 2006).

*Data is not available in the scientific literature for the proportion of MDA that is eliminated after MDA consumption. However, data is available detailing the proportion of MDA eliminated after MDMA consumption. Therefore, our MDA estimate of mg excreted per day per 1,000 people is the amount of MDA excreted from the population after considering the metabolic fraction excreted from MDMA.

#It is likely that the dose for MDA is similar to that of MDMA, or 100 mg.

^Ketamine is excreted as norketamine and several conjugated metabolites. As the level of conjugation is not well known and conjugated metabolites (e.g., glucuronides) are likely to deconjugate in the sewer, a ketamine excretion rate has not been assigned at this time. Once the impact of in-sewer deconjugation is known, this will be revised.

APPENDIX 2: SAMPLING DETAILS FOR DECEMBER 2021 AND FEBRUARY 2022

Site	Capital or regional	Dec 2021	Feb 2022	Population
ACT: 009	Capital	7	7	> 150,000
NSW: 003	Capital	7	7	> 150,000
NSW: 006	Capital	7	7	> 150,000
NSW: 008	Capital	7	7	> 150,000
NSW: 016	Regional	7	–	30,000 to 150,000
NSW: 025	Regional	7	–	30,000 to 150,000
NSW: 068	Regional	7	–	> 150,000
NSW: 081	Regional	7	–	< 30,000
NSW: 115	Regional	7	–	30,000 to 150,000
NSW: 163	Regional	7	–	< 30,000
NSW: 164	Regional	7	–	< 30,000
NSW: 165	Regional	7	–	< 30,000
NT: 010	Capital	7	7	30,000 to 150,000
NT: 078	Regional	7	–	< 30,000
Qld: 002	Capital	7	–	> 150,000
Qld: 005	Capital	5	7	> 150,000
Qld: 011	Capital	7	7	> 150,000
Qld: 012	Regional	7	–	> 150,000
Qld: 024	Regional	7	–	30,000 to 150,000
Qld: 028	Regional	7	–	30,000 to 150,000
Qld: 029	Regional	7	–	30,000 to 150,000
Qld: 033	Regional	7	–	30,000 to 150,000
Qld: 042	Regional	7	–	30,000 to 150,000
Qld: 053	Regional	7	–	< 30,000
Qld: 077	Regional	7	–	< 30,000
SA: 007	Capital	7	7	> 150,000
SA: 013	Capital	7	7	> 150,000
SA: 027	Capital	7	7	30,000 to 150,000
SA: 059	Capital	7	7	> 150,000
SA: 017	Regional	7	–	< 30,000
SA: 022	Regional	7	–	< 30,000
SA: 063	Regional	7	–	< 30,000
SA: 076	Regional	7	–	< 30,000
SA: 119	Regional	7	–	< 30,000
Tas: 004	Capital	5	7	< 30,000
Tas: 019	Capital	5	5	< 30,000
Tas: 041	Capital	5	7	< 30,000
Tas: 018	Regional	5	–	< 30,000

APPENDIX 2 (CONTINUED)

Site	Capital or regional	Dec 2021	Feb 2022	Population
Tas: 048	Regional	5	–	< 30,000
Vic: 001	Capital	7	7	> 150,000
Vic: 067	Capital	7	7	> 150,000
Vic: 037	Regional	7	–	> 150,000
Vic: 061	Regional	7	–	30,000 to 150,000
Vic: 066	Regional	7	–	30,000 to 150,000
Vic: 121	Regional	7	–	< 30,000
Vic: 122	Regional	7	–	< 30,000
Vic: 125	Regional	7	–	30,000 to 150,000
Vic: 155	Regional	7	–	30,000 to 150,000
Vic: 156	Regional	7	–	< 30,000
WA: 101	Capital	7	7	> 150,000
WA: 103	Capital	7	7	> 150,000
WA: 104	Capital	7	7	> 150,000
WA: 102	Regional	7	–	30,000 to 150,000
WA: 116	Regional	7	–	< 30,000
WA: 120	Regional	7	–	30,000 to 150,000
WA: 129	Regional	7	–	< 30,000
Regional Sites		36	–	
Capital Sites		20	19	
Total Sites		**56**	**19**	
Regional Samples		248	–	
Capital Samples		132	131	
Total Samples		380	131	
Cumulative Samples		**7,883**	**8,014**	

APPENDIX 3: PROPORTION OF SAMPLES ABOVE LOD (%) FOR EACH DRUG AND PERIOD ASSESSED[7]

Drug	Capital or regional	Dec 2021	Feb 2022
Alcohol	Capital	100	100
Alcohol	Regional	100	–
Cannabis	Capital	100	100
Cannabis	Regional	97	–
Cocaine	Capital	99	95
Cocaine	Regional	76	–
Fentanyl	Capital	97	92
Fentanyl	Regional	89	–
Heroin	Capital	77	59
Heroin	Regional	23	–
Ketamine	Capital	98	91
Ketamine	Regional	77	–
MDA	Capital	61	42
MDA	Regional	51	–
MDMA	Capital	100	100
MDMA	Regional	93	–
Methylamphetamine	Capital	100	100
Methylamphetamine	Regional	100	–
Nicotine	Capital	100	100
Nicotine	Regional	100	–
Oxycodone	Capital	100	99
Oxycodone	Regional	100	–

7 Percentage detections for previous collection periods are available in Appendix 4 of Report 6 and Appendix 3 of Reports 7 to 15.

CONCLUSIONS

For the 16th report of the National Wastewater Drug Monitoring Program, wastewater analysis was conducted in December 2021 (capital city and regional sites) and February 2022 (capital city sites only). The Program identified variations in patterns of drug consumption, both over time and within and between jurisdictions. Consistent with previous reports, findings show that of the substances monitored with known doses, nicotine and alcohol are the most consumed drugs in Australia, while methylamphetamine remains the most consumed illicit drug.[8]

METHYLAMPHETAMINE

When comparing data for August and December 2021, the population-weighted average consumption of methylamphetamine increased in both capital city and regional sites. Average capital city methylamphetamine consumption then increased further from December 2021 to February 2022. In December 2021, capital city methylamphetamine consumption exceeded regional consumption for the first time since December 2020. In December 2021, Western Australia had the highest estimated average capital city consumption of methylamphetamine, while New South Wales had the highest average regional consumption.

COCAINE

When comparing data for August and December 2021, the population-weighted average consumption of cocaine increased in both capital city and regional sites. Average capital city cocaine consumption then decreased from December 2021 to February 2022. Average capital city cocaine consumption continued to exceed average regional consumption. In December 2021, New South Wales had the highest estimated average capital city and regional consumption of cocaine.

3,4-METHYLENEDIOXYMETHYLAMPHETAMINE (MDMA)

When comparing data for August and December 2021, the population-weighted average consumption of MDMA increased in both capital city and regional sites. Average capital city MDMA consumption then decreased from December 2021 to February 2022 to the lowest level recorded by the Program. In December 2021, average capital city MDMA consumption exceeded regional consumption. In December 2021, Queensland had the highest estimated average capital city MDMA consumption, while New South Wales had the highest regional consumption.

3,4-METHYLENEDIOXYAMPHETAMINE (MDA)

MDA is a metabolite of MDMA, but also an illicit drug in its own right. When comparing data for August and December 2021, MDA excretion increased in both capital city and regional sites. Average capital city MDA excretion then decreased from December 2021 to February 2022. In December 2021, average regional MDA excretion exceeded average capital city excretion for the first time since December 2020. In December 2021, Victoria had the highest estimated average capital city excretion of MDA, while the Northern Territory[9] had the highest average regional excretion.

8 Throughout this report, unless otherwise stated, all comparisons on the consumption of different drugs are based on doses consumed rather than drug mass.

9 As the Northern Territory only had two participating sites, results may not be representative of the Territory as a whole, however the two sites cover approximately 25 per cent of the population of the Northern Territory.

HEROIN

When comparing data for August and December 2021, the population-weighted average consumption of heroin decreased in both capital city and regional sites. Average capital city heroin consumption then increased from December 2021 to February 2022. Average capital city heroin consumption continued to exceed average regional consumption. In December 2021, Victoria had the highest estimated average capital city consumption of heroin, while New South Wales had the highest average regional consumption.

CANNABIS

When comparing data for August and December 2021, the population-weighted average consumption of cannabis decreased in both capital city and regional sites. Average capital city cannabis consumption then decreased further from December 2021 to February 2022. Average regional cannabis consumption continued to exceed average capital city consumption. In December 2021, Tasmania had the highest estimated average capital city consumption of cannabis, while the Northern Territory[10] had the highest average regional consumption.

KETAMINE

When comparing data for August and December 2021, the population-weighted average excretion of ketamine increased in capital city sites and remained relatively stable in regional sites. Average ketamine excretion then decreased from December 2021 to February 2022. Average capital city ketamine excretion exceeded regional ketamine excretion. In December 2021, Victoria had the highest estimated average capital city and regional ketamine excretion.

OXYCODONE

When comparing data for August and December 2021, the population-weighted average consumption of oxycodone decreased in capital city sites and increased in regional sites. Average capital city oxycodone consumption then increased from December 2021 to February 2022. Average regional oxycodone consumption continued to exceed average capital city consumption. In December 2021, Tasmania had the highest estimated average capital city consumption of oxycodone, while Victoria had the highest average regional consumption.

FENTANYL

When comparing data for August and December 2021, the population-weighted average consumption of fentanyl increased in capital city sites and decreased in regional sites to the lowest level recorded by the Program. Average capital city fentanyl consumption then decreased from December 2021 to February 2022. Average regional fentanyl consumption continued to exceed average capital city consumption. In December 2021, Tasmania had the highest estimated average capital city consumption of fentanyl, while South Australia had the highest average regional consumption.

10 Ibid.

NICOTINE

When comparing data for August and December 2021, the population-weighted average consumption of nicotine increased in capital city sites and decreased in regional sites. Average capital city nicotine consumption further increased from December 2021 to February 2022. Average regional nicotine consumption continued to exceed average capital city consumption. In December 2021, the Northern Territory[11] had the highest estimated average capital city and regional consumption of nicotine.

ALCOHOL

When comparing data for August and December 2021, the population-weighted average consumption of alcohol increased in capital city sites and decreased in regional sites. Average capital city alcohol consumption remained relatively stable from December 2021 to February 2022. Average regional alcohol consumption exceeded average capital city consumption. In December 2021, the Northern Territory[12] had the highest estimated average capital city and regional consumption of alcohol.

NEXT REPORT

The 17th report of the National Wastewater Drug Monitoring Program is scheduled for public release in October 2022.

11 Ibid.
12 Ibid.